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Anatomical and Histological Study of the Cerebellum in cognitive modern birds species (gold-capped parrot)

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الخلاصة

تميز المخيخ بكبر حجمه وبامتلاكه العديد من الطيات بكونه من النوع المتقدم للامام في (gold–capped parrot). اظهرت المقاطع التشريحية السهمية الطيات العشرة الكبيرة الحجم والطويلة الشكل والمتفرعة والتي كانت بالتحديد (الخامسة, السادسة والتاسعة) كما واظهرت نتائج الفحص المجهري وجود مساحة قشرية واسعة تمثل (المادة السنجابية) تتناسب سعتها ومكوناتها مع سعة وطول المخيخ واظهرت ايضا وجود منظقة داخلية هي اللب وتمثل (المادة البيضاء) للمخيخ.

تضمنت القشرة وجود ثلاث طبقات منفصلة هي الخارجية اي الطبقة الجزيئية والوسطى اي طيقة خلايا بركنجي, والداخلية اي الطبقة الحبيبية.

تميز البنيان او التركيب الدداخلي للمخيخ وجود طبقة حبيبية واسعة جدا مثلت القسم الاكبر من قمم طيات المخيخ, ووجود مجاميع من الانوية العميقة الموقع ضمن مركز اللب في المخيخ.

Abstract

The gold- capped Parrots have large and highly folded cerebellum the latter design is protruded forward. Ten long and large primary folia are found in sagittal sections. Some of these folia (i.e. V, VI, IX) are subdivided. The result of microscopic examination indicates that there are an outer long strip of cortex that corresponding with cerebellum length, and inner white matter (medulla). Three distinct layers are clearly detected in the cortex (i.e. outer molecular layer, middle Purkinje cells layer, and inner molecular, layer). The internal structure of cerebellum is characterized by the great prominence of granular layer especially in the folia summit and the appearance of deep nuclei in the center of cerebellum.

Introduction

Modern birds and mammals have cognitive abilities that clearly exceed those of other birds and mammals [1]. The cerebellum (metencephalon) is a large bulge located in the inferior and posterior portion of the head (the hindbrain) name means (Latin little brain) [2].

The cerebellum has a broader role in number of cognitive functions, including (attention, language, music, and other sensory temporal stimuli [3].

The cerebellum is an important integration region in the brain which contains more than 50% of all neurons found in the brain but it is only take up 10% of total brain volume. The cerebellum play an important role in sensory perception, posture, balance and skeletal coordinated movement which is using the constant feed back on body position to fine-tune motor movement [4]. Cerebellum function in birds was modified by experience.

Birds have folded cerebella, and there are very considerable variation in cerebellar design [5,6], cerbellar size [7,8,9] number and size of cerebeller folia[8,10,11,12,13]. The cerebellum in large brained birds has not scale uniformly[8,13]. Our study has been made to find out the anatomical aspect of gold- capped Parrot cerebellum which may be helpful for better understanding of the physiology of this organ.

Materials and methods

Six healthy gold- capped Parrots were utilized in this investigation; the brains were extracted from the skull by earful dissection, the whole brain and cerebellum were submersion fixed in 10% Buffered formalin. The brains were bisected in the sagittal plane to examine cerebellar folia.

For histological observation 5-6 micron thickness, sections were cut with the help of rotary microtome; the sections were stained with haematoxylin in and Eosin (H&E) and the periodic acid shift reagent (PAS) as per standard procedures. The tissue sections were washed, dehydrated cleared and mounted as per usual method [14,15].

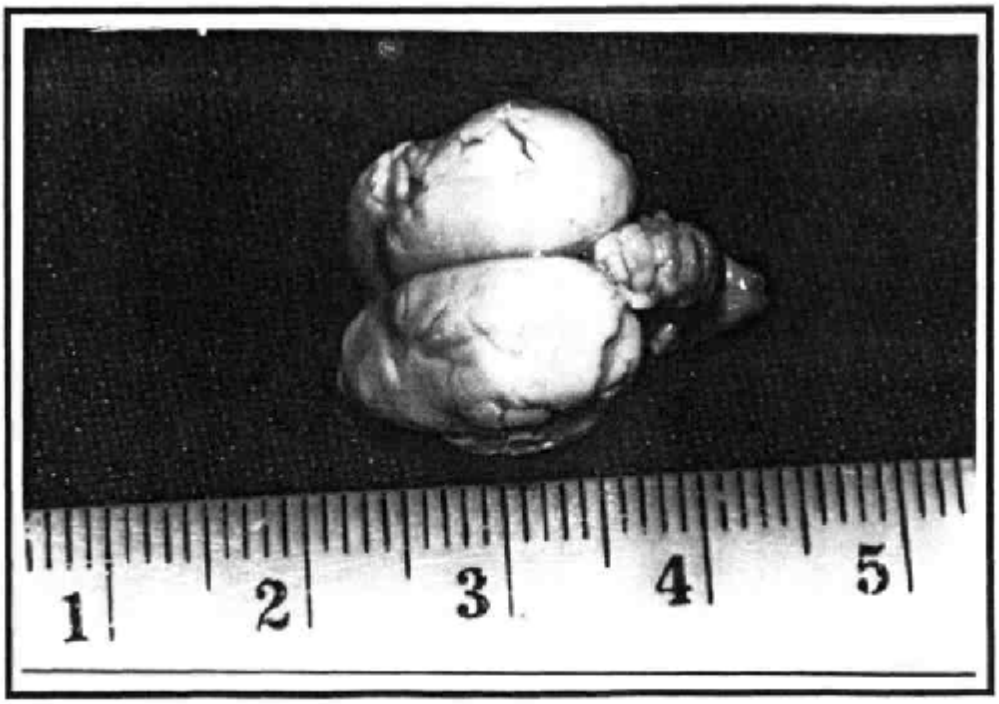
Result

The cerebellum: gross anatomy:

The large cerebellum in gold- capped Parrot found to be protruded forward. The cerebellum is composed of central body (corpus cerebelli), and Paired auricles (Fig. 1).

The middorsal surface of the cerebellum presented aseries of transverse gyri and sulci, the cerebellum was connected with the midbrain rostraly, and with the medulla oblongata by the peduncles (Fig. 2).

The cerebellum is divided into three strongly folded lobes (anterior, middle, and posterior) separated by two deep fissures (i.e. primary (x) and secondary (y)). Ten long and large primary lobulli or folia (number I to X) was found in sagittal section, some of them (i.e. V, VI, IX) are subdivided which are shown in (Fig. 3). The cerebellum enclosed a small centrally placed cavity continuous by a small passage with the fourth ventricle of the brain.



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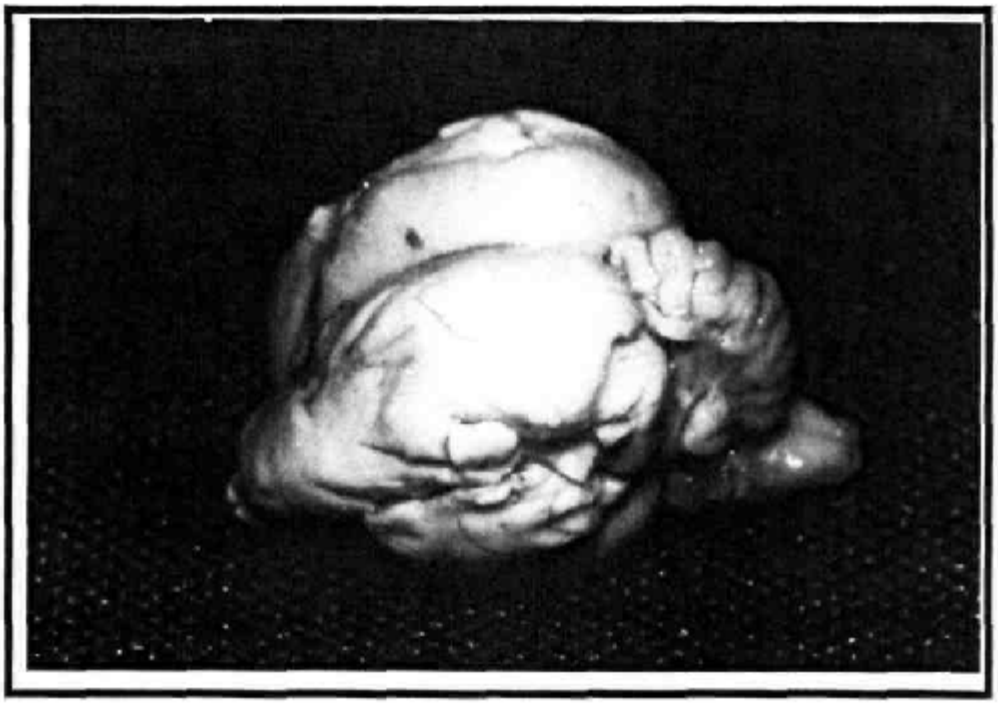

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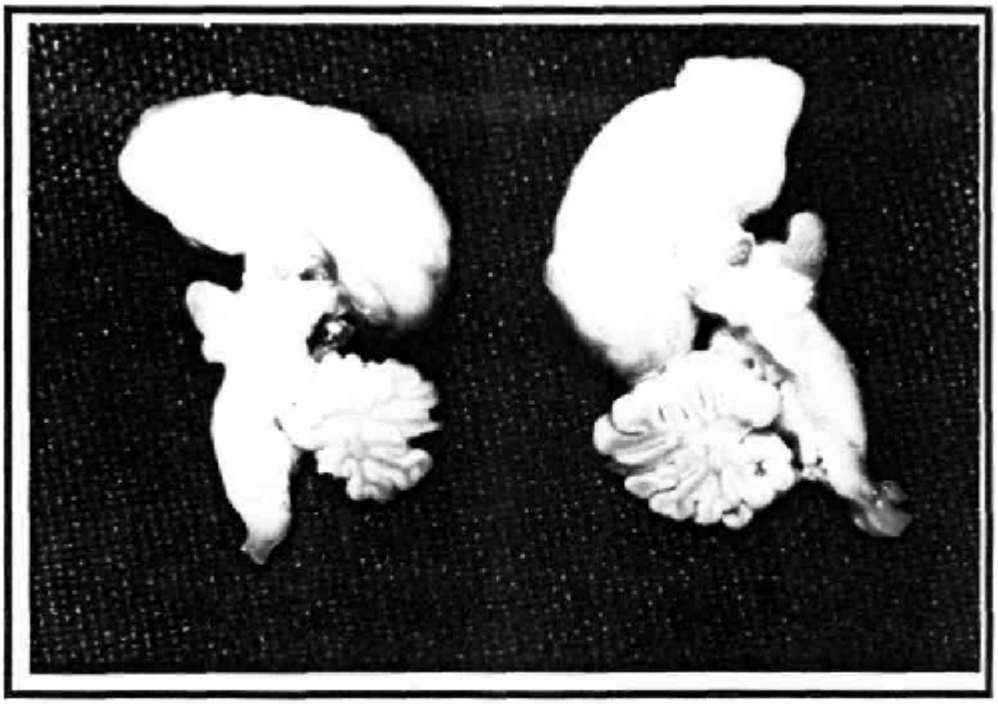

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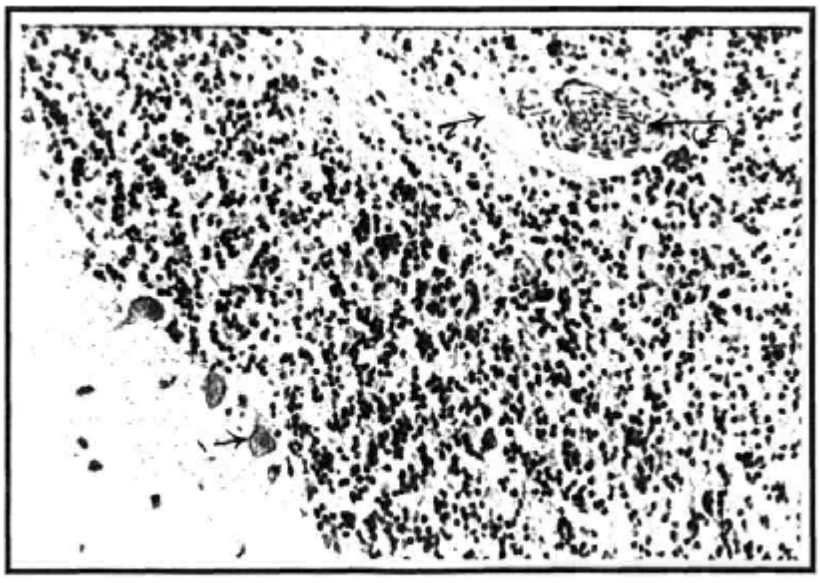

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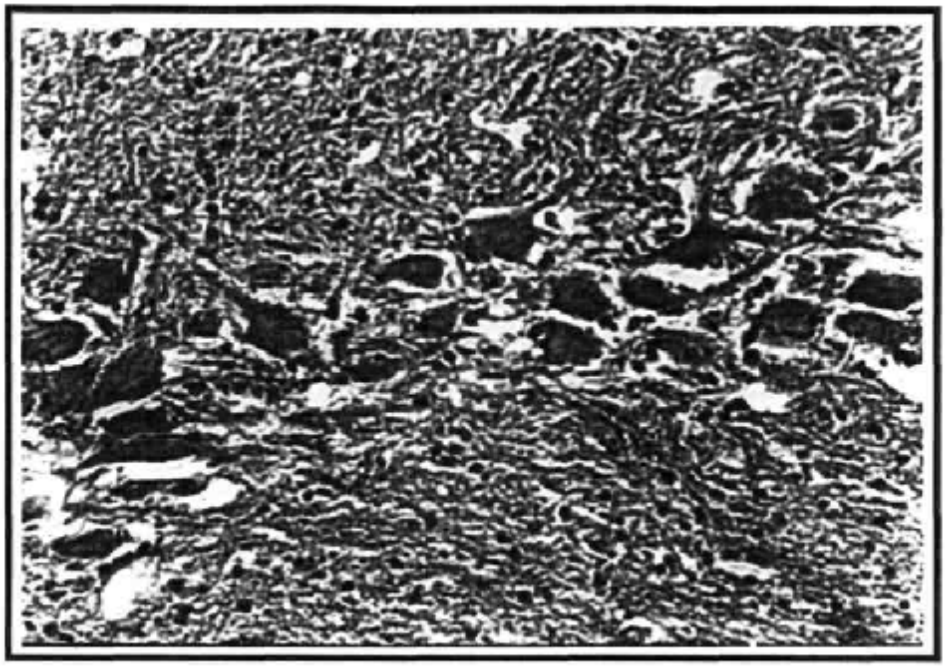

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The cerebellum in gold- capped parrot is divided in to three strongly folded lobes by two fissures, primary (x) and secondary (y), this finding is in agreement with [12] who was stated that (songbirds, shorebirds, and smaller parrot) have three highly folded cerebella, and lack a reduced anterior lobe, there was relatively small anterior lobe in (Apodiformes and Camprimulgiformes). The fowl cerebellum divided into three folded lobes (anterior, middle, posterior) by deep fissures (x), and (y) [5]. The anterior lobe in (nightjars and humming birds) was absent or reduced [10].

According to [6], the anterior lobe has four lobuli, the middle lobe is the most variable, and the posterior lobe really consists of three lobuli in birds, correspond with the mammalian (pyramids, uvula, and nodulus). The fissure (x) was separated the anterior from the middle lobe, the fissure (y) was separated the middle lobe from the posterior lobe. The identity of individual folia or lobules in fowl were (lingual, central lobule, culmen, declive, folium and tuber vermis, pyramid, uvule and nodule)[5]. The primary fissure was separated the two culmens from the declive as stated by [6] in dove.

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The internal structure of the cerebellum in gold- capped Parrots was divided into outer long single strip of cortex (gray matter), and inner medulla (white matter). According to [8] who was stated that the cortical strip varies in different species of birds in the anterio-posterior extension, which corresponds to the cerebellum length.

The outer long single strip of cortex in parrot is divided into three layers (i.e. molecular, Purkinje, granular) these findings are in agreement with [10] in birds [5] in fowl. The granular layer in gold- capped Parrot occupy wide area of cortex composed of numerous tiny small cells together with nerve fibers an large Golgi cells. There was a dense plexus of thin varicose nerve fiber innervated more than one class of neurons in the cortical layer of adult hens [17].

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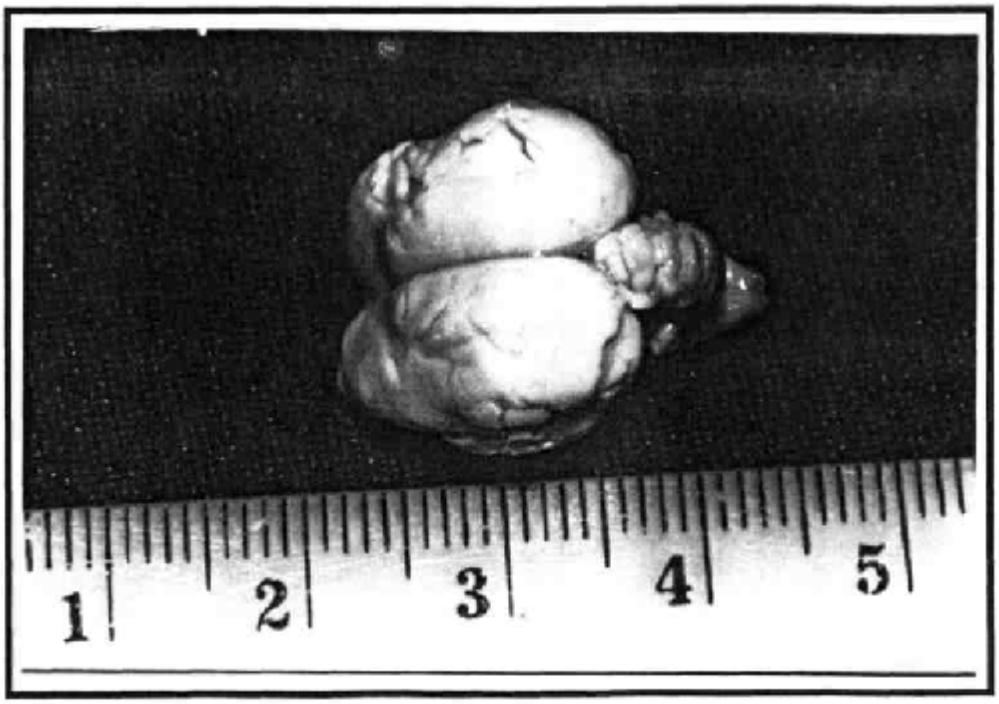

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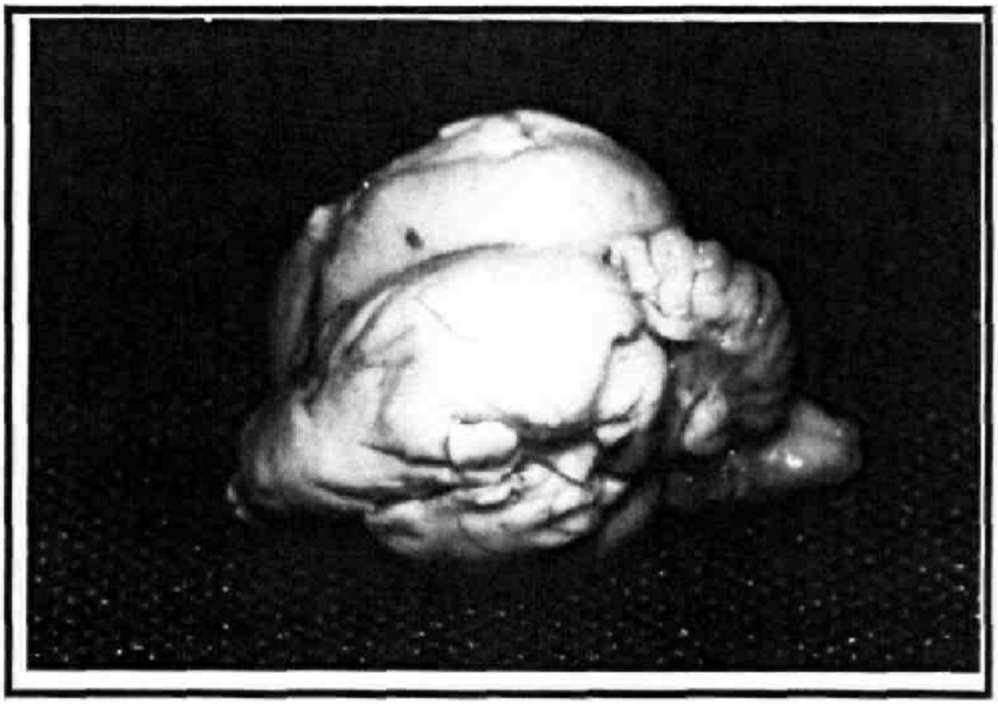

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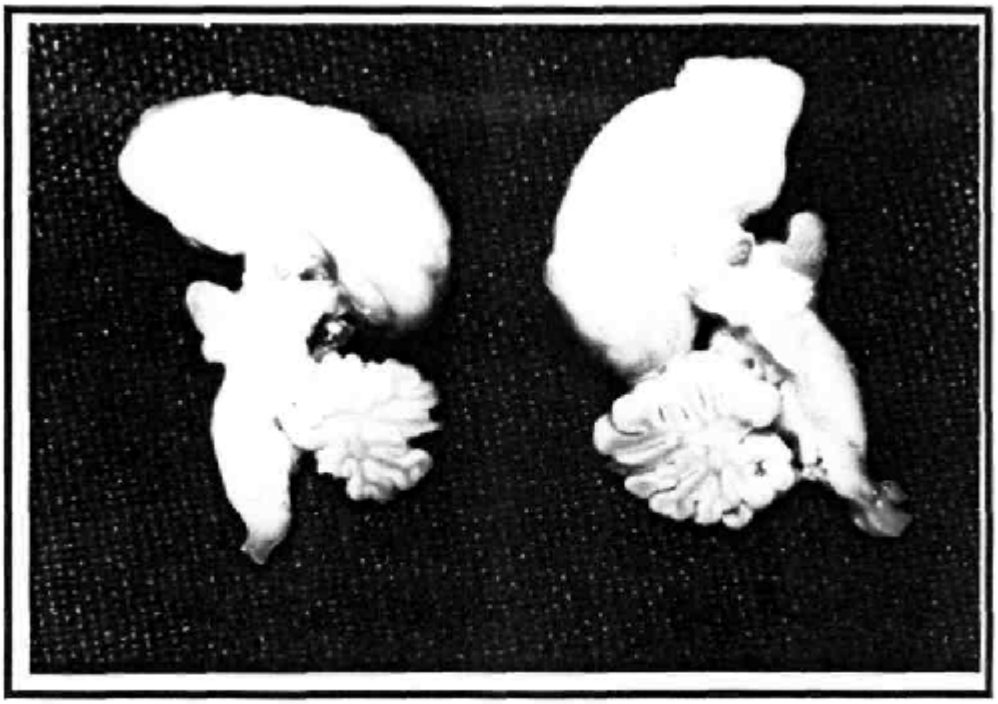

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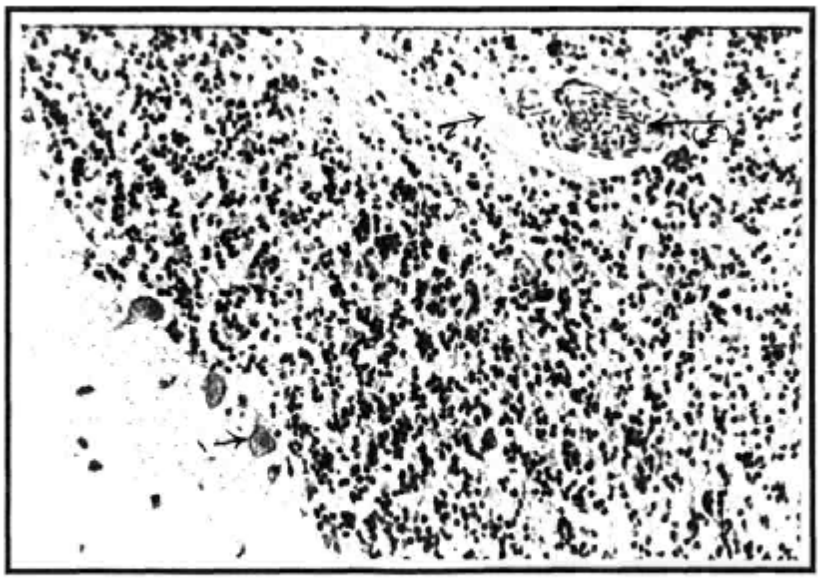

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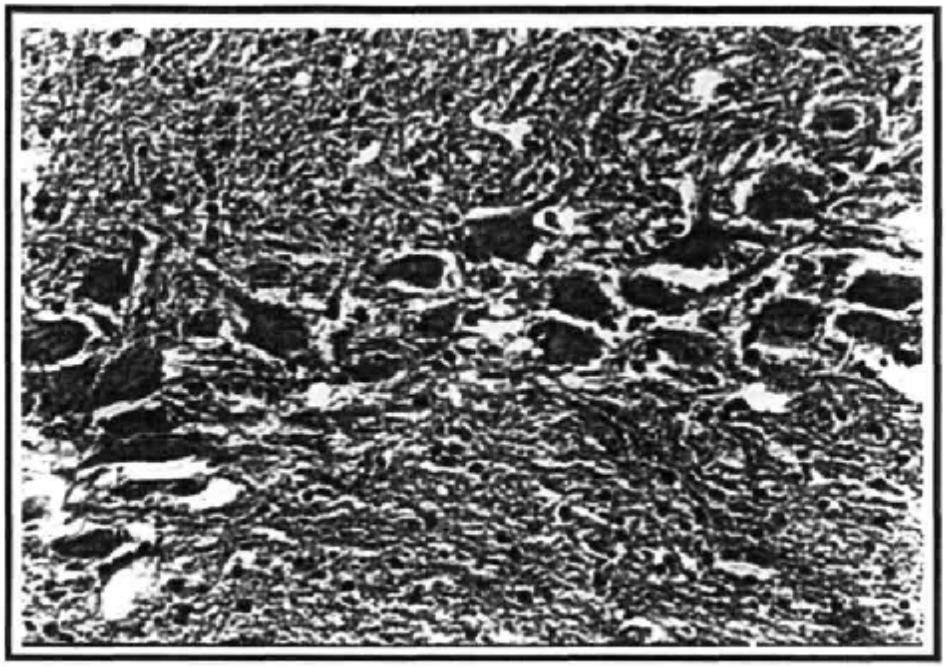

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Anatomical and Histological Study of the Cerebellum in cognitive modern birds species (gold-capped parrot)

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***** College of Pharmacy/ University of Al Mustansiriya.***

الخلاصة

تميز المخيخ بكبر حجمه وبامتلاكه العديد من الطيات بكونه من النوع المتقدم للامام في (gold–capped parrot). اظهرت المقاطع التشريحية السهمية الطيات العشرة الكبيرة الحجم والطويلة الشكل والمتفرعة والتي كانت بالتحديد (الخامسة, السادسة والتاسعة) كما واظهرت نتائج الفحص المجهري وجود مساحة قشرية واسعة تمثل (المادة السنجابية) تتناسب سعتها ومكوناتها مع سعة وطول المخيخ واظهرت ايضا وجود منظقة داخلية هي اللب وتمثل (المادة البيضاء) للمخيخ.

تضمنت القشرة وجود ثلاث طبقات منفصلة هي الخارجية اي الطبقة الجزيئية والوسطى اي طيقة خلايا بركنجي, والداخلية اي الطبقة الحبيبية.

تميز البنيان او التركيب الدداخلي للمخيخ وجود طبقة حبيبية واسعة جدا مثلت القسم الاكبر من قمم طيات المخيخ, ووجود مجاميع من الانوية العميقة الموقع ضمن مركز اللب في المخيخ.

Abstract

The gold- capped Parrots have large and highly folded cerebellum the latter design is protruded forward. Ten long and large primary folia are found in sagittal sections. Some of these folia (i.e. V, VI, IX) are subdivided. The result of microscopic examination indicates that there are an outer long strip of cortex that corresponding with cerebellum length, and inner white matter (medulla). Three distinct layers are clearly detected in the cortex (i.e. outer molecular layer, middle Purkinje cells layer, and inner molecular, layer). The internal structure of cerebellum is characterized by the great prominence of granular layer especially in the folia summit and the appearance of deep nuclei in the center of cerebellum.

Introduction

Modern birds and mammals have cognitive abilities that clearly exceed those of other birds and mammals [1]. The cerebellum (metencephalon) is a large bulge located in the inferior and posterior portion of the head (the hindbrain) name means (Latin little brain) [2].

The cerebellum has a broader role in number of cognitive functions, including (attention, language, music, and other sensory temporal stimuli [3].

The cerebellum is an important integration region in the brain which contains more than 50% of all neurons found in the brain but it is only take up 10% of total brain volume. The cerebellum play an important role in sensory perception, posture, balance and skeletal coordinated movement which is using the constant feed back on body position to fine-tune motor movement [4]. Cerebellum function in birds was modified by experience.

Birds have folded cerebella, and there are very considerable variation in cerebellar design [5,6], cerbellar size [7,8,9] number and size of cerebeller folia[8,10,11,12,13]. The cerebellum in large brained birds has not scale uniformly[8,13]. Our study has been made to find out the anatomical aspect of gold- capped Parrot cerebellum which may be helpful for better understanding of the physiology of this organ.

Materials and methods

Six healthy gold- capped Parrots were utilized in this investigation; the brains were extracted from the skull by earful dissection, the whole brain and cerebellum were submersion fixed in 10% Buffered formalin. The brains were bisected in the sagittal plane to examine cerebellar folia.

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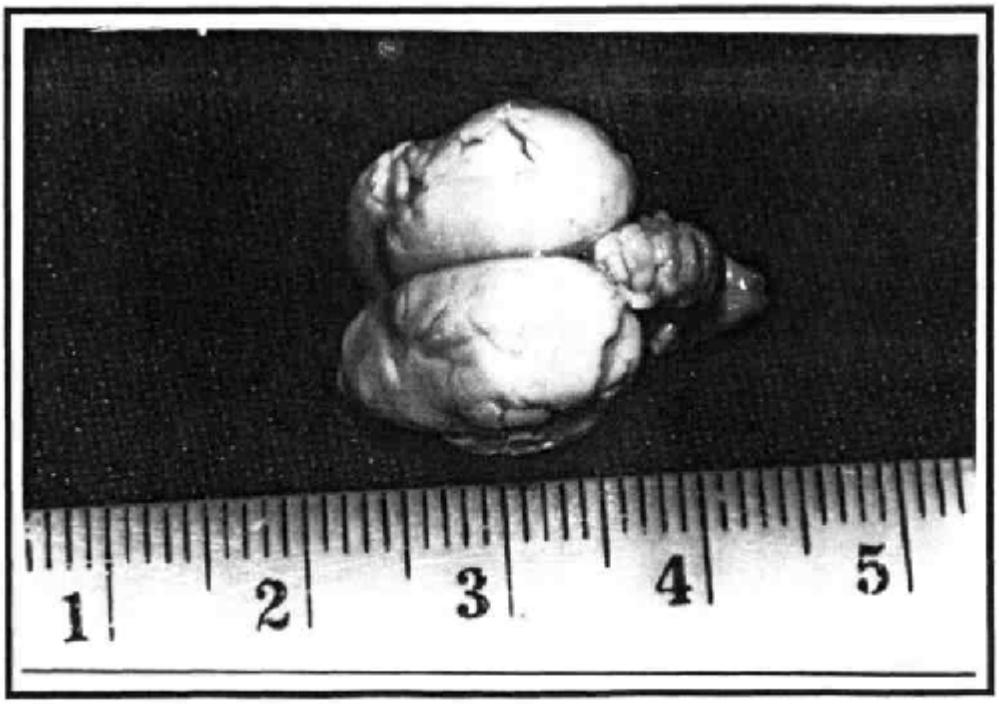
The large cerebellum in gold- capped Parrot found to be protruded forward. The cerebellum is composed of central body (corpus cerebelli), and Paired auricles (Fig. 1).

The middorsal surface of the cerebellum presented aseries of transverse gyri and sulci, the cerebellum was connected with the midbrain rostraly, and with the medulla oblongata by the peduncles (Fig. 2).

The cerebellum is divided into three strongly folded lobes (anterior, middle, and posterior) separated by two deep fissures (i.e. primary (x) and secondary (y)). Ten long and large primary lobulli or folia (number I to X) was found in sagittal section, some of them (i.e. V, VI, IX) are subdivided which are shown in (Fig. 3). The cerebellum enclosed a small centrally placed cavity continuous by a small passage with the fourth ventricle of the brain.



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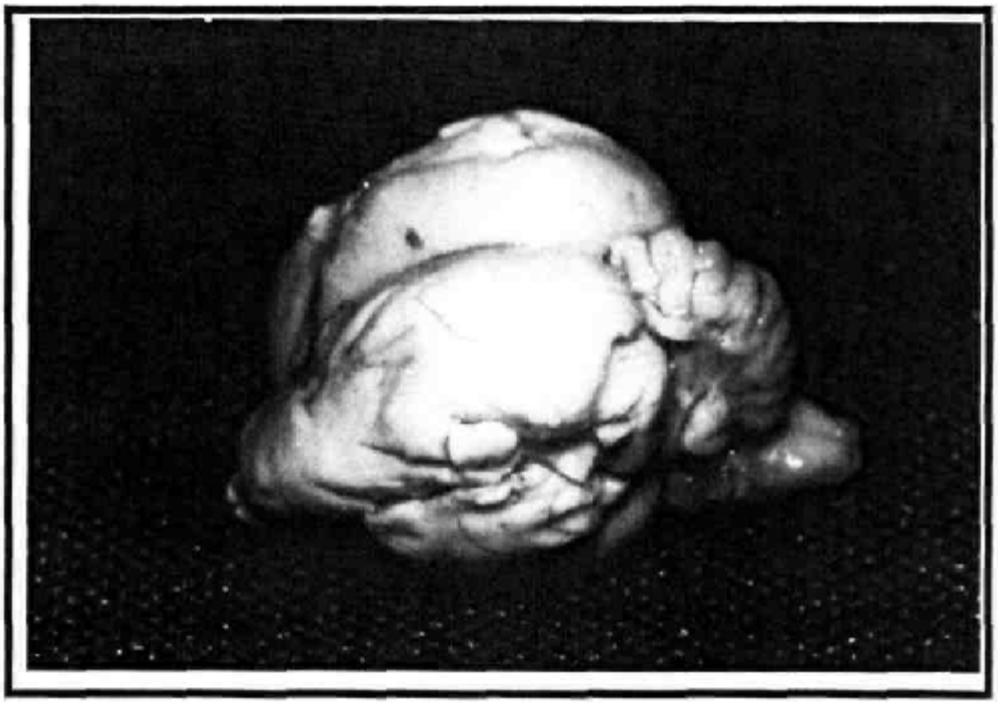

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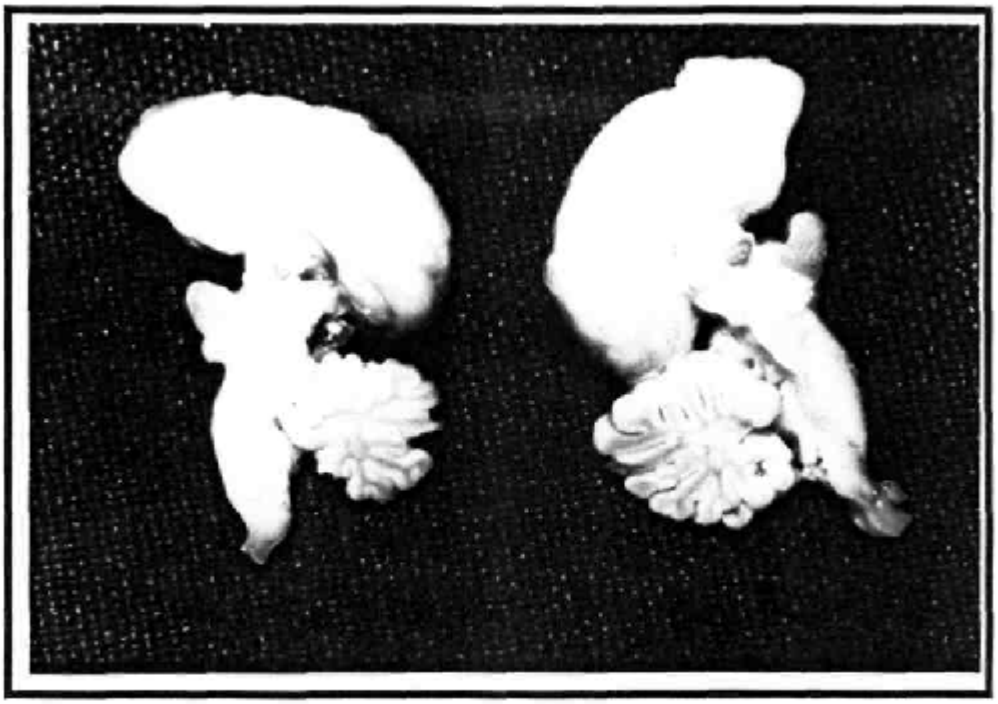

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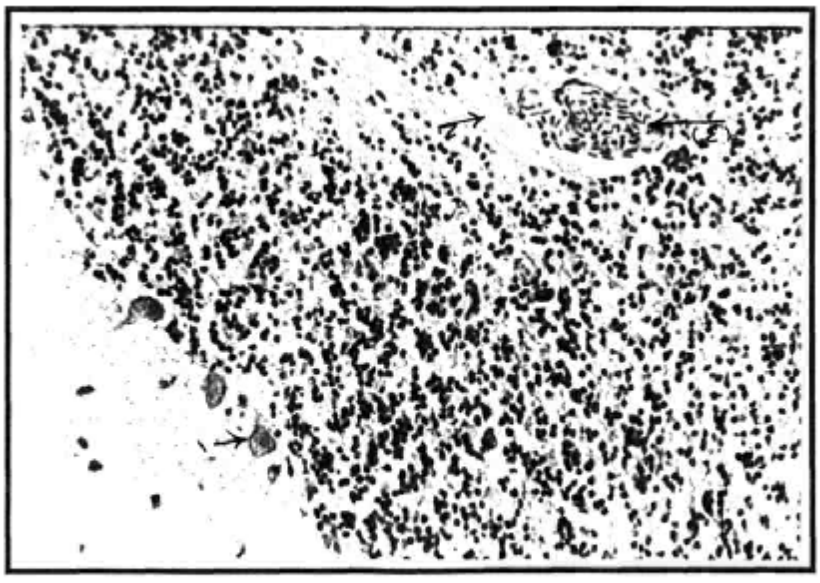

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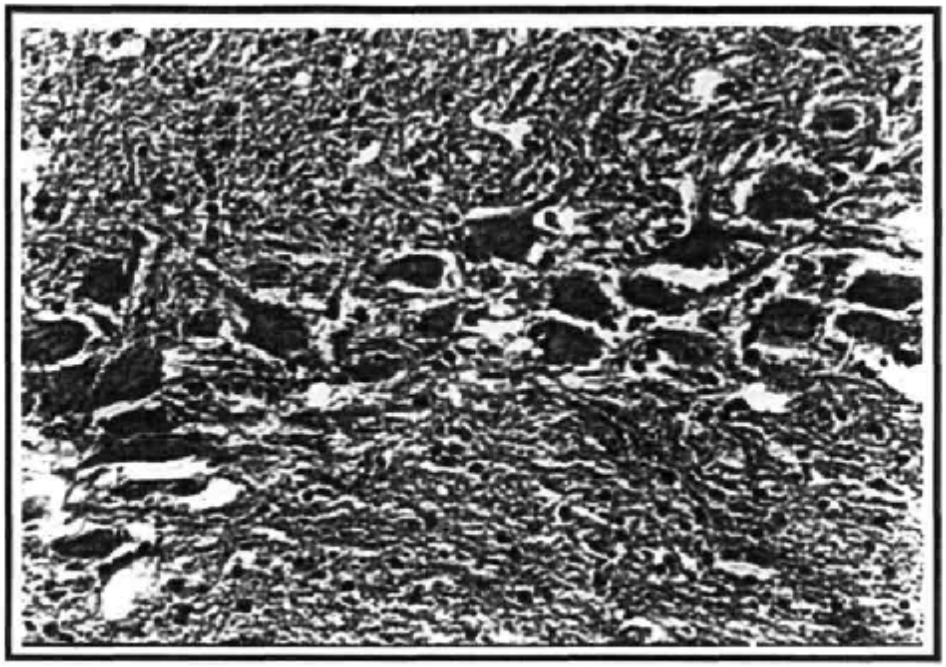

Figure (6): Deep cerebella nuclei in the center of cerebellum. (H&E) stain, (20X)

Discussion

The gold - capped Parrots have Large and highly folded cerebellum, this findings is inagreement with [7] in birds [11,13] in (seabirds, parrots, and corvids), and [16] in (crows, parrots, woodpeckers). The domestic pigeons, and chicken like birds do not have large, and highly folded cerebellum [9,11].

The cerebellum design in gold- capped parrot was protruded forward, while in fowl it was rounded in outline as stated by [5].

The cerebellum in gold- capped parrot is divided in to three strongly folded lobes by two fissures, primary (x) and secondary (y), this finding is in agreement with [12] who was stated that (songbirds, shorebirds, and smaller parrot) have three highly folded cerebella, and lack a reduced anterior lobe, there was relatively small anterior lobe in (Apodiformes and Camprimulgiformes). The fowl cerebellum divided into three folded lobes (anterior, middle, posterior) by deep fissures (x), and (y) [5]. The anterior lobe in (nightjars and humming birds) was absent or reduced [10].

According to [6], the anterior lobe has four lobuli, the middle lobe is the most variable, and the posterior lobe really consists of three lobuli in birds, correspond with the mammalian (pyramids, uvula, and nodulus). The fissure (x) was separated the anterior from the middle lobe, the fissure (y) was separated the middle lobe from the posterior lobe. The identity of individual folia or lobules in fowl were (lingual, central lobule, culmen, declive, folium and tuber vermis, pyramid, uvule and nodule)[5]. The primary fissure was separated the two culmens from the declive as stated by [6] in dove.

The gold- capped Parrots have long and large primary folia correspond with the cerebellum length. (V, VI, IX). The cerebellar folia or lobuli in large brained birds has not scale uniformly [8,13]. The enlargement/ reduction of individual folia is relating to specific behavioural differences among taxa [18] and the cognitive abilities of modern birds [1]. Corvids, parrots and seabirds have more foliated cerebella than other groups of birds [13]. [8] reported that (woodpeakers, corvids and parrots) have some larger, and longer Cerebellar folia or lobuli that coordinate visual and beak - related movement, they are generally very adept when it comes to using their beaks and or tongues to manipulate and explore external objects. There was a correlation between strong hind limbs and expansion of the anterior lobe, also there was a correlation between the reductions in anterior lobe (i.e. folia I-III) and the expansions in posterior lobes (VI and VII)in birds as stated by [12,18].

The internal structure of the cerebellum in gold- capped Parrots was divided into outer long single strip of cortex (gray matter), and inner medulla (white matter). According to [8] who was stated that the cortical strip varies in different species of birds in the anterio-posterior extension, which corresponds to the cerebellum length.

The outer long single strip of cortex in parrot is divided into three layers (i.e. molecular, Purkinje, granular) these findings are in agreement with [10] in birds [5] in fowl. The granular layer in gold- capped Parrot occupy wide area of cortex composed of numerous tiny small cells together with nerve fibers an large Golgi cells. There was a dense plexus of thin varicose nerve fiber innervated more than one class of neurons in the cortical layer of adult hens [17].

The white matter which formed the medullae found under the gray matter in Parrot, it is formed the inner bulk of cerebellum, these findings are inagreement with [10] in birds, and [5] in fowl. There are deep cerebellar nuclei found in the center of the cerebellum in Parrots. They receive both mossy fiber and Purkinje cell inputs, in human [4].

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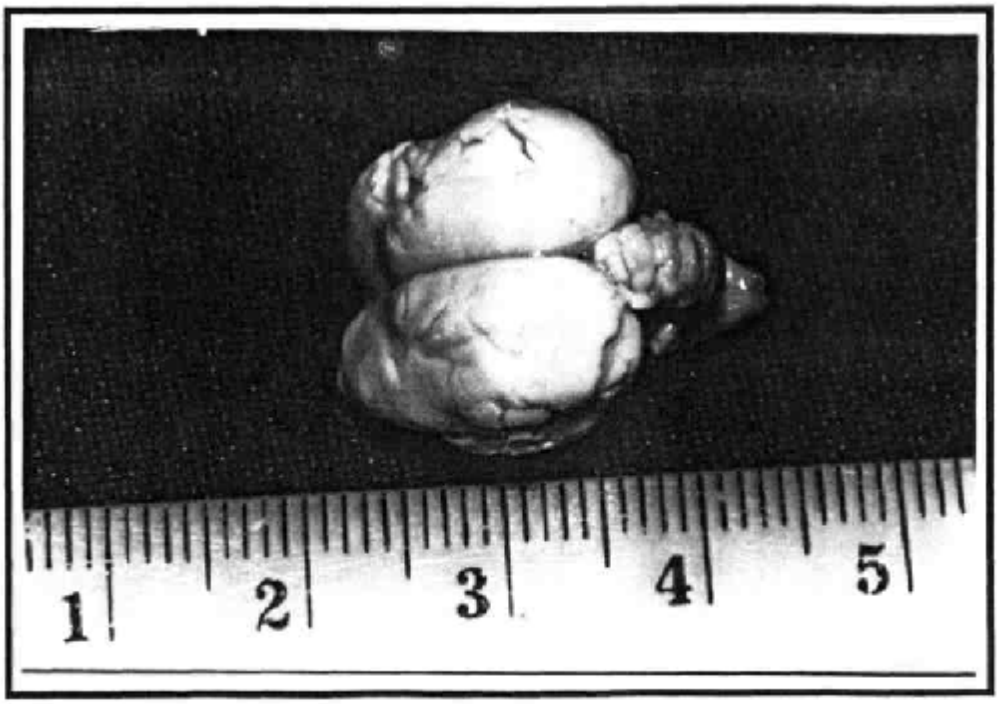

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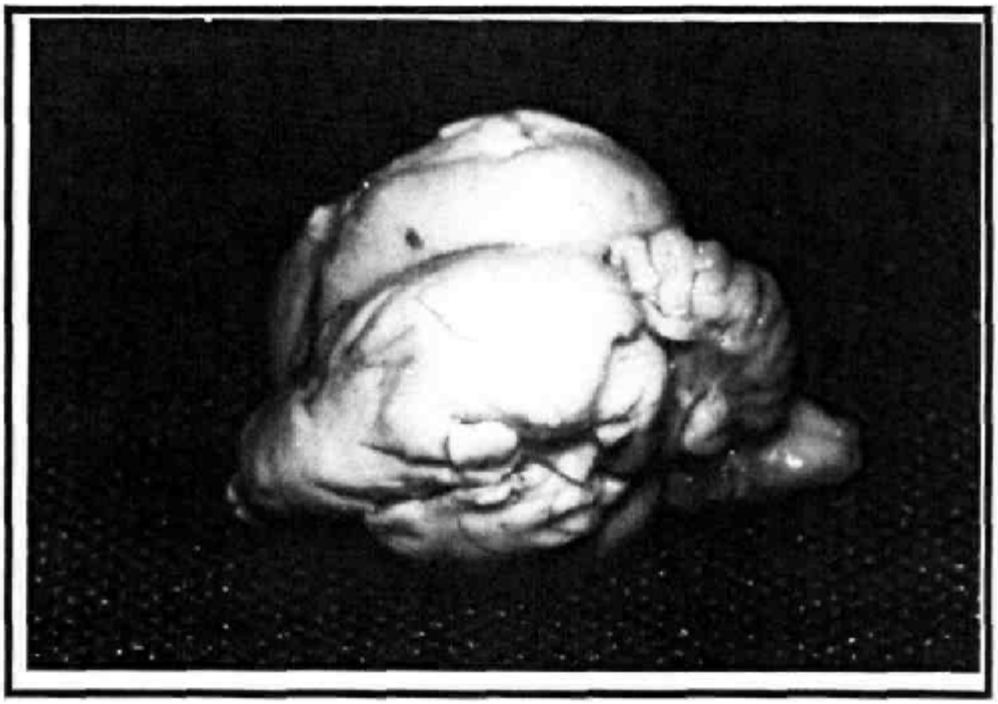

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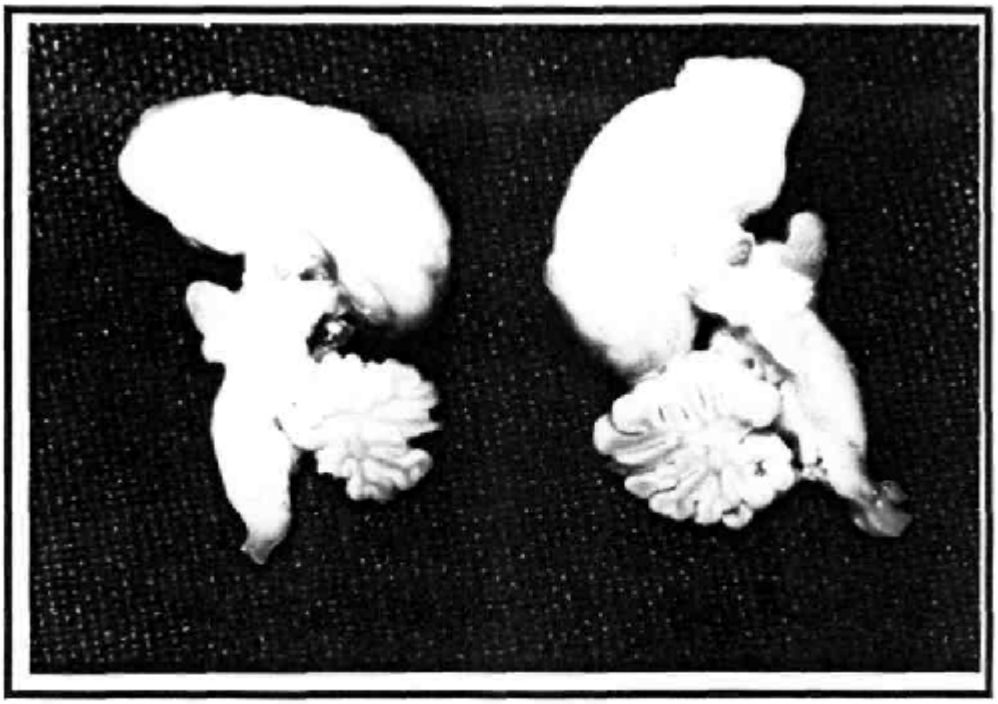

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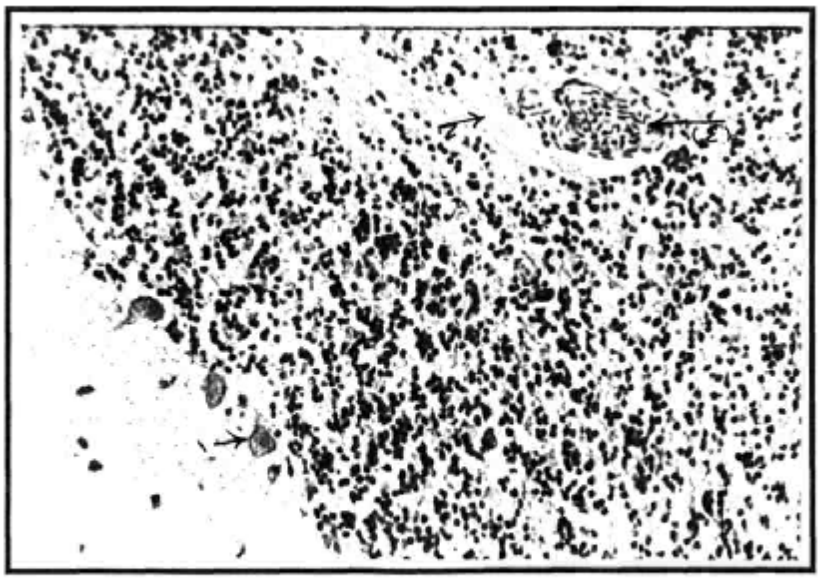

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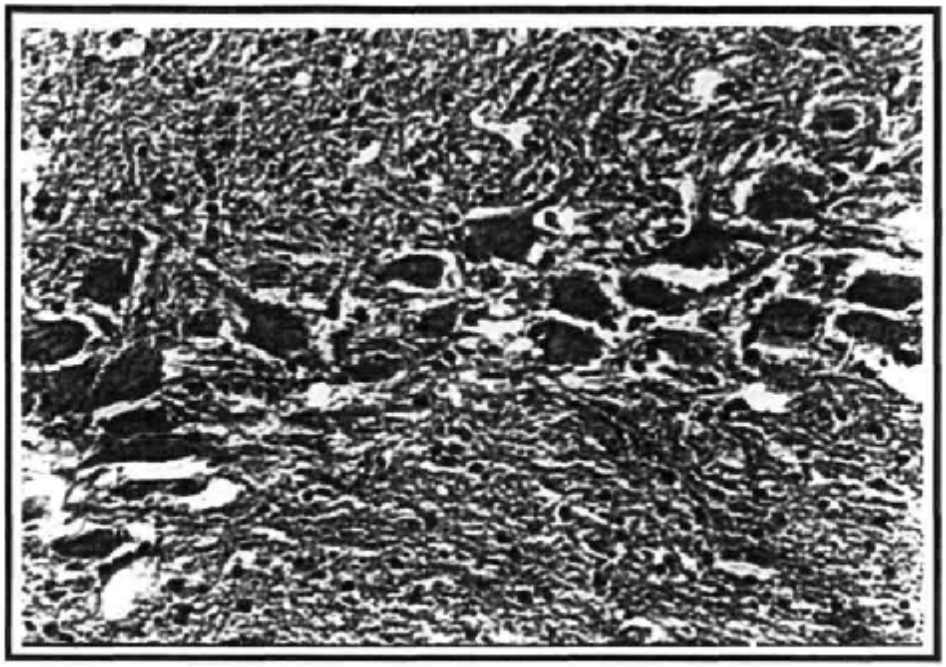

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The cerebellum in gold- capped parrot is divided in to three strongly folded lobes by two fissures, primary (x) and secondary (y), this finding is in agreement with [12] who was stated that (songbirds, shorebirds, and smaller parrot) have three highly folded cerebella, and lack a reduced anterior lobe, there was relatively small anterior lobe in (Apodiformes and Camprimulgiformes). The fowl cerebellum divided into three folded lobes (anterior, middle, posterior) by deep fissures (x), and (y) [5]. The anterior lobe in (nightjars and humming birds) was absent or reduced [10].

According to [6], the anterior lobe has four lobuli, the middle lobe is the most variable, and the posterior lobe really consists of three lobuli in birds, correspond with the mammalian (pyramids, uvula, and nodulus). The fissure (x) was separated the anterior from the middle lobe, the fissure (y) was separated the middle lobe from the posterior lobe. The identity of individual folia or lobules in fowl were (lingual, central lobule, culmen, declive, folium and tuber vermis, pyramid, uvule and nodule)[5]. The primary fissure was separated the two culmens from the declive as stated by [6] in dove.

The gold- capped Parrots have long and large primary folia correspond with the cerebellum length. (V, VI, IX). The cerebellar folia or lobuli in large brained birds has not scale uniformly [8,13]. The enlargement/ reduction of individual folia is relating to specific behavioural differences among taxa [18] and the cognitive abilities of modern birds [1]. Corvids, parrots and seabirds have more foliated cerebella than other groups of birds [13]. [8] reported that (woodpeakers, corvids and parrots) have some larger, and longer Cerebellar folia or lobuli that coordinate visual and beak - related movement, they are generally very adept when it comes to using their beaks and or tongues to manipulate and explore external objects. There was a correlation between strong hind limbs and expansion of the anterior lobe, also there was a correlation between the reductions in anterior lobe (i.e. folia I-III) and the expansions in posterior lobes (VI and VII)in birds as stated by [12,18].

The internal structure of the cerebellum in gold- capped Parrots was divided into outer long single strip of cortex (gray matter), and inner medulla (white matter). According to [8] who was stated that the cortical strip varies in different species of birds in the anterio-posterior extension, which corresponds to the cerebellum length.

The outer long single strip of cortex in parrot is divided into three layers (i.e. molecular, Purkinje, granular) these findings are in agreement with [10] in birds [5] in fowl. The granular layer in gold- capped Parrot occupy wide area of cortex composed of numerous tiny small cells together with nerve fibers an large Golgi cells. There was a dense plexus of thin varicose nerve fiber innervated more than one class of neurons in the cortical layer of adult hens [17].

The white matter which formed the medullae found under the gray matter in Parrot, it is formed the inner bulk of cerebellum, these findings are inagreement with [10] in birds, and [5] in fowl. There are deep cerebellar nuclei found in the center of the cerebellum in Parrots. They receive both mossy fiber and Purkinje cell inputs, in human [4].

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