POSTNATAL DEVELOPMENT OF THE OVIDUCT IN THE JAPANESE QUAIL *(Coturnix coturnix japonica)*

By

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THESIS

Submitted in partial fulfilment of the
requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Anatomy
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy, Thrissur

1994

DECLARATION

I hereby declare that the thesis entitled "**Postnatal Development of the Oviduct in the Japanese Quail (Coturnix coturnix japonica)**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

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CERTIFICATE

Certified that the thesis entitled "**Postnatal Development of the Oviduct in the Japanese Quail (Coturnix coturnix japonica)**" is a record of research work done independently by Smt. Lucy, K.M. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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ACKNOWLEDGEMENTS

I, with immense pleasure, express my deep sense of gratitude to Dr.K.R. Harshan, Associate Professor, Department of Anatomy and Chairman of the Advisory Committee for his valuable and inspiring guidance and constant encouragement throughout this work.

I am deeply indebted to Dr.Lucy Paily, Professor and Head, Department of Anatomy and a member of the Advisory Committee for her precious guidance and stable support throughout this work. I also extend my sincere gratitude to Dr.P.A. Ommer, former Professor and Head, Department of Anatomy for the valuable help and suggestions.

I sincerely thank Dr.G. Reghunathan Nair, Professor, Department of Poultry Science and Dr. Jose John Chungath, Associate Professor, Department of Anatomy for their valuable guidance and generous help as members of the Advisory Committee.

I am thankful to Dr.K.C. George, Professor and Head, Department of Statistics and Smt. K.P. Santha Bai, Senior Programmer for their help in the statistical analysis of the data.

My sincere thanks are due to Dr.C.K. Sreedharan Unni, Dr. Shyla Prakash and Dr.N. Ashok, Staff members of the Department of Anatomy for their help and co-operation during various stages of the study.

The generous help and co-operation of Dr.K.V. Valsala, Associate Professor, Centre of Excellence in Pathology, Dr.K.V. Raghunandanan, Associate Professor, Department of Animal Breeding and Genetics and Dr.C.P. Gopakumar, M.V.Sc student, deserve my special gratitude.

I wish to place on record my sincere thanks to Dr.P.T. Philomina, Associate Professor, Department of Physiology for the invaluable advice and help throughout the period.

I express my gratitude to Dr. S. Maya, M.V.Sc student for her remarkable co-operation and encouragement extended to me during this tenure. I also appreciate all my friends who have helped me during this period.

I am greatful to Dr.A. Rajan, Dean, College of Veterinary and Animal Sciences, for the facilities provided for the study.

I am thankful to Indian Council of Agricultural Research for awarding the Junior Fellowship in Veterinary Anatomy for this study.

Finally, I am indebted to my beloved parents, husband and brother for their love and blessings for the successful completion of this work.

Mannuthy

LUCY. K.M.

Dedicated to my
parents and husband

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Introduction

INTRODUCTION

Poultry farming in India is rapidly gaining momentum towards developing into a full-time occupational industry. As regards Kerala, this state has acquired a unique status in the field of poultry development. Quail rearing has now been taken up by Indian farmers on a large scale and it is getting more and more popular as years pass by. The introduction of the Japanese quails in the country during the seventies has opened a new line of poultry production and created an alternative for diversification.

The quails produce excellently exceeding the chicken, yielding about 250-300 eggs in a year. The egg weight represents nearly 8% of the body weight against 3% in chicken and 1% in turkey. The egg is built up gradually over a considerable period of time. The oviduct acts as the final assembly room where the albumen and the egg envelopes are added (Romanoff and Romanoff, 1949).

In order to ensure persistent and maximum production in the flock and to evolve better management practices, a sound knowledge in anatomy and physiology of the reproductive tract is essential. Knowledge on the normal structure and

development of the oviduct in the Japanese quail is incomplete. The present work is undertaken to study the normal postnatal development of the oviduct of the Japanese quail at different ages and to establish their relations, if any, with the age and body weight. It is expected that this study will form a basis for understanding the physiology and the pathology of the oviduct.

Review of Literature

REVIEW OF LITERATURE

It has been accepted that in most avian species, the left paramesonephric duct alone develops fully, the right one ceasing to do so. However, vestiges of the right oviduct were detected in the adult hen (Bradley, 1960; Aitken, 1971; Hlozankova and Zelenka, 1978 and Paneerselvam et al., 1989).

Kar (1947) reported that the oviduct was suspended from the dorsal abdominal wall by a peritoneal fold, the dorsal ligament which surrounded the duct and then formed the ventral ligament. Both the ligaments contained smooth muscle fibres which were more abundant in the free border of the ventral ligament that fused posteriorly with the vagina. Nickel et al. (1977) found that in day-old chick the oviduct occurred as a tiny tube just visible to the naked eye which gradually increased in size until puberty and in the laying hen, it was more than double the length of the bird's trunk. The regions viz. infundibulum, magnum, isthmus, uterus and vagina were not differentiated in the early stages.

Surface (1912) observed that the much convoluted oviduct of the laying hen completely occupied the left dorsal quadrant of the coelom, and also to some extent the left ventral quadrant. The oviduct extended backwards against the

dorsal part of the left body wall in relation to the ilium and ischium, and emptied into the cloaca lateral to the left ureter (Sisson and Grossman, 1938). The topographic relations of the oviduct in the fowl was described by Kern (1963). According to him, the oviduct was related dorsally to the left kidney; laterally to the left lateral body wall; ventrolaterally to the intestines and ventrally on the left, to the gizzard and spleen.

Rao Saheb and Iyengar (1945) stated that the infundibulum was not fimbriated in the fowl. Magnum in the fowl constituted more than half of the total length of the oviduct (Rao Saheb and Iyengar, 1945 and Marshall, 1947). Romanoff and Romanoff (1949) found that most of the coils and convolutions of the oviduct were in the magnum region. Isthmus was reported to be a short section of the oviduct and its diameter was less than that of the magnum. Anita (1971) and Solomon (1975) found that the beginning of the isthmus was marked by a narrow translucent constriction.

Uterus was reported to be a short sac-like expanded region by Romanoff and Romanoff (1949). Vagina was a relatively short, S-shaped tube which extended from a well developed muscular sphinctor at the posterior end of the shell gland (Rao Saheb and Iyengar, 1945; Bradley, 1960 and

Marshall, 1961). Bone (1979) stated that the vagina was merely a connecting tube between the uterus and the vent.

Woodard and Mather (1964) studied the mature oviduct of Japanese quail and recorded the average length of the individual components of the oviduct. The infundibulum, magnum, isthmus, uterus and vagina measured 5.7, 14.7, 6.3, 3.1 and 1.5 cm respectively. Fitzgerald (1969) and Luciana (1971) described the morphology of the female reproductive system of the coturnix quail.

Hafez and Kamar (1955) found that the size and weight of the hen's ovary and oviduct were influenced by age as well as by the reproductive phase. The oviduct was small and non-functional before sexual maturity while it attained a big size at sexual maturity. After sexual maturity, there was only an increase in oviduct thickness. It was 13 times heavier during laying than during rest. Hafez (1955) compared the growth rate of different organs and observed that the ovary had the highest growth rate followed by the oviduct and spleen.

The observation of Fitzgerald (1969) indicated that functional maturity of the oviduct of coturnix quail was attained by six to seven weeks of age. In the quail, oviduct started to grow very rapidly between 21 and 28 days of age and reached adult weight by 45 days (Pageaux et al., 1984).

Postnatal development of the genitalia in ducks was studied by Vernerova and Burda (1984). They found that the female genitalia showed maximum development between 130 and 160 days of age. Vernerova and Firmanova (1985) compared the morphology and weight of genitalia in female turkeys and hens and found that the ovary weight and oviduct weight increased along with the increase in body weight and age. Elashi and Horst (1985) noticed that the oviduct weight was significantly correlated with egg weight and albumen weight, but not with egg shell weight. Kelany et al. (1993) studied the development of oviduct in fowls and observed that the increase in oviduct length was slow until the 16th week of age. At the 20th week, the oviduct was markedly longer.

The histology and development of the oviduct in domesticated canaries was described by Hutchison et al. (1968). The histology resembled that of the fowl and the oviduct development was closely correlated with that of the ovary. Geetha et al. (1992) reported the presence of elastic and reticular fibres in the lamina propria of all the regions of the adult quail oviduct.

Romanoff and Romanoff (1949) revealed that the most anterior portion of the oviduct opened into the body cavity near the ovary by way of an elliptical aperture-the ostium tubae abdominale. The histological structure of the

infundibulum of the fowl was investigated by Romanoff and Romanoff (1949), Bradley (1960), Aitken and Johnston (1963) and Wyburn et al. (1970). Bradley (1960) and Stott et al. (1966) observed low mucosal folds in the infundibulum of the fowl and that of the quail respectively.

Histological studies on the surface epithelium of the infundibulum were made by Aitken and Johnston (1963), Enbergs (1969), Blom and Lars (1973) and Fujii (1975) in the hen and Tamura and Fujii (1966) and Sandoz and Ulrich (1976) in the laying quail. All of them reported that the luminal epithelium was composed of ciliated columnar cells and goblet cells. The ciliated cells were tall columnar with oval nuclei lying at or above the centre of the cell and possessed an apical tuft of cilia. In the occasional goblet cell, the oval nucleus was basal and the apical portion of the cell was swollen with a granular material which frequently projected into the lumen in the form of a bleb. The secretory material was PAS-positive, slightly alcian blue-positive and toluidine blue metachromatic. At the bases of the epithelial ridges were the glandular grooves lined by cuboidal secretory cells with large, oval, basal nuclei and very fine PAS-positive granules (Aitken and Johnston, 1963).

Romanoff and Romanoff (1949) and Bradley (1960) reported the presence of tubular glands in the caudal part of

the neck of the infundibulum. Hodges (1974) observed that the tunica muscularis of the funnel region consisted of a connective tissue layer with scattered bundles of muscle fibres. At the neck region, the muscle fibres were arranged into ill-defined longitudinal and circular layers. Burke (1972) believed that the infundibulum was the site of fertilization and that the sperm could not penetrate the ovum after it was covered by albumen.

Biswal (1954), Trautmann and Fiebiger (1957), Bradley (1960) and Kimijima (1989) reported that lymphocytes in diffuse form and nodular aggregates and many plasma cells were present in the infundibulum of hen. But these cells were not present in the oviduct of duck (Das and Biswal, 1968).

The wall of the magnum was markedly thicker than that of the infundibulum. This development partly resulted from an increase in the development of the muscular layer but was mainly due to the increased thickness of the mucosa. Studies by Das and Biswal (1968) on the oviduct of domestic duck revealed that, in the magnum, each villus was formed by a compact layer of glands located around the central core of blood vessels, smooth muscle fibres and connective tissue fibres. These folds were found to be higher and thicker than

those in all other parts of the oviduct, increasing the surface area of the mucosa (Wyburn et al., 1970). Mc Lelland (1990) distinguished 22 well developed primary folds with no secondary folds in the magnum of the fowl.

The epithelium lining the magnum consisted of secretory and ciliated cells; its height varied according to the degree of distension of the underlying proprial glands (Aitken, 1971 and Sandoz and Ulrich, 1976).

Pageaux et al. (1986) reported that in quail the most interesting aspects of magnum growth (proliferation, differentiation and initiation of the synthesis of specific proteins) took place in the beginning of the period when the oviduct weighed less than one gramme. Further development of the magnum involved only the accumulation of secretory products. According to them, immature magnum was characterized by low mucosal folds with densely packed cells of connective tissue lined by a single layer of undifferentiated luminal epithelial cells. During sexual development, first the luminal cells started rapid proliferation and began to evaginate into subepithelial stroma and the tubular glands were formed.

The light and electron microscopic studies on the albumen-secreting cells of the oviduct were made by Hendler

et al. (1957), Bosch and Angulo (1963), Suzuki et al. (1970), Gerlinger et al. (1971) and Zahnd et al. (1971) in the fowl, Fertuck et al. (1970) in the quail and Sharma and Duda (1986) in the common mallard. Fertuck et al. (1970) found that granules first appeared in the tubular gland cells of the magnum of the quail at about 4½ weeks of age. The proprial glands of the magnum were tightly packed tubules which opened at all points on the luminal surface. Davidson et al. (1968) observed prominent acidophilic granules in the tubular glands of the magnum of fowl which were different in form from those found in the upper part of the isthmus. Aitken (1971) reported that the tall pyramidal cells lining the tubular glands secreted the bulk of the egg white protein.

According to Bradley (1960), the musculature in the magnum of the fowl was very thin, consisting of bundles of plain muscle running in a tight spiral for the outer layer, and a very poorly defined inner circular layer. Arjamaa and Talo (1983) could observe fibres and bundles of collagen between the muscle cells in the magnum and to a lesser extent in the isthmus of quail. Kimijima (1989) reported the presence of lymphocytes in the magnum of fowl.

Histomorphological studies on the isthmus region was made by Romanoff and Romanoff (1949), Draper et al. (1972) and

Solomon (1975) in the domestic fowl, Tamura (1971) and Anita (1971) in Japanese quail and Sharma and Duda (1992) in common mallard. Anita (1971) reported that the mucosa of the quail isthmus was thrown into 20 to 30 longitudinally oriented folds which branched occasionally. Draper et al. (1972) reported that the surface epithelium consisted of approximately equal numbers of ciliated and non-ciliated cells separated from an underlying layer of tubular glands by a thin glycoprotein basement membrane and a thin layer of connective tissue containing blood vessels and plasma cells. At the light microscope level a positive reaction for acid phosphatase and β-glucuronidase was demonstrated in the apical region of the ciliated cells in the quail. The non-ciliated cells possessed numerous mucigen granules in the supranuclear region indicated by their intensely positive reaction with PAS.

The isthmus glands showed a marked hypertrophy and hyperplasia during secretory phase as a consequence of which the shape of mucosal folds changed and secretory activity of the glands got intensified (Aitken, 1971 and Sharma and Duda 1992). The closely packed secretory granules of the principal cells were intensely eosinophilic and PAS-positive (Anita, 1971). She also reported that mucosa of the isthmus was surrounded by two layers of smooth muscle. The inner layer, made up primarily of circumferentially oriented fibres

was separated from the outer thin layer by connective tissue containing many large blood vessels. Creger et al. (1976) and Stemberger et al. (1977). in their study on the formation of egg shell, demonstrated that the shell deposition was actually initiated in the isthmus. The presence of lymphocytes and plasma cells in the isthmus region of hen was reported by Kimijima (1989). But these cells were absent in the oviduct of duck (Das and Biswal, 1968).

Structure of the uterine mucosa was different from that found in the remainder of the oviduct (Surface, 1912). Instead of the usual continuous ridges, the mucosa was thrown into numerous flat, discontinuous, leaf-shaped folds which were however, still oriented longitudinally. Surface epithelium of the shell gland has been studied extensively in the fowl by Johnston et al. (1963), Breen (1966), Nevalainen (1969), Aitken (1971), Bakst and Howarth (1975) and Huntley and Holder (1978) and in the quail by Tamura and Fujii (1966). The epithelium consisted of the apical ciliated cells and basal mucous cells. Three types of secretion materials were demonstrated in these cells of the quail. Pigment granules (porphyrin) and the PAS-positive granules were seen in the apical cells and the basophilic mucin granules in the basal cells (Tamura and Fujii, 1966). Aitken (1971) observed that the basal cells were more slender than elsewhere in the oviduct, especially during shell formation, when they appeared to be compressed by apical cells.

The tubular glands of the uterus were close to the capillaries in the lamina propria and the nuclei of the glandular cells were spherical and located basally (Nevalainen, 1969). An unusual feature of these glandular cells was the complexity of their microvilli, some of which were elongated with bulbous tips which budded off and appeared to form part of the cell secretion (Breen, 1966; Draper et al., 1968; Aitken, 1971 and Huntley and Holder, 1978). The musculature was well developed, particularly the outer longitudinal layer. In general these layers were better developed than in the more anterior segments of the oviduct (Hodges, 1974).

The presence of lymphocytes in diffuse form and nodular aggregates in the uterus of fowl had been reported by Bradley (1960) and Kimijima (1989). But these cells could not be demonstrated in the oviduct of duck (Das and Biswal, 1968).

Romanoff and Romanoff (1949) explained that egg shell colouring was due to pigments derived from the colouring matter of red blood corpuscles and in hen's egg appeared to be distributed evenly throughout the shell. In the more deeply pigmented quail egg it was most prominent in the cuticle and accumulated after ovulation with time (Tamura and Fujii, 1966 and Soh et al., (1989). Woodard and Mather (1964) reported that in this species pigmentation appeared to begin some 3½ hours before laying. The distribution in the

hen's egg suggested continuous deposition and therefore, continuous secretory activity throughout the whole period of shell formation. Turkey eggs also acquired their speckles during the last two to three hours when the egg was in the uterus (Wolford et al., 1964). The effect of sex steroids on the pigment accumulation in the shell gland of Japanese quail was investigated by Soh and Koga (1994). They suggested that preovulatory plasma progesterone might affect the accumulation of pigment in the quail shell gland.

Bobr et al. (1964) reported that the normal residence sites for spermatozoa in the avian oviduct were the tubular glands within the mucosa of utero-vaginal junction. The microscopic structure of sperm host glands was described by Bobr et al. (1964), Schindler et al. (1967), Van Krey et al. (1967), Gilbert et al. (1968), Burke (1972), Tingari and Lake (1973) and Fugii (1975) in the fowl, Van Krey et al. (1974), Schuppin et al. (1984), Bakst and Richards (1985), Zaveleta and Ogasawara (1987) and Bakst (1992) in the turkey, Pal (1977) in the domestic duck and Renden et al. (1981) in the quail. The cells of the sperm-host glands in all these species were non-ciliated except near their openings into the oviduct lumen.

The histochemistry and ultracytochemistry of the sperm host glands differed from those of the surrounding oviductal

epithelia. Large amounts of lipid were observed in the sperm-host glands of chickens (Gilbert et al., 1968; Tingari and Lake, 1973 and Fujii, 1975), ducks (Pal, 1977), quails (Renden et al., 1981) and turkeys (Schuppin et al., 1984). Glycogen was also found in these cells of chickens (Gilbert et al., 1968 and Tingari and Lake, 1973) and turkeys (Schuppin et al., 1984) but was completely absent in ducks (Pal, 1977) and quails (Renden et al., 1981). The basement lamina in the quail stained lightly with PAS. Renden et al. (1981) reported the acid phosphatase activity in the apical portion of the sperm-host gland cells.

The mucosa of vagina formed longitudinal ridges which were narrow due to the absence of glands (Aitken, 1971). Surface epithelium consisted of alternating ciliated cells with apical nuclei, and non-ciliated, mucus secreting glandular cells with basal nuclei. The height of epithelium, especially over the crests of folds, was greater than that of shell gland (Richardson, 1935). The cells were narrower than those of other regions (Hodges, 1974).

Biswal (1954), Trautmann and Fiebiger (1957), Bradley (1960) and Kimijima (1989) reported that lymphocytes in diffuse form and nodular aggregates were present in the vagina of hen. But these were not present in the oviduct of duck (Das and Biswal, 1968).

Romanoff and Romanoff (1949) and King (1974) reported that the most outstanding feature of vagina was the well developed muscle layers, particularly the inner circular layer, which was several times thicker than in any other portion of the oviduct.

Aire and Steinbach (1976) conducted histochemical studies on the ovary and oviduct of the fowl and reported that alkaline phosphatase (ALP) activity appeared in the pits of epithelial evaginations as glandular formation commenced. The young, non-secretory glands also showed the enzyme activity, but in the mature oviduct, ALP activity was confined only to the utero-vaginal glands and the vaginal epithelium. Brown and Badman (1962), Wilcox and Cloud (1965) and Snapir and Perek (1970) found significantly higher ALP activity in the uterus than in the isthmus. Solomon (1970) reported that ALP was found only in the vascular endothelium while acid phosphatase (ACP) was present in the lining epithelium and lamina propria of the uterus in fowl. Light microscopic studies showed that free ACP occurred principally in the basal non-ciliated epithelial cells during the first four hours of calcium deposition. Membrane bound ACP was observed only in the tubular gland cells (Solomon, 1973). According to Prabhakar et al. (1975), in the Fallopian tube the maximal activity of ALP was recorded in immature pullets.

Kansal et al. (1980) detected ALP and ACP in the uterus, isthmus and magnum of fowl in the decreasing order of intensity. In the quail, the activities of ALP and ACP were significantly greater in the shell gland than in the isthmus and magnum (Darshan and Panda, 1987). Mohan et al. (1991) observed that ACP activity was several folds higher than ALP activity in all regions of the oviduct in hen.

Materials and Methods

MATERIAL AND METHODS

In all, 72 coturnix quails were used for the present study. The birds were selected randomly from a single hatch and reared at the University Poultry Farm, Mannuthy under cage system of management. The chicks were not given any vaccination. Feed and water were provided ad lib.

The study was carried out in birds of different ages, ranging from day-old to 60 days as shown in table 1. From the day of hatch upto 15 days material was collected at three days interval, from 15 to 30 days at five days interval and 30 to 60 days at 10 days interval.

Table 1. Age and number of birds used for the experiment

S.No.	Age of birds	No.of birds
1	Day-old	6
2	3	6
3	6	6
4	9	6
5	12	6
6	15	6
7	20	6
8	25	6
9	30	6
10	40	6
11	50	6
12	60	6
	Total	72

The live body weight of the birds were recorded and then they were bled to death. The birds were dissected and the topography of the reproductive tract such as position and relationship were noted. From each group three specimens were used for histological examination and three for gross study. The material was washed in normal saline and mopped with blotting paper. The total length and weight of the oviduct was recorded.

For the last two age groups, the lengths of the infundibulum, magnum, isthmus, uterus and vagina were measured as follows.

Infundibulum : From the tip of the funnel to the base of the neck.

Magnum : From the base of the neck of the infundibulum to a narrow translucent zone at the magnum-isthmus junction.

Isthmus : From the narrow translucent zone to the isthmo-uterine junction.

Uterus : From the isthmo-uterine junction to the utero-vaginal junction.

Vagina : From the utero-vaginal junction to the cloaca.

After recording the biometry and gross features, the material was fixed in formol saline. The tissue pieces were processed and paraffin sections of 5 µm thickness were made. The following staining methods were employed.

1. Haematoxylin and Eosin (H & E) method (Drury and Wallington, 1967) for routine histological examination.

2. van-Gieson's method (Drury and Wallington, 1967) for connective tissue and muscle.

3. Gomori's rapid one step trichrome method (Drury and Wallington, 1967) for connective tissue fibres.

4. Periodic acid Schiff's (PAS) reaction (Drury and Wallington, 1967) for mucins.

5. Best's carmine method (Luna, 1968) for glycogen.

6. Osmium tetroxide method (Paraffin sections) (Luna, 1968) for lipids.

7. Verhoeff's haematoxylin method (Drury and Wallington, 1967) for elastic fibres.

8. Gomori's reticulin method (Drury and Wallington, 1967) for reticular fibres.

For alkaline and acid phosphatases (ALP & ACP) the material was fixed using chilled acetone and paraffin sections of 5 µm thickness were made. Gomori's (1952) calcium phosphate method (Drury and Wallington, 1967) was employed for detecting ALP. Presence of a ACP was tested using Gomori's (1952) method (Humason, 1972).

The data was analysed statistically following Snedecor and Cochran (1967).

Results

RESULTS

Gross observations

In the day-old quail chick, the oviduct could be seen as a narrow white translucent tube towards the left side of the coelom extending from the level of the fifth segment of the lumbosacral mass to the cloaca (Fig.1). The oviduct originated caudal and lateral to the ovary, extended posteriorly along the ventral aspect of left kidney and joined the cloaca at the caudal end. The duct was connected to the dorsal body wall along its whole extent by a dorsal ligament. Attached to the ventral surface of the oviduct was the ventral ligament, the lower edge of which was free. Upto 20 days of age, the oviduct was almost straight and did not show any sign of coiling.

The signs of coiling of the oviduct was evident from 25 days of age (Fig.2). In the adult bird, the oviduct was highly convoluted and occupied the left half of the body cavity. But, the oviduct containing a developing egg extended towards the right side also, displacing the intestines ventrally and to the right (Fig.3). The infundibulum opened into the body cavity, and at the time of

ovulation it was in close contact with the ovary. Dorsal surface of the oviduct was related to the ventral surface of left kidney and part of the right kidney. Ventrally, on the left side it was related to the dorsal surface of the gizzard and spleen towards the cranial aspect. The caudal part of the oviduct was located dorsal to the intestines. Laterally it was related to the left body wall.

Body weight

The mean body weights of the birds used are presented in table 2. Upto 20 days, the body weight increased gradually and thereafter, a spurt in growth was noticed upto 60 days (Fig.4).

Weight and length of oviduct

The average weights of oviduct at different ages are shown in table 3. In the initial stages, the increase was in accordance with the growth of the bird. The actual development of the oviduct started between 30 and 40 days of age. Weight of the oviduct increased about four times from 0.0495 g in 30 days old to 0.193 g in 40 days old birds. At 50 days of age, the weight again increased by 17 folds (Fig.5). The adult weight was attained between 50 and 60 days of age with an average weight of 6.62 g at 60 days of age. The

contribution of oviduct to body weight was 4.05% at this age.

The length of oviduct at different ages are given in table 4. The length showed a gradual increase from day-old to 30 days of age. Thereafter, the increase was very rapid, reaching a maximum length at 60 days of age (Fig. 6).

The length of the various segments of the oviduct at 50 and 60 days are given in table 5. The maximum length was recorded for the magnum, which was about 48.3% of the total length at 60 days (Fig.7&8).

Infundibulum

Infundibulum consisted of two parts, the funnel and neck. But in day-old chicks, this differentiation was not clear. The infundibulum, magnum and isthmus regions were continuous without any line of demarcation upto 40 days of age.

In the adult birds, the thin-walled funnel was flattened dorsoventrally and its flared lips were in close proximity to the ovary. The funnel walls converged rapidly to form a narrow tube, the infundibular neck. Average length of infundibulum in the adult bird was 4.62 cm which was about 17.1% of the total length of oviduct.

Magnum

In the undifferentiated oviduct, this region was continuous with the infundibulum and isthmus. After differentiation, the region close to the infundibulum increased in size to form the magnum which became the longest and the most coiled segment of the oviduct. The contribution of magnum to the total length was 48.3%. The overall diameter of the magnum was considerably greater than that of the neck, the increase being mainly due to a marked increase in the thickness of the walls. In the terminal region, the diameter gradually reduced to that of the isthmus.

Isthmus

In the differentiated oviduct, the junction between magnum and isthmus was marked by a narrow translucent zone. The isthmus was a relatively short section, being about 4.78 cm long which was about 17.7% of the total length. Its overall diameter was less than that of the magnum.

Uterus

Even at hatch, the uterine region could be distinguished by a small dialatation located between the 14th lumbosacral segment and the third caudal vertebra. In the

adult bird, the uterus was an expanded pouch-like part with dark grey colour. Initial part-the isthmo-uterine junction-was short and tube shaped. The sac-like shell gland proper, measured 3.08 cm in length and 2.1 cm in width. Uterus contributed 11.4% of the total length. The wall was thin compared to that of magnum and isthmus, but was distensible.

Vagina

Vagina appeared to be a short S-shaped tube. Externally the wall showed fibrous bands which held the region of the vagina close together. Total length of the vagina was 1.48 cm which contributed 5.5% of the total length. Posteriorly, the vagina opened into the urodeum of cloaca.

Microscopic observations

Infundibulum

In day-old birds, the cranial end of the oviduct corresponding to the infundibulum consisted of innermost epithelium and subepithelial tissue (Fig.9). The different tunics of the oviduct wall were not differentiated. The lumen was characterized by low primary mucosal folds lined by simple columnar epithelium. Subepithelial connective tissue

layer was made up of densely packed cells with fine collagen and reticular fibres. Externally there was a thin layer of collagen fibres.

The dorsal ligament was very thin made up of collagen fibres and cells. There was a well developed ventral ligament, the central part of which showed smooth muscle tissue. The cranial region of the duct remained without much change upto 15 days of age.

At 15 days of age, height and number of the primary folds increased and were more regular in arrangement. The layers still remained undifferentiated. Morphological development of the oviduct started between 30 and 40 days of age. The luminal epithelial cells showed rapid proliferation. The large number of epithelial cells and the increase in height of the mucosal folds indicated entry into a rapid growth phase. In the funnel region, the mucosa was thrown into low, thin primary folds. Lamina propria was loosely arranged and was free of glands. The neck region showed well developed primary folds and glandular tissue was seen in the lamina propria (Fig.10). Lamina propria was made up of mainly collagen fibres. Fine reticular fibres also could be noticed. Deeper part of the propria was formed of loosely arranged connective tissue. Tunica muscularis

consisted of well developed circular layers and scattered bundles of muscle fibres arranged in various planes.

In the adult bird, wall of the fimbriated end of the oviduct was very thin. The mucosal ridges were narrow with many secondary folds (Fig.11). The lining epithelium consisted of simple columnar cells with low cilia and goblet cells. At the bases of the grooves between the mucosal ridges, there were accumulation of secretory cells. Lamina propria was devoid of glands and contained collagen fibres. Fine reticular fibres and a few elastic fibres could also be noticed. Muscle layer consisted of circularly arranged fibres and scattered bundles. A very thin collagenous serosa, well developed blood vessels and loose connective tissue were noticed.

Within the neck of the infundibulum, the mucosal folds were very high with primary, secondary and tertiary folds (Fig.12). Lamina propria showed tubular glands and scattered lymphocytes. Lining cells of the secretory end piece showed intense PAS activity. Glandular lumen was wider. The borders of the lining cells were indistinct. Thickness of the tunica muscularis was more than in the funnel region. It consisted of inner circular layers and outer irregular bundles. In between, blood vessels could also be noticed.

Magnum

Immature magnum was almost similar in structure to that of the infundibulum except that the primary folds were more prominent. Developmental changes were also similar to those of the infundibulum neck.

In the adult bird, the mucosal ridges of the magnum considerably increased in height and width (Fig.13), the greater part of this development being due to the intense development of tubular glands. There were 14 to 19 primary folds with a few secondary folds. Lining epithelium consisted of ciliated columnar cells and goblet cells (Fig.14). The tall columnar cells possessed basally located roughly spherical nuclei and the cell boundaries were distinct. Surface showed low cilia. In H & E staining technique, cytoplasm was clearly basophilic. The goblet cells presented broad apical regions containing numerous PAS-positive granules (Fig.15).

Lamina propria of the magnum was tightly packed with glandular tissue. Each secretory end piece possessed a narrow lumen in the centre, which was surrounded by pyramidal cells with basal spherical nucleus and eosinophilic cytoplasm. Core of the epithelial folds were formed mainly of collagen fibres (Fig.14). Fine reticular and a few elastic fibres could be detected. Scattered lymphocytes were also present. Musculature consisted of very thin circularly

arranged muscle bundles. The serosa was fibrous in nature and was very thin.

Magnum-isthmus junction

The junction of magnum with the isthmus was clearly demarcated by a narrow, translucent zone. This region was characterized by thin mucosal folds with several secondary folds (Fig.16). Lining epithelium showed a diffuse basophilic cytoplasm. A notable feature was the absence of tubular glands and the presence of a relatively dense connective tissue corium with scattered lymphocytes.

Isthmus

Structure of the immature isthmus was similar to that of the other regions. It was continuous distally with the future magnum region. Morphological changes during growth were also of the similar pattern.

The mucosa of the isthmus of the differentiated oviduct was thrown into 19 to 22 longitudinally oriented folds with several secondary folds. These folds were angular in appearance and were narrower than those of the magnum (Fig.17). Lining epithelium was pseudostratified. The columnar cells possessed low cilia. Goblet cells gave a

positive PAS reaction. The apex of the lining cells presented glycogen granules in the Carmine stained slides (Fig.18).

Lamina propria was loosely packed with tubular glands in 50 days old birds (Fig.19). The connective tissue core was proportionately wider (Fig.20). As age advanced, the core became thinner and the propria was tightly packed with glands. Each secretory end piece was lined by pyramidal cells with a narrow lumen in the centre. The cytoplasm contained numerous eosinophilic granules. Scattered lymphocytes could also be noticed in the lamina propria. Bundles of collagen fibres could be noticed in the core region along with a few elastic fibres (Fig.21). Reticular fibres were also demonstrated in the lamina propria (Fig.22).

Tunica muscularis consisted of inner circular and outer poorly developed discontinuous longitudinal smooth muscle bundles. In between, loose connective tissue and blood vessels were present. External to the muscularis, there was a typical serosa.

Uterus

Uterus/shell gland region was wider than the cranial portions in the day-old birds itself. Structurally it was

similar to the cranial regions except for a slight reduction in the thickness of the wall. In three days old birds, the folds were higher and they were more in number. At 15 days of age, secondary folds started developing from the primary folds and scattered bundles of muscle fibres could be noticed in the subepithelial layer. In 40 days old birds, tertiary folds also could be identified in the mucosa (Fig.23). The lamina propria was very loose and showed blood capillaries.

The uterus of the mature bird had a different pattern of mucosal folds compared to the other regions of the oviduct. Instead of the ususal continuous ridges, the mucosa was thrown into numerous long, flat, discontinuous, spatula-shaped folds (Fig.24). These ridges consisted of low and high primary folds with several secondary and tertiary folds.

The pseudostratified ciliated columnar epithelium of uterus was exceptionally regular with alternating apical and basal nuclei (Fig.25). The more superficial layer of nuclei belonged to the ciliated apical cells. The cytoplasm contained basophilic secretory granules. Alternating with the apical cells were the basal cells containing PAS positive granules. In some regions, the epithelium showed lipid droplets also.

In 50 days old birds, just below the epithelium, tubular glands were seen in a row. The remainder of the core of the mucosal fold was filled up with connective tissue. At 60 days of age, density of glandular tissue was more. The cells lining the secretory end piece possessed a basal spherical nucleus and eosinophilic cytoplasm (Fig.25). Numerous collagen bundles and a few elastic and reticular fibres formed the connective tissue core of the mucosal folds (Fig.26) which also contained many lymphocytes in diffuse form.

Tunica muscularis was better developed than in the anterior regions of the oviduct (Fig.27). Inner part of the musculature was made up of circular and irregular bundles. Towards the outer part, fairly thick longitudinal muscle layer could be seen. In between the muscle layers loose connective tissue with large blood vessels were noticed. Externally a serosa was present.

Utero-vaginal junction

Mucosal folds in this region were long, narrow and filiform. This region was characterized by the presence of sparsely distributed glands in the lamina propria, the sperm-host glands (Fig.28). They were of simple tubular type. The lining epithelium consisted of the simple tall columnar type with basal spherical nucleus. The cells were

characterized by the presence of lipid droplets in the apical region (Fig.29). The apical region of these cells also gave a positive reaction for alkaline and acid phosphatase. No glycogen could be demonstrated in these cells. Musculature was thicker than that of the uterine portion.

Vagina

Immature vagina had the same structure as that of the cranial segments but was narrower than the uterus. In 15 days old birds, presence of muscle bundles was noticed outside the propria. Developmental sequence was almost similar to that of the cranial regions. But glandular development could not be noticed. In 40 and 50 days old birds, mucosa was thrown into primary and secondary folds, which were not fully developed (Fig.30).

In the adult birds, the mucosa was raised into numerous, narrow, longitudinal ridges which were regular in their arrangement (Fig.31). Primary, secondary and tertiary folds were present. The secondary folds were perpendicular to their parent ridges. The surface epithelium was formed of ciliated cells and non-ciliated glandular cells. Height of the epithelium, especially over the crests of the folds, was greater than that found in any other regions of the oviduct. Lamina propria was formed of loose connective tissue devoid of glands. Lymphocytes in diffuse form and nodular

aggregates were present (Fig.32).

Greater part of the thickness of vaginal wall was contributed by the musculature (Fig.33). The inner circular layer was well developed, being the thickest. The outer longitudinal layer was only moderately developed and consisted of scattered muscle bundles separated by collagenous connective tissue. The connective tissue showed many blood vessels. Externally a thin serosa could be seen.

Alkaline and acid phosphatase (ALP and ACP) activities were intense in the lining epithelium and tubular glands of the uterus (Fig.34). In the isthmus and magnum, the activity was only of moderate intensity. In the infundibulum and vagina, the inner most epithelium showed a mild positive reaction for both the enzymes.

Table 2. Body weight of Japanese quails at different ages (Mean ± S.E.)

Age in days	Body weight (g)
Day-old	6.07 ± 0.24
3	9.43 ± 0.55
6	13.90 ± 0.45
9	19.39 ± 0.81
12	24.99 ± 1.06
15	33.35 ± 1.86
20	39.99 ± 2.40
25	59.69 ± 2.95
30	79.19 ± 4.05
40	117.00 ± 2.31
50	133.33 ± 4.59
60	163.33 ± 2.11

Table 3. Average weight of oviduct at different ages

Age in days	Oviduct weight (g)
Day-old	0.0043
3	0.0053
6	0.0061
9	0.0131
12	0.0163
15	0.0227
20	0.0282
25	0.0341
30	0.0495
40	0.1930
50	3.3420
60	6.6230

Table 4. Length of oviduct at different ages (Mean ± S.E.)

Age in days	Length of oviduct (cm)
Day-old	1.47 ± 0.03
3	1.87 ± 0.02
6	2.08 ± 0.03
9	2.41 ± 0.01
12	2.6 ± 0.04
15	2.93 ± 0.12
20	3.22 ± 0.09
25	3.47 ± 0.03
30	3.97 ± 0.12
40	8.63 ± 0.05
50	18.73 ± 1.61
60	27.05 ± 0.49

Table 5. Length of oviduct segments at different ages (Mean ± S.E.)

Oviduct Segments	Length at 50 days (cm)	Length at 60 days (cm)
Infundibulum	3.85 ± 0.29	4.62 ± 0.25
Magnum	7.82 ± 0.99	13.08 ± 0.10
Isthmus	3.72 ± 0.30	4.78 ± 0.20
Shell gland	2.17 ± 0.08	3.08 ± 0.10
Vagina	1.18 ± 0.07	1.48 ± 0.04

Figures

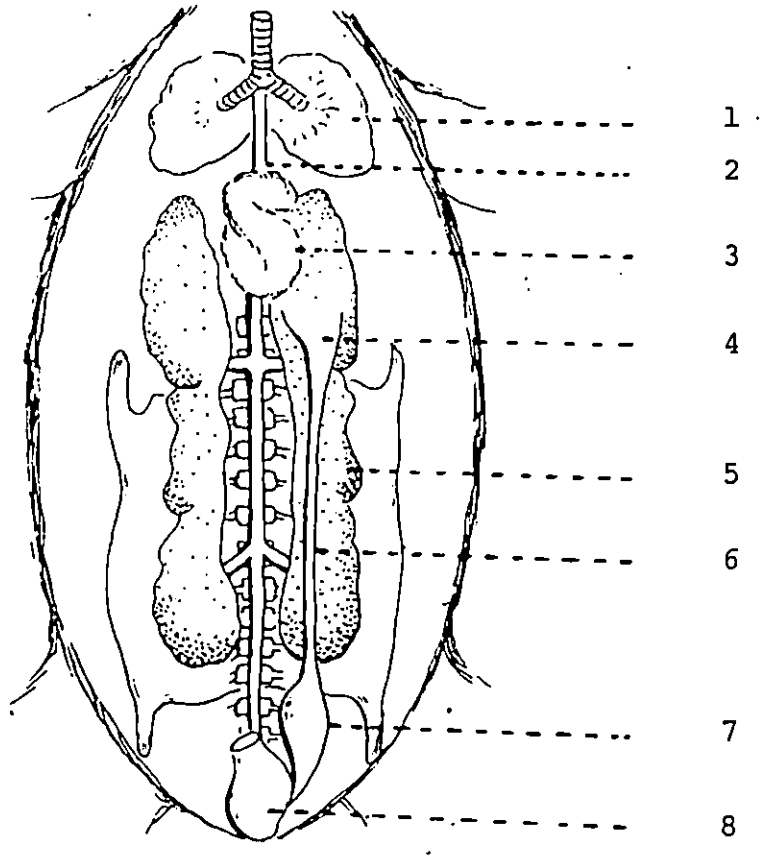

Fig.1. **Oviduct in day-old quail chick.**

1 Lungs; 2 Aorta; 3 Ovary; 4 Infundibulum;
5 Kidney; 6 Oviduct; 7 Uterus; 8 Cloaca.

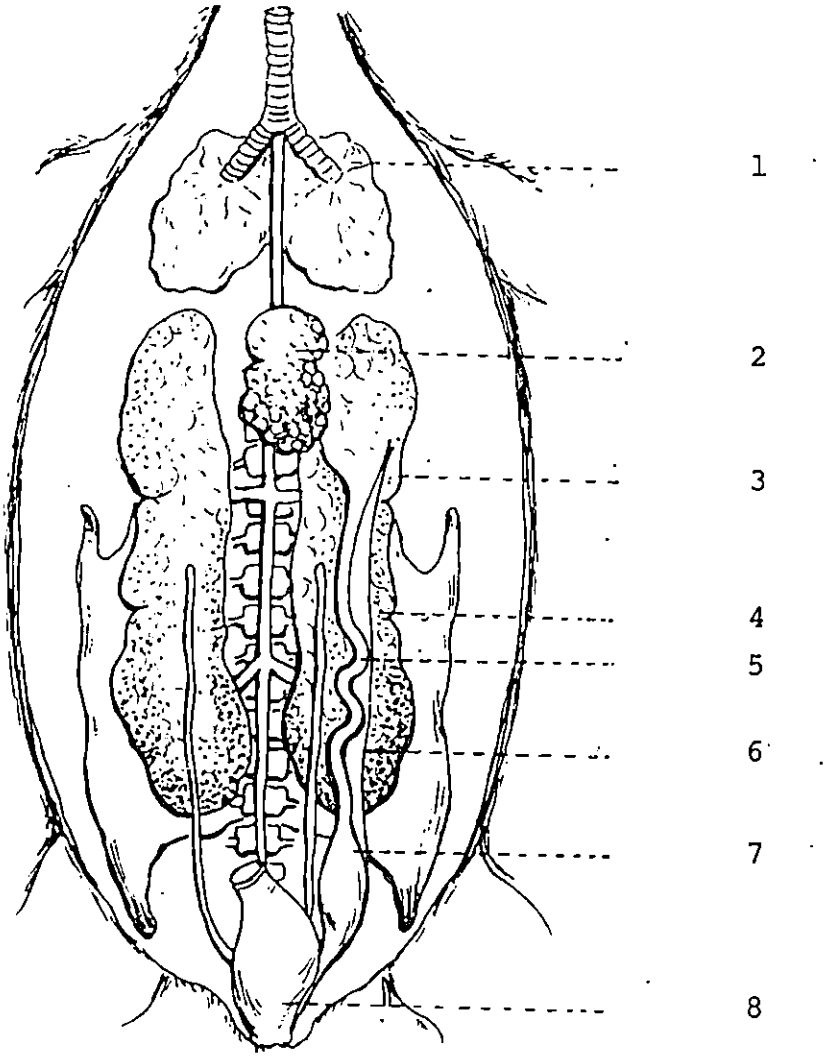

Fig.2. **Oviduct in 25 days old quail showing beginning of coiling.**

1 Lungs; 2 Ovary; 3 Infundibulum; 4 Kidney;
5 Coiled region of the oviduct; 6 Ventral ligament;
7 Uterus; 8 Cloaca.

Fig. 3 Body cavity of the adult quail showing the oviduct containing a developing egg

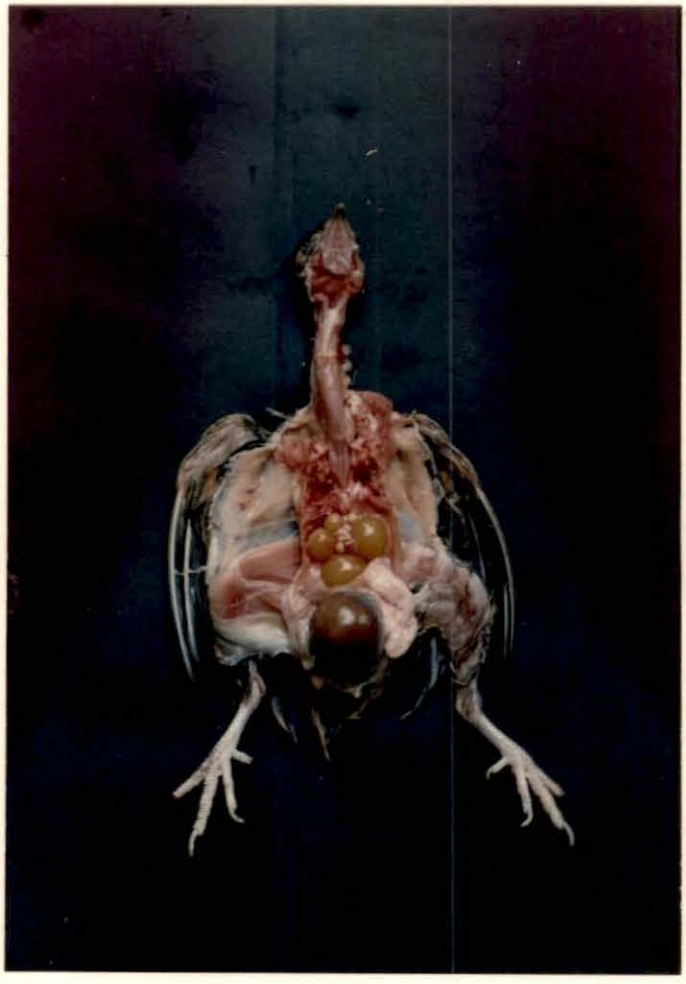

Fig.4 RELATION BETWEEN BODY WEIGHT AND AGE

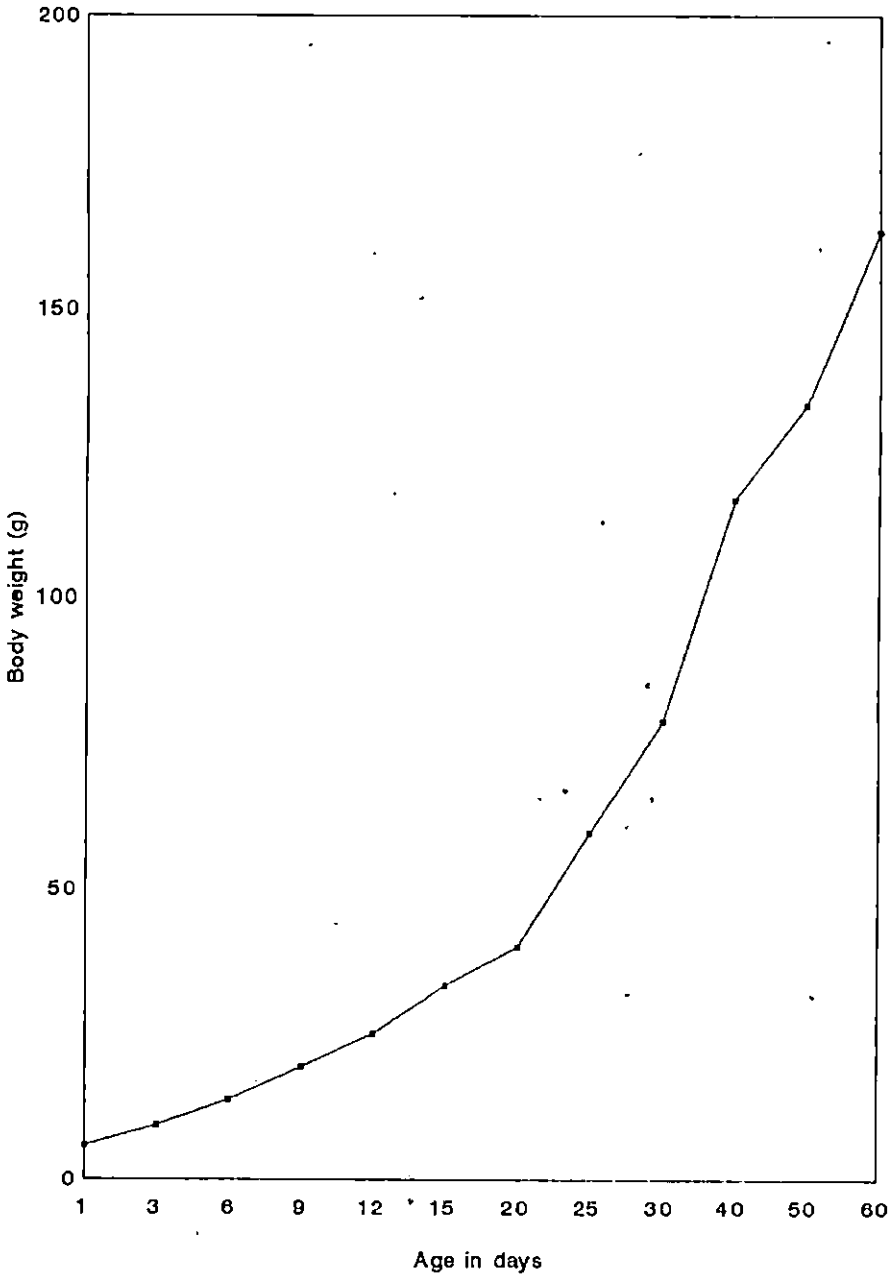

Fig.5 RELATION BETWEEN OVIDUCT WEIGHT AND AGE

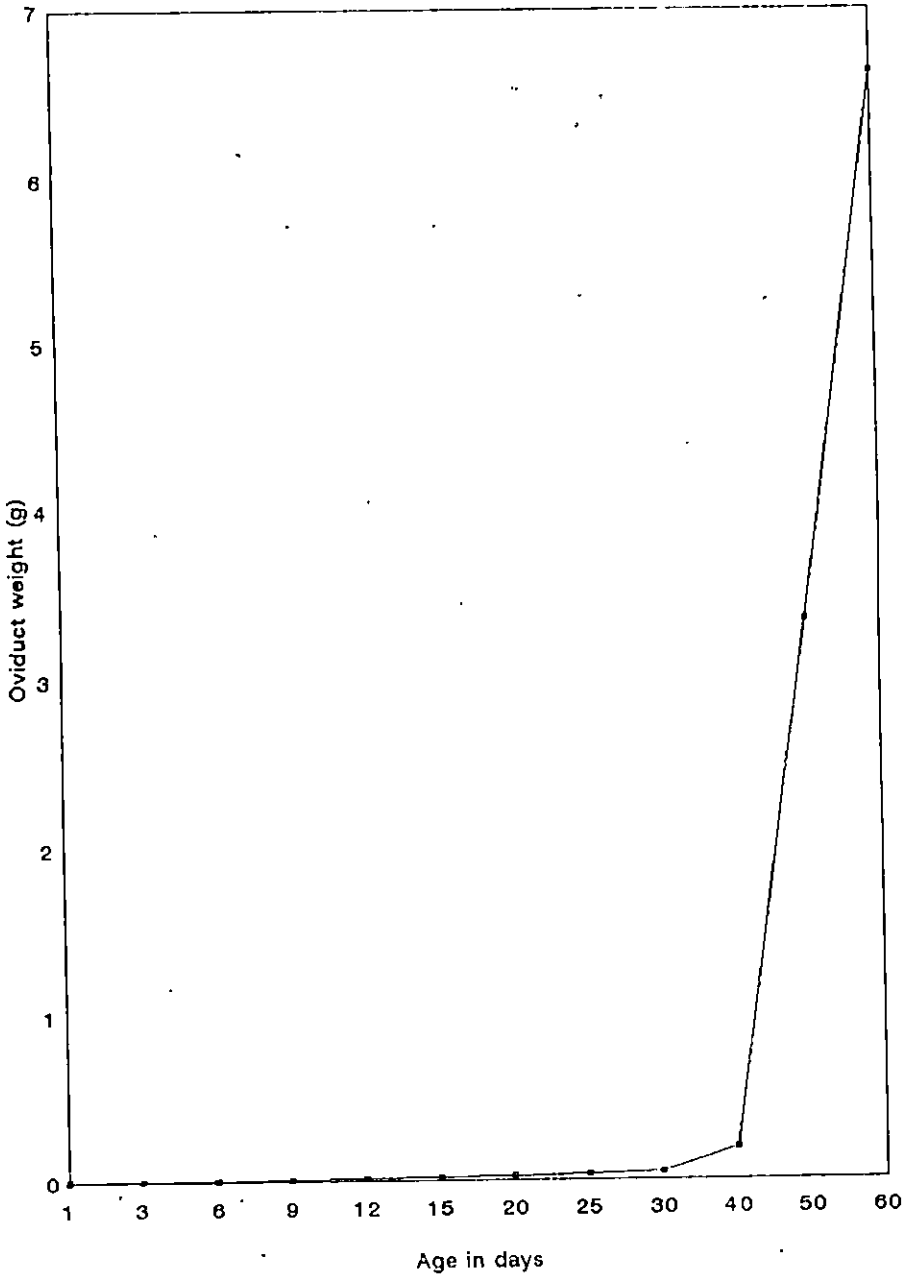

Fig.6 RELATION BETWEEN OVIDUCT LENGTH AND AGE

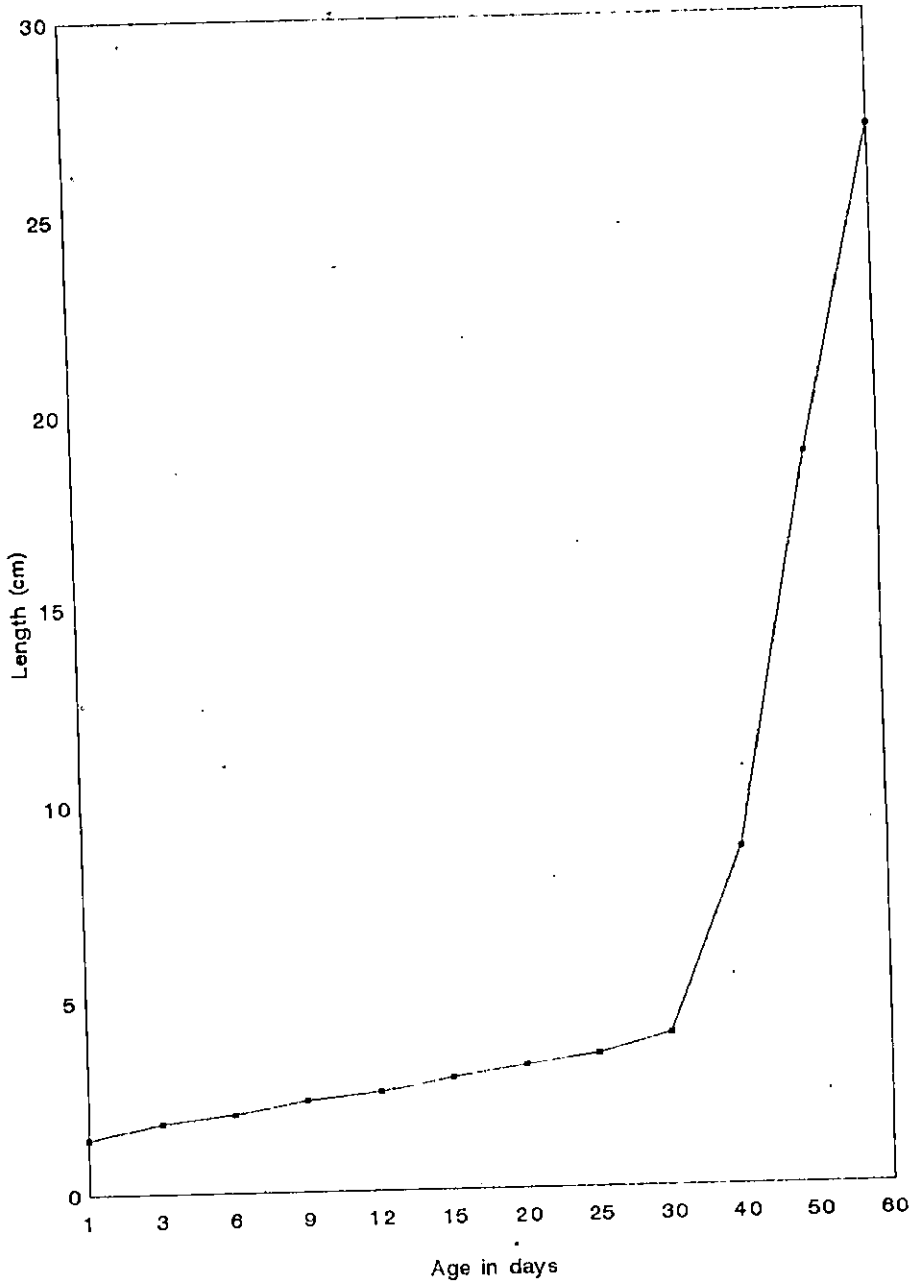

Fig.7 COMPARISON BETWEEN THE LENGTH OF OVIDUCT SEGMENTS AT DIFFERENT AGES

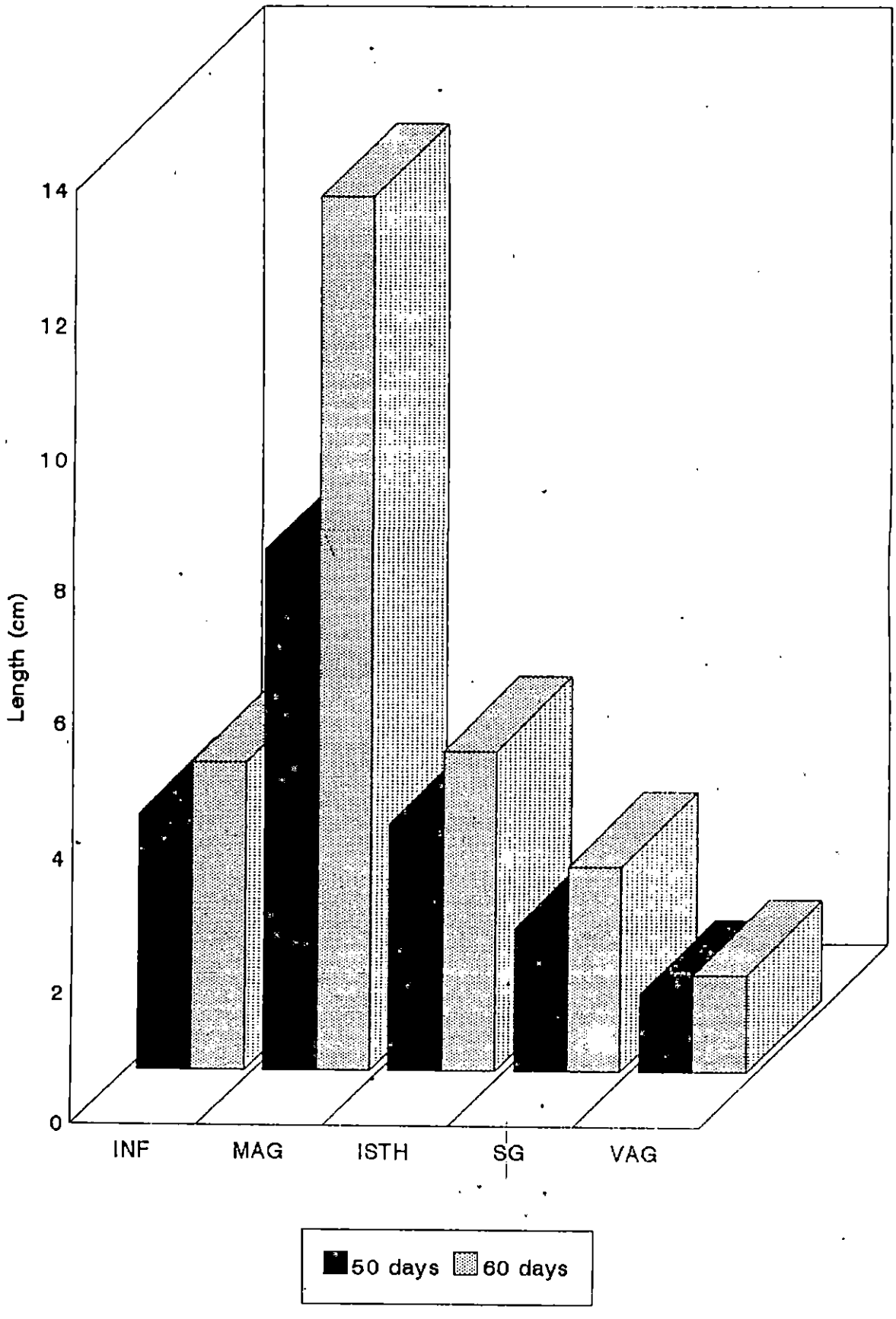

Fig.8 Ovary and oviduct (extended) of the adult Japanese quail containing an egg

Fig.9 C.S. of the cranial region of the oviduct (day-old). H & E. x 400

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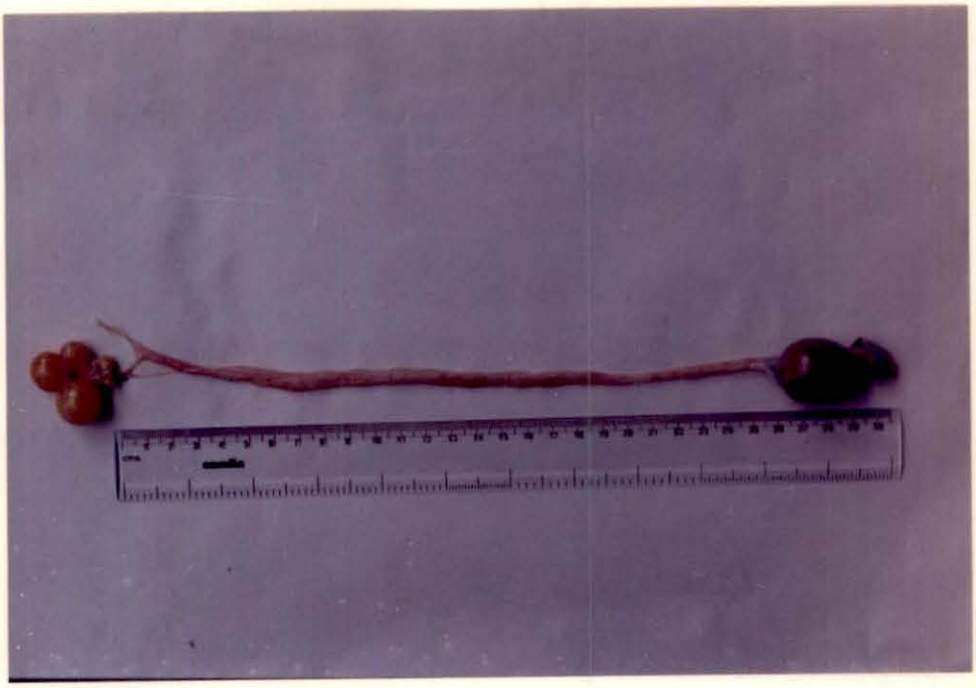


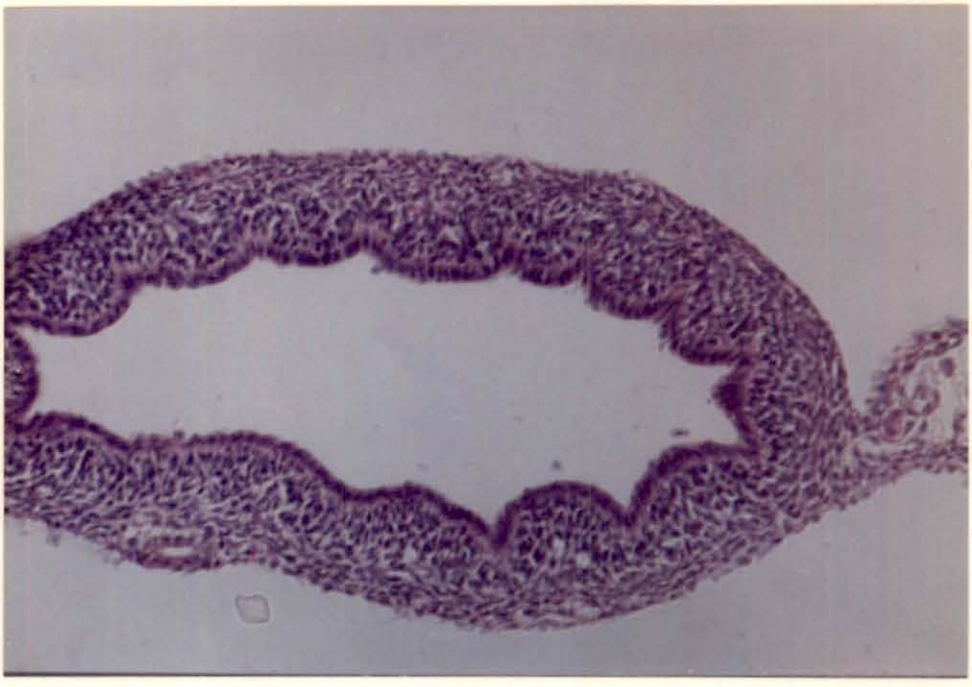
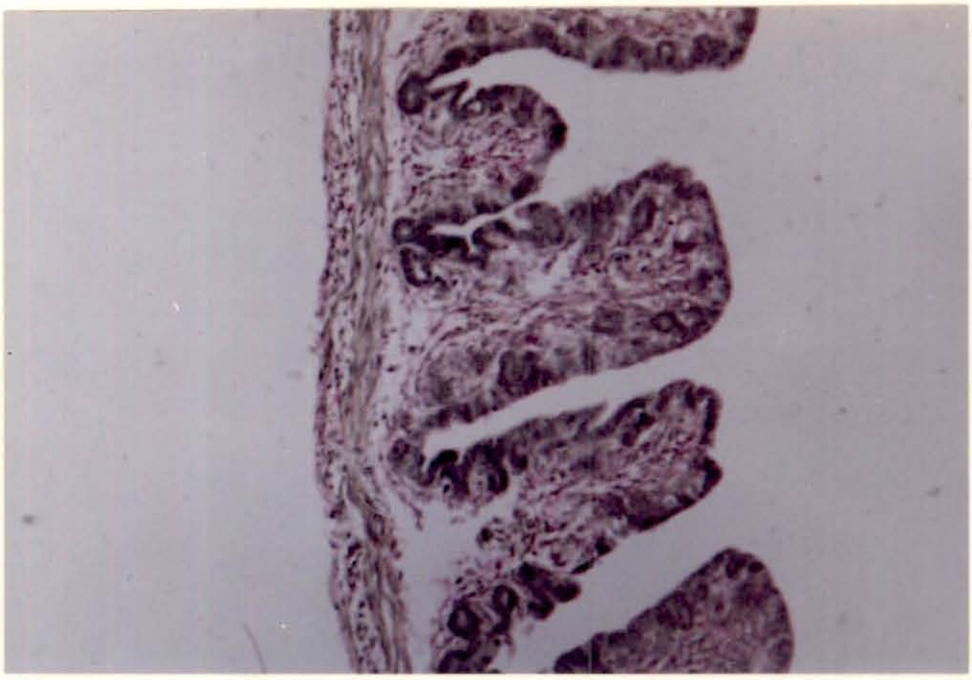


Fig.10 C.S. of the cranial region of the oviduct showing primary folds and glands (40 days). van-Gieson's staining.x160

Fig.11 C.S.of the funnel of infundibulum showing secondary folds (60 days).H & E. x 160



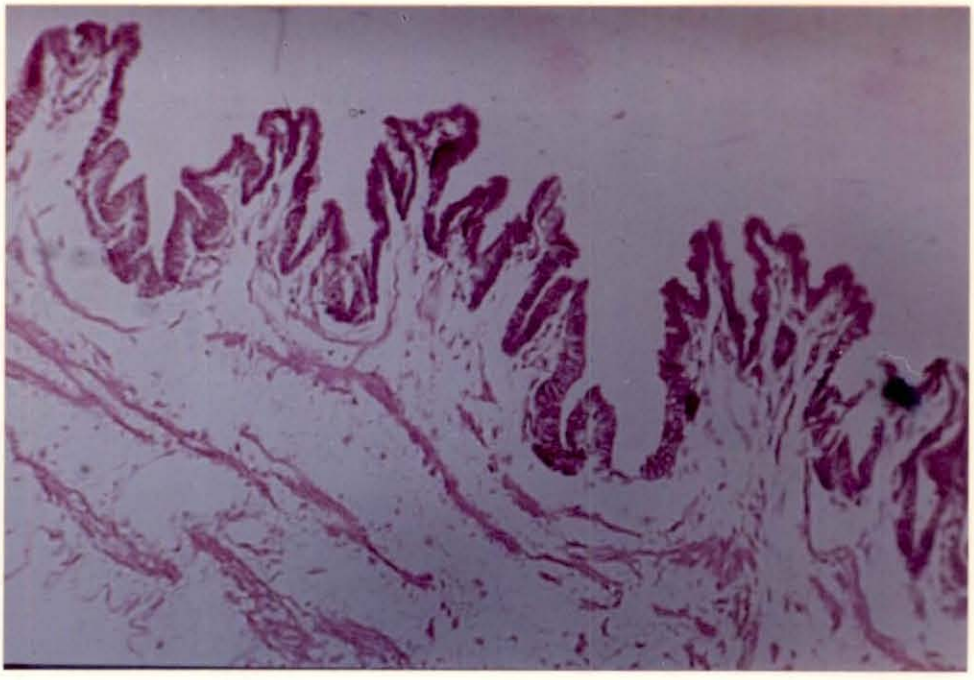
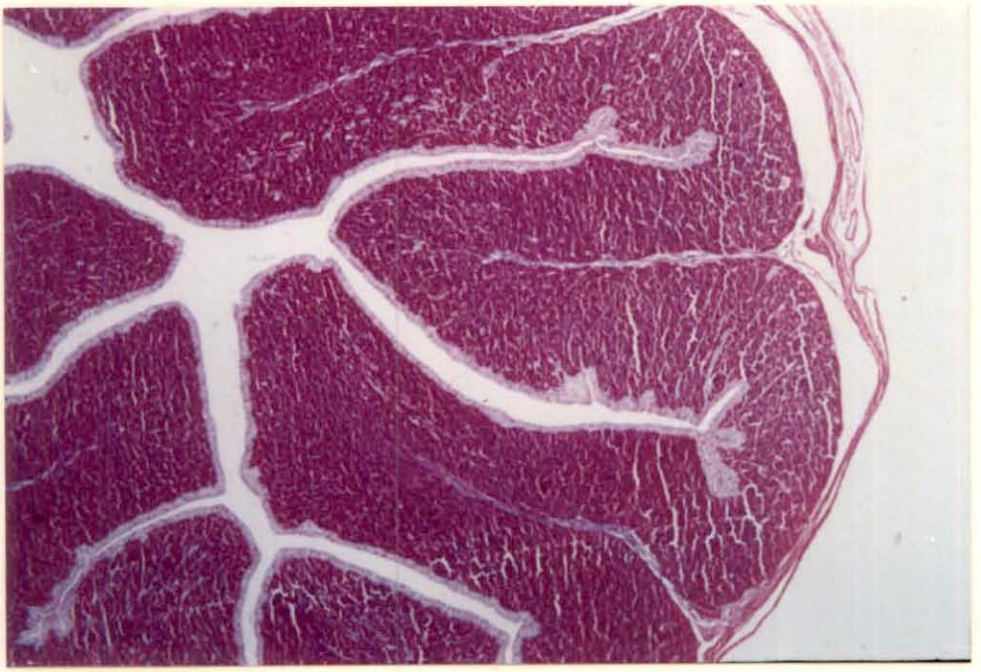


Fig.12 C.S. of the neck of infundibulum showing the mucosal folds and glands (60 days). H & E. x 160

Fig.13 C.S. of the magnum showing well developed mucosal folds and tubular glands (60 days). Gomori's rapid one step trichrome method.x60



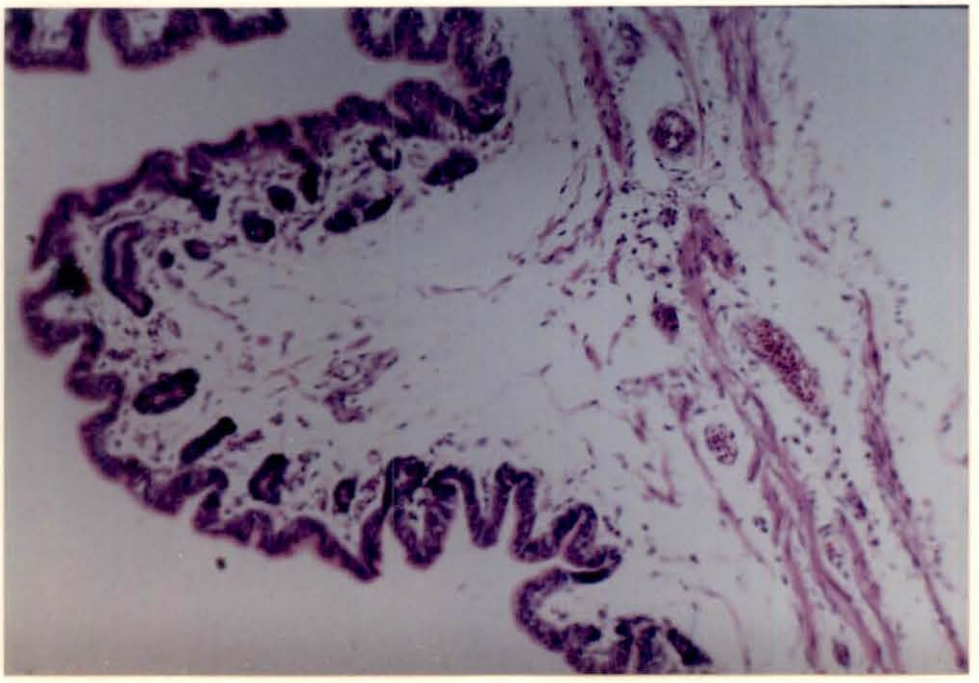
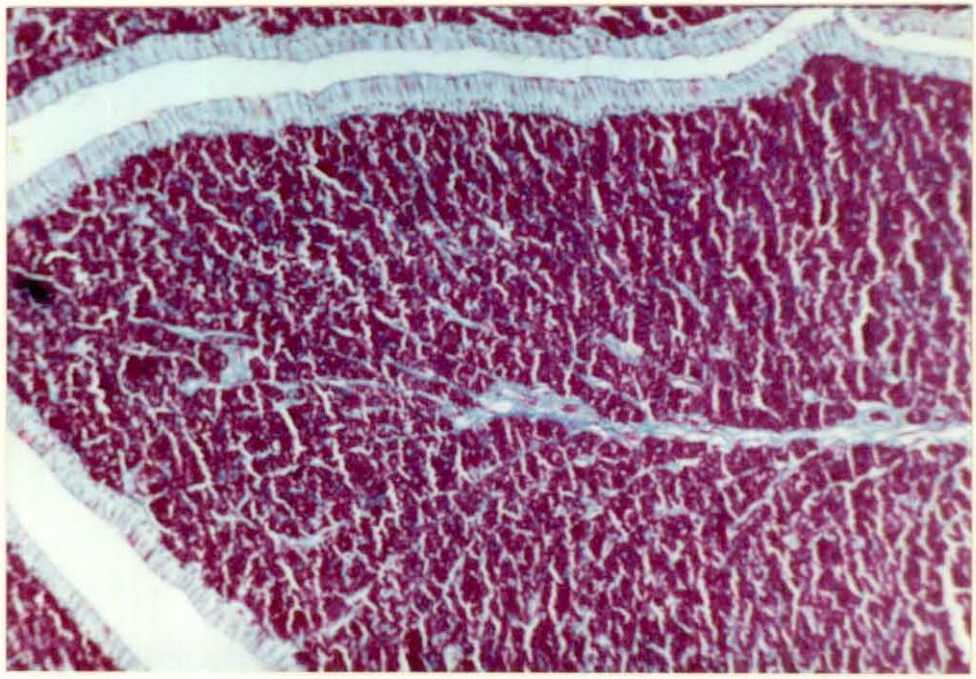


Fig.14 C.S. of the magnum showing epithelium and core of mucosal fold with collagen fibres (60 days). Gomori's rapid one step trichrome method. x 160

Fig.15 C.S. of the magnum showing the lining epithelium with goblet cells (60 days). PAS. x 250



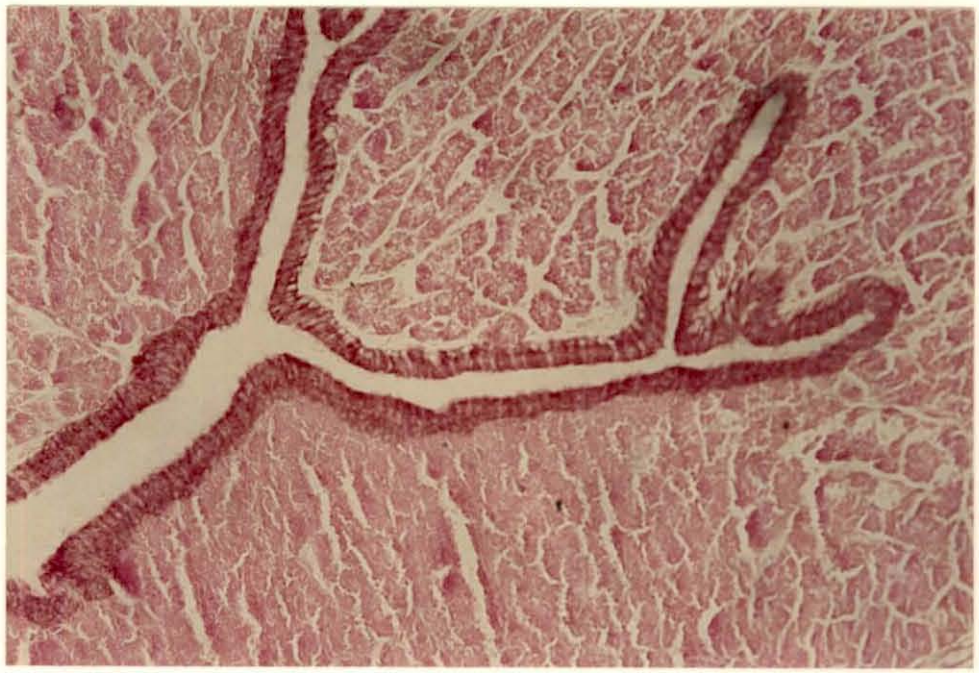
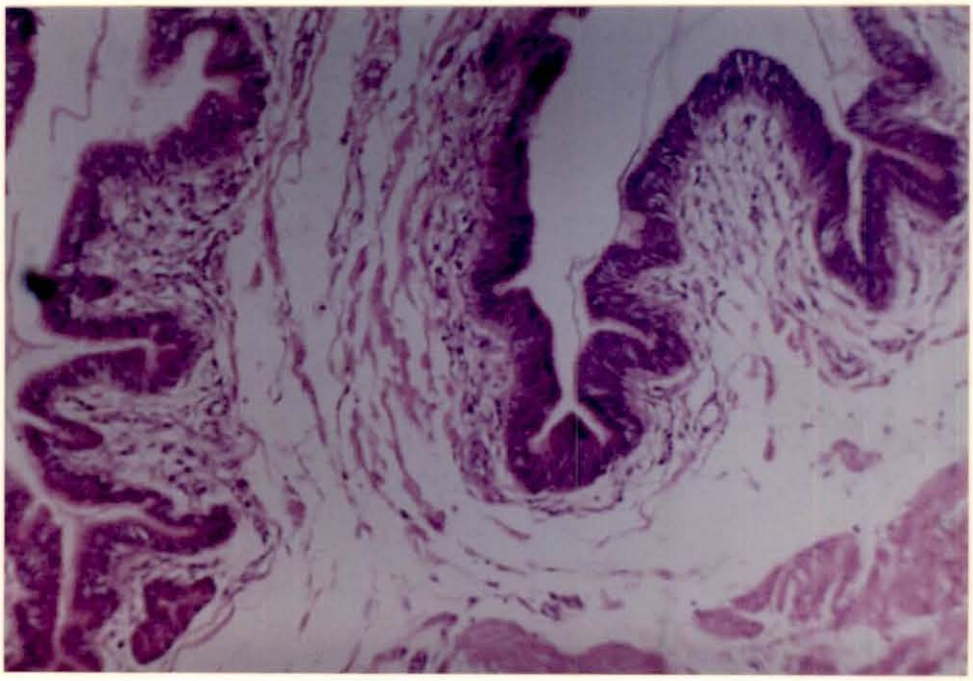


Fig. 16 C.S. of the magnum isthmus junction showing mucosal folds with and without glands (60 days). H & E. x 160

Fig. 17 C.S. of the isthmus showing angular mucosal folds (60 days). Gomori's rapid one step trichrome method. x 160



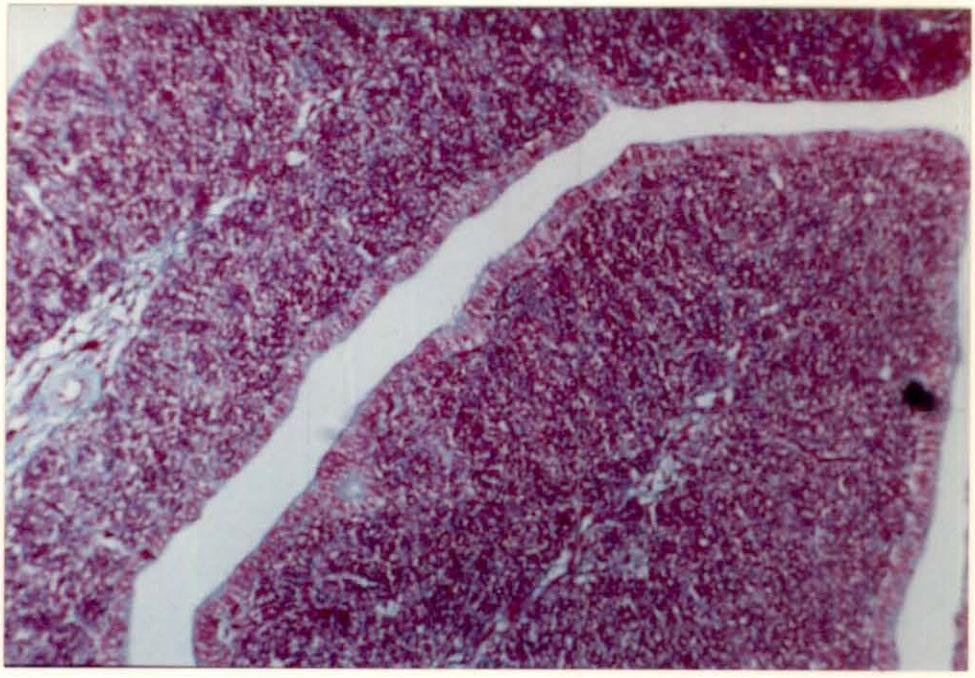
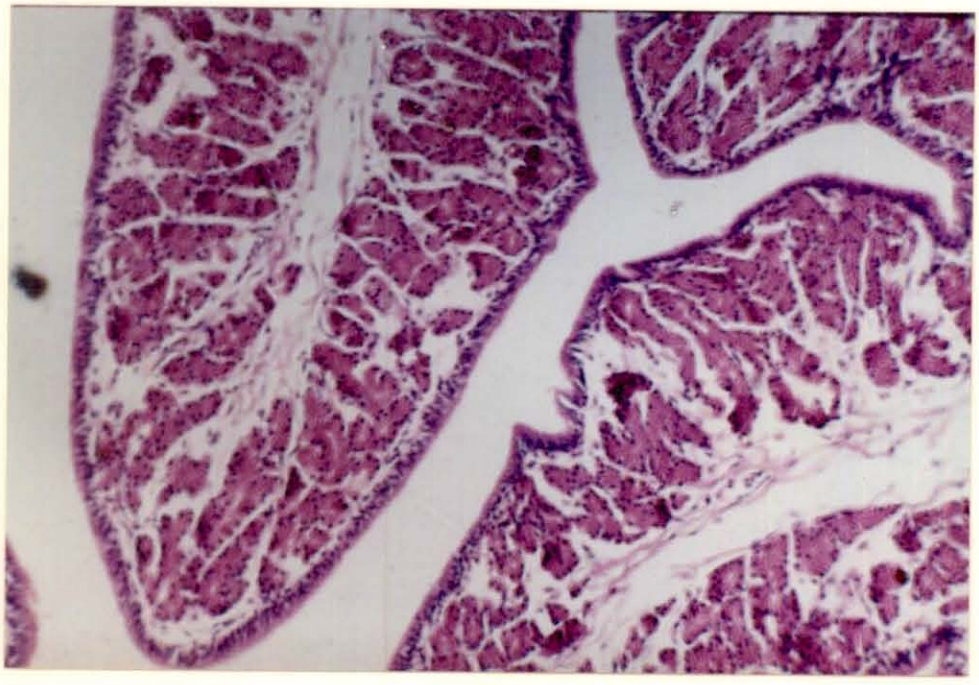


Fig. 18 C.S. of the isthmus showing the lining epithelium containing apical glycogen granules (60 days). Best's Carmine.x 250

Fig. 19 C.S. of the isthmus showing loosely arranged tubular glands (50 days). H & E. x 160



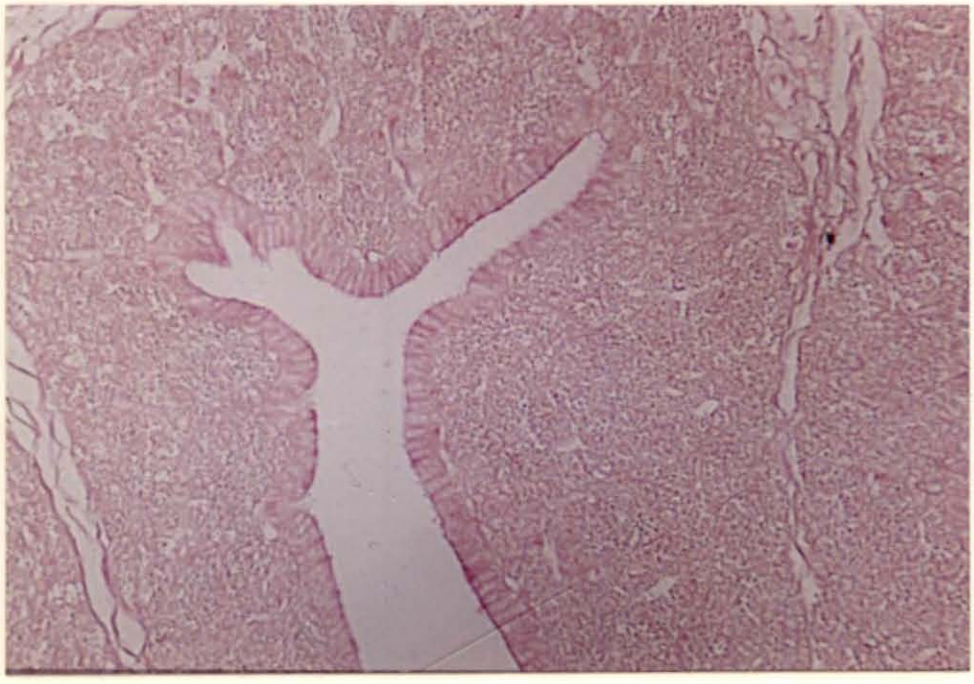
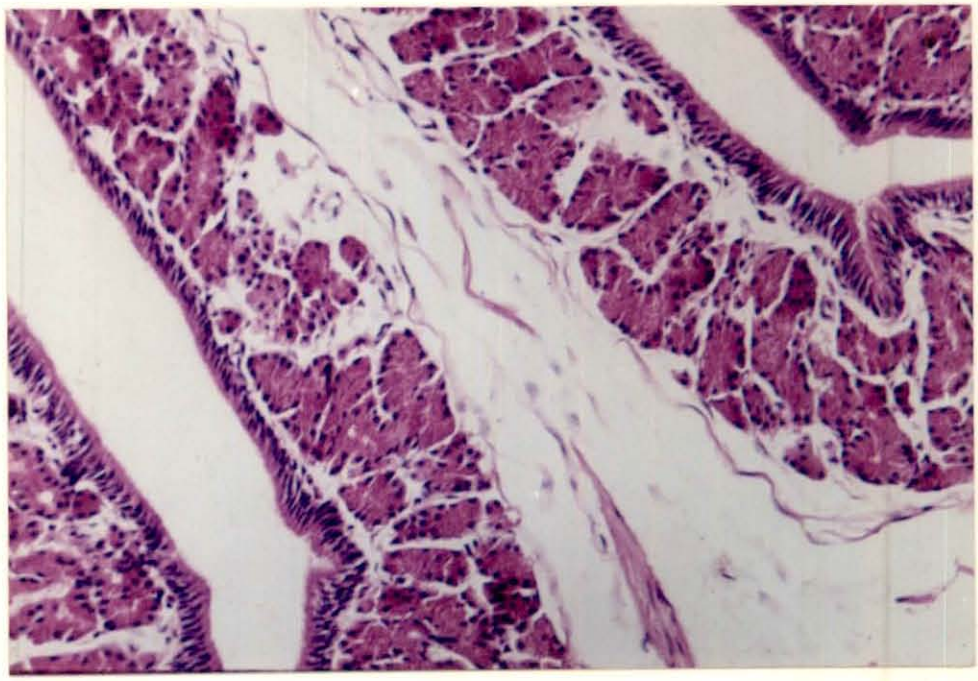


Fig. 20 C.S. of the isthmus showing wide connective tissue core (50 days). H & E. x 250

Fig. 21 C.S. of the isthmus showing the collagenous core of mucosal fold (60 days). Gomori's rapid one step trichrome method. x 160



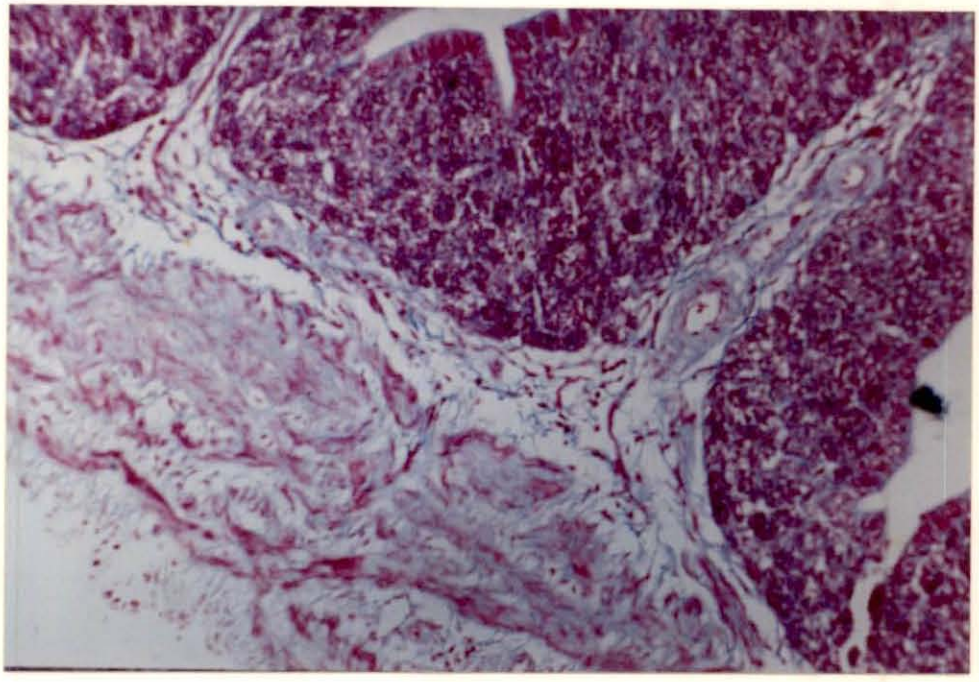
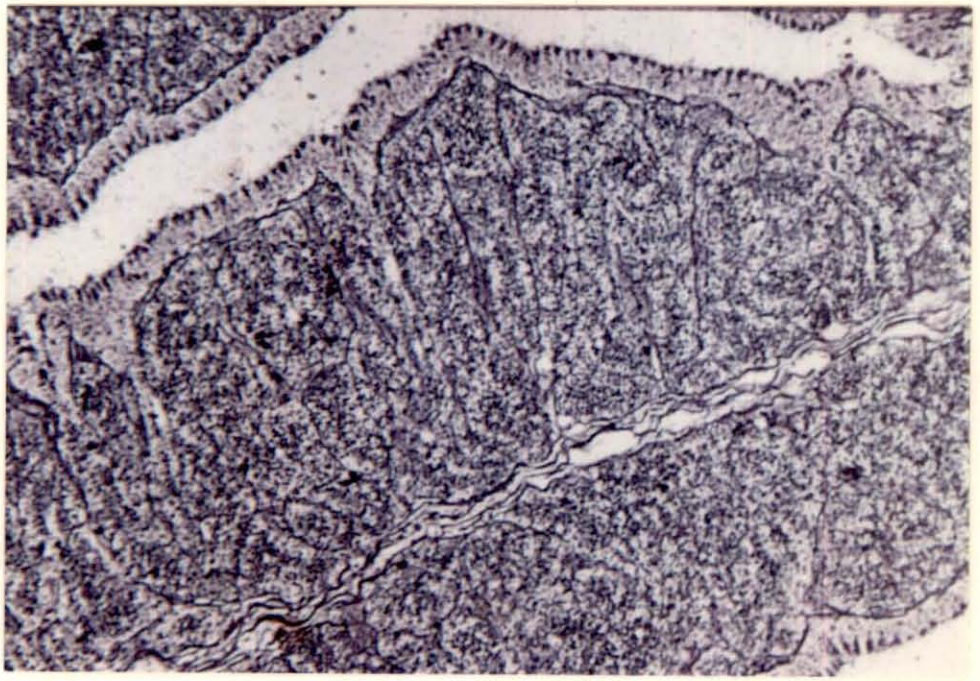


Fig. 22 C.S. of the isthmus showing reticular fibres in the propria (60 days). Gomori's reticulin method. x 250

Fig. 23 C.S. of the uterus showing primary, secondary and tertiary mucosal folds (40 days). H & E. x 160



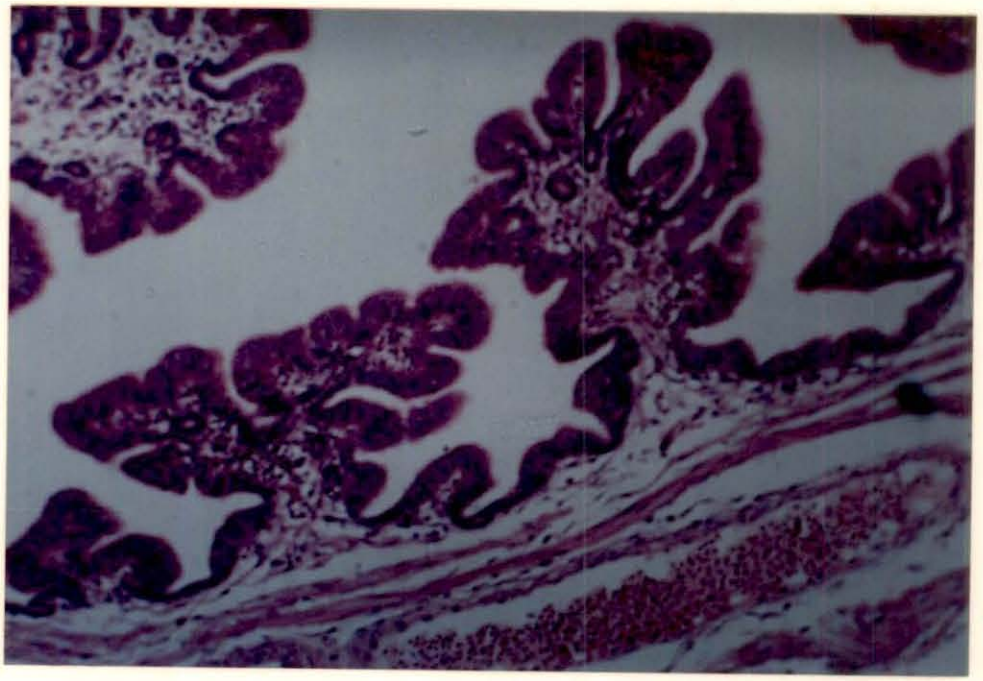
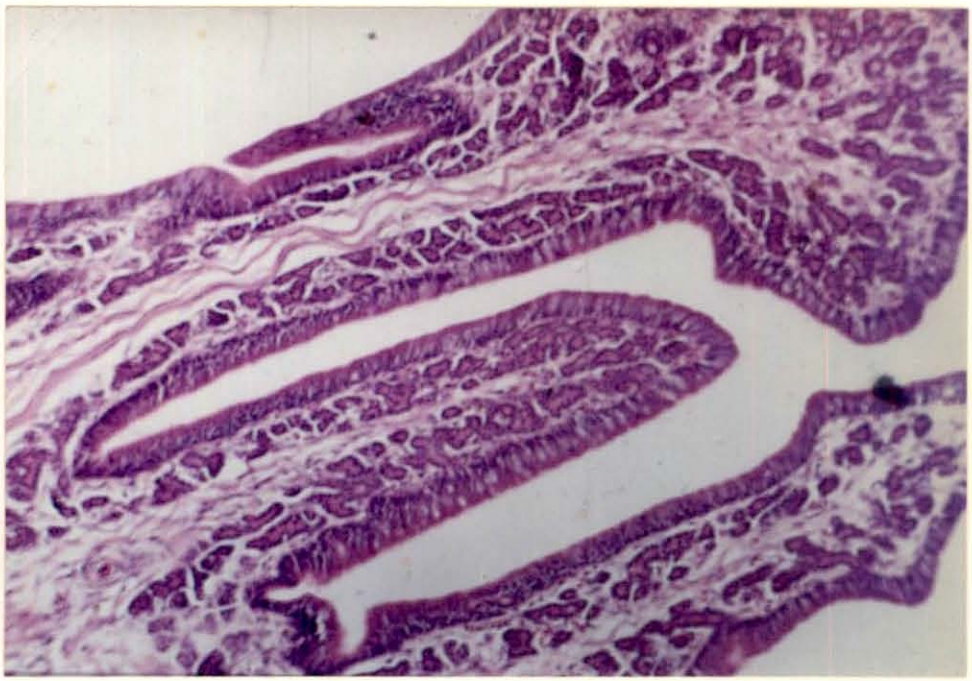


Fig. 24 C.S. of the uterus showing spatula-shaped folds (60 days). H & E. x 160

Fig. 25 C.S. of the uterus showing glands and lining epithelium with apical and basal cells (60 days). H & E. x 250



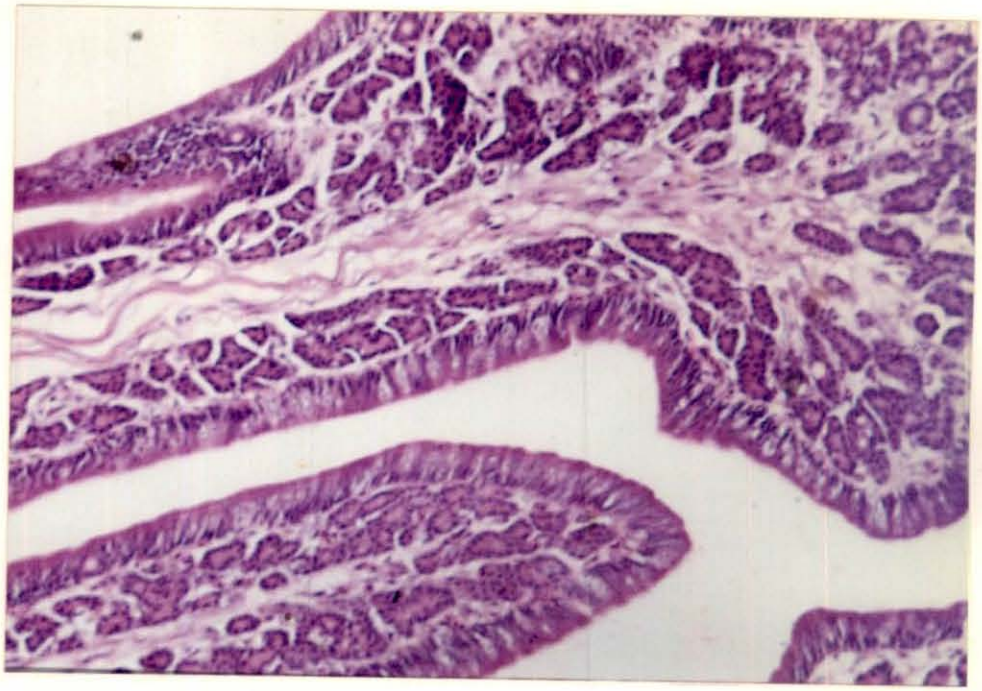
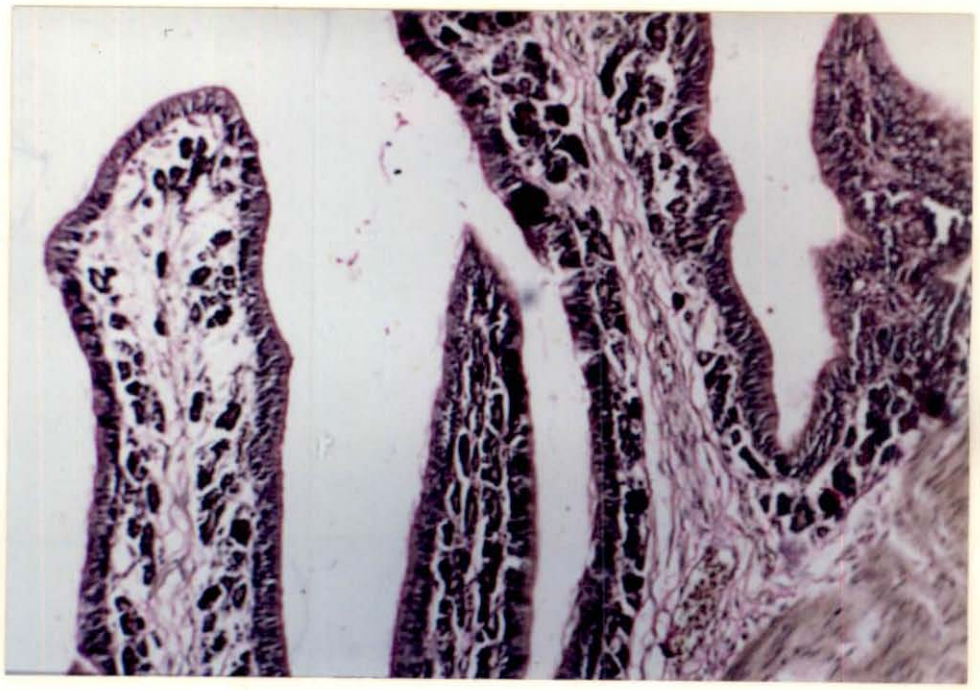


Fig. 26 C.S. of the uterus showing the core of mucosal folds containing collagen and elastic fibres (60 days). Verhoeff's haematoxylin method. x 160

Fig. 27 C.S. of the uterus showing well developed tunica muscularis (60 days). van-Gieson's staining. x 160



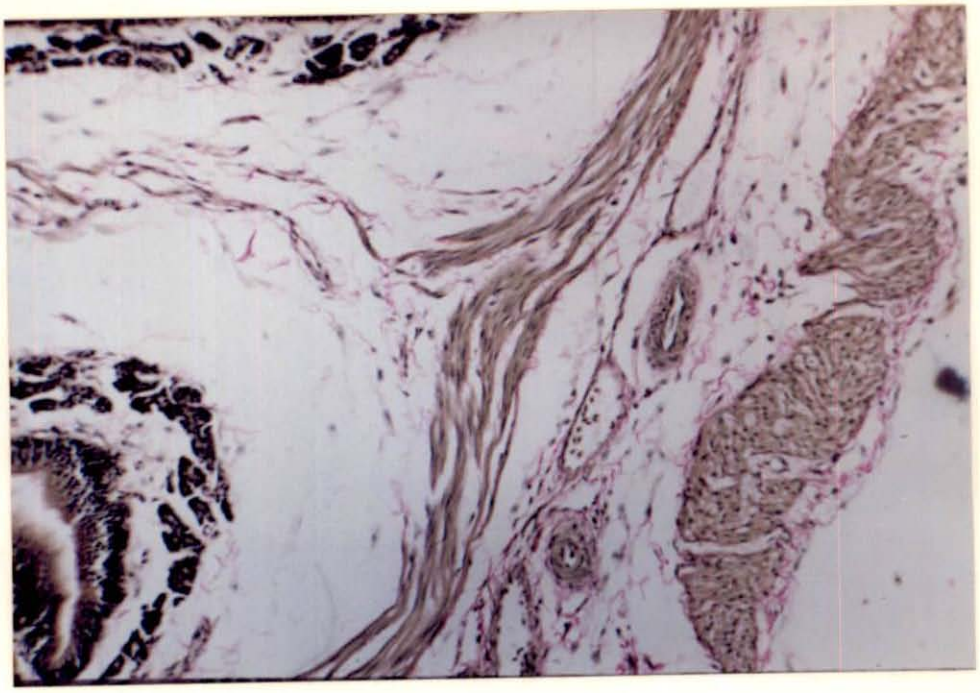
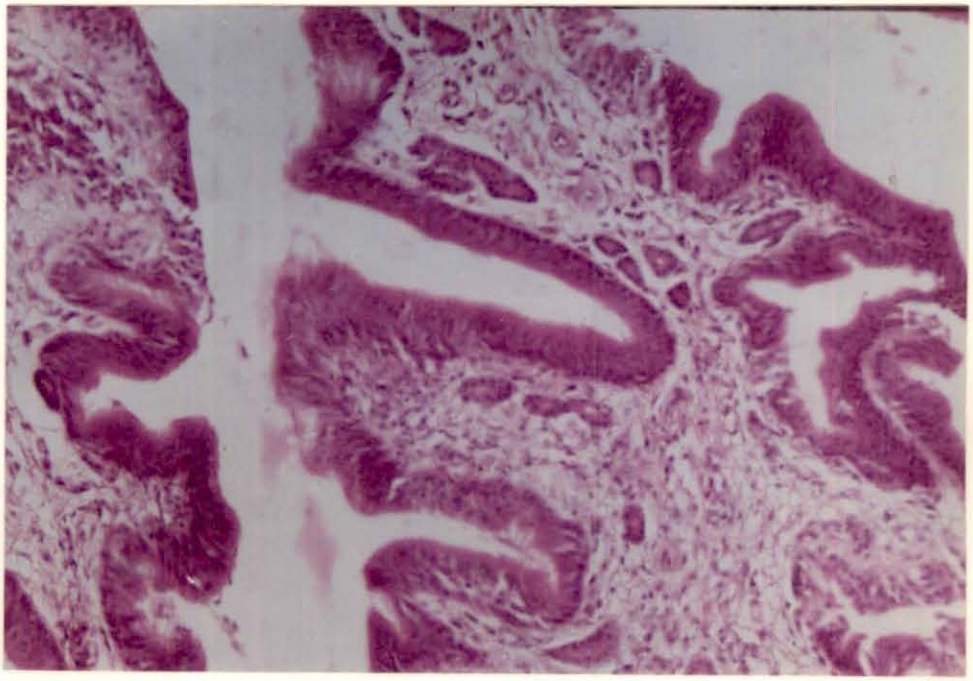


Fig. 28 C.S. of the utero-vaginal junction showing sperm-host glands in the lamina propria (60 days). H & E. x 250

Fig. 29 C.S. of the utero-vaginal junction showing lipids in the sperm-host glands (60 days). Osmium tetroxide method. x 250



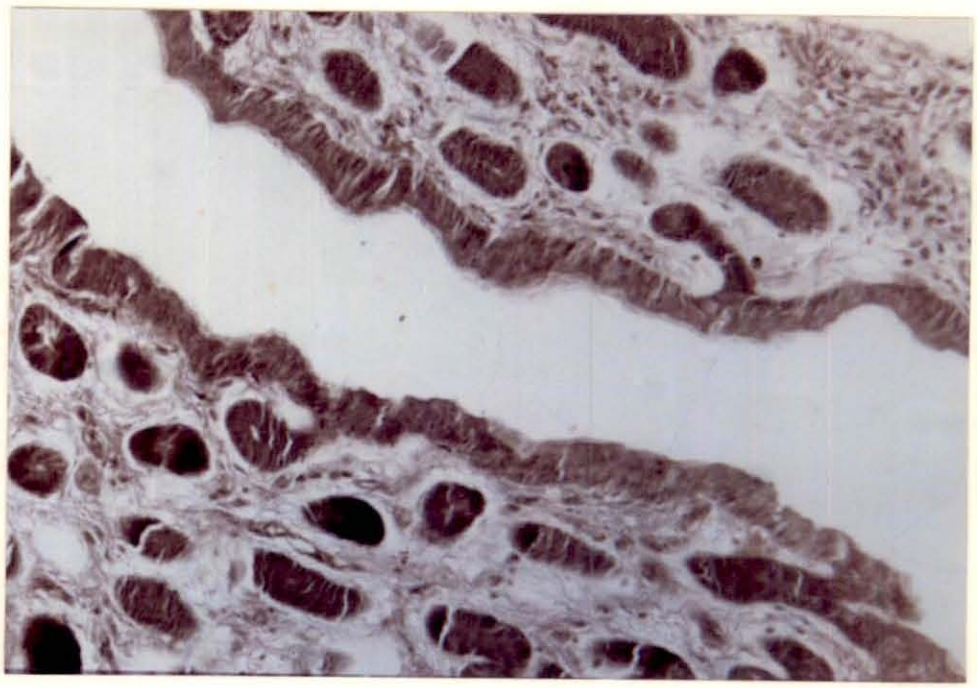
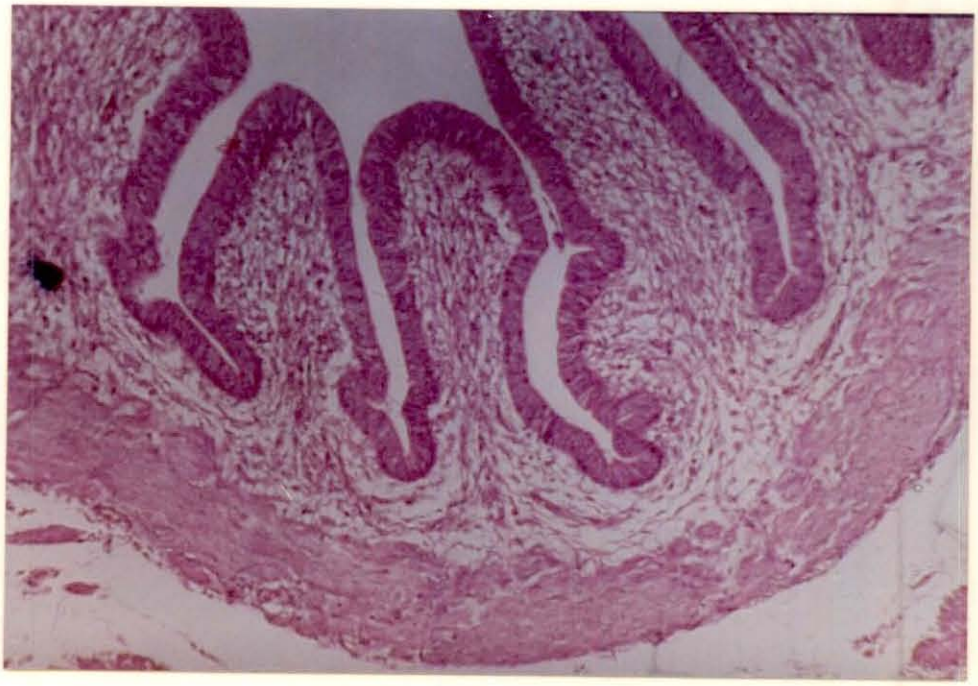


Fig. 30 C.S. of the vagina showing primary and secondary folds (40 days). H & E. x 160

Fig.31 C.S. of the vagina showing narrow mucosal folds (60 days). H & E. x 160



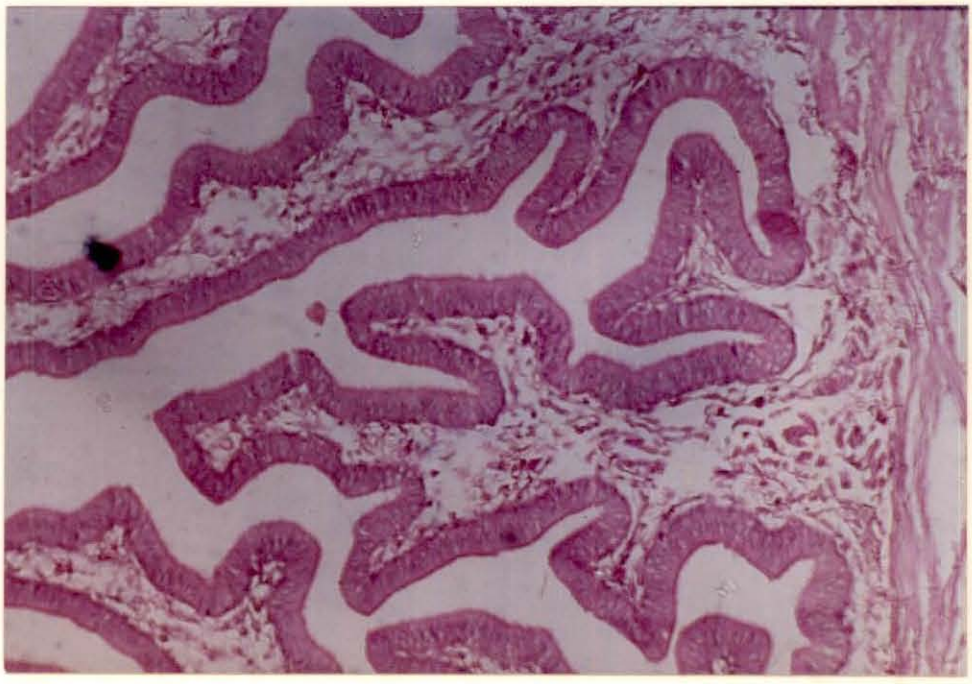
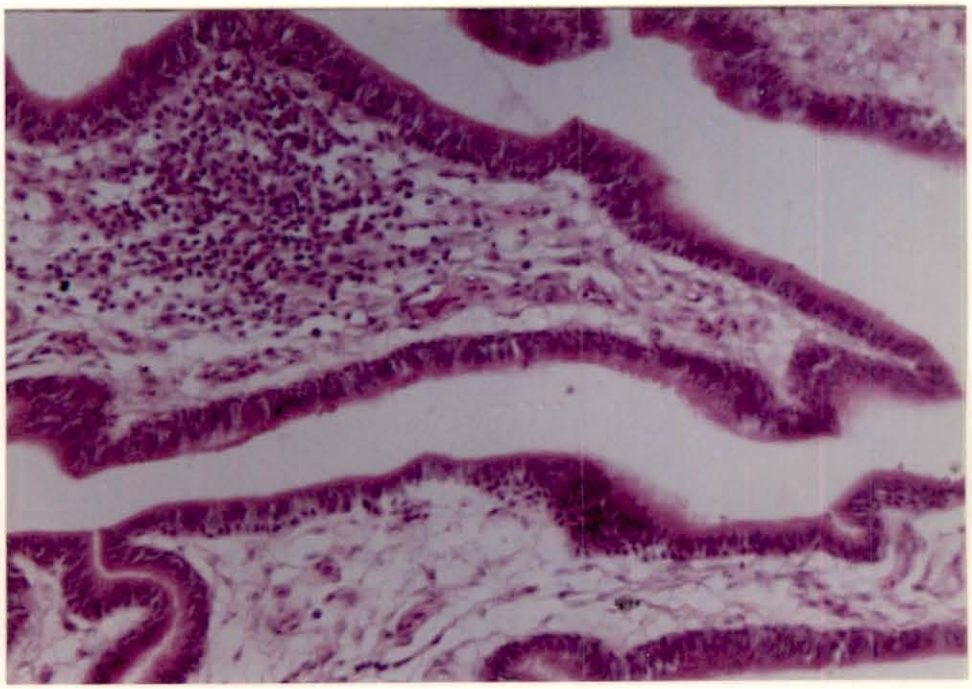


Fig. 32 C.S. of the vagina showing lymphoid aggregates in the lamina propria (40 days). H & E. x 160

Fig. 33 . C.S. of the vagina showing thick muscular layer (60 days). H & E. x 160



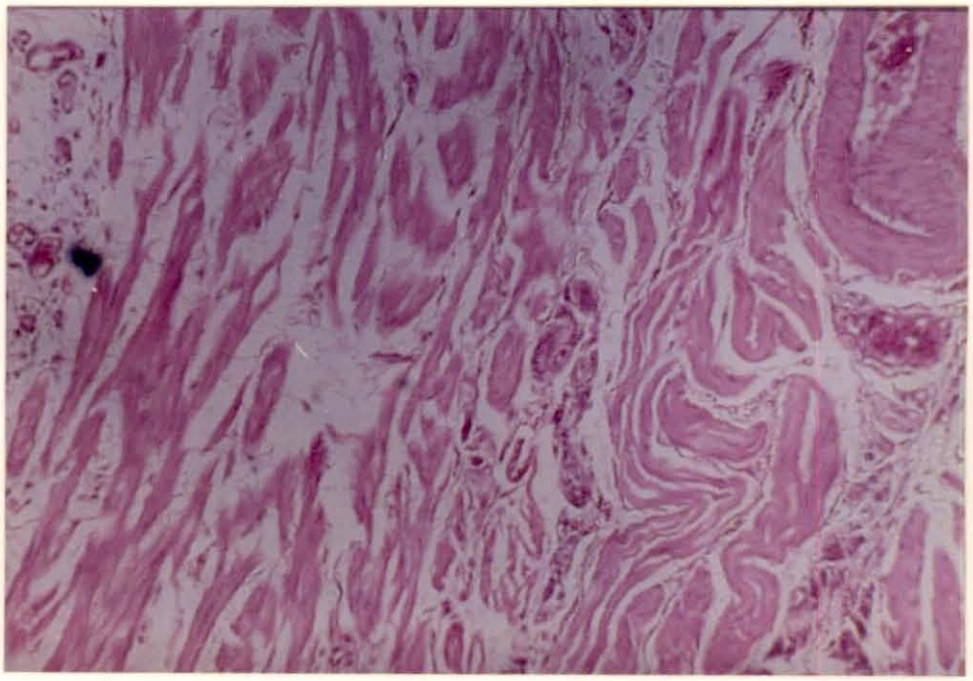
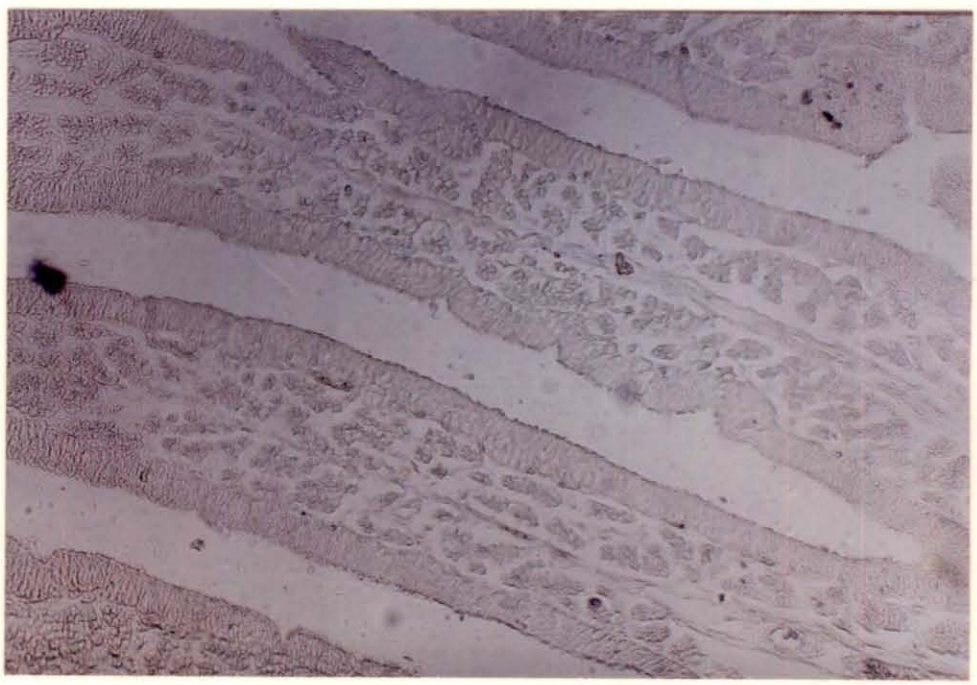


Fig. 34 C.S. of the uterus showing alkaline phosphatase activity in the lining epithelium and glands (60 days). Gomori's calcium phosphate method. x 160



Discussion

DISCUSSION

Gross anatomy

The oviduct in the day-old quail chicks occurred as a tiny white translucent tube along the left side of the body cavity, supported by peritoneal folds-the dorsal and ventral ligaments. A similar observation was made in the fowl by Nickel et al. (1977). Kar (1947) also reported the presence of dorsal and ventral ligaments in the fowl which confirmed the findings of the present work.

The oviduct was a straight tube upto 20 days of age and the signs of coiling were evident from 25 days of age. The size and relations of the highly convoluted adult oviduct depended on its functional state. The present results confirmed the earlier observations of Surface (1912) and Kern (1963) who stated that in the non-laying fowls, the oviduct occupied the left half of the coelom ventral to the left kidney, but, the oviduct containing a developing egg extended towards the right side also, displacing the intestines ventrally and to the right.

Growth

The increase in weight and length of oviduct in quail was slow and in accordance with the growth of the bird upto

30 days of age. Rapid changes in the development of the organ occurred between 30 and 40 days of age. Weight of the oviduct increased about 17 times between 40 and 50 days of age. The adult weight was attained between 50 and 60 days of age. Contrary to this Pageaux et al. (1984) reported that the oviduct in quail started to grow very rapidly between 21 and 28 days of age and reached adult weight by 45 days. These variations might to be due to the difference in the managemental practices. Fitzgerald (1969) reported that functional maturity of the quail oviduct was attained by six to seven weeks of age, which is in agreement with the present results. The contribution of oviduct to body weight was 4.05% at 60 days of age. The various segments of the oviduct viz. infundibulum, magnum, isthmus, uterus and vagina were not clearly differentiated upto 40 days of age in the present study. Similar reports in the quail are not available for comparison.

Infundibulum

In the day-old quail chicks, the infundibulum was not differentiated. The oviduct was a simple continuous tube upto 40 days of age. The funnel region of the infundibulum in the adult birds was very thin and its flared lips lay in close proximity to the ovary at the time of ovulation to

receive the ovum. But Rao Saheb and Iyengar (1945) stated that the infundibulum was not fimbriated in the fowl. The funnel wall converged to form the narrow neck region. Infundibulum was relatively longer and contributed 17.1% of the total length of the oviduct. But in chicken and turkey, Woodard and Mather (1964) observed a relatively short infundibulum.

Magnum

Magnum was undifferentiated in the early stages. In the differentiated oviduct, this was found to be the longest and most coiled segment. The contribution of magnum to the total length was 48.3% in the quail. Similar observations have been made in most of the domestic birds by many workers with slight differences in the proportion of measurements. Romanoff and Romanoff (1949) reported maximum amount of coiling for this region in the fowl. Rao Saheb and Iyengar (1945) and Marshall (1947) noticed that the magnum made up more than 50% of the total length of oviduct. The overall diameter was considerably greater than that of the neck, the increase being mainly due to a marked increase in the thickness of the walls. In the terminal region, the diameter gradually reduced to that of the isthmus.

Isthmus

The junction between magnum and isthmus in quail was marked by a narrow translucent zone, as noticed by Anita (1971). A comparable translucent zone was reported in the fowl by Solomon (1975). Isthmus in quail was about 4.78 cm long which contributed to about 17.7% of the total oviduct length. In the chicken and turkey, Woodard and Mather (1964) observed that the isthmus was relatively shorter. This may account for the thicker shell memberane of the coturnix egg as compared to that of the chicken since the developing egg spends more time in the isthmus. Overall diameter of the isthmus was less than that of the magnum.

Uterus:

In the day-old quail chick itself, the uterine region could be distinguished by a small dialatation located between the 14th lumbosacral segment and the third caudal vertebra. Uterus of the adult quail was sac-like expanded region as reported by Romanoff and Romanoff (1949) in the fowl. It was dark grey in colour in the fresh state and measured 3.08 cm in length and 2.1 cm in width. In comparison to that of the chicken and turkey, this region was relatively short which is in accordance with the observations of Woodard and Mather (1964). The wall of the uterus was thin compared to that of the magnum and isthmus, but was more distensible.

Vagina:

Vagina in the quail was a short S-shaped tube as reported by Bradley (1960) in the fowl. Externally, fibrous bands held the region of the vagina close together. It was relatively shorter in the quail than in the chicken and turkey, which supports the findings of Woodard and Mather (1964). Posteriorly, the vagina opened into the urodeum of cloaca.

Microscopic anatomy

Infundibulum

In the day-old quail chick, cranial end of the oviduct corresponding to the infundibulum consisted of low primary mucosal folds lined by simple columnar epithelium and subepithelial connective tissue containing densely packed cells with fine collagen and reticular fibres. Externally there was a thin collagenous covering. Reports on the infundibulum of the day-old quails are not available for comparison.

The dorsal and ventral ligaments were present even in day-old birds. Dorsal ligament was very thin with collagen fibres and cells. Ventral ligament possessed smooth muscle tissue also. In addition to the supporting function,

contraction of the smooth muscle of the ventral ligament has been reported to help the fimbriated end of the infundibulum to come in close contract with the ovary at the time of ovulation for engulfing the ovum (Aitken, 1971).

Structural changes in the oviduct were more evident between 30 and 40 days of age. A higher number of luminal epithelial cells and the increase in height of the mucosal folds indicated entry into a rapid growth phase. This observation supports the findings of Pageaux et al. (1986).

The funnel region of the infundibulum in the adult quail possessed numerous low and narrow mucosal folds with many secondary folds. This was similar to the observations of Bradley (1960) in the fowl and Stott et al. (1966) in the quail. Lining epithelium consisted of ciliated columnar cells and goblet cells as noticed by Tamura and Fujii (1966) and Sandoz and Ulrich (1976) in quail. At the bases of the grooves between the mucosal ridges, there were accumulation of secretory cells. Such region have been described as "glandular grooves" by Aitken and Johnston (1963). Lamina propria was devoid of glands. Collagen fibres, fine reticular fibres and a few elastic fibres could be noticed in the region. Geetha et al. (1992) observed elastic and reticular fibres in the propria, but no mention was made

about the collagen fibres. Tunica muscularis consisted of circularly arranged fibres and scattered bundles. But in the fowl, only scattered bundles of muscle fibres were reported by Hodges (1974). Between the muscularis and serosa, well developed blood vessels and loose connective tissue were noticed.

Within the neck of the infundibulum, the mucosal folds were very high with primary, secondary and tertiary folds. Lamina propria showed tubular glands, the presence of which has been reported by many workers in various species of birds (Romanoff and Romanoff, 1949 and Bradley, 1960). Cells of the secretory end piece showed intense PAS activity. Thickness of the tunica muscularis increased in the neck region with inner circular and outer irregular bundles. In the case of fowl, ill-defined circular and longitudinal bundles were reported by Hodges (1974). Scattered lymphocytes could be identified in the infundibulum of quail oviduct which agreed with the findings of Biswal (1954), Trautmann and Fiebiger (1957), Bradley (1960) and Kimijima (1989) in the fowl. However, Das and Biswal (1968) reported that these cells were not present in the oviduct of duck.

Infundibulum is the site of fertilization since the sperm can not penetrate the ovum after it is covered by albumen. Aitken (1971) concluded that formation of the outer

layer of perivitelline membrane and chalazae begins in the infundibulum. Ovum remains in the infundibulum for about 30 minutes.

Magnum

Immature magnum was similar in structure to that of the infundibulum except that the primary folds were more prominent. Developmental changes were also similar to those of the neck of infundibulum. This agrees with the findings of Pageaux et al. (1986) in the quail,

In the adult bird, mucosal ridges of the magnum were considerably higher and wider, the greater part of this development being due to the intense development of tubular glands. A similar observation was made by Das and Biswal (1968) in duck and Wyburn et al. (1970) in fowl. In this study 14 to 19 primary folds with a few secondary folds were noticed in the magnum. In the fowl, Mc Lelland (1990) distinguished on an averge 22 well developed primary folds with no secondary folds.

The epithelium lining the magnum was of the ciliated columnar type with goblet cells. Aitken (1971) also made a similar observation. The columnar cells possessed basal spherical nucleus and basophilic cytoplasm. Goblet cells presented broad apical regions containing numerous mucin

granules.

The tubular glands of the magnum were lined by pyramidal cells with basal spherical nucleus and eosinophilic cytoplasm as observed in the fowl by Davidson et al. (1968). Aitken (1971) reported that these cells secreted the bulk of egg white protein. Core of the epithelial folds were formed of collagen fibres and fine reticular and elastic fibres. Musculature consisted of very thin circularly arranged bundles. Scattered lymphocytes could also be noticed as reported in the fowl by Kimijima (1989). In the magnum region of quail, ovum spends 2-2½ hours (Woodard and Mather, 1964).

Magnum-isthmus junction

This region was clearly demarcated by a narrow, translucent zone. A similar observation was made by Anita (1971) in quail and Solomon (1975) in fowl. This region was characterized by thin mucosal folds with several secondary folds. Glands were absent in this zone.

Isthmus:

Structure and development of the immature isthmus were similar to those of the other regions.

The mucosa in the adult oviduct was thrown into 19 to 22 longitudinally oriented folds with several secondary folds, whereas Anita (1971) observed 20 to 30 folds in the quail which branched occasionally. These folds were angular and narrower than those of the magnum. Lining epithelium was pseudostratified and apex of the cells presented glycogen granules. This supported the observation of Anita (1971) who obtained a positive reaction for β-glucuronidase in the apical region of the ciliated cells in the quail. This may contribute to the carbohydrate portion of the shell membrane as suggested by Draper et al. (1972) in the fowl. The goblet cells possessed numerous mucigen granules in the supranuclear region.

In 50 days old birds, lamina propria was loosely packed with tubular glands with a proportionately wider connective tissue core. In the adult, propria was tightly packed with glands. Each secretory end piece was lined by pyramidal cells containing numerous eosinophilic granules. Anita (1971) reported similar type of granules which were PAS-positive and inferred that these granules contained neutral mucopolysaccharides and sulphur-containing proteins. Scattered lymphocytes could also be noticed in the lamina propria of present material which supported the report of Kimijima (1989) in fowl. But Das and Biswal (1968) could not observe these cells in the duck isthmus.

Muscle layer consisted of inner circular and outer poorly developed longitudinal smooth muscle separated by a layer of loose connective tissue and blood vessels, as reported by Anita (1971).

Isthmus is the site of shell membrane formation. Here ovum remains for 1½-2 hours (Woodard and Mather, 1964). Creger et al. (1976) and Stemberger et al. (1977) demonstrated that the shell deposition was actually initiated in the isthmus.

Uterus

This region was found to be wider than the other portions in the day-old quail chick itself. At 15 days of age, secondary folds started developing and scattered muscle bundles could be noticed below the epithelium. Tertiary folds made their presence in 40 days old birds.

The mucosa in the mature bird was thrown into numerous long, flat, spatula-shaped folds with several secondary and tertiary folds. The findings of Surface (1912) in the fowl fully agrees with these results.

The pseudostratified ciliated columnar epithelium was exceptionally regular with alternating apical and basal cells

as observed by Tamura and Fujii (1966) in the quail. Cytoplasm of the apical cells contained basophilic secretory granules. Basal cells gave a positive PAS reaction. The secretion of the proteinaceous shell matrix and cuticle would appear to occur in the surface epithelium, the shell matrix probably being secreted by both the apical and basal cells and the cuticle by the apical cells (Johnston et al., 1963 and Aitken, 1971).

In 50 days old birds, density of the glandular tissue in the lamina propria was less. The lining cells of the tubular glands possessed basal nuclei and eosinophilic cytoplasm. Collagen, elastic and reticular fibres could be demonstrated in the lamina propria. Geetha et al.(1992) reported elastic and reticular fibres throughout the propria of the oviduct in adult quails. Scattered lymphocytes also could be noticed in the uterus as observed by Bradley (1960) and Kimijima (1989) in fowl.

Tunica muscularis was better developed than in the cranial portions of the oviduct supporting the observation made by Hodges (1974) in the fowl. Inner circular and irregular bundles were separated from the fairly thick outer longitudinal layer by loose connective tissue containing blood vessels.

In the relatively short uterus of the coturnix, egg

remains for 19-20 hours (Woodard and Mather, 1964). The exact involvement of the various parts of the uterus in the secretion of the shell remains obscure. Johnston et al. (1963) reported that the apical cells were highly active in the period immediately following the arrival of the egg in the uterus. During this period calcium deposition was reported to be minimal which suggested that the cells might be concerned, at least primarily, with the formation of the proteinaceous framework of the shell. They also observed changes in the morphology of the proprial gland cells, which prompted them to suggest that this region may be associated with the elaboration of a watery, calcium-containing fluid which gives rise to the inorganic part of the egg shell. Basal cells of the innermost epithelium were reported to be compressed by the apical cells during shell formation. But after shell deposition, when the apical cells are presumably less active, they become larger and contain more secretory granules in view of their supposed function in forming the cuticle of the shell (Johnston et al., 1963).

Utero-vaginal junction

Here the mucosal folds were narrow, long and filiform. This region showed sparsely distributed simple tubular glands, the sperm-host glands. This region has been reported

as the normal residence sites for spermatozoa (Bobr et al., 1964). These glands were lined by simple, tall columnar epithelium. The cells possessed basal spherical nuclei. These cells showed the presence of lipid droplets in the apical region which supported the findings of Gilbert et al. (1968), Tingari and Lake (1973) and Fujii (1975) in the fowl, Pal (1977) in ducks, Schuppin et al. (1984) in turkeys and Renden et al. (1981) in quails. The significance of lipid in maintaining sperm is suggested by the absence of lipid-containing vacuoles from the utero-vaginal gland cells of infertile turkeys in which normal laying is associated with an absence of sperm from these glands despite of normal insemination (Gilbert et al. 1968). Glycogen could not be demonstrated in these cells. Similar findings were made in the duck by Pal (1977) and quail by Renden et al. (1981). Contrary to this, Gilbert et al. (1968) and Tingari and Lake (1973) reported the presence of glycogen here in the chicken, and Schuppin et al. (1984) in turkeys. Apical region of these cells also gave a positive reaction for acid and alkaline phosphatase. But Renden et al. (1981) could only demonstrate acid phosphatase in these cells.

Vagina

Immature vagina showed no difference in structure from the other regions but was narrower than the uterus.

Developmental sequence was almost similar to that of the cranial regions. But no glandular development could be noticed.

Mucosal folds were longitudinal and narrow due to the absence of glands. This compares favourably with the findings in fowl (Aitken, 1971). The secondary folds were perpendicular to their parent ridges. The surface epithelium formed by ciliated cells and goblet cells was highest especially over the crests of the folds supporting the findings of Richardson (1935) in fowl. Lymphocytes in diffuse form and nodular aggregates were present in the lamina propria. Similar findings were made in the fowl by Biswal (1954), Trautmann and Fiebiger (1957), Bradley (1960) and Kimijima (1989). Contrary to this Das and Biswal (1968) reported that lymphocytes were absent in the oviduct of duck.

The most outstanding feature of vagina was a well developed tunica muscularis. The inner circular layer was more prominent. Similar observation has been reported in fowl by Romanoff and Romanoff (1949) and King (1974).

Alkaline and acid phosphatase (ALP and ACP) activities were intense in the lining epithelium and tubular glands of the quail's uterus. Similar results have been reported by Brown and Badman (1962); Wilcox and Cloud (1965) and Snapir

and Perek (1970) in fowl. In the isthmus and magnum, the activity was in the decreasing order of intensity. Similar observations were made by Kansal et al. (1980) in fowl and Darshan and Panda (1987) in quail. But solomon (1970) reported that ALP was found only in the vascular endothelium while ACP was present in the lining epitheliium and lamina propria of the uterus in fowl. Both ALP and ACP activities were almost of the same intensity in a particular segment whereas Mohan et al. (1991) observed that ACP activity was several folds higher than that of ALP in all the regions of the oviduct in hen. The intensity of these enzymes has been reported to change with the functional status (Solomon, 1970).

Summary

SUMMARY

Postnatal development of the oviduct in the coturnix quail was carried out using 72 quail chicks of day-old to 60 days of age. In the day-old birds, the oviduct could be seen as a narrow white translucent tube towards the left side of the coelom, suspended by the dorsal ligament. The lower part was connected to the ventral ligament.

The signs of coiling of the oviduct was evident from 25 days of age. The much convoluted oviduct of the adult bird completely occupied the left half of the body cavity. At the time of ovulation, the funnel of the infundibulum was seen close to the ovary.

In the initial stages, the increase in weight and length of oviduct was in accordance with the growth of the bird. Rapid changes in the development of the organ occurred between 30 and 40 days of age and a spurt in growth was noticed from 40 to 60 days of age. The contribution of oviduct to body weight was 4.05% at 60 days of age.

Infundibulum, magnum and isthmus regions were not differentiated in day-old chicks. But the uterus could be distinguished even at hatch as a small dialatation.

Differentiation of the various segments was completed at 50 days of age.

In the adult birds, infundibulum consisted of funnel and neck regions. The thin-walled funnel was flattened dorsoventrally and its flared lips were in close proximity to the ovary. Magnum was the longest and most coiled component of the oviduct. Junction between magnum and isthmus was marked by a narrow translucent zone. Isthmus was relatively longer than that of the chicken and turkey. Uterus was a short sac-like expanded region with dark grey colour in the fresh state. Vagina was a short S-shaped tube which opened posteriorly into the urodeum of cloaca.

In the day-old quail chick, the cranial regions of the oviduct corresponding to the infundibulum, magnum and isthmus consisted of low primary mucosal folds lined by simple columnar epithelium and subepithelial connective tissue. The dorsal ligament was very thin and consisted of collagen fibres and cells. Ventral ligament possessed smooth muscle tissue in addition to the connective tissue elements. The large number of luminal epithelial cells and the increase in height of the mucosal folds indicated entry into a rapid growth phase which started between 30 and 40 days of age.

In the adult bird, mucosal ridges of the thin walled funnel region were narrow with many secondary folds. Lining epithelium consisted of ciliated columnar cells and goblet cells. At the bases of these ridges were the glandular grooves. Lamina propria was devoid of glands and consisted of bundles of collagen and a few elastic and reticular fibres. Tunica muscularis consisted of circularly arranged fibres and scattered bundles of smooth muscle. This was covered by the serous layer.

Within the neck of the infundibulum the mucosal ridges were higher. Lamina propria showed tubular glands and scattered lymphocytes. Secretory cells gave PAS-positive reaction. The muscular layer was slightly thicker in this region.

The wall of magnum was markedly thicker due to the intense development of tubular glands. Lining epithelium consisted of ciliated columnar cells and goblet cells containing PAS-positive granules. Tubular glands showed pyramidal secretory cells containing eosinophilic cytoplasm. Musculature was very thin and consisted of circularly arranged fibres. Magnum-isthmus junction was characterized by the absence of glands.

Mucosal ridges of the isthmus were angular in appearance lined by pseudostratified epithelium. Apex of the

epithelium presented glycogen granules. Secretory end piece of the glands was lined by pyramidal cells containing numerous eosinophilic granules. Tunica muscularis consisted of inner circular and outer poorly developed longitudinal, smooth muscle bundles separated by loose connective tissue and blood vessels. Externally there was a typical serosa.

Uterus was wider and thinner than the cranial portions in the day-old bird itself. At 15 days of age, secondary folds started developing and scattered muscle fibres could be noticed in the subepithelial layer. In the adult bird, mucosa was thrown into numerous long, flat, discontinous, spatula-shaped folds. Lining epithelium consisted of ciliated apical and basal cells. Cytoplasm of apical cells showed basophilic granules and that of basal cells had PAS-positive granules. Lamina propria was loosely packed with tubular glands. Numerous collagen fibres and a few elastic and reticular fibres formed the connective tissue core. Tunica muscularis was well developed with inner circular and irregular bundles, and outer fairly thick longitudinal muscle layer. Externally a serosa was present. Utero-vaginal junction was characterized by the presence of sperm-host glands. These were simple tubular glands lined by tall columnar cells which contained lipid droplets. Apical region also gave a positive reaction for alkaline and acid phosphatases.

In 15 days old birds, the vaginal region showed the presence of muscle bundles. In the adult bird, mucosal folds were narrow and longitudinal and the secondary folds were perpendicular to their parent ridges. Height of the epithelium was more than that in the cranical regions of the oviduct. Lamina propria was devoid of glands and contained lymphocytes in scattered and aggregated form. Musculature was thickest in this region. Externally a thin serosa was present.

Alkaline and acid phosphatase activities were detected in uterus, isthmus and magnum in the decreasing order of intensity. In the infundibulum and vagina, the lining epithelium showed a mild positive reaction for both the enzymes.

It was concluded that the oviduct in the Japanese quail completed the structural development and attained sexual maturity between 50 and 60 days of age.

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ABSTRACT

The structure and postnatal development of the oviduct in quails were investigated using 72 birds aged from day-old to 60 days. The growth, morphology and histology of the oviduct were studied using six birds at each age group.

In the day-old quail chick, the oviduct could seen as a narrow white translucent tube towards the left side of the coelom connected by dorsal and ventral ligaments. The sign of coiling was evident from 25 days of age. In the initial stages, the increase in weight and length of oviduct was in accordance with the growth of the bird. Rapid changes in the development of the organ occurred between 30 and 40 days of age and a spurt in growth was noticed from 40-60 days of age.

In the day-old chick, the cranial regions of the oviduct corresponding to the infundibulum, magnum and isthmus were undifferentiated. Throughout the length of the oviduct, histological appearance was the same. The mucosa was thrown into low primary folds lined by simple columnar epithelium and there was subepithelial connective tissue containing densely packed cells with fine collagen and reticular fibres. The large number of luminal epithelial cells and the increase in height of the mucosal folds indicated entry into a rapid

longitudinal smooth muscle separated by loose connective tissue and blood vessels.

Uterus was wider and thinner than the cranial portions, in day-old bird itself. Secondary mucosal folds and scattered muscle fibres could be noticed at 15 days of age. In the adult bird, mucosa was thrown into numerous long, flat, discontinuous, spatula-shaped folds lined by alternating apical and basal cells. Lamina propria was loosely packed with tubular glands. Tunica muscularis was better developed with inner circular and irregular bundles and outer longitudinal muscle layer. Utero-vaginal junction was characterized by the presence of sperm-host glands. In the vagina, mucosal folds were narrow and regular. Lining epithelium was higher. Musculature was thickest in this region. Acid and alkaline phosphatase activities were detected throughout the oviduct, the greatest activity being in the uterine region.