INTRODUCTION

Paleontological materials are a factual basis that document evolutional processes in geological time. Investigation of trends in this process is based on comparison of groups divided by significant periods of time. This method is also employed in investigation of the evolutionary alterations of organs and systems; i.e., comparative morphological method was and remains a leading method in evolutional biology.

I.I. Schmalhausen’s book “Fundamentals of Comparative Anatomy of Vertebrates” (1947) is distinguished in the scientific heritage of these scientists. The morphology of the vertebrate from lower to higher groups succinctly and compactly is described in this book. This book was and remains one of the most popular guides for researchers, because of the different scientific interests, particularly when there is a need to involve areas outside their specialty.

Such a situation is typical for paleontologists, who compare fossil material with modern materials. The need for consolidation of vertebrate morphology studies especially increases when there is reconstruction of an ancient, long extinct animal group. These groups include agnathans (Agnatha).

The value of agnathans in the history of the biosphere lies in the fact that they morphologically precede fish in the time of appearance; i.e., agnathans take their place on a lower step on the evolutionary ladder of vertebrates. The biodiversity of all modern vertebrates, an essential part of our environment, originated from agnathans.

Ancient remains of vertebrate fossils, attributed to agnathans, were found in deposits of the Upper Cambrian and Middle Ordovician of North America, as well as in Ordovician sediments of South America, Australia, and Europe (Spitsbergen) (Ritchie, Gilbert-Tomlinson, 1977; Gagnier, 1989). The age of agnathans in the sediments of the Middle Ordovician is about 470 million years (Gagnier, 1989). Agnathans disappeared in the sediments of the Paleozoic approximately 350 million years ago, at the end of the Late Devonian.

The external structure of the ancient vertebrates reached its maximum diversity in the early Devonian. Reconstruction of the Heterostracans (Heterostraci subclass), a jawless animals with a well-developed shell, allows us to present the external structure of the ancient vertebrates (Figs. 1, 2). These materials were found in the sediments of the Lower Devonian of Siberia: in the northwestern part of the Siberian platform and Taimyr. The reconstructions show the (Amphiaspids, Amphiaspidiformes) with large sizes: Olbiaspis coalescens Obruchev and Lecaniaspis lata Novitskaya (Fig. 1), as well as Gabreyaspis tarda Novitskaya (Fig. 2). The length of olbiaspis shells was 13–14 cm. Their total length (from the front edge of the shell to the end of the caudal fin) was about 30 cm. The length of Lecaniaspis shells was 17–18 cm, and its total length was 37–38 cm. The length (and width) of the Gabreyaspis shield was 14 cm; its total length was 31–32 cm. Seismo-sensory grooves were preserved clearly on the Lecaniaspis lata and Gabreyaspis tarda shells. They are visible in Figs. 1 and 2 and separately reconstructed in the diagram (Fig. 5).

It is important to note that Lecaniaspis were blind. In addition, there are other blind amphiaspids (Eglogonaspis) that were found in the Lower Devonian of
Siberia. There are no traces of orbits. Nevertheless, due to the large size of the agnathans, and because of the relatively frequent findings, they survived successful in Early Devonian biocenoses, quite close with many predators. As predators the crossopterygians (Crossopterygii: *Porolepis*), were the most habitual among fishes; their scales are often found in the sediments of the Lower Devonian of Siberia (Vorob’eva, 1963, 2004). The biocenoses content, including different invertebrates (brachiopods, ostracods, arthropods, corals, etc.) and vertebrates (agnathans, fishes: acanthodians, crossopterygians, arthredires) allow us to consider that blind heterosarc’s survived not only because of their shell, which performed protective and other functions, but also due to their seismosensory organization. Information about seismosensor and other systems (neural, respiratory) was obtained due to agnathous exoskeleton investigation.

There are grooves of the lateral lines on the heterostrac’s shell surface, strongly pronounced in the sculptural layer (Figs. 3a and b). Sometimes the situation of the lateral line canals, located in the middle layer, is visible in the relief of the surface layer. Only the pore location often allows us to understand the canal situation. Pores may be located very tightly. Sometimes they formed a dense net, for instance, in Irregulareaspidid (Irregulareaspididae family) (Fig. 3d). Siesmosensor canals and grooves usually form longitudinal and transversal lines, interrupted or uninterrupted, almost orthogonally to each other or V-shaped. Supraorbital and infraorbital lines are present.

The head–body shell of the *Liliaspis philippovae* Novitskaya is a rare example of a conserved seismosensory system. The shied was found in Devonian deposits of the Polar Urals, Usa River (Novitskaya, 1973). On its surface, in the sculpture layer, traces of lateral line canals were preserved in the form of ridges (Fig. 3c). Large pores are visible along and over the rolls. The seismosensor system of *Liliaspis*, besides lateral line canals, is presented with grooves, which formed an infraorbital line and, in part, some of the peripheral lines. The combination of canals and grooves is sometimes found in different groups of the heterostracans (orders Cyathaspidiformes, Amphiaspidiformes).

Several large heterostracans orders had longitudinal, transversal, and V-shaped lateral lines. Detailed reconstructions of the lateral line system were made for many Cyathaspids (Denison, 1964), and for major types of the Amphiaspids (Novitskaya, 1971; Novitskaya, 1983, 2004). The fact that longitudinal and transversal lines are almost perpendicular to each other, preventing growth of dentinal (sculptural) grooves of the shell surface layer, is one of the arguments supporting the idea that the shell was formed after the animals reached adult size (Obручев, 1964; Denison, 1964). In groups with growing shells (Pteraspidiformes, Psammosteiformes), the lateral line location became radial.

In publications about the agnathans, their canal and groove system, like in fish, is determined as the sensor lateral line system, or the sensor system, or the seismosensor system.