ISSN 1982-1263

https://doi.org/10.31533/pubvet.v17n12e1486

Morphological aspects of eyeball extrinsic muscles and other anatomical aspects in a tapir (*Tapirus terrestris*): Case report

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Abstract. The aim of this work was to describe the morphological aspects of the eyeball and associated anatomical components of the *Tapirus terrestris*. The study was performed with two heads of unknown origin, donated to the Laboratory of Morphological studies of the Veterinary Medicine University in Araçatuba, São Paulo. External aspects revealed similarities with other mammals; however, the orbital cavity has an area of 20-mm3 ± 1.4 mm^3, considered higher than a horse's, for example. The description of eyeball muscles followed what has been described for other species with defined origin and insertion. The tapir is a mammal found in South America and almost all biomes, but with little information about its macro and microscopic morphology in literature. The choice of this species for the study is also justified based on their macro morphological features which, notably, are fundamental to the biological knowledge of the species. This kind of research contributes with relevant data about this species which is still scarcely studied.

Keywords: Eyes, intrinsic and extrinsic structures**,** mammals, morphology

Aspectos morfológicos da musculatura extrínseca do globo ocular e outros aspectos anatômicos em anta (Tapirus terrestris): Relato de caso

Resumo. O objetivo foi descrever os aspectos morfológicos do globo ocular e os componentes anatômicos associados de *Tapirus terrestris*. O estudo foi realizado com duas cabeças, de origem desconhecida, doadas ao Laboratório de Estudos Morfológicos da Faculdade de Medicina Veterinária da cidade de Araçatuba, São Paulo. Aspectos externos revelaram semelhanças com outros mamíferos; entretanto, a cavidade orbitária tem área de 20 mm3 ± 1,4 mm3 considerada maior que cavalo, por exemplo. A descrição da musculatura do globo ocular seguiu o que já fora descrito para outras espécies, com origem e inserção definidas. A anta é um mamífero encontrado na América do Sul e em quase todos os biomas, mas com minúsculas informações literárias sobre morfologia macro e microscópica. Assim, justifica-se a escolha desta espécie para o estudo, com base em suas características macro morfológicas, que, notadamente, são fundamentais para o conhecimento biológico da espécie. Este tipo de pesquisa contribui com dados relevantes sobre esta espécie ainda pouco estudada.

Palavras chave: Olhos, estruturas intrínsecas e extrínsecas, mamíferos, morfologia

Introduction

The lowland tapir (*Tapirus terrestris)*, (Linnaeus, 1789) is one of the surviving members of the Neotropical megafauna (Burs et al., 2022; Cordeiro et al., 2016; Moyano & Giannini, 2017). In Brazil, tapirs are considered vulnerable, largest terrestrial mammal with low reproductive potential, a long gestation period, and a large home range that limit their wild-free population (Flesher & Medici, 2022;

Garcia et al., 2012; Tobler et al., 2010). Over the years, the life expectancy of wild animal species in captivity condition, inside sanctuary and/or inside zooparks has increased significantly, which has consequently resulted in senility disorders, specially related to surgeries and/or image diagnostic (Costa et al., 2022; Cunha et al., 2018; D'Ovidio & Adami, 2019). Besides, many veterinary hospitals specialized in wildlife species care are under activity across Brazil country, which improve new specific knowledge on all veterinary medical care aspects (Bertassoni, 2018).

Interesting, morphology knowledge is essential for surgeries, imaging diagnosis, pathology and physiology to improve veterinary medicine advances. Meanwhile, a significant increase in the number of ophthalmic surgeries performed on pets, ranging from dogs and cats to other species and among non-domestic animals (Maggs et al., 2017; Slatter, 2005). Although these surgeries are frequent in domestic animals' veterinary practice, in wild animals, these surgeries face additional challenges, making them risky and difficult to perform and most of the time used an anatomical comparison with other animal species (Aparicio & Plana, 2021; Chalukian et al., 2013; Dyce et al., 2010; Evans, 1993; Nickel et al., 2004). This case report has an objective help to describe anatomical aspects of *Tapirus terrestris* eyeball and other structures for the first time.

Case report

Herein, two heads of tapir with unknown origin, conserved at formaldehyde and belong to Laboratory of Morphological Analysis for a long term, were used in order to study overall aspects of anatomical structures of their eyes. The procedures followed all applicable institutional guidelines for the care and ethical use of animals as recommended by Animal Brazilian Experimentation Committee protocol. The anatomical analysis was prepared under technical supervision and tapir eyes removed. Gross anatomical dissection to remove the eyeball, was carried out sequentially from superficial to deep. The descriptions and illustrations showed below derived from a combination of radiographic imaging, gross anatomical dissection and illustrations schemes (Thrall, 2019).

The digital radiography was performed using Cassette 46 x 38.4 x 1.5 cm, Model KLX-1417 Shanghai PZ Medical Technology Co., Ltd. The images were captured by X-ray acquisition software Voyance. Features used: Drawings traced with brush of variable thickness, following the outline of the original anatomical pieces. Continuous lines for representation of the most prominent elements and fine hatches for representation of minor details and (or) suggestion of relief. The illustrations were made with pen and tablet, 4 model TPK-640 from Wacom.

Results and discussion

All anatomical structures followed Nomina Anatomica Veterinaria (1973). The orbit is the most prominent structure of the dorsal and lateral aspect of the tapir skull, situated between its cranial and facial parts (Figures 1A and B; Figures 2A and B). Moreover, four bones, frontal, lacrimal, zygomatic, maxillary are responsible to compound the orbit cavity (lateral plane) and correspondent area represent 13 $mm^3 \pm 1.7$ mm^3 in horses and 20 $mm^3 \pm 1.4$ mm^3 in Tapir (Figures 2C and D, respectively). There are seven extrinsic muscles of the eyeball: two oblique muscles, four recti muscles, and the retractor bulbi (Evans, 1993). Closely associated with these, but inserting in the superior eyelid, is the m. *levator palpebrae superioris* (Dyce et al., 2010). All of the extrinsic ocular muscles insert in the fibrous coat of the eyeball near its equator (Figures 3-6). The level of insertion of the recti muscles is nearer the cornea-scleral junction divided into four parts of the retractor (Figures3-6). In general, the oblique muscles insert in an intermediate zone between the insertions of the recti and retractor groups (Figures 3-6).

The extraocular muscles, or *Musculi bulbi*, are striated muscles: the dorsal, medial, ventral, and lateral rectus muscles; the dorsal and ventral oblique muscles; and the retractor bulbi muscle (Figures 3-6). The extraocular muscles rotate the globe around three mutually perpendicular axes passing through the center of the globe (Nickel et al., 2004). The dorsal and ventral rectus muscles rotate the globe around a medial to lateral axis (Costa et al., 2022). The medial and lateral rectus muscles rotate the globe about a superior to inferior axis, and the oblique muscles rotate the eyeball around the axis (D'Ovidio & Adami, 2019).

The dorsal and ventral rectus muscles rotate the globe around a medial to lateral axis (Figures 3-6). The medial and lateral rectus muscles rotate the globe about a superior to inferior axis, and the oblique muscles rotate the eyeball around the axis (Figures 3-6). The carnivores, such dog, is able to rotate the eye through approximately 90 degrees of arc in the dorsal plane and 60 degrees in a sagittal plane, movement not allowed in tapir (Evans, 1993). By eyeball morphology analysis performed here, this movement has limitations in tapir, which probably affect the vision amplification (Evans, 1993).

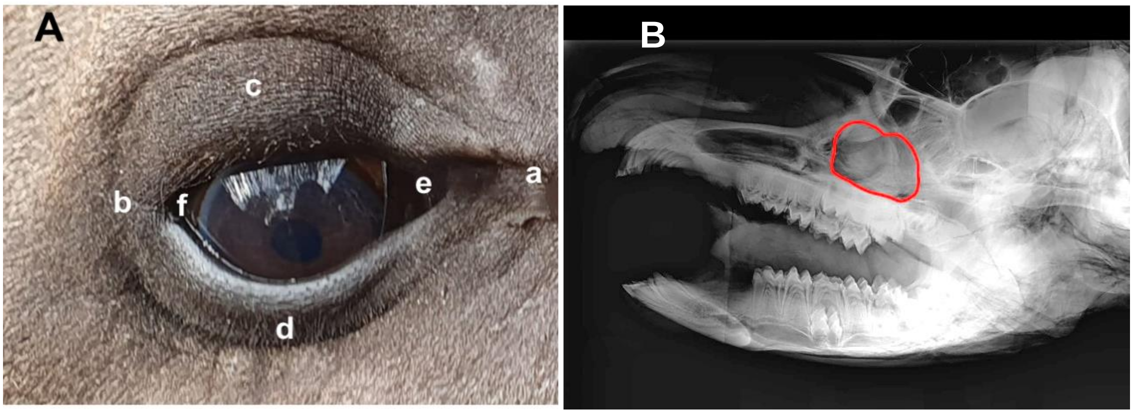

Figure 1. A) Photographs of the eye of *Tapirus terrestris* in a lateral view. (**a**) medial commissure of eyelids; (**b**) lateral commissure of eyelids; **c**) superior eyelid and cilia; **d**) inferior eyelid; **e**) third eyelid; **f**) lateral angle of eye; **B**) Lateral skull radiograph with a ring to delineate the orbital margin.

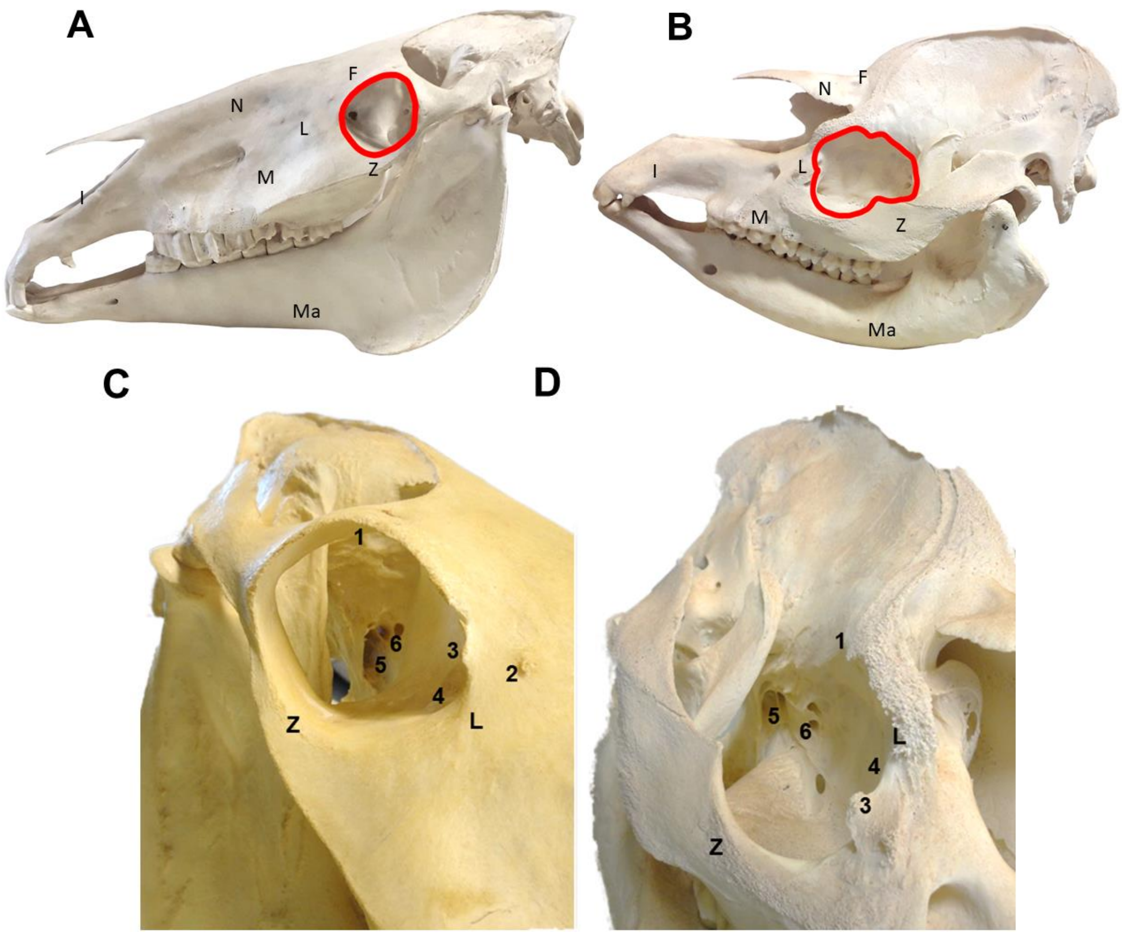

Figure 2. The skulls belong to Anatomy of Domestic Animals Laboratory at College of Veterinary Medicine, Araçatuba, São Paulo State. Bones of the horse (**A**) and Tapir (**B**) skulls showing lateral aspect of orbit cavity (red). F-frontal; L-lacrimal; Z-zygomatic; N-nasal; M-maxillary; Ma-mandible; I-incisive. Close view of orbit cavity (**C**) horse and (**D**) tapir; 1-trochlear fossa; 2-supraorbital foramen; 3-rostral and caudal lacrimal process; 4-fossa for oblique ventral muscle; 5-optical nerve foramen; 6- trochlear nerve foramen.

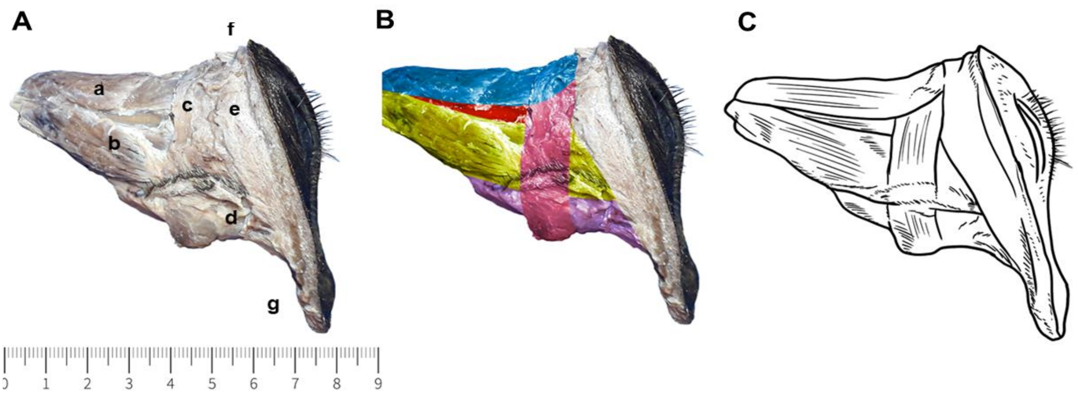

Figure 3. Schema of muscle attachments in orbital fissure and relationship of dura to periorbital; **a**) dorsal straight muscle (blue); **b**) lateral straight muscle (yellow); **c**) Dorsal oblique muscle (pink); **d**) ventral straight muscle (purple); **d**) medial commissure of eyelids; **e**) muscle orbicularis oculi; **f**) lateral commissure of eyelids.

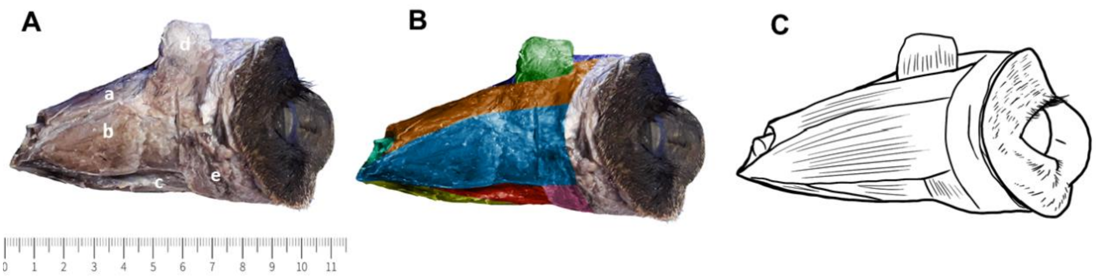

Figure 4. Schema of muscle attachments and origin of extraocular muscles, rostral lateral aspect; **A**) anatomical sample: a) dorsal straight muscle (orange B); b) lateral straight muscle (blue B); c) ventral straight muscle (red **B**); e) dorsal oblique muscle (green B). **C**) Represent a draw of all described anatomical structures.

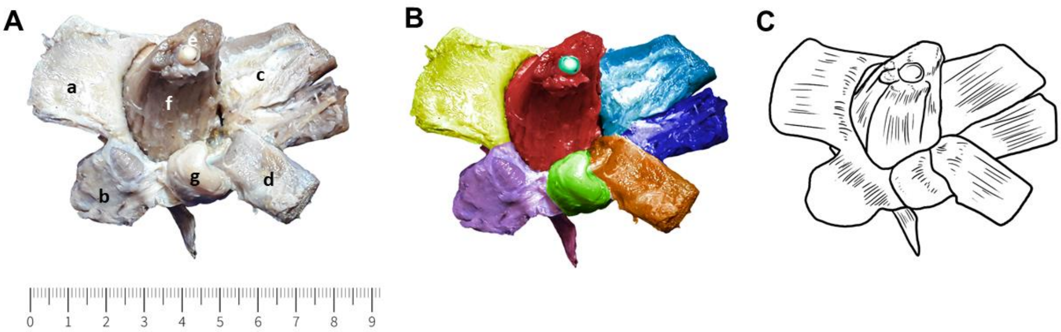

Figure 5. Schematic of structures within the apex of the periorbita, caudal aspect; **A**) anatomical sample: **a**) dorsal medial straight muscle (light green B), **b**) ventral medial straight muscle (purple B); **c**) dorsal lateral straight muscle (blue B), **d**) ventral lateral straight muscle (orange B), **e**) optic nerve; **f**) retractor muscle of the eyeball (red B); g) trochlea (green B). **C**) Represent a draw of all described anatomical structures.

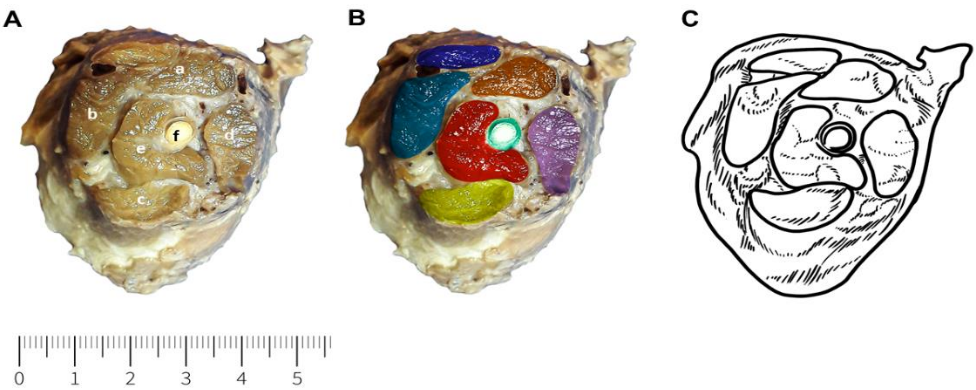

Figure 6. Schematic transection of structures within the apex of the periorbital area, caudal aspect; **A**) anatomical sample: **a**) dorsal straight muscle (brown B); **b**) lateral straight muscle (blue B); **c**) ventral straight muscle (green B); **d**) medial straight muscle (purple B); **e**) retractor muscle of the eyeball (red B); **f**) optical nerve. **C**) Represent a draw of all described anatomical structures.

Conclusion

Because the lowland tapir is one of the species at risk of extinction, some animals are localized inside zoo parks worldwide, including Brazil. In this respect, specialized veterinarians perform various ophthalmological procedures; it is therefore worth learning about the eye anatomy at all levels. Herein, new aspects of eyeball muscles of tapir and some other anatomical issues were described for the first time.

Ethics committee and biosafety

Protocol n. 10/87650 (CEEA/FOA). Rebeca F Nalesso and Letícia Colin Panegossi were fellowship by CNPQ.

Acknowledgments

The authors thank Polícia Rodoviária Federal, SP, Brazil who capture dead/injured animals. We thank members of the University of São Paulo State, FMVA, Araçatuba, Brazil, for technical support. Partially of this study was presented at *Congresso de Iniciação Científica* da UNESP in 2021.

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Article History:
Received: October 19, 2023
Accepted: November 30, 2023