Anatomic and Radiographic Studies on the Paranasal Sinuses of the Buffalo in Egypt (*Bos bubalis,* L.)

Farag, F.M.M., Hagrass S.M., Daghash, S.M., El-Bably, S. H. and Sary, R.G.
Anatomy and Embryology Department, Faculty of Veterinary Medicine, Cairo University

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Abstract
This survey was applied on the paranasal sinuses of the Buffalo in Egypt (*Bos bubalis* L.) and its surgical approach. Ten adult buffaloe heads of ages ranging between 2 -7 years were used. Six of these heads were used for dry skull preparation while the other four were used for radiography and cross sections. The study concluded that, in addition to sinuses conchales, four paranasal sinuses have been found to occur in adult buffalo comprising the sinus frontalis, sinus maxillaris, sinus palatinus and sinus lacrimalis. The anatomical and radiographic description of these paranasal sinuses as well as its dimensions and communications has been mentioned. Two sites for trephination of the frontal sinus could be indicated.Trephining the rostral frontal sinus through was indicated at the middle of a transverse line extending between the caudal margins of the orbital rim to the median plane while trephination site to gain the caudal frontal sinus was indicated at the middle of another transverse line extending from the middle of the base the horn to the median plane. Surgical approach of the maxillary sinus for trephining could be indicated on a vertical line extending upward from the caudal margin of the 2nd premolar for about 4.0-4.5 cm.

Keywords: Anatomy, Radiography, Paranasal Sinuses, Buffalo.

Introduction
The paranasal sinuses are air-filled spaces located within the bones of the skull and face. They are centered on the nasal cavity and have various functions, including lightening the weight of the head, humidifying and heating inhaled air, increasing the resonance of speech (in human), and serving as a crumple zone to protect vital structures in the event of facial trauma (Reddy and Dev, 2012; Dalgorf and Harvey, 2013). However, their role in increasing the thermal and mechanical

protection of the brain, without concurrently increasing the weight of the skull, being proposed. It is to add that the hypothesis that these sinuses are functionless and are formed as result of the removal of mechanically unnecessary bone, a process which was designated as opportunistic pneumatisation' (Farke, 2010).
The paranasal sinuses in bovine comprised the frontal, maxillary, lacrimal, palatine, sphenoid and nasal conchal sinuses. Some of these sinuses communicate with each other while others open independently into the nasal meatus. In cattle, the paranasal sinuses continue to develop, changing in shape and size, up to seven years of age (Dyce et al. 2010). Alsafy et al (2012) studied a computed tomography of paranasal sinuses and their communications in the Egyptian buffalo while Basso et al (2016) compared between three techniques for videosinuscopy in cattle.

Among the pathologies of the sinuses, an inflammatory process called sinusitis stands out. In cattle, the leading cause of frontal sinusitis is associated with dehorning, as about 2% of surgically dehorned animals develop this disease (Silva, 2008). It can also be associated with respiratory infections, trepanations or fractures with frontal sinus exposure, cysts or nasal cancer (Smith, 2006).

However, this study is undertaken to extend knowledge of the topography of the paranasal sinuses in the buffalo and suggest best sites for surgical approach to these sinuses, which may be helpful for surgeons in trephining of the sinuses and dehorning.

Materials and Methods

The present study was applied on ten heads of buffaloes of age 2 -7 years collected from the slaughterhouses in Giza and transported to the laboratory of the Anatomy and Embryology Department Faculty of Veterinary Medicine, Cairo University. Six of these heads were used for dry skull preparation while the other four were used for radiography and cross sections.

Anatomical cross sections were performed on two buffalo's heads (one fresh and one frozen) by using table of a band saw and transverse sections were cut at the level of last molar check tooth, first premolar check tooth and middle of interdental space. Slices were numbered and gently cleaned from debris with water and light brushing and were photographed immediately with the caudal and cranial surfaces of each slice facing the camera. Radiographs were performed on two other fresh heads at 55 k v 30-70 MA, 0.5 second and FFd 70 cm.

Skulls preparation was adopted according to Hildebrand (1968) and Lee post (2005). Manual and electric saws were used for sagittal sections in three skulls and another three skulls were used for exposure of frontal, maxillary, palatine and lacrimal sinuses. Vernier caliper was used to measure different dimensions of each sinus. The access to the sinuses was carried out by a trephining technique, first with a drill, making a small skull opening, then amplified by rotational moves with a 20mm circular trephine. The chosen sites for trephination were based on the anatomy and measurements of the frontal and maxillary sinuses.

The nomenclature used was adopted according to the Nomina Anatomica Veterinaria (2012).

Results

The major paranasal sinuses in buffalo comprised the frontal, maxillary, palatine, and lacrimal sinuses.

Sinus frontalis

The frontal sinus is the largest of the paranasal sinuses in the buffalo. It was extensive, excavated almost all the frontal bone (Fig 3/10), and a large part of the caudal and lateral wall of the cranium, invading also the parietal, interparietal and extended for a variable distance into the core of the cornual process (Figs 1/4 & 2/3). A complete median septum separated the right and left sinuses. It was in the form of a rectangular space, narrow at its rostral portion and widen gradually in caudal direction. The outer limit of each sinus could be indicated rostrally by an imaginary line extending transversely through the rostral margin of the orbits passing through the rostral end of the rostral supraorbital groove. It was bounded caudally by the occipital bone and laterally by the frontal crest and temporal bone and extended medially to the median plane which indicates the site of the interfrontal septum. The cavity of the frontal sinus was divided into two main sinuses, rostral and caudal by an inverted V- shaped incomplete septum (Fig 1/10) which started from the middle of the base and extended rostromedially to about the middle of the sinus where it formed an acute angle, then redirected caudomedially to join the interfrontal septum.

The rostral frontal sinus was larger and further divided by two irregular incomplete sagittal partitions into three compartments; lateral, intermediate and medial. Each of these compartments was further subdivided by fine boney plates into minor compartments. The lateral compartment (Fig 1/1) was the longest one, wide near its middle and narrowed both rostrally and caudally.

The supraorbital canal (Fig 1/9), extended as short canal passing through the lateral margin of this compartment through an irregular bony septum. From this compartment extended two diverticula; a postorbital diverticulum and cornual diverticulum. The **postorbital diverticulum** was situated about the middle of the lateral compartment and was about 2.5-3.0 cm in depth and was divided by 2-3 smaller lamellae. The **cornual diverticulum** extended from the caudal part of the lateral compartment into the core of the cornual process where it divided into two recesses a rostral and a caudal one. The rostral recess (Fig 1/5) was shorter measuring about 9 cm long from the base of the horn while the caudal recess (Fig 1/6) was longer extended for about 14 cm into the cornual process. The intermediate compartment (Fig 1/2) was the narrowest and shortest of the three subdivisions of the rostral frontal sinus. The medial compartment (Fig 1/3) was a narrow space adjacent to the interfrontal septum. It was wider rostrally and narrow caudally.

The caudal frontal sinus (Fig 1/7) was in the form of wide triangular space with its apex rostrally and the base caudally situated. Its apex could be indicated by a transverse line extending from the middle of the distance between the caudal margin of the orbital rim and base of the horn to the midline, while its base towards the occipital bone. The caudomedial portion of the sinus formed the nuchal diverticulum (Fig 1/8) in the form of transverse excavation of about 3.5 cm in depth. It invaded the well-developed parietal bone to the level of the nuchal crest and was divided by 3-4 lamellae into smaller sub compartments. Measurements revealed that the frontal sinus measured about 18-20 cm in length. Its width was about 5.0 - 6.5 at its rostral part and widen gradually in caudal direction reaching its maximum width on the level of the middle of the horn base where it measured 9.0-10.0 cm. Its maximum height measured about 3.0-4.0 cm near its middle portion. The rostral frontal sinus was communicated with the cavity of the dorsal turbinate through the conchofrontal opening and with the lacrimal sinus through small frontolacrimal opening and communicated with the nasal cavity through a nasofrontal opening into the ethmoidal meatuses. No direct connection of the caudal frontal sinus with either the nasal cavity or other sinuses could be observed.

Two sites for trephination of the frontal sinus could be indicated. Trephining the rostral frontal sinus (Fig 2/1) is at the middle of a transverse line extending between the caudal margins of the orbital rim to the median plane. Trephination site to gain the caudal frontal sinus (Fig 2/2) is the middle of another transverse line extending from the middle of the base the horn to the median plane.

Sinus maxillaris

The maxillary sinus (Fig 3/6 and 4) was an extensive excavation which occupied entirely the maxilla (Fig 3/1) and extended into the adjoin part of the lacrimal (Fig 5/4) and zygomatic bones (Figs 3/7 & 5/5). It was nearly triangular in outline with its apex rostrally coincided the facial tuberosity (Fig 3/2) at the level of the caudal margin of the 2nd premolar. It widen gradually in caudal direction till reaching its maximum width at the level of the last molar tooth where it began to be narrowed at its most caudal portion where it embraced the rostral and ventral margin of the orbital rim and continued caudally into the thin-walled lacrimal bulla (Fig 5/6). The dorsal limit of the sinus was indicated by a line extending from the facial tuberosity to the rostral margin of the orbital rim (Fig 4/5), while the ventral limit was about 2.5 cm above alveolar border (Fig 4/6) of the maxillary cheek teeth.

The cavity of the maxillary sinus was nearly prismatic in shape and not divided by any partition. Its average length was about 10.0-11.5 cm while its height was about 1.0 cm at its apex and its maximum height at the level of the last molar tooth was about 7.0-8.0 cm. The transverse width of the sinus also increases in caudal direction from about 0.8 cm at its rostral part to about 3.5 cm at its caudal part. The floor of the sinus was irregular where the roots of the last three or four cheek teeth project up, being covered by a plate of bone. In cross section of the head, the maxillary sinus began to appear at the level of caudal margin of the 2nd premolar tooth.

The maxillary sinus was communicated with the nasal cavity through the small slit-like 0.4-0.5 cm in length, **nasomaxillary orifice,** near its rostral portion on the level of the 3rd premolar at a height of about 2.0 cm from the floor of the sinus. This location was relatively high and might hinder the natural drainage of the pus or other fluids from the maxillary sinus. It was also communicated with the caudal part of the palatine sinus through an extensive **maxillopalatine opening** (Fig 4/3) which was an oval opening located over the infraorbital canal (Fig 4/4) just caudal to the nasomaxillary orifice, at a level extending between the caudal margin of the 3rd premolar to the caudal margin of the 2nd molar teeth. It was also communicated with the lacrimal sinus through **maxillolacrimal opening** on a level with the last molar tooth. Surgical approach of the maxillary sinus for trephining (Fig 5/3) could be indicated on a vertical line extending upward from the caudal margin of the 3rd premolar for about 4.0-4.5 cm.

Sinus palatinus

The palatine sinus (Figs 6, 7/1, 8/6) was represented by an extensive excavation in the horizontal part of the palatine bone and the palatine process of the maxilla and considered the second in size after the frontal sinus. The right and left sinuses were separated by an, undulant interpalatine septum. Its caudal limit coincided the caudal border of the palate bone, about 4 cm caudal to the last molar tooth while its rostral limit extended to a level about 2.5-3.5 cm in front of the first premolar tooth. The sinus cavity was subdivided into two unequal compartments caudal and rostral by incomplete transverse bony partitions (Fig 6/4) arising from the floor of sinus. The caudal part of the sinus (Fig 6/5) was the largest of the two compartments and appeared quadrilateral in sagittal section of the palate. It measured about 7.5-8.5 cm long and 3.5-4.0 cm width. It was traversed obliquely by the palatine canal, and communicated with the maxillary sinus by maxillopalatine opening (Fig 4/3) over the infraorbital canal (Fig 4/4). The rostral compartment (Fig 6/3), appeared triangular in the sagittal section of the palate with its narrow apex rostrally and wide base caudally. It measured about 6.5- 7.5 cm in length and maximum width about 3.5 cm at is base. In cross section, the palatine sinus appeared at the level of last molar tooth (Fig 7), at the level of the first premolar check tooth (Fig 8).

Sinus lacrimalis

The lacrimal sinus (Fig 3/9) was in the form of small quadrilateral excavation mainly in the lacrimal as well as the small adjoin portion of the frontal bone while its medial wall was formed by lateral mass of the ethmoidal bone at the rostromedial portion of the orbit. It measured about 3.5-5.0 cm in length and about 2.0-2.5 cm width. The nasolacrimal duct traversed its lateral wall and it was communicated at its rostral end with the maxillary sinus through maxillolacrimal opening and at its caudal end with the lateral compartment of the rostral frontal sinus through frontolacrimal opening and thus the lacrimal sinus considered as an indirect communicator between the maxillary and frontal sinuses.

Discussion

In accordance with Saigal and Khatra (1977) and Eshrah (2006) the paranasal sinuses in the buffaloes comprised the frontal, maxillary, palatine and lacrimal, while the sphenoid sinus was not observed in any of the examined specimens. Alsafy et al. (2012) mentioned that the sphenoid sinus was noticeable small and shallow only in two specimens. On the other hand, Eshrah (2006) and Alsafy et al. (2014) mentioned that the latter sinus was well developed in camel while the palatine sinus was absent. He added that, the palatine sinus was absent in camel while the lacrimal sinus was absent in donkey. Budras et al. (2011) classified the paranasal Sinuses of the ox into two groups. Group I were those sinuses which open into the middle nasal meatus and comprised the maxillary, lacrimal, palatine in addition to the dorsal and ventral conchal sinuses while group II were those sinuses that open in the ethmoidal meatuses and constituted the frontal and sphenoid in addition to the middle conchal sinuses.

The present study declared that the frontal sinus in the buffalo was extensive and excavated almost all the frontal bone and a large part of the caudal and lateral wall of the cranium, invading also the parietal, interparietal bones. Budras et al. (2011) in ox mentioned that the frontal sinus also excavated part of the occipital and temporal bones an, observation which could not be ascertained in buffalo. In agreement with Alsafy et al. (2012) in buffalo, Budras et al. (2011) in ox, and Farke (2010) in Bovidae the right and left frontal sinuses were separated by complete interfrontal septum. In this respect, in cattle, El-Hagri (1967) found a communication between the two frontal sinuses caudally where the interfrontal septum was deficient.

The present study revealed that, the frontal sinus was divided into two main sinuses, rostral and caudal by an inverted V- shaped incomplete septum which started from the middle of the base and extended rostromedially to about the middle of the sinus where it formed an acute angle then redirected caudomedially to join the interfrontal septum. Budras et al. (2011) mentioned that the division of the sinus in the ox was achieved through an oblique transverse septum that runs from the middle of the orbit caudomedially to join the median septum in the transverse plane of the caudal margin of the orbit. In this respect Eshrah (2006) and Alsafy et al. (2012) in the buffalo mentioned that, a transverse oblique septum at the level of the perpendicular plate of the ethmoid bone separated the larger caudal frontal sinus from the smaller rostral frontal sinus. However, in accordance with the latter authors the rostral frontal sinus was further divided into medial, intermediate and lateral sinuses. Saigal and Khatra (1977) added that the caudal frontal sinus was divided into medial and lateral compartments by an oblique septum and also mentioned that the frontal sinus was divided into numerous interconnected diverticula by ridges and partial septa. Eshrah (2006) and Alsafy et al. (2012) in buffalo added that an incomplete oblique transverse septum divided the caudal frontal sinus into large caudolateral and small rostromedial sinuses was present. Moreover, Osman et al.

(2012) and Kareem and Sawad (2016) mentioned that in goat, the frontal sinus was demarcated into large lateral frontal sinus caudally, and small medial frontal sinus rostrally.

The present study reported that, supraorbital canal invaded the rostral frontal sinus as short canal passing through the lateral margin of the lateral compartment through an irregular bony septum. On the contrary, Budras et al. (2011) in ox, as well as in the buffalo of this study, mentioned that this canal traversed the caudal frontal sinus.

In Accordance with Budras et al. (2011) in cattle, the frontal sinus had three clinically important diverticula: the nuchal, cornual, and postorbital diverticula. However, the latter authors and Alsafy et al. (2012) mentioned that these three diverticula were derived from the caudal frontal sinus while the present study revealed that only the nuchal diverticulum was partitioned from the caudal frontal sinus while the cornual and postorbital diverticula were protracted from the rostral frontal sinus. The current investigation recorded an extensive nuchal diverticulum, which excavated the well-developed parietal bone. It is further subdivided by 3-4 lamellae into smaller subcompartments, which is in agreement with the findings of Saigal and Khatra (1977), Kumar and Dhingra (1980) and Alsafy et al (2012) in buffalo. Kumar and Dhingra (1980) added that both the cornual and nuchal diverticula were absent in the buffalo calf.

In buffalo the rostral frontal sinus was communicated with the cavity of the dorsal turbinate through the conchofrontal opening and with the lacrimal sinus through small fronto-lacrimal opening and communicated with the nasal cavity through the nasofrontal opening into the ethmoidal meatuses but no direct connection of the caudal frontal sinus with either the nasal cavity or other sinus could be observed. In this respect, Alsafy et al. (2012) in buffalo reported that all rostral frontal sinus compartments communicated separately with the ethmoidal meatus and rostrally with the dorsal nasal conchal sinus by nasofrontal opening. Budras et al. (2011) in cattle added that also the caudal frontal sinus has only one aperture: at its rostral extremity, there is a small outlet to an ethmoid meatus. A result, which could not observed in any of the examined buffalo specimens.

The present work indicated two sites for trephination of the frontal sinus. Trephining the rostral frontal sinus through was indicated at the middle of a transverse line extending between the caudal margins of the orbital rim to the median plane while trephination site to gain the caudal frontal sinus was indicated at the middle of another transverse line extending from the middle of the base of the horn to the median plane. The site for trephination of the caudolateral compartment of the sinus is at the mid-distance between the base of the horn and the median plane. Saigal and Khatra (1977) and Alsafy et al. (2012) mentioned that the most suitable site of trephining the maxillary sinus could be located at about the midpoint between the infraorbital margin and the facial tuber. They also added that the most suitable trephining site of frontal sinus is on a line joining the middles of temporal regions about midway between the median plane and the lateral margin of the head. Basso et al. (2016) in bovine mentioned that the trephination areas and sinuses were selected based on anatomy, but they may be modified according to the purposes of the exam. The authors identified three main areas for trephination comprising the nuchal diverticulum, the caudal region of the sinus as well as postorbital region and added that exploration of the rostral portion of the sinus was complicated by the presence of large numbers of intrasinusal lamellae resulting in irregular areas which prevent the insertion of endoscopes through the proposed access. Eshrah (2006) indicated the suitable site for trephination of frontal sinus in buffalo was located on both sides of intersection point of a line joined between the rostral borders of base of horns and midline. While in camel the point of trephination was located on both sides of intersection point of a line joined between the caudal border of orbits and midline. While in donkey it was located on both sides of intersection point of a line joined between the supraorbital foramen and midline.

In agreement with Eshrah (2006) and Alsafy et al. (2012) in buffalo, the maxillary sinus was nearly triangular in outline and extended from the facial tuberosity rostrally to the orbital rim caudally and extended into the thin walled lacrimal bulla. Similar the observation of Eshrah (2006) the maxillary sinus in buffalo was a single sinus had no partition, while the same author mentioned that, in donkey it divided unequally by an oblique osseous partition into a rostral maxillary sinus and a caudal maxillary sinus. The present study revealed that, maxillary sinus was communicated with the nasal cavity through the small slit-like 0.4-0.5 cm in length, nasomaxillary orifice near its rostral portion on the level of the 3rd premolar at height of about 2.0 cm from the floor of the sinus. This location was relatively high and might hinder the natural drainage of the pus or other fluids from the maxillary sinus. It was also communicated with the caudal part the palatine sinus through an extensive maxillopalatine opening and with the lacrimal sinus through maxillolacrimal opening. Alsafy et al. (2012) in buffalo mentioned that, the nasomaxillary opening was situated on the medial wall midway between the orbit and facial tuber at a level from 1st molar to 3rd molar teeth. According to Saigal and Khatra (1977), the nasomaxillary opening was not distinguishable because of its continuity with the defect in the roof of palatine sinus, whereas in ox, it was much narrower and lied dorsal to the maxillopalatine opening. In small ruminants, it lied in dorsal passage of the middle conchal meatus caudally (Nickel et al., 1986). Eshrah (2006) mentioned that the maxillolacrimal opening was not observed in buffalo but present in camel.

Eshrah (2006) declared that the suitable site for trephination of the maxillary sinus in buffalo was located at a point 2.5 cm caudal to infraorbital foramen and 2.5 cm dorsal this foramen. In this respect Saigal and Khatra (1977) and Alsafy et al. (2012) in buffalo mentioned that the most suitable site of trephining the maxillary sinus could be located at about the midpoint between the infraorbital margin and the facial tuber. In the view of the morphometric studies applied in the present study the suggested sites were considered rostral to the rostral limit of the sinus and mostly leads to the nasal cavity, and the accurate site for trephining the sinus was indicated on a vertical line extending upward from the caudal margin of the 2nd premolar for about 4.0-4.5 cm.

The current investigation confirmed the observation of Alsafy et al. (2012) in buffalo that the palatine sinus was located within the horizontal part of the palatine bone and the palatine process of the maxilla and that the right and left sinuses were separated by an, undulant interpalatine septum and the sinus cavity was subdivided into two compartments caudal and rostral by incomplete transverse bony partitions. Eshrah (2006) reported that in buffalo and donkey the cavity of sinuses partly were divided by bony specules into several diverticulae 3-4 in buffalo and 2 -3 in donkey. The author also added that, the palatine sinus in buffalo lacked bony roof that permit mucous membrane of nasal cavity to lie back to back against that of palatine sinus. An observation, which was not documented in the present study. Kareem and Sawad (2016) recorded pyramidal shaped palatine sinus in goat.

In accordance with Alsafy et al. (2012) in buffalo, the lacrimal sinus was in the form of small excavation mainly in the lacrimal as well as the small adjoin portion of the frontal bone while its medial wall was formed by lateral mass of the ethmoidal bone at the rostromedial portion of the orbit and that the nasolacrimal duct traversed its lateral wall. Eshrah (2006) mentioned that he cavity of the lacrimal sinus in buffalo was irregular due to the presence of bony specules divided it into 3-4 diverticulae. In confirmation with Eshrah (2006) and Alsafy et al. (2012) in buffalo the lacrimal sinus was communicated with the maxillary sinus by maxillolacrimal opening. In addition, the present study revealed that the lacrimal sinus was also communicated with the lateral compartment of the rostral frontal sinus through frontolacrimal opening and thus the lacrimal sinus is considered as an indirect communicator between the maxillary and frontal sinuses. Such communication was achieved through direct frontomaxillary opening in the donkey as recorded by Eshrah (2006) and El-Gendy and Alsafy, (2010) and in the Arabian foal by Bahar et al. (2014).

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Corresponding author
Farag, F.M.M.
email: fouad.farag@cu.edu.eg

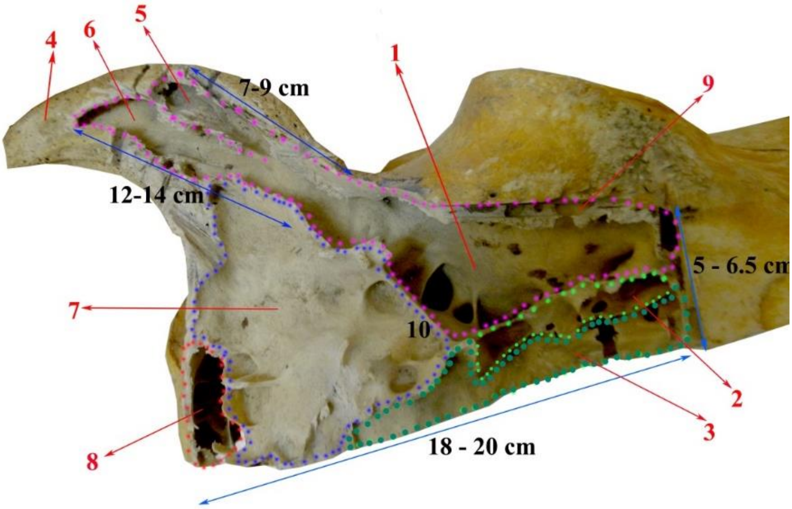

Fig (1): A photograph showing the frontal sinus of buffalo, dorsal view.
1 Sinus frontalis rostralis lateralis, 2 Sinus frontalis rostralis intermedius, 3 Sinus frontalis rostralis medialis, 4 Processus cornualis, 5 Recess rostralis, 6 Recess caudalis, 7 Sinus frontalis caudalis, 8 Diverticulum nuchalis, 9 Canalis supraorbitalis, 10 Inverted V- shaped incomplete septum.

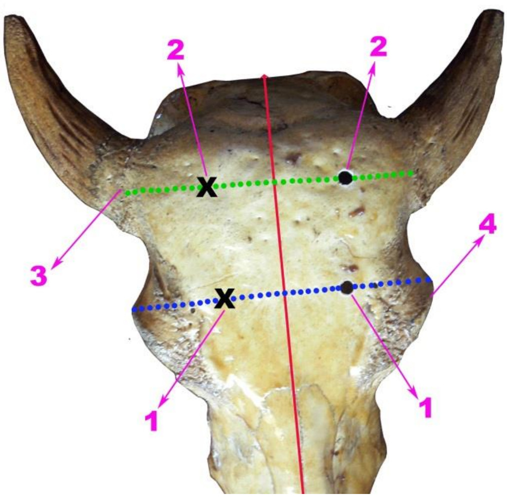

Fig (2): A photograph of a skull of buffalo, dorsal view, showing the sites of approach of frontal sinus.
1 Site for trephining of Sinus frontalis rostralis, 2 Site for trephining of Sinus frontalis caudalis, 3 Processus cornualis, 4 Margo orbitalis.

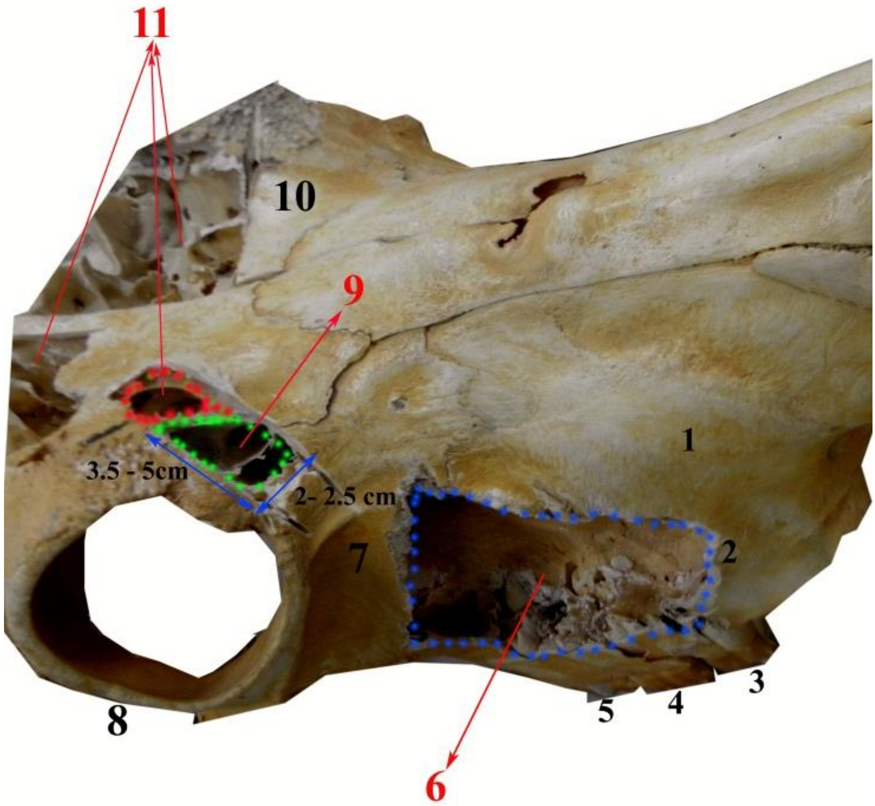

Fig (3): A photograph showing the maxillary and lacrimal sinus of buffalo.
1 Maxilla, 2 Tuber faciale, 3 Dentes molars I, 4 Dentes molars II, 5 Dentes molars III, 6 Sinus maxillaris, 7 Os zygomaticum, 8 Margo orbitalis, 9 Sinus lacrimalis, 10 Os frontale, 11 Sinus frontalis.

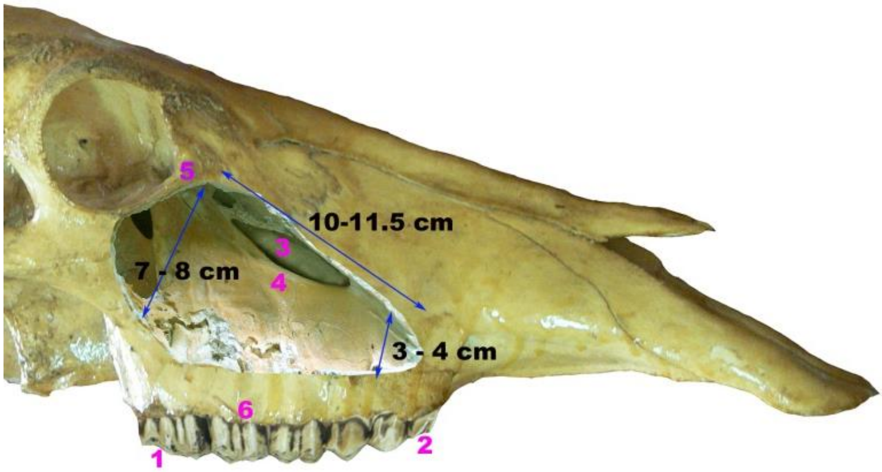

Fig (4): A photograph showing the maxillary sinus in a skull of buffalo, lateral view.
1 Dentes molars III, 2 Dentes premolars I, 3 Apertura maxillopalatina, 4 Canalis infraorbitalis, 5 Margo orbitalis, 6 Margo alveolaris.

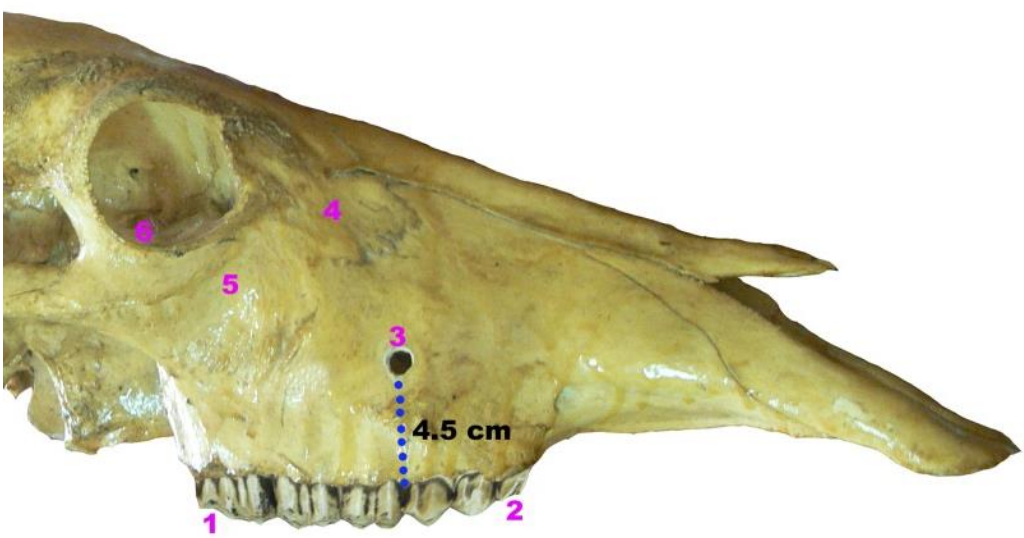

Fig (5): A photograph of a skull of buffalo, lateral view, showing the site of approach of maxillary sinus.
1 Dentes molars III, 2 Dentes premolars I, 3 Site for trephining of sinus maxillaris, 4 Os lacrimale, 5 Os zygomaticum, 6 Bulla lacrimalis.

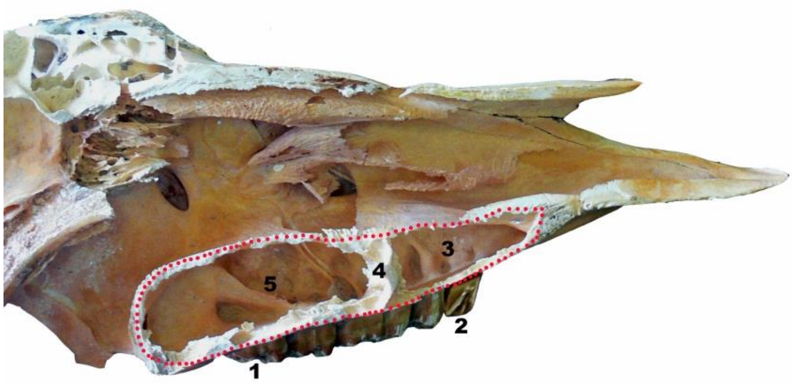

Fig (6): A photograph of a sagittal section in a skull of buffalo showing the palatine sinus.

1 Dentes molars III, 2 Dentes premolars I, 3 Sinus palatinus rostralis, 4 Incomplete transverse bony partitions, 5 Sinus palatinus caudalis.

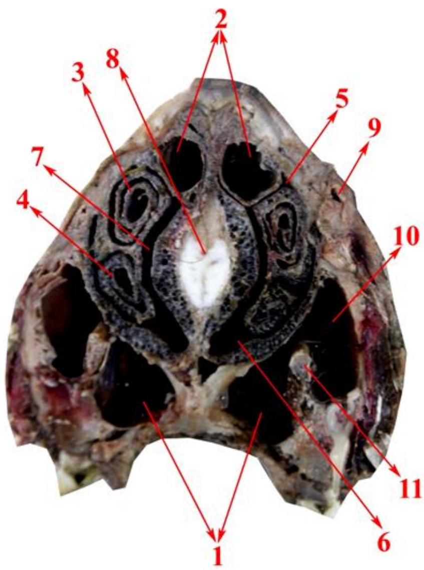

Fig (7): A photograph showing a cross section in the nasal cavity of buffalo at the level of last molar tooth.

1 Sinus palatinus, 2 Concha nasalis dorsalis, 3 Dorsal part of Concha nasalis ventralis, 4 ventral part of Concha nasalis ventralis, 5 Meatus nasi medius, 6 Meatus nasi ventralis, 7 Meatus nasi communis, 8 Septum nasi osseum, 9 canalis nasolacrimalis, 10 sinus maxillaris, 11 canalis infraorbitalis.

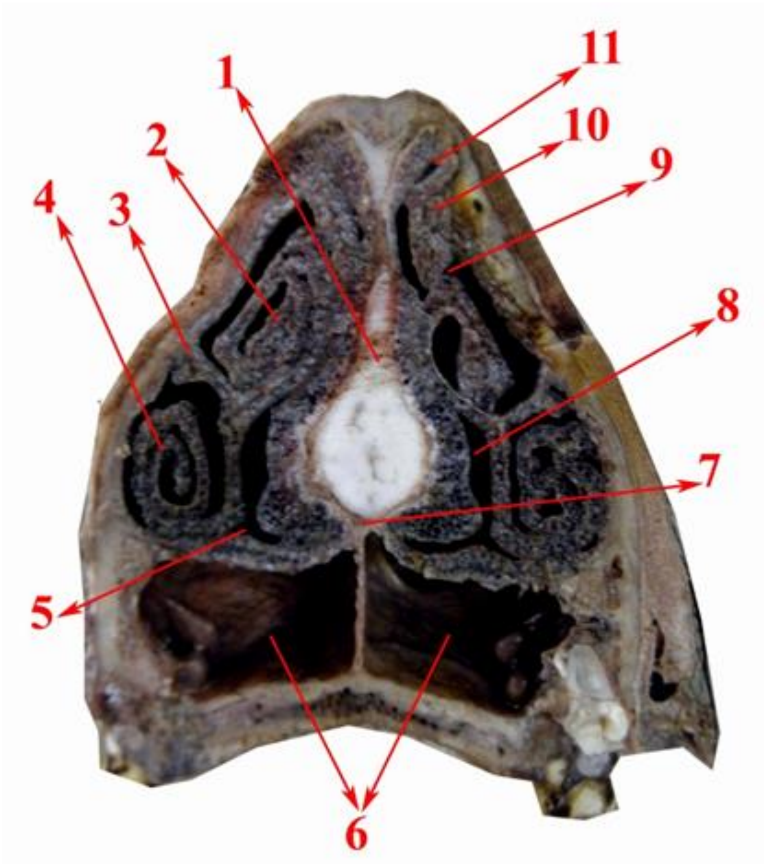

Fig (8): A photograph showing a cross section in the nasal cavity of buffalo at the level of first premolar tooth.

1 Septum nasi osseum, 2 Dorsal part of Concha nasalis ventralis, 3 Basal lamella, 4 ventral part of Concha nasalis ventralis, 5 Meatus nasi ventralis, 6 Sinus palatinus, 7 Vomer, 8 Meatus nasi communis, 9 Meatus nasi medius, 10 Concha nasalis dorsalis, 11 Meatus nasi dorsalis.

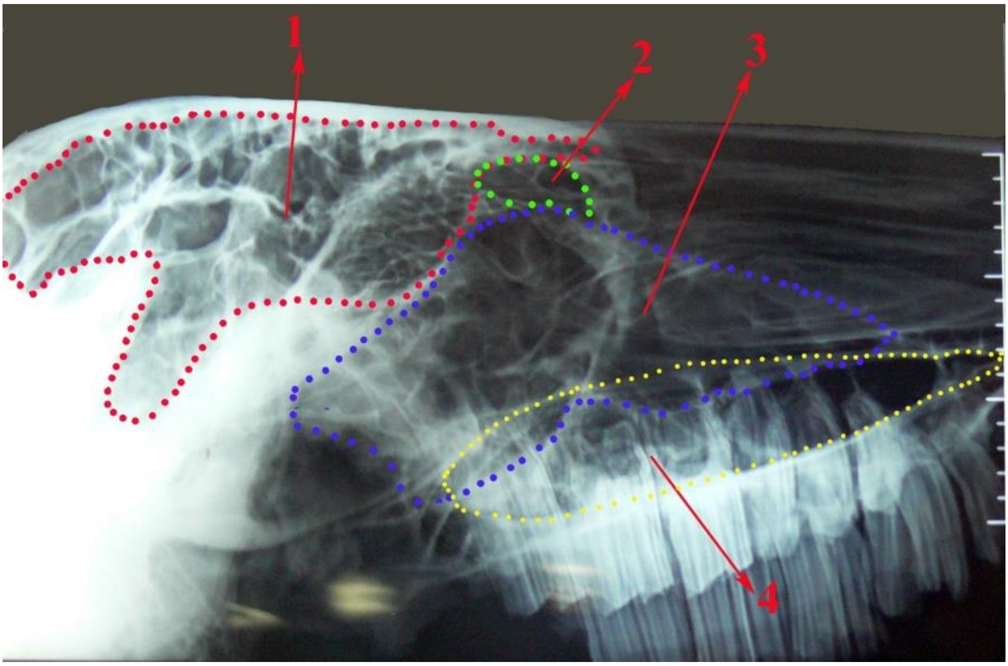

Fig (9): A photograph of X-ray on the head of buffalo, lateral view.
1Sinus frontalis, 2 Sinus lacrimalis, 3 Sinus maxillaris, 4 Sinus palatinus.

Animal species in this Issue

Red Fox *(Vulpes vulpes*, Demarest 1820*)*

Kingdom: Animalia & Phylum: Chordata & Class: Mammalia & Order: Carnivora & Family: Canidae & Genus: ***Vulpes*** *&* Species: *V. Vulpes* (Demarest 1820)

The **red fox** (*Vulpes vulpes*), largest of the true foxes, has the greatest geographic range of all members of the Carnivora order, being present across the entire Northern Hemisphere from the Arctic Circle to North Africa, North America and Eurasia. Apart from its large size, the red fox is distinguished from other fox species by its ability to adapt quickly to new environments. Despite its name, the species often produces individuals with other colourings, including albinos and melanists. Forty-five subspecies are currently recognized, which are divided into two categories: the large northern foxes, and the small, basal southern foxes of Asia and North Africa.
The species has a long history of association with humans, having been extensively hunted as a pest and furbearer for many centuries, as well as being represented in human folklore and mythology. Because of its widespread distribution and large population, the red fox is one of the most important furbearing animals harvested for the fur trade.

The largest red fox on record in Great Britain was a 17.2 kg (38.1 lbs), 1.4-metre (4 ft 7 in) long male, killed in Aberdeenshire, Scotland, in early 2012.

Source: Wikipedia, the free encyclopaedia