



# Anatomical Description of the Bony Segments that Make Up the Skull of the Puma Concolor Species

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. Author MS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KZ and LC managed the analyses of the study. Author PC managed the literature searches. All authors read and approved the final manuscript.*

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## **ABSTRACT**

The *Puma concolor* is one of the largest carnivores present in Chile, although its size varies according to the geographical area in which it is found. It is increasingly common to find them outside their habitat and more in our environment. Its ecology, reproduction and nutritional aspects are known, but very little about its anatomy, which creates a challenge in the veterinary morphological area that needs strengthening.

The present study consisted of an anatomical description of the skull of five adult specimens of *Puma concolor* (2 female and 3 male) in the veterinary anatomy laboratory of the Santo Tomás University, of the Puerto Montt headquarters and the Austral University of Valdivia headquarters. , which allowed a detailed study on the bone conformation of each structure present in the skull of these specimens. This allowed us to achieve results of morphological interests and deepening in the anatomy of this species.

**Keywords:** *Anatomy; skull; description; splanchnocranium; neurocranium; puma.*

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## 1. INTRODUCTION

The puma (*Puma concolor*) is a mammal that belongs to the order of carnivores and to the family of cats. It is also known by the name of león, lluchupuma and kirajari malsonori [1].

This feline is the largest land carnivore that lives in Chile, although its size and weight vary according to the subspecies and geographic areas it inhabits [2]. In general, the specimens from the highlands and those from the extreme south of the country are larger. It has a uniform coloration throughout the body, with a coat that varies from gray to reddish-brown tones, highlighting the whitish coloration around the mouth [3].

Regarding the current state of knowledge of this species, aspects of its ecology, reproduction and nutrition are known, however, the aspects related to its anatomy are very general.

It is possible that, because it is a protected animal, it is not always feasible to have well-preserved corpses that can be used for morphological studies under special conditions, and that allow their anatomy to be compared with that of another feline such as the domestic cat, a more studied species regarding what concerns its anatomy [4].

In this way, through an anatomical study, it is possible to understand about this species, allowing to understand structures, shape, position and coordination of segments that make up the body of every organism [5].

The present study consisted of the description of the Puma concolor skull, both at the level of the neurocranial bones and the splanchnocranium, making a comparison with respect to the absence or presence of bone structures already described in the anatomy of the domestic cat. With the aim of contributing to veterinary anatomy and biological sciences, in addition to being a basis for future medical procedures, both complementary (imaging) and surgical examinations in this species.

## 2. MATERIALS AND METHODS

### 2.1 Materials

The material associated with this study is directly related to the manipulation and intervention of

bone pieces, and to obtaining digital photographs of them. For this we used:

- Latex gloves and white apron
- Photographic camera
- Black paper as a background for photos
- Saw and saw frame for metal
- 5 Puma concolor species skulls (3 males and 2 females). These samples were donated by the agricultural and livestock service (SAG), after being found dead, near the city of Valdivia, Chile.

Being transferred to the veterinary anatomy laboratory of the Austral University of Chile. Place where its conservation and subsequent osteotechnics were carried out.

### 2.2 Type of Study

It was of a qualitative descriptive type, which was based on the observation and description of bone structures, where different planes of the cranial skeleton were covered; mainly neurocranium and splanchnocranium.

For this study, the skulls of five adult specimens (2 female and 3 male) of the Puma concolor species were used, both obtained from the veterinary anatomy unit of the Austral University of Chile, Valdivia headquarters.

### 2.3 Location

All descriptions and imaging were carried out in the anatomy laboratory of the Santo Tomás University, Puerto Montt headquarters.

### 2.4 Method

The bone pieces that were used in the development of this work belong to the veterinary anatomy unit of the Universidad Austral de Chile, Valdivia headquarters, obtained in previous years, where a maceration procedure was performed in order to carry out the osteotechnic technique to its subsequent cooking and assembly [6]. In addition, modern plastination techniques were used for some muscle masses on the heads of these specimens [7].

For in-depth observation of the different segments of the Puma concolor skull, a cut was made in the median sagittal plane of the cranial skeleton. This allowed an appreciation of the

conformation of the skull from both an external view and an internal view of the nasal cavity and endocranial cavity.

As a start, a general description of the different planes of the Puma concolor skull was made and then continued with its divisions.

The descriptive development followed a methodical order; where the concepts used to refer to the different structures (view and observation planes, topography, spatial arrangement, underlying relationship and names) were taken from the current veterinary anatomical list [4].

By means of photographic images using a Canon PowerShot model SX530 HS digital camera, 16 Mpx® resolution with possible to have a detailed record of what was observed and thus support the description process. These images also served to graphically complement this article.

### 3. RESULTS

To observe the existence of anatomical differences at the level of the different bone segments of the puma skull, a comparative table with the domestic cat was made. See Tables 1 and 2.

**Table 1. Observations of differences at the neurocranial level between *Puma concolor* and domestic cat**

Bone segment	Portion or segment	Difference with the cat's skull	Anatomical site of differentiation
Occipital	Squamous portion	YES	Nuchal ridges
	Lateral portion	YES	Holes magnum
	Basilar portion	NO	Does not present
Esfenoidal	Basiesfenoides	YES	Yes Greater deepening of the pituitary fossa
	Presfenoides	YES	Optic canal
Temporal	Squamous portion	NO	Does not present
	Tympanic portion	YES	Elongated tympanic bullae.
	Petrous portion	NO	Does not present
Parietal	Parietal	NO	Does not present
Interparietal	Interparietal	NO	Does not present
Etmoidal	Etmoidal	NO	Does not present
Frontal	Squamous portion	NO	Does not present
	Nasal portion	NO	Does not present
	Orbital portion	NO	Does not present
Pterigoides	Pterigoides	YES	Hamulus Pterigoideos
Vómer	Vómer	NO	Does not present

(For anatomical differentiations, sizes and measurements were not considered).

**Table 2. Observations of differences at the level of the spleen skull between *Puma concolor* and domestic cat**

Bone segment	Portion or segment	Difference with the cat's skull	Anatomical site of differentiation
Maxilar	Palatal face	YES	Deep and very marked grooves on the palatal aspect of the maxilla
Incisivo	incisivo	NO	Does not present
Palatino	Horizontal portion	YES	Horizontal sheet
Nasal	nasal	NO	Does not present
Lagrimal	lagrimal	NO	Does not present
Cigomático	cigomático	YES	-Temporal process of the zygomatic - Frontal process of the zygomatic
Mandibular	mandibular	YES	Rounder condylar process
Ventral nasal shell	ventral nasal shell	YES	Greater bone folds
Hyoid apparatus	Hyoid apparatus	NO	Does not present

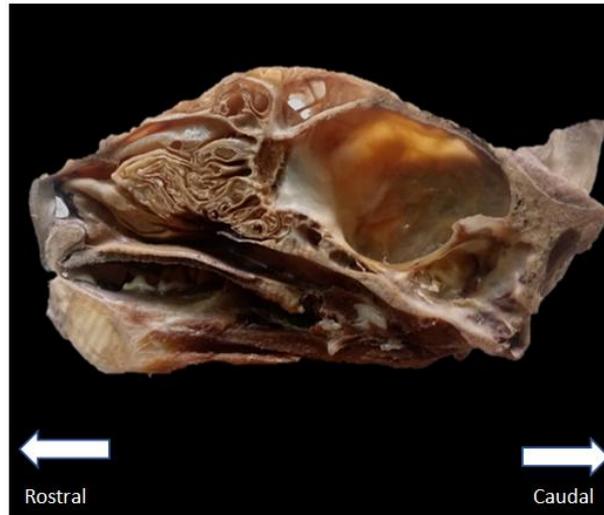
(For anatomical differentiations, sizes and measurements were not considered).

## 4. DISCUSSION

### 4.1 Cranial Skeleton

The skull is a mosaic of many bones, most are even bones, but some are odd bones that are closely joined together to form a rigid and unique structure [8]. The skull of the *Puma concolor* species, as in all vertebrates, is made up of two

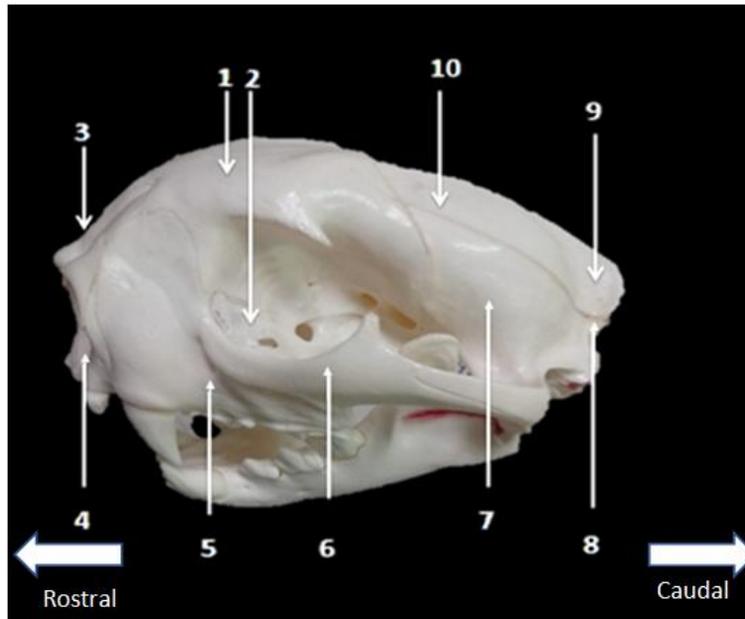
large regions, the neurocranium and the splanchnocranium. Like Dyce et al. [9] we must bear in mind that this differentiation and separation between bones and portions is generated in its embryonic stage, as they develop in size and ossification processes in the adult, these differentiations are less noticeable (See Photos 1, 2, 3 and 4).



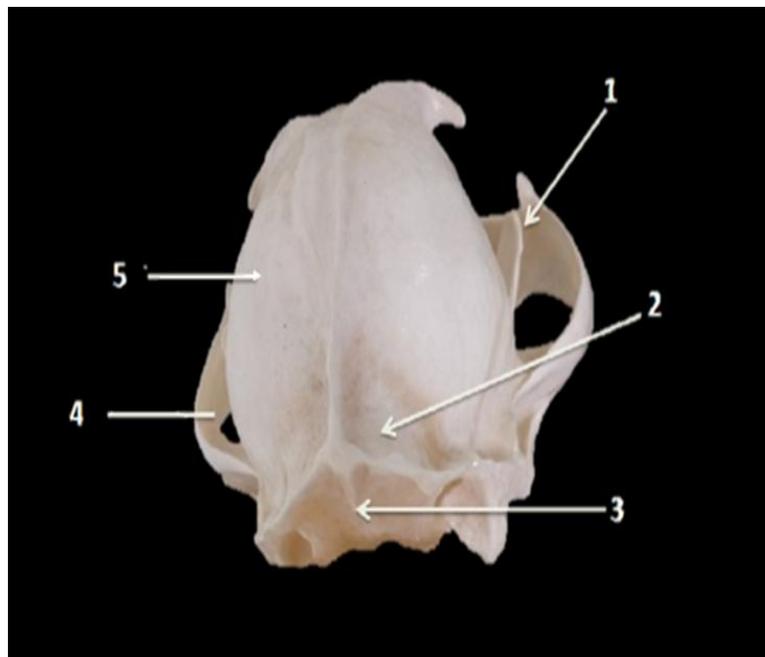
**Photo 1. Median sagittal section of the head of the *Puma concolor* specimen. Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters. Scale bars should be provided for all images**



**Photo 2. Rostral view of the cranial skeleton of a specimen of the species *Puma concolor*. Frontal bone (1), Zygomatic bone (2), Nasal bone (3), Incisor bone (4), Maxillary bone (5), Temporal bone (6), Parietal bone (7). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 3. Left lateral view of the cranial skeleton of a specimen of the species *Puma concolor*. Frontal bone (1), Lacrimal bone (2), Nasal bone (3), Incisor bone (4), Maxillary bone (5), Zygomatic bone (6), Temporal bone (7), Occipital bone (8), Interparietal bone (9), parietal bone (10). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 4. Caudal view of the cranial skeleton of a specimen of the species *Puma concolor*. (1) Zygomatic bone, (2) Interparietal bone, (3) Occipital bone, (4) Temporal bone, (5) Parietal bone. Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**

## 4.2 Neurocranium

### 4.2.1 Occipital bone

Like what was stated by König and Liebich [5]. The occipital bone is found forming the ventro-caudal surface of the skull. It is originated by three portions; lateral, squamous and basilar portions, which come from the ossification of three exoccipital, supraoccipital and basioccipital nuclei that fuse in the fetal stage. In the occipital bone is the foramen magnum where the dorsal and ventral intercondylar incisura can be seen, communicating the cranial cavity with the vertebral canal. The occipital condyles articulate with the first cervical vertebra (C1) forming the atlanto-occipital joint, these are located laterally to the foramen magnum (Photo 5).

Limiting dorsally and ventrally, the dorsal and ventral condylar fossae are observed through which the canal for the hypoglossal nerve can be seen.

In the most caudal and ventral area of the cranial cavity is the basilar portion, on its internal face two impressions can be seen, the pontine that limits cranially by the sellar dorsum and the more caudal medullary impression and that borders the dorsal edge of ventral intercondylar incisure. The muscular tubercles can also be seen from

the external side and the pharyngeal tubercles very little visible.

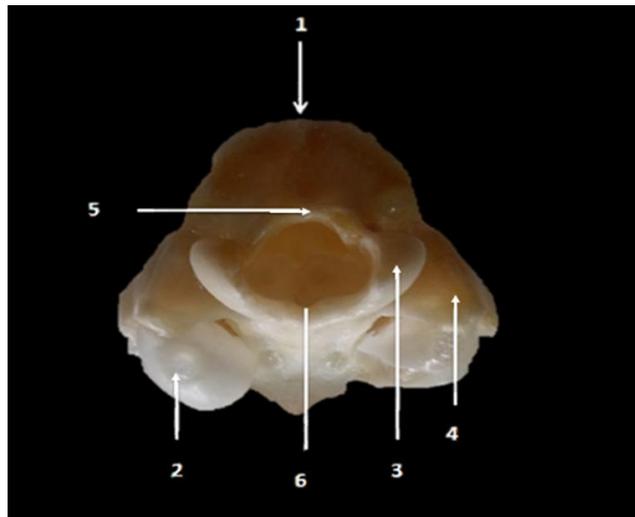
The squamous portion is located dorsal to the foramen magnum, a large eminence called the external occipital protuberance can be found, lateral to this are the nuchal ridges (Photo 6).

Something characteristic of the occipital bone in the puma at the level of the squamous portion of the occipital bone is the morphology of the nuchal ridges, which are more pronounced in contrast to the domestic cat.

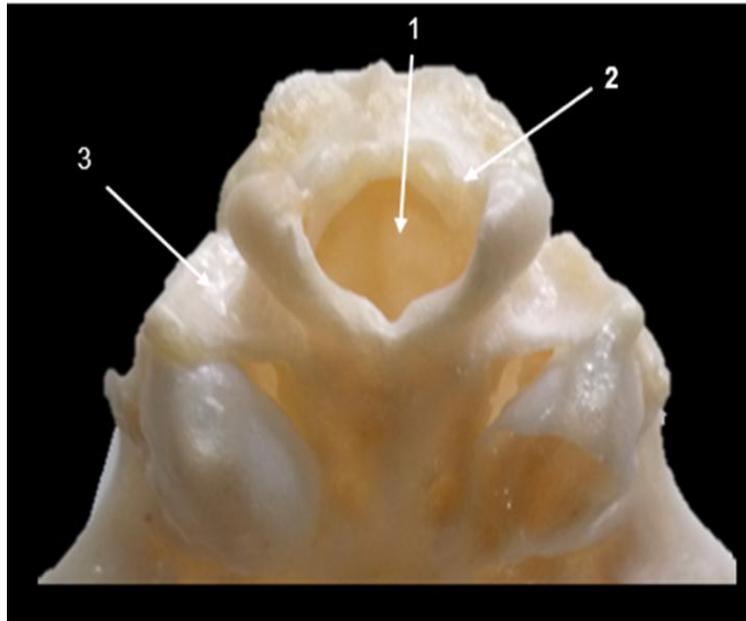
On the other hand, the foramen magnum is more oval and slightly flattened on its lateral margins. Both species do not present mastoid holes in the squamous portion of the occipital bone (Photo 6).

### 4.2.2 Sphenoid bone (Basisphenoids)

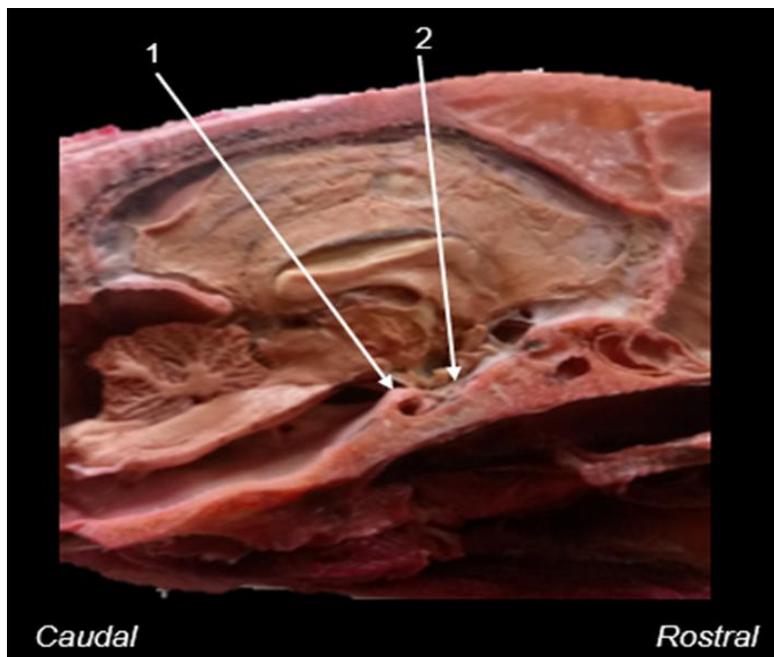
It is located caudal to the presphenoid bone and rostral to the basilar portion of the occiput. It has a body and two wings, the latter articulate with the temporal and parietal bones, and together with the body they form the middle cranial fossa, which at the level of the body presents a depression called the sella turcica where the grooves are found on each side. carotids.? In its center there is an oval excavation called the pituitary fossa, much deeper in relation to domestic cats, where the pituitary gland is housed (Photo 7).



**Photo 5. Caudal view of the cranial skeleton of a specimen of the species *Puma concolor*. External occipital protuberance (1), Tympanic bulla (2), Occipital condyle (3), Jugular process (4), Dorsal intercondylar incisure (5), Ventral intercondylar incisure (6). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 6. Caudo-ventral view of the cranial skeleton of a specimen of the species *Puma concolor*. Foramen magnum (1), squamous portion of occiput (2), paracondylar processes (3). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 7. Mid-sagittal view of the cranial skeleton of a specimen of the *Puma concolor* species. Back seal (1), Pituitary fossa. Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**

The wings are larger in size compared to the pre-sphenoid wings. Ventrally on the external surface there is an alar foramen divided into one rostral and another caudal, both of which communicate internally with the round foramen. Like the cat, it is possible to observe an oval hole and an orbital fissure in similar proportions and locations (Photo 8).

#### **4.2.3 Sphenoid bone (presphenoid)**

It articulates caudally with the basisphenoid specifically the body of this bone and face dorsally with the ethmoid bone. Regarding its division, it shares similar characteristics to domestic felines, observing the presence of two wings that articulate with the frontal bone and with the wings of the basisphenoid. Towards dorsal they form part of the medial wall of the orbital cavities and the temporal fossa, in addition to helping the formation of the optic holes where the optic nerve emerges on its external face. The set of these two, the body and the wings will give rise to the rostral cranial fossa.

The optical channels are covered dorsally by a bone lamina and are of greater amplitude in relation to those observed in domestic felines (Photo 9).

#### **4.2.4 Temporal bone**

It has three portions called petrous, tympanic, and squamous, and it is located caudolaterally in the skull. The squamous portion comes into contact with the frontal, parietal and sphenoid bone, it has a structure called the zygomatic process of the temporal bone that together with the temporal process of the zygomatic bone make up the zygomatic arch. The mandibular fossa is located on its ventral margin, which makes contact with the condylar process of the ramus of the mandible, allowing the formation of the temporomandibular joint (Photo 10) [9].

Like Concha., [4] it is possible to distinguish at the level of the temporal bone a petrous portion, which is located between the tympanic and squamous portion of the temporal bone, and articulates with the occipital bone. The petrous portion is located on the inside of the skull. Caudal to the external acoustic meatus is the mastoid process, between the latter and the tympanic bulla is the stylomastoid foramen that leads to the facial nerve. The tympanic portion is

represented by the tympanic bulla, this is more elongated than in cats, it is located ventral to the tympanic cavity and external to the cranial cavity. This structure has the function of housing the middle ear and is subdivided into two unequal parts by means of a bony septum equally developed as in the domestic cat, the septum bullae. The tympanic bulla together with the tympanic cavity communicates outwards through the external acoustic meatus See Photo 11.

#### **4.2.5 Parietal bone**

Provides bone protection for the brain, cerebellum, and brainstem. It is located caudal to the frontal bone and rostral to the occipital bone, it is limited ventrally with the squamous portion of the temporal bone. The parietal bone has a suture that joins said bone with the frontal one, called the frontoparietal bone. The bony cerebellar tentorium is made up of the inner face of the parietal bone together with the occipital bone. It has an extension by the dorsal view called the external sagittal crest that is formed from the prolongation of the interparietal occipital bone, this crest is short and less pronounced in felines in relation to other species (Done, 2010).

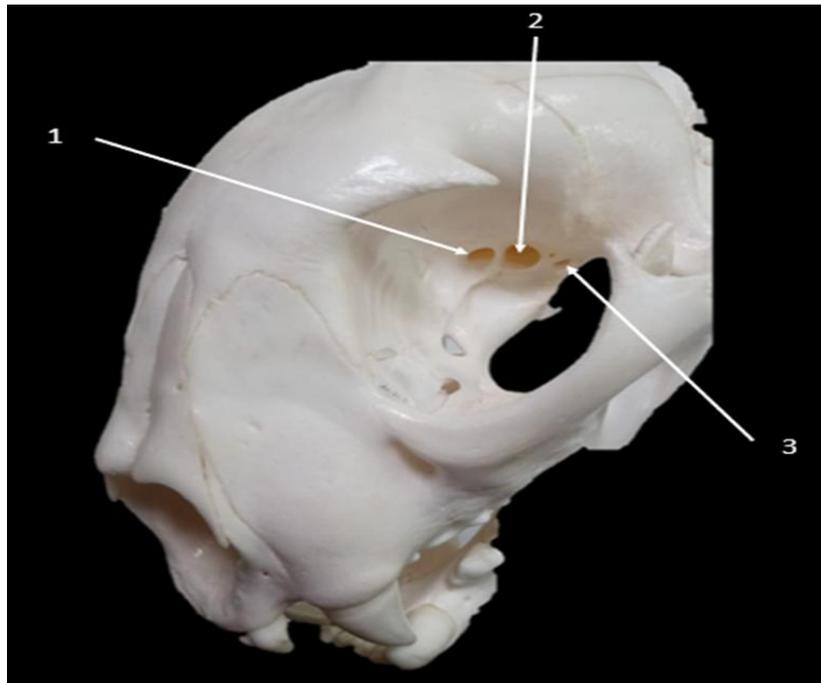
#### **4.2.6 Interparietal bone**

During the fetal period this bone fuses with the occipital bone, being the continuation of the nuchal ridges, allowing it to be differentiated between the parietal and occipital bone. In relation to what has been observed, there are not many differences in this bone between pumas and domestic cats.

#### **4.2.7 Ethmoid bone**

It shares similar characteristics with the domestic cat. It is bounded dorsally by the frontal bone, laterally by the maxillary bone, and ventrally by the palatine bone and vomer. This bone has the function of forming a boundary of the nasal cavity and the endocranium. The olfactory nerves pass through a series of holes through the ethmoid cribriform plate which is arranged transversely (Photo 13).

The ethmoidal labyrinth presents lateral and dorsal walls of the nasal cavity, a structure composed of ethmoturbinates which are divided into ectoturbinates (small and external) and endoturbinates (large and internal), similar characteristics with the cat.



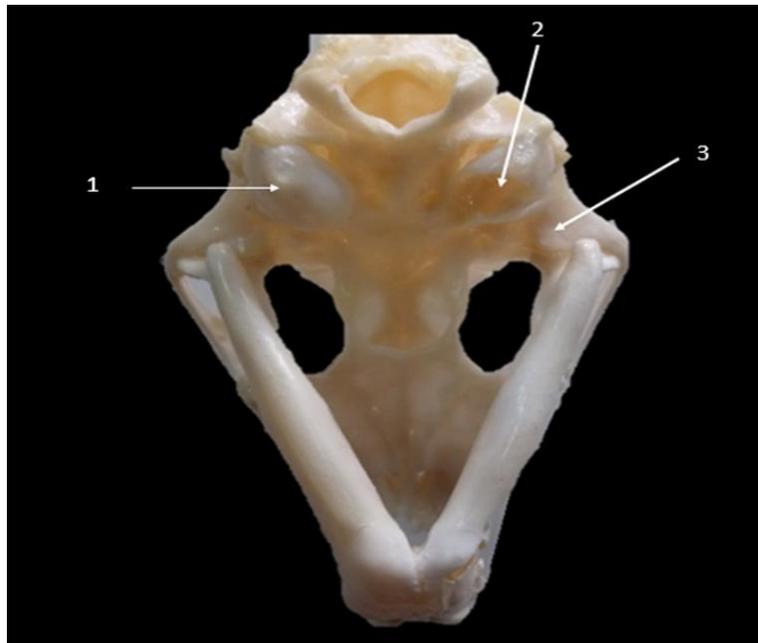
**Photo 8.** Lateral view of the cranial skeleton of a specimen of the species *Puma concolor*. Optic foramen (1), Orbital fissure (2), rostral alar foramen (3). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters



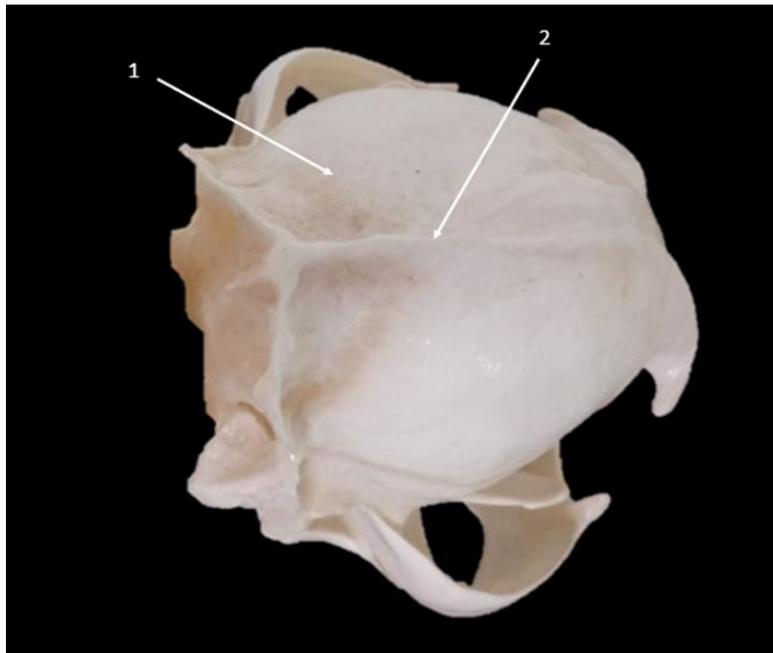
**Photo 9.** Lateral view of the cranial skeleton of a specimen of the species *Puma concolor*. Pre-sphenoid wings (1). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters



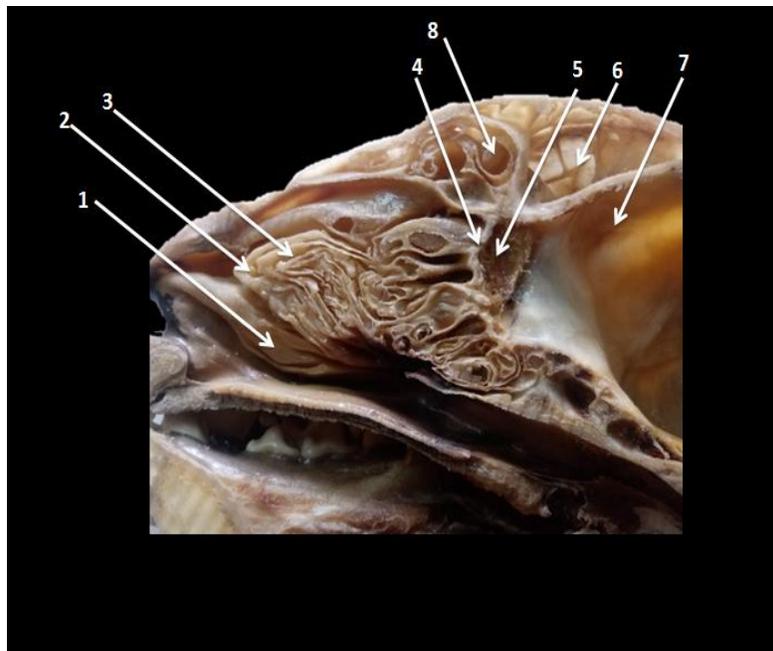
**Photo 10.** Lateral view of the cranial skeleton of a specimen of the species *Puma concolor*. Temporal fossa (1), Mastoid process (2), Squamous portion of the temporal bone (zygomatic temporal process) (3). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters



**Photo 11.** Ventral view of the cranial skeleton of a specimen of the *Puma concolor* species. Bulla tympanica (1), Septum bullae (2), Articular fossa (3). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters



**Photo 12. Dorsal view of the cranial skeleton of a specimen of the Puma concolor species. Parietal bone (1), external sagittal crest (2). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 13. Median sagittal plane section- medial view of the right half of the species Puma concolor. Vomer bone (1), Ventral nasal shell (2), Middle nasal shell (3), Lamina cribrosa of the ethmoid bone (4), Ethmoid bone (5), Frontal sinus (6), Frontal bone (7), Ectoturbinates II ( 8). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**

#### 4.2.8 Frontal bone

This bone in terms of its morphological division does not vary in comparison to domestic felines. It is subdivided into the squamous, nasal and orbital portion. The squamous portion can be seen in the superciliary arch and ends in the caudal margin in the shape of a point, creating the frontal zygomatic process. Its rostral projection portion is connected to the nasal bone by means of the frontonasal suture. In relation to the orbital portion, it borders the ocular region, being of the open type (Photo 14).

#### 4.2.9 Pterygoid bone

It is a short bone of great amplitude, bordering laterally with the cones. In ventral arrangement it presents a structure called pterygoid hamulus, being very blunt in puma, unlike cats (Photo 15).

#### 4.2.10 Vomer bone

They are part of the caudal area of the nasal cavity (see Photo 16), limiting with the choanas. It is located in the median plane of the nasal cavity, by means of its lateral and basal laminae, it forms a groove in the shape of a "U" in which it rests on the bony nasal septum, which will later articulate with the perpendicular lamina of the

ethmoid. The basal lamina joins the horizontal lamina of the palatine bone similar to that proposed by Currier [10].

### 4.3 Splanchnocranium

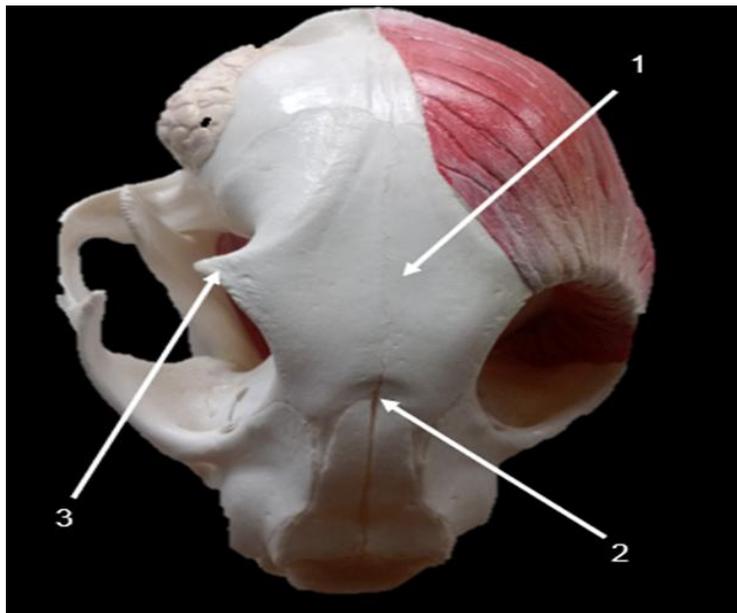
#### 4.3.1 Maxillary bone

It is part of the lateral regions of the face. Ventrally it limits with the palatine bone and rostrally with the incisor bone.

At the level of its lateral facial walls, it has an infraorbital foramen and canal, the latter extending from the ventral part of the orbit and reaching the maxillary foramen of the pterygopalatine fossa. In the pterygopalatine fossa there are also the sphenopalatine and caudal palatine foramen, sharing similar characteristics with the domestic cat (Photo 17).

#### 4.3.2 Incisor bone

There are no differentiations with the skull of domestic cats. A palatal process can be observed that articulates with the maxillary bone ventrally and a nasal process that articulates with the nasal bone, forming the palatine fissures and the alveolar process where it articulates through the dental alveoli with the incisor teeth.



**Photo 14. Rostral view of the cranial skeleton of a specimen of the species *Puma concolor*. Squamous portion of the frontalis (1), Frontonasal suture (2), zygomatic process of the frontal (3) Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**

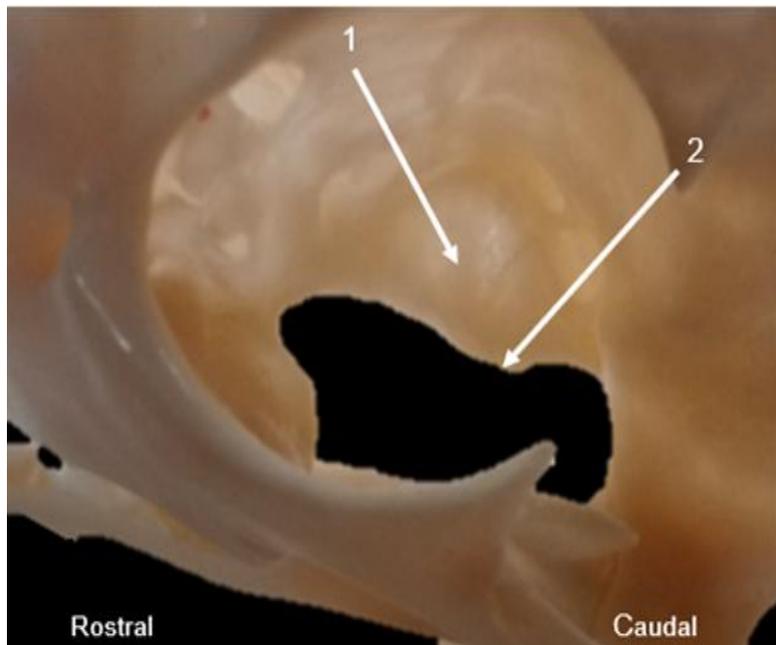


Photo 15. Lateral view of the cranial skeleton of a specimen of the species *Puma concolor*. Pterygoid bone (1), Pterygoid hamulus (2). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters

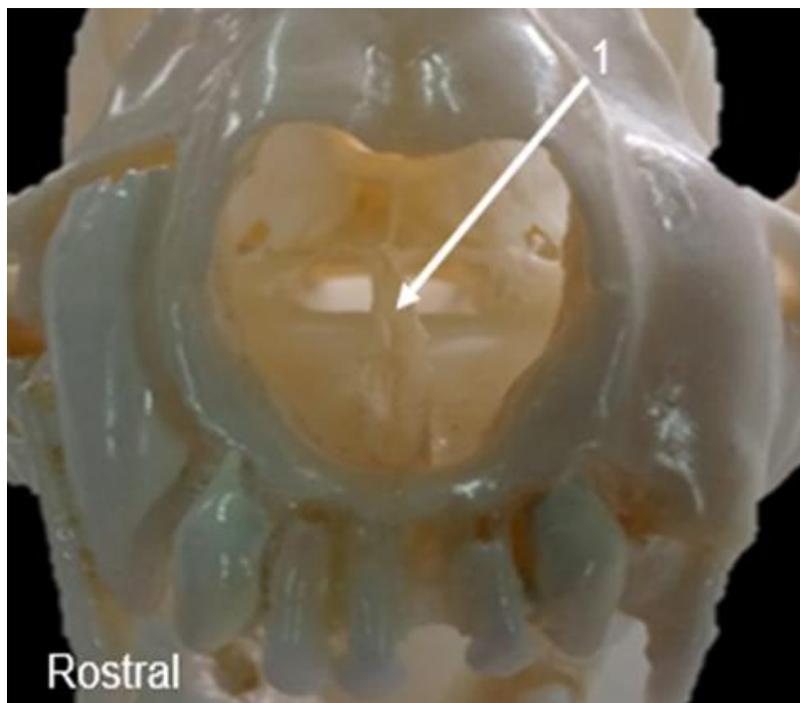
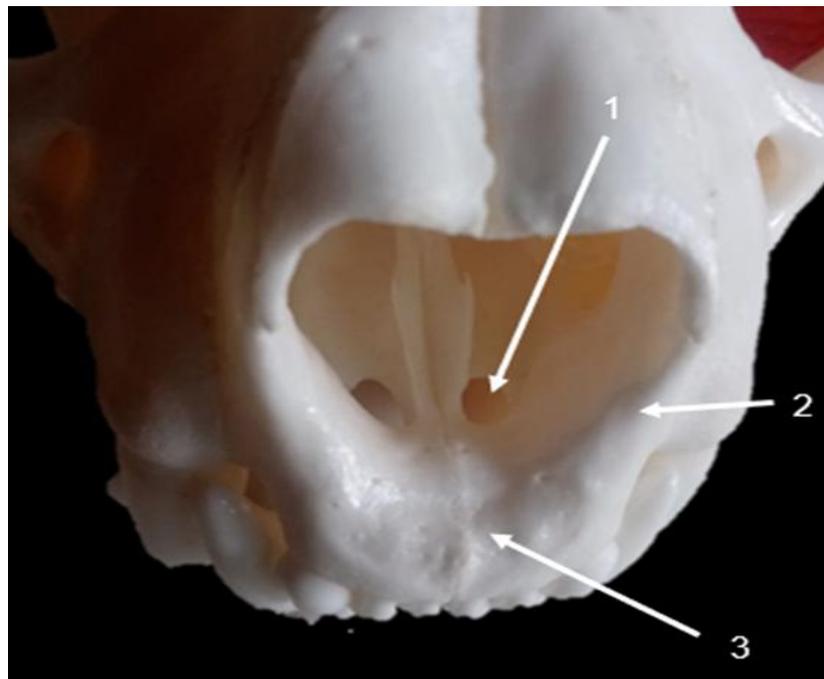


Photo 16. Rostral view of the cranial skeleton of a specimen of the species *Puma concolor*. Vomer bone (1), Source: Veterinary Anatomy Unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters



**Photo 17. Lateral view of the cranial skeleton of a specimen of the species *Puma concolor*. Infraorbital foramen (1), Maxillary bone (2). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 18. Rostral view of the cranial skeleton of a specimen of the species *Puma concolor*. Palatal cleft (1), Nasal process of the incisor (2), body of the incisor (3). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**

The alveolar process has three processes for the incisor teeth which increases in size from the first to the third. It will have an extension that is wide and cut at the interalveolar border. This bone will present a union of its two parts through an interincisive suture that limits the palatal fissure medially.

The nasal process caudally extends to a distance between the nasal and maxillary bone. It forms the lateral edge of the bone nose opening for its rostral part which presents a dorsal curve (Photo 18).

#### 4.3.3 Palatine bone

Participates in the formation of the hard palate next to the incisor and maxillary bone. It has a caudal nasal spine that is located in the median plane. It is possible to observe at the level of this bone, two holes which correspond to the minor and major palatine foramen.

It has a horizontal lamina where very noticeable furrows can be observed in the vicinity of the minor palatine foramina, a finding that differs from the domestic cat. Its perpendicular lamina corresponds to a caudal extension of the

palatine, a place where it allows the formation of the choanae and the presence of the sphenopalatine and caudal palatine foramina.

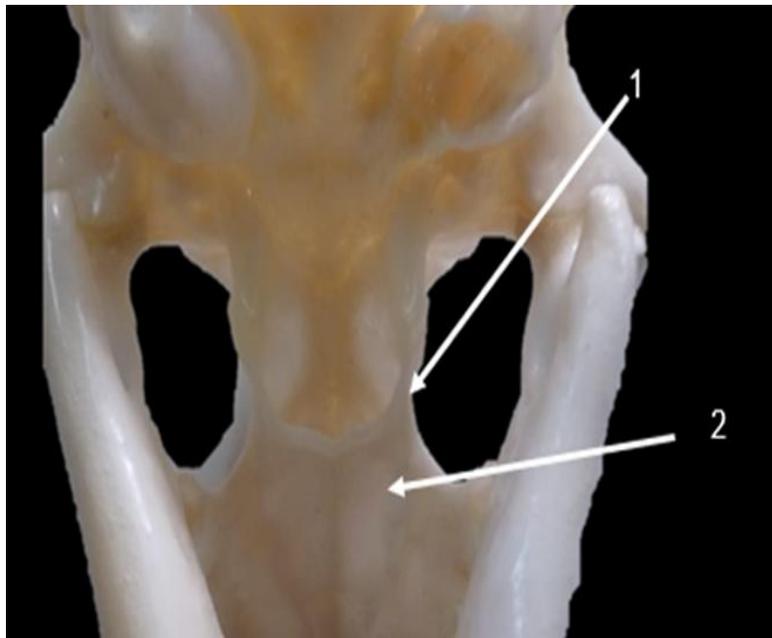
The sphenopalatine foramen is perforating the dorso-caudal border of the internal and external laminae that separate the sphenopalatine sinuses (Photo 19).

#### 4.3.4 Nasal bone

It is located rostrally in the skull, bordering laterally with the incisor bone and maxillary bone and caudally with the frontal bone. It has two faces, an external one that has a slightly convex shape and an internal one, which together will make up part of the bony base of the nasal cavity.

#### 4.3.5 Lacrimal bone

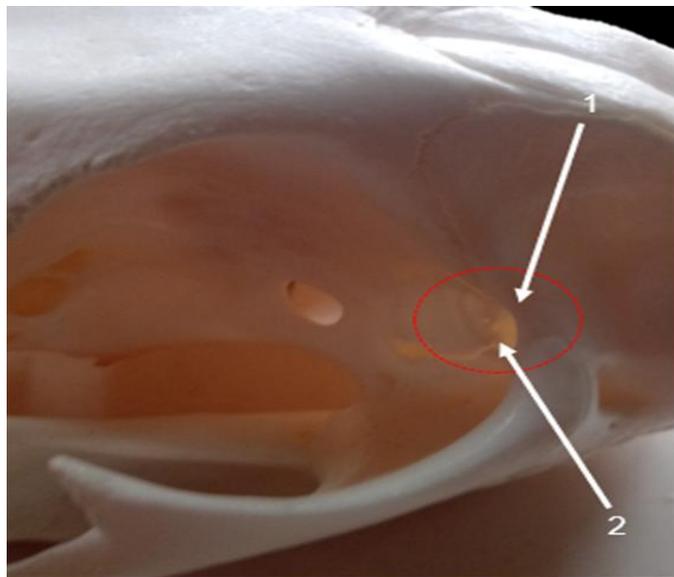
It is found face-ventrally limiting the orbit. It has a small and triangular shape. On its medial side, it is possible to observe a depression that allows the middle lacrimal gland to be accommodated, through the formation of a fossa, known anatomically as the lacrimal sac fossa and a lacrimal foramen.



**Photo 19. Ventral view of the cranial skeleton of a specimen of the species Puma concolor. Perpendicular lamina of the palatine (1), Horizontal lamina of the palatine (2), palatine groove (3). Source: Veterinary anatomy unit, Universidad Austral de Chile headquarters Valdivia and UST**



**Photo 20. Dorsal view of the cranial skeleton of a specimen of the species *Puma concolor*. Nasal bone (1), internal suture (2). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 21. Lateral view of the cranial skeleton of a specimen of the species *Puma concolor*. (1), Lacrimal hole (2) Lacrimal Source: Veterinary Anatomy Unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**

#### 4.3.6 Zygomatic bone

Main component of the zygomatic arch, it is found ventrolateral to the lacrimal bone, being long, flattened and convex towards the side until it articulates with the zygomatic process of the temporal bone. It presents a very sharp temporal process in lateral caudal projection unlike the cat. The frontal process, also very stylized, projects in a dorsal rostral direction with respect to the

temporal process of the cat's zygomaticus (Photo 22).

#### 4.4 Mandible

Like the domestic cat, it can be divided into a body and a branch, each hemimandibula is joined by means of a cartilaginous joint corresponding to a symphysis at the level of the rostral end of the mandibular body.

The branch of the mandible, which corresponds to the vertical portion of this bone, presents an angular process, a condylar structure, more rounded in a puma, which participates in the conformation of the TMJ (temporomandibular joint) and a coronoid process.

The body of the mandible has an alveolar margin which contains the alveoli for the roots of the teeth. Presenting a lingual (medial) face and a buccal (lateral) face.

The masseteric fossa, which corresponds to a zone of insertion of the masseter muscle, can be seen at the level of the lateral margin of the mandibular ramus.

The pterygoid fossa can be seen on the medial margin, of the ramus of the mandible in the vicinity of the mandibular foramen, which allows entry to the mandibular canal.

At the level of the rostral end of the mandible, the mental foramina are observed (Photo 23).

#### 4.5 Ventral Nasal Shell

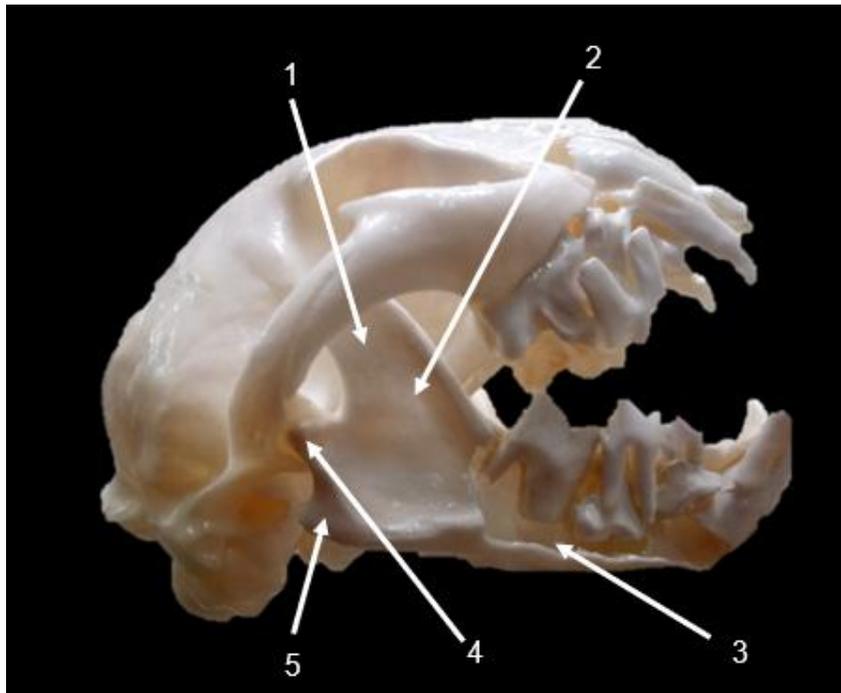
It is observed inside the nasal cavity, extending in a rostral direction. It makes contact with the other nasal shells, allowing it to generate communication spaces known as the nasal meatus. It has greater bone folds unlike the domestic cat (Photo 24).

#### 4.6 Hyoid Apparatus

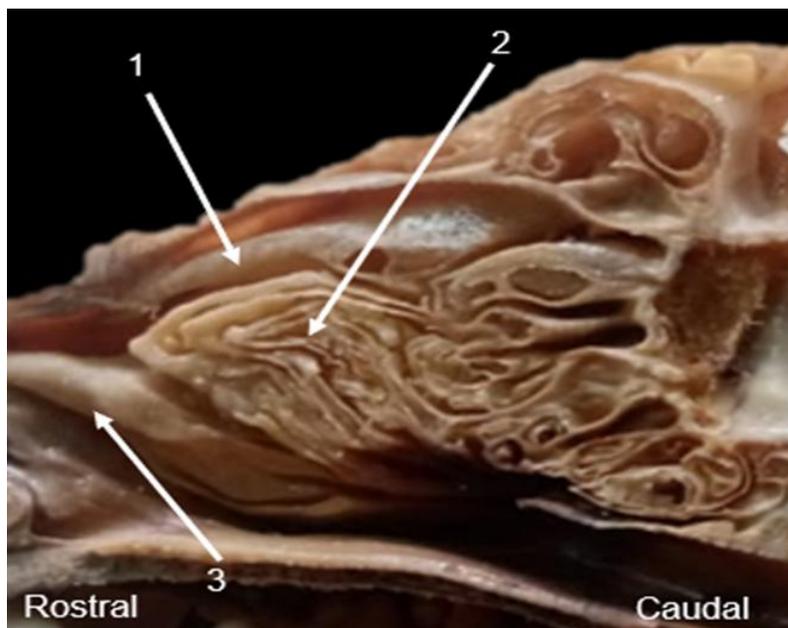
We can divide it into: Stylohyoid, epihyoid, keratohyoid, basiohyoid and thyrohyoid. Its bone segments are thin and strongly united by cartilage, (Photo 25).



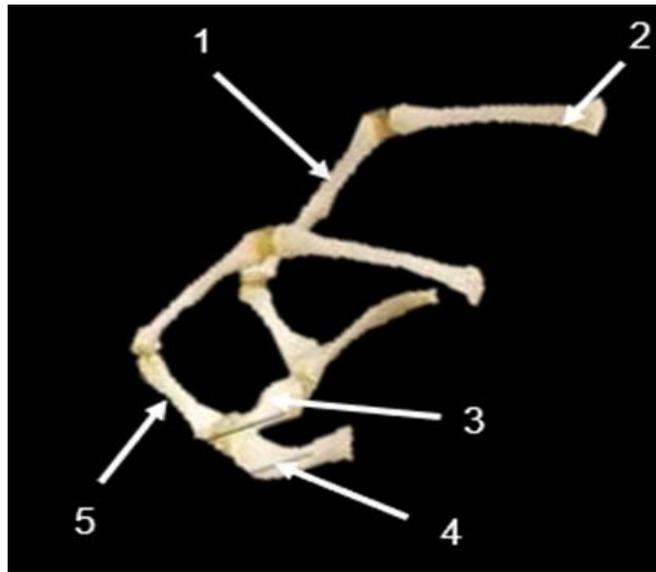
**Photo 22. Lateral view of the cranial skeleton of a specimen of the species Puma concolor. Frontal zygomatic process (1), zygomatic temporal process (2), temporal zygomatic process (3). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 23. Lateral view of the cranial skeleton of a specimen of the species *Puma concolor*. Coronoid process (1), masseteric fossa (2), body (3), condylar process (4), angular process. Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 24. Mid-sagittal view of the cranial skeleton of a specimen of the *Puma concolor* species. Dorsal nasal concha (1), middle nasal concha (2), ventral nasal concha (3). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**



**Photo 25. Lateral view of the hyoid apparatus of a specimen of the species *Puma concolor*. Stylohyoid (1), epihyoid (2), keratohyoid (3), basihyoid (4), thyrohyoid (5). Source: Veterinary anatomy unit, Universidad Austral de Chile, Valdivia headquarters and UST, Puerto Montt headquarters**

## 5. CONCLUSION

Through the following study it was possible to evidence a series of observations of the cranial skeleton of the puma that differentiates it from the skull of the domestic cat. The description of the bone segments made it possible to understand adaptations of the skull of this species that guide us to understand anatomical architecture in a more practical way.

In this way, it can be concluded that the anatomy of the puma skull, despite differing from the cat's skull, has a very similar distribution of the neurocranium and the skull. The observations were basically presented in some segments or portions of the studied bones.

With the information gathered in this investigative article, we hope to signify a contribution to the veterinary and biological morphological area. We understand that yes, it is necessary to give continuity to this study, in order to promote other research on the general anatomy of this species.

## ETHICAL APPROVAL

The following study was not considered for evaluation by the macro-south ethics committee of the Santo Tomás University, as they are

biological samples of animals conserved for studies and research, for academic purposes.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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