The post hatching development of the female genital system in Indigenous Mallard Duck (*Anas platyrhynchos*)

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Summary

The current research aimed at obtaining principal data on the morphological developmental changes that could occur during the post hatching periods in the female genital system of the Indigenous Mallard ducks and to conduct that twenty (immature and mature) ducks were used. Gross findings have revealed that the left ovary in 4 weeks sold ducklings appeared small triangular in shape, located at the dorsal part of coelom in contact caudally with the cranial division of the left kidney and cranially with left lung. In 8 and 12 weeks the left ovary has enlarged showed prominent granular surface. The left oviduct appeared as thin, translucent straighten tube with unapparent regions fixed by a thin doubled folds of oviductal ligament and ureter. In mature and laying ducks, the left ovary was large and irregular in shape, and showed numerous follicles of different developmental stages. The mature and laying left oviduct was fully developed into six well distinguished regions (infundibulum, magnum, isthmus, uterus, junction region and vagina). The present study has concluded that the first twelve weeks of post hatching periods had similar morphological features and showed inert genital organs which were not completely differentiated, while the age of twenty four weeks revealed completely differentiated female genital organs with sexual activity.

Keywords: Anatomy, Histology, Mallard Duck, Female genitilia, Ovary.

Introduction

Ducks are well known for their attractive egg's size and their highest resistance against different avian diseases (1 and 2). Ducks and other species such as geese and swans are members of the aquatic bird family (*Anatidae*) which is classified as one of the three families of the order *Anseriformes* (waterfowl) (3 and 4). In Iraq, the Mesopotamian marshlands are imperative sites of several migratory birds, if they restored, they may become once again a vital strategic stop-over site for millions of water birds migrating between breeding areas in northern Russia and Africa (5). Previously, about 10 sites were recorded in Iraq of proven international importance for ducks and geese. The most famous of these sites are Al Hammar marsh and Al Hweaza marsh which hold up more than 1% of the populations of duck species in a survey conducted in1979 (6).Avian ovary occupies the dorsal part of the mid-region in the coelom, in contact caudally with cranial division of the left kidney and cranially with base of the lung. The ovary showed follicular development in earlier stages of life given the organ granular surface, whereas, in non-breeding mature hen the ovary showed tapioca appearance with the presence of many small follicles (7 and 8).Previously the measurements such as weight, width and length were carried out to the ovary in many avian species, (9) recorded that, in immature bird the ovary was about 1.0-1.5 cm in length, 1cm width and 3-4 mm depth. In immature chicks, the length and width of the ovary was recorded about 3.5-3.7 and 1.5mm, respectively. The ovary before sexual maturity is weighing within the approximate range of 0.3-0.45gm (10). In aquatic domestic fowl the ovary is relatively longer craniocaudally and the weight of ovary in actively laying turkey ranges from 129 to 145g (7). In pigeon, the ovarian weights were 0.0640, 0.0773 and 0.2552g. in ages of 4, 12, 14 weeks, respectively (11). The avian oviduct is long convoluted tube in fully developed matured females and divided into five apparent regions (infundibulum, magnum, isthmus, uterus and vagina) (12). The maturation of oviduct plays an important role in the production of eggs (13).The current research was intended to investigate the development of the female reproductive system in the Mallard duck during post hatching periods with special

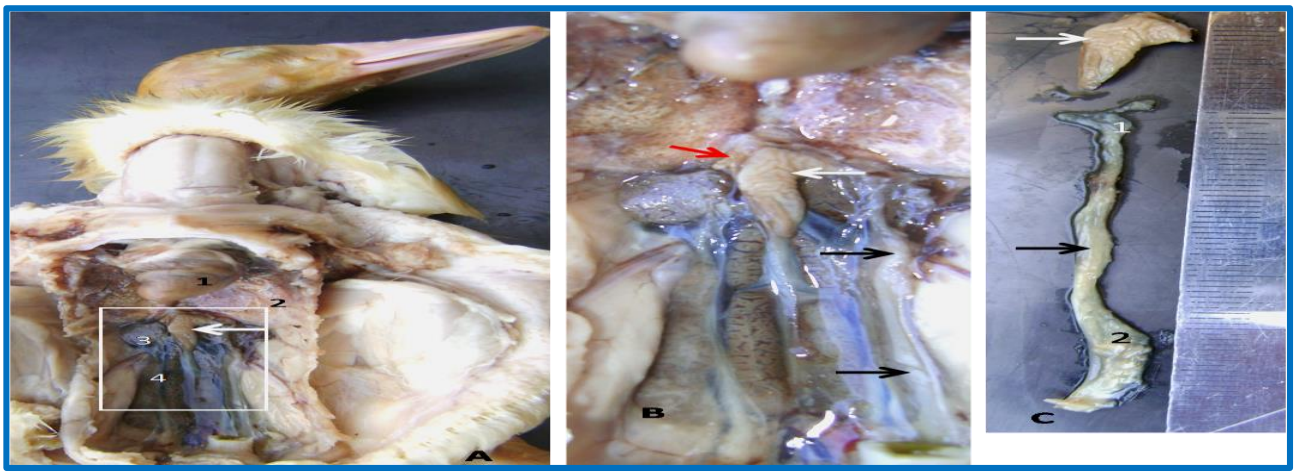
attention to the features that distinguished early and late duck ontogeny.

Materials and Methods

This study included twenty females Mallard ducks which have been obtained by hatching their eggs in the incubator for various periods in order to gain the required post-hatched ducklings, which subsequently were grouped as in the following: Immature ducklings group: It consisted of 15 birds and involved 4, 8 and 12 weeks old, each /5. And Mature ducks group: It consisted of five birds (n=5) of approximately 24 weeks of age. Both immature and mature ducks were killed by cervical dislocation. Eventually, abdominal dissection was conducted to expose the viscera which subsequently was removed to view the reproductive organs. General morphological and morphometric measurements such as weight, length and width as well as topographical relationships of the ovary and the related genital tract were examined grossly, and photographed using digital camera (SONY 14 Megapixels). The data were statistically analyzed by using SPSS (version 16.0). All numerical results have expressed as the mean ± standard error (SE). For comparisons, the statistical significance was assessed by ANOVA. The significance level was set at ($P< 0.05$).

Results and Discussions

Morphological results at 4, 8 and 12 weeks (Immature periods): Ovary at 4 weeks old ducklings, the left ovary was small triangular in shape with caudally pointed apex, yellowish in color with granular surface. It was located at the dorsal part of mid-region in the coelom in contact caudally with cranial division of the left kidney and cranially with caudal end of left lung (Fig. 1).



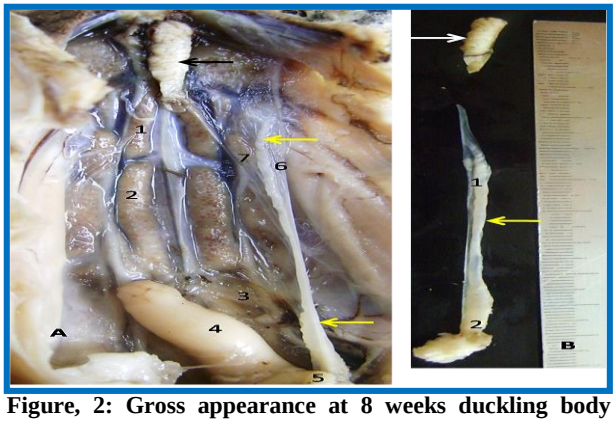
Figure, 1: Gross appearance at 4 weeks duckling body (Mallard duck) shows: A. Heart (1), lung (2), cranial division of right kidney (3), middle division of right kidney (4), ovary (White arrow), B. The magnification of white rectangle area in figure (A) shows left ovary (white arrow), right ovary (red arrow), and oviduct (Black arrow), C. The ovary (White arrow) and the left oviduct (Black arrow) which consisted of cranial end (1), caudal end (2).

At 8 weeks old, the left ovary was enlarged and appeared more elongated with prominent granular surface (Fig. 2). Subsequently, the left ovary of the 12 weeks old ducks appeared larger and irregular in shape (Fig. 3). Measurements such as length, width and weight of ovaries have revealed that at 4 weeks was 1.66±0.050 cm in length, 3.4±0.089 mm in width and10.2±0.10 mg in weight, whereas, increased at 8 weeks to 1.94±0.024cm, 3.9±0.05 mm and 14.68 ± 0.195mg, in length, width and weight, respectively. At 12 weeks the mean length, width and weight were 2.22±0.10cm, 6.52±0.19 mm and 27.7±9.96 mg, respectively. Statistical analysis has revealed significant ($P<0.05$) differences between the mean values of ovary length and weight of 4 and 8 weeks, as well as those of 12 weeks old ducks. Whereas, values of the width were insignificant ($P<0.05$) increased. This analysis has given rise to the suggestion that such as increase was due to the effect of growth hormone (GH) on all body organs including gonads and not related to the effect of Gonadotropine hormones (GnH). Current

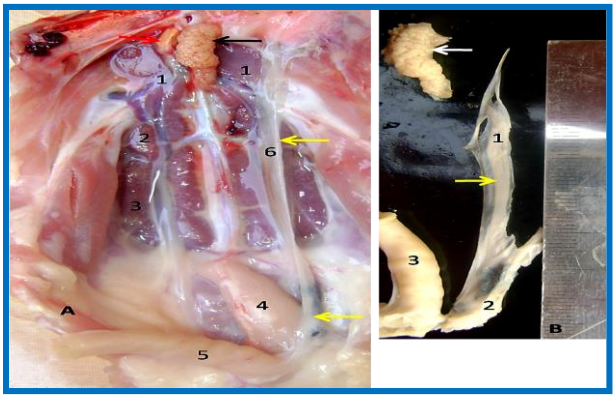
analysis and suggestion were in accordance with previous documentations (14) that the raise in blood circulating concentrations of GH was observed in all species of birds during both late embryonic development and early post hatching development. Other hormones such as thyroid hormone may influence both phases of development (growth and differentiation/maturation) of birds.

In general, thyroid hormones act permissively or indirectly to stimulation growth in birds (15) and its primary direct hormonal stimulation of body growth resulted from circulating growth factors such as insulin like growth factor-1 (IGF-1) which acts primarily under the control of growth hormone. The location and appearance of the ovary at these ages were parallel with those found in young and immature birds (7) and in young hen (8). On the same time the ovarian shape and color of Mallard ovary at this age were well-matched with those found in immature chicken (7). However in Mallard, ovary was more elongated in shape. The present measurements of ovary length and width were comparable to those estimated in immature birds (9), but the current measurements were exceeded those recorded in immature chicks (10). Measurements of the Mallard ovaries during different post-hatching periods showed gradual elevation in their weights untill the age of sexual maturity, which exceeded those recorded by others. The raise of ovary's weight might be due to the normal effect of growth factors such as growth hormone.

Oviduct: The examination revealed unapparent different regions of the left oviduct. It was located at the left side of the coelom as a thin straight-like tube that extended from left ovary to cloaca. It was fixed in situ by a thin doubled fold of serous membrane. This serous membrane was extended as a single layer from the dorsal body wall into the tube of the oviduct. The first two third of the oviduct was related dorsolaterally to the wall of coelom, whereas the last third was related to the nearby part of the ureter. The oviduct subsequently opened into cloaca (Fig. 2).



Figure, 2: Gross appearance at 8 weeks duckling body (Mallard duck) shows: A. The cranial division of right kidney (1), middle division of right kidney (2), caudal division of left kidney (3), supra cloacal gland (4), cloaca (5), ventral oviductal ligament (6), dorsal oviductal ligament (7) ovary (black arrow) oviduct, (yellow arrow). B. Theovary (White arrow) and the left oviduct (yellow arrow) which consisted of cranial end (1), caudal end (2).



Figure, 3: Gross appearance at 12 weeks duck body shows: A. The cranial divisions of left & right kidneys (1), middle division of right kidney (2), caudal division of right kidney (3), supra cloaca gland (4), rectum (5), ventral oviductal ligament (6), left ovary (Black arrow), right ovary (red arrow) and left oviduct (Yellow arrow). B. The ovary (White arrow) and the left oviduct (yellow arrow) which consisted of cranial end (1), caudal end (2). Rectum (3).

The morphological measurements such as mean of the length, diameter and weight of the oviduct at 4 weeks ducklings were 5.68±0.08 cm, 2.12±0.12 mm and 0.33±0.65g, respectively. At 8 weeks these measurements increased to 7.78±0.08cm, 2.86±0.05mm and 0.39±0.90g in length, diameter and weight, respectively. Whereas at 12 weeks old the means length, diameter and weight were changed 8.12±0.05cm, 3.72±0.05mm and 0.44±0.50g, respectively. Statistically, the immature ages has revealed that, the values of means length, diameter and weight were not different among immature ages. This indicated at that age the oviduct was inert organ and ceased their development and growth, thus had

showed no morphological changes. This attitude suggested that the oviduct at these periods was out of hormonal effect. The current gross assessment revealed that the appearance and location of left oviduct at 4 and 12 weeks Mallard were not different from those observed at one day old ducklings which were also recorded recently by others (2 and 16). In addition to that these findings were almost similar to those observed in 16 weeks old immature geese (17). The current findings were comparable to those recorded that the oviduct in all birds was attached to the coelom by a thin double fold of dorsal and ventral oviductal ligaments (17- 20), whereas, (21) divided the oviductal ligaments in rhea bird into three named ligaments according to the fixed region of the oviduct. The present measurement of the weight of the immature oviduct might indicated that the weight of oviduct increased with advanced ages similar to that recently measured in 16 to 20 weeks old immature geese (17).

Morphological results at 24 weeks (mature periods) *Ovary:* During period of sexual activity (24 weeks) the left ovary was enlarged and showed variable shape. It was structured from numerous follicles of variable sizes giving the shape similar to bunch. The large follicles were suspended and attached to the ovary by their stalks (Fig. 4). The ovary was attached to the dorsal part of coelom, at the mid line of the body by a fold of peritoneum (mesovarium) in adjacent to the cranial division of the left kidney. Dorsally, it was closely adhered to the abdominal aorta and caudal vena cava. The mean length of left ovary was 4.12±0.08 cm, 12.2±0.13mm in diameter and 142.8±1.24g in weight. Statistically the values of these measurements were increased significantly at 24 weeks old in compare to those measured at 4, 8 and 12 weeks ducks. These values were associated with morphological as well as physiological changes on ovary at period of laying under the influences of GnH and follicular stimulating hormone.

The present findings revealed the presence of functional left ovary while in both falconiformes and brown kiwi both ovaries were functional at mature periods (22-24). The location and the relations of left ovary at this age were almost similar to those found in growing hen (8). Also the present findings were well-matched with descriptions of (7) who described the shape of mature left ovary as a bunch of grapes due to the presence of numerous follicles and found that the ovary in aquatic domestic fowl was relatively longer craniocaudally which differed from those present in Mallard duck which displayed the ovary of variable in shaped and size. The current measurements of mature ovary weight were in accordance to those in actively laying turkey and higher to what was recorded in chicks (7 and 17). The present findings indicated that the ovary weight of Mallard ducks was not related to the body weight and size of the birds. In addition to that the ovary weight increased with the advanced of the bird's age which was similar to what recently postulated in the ovary of the pigeons (25).

The present finding showed that the left oviduct was completely developed and occupied the most left side of coelom (Fig. 4). The left oviduct was consisted of six well distinguished regions (infundibulum, magnum, isthmus, uterus, junction region and vagina) (Fig. 4 and 5). The internal mucosal surface of the oviduct showed variable numbers of longitudinally oriented mucosal folds at the neck of infundibulum and persists untill the last part of the vagina (Fig. 5). The mean length of mature, laying oviduct was 47.98±0.3cm, diameter was 20.86±6.6 mm and weight was 52.6±2.5g. Statistically, the mature oviduct length, diameter and weight values were parallel with those recorded in the above in the ovary. The morphological finding of this period (mature mallard duck) revealed the presence of the left oviduct only which disagree with (22 and 23) who referred to presence of both oviduct in falconiformes and in brown kiwi. Previous researches (8, 20, 26 and 27) documented that the oviduct in most of birds constructed of only five different regions, the present finding was not corresponding with those in Muscovy duck (28) who considered the fimbria part as dependent region, but the present research revealed that the left oviduct comprised of six anatomically and functionally different regions.

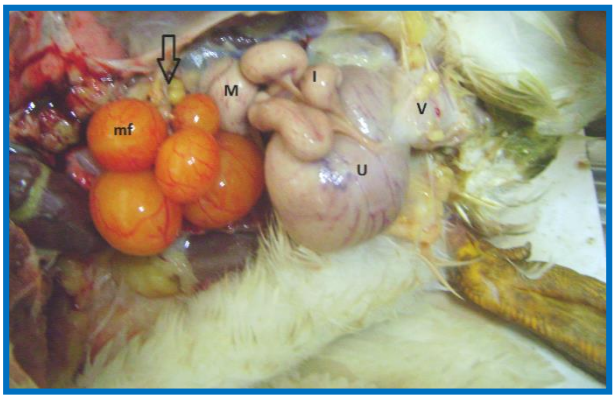
The current findings agreed with what mentioned previously by other investigators (17, 29 and 30) who referred to the direction and longitudinal orientation of the mucosal folds. The folds arrangement evolved their mechanical role in the transportation of egg mass, in addition these folds provided wide surface area in the sake of normal deposition of albumin by magnum and isthmus and egg shell in uterus. The sperms movement up toward the infundibulum requires deep grooved area that is provided between these tall folds, and this attitude is in accordance with (31) who postulated that the caudal part of oviduct (uterus and vagina) possess the longer mucosal folds than the other parts, and probably increase the surface area of ciliated and secretory cells to aid the descending ovum. The mean weight and length of Mallard oviduct were lesser compared to the turkey (18) mature hen (29) and duck (32). While these parameters in Mallard were similar to those of duck (Tsia-ya) and duck (*compbell*) as well as in geese (17, 33 and 34) and this give rise the thought that the variable values of weight and length are due to species variations.

The infundibulum was constructed of two distinguishable parts; the first was cranially wide, thin walled and funnel-shaped "funnel", the second was the caudal narrow tubular part could be named "neck" of the infundibulum (Fig. 5 and 6). The mucosal surface of funnel showed ill-defined low mucosal folds. Whereas, these fold were obviously clear at the neck parts. The mucosal surface of the neck was red-pink with narrow lumen overcrowded by slightly tall mucosal folds which are longitudinally oriented with the long axis of oviduct (Fig. 6). The mean length of funnel part was 1.66±0.06 cm, diameter 2.9±0.052 cm was significantly ($P<0.05$) higher in compare with the neck part which showed 5.38±0.2 cm in length and 0.8±0.31 cm in diameter. The funnel part insure quick engulfment of the yolk by its thin funnel part consequently pick up the yolk from the body cavity and transform it into the next neck part in order for fertilization throughout the released sperms from its epithelial crypts that stored sperm for a time. The two parts observed in the infundibulum of Mallard duck were well recorded in other species (17, 18 and 20). In contrary to the Brown Kiwi bird the funnel was very wide to receive the ovum from both left and right ovary (35). But in the infundibulum of laying hen, three parts are found that are funnel, neck and fimbriae (29). The histological structure of fimbriae in Mallard ducks considered the continuity of the cranial end of the funnel next to the ovary. The length and diameter of the infundibulum during laying period is approximately almost similar to those recorded in others birds such as turkey (18) and duck (34). But the length value was higher than that in duck (*Tsai–ya*) (33) and in mature geese (17), whereas the length value was lesser compared to those in mature hens and immature or mature ostrich (36) and such differences could be due to species variations.

Magnum was the second region of the oviduct which appeared pinkish in color, highly coiled and considered the longest part of the oviduct. It showed slightly thickened wall compare to that of the isthmus and its internal mucosal surface showed thick tall simple mucosal folds which were longitudinally oriented and separated by indentations (Fig. 5 and 6). The mean length of magnum was 18.52±0.18, 1.7±0.054 cm in diameter. The statistical analysis showed that the magnum was the longest region of oviduct and such character may be related to the capacity of this region in production and secretion of thick albumin layer which constitute the bulked layer of the egg. The Mallard duck magnum was the longest part which was a feature observed in other avian species, but its whole length was the shortest compared to the magnum in other birds. The mucosal folds of the magnum was simple type and greatest in size compared to the other regions of the oviduct, a character which is parallel to other birds such as Gallus domesticus (14), Japanese quails (37), ostrich (38), Mature Rhea bird (21) and geese (17).

Isthmus was the third region which was whitish in color with thin wall and their mucosal folds were less prominent and longitudinally oriented and separated by the presence of indentations (Fig. 5 and 6). The mean length of isthmus was 7.6±0.10 cm and 1.18±0.08 cm in diameter. The statistical

analysis showed that the isthmus was the second longest region of oviduct, next to the magnum. Physiologically this region was associated with synthesis the thin albumin of the egg which constitute the less volume of egg that not require as region as magnum. In Mallard duck, this region was the second longest part and their length and diameter were almost similar to that in duck (*Khaki Campbell*) (34) and the values of these measurements were higher than those in mature geese (17). However, these values were lower than those found in duck (*Tsai–Ya*) (33), hen (2), turkey (18) and laying ostrich (39).



Figure, 4: Gross appearance of laying female body (24 weeks Mallard)duckshows: magnum (M), isthmus (I), uterus (U), vagina (V) mature follicles (mf) immature follicles (arrow).

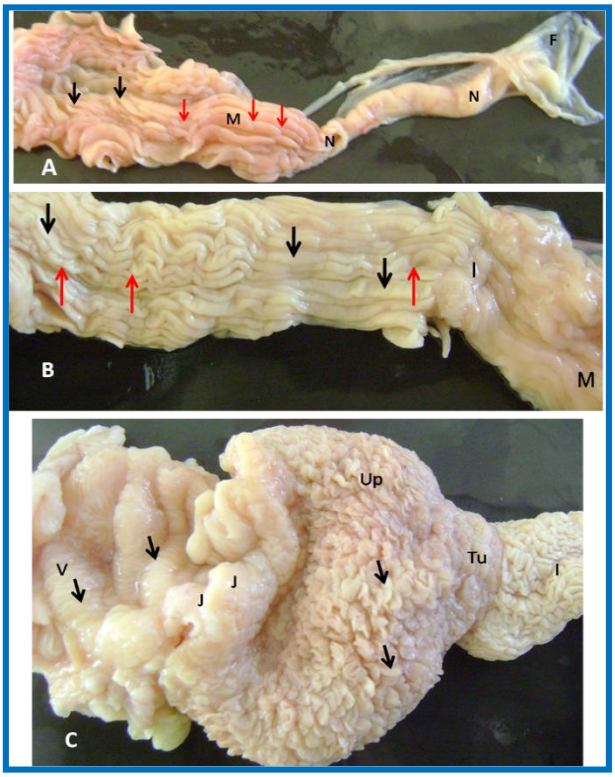
Figure, 5: Gross appearance of laying oviduct (24 weeksMallard duck) shows: A. The funnel (f), neck (n), magnum (m), isthmus (i), uterus (u), junction region (j), vagina (v), mucosal folds (arrows). B. The internal surface of the oviduct with longitudinally oriented mucosal folds.

The uterus composed of two parts; short anterior tubular part and expanded posterior pouch-like part. It was the thickest and widest part of the oviduct. Its surface showed mucosal folds which were oriented in both longitudinally and circularly directions. These mucosal folds were clearly form leaf-like structures (Fig. 5 and 6). The mean length of uterus was 5.38±0.18 cm and 3.62±0.08 cm in diameter. The mean diameter values of oviduct regions showed that the uterus was the widest region in oviduct followed by junction region and vagina. The significantly wide diameter suggested that the egg resided at uterus region about 18hr (from totally 24 hr) in order to secrete an egg shell. The subdivision of the uterus in Mallard ducks into anterior and posterior parts confirmed agreed with the findings observed in the uterus of hens (40), turkey (18 and 41), geese (17). The mean length of uterus in the current measurements appeared nearly similar to other species such as duck (*Khaki Campbell*) (34) and marreca (27). Whereas, the length of uterus in Mallard duck is shorter than those measured in turkey (42), hen (18), mature geese (17) and in ostrich (39).

The uterovaginal junction was the shortest region that connects the uterus with the vagina and characterized by its numerous short mucosal folds. This region was projected slightly into the uterine and vaginal lumens (Fig. 5 and 6). Its mean length was 1.96±0.02 and 2.28±0.13 cm in diameter. The junction region length was similar to those of funnel part of infundibulum, this result suggested that the function of junction region was related to that of the infundibulum thus, the junction region plays as primary station for sperms storage in spermatozoa storage tubule consequently release sperm to swim vertically toward the next second station of the sperm storage region (infundibulum). In Mallard duck the projection into both uterus and vagina confirmed the previous observations (29 and 41). The length of this region in Mallard oviduct was clearly short compared to that recorded in the Rhea bird (21). The length of junction region was longer to what previously found in mature laying geese (0.7cm), although both Mallard ducks and geese were considered marine species (17).

Vagina was the last region of the oviduct appeared as straight short tube that opened into the cloaca. The vaginal mucosal folds were continuous of those in junction region and white in color, with delicate longitudinally oriented folds (Fig. 5 and 6). The vagina mean length was 5.44±0.16 and 2.58±0.14 cm in

diameter. The vagina shape of Mallard resembled those described in mature geese (17), but was different from those in adult ISA-brown chicken (19) and laying turkey (18). The latter species showed different shapes of the vagina. In Mallard, the mucosal folds were similar to those described in duck (28), laying hen (43) and in mature geese (17). Furthermore, the length and diameter of vagina in Mallard duck is shorter than those of adult ISA-brown chicken (19), ostrich (20) and in turkey (42). Whereas, it was longer than those in Duck (*Anas boscas*) (44) and mature geese vagina (17).



Figure, 6: Gross appearance of laying oviduct regions (24 weeks Mallard duck) shows: A. Theneck (N), funnel (F) magnum (M), mucosal folds (Black arrows), and indentations (Red arrows). B. The magnum (M), isthmus (I), mucosal folds (Black arrows), and indentations (Red arrows). C. The isthmus (I), tubular part of uterus (Tu), uterine pouch (Up), junction region (J), vagina (V). (Black arrows) mucosal folds.

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دراسة شكلية لتطور الجهاز التناسلي الأنثوي في البط المحلي (*Anas platyrhynchos*)

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الخلاصة

تضمنت الدراسة التعرف على التغييرات التطورية الشكلية للمدد بعد الفقس للجهاز التناسلي الأنثوي في البط المحلي. استعملت لهذا الغرض عشرون من إناث البط غيرالبالغة والبالغة. وقد أظهرت النتائج ان المبيض الأيسر في الإناث بعمر 4 اسابيع صغيرالحجم ومثلث الشكل يقع عند الجزء الظهري للجوف العام. والجزء الخلفي منه يكون بتماس مع الفص الامامي للكلية اليسرى وامامياً بتماس مع الرئة اليسرى. بعمر 8 و12 اسبوع ظهر المبيض الأيسر كبيراً وذو سطح محبب بينما ظهرت قناة البيض اليسرى بشكل ابنوب نحيف مستقيم وشفاف غير متمايز ومثبت بالجوف العام بوساطة طية مزدوجة لرباط قناة البيض والحالب. أما في الإناث البالغة والبياضة فقد ظهر المبيض الأيسر أكبر حجماً وغير منتظم الشكل ويحتوي على العديد من الجريبات المتغايرة التطور كما ظهرت قناة البيض ناضجة ومتمايزة إلى ست مناطق (القمع، المعظم، البرزخ، الرحم، منطقة الاتصال، والمهبل). نستنتج من هذه الدراسة أن الأنثي عشر أسبوعا الأولى من مدد بعد الفقس أظهرت معالم شكلية متشابهة والأعضاء التناسلية خاملة ولم تكن متباينة في حين بعمر أربع وعشرين أسبوعاً بدت الأعضاء التناسلية الأنثوية متباينة وأظهرت نشاط جنسي ملحوظ.

الكلمات المفتاحية: التشريح، الأنسجة، البط المحلي، الجهاز التناسلي الأنثوي، المبيض.