

The middle ear of Baikal seal (*Pusa sibirica* Gmelin, 1788)

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ABSTRACT. The research purpose is to study the structure of the middle ear of the Baikal seal. It consists of an eardrum and auditory ossicles located in the tympanic cavity. The Baikal seal has a triangular-shaped drum bubble. At the top of the tympanic cavity, the Eustachian tube is located. Another feature of the tympanic cavity is a bone roller of the carotid artery which has not been found in other seals. Passing through the roller, the carotid artery does not enter the tympanic cavity. There are differences in the structure of the auditory ossicles: on the external surface of the malleus head, there is a recess; the joint between the malleus head and the anvil is quite mobile, which makes it easy to separate the auditory ossicles; the stirrup is light and of a triangular shape; legs of the stapes differ in thickness; the lenticular bone which serves as a joint between the long leg of the anvil and the stirrup, is well seen. At the lateral side of the bony cape, there is an oval vestibule window closed by the stirrups. The cochlea window is covered with an internal mucous membrane of the tympanic cavity and its own membrane.

Keywords: Baikal seal, middle ear, tympanic cavity, auditory ossicles

1. Introduction

The structure of the middle ear of pinnipeds is determined by the need to adapt to special living conditions: to stay in water and on land. Reichmuth C. et al. (2013) found that in pinnipeds sensitivity of the underwater hearing is not worse than that in aquatic cetaceans and sirens. On land, many seals and sea lions hear no worse than land predators. G.N. Solntseva studied the structure of the organ of hearing of pinnipeds (Solntseva, 2006; 2013; 2017) and identified differences in the structure of the middle ear of eared and real seals. The intraspecific differences in superfamilies were not found. There are no data on the structure of the organ of hearing of the Baikal seal which, unlike other representatives of these seals, lives in fresh water. The aim of this research is study the anatomical structure of the middle ear of the Baikal seal.

2. Material and methods

The middle ear of the Baikal seal aged from 1.5 to 10 years ($n = 8$) was used as a research object. Carcasses of seals obtained under the scientific quota (the research program approved by the Russian Federal Fisheries Agency for 2015), as well as dead seals from Lake Baikal were research materials. The skull was boned, and the tympanum was cut to gain access to

the tympanic cavity of the middle ear. Morphometry was performed using a Shahe 5422-200 digital caliper (China). The data obtained were analyzed by the parametric method using the Student's t-test. The differences were considered significant at $p < 0.05$. The studies were approved by the ethics committee of Irkutsk State Agrarian University (protocol No. 2 dated 03/23/2017).

3. Results and discussion

Endo H. et al. (1999) described the skull of the Baikal seal using computer tomography; however, the tympanic part of the stony bone has not been described yet. In the Baikal seal, bulla tympanica (tympanic bubble) is of a triangular shape. The base is directed aborally, the apex is directed rostrally. The base follows the contour of bulla tympanica (18.32 ± 0.43 mm in width, the medial side is 24.67 ± 0.49 mm, the lateral side is 26.33 ± 0.59 mm). At the top of the base, there is an opening of the Eustachian tube, which extends into the tympanic cavity as a trench going to the tympanic membrane. It is deeper on the top of the tympanic cavity. The depth varies from 1.4 to 1.5 mm. There is an opening for the entrance of the carotid artery from the medial surface of the tympanic cavity, but it does not enter the cavity, passing along the base inside the bone roller of a triangular shape, 2.53 ± 0.02 mm high and 17.08 ± 0.73 mm long. At the border of the mastoid

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part, above the opening of the external auditory canal, there is an opening of the facial nerve. At the base of the triangle bulla timpanica, there is a cape of the bone cochlea 5.0 ± 0.1 mm high. At the base of the cape, from the lateral side, there is an oval vestibule window closed by a stepladder. Behind the cape, there is a snail window covered with a membrane. On the lateral side of the tympanic bubble, there is a tympanic ring of a regular oval shape (in the narrow part, the diameter is 1-1.5 cm; in the wide part, it is 4-6 mm). The eardrum is stretched over the tympanic ring, but in the center, it rises slightly above the plane of the tympanic ring, forming a low cone.

The drum ring is more pronounced on the ventral side of the tympanic cavity. Behind the drum ring, on the lateral side of the tympanum base, there is a small cavity where the malleus head is connected to the anvil body. In the external part of the head, there is a small cavity, which has not been found in other seals. A thin long process (pr. longus) of the malleus (with a diameter of 0.05 mm) departs from the malleus neck. Its triangular base is attached to the eardrum. The anvil is larger than other bones which is typical of seals. Between the long leg of the anvil and the stirrup, there is a lenticular bone 0.5-0.7 mm in size. In the Baikal seal, the stirrup is different: it is of a triangular rather than rounded shape, and rather light.

4. Conclusions

Thus, the middle ear of the Baikal seal is characterized by a peculiar tympanic cavity (e.g., the

bone shaft of the carotid artery) and species features of the auditory ossicles.

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