

ANATOMIA FUNCIONAL DO MÚSCULO ESTERNOGLOSSO DO TAMANDUA TETRADACTYLA (LINNAEUS, 1758)

(Functional anatomy of the sternoglossus muscle of the tamandua tetradactyla (linnaeus, 1758))

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RESUMO: O tamanduá-mirim (*Tamandua tetradactyla*) (Linnaeus, 1758) apresente um mecanismo de alimentação ativo graças a atividade sinérgica dos músculos extrínsecos relacionados com ele, como por exemplo, o músculo esternoglossos. Este trabalho se propõe caracterizar este músculo tendo em conta suas origens e as inserções, e discutir os resultados com espécies similares já estudadas. Foram utilizadas cinco tamanduás-mirins doados pelo ICMBio. As amostras foram submetidas a procedimentos de dissecação para o acesso a cavidade torácica e visualização do músculo esternoglossos. O músculo esternoglossos do tamanduá-mirim se origina nas laterais da cartilagem xifóide e continua com dois feixes musculares na direção cranial, que une-se perto da base da língua, fazendo parte de sua constituição. Durante o curso do músculo no existe qualquer conexão com o osso hióide e estruturas adjacentes, unido cranialmente com a língua, o que justifica a nomenclatura 'esternoglossos' e não 'esternohioglossos'. Portanto, as características musculares combinados demonstram um aspecto específico analisados dentro das espécies e destaca a principal função dos músculos como para mover a língua dentro e fora da cavidade oral. Assim, a ausência deste músculo não proporciona as condições para alimentação animal, já que sua direta relação com a captação de alimentos é através da língua.

Palavras-chave: Língua; Tamandua mirim; Xenartrico

ABSTRACT: The lesser anteater (*Tamandua tetradactyla*) (Linnaeus, 1758) presents a feed mechanism triggered thanks to the synergistic activity of the extrinsic muscles related to it, with the example sternoglossus muscle. This paper proposes characterizing this muscle, considering the origins and insertions, and discussing the results compared to similar species studied. Five anteaters donated by ICMBio were used. The samples were subjected to dissection procedures for access to the thoracic cavity and visualization of the muscle. The sternoglossus muscle of the lesser anteater originates on the side of the xiphoid process and continues with two bundles of muscles in the cranial direction that join near the base of the tongue, as part of its constitution. During the course of the muscle there is no connection to the hyoid bone and adjacent structures, connecting the cranium to the tongue, which justifies the nomenclature sternoglossus rather than sternohyglossus. Thus, the combined muscle characteristics demonstrate a specific aspect within the analyzed species and highlight the main function performed by the muscles to move the tongue out of the oral cavity. Therefore, the absence of this muscle makes impossible the animal feed, since its directly related to the seizure of food through tongue.

Key Words: Lesser anteater; Tongue; Xenarthric

INTRODUCTION

The great biodiversity in Brazil makes this interpreted as a natural reservoir of species (AYRES *et al*, 2005; VALENTE *et al*, 2006), which has numerous rare elements of the fauna and flora. This wealth of species gave the country the title of a "biologically healthy nation" (MITTERMEIER *et al.*, 2005). As a representative group of the fauna of the Americas, the superorder Xenarthra refers to animals of different morphological and ecological specializations, including the lesser anteater (*Tamandua tetradactyla*), sloths and armadillos. The lesser anteaters are inserted into the Pilosa order, those who have a body covered by hair. Moreover, an important feature of the anatomical aspect is feed that is independent of the species (ZIMBRES, 2010).

The species *Tamandua tetradactyla* (Linnaeus, 1758), popularly known as the anteater, is a mammal belonging to the superorder Xenarthra (TAVARES & KOENEMANN, 2008). Moreover, this species belongs to the group of the genus *Tamandua* anteaters, whose feed shows the family they belong to, ie Myrmecophagidae family also known as 'ant-eaters' (JUNIOR, 2007).

According to Lima *et al.* (2013), the anteater is located east of the Andes, from Venezuela to northern Argentina and Uruguay to Brazil, and adapts to all biomes (Amazon, Caatinga, Cerrado, Atlantic Forest, Pantanal and Pampa). It has solitary habits in nature (only seen in pairs during the breeding season), is predominantly nocturnal, and is insectivorous, with its feed consisting mainly of ants, bees and termites (MACEDO *et al.*, 2013).

Currently, the *Tamandua tetradactyla* species is threatened by the predation of man, by fires that remove their food source and pedestrians on roads that cross the wild (PINHEIRO *et al.*, 2014). In addition, this animal is also

considered aggressive and may attack any person or animal, but besides this belief, the anteater is deemed a harmless animal, as long as it is not threatened (TAVARES & KOENEMANN, 2008). Fortunately, the anteater is classified by the International Union for the Conservation of Nature and Natural Resources - IUCN as Least Concern in relation to the extinction of the species (MIRANDA & MERITT, 2013). However, possible morphological studies on the characteristics related to nutrition are being considered, since little is known about their dietary habits and anatomical elements involved in this activity.

So far, we know that this species has a well-developed small, elongated tongue that can reach up to one meter. They have conical goblet, and well-developed salivary glands that produce a viscous, sticky substance and help the mucus slip off the tongue, both inside and outside the oral cavity. With the help of pliers that open termite and ant hills, the anteater still boasts its ability to produce and excrete sticky substances from the submandibular glands at the tip of the tongue in order to perform this action (JUNIOR, 2007; SMITH, 2007). However, this species lacks teeth and crushes food in its stomach (NAPLES, 1999; TAVARES & KOENEMANN, 2008; CHINEM, 2010). More detail of these morphological and functional characteristics is lacking, including information that can promote a link between anatomical structures involved in nutrition and the technique used by these animals for the seizure of food.

With regard to the seizure of food, it is known that this consists of the species using energy exerted by the muscles related to tongue that animals seize insects. Here, the tongue sticks to captured prey and retracts to eat them (NAPLES, 1999; BRAGA, 2010). The muscles and nerves act together so that the anteater can perform this movement (BRAGA, 2010). These muscles, one in

particular, for this mechanism of animal feed only, has drawn the attention of researchers, as the topography and morphological characteristics have not been described in this species. There are reports in the literature only for *Mirmecophaga tridactyla* (NAPLES, 1999) and *Manis Javanica* (PRAPONG *et al.*, 2009). However, the latter was not given a specific name for the muscle, and in *Mirmecophaga tridactyla*, the researcher Naples (1999) called it the sternoglossus muscle.

The name 'sternoglossus' can be explained by the connection established between the sternum and the language. However, some researchers who have studied the collateral branches of the aortic arch in the anteater gave the name sternohyoid sternoglossus muscle, relying hypothesized that this also relates to the hyoid bone (PINHEIRO *et al.*, 2014).

Thus, this paper attempts to characterize this muscle in relation to its topography, anatomical and functional aspects, propose an appropriate name for the muscle in the anteater given its origins and insertions, and discuss the results in comparison with other species already studied which use the same feeding mechanism, such as the giant anteater (Giant anteater) and Pangolin (*Manis javanica*).

MATERIAL AND METHODS

During this study, five lesser anteater animals (*Tamandua tetradactyla*) were acquired after death and transferred to the laboratory Histotécnica and Embryology, Department of Morphology of the Federal University of Piauí, were given as a gift from the Brazilian Institute of Environment (IBAMA-PI). They were used with the permission of the Licensing and Biodiversity Information system (SISBIO, Brazil) under protocol number 49196-2.

Specimens were fixed with 10% formaldehyde solution pH 7.29 (intramuscular, subcutaneous, intracavitary); as a result, animals were immersed for at least 48 h in a reservoir containing the same solution. The lesser anteaters were placed in the supine position and underwent an incision in the ventral midline, leaving the region of the chin to the umbilical region exposed. Initially, the skin is folded back, exposing the intercostal muscles to start removing the breastbone.

Therefore, the costochondral joint sternal ribs are separated in the craniocaudal direction so that they can access the chest cavity and see the muscles that run along the major axis. During the procedure, images were recorded using the digital machine Sony DSC-H10 as the dissection was performed.

RESULTS

During dissection of the cervical and thoracic regions of the anteater to access the muscle in question, it was noted that this originates in the side of the sternum to the xiphoid process and has its insertion at the base of the tongue (Figure 1).

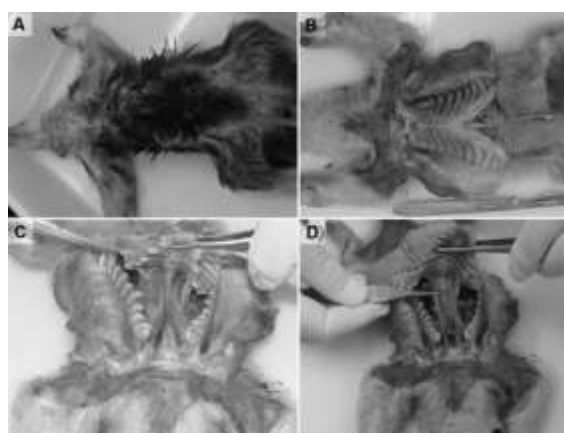


Figure 1- Photographic board of dissection of sternoglossus muscle in lesser anteater (*Tamandua tetradactyla*). A-Picture showing the animal positioned dorsal decubitus. B-Picture showing retracted of the skin and subcutaneous tissue with exposure of intercostal muscles subsequently removed to start the extraction of the sternum. C-Photo showing the dislocation of

the sternum with the ribs in the craniocaudal direction for access cavity. D-Photo showing the location sternoglossus muscle in the chest cavity.

Therefore, the muscle part of the xiphoid cartilage of the sternum, emitting two parallel muscle bundles that are implemented dorsal sternebrae lateral to the sternum body and passes the cartilage dorsolaterally handlebar. Upon reaching the area of the pharynx, the pair combined to form a thin beam that connects to the base of the tongue (Figure 2).



Figure 2- Photography of mentonian region and lesser anteater (*Tamandua tetradactyla*) highlighting the trajectory sternoglossus muscle and the union of the same beams near the larynx.



Figure 3- Schematic drawing of the skull, hyoid bone, larynx and the trachea of lesser anteater (*Tamandua tetradactyla*), with emphasis on the topography of sternoglossus muscle (1), geniohyoid muscle and (2) these structures and their relation to tongue (3).

DISCUSSION

The sternoglossus muscle is historically recent; it is a morphological change in the muscles of prehistoric animals which showed similar feeding activity to anteaters. For years, these animals were dependent on the synergistic activity of two muscles for

movement of the tongue in the oral cavity: the sternohyoid and the hyoglossus. However, anteaters have evolved, and the muscles described above joined to form a single muscle structure, called the sternoglossus (NAPLES, 1999).

However, over time, the sternoglossus muscle has lost the connection to the hyoid bone. Furthermore, all structures that favor the movement of the tongue now come across a more elongated tongue, so it was necessary to increase the length of the muscle bundles so that it was able to move the full extent of the tongue inside and outside the oral cavity (REISS, 1997).

The topographic feature described in the lesser anteater sternoglossus muscle analyzed, including its origin in the xiphoid cartilage and insertion into the base of the tongue, was the same as the findings of Naples (1999) in a study of the same structure in giant anteaters and supports the proposal by the author for the nomenclature: sternoglossus muscle.

During its lifetime, the sternoglossus muscle fills a space located ventral to the oropharynx, which allows the passage of cranial muscles without connection to adjacent structures, including the hyoid bone. The nomenclature 'sternohyoid', recommended by Pinheiro *et al.* (2014), contradicts the findings in lesser anteater bears, due to the lack of connection with any bone structure.

One explanation for this anatomical feature is related to the muscle function of protraction and full retraction, mainly of the tongue in the oral cavity, similar to the results found by Reiss (1997) in Pangolins (*Manis javanica*), so it is necessary that this muscle be able to pass freely through the regions of the chin, neck and chest.

As a complement, the geniohyoid muscle acts with the sternoglossus,

helping to set part of the tongue in the oral cavity, through a connection established with the hyoid bone. This muscle-bone relationship prevents the tongue from making irregular movements during food intake. Some animals such as Pangolins (*Manis javanica*) have this same feature and muscle use (REISS, 1997).

According to Reiss (1997), the sternoglossus muscle is considered the main muscle of the tongue and is innervated by branches of the hypoglossal nerve, which is also associated with other lingual flexor and extensor muscles.

Based on this, the sternoglossus muscle of lesser anteater bears (*Tamandua tetradactyla*) receives this designation exclusively to present connections with the sternum and tongue. Thus, for years, it was connected with the hyoid bone and other structures, but the adaptation imposed by the feeding mechanism of the animal was instrumental in the morphological feature described now.

The sharp and long tip reflects the muscle in question exerted on the tongue movement, which depends on the total length of the muscle required to extract and protract. Along with sternoglossus muscle, the genioglossus has the task of adjusting the tongue in the cavity so that it is correctly placed on the floor of the mouth.

CONCLUSION

However, the sternoglossus muscle does not communicate with the hyoid bone or other adjacent structures related exclusively to tongue and movements when capturing food.

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