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COMPARATIVE STUDIES ON THE BRAINSTEM OF SOME DOMESTIC ANIMALS
III- Diencephalon.

(With 3 Tables and 8 Figures)

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دراسات مقارنة لساق الدماغ لبعض الحيوانات المستأنسة
٣- الدماغ الثنائي

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تم في هذا البحث دراسة أهم الأختلافات التشريحية للدماغ الثنائي في الحمير والأغنام والخنازير والكلاب والقطط باعتبارها جزء من ساق الدماغ ويمثل نهايته الأمامية. وقد وجد أن أطول دماغ ثنائـــي بالنسبة للطول الكلى للدماغ ولساق الدماغ في الكلاب (١٩,٦%, ٣٠,٢%) بالترتيب. بينما أقصرها شوهد في الخنازير(١١,٣%, ٢٤,٣%). أن هناك اختلافات واضحة في تركيب الجسم تحت المهاد والذي يشكل قاعدة الدماغ الثنائى والذى يتكون من جزء بصري وجزء غدي وأنوية تابعة لمراكز الشم الحشوي.ويحتوى الجزء البصري على العصب البصري (وهو دائري المقطع في الحمير والخنازير والقطط, مفلطح في الأغنام والكلاب) والتصالب البصري (والذي يكون متساوي الأبعاد في الحمير ومطوله أكبر من عرضة في الكلاب والأغنام وعرضة أكبر من طوله في القطط والخنازير) والمسالك البصرية. والجزء الغدى (الغدة النخامية) يمكن تمييزها عيانيا إلى جزئين واضحين بناء على اللون إلى جزء غدي بطني بنى اللون وجزء عصبي ظهري باهت اللون. وكلاهما يختلف في الشكل والامتداد بين الحيوانات تحت الدراسة(والجزء الغدي البطني كبير مستدير الشكل في الحمير ذو لون بنى داكن بينما يكون صغير يميل إلى الأصفرار في القطط وبنى اللون في الكلاب ,طويل سميك ذو لون بنى فاتح في الأغنام ومستدير سطحه البطنى محدب في الخنازير. ويمتد الجزء الغدى جانبيا تجاة الجهة الظهرية ليحيط بالجزء العصبى تماما في حالة الحمير والكلاب والقطط بينما يكون باحتين جانبيتين في الأغنام والخنازير . والجزء العصبى يشكل لب الغدة ويظهر على شكل قضيب في الحمير, دائري صغير يحتل الجزء الأمامى من الغدة في القطط والكلاب وعلى شكل قضيب رفيع يبرز بوضوح من الجهة الخلفية للغدة في الأغنام أما في الخنازير فيظهر على شكل قطعة بيضاء ممتدة بطول السطح الظهري للغدة. ويتصل الجزء العصبي بتجويف البطين الثالث). ويحتوى تحت المهاد أيضا على أنوية تابعة لمراكز الشم الحشوي وتتمثل في الجسم الحلمي والحدبة الصنجابية. والجسم الحلمى يظهر كجسم واحد مدورا" في الحمير بيضاوي مفلطح في الخنازير ومشقوق من نهايته السفلية فقط في الأغنام ويظهر علي شكل جسمين صغيرين مستديرين الى بيضاويين

في القطط والكلاب. ومقدمة المهاد تحتوى على غدة صماء (الجسم الصنوبري) وتظهر في شكل جسم دائري سطحه العلوي مفلطح في الأغنام والقطط وكمثرى الشكل في الحمير وعلى شكل مخروط رفيع في الخنازير. ولوحظ أيضا أن مقدمة المهاد تحتوى على الصفيرة المشيمية للبطين الثالث والهيئية وهى نامية جدا في الخنازير وغير واضحة في الحمير. أما مؤخرة المهاد فيتمثل في الجسم الركبي الأنسي والوحشي. ويظهر الجسم الركبي الأنسى مثلث الشكل في الحمير ومدوراً في الخنازير ورباعي في الأغنام ويكون على هيئة بروز واضح في الكلاب والقطط. أما الجسم الركبي الوحشي فهو نامي جدا في القطط والكلاب والخنازير. والمهاد العلوي(المهاد) عبارة عن باحتين جانبتين يتقابلا عند الخط الوسطى (منطقة اتصال المهاد) وعموما شكل المهاد يختلف بين الحيوانات تحت الدراسة. ويحيط بالمهاد جهة سطحه العلوي والخارجي تجويف البطين الثالث.والمهاد العلوي والجسم تحت المهاد يكونا معا ناميان جدا في القطط والخنازير والكلاب والأغنام ثم الحمير بالترتيب.

SUMMARY

In this work the main anatomical differences of the diencephalon as a part of the brainstem of donkey, sheep, pig, dog and cat were studied. The longest diencephalon to the total length of the brain and also to the brainstem was observed in dog (19.6%, 30.2% respectively) and the shortest was observed in pig (11.3%, 24.3%). The structures of the hypothalamus which forms the floor of the diencephalon showed species variation. It includes the *pars optica hypothalami* (optic nerve, optic chiasma and the optic tract), the *hypophysis cerebri* and the *olfacto-visceral correlated centers(* mammillary body and the tuber cinereum). The optic nerve is rounded in cross section in donkey and pig. In sheep and dog it is in the form of broad flattened band. In cat it is variable along its length. The optic chiasma was of equal dimensions in donkey, longer in sheep and dog; broader in cat and pig. Grossly the hypophysis cerebri can be distinguished into two parts; ventral adenohypophysis (dark brown) and dorsal neurohypophysis(pale color).The adenohypophysis is flattened and circular in shape in donkey, cat and dog, thick and elongated in sheep and rounded with convex ventral surface in pig. The neurohypophysis forms the core of the gland. It appears as a long rod in donkey, rounded in shape and occupied the rostral part in dog and cat, appears narrow rostrally and wide with projected extension caudally in sheep while in pig it appears as a white zone. The nerurohypophysis connected with the cavity of the 3rd ventricle. The mammillary body was unpaired, rounded in donkey and flattened oval in pig, divided only ventrally in sheep and is formed from two small rounded to ovoid tubercles in dog and cat. The epithalamus included *the choriod plexus of the 3rd ventricle, the pineal body and the*

habenula. The pineal body which is blunt rounded in shape in sheep and cat, pear-shaped in donkey, small elongated cone shaped in pig. *The habenula* with its habenular commissure is well developed in pig, sheep and very weak in donkey. The metathalamus included the geniculate body. *The medial geniculate body* is triangular in shape in donkey, rounded nodular in pig, rectangular in sheep and well distinct nodular mass in dog and cat. *The lateral geniculate body* is well developed in dog, cat and pig. The thalamus which is represented by two lateral portions connected at the midline by an intermediate part. The cavity of the 3rd ventricle surrounded the thalamus and the intermediate zone dorsally. *The thalamic and subthalamic nuclei* are well developed in cat, pig, dog, sheep and donkey respectively.

Key words: *Comparative Brainstem, Domestic animals, Diencephalon.*

INTRODUCTION

The diencephalon comprises many vital component concerned with most sensory functions of the body. The most important part is the *thalamic nuclei* which act as relay station for most sensory input to the cerebral cortex [Beitz and Fletcher (1993); Seeley Stephen and Philip Tate (1992); Nickel Schummer and Seiferle (1984); Dyce, Sack and Wensing (1987) as well as Ariens Kappers, Huber and Crossby (1965)]. It also plays an important role in influencing mood and general body movements that are associated with strong emotions (Seeley *et al.* 1992). The *subthalamic nuclei* are involved in controlling motor function and rhythmic movement [Beitz and Fletcher (1993) as well as Ariens Kappers *et al.* (1965)]. *The epithalamic nuclei* are involved in emotional and visceral responses to odors, controlling onset of puberty, sexual activity and sleep walk cycle [Beitz and Fletcher (1993); Seeley *et al.* (1992)]. *The hypothalamic nuclei* are very important in many functions. All of which have emotional and mood relationships. Efferent component from the hypothalamus extend to the brainstem and the spinal cord, where they synapse with autonomic nervous system, pituitary gland and nuclei of some cranial nerves(XII et VII) [Brodal (1998); Seeley *et al.* (1992); Banks (1990) and Morgan (1928, 1930a)]. Inspite of these vital functions of the diencephalon as a part of the brainstem; there is a lack of information about its morphological features particularly that of the donkey, sheep, pig, dog and cat which attracted our attention to cast light on their structure and main anatomical differences.

MATERIAL and METHODS

In the present work heads of adult donkeys, sheep, pigs, dogs and cats of both sexes (10 each) were injected with 10% formalin solution through the common carotid artery and immersed in the same fixative for sufficient time. The cranial cavity was opened and the brain with its meninges was extracted. The meninges were isolated carefully. Different measurements of the brain, brainstem and the diencephalon as well as its structures were recorded (Fig.1). Sectioning of the diencephalon at certain levels were made to examine some of its internal structures.

RESULTS

The diencephalon forms the rostral extension of the brainstem. It is situated between the telencephalon rostrally and the mesencephalon caudally (Fig.1). The diencephalon comprises the hypothalamus, thalamus, epithalamus, metathalamus, subthalamus and the 3rd ventricle. In all examined animals the diencephalon is relatively longer than the mesencephalon. In pig it is the smallest among the examined animals (Table1).

The hypothalamus:

The hypothalamus is that part of the diencephalon, which forms the floor and the ventral walls of the 3rd ventricle. It extends from the level of the rostral border of the optic chiasma rostrally to the level of the caudal border of the mammillary body caudally (Figs. 3/A-E). When the brain is intact the hypothalamus is the only part that could be observed from the diencephalon. It includes a *non-olfactory commissural portion* (the pars optica hypothalami which contains the optic nerve, optic chiasma, optic tract and the supraoptic commissure), *a glandular portion* (hypophysis cerebri) and *olfacto-visceral correlated centers* (the mammillary body and the tuber cinereum).

The pars optica hypothalami:

- **The optic nerve** is rounded in shape in cross-section, in donkey and pig (Figs.3/A,C). It is in the form of broad flattened band in sheep and dog (Figs.3/B,D). In cat the optic nerve starts narrow and rounded then becomes broader towards the optic chiasma (Fig.3/E and Table 2).

-**The optic chiasma** is the region of passage of the optic fibers to the mesencephalic tectum. It appears as a flattened quadrilateral broad band of crossed nerve fibers. It was observed that, the angle between the

two optic nerves reaches its highest value in cat and pig where it measures about 110° and 105° respectively so the optic nerves directed more laterally (Figs.3/E,C). Consequently, the breadth of the optic chiasma is more than its length (Table 2). In contrast the angle between the two optic nerves is too small in sheep and dog where it measures about 75° and 45° respectively and the length of the optic chiasma is more than its width (Figs.3/B,D and Table 2). In donkey the two optic nerves are perpendicular to each other and the length and breadth of the optic chiasma are equal (Fig. 3/A and Table 2).

-The optic tracts are flattened and compressed dorsoventrally in dog, cat, sheep and pig. In donkey it is rounded in shape. Each tract courses caudolaterally and dorsally where it passes over the ventral and lateral sides of the cerebral crura then disappeares between the cerebral crura and the piriform lobe to terminate in the lateral geniculate body where it became wider and reaches about one and half its width (Figs. 3/A-E and Table 2).

The glandular portion of the diencephalon (hypophysis cerebri) (Figs. 2/A-E and Table 3): On gross examination the hypophysis cerebri consists of two parts which can be distinguished in median section by their color. The ventral adenohypophysis is brown and the dorsal neurohypophysis is pale. The topographical relationships of the two parts shows some species differences among the examined animals. In donkey, dog and cat the adenohypophysis is flattened rounded of dark brown color in donkey and dog (Figs.2a/A,D) while in cat it is yellowish brown (Fig.2a/E).It extends dorsolaterally and caudally to enclose the neurohypophysis. The neurohypophysis forms the core of the gland. In donkey it appears as long rod (Fig.2b,c/A), but in dog and cat it is rounded and occupies the rostral part of the gland (Figs. 2b,c/D,E). In cat the intra-glandular cleft is wide. In sheep the adenohypophysis is long oval in shape, very thick and brown (Fig. 2a/B). It extends dorsolaterally to partially surround the neurohypophysis. The neurohypophysis appears narrow rostrally and wide caudally (Figs.2b,c/B). In pig the adenohypophysis is semicircular in shape and of dark brown color with convex ventral surface and flattened dorsal one (Fig.2a/C). It extends dorsolaterally to surround the neurohypophysis. The neurohypophysis appears as a white zone that extends caudally between the two parts of the adenohypophysis (Figs. 2b,c/C).

The hypophysis is connected with the infundibulum by a stalk which is large in donkey (0.9x0.9cm)followed by sheep(0.5x0.2cm), pig (0.3x0.2cm), dog and cat (0.1x0.2cm)(Figs.2a,b,c/A-E).

The olfacto-visceral correlated centers:

- **The mammillary body** (Table3) is represented by a well-developed prominent rounded tubercle protruded from the ventral surface of the brain in donkey (Fig.3/A). In dog and cat the mammillary body is represented by two small rounded to ovoid tubercle separated from each other by a shallow longitudinal groove (Figs.3/D,E). In sheep it is represented by a less prominent semicircular elevation divided ventrally by a shallow longitudinal groove (Fig.3/B). In pig the mammillary body is represented by a well prominent large flattened oval tubercle (Fig.3/C).

-**The tuber cinereum** (Table 3) is represented by a large convex grayish white prominence with a broad base in donkey (Fig.3/A), oval gray elevation in sheep and dog (Figs.3/B,D), white rounded elevation in cat(Fig.3/E). In pig it is large bean shaped which encircles the mammillary body dorsolaterally with its ventral surface is somewhat concave caudally and convex rostrally (Fig. 3/C). The infundibular opening appears as elongated cleft in donkey, narrow fissure in dog and sheep, semicircular in cat and pig (Figs. 3/A-E and Table 3). In the latter animal the infundibular opening lay more rostrally just caudal to the optic chiasma .

The thalamus:

The thalamus is the largest part of the diencephalon. It consists of two large lateral portions lie on either sides of the midline and connected in the center by a small stalk; the intermediate portion (interthalamic adhesion). The space surrounding the intermediate portion and separating the two large lateral portions of the thalamus is the 3rd ventricle (Figs. 4/A-E). The medial surface of the thalamus forms the lateral wall of the 3rd ventricle, while the dorsal surface forms part of the floor of the lateral ventricle. The thalamus is bounded laterally by the caudate nucleus and fibers of the internal capsule (Figs. 7/A-E). Ventrally, it continuous with the hypothalamus and subthalamus. The tuberculated rostral end of the thalamus is prolonged rostroventrally to form the caudal boundary of the interventricular foramen (Fig. 6). The wide caudal end is capped by the lateral geniculate body (Figs. 5/A-E).The shape of the surface of the interthalamic adhesion varies among the different examined animals. It is of rounded shape in donkey and pig, ovoid in dog, cat and sheep (Figs. 4/A-E).

The cavity of the diencephalon is represented by the third ventricle. The tela choroidea tertii of the 3rd ventricle extends caudally dorsal to the pineal body to form the suprapineal recess which is wide in donkey, sheep, pig and narrow in cat through which the choroid plexus of the 3rd and lateral ventricles are continuous (Fig. 4/A). At the optic chiasma the 3rd ventricle extends rostrally to form the supraoptic recess, which is broader in donkey, sheep and pig very narrow in cat and dog (Figs. 4/A-E). Midway between the optic chiasma and the mammillary body the 3rd ventricle extends into the infundibulum of the hypophysis to form the infundibular recess which is wide in donkey, pig and sheep narrow in dog. In cat it appears as a tube(channel)across the length of the ventricle (Fig. 4/E) .

The epithalamus:

The epiphysis cerebri (pineal body) (Figs. 5 /A-E and Table 3).

The epiphysis cerebri (pineal body) is composed of corpus glandulae pinealis and two peduncles (Figs.4/A-E). Its shape and size is variable among the different examined animals. In donkey it is pear shaped with pigmented grayish black color (Figs.4,5/A-E). In sheep and cat it appears as a small spherical mass of pink grayish color with blunt dorsal surface. It lay between the two rostral colliculi, the habenula and the medial geniculate body (Figs. 4,5/B, E). In dog the pineal gland is too small, of dark gray color. It is located rostral to the two rostral colliculi; at the end of the habenula and the caudal commissure (Fig. 5/D). In pig the pineal gland is in the form of a small elongated narrow cone and light pink in color. It lies dorsal to and between the rostral colliculi and caudal to the habenula and its commissure (Fig.5/C).

The habenula is represented by a small rounded nuclear mass on both sides rostral to the pineal gland. It is well developed in pig, sheep, cat, dog and very weak in donkey (Figs.5/A-E). *The habenular commissure* is represented by fibers connecting the two habenular masses.

The Metathalamus:

-The geniculate body lies at the caudal end of the diencephalon and along the lateral surface of the midbrain at the level of the rostral colliculi. It can be demarcated by indistinct groove into large lateral and small medial one (Figs. 5,8/A-E). It is demarcated from the rostral colliculli by a well-marked groove. In donkey the medial geniculate body is represented by a triangular tubercle (Figs. 5,8/A) with convex caudodorsal surface. Its base is directed dorso-rostrally towards the lateral geniculate body and measures about 1.4cm while its apex is

inserted between the rostral part of the cerebral crura and the end of the brachium of the caudal colliculus at the level of the crural tract. It measures about 0.8cm in length. The medial geniculate body is demarcated from the surrounding structures by a well visible groove. In pig the medial geniculate body is represented by a small rounded nodule (Figs. 5,8/C) which, measures about 0.6cm in diameters. It is bounded ventrally by the rostral rounded part of the cerebral crura and dorsally by the rostral colliculi (Figs.5,8/C). In dog and cat the medial geniculate body is represented by a well distinct nodular mass (Figs.5,8/D, E) demarcated from the surrounding structures by a deep groove. Its medial angle lies rostrolateral to the rostral colliculus while its lateral one is inserted between the optic tract and the cerebral crura. It measures about 0.4cm in length and 0.7cm in width. In the two recorded samples of the previous paper the geniculate body was represented by a well distinct nodular part, similar to the lotus flower (Fig.6). In sheep the medial geniculate body is rectangular (Figs. 5,8/B), Its rostral border which is related to the lateral geniculate body was 1.2cm. Its caudal border which is related to the brachium of the caudal colliculus was 0.9cm. The dorsal border toward the rostral colliculus and pineal body is 0.9cm and its ventral border which is related to the cerebral crura was 0.2cm (Fig. 5,8/B). In dog, cat and pig the lateral geniculate body is well developed where it appears higher than the dorsal surface of the thalamus (Figs. 5/D,E and C). In donkey and sheep the lateral geniculate body appears nearly at the same level with the thalamus; where they demarcated from each other by a shallow furrow (Figs. 5/A,B).

The sagittal and cross-sections of the diencephalon at the level of the optic chiasma reveales that the thalamic and subthalamic regions in cat, pig, dog, sheep and donkey were developed respectively (Figs. 4,7/A-E).

DISCUSSION

Whether the diencephalon is the rostral extension of the brainstem or not is a controversial matter. Breazile(1966) attributed his consideration that the diencephalon is a part of the brainstem as his cytoarchitectonic study in pig described cell nuclei from the caudal to the rostral pole of the brainstem of topographical sequence. Jenkins (1972) in dog considered that the diencephalon is a part of the brainstem, as the cavity of the 3rd ventricle is a single cavity located in the midline in direct line with the cerebral aqueduct and the 4th ventricle. He added that in adult brain the lamina terminals is the rostral boundary of the 3rd ventricle while the sulcus limitans is generally

considered to be represented in the adult diencephalon as the hypothalamic sulcus.

Optic nerve was rounded in cross-section in donkey, pig and cat, similar to that observed in camel by El-Khaligi (1977) and Mansour(1983). Its diameters was about 0.5cm, 0.3cm, 0.15cm respectively; In water buffalo the diameters of the optic nerve measures about 0.4cm El-Nahla (1982). However, in dog and sheep the optic nerve was flattened and measures about 0.4x0.2cm and 0.5x0.3cm in diameters respectively. In cat the caliber of the optic nerve was different along its course. Godinho and Getty(1975) in the same animal stated that the optic nerve form S shape along its course in the orbital cavity.

The result of the present observation was in agreement with that described by Dellmann and McClure(1975)in dog and sheep, El-Nahla (1982) in water buffalo, Mansour(1983) in camel and Amin (1984) in goat, that the optic tract was flattened dorsoventrally and wider than the optic nerve. However, El-Khaligi(1977) in camel mentioned that after the optic chiasma; the optic nerve retained its normal size and is rounded in shape.

In cat and pig the optic chiasma was broad where its width to its length was nearly 2:1.5 this was in agreement with that described in water buffalo by El-Nahla (1982) and in goat by Amin (1984). On the other hand; the optic chiasma of sheep and dog was narrow, long and its length was one and half its width. Same finding was recorded in camel by Mansour (1983).

The present study described the mammillary body of donkey as a rounded elevation, measured about 0.9 cm in diameter. Dellmann and McClure (1975) mentioned that the mammillary body of horse was oval to rounded elevation. Areins Kappers *et al.*(1965) in mammals mentioned that, it appeared as a very prominent unpaired tubercle. They added that the mammillary bodies (the corpora candescantia, as they are of white color) in many animals are unpaired externally although they are derived generally from paired nuclei internally. Mansour (1983) in camel described the mammillary body as small oval to nodular mass measuring about 0.3cm rostrocaudally and 0.5cm transversely. However El-Khaligi (1977) in the same animal described it as a small rounded structure. In dog the present observation was in agreement with that described by Bradley and Graham (1959), Miller, Christensen and Evan's (1964), Jenkins (1972) as well as Dellmann and McClure (1975) in the same animal. The present study in cat was in agreement with that described by Fry, Krumins, Fry, Thomas, Borbely and Ades(1963) in

that the feline have two mammillary bodies. The mammillary body of the examined sheep was less prominent, semicircular elevation divided only ventrally by a shallow longitudinal groove. Ganguli and Singh(1977), Dellmann and McClure (1975) and May (1970) described in the same animal two mammillary bodies separated by a shallow furrow. Amin (1984) in goat described the mammillary body as a nipple shaped eminence. McLeod(1958) mentioned that the bovine mammillary body is oval in shape. On the other hand Raghavan and Kachroo (1964) in ox, Dellmann and McClure(1975) in large ruminant and El-Nahla(1982) in water buffalo described it as a large rounded elevation. The mammillary body of pig is a large flattened oval tubercle measures about 0.5cm in diameter. Dellmann and McClure (1975) in the same animal described it as a hemispherical, prominent unpaired tubercle.

The present study observed that the tuber cinereum of donkey was similar to that mentioned in camel by Mansour (1983) and El-Khaligi (1977) who described it as a rounded gray elevation. In dog the tuber cinereum was oval gray eminence, Dellmann and McClure (1975). The present investigation was in agreement with that observed in water buffalo by El-Nahla (1982) and in bovine by McLeod (1958), that the tuber cinereum of sheep was oval gray elevation with narrow fissure like infundibular opening. Dellmann and McClure (1975) in small ruminant described the tuber cinereum as not uniform but characterized by four spherical elevations which are located rostro-lateral to the mammillary body and lateral to the infundibulum, immediately caudal to the optic chiasma. Amin (1984) in goat described the tuber cinereum as a gray triangular eminence with a small central opening. The tuber cinereum of pig is a large bean shaped structure that encirclie the mammillary body dorsolaterally but Dellmann and McClure (1975) in the same animal described it to be gray in color and convex in all directions.

The result of the present study in donkey was similar to that described by Sisson and Grossman (1969) in horse who mentioned that the pineal body was fusiform in shape; but they added that it may be oval in shape. Mansour (1983) in camel described the pineal body as a small oval and gray in color. However El-Khaligi (1977) in the same animal described it small and rounded.

Concerning the pineal body; the present investigation in sheep showed that it is spherical mass with blunt dorsal surface. This was in accordance with that of Dellmann and McClure (1975) in the same animal, Ariens Kappers *et al.* (1965) in mammals and Amin (1984) in goat. On the other hand Ganguli and Singh (1977) in Indian sheep

observed it as small spherical mass. However, May (1970) in the same animal described it as prolonged body extending between the corpora quadrigemina and the mesencephalon. El-Nahla (1982) in water buffalo described the pineal body as ovoid structure lying between the two thalami and the rostral colliculi. Raghavan and Kachroo (1964) in ox described it as a conical shape, McLeod (1958)in bovine stated that the pineal body was long fusiform body. Dellmann and McClure (1975) in large ruminant described it as an elongated pointed narrow organ. In cat the present study described it as a spherical mass, while in rabbit Ariens Kappers *et al.* (1965) mentioned that it is club shaped. The present study was in agreement with that described by Dellmann and McClure (1975) that the pineal body of pig was conical in shape and in dog the pineal body was very small and narrow organ. Dyce *et al.* (1987), Banks (1990) mentioned that the pineal gland functions as biological clock regulating both the long and short term variations in gonadal activity.

As described in camel by Mansour (1983) in water buffalo by El-Nahla (1982) and in horse by Dellmann and McClure (1975) the lateral geniculate body was the larger one. However, the latter author in dog, pig and ox, Raghavan and Kachroo (1964) as well as Sisson and Grossman(1969) in ox, Ganguli and Singh (1977) in sheep stated that the lateral geniculate body was less prominent than the medial one. Our study revealed that the lateral geniculate body of dog, cat and pig appeared well developed and projected higher than the dorsal surface of the thalamus. In dog Dellmann and McClure (1975) described it as a comma shaped or half moon with irregular dorsal surface. However in donkey and sheep the lateral geniculate body appeared nearly at the same level with the thalamus, but Mansour (1983) in camel mentioned that the lateral geniculate body capped the caudolateral part of the thalamus. Raghavan and Kachroo (1964) in ox, Sisson and Grossman (1969) in horse as well as Dellmann and McClure (1975) in ruminant described the lateral geniculate body as a semicircular curve around the thalamus but Amin (1984) in goat described it as a typical knee curve above the thalamus.

The present study observed that the medial geniculate body of dog is well distinct nodular mass. Dellmann and McClure (1975) in the same animal described it as a very prominent oval structure. In the present study the medial geniculate body of donkey was a small triangular eminence with convex surface; the same was observed in water buffalo by El-Nahla (1982) and Mansour (1983) in camel. Dellmann and McClure (1975) in horse observed it as a small rounded

prominence. In sheep the medial geniculate body is faint rectangular area but Amin (1984) in goat described it as a prominent triangular area at the di-mesencephalic border. Ganguli and Singh (1977) in Indian sheep described it as an oval prominence.

The result of the present study was in accordance with that described by Ariens Kappers *et al.* (1965)in mammals, Dellmann and McClure (1975)and Nickel *et al.* (1984) that the thalamus was the largest part of the diencephalon where it forms about 4/5 of the diencephalic area. The latter author applied the term thalamoncephalon to the diencephalon. Ariens Kappers *et al.* (1965) applied the term dorsal thalamus to the thalamic area and the ventral thalamus to the subthalamic area. They added that the most obvious increase in size of the diencephalon has occurred in the dorsal thalamus. Raghavan and Kachroo (1964) in ox, El-Nahla (1982) in water buffalo reported that the thalamus has an ovoid contour, El-Khaligi (1977) in camel reported that the thalamus has a rounded contour, however Mansour (1983) in the same animal reported that the thalamus was a large ovoid gray mass. Amin (1984) in goat described it as ovoid in shape. The present study was in agreement with that mentioned by Bradley and Graham (1959) in dog who reported that the thalamus has an oval contour but Evan's and Delahunta (1996) in the same animal mentioned that the interthalamic adhesion appears rounded in median section. On the other hand Miller *et al.* (1964) in the same animal mentioned that it was wedge shaped gray matter. According to Dellmann and McClure (1975) in horse, the thalamus was ovoid mass. The afford mentioned author in pig mentioned that the dorsomedial surface of the thalamus was characterized by small rostral tubercle and pulvinar.

The present study described four recesses of the 3rd ventricle. The same was described by Beitz and Fletcher (1993) in dog, Nickel *et al.* (1984), Mansour (1983), El-Khaligi (1977) in camel, Dellmann and McClure (1975) in domestic animals and Sisson and Grossman (1959) in horse described three recesses. Evan's and Delahunta (1996), Beitz and Fletcher (1993) in dog, Ariens Kappers *et al.* (1965) mentioned that the dorsal part of the 3rd ventricle in carnivora is very narrow and appears as tubular shape.

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LEGENDS

Fig. 1: A Diagram showing the ways of measurements of the brain, A; brainstem, B and diencephalons, C in examined animals.

Fig. 2:A photograph of the hypophysis cerebri (Scale 1cm) in Donkey,A; Sheep, B; Dog, D; Cat, E and pig C. a-Ventral view b-Dorsal view c- Midsagittal section. showing: N-Adenohypophysis M-Neurohypophysis S-Infundibular stalk T-Intraglandular cleft.

Fig. 3A-E: Photographs of the Ventral (ventrolateral) view of the diencephalon in: Donkey, A; Sheep, B; Dog, D; Cat, E and pig, C (Scale 1cm) showing: 2-optic nerve 3-Optic chiasma 4-Optic tract Δ-Tuber cinereum ➸-Infundibulum ■- Mammillary body 5-Crura cerebri 6-Intercrural fossa.

Fig. 4A-E: Photographs of the Sagittal sections of the diencephalon in: Donkey, A; Sheep, B; pig, C; dog, D and cat, E (Scale 1cm) showing: P-Pineal body °-Pineal peduncle T-Thalamus M-Mammillary body X-Optic chiasma S-Mesencephalic tectum 2- Pons 6-Infundibular recess 5-Supraoptic recess 7-Pineal recess 8-supra pineal recess ◢■-Dorsal surface of the thalamus C-caudal commissure.

Fig. 5A-E: Photographs of the dorsolateral view of the diencephalon in donkey, A; dorsal view in sheep, B; dog, D; cat, E and caudo-dorsal view in pig, C (Scale 1cm) showing: P-Pineal body H-Habenula L-Lateral geniculate body M-Medial geniculate body 3-Third ventricle T-Thalamus.

Fig. 6: Photographs of the dorsal aspect of the diencephalon in two recorded samples of dogs (Scale 1cm) showing:→-The rostrocaudal truncated end of the thalamus L-lateral geniculate body M-Medial geniculate body T-Thalamus 2-Optic nerve S-Rostral colliculi

Fig. 7A-E: Photographs of Cross-sections of the diencephalon of Donkey, A; Sheep, B; pig, C; dog, D and cat, E at the level of the optic chiasma (Scale 1cm) showing: ●-Internal capsule ▲-External capsule ■-Thalamus □-hypothalamus →-Longitudinal fissure S-Septum pellucidum L-Lateral ventricle T-Optic tract V-Third ventricle R-Rostral commissure Q-Optic chiasma W-Cuadate nucleus C-Corpus callosum ➸Thalamic reticular formation P-Pireform lob.

Fig. 8A-E: Photographs of the lateral side of the diencephalon of Donkey, A; Sheep, B; Pig, C; Dog, D and Cat, E (Scale 1cm) showing:1-Rostral colliculus 2-Caudal colliculus 3-Brachium of the caudal colliculi 4-Medial geniculate body 5-Lateral geniculate body 6-Optic tract 7-Pripontine sulcus 8- Cerebral crura 9- Rostral cerebellar peduncle P-Pineal body ■- Pons *- Leminescal trigone →-Crural tract ➸-Transverse groves.

Table 1: Showing the mean relative and absolute length of the brain (B), brainstem (S) and diencephalons (D), D/B, D/S in examined animals.

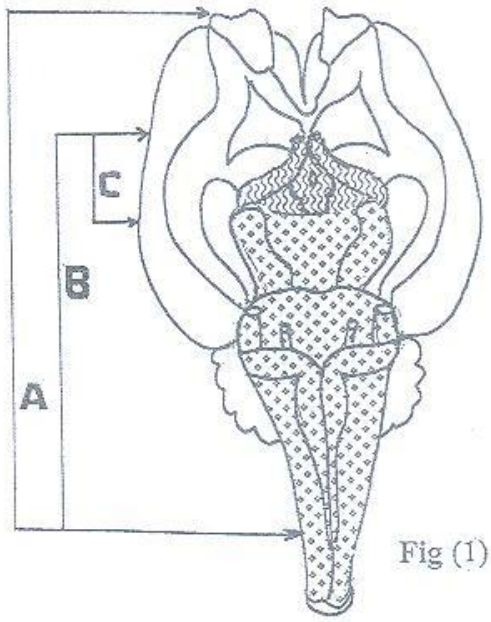
Animal	Brain		Brainstem				Diencephalon					
	L		L		S/B		L		D/B		D/S	
	Cm	SD	Cm	SD	%	SD	Cm	SD	%	SD	%	SD
Donkey	12.8	±1.7	9.8	±0.7	61	±5.3	2.3	±0.3	18.4	± 1.8	29.5	±2.12
Sheep	10.5	± 1.1	6.0	±0.3	57	±5.1	1.8	±0.09	17.1	±1.3	30.0	±2.60
Pig	08.0	±0.2	3.7	±0.1	41	±3.1	0.9	±0.08	11.3	±1.2	24.3	±1.80
Dog	09.7	± 0.9	6.3	±0.5	64	±6.2	1.8	±0.09	19.6	±1.6	30.2	±2.10
Cat	05.3	± 0.7	3.2	±0.9	60	±3.7	0.9	±0.07	17.0	±1.1	28.1	±2.30

Table 2: Showing the mean length (L)&width (W)of the optic nerve, optic chiasma and optic tract in examined animals.

Animal	Optic nerve				Optic chiasma				Optic tract			
	L		W		L		W		L		W	
	Cm	SD	Cm	SD	Cm	SD	Cm	SD	Cm	SD	Cm	SD
Donkey	0.50	±0.01	0.50	±0.08	0.80	±0.02	0.80	±0.03	2.5	±0.16	0.5	±0.10
Sheep	0.30	±0.03	0.50	±0.04	0.70	±0.03	0.50	±0.03	1.5	±0.08	0.5	±0.07
Pig	0.30	±0.05	0.30	±0.07	0.60	±0.06	0.90	±0.06	1.6	±0.10	0.4	±0.08
Dog	0.20	±0.03	0.30	±0.03	0.50	±0.05	0.30	±0.03	1.6	±0.09	0.2	±0.09
Cat	0.15	±0.03	0.15	±0.06	0.30	±0.02	0.70	±0.02	1.0	±0.03	0.2	±0.08

Table 3: Showing the mean length x width and thickness of the Pitutary gland (P), Mammillary body (M), Tuber cinereum (C), Infundibulum (I) and Eepiphysis cerebr (E) in examined animals.

Animal	(P)	(M) cm	(C) cm	(I) cm	(E) cm
Donkey	2.5x1.2x0.5	0.9x0.9	0.7x0.3	0.6x0.6	1.9x0.6-0.2
Sheep	1.8x0.9x0.9	0.6x0.5	0.5x0.2	0.6x0.5	0.5x0.5
Pig	1.0x1.0x0.6	0.5x1.0	0.2x0.2	0.5x0.5	0.9x0.4
Dog	0.7x0.7x0.4	0.7x0.4	0.6x0.2	0.3x0.2	0.2x0.1
Cat	0.3x0.4x0.4	0.5x0.5	0.3x0.2	0.3x0.3	0.3x0.3



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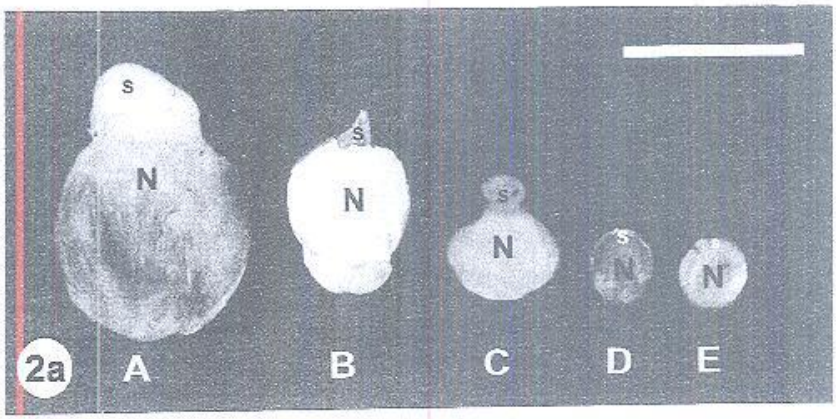
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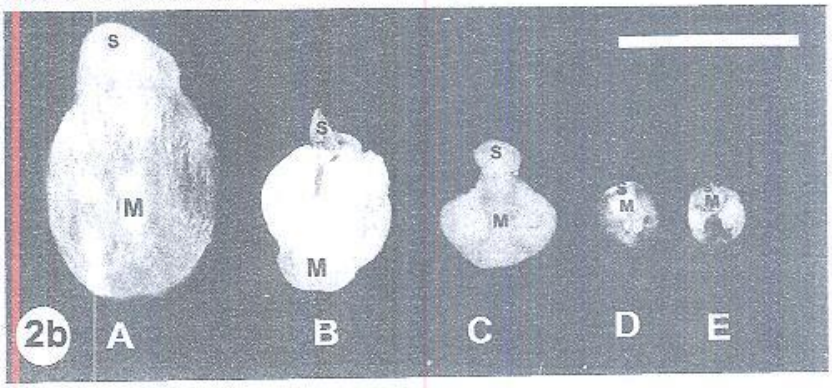
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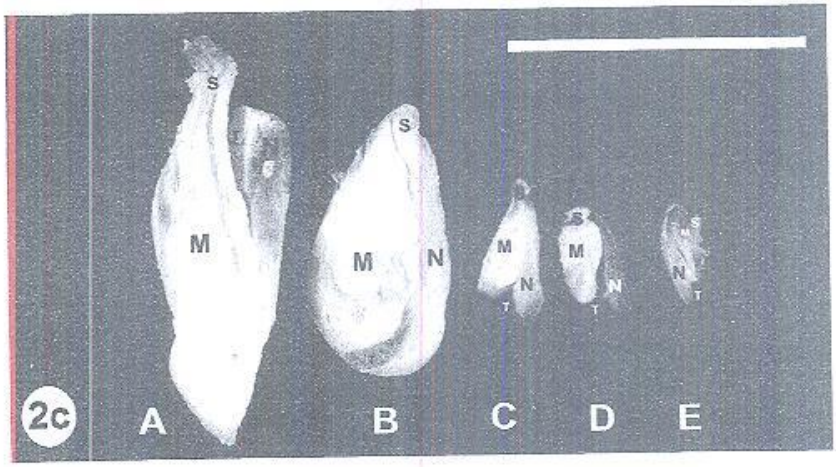
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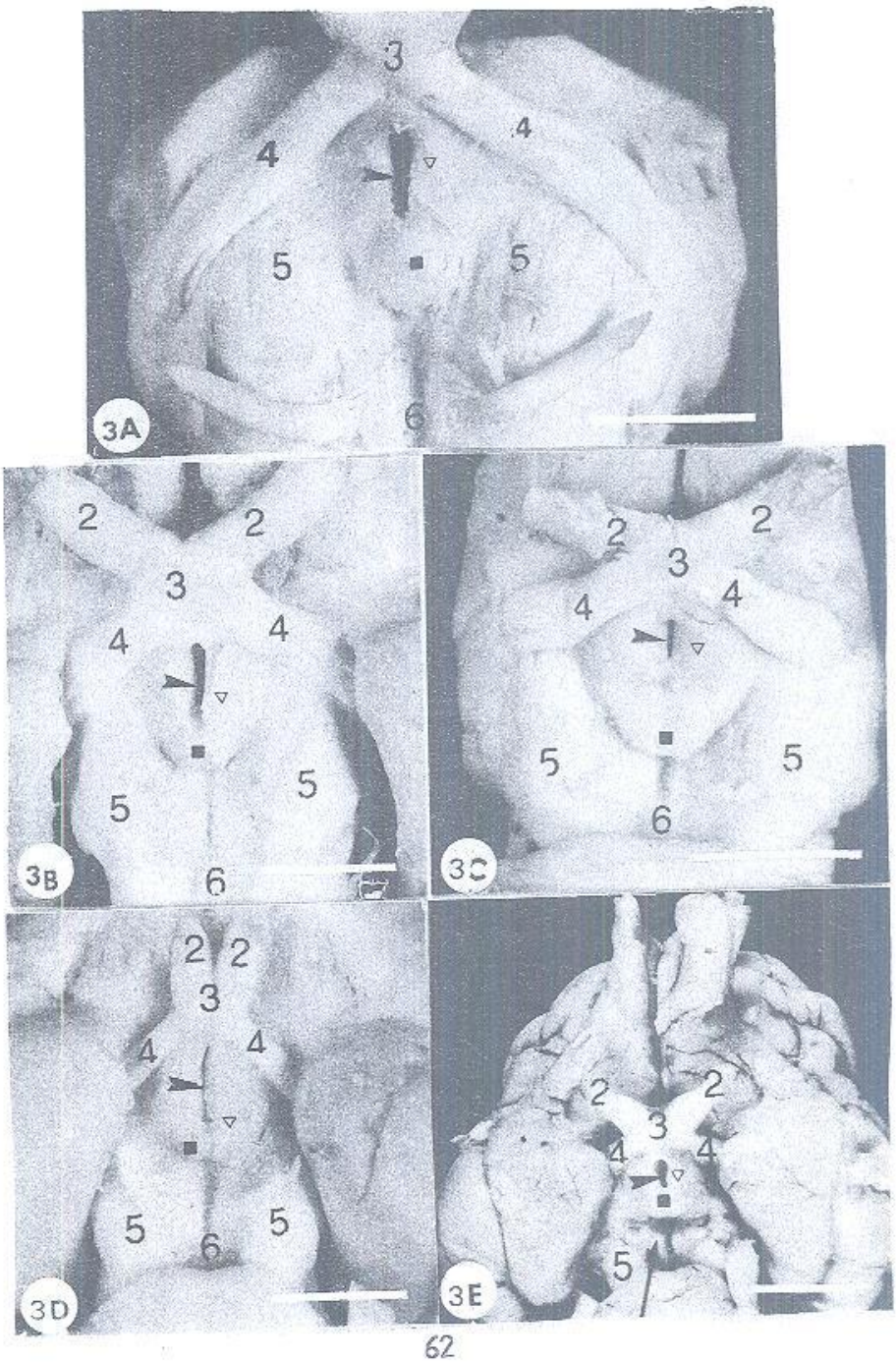
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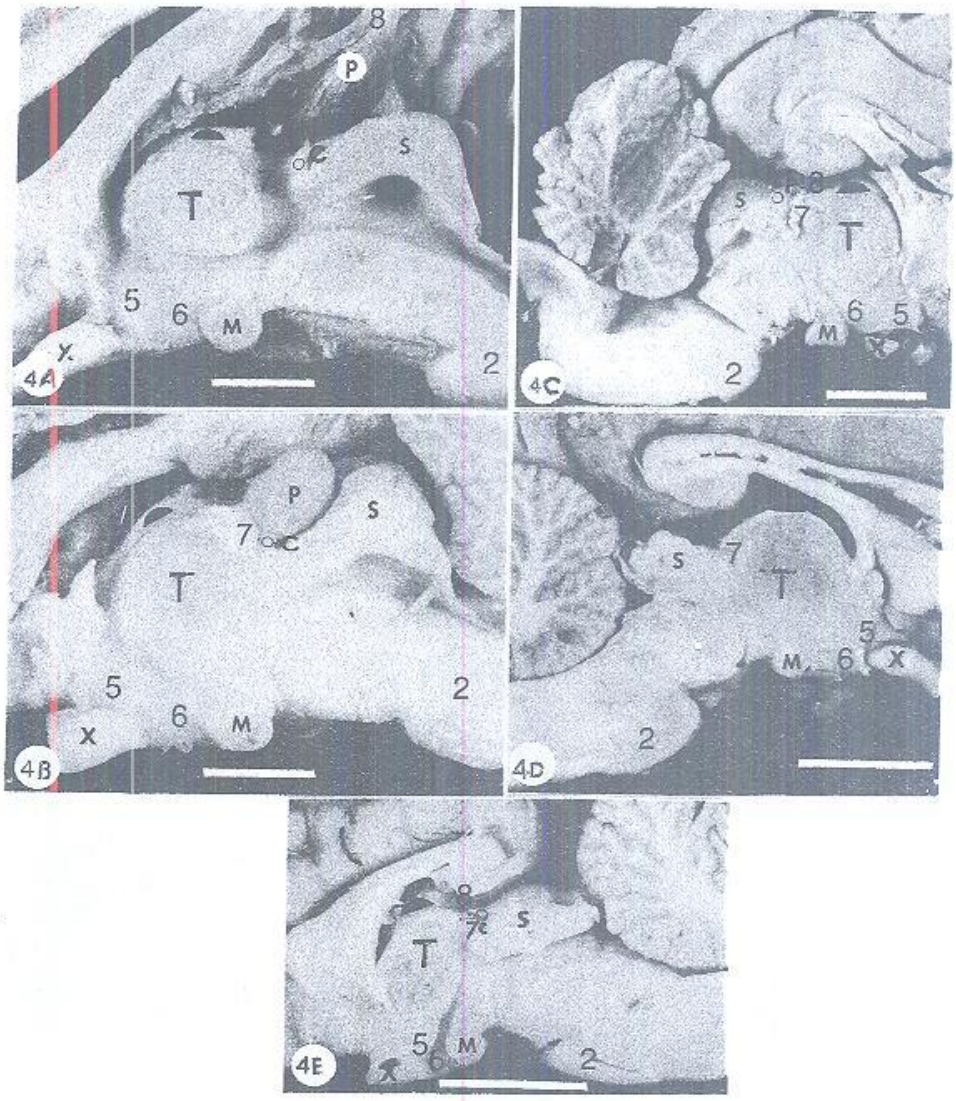
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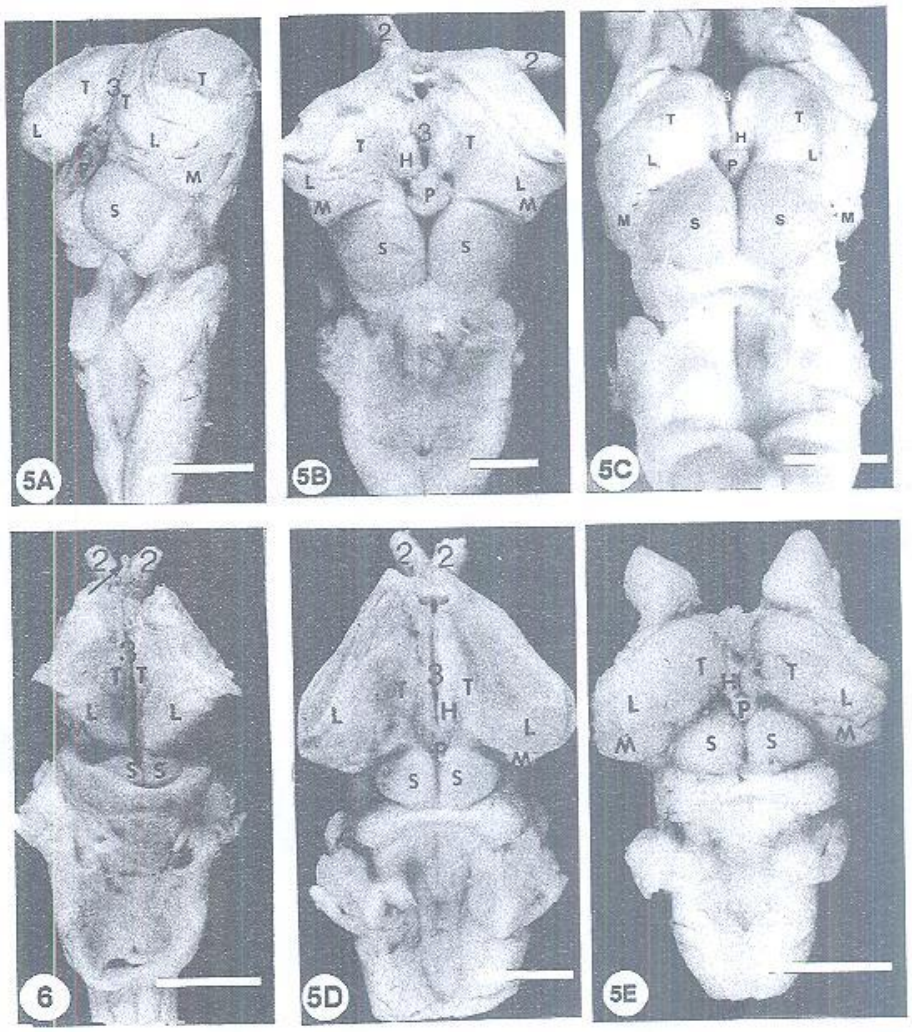
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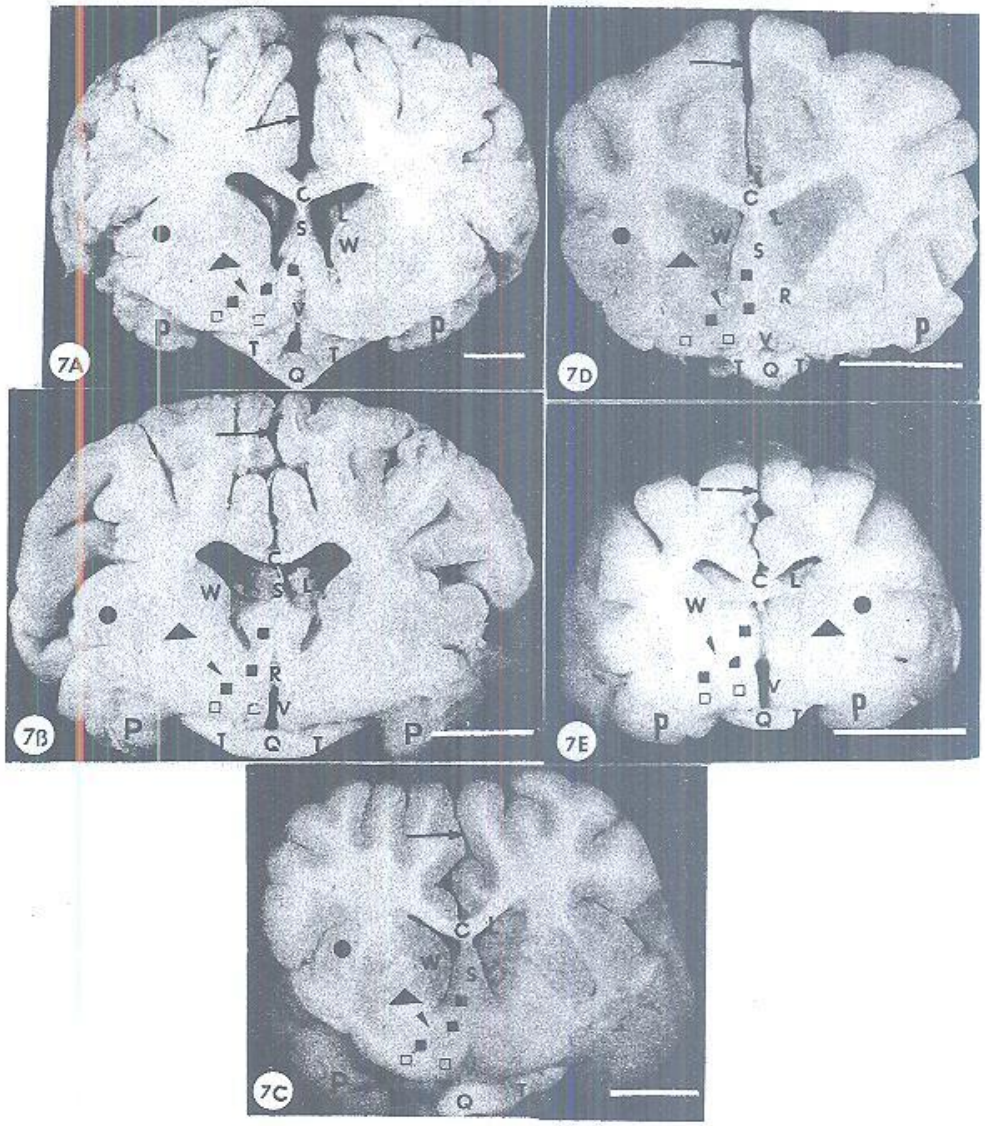
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