Research Article

FINDING OF SKELETAL ATTACHING STRUCTURES OF EUCONODONTS (H-ELEMENTS) FROM THE LOWER TRIASSIC OF SOUTH PRIMORYE: ETOLOGICAL SIGNIFICANCE

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Abstract – Comparative-morphological analysis of hard rounded and rhomb- and trapezoid-like structures from the Lower Triassic deposits of South Primorye and the Polar Urals of Russia as well as from the Upper Ordovician of South Africa, from the Silurian of North America, and from the Lower Carboniferous of Scotland showed that they are located in the head part of euconodont animals in front of the tooth apparatuses symmetrically to its sagital axis. It is suggested that a pair of such attaching H elements with the help of muscles connected the isolated tooth elements and governed them in the working process. All skeletal and tooth elements and their connective tissues were in the rounded food sac localized on the outer ventral side of the animal. In the process of the food sac functioning, probably, the food particles in it were filtered from water, which was removed through special holes, and then a food clot was formed and migrated into the food channel (gut). Some groups of the euconodont animals were, perhaps, swimming filtrators and dwelled in the benthic water layer.

INTRODUCTION

In the Lower Triassic deposits of South Primorye (siltstone bed of the Perevalnyi Creek, the Kamenushka River basin, 50 m thick) in the calcareous sandstone lens in 1979 the skeletal phosphatic elements looking like rings (up to 0.72–0.87 mm in diameter) and rhomb-like plates (Fig. 1 A, B) were found together with tooth conodont elements and ammonites of the Anasibirites nevolini zone. These rings and plate in color and structure of the surface are indistinguishable from the associated conodont elements (their color varies from transparent light-brown to dark-brown). Our attention to the extreme impotence of this finding for understanding the structure of the conodont animal was called by Dr. K. Budurov. Subsequently, the analogous skeletal elements were found in the euconodont imprints from the Upper Ordovician deposits in South Africa (Aldridge & Theron, 1993), Silurian of Wisconsin (North America) (Mikulic et al., 1985), the Lower Carboniferous of Granton (Scotland) (Briggs et al., 1983; Aldridge et al., 1986, 1993), and Polar Urals (Russia) (Buryi et al., 2010). Structure and role of these morphological structures of euconodont animals were for long time unknown, and some researchers (e.g. Aldridge et al. 1993, figs. 3, 4) considered them to be the remains of the eye capsules.

POSITION AND ROLE OF ATTACHING ELEMENTS IN MOUTH COMPLEX OF EUCONODONTS

The comparative-morphological analysis of the new morphological structures allowed us to establish that they are the hard cephalic elements located in front of the tooth apparatuses of euconodont animals symmetrically to their sagital axis. These structures demonstrate both rounded and rhomb- and trapezoid-like contours that exclude their belonging to eyes (Aldridge & Theron 1993, figs. 1, 2, pl. 1). Some of them have preserved the remains of a soft muscle tissue (muscules) in the form of a cap (Müller et al., 1974), which appeared to be attached to the projections of the outer margin and ring crest of the described cephalic structures and served for the connection of the tooth conodont elements with each other and for governing them in the working process (Fig. 2 A, B). We proposed to call them the H head attaching elements (Buryi & Kasatkina, 2003, 2004). The data obtained allowed us to conclude that, apparently, the cephalic mouth complexes of the euconodont animals together with about 15 P, M, and S elements of the tooth apparatus appeared to incorporate a pair of the H attaching structures and soft connective formations (muscles). Further investigation of

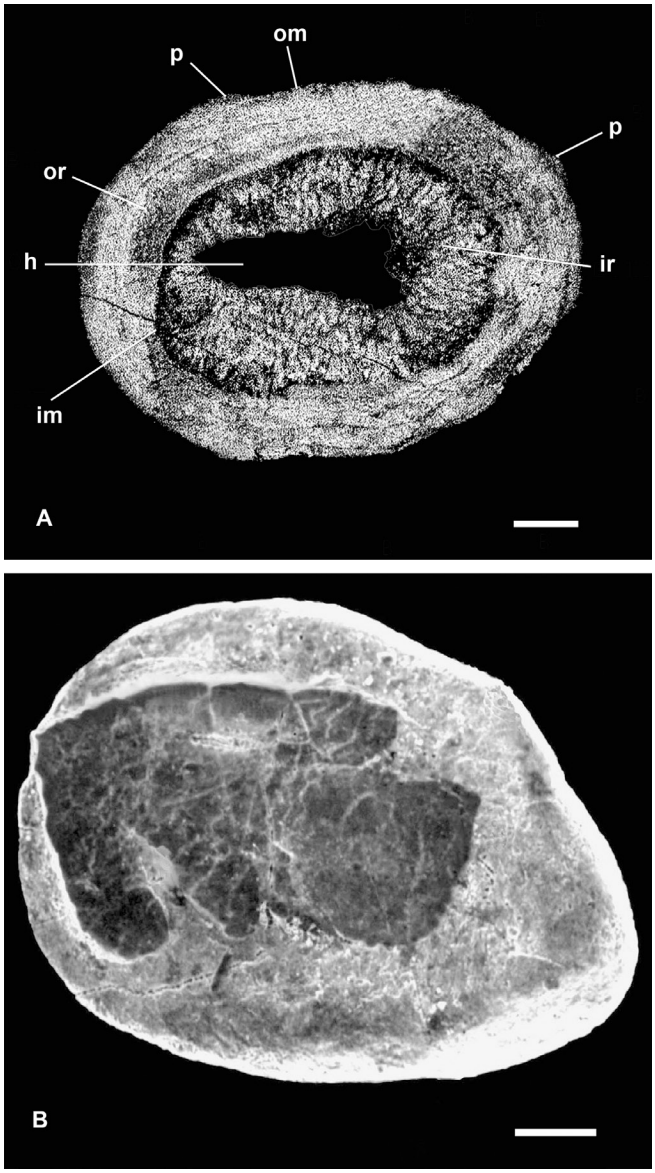

Figure 1 – Euconodont H skeletal elements from the Lower Triassic deposits of Primorsk Terr. ***A***, rounded structure, specimen DVGI 3B-1 (om, outer margin; p, projection; im, inner margin; or, outer ring; ir, inner ring; h, hole); ***B***, rhomb-like structure, specimen DVGI 3B – 4. Scale bars = 0.1 mm.

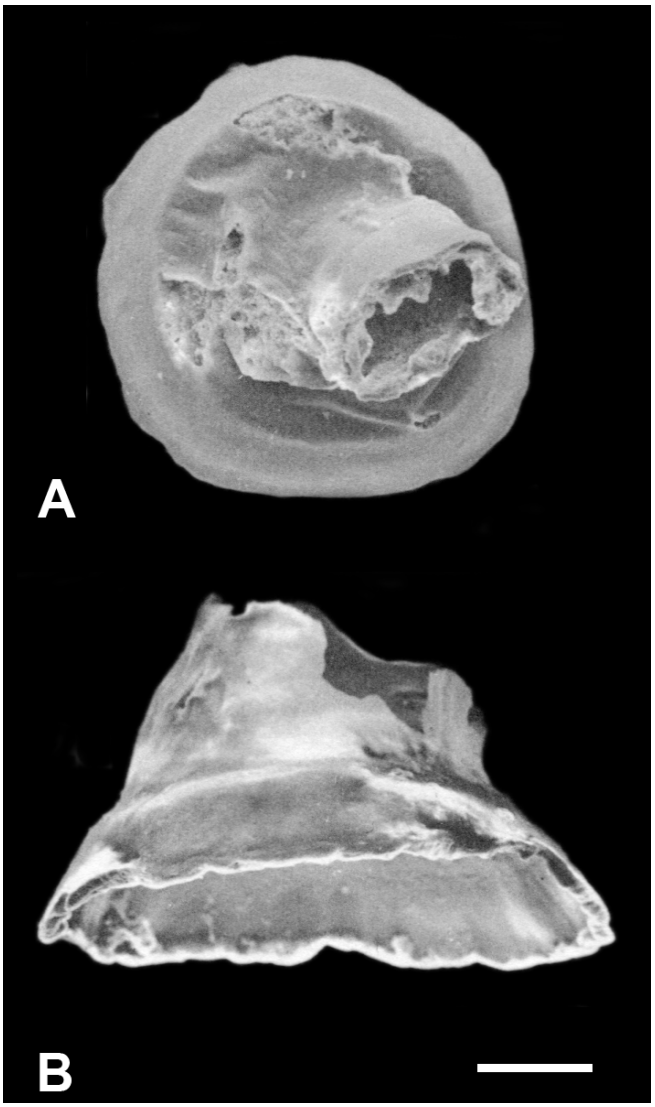

Figure 2 – Specimens with partly preserved tube-like structures from the Upper Silurian deposits of Germany, specimen UB no. 532 (after Müller et al., 1974): ***A***, rounded structure coated with a soft connective tissue; ***B***, cap of the soft connective tissue. Scale bar = 0.1 mm.

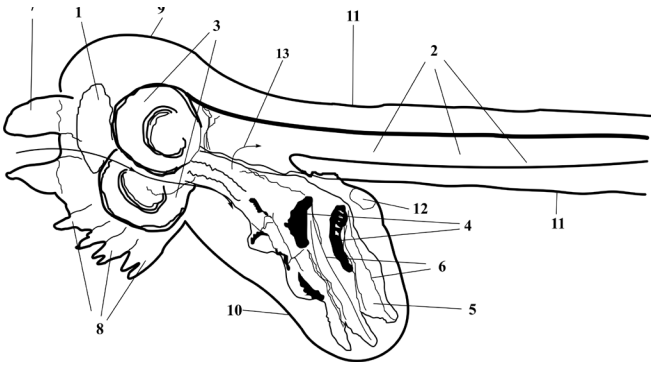

Figure 3 – Interpretative scheme of head region of specimen 5, RMS GY 1992.41.1, Granton, Scotland from Aldridge et al. (1993): ***1***, mouth; ***2***, putative food canal (gut); ***3***, H skeletal elements; ***4***, tooth elements; ***5***, soft muscular lobe; ***6***, muscular fibers; ***7***, tentacles (tactile, sensitive, and for driving food items); ***8***, head lobes; ***9***, head boundary; ***10***, boundary of food sac; ***11***, wall of body; ***12***, putative water outflow opening; ***13***, gut entry opening.

the Triassic and more ancient H attaching elements as well as the imprints of soft tissues of euconodonts made it possible to understand that the whole mouth complex of the animal was localized in its head part, and namely in the food sac (Guravskaya & Kassatkina, 2015). On the outer ventral part of the imprint from the Polar Urals (Russia) the same oval widening of its head part is observed, suggested to be a food sac. The analogous structure is described also in the head part of the fifth, best preserved imprint from Granton (Great Britain), uncovered along the inner plane (Guravskaya & Kassatkina, 2015) (Fig 3). On the ventral side the elements of the conodont tooth apparatus are surrounded by the muscle tissue of the anterior division of the gut forming a food sac stepping outside the animal trunk. Inside this food sac there is a soft lobe with a branched system of the muscular fibres, to which the ramiform and pectiniform

tooth elements are attached (Fig. 3). In our opinion, these tooth elements with the help of the muscular lobe were connected with each other and with the H skeletal attaching elements. Most likely the same muscular fibres governed the position and sizes of the pharynx food sac. The soft food sac appeared to be able to extend and to take big volumes of food. When the pharynx sac was filled with water together with the food particles it stretched and expanded. Then when the muscles contracted the sac may pull up to the head and shrink.

The outer and inner morphology of the head part of euconodont animals suggests that originally the food together with water entered the pharynx through the slit-like mouth located between the H attaching elements. The food together with water with the help of tentacles and cephalic lobes was sucked up into the sac-like formation (food sac). Then it arrived onto the "sieve" of S elements, which performed the intricate movements in the food sac. With their help the fine food particles were filtered and moved towards the P elements where they were pressed to form a food clot necessary for further movement along the gut channel with the help of muscles. The water, possibly, may leave the food sac through the paired holes located on the animal sides.

CONCLUSIONS

It has been established that the H attaching and tooth elements were in the food sac located on the outer ventral side of the euconodont animal head. It was also suggested that in the sac the food particles were filtrated and excess water was removed. Data obtained on the structure and functioning of mouth apparatuses governed by the H attaching elements make possible a new interpretation of the behavior and feeding habits of euconodont animals. Some groups of euconodonts, most likely, adapted themselves to the benthic dwelling near the bottom substratum, in the places of the greatest concentration of organic material suitable for filtration. Such organ as the pharynx food sac appeared to be necessary for their adaptation to the environment. The euconodont animals were, probably, the swimming filtrators and dwelled in the water benthic layer that is indirectly supported by the data on the euconodont morphology. Their head division occupies a rather big part of the trunk – about 18 %, whereas in the predators, for example, in protoconodonts (Chaetognatha) the length of the head division is not more than 5–8 % of the whole body (Kasatkina & Stolyarova, 2010).

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