not only the better shelters of ophiuroids, but also a generally deeper bioturbation and well-evidenced expansion of some activities to deep parts of basins (dwelling burrows Ophiomorpha are an example - see Bottjer et al. 1988).

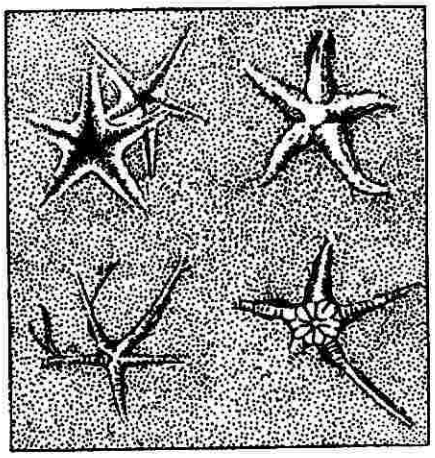

Fig. 1 – Surface resting trace Asteriacites von Schlotheim, 1820. – of natural size. After Seilacher (1953) and Mikuláš (1992).

The presumed change of ophiuroid behavior is very probably joined with the crisis of biota, but it can be incidental only. In addition, the study concerns only a taxon of a high order (subclass Ophiuroidea); if we had considered changes of individual ophiuroid genera and species and their activities (that is impossible in present-day stage of knowledge), the problem would be very probably much more complicated. However, the above-mentioned case is, in my opinion, an interesting exhibition of change of activity and of documentation of the change by trace fossils.

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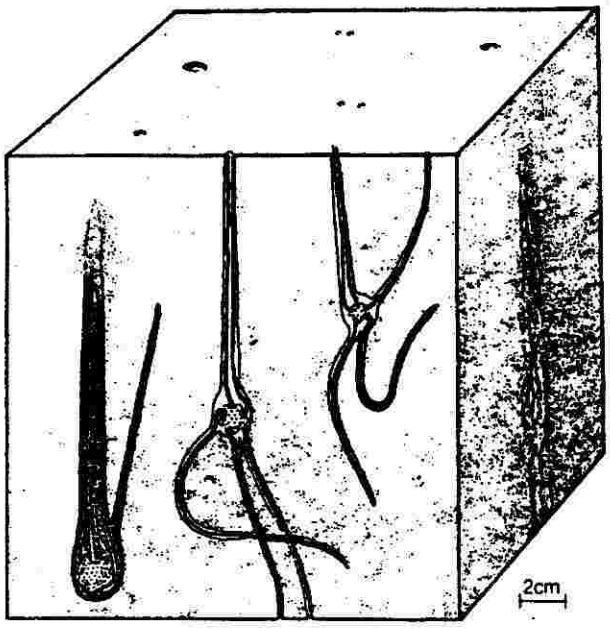

Fig. 2 – Recent hidings of ophiuroids inside the sediment and corresponding dwelling adnd escape traces. After Frey et al. (1987).

Ichnology and its possibilities in the study of crises of biota

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Trace fossils were (and sometimes still are) evaluated as a part of their makers, as "non-fullvalue biotaxa". Their character is, however, different: an ichnotaxon is often made by more biotaxa; maker of the particular trace should change in a geological time, and on the contrary, particular organism often formed various types of traces (in dependence on conditions of the moment, or on longstanding circumstances). Therefore, ichnofossil is not a part of the tracemaker – it is a record of certain type of behaviour. This type should be peculiar to organisms of various systematic appurtenance (namely in different time and place).

Present-day stage of ichnological research in the Bohemian Massif consists namely in collection and description of the material, in environmental conclusions following the characteristics of individual ichnoassemblages, and in gradual recognizing the problems which are important not only for regional study. In ichnological literature, the interest in the topic of this workshop is also rather low. Yet the traces might give a certain information in that line. I have tried to define this information value in replies to four questions put to the participants of the workshop.

1. Which life strategies are successful in crises and recoveries?

The ichnology gives or may give exact answers to this question, because the traces are a direct record of behaviour (feeding, dwelling, resting, locomotion, escaping, a.o.). Value of the information is the highest as the organisms (mostly invertebrate) living in the sediment and on its surface are concerned. They formed most traces, and they often were not able to fossilize. Even if the fossils are known, considerations on the behaviour often remain speculative (e.g., in hyolithids). The information value of traces is, in addition, important in some specific cases (dinosaurs). On the contrary, plankton, nekton, or organisms attached on hard substrates left minimum of traces. In these cases, conclusions on the behaviour made on the basis of functional morphology are, as a rule, much more explicit.

I have stated some examples of ichnological record within the crises of biota in further conrtibutions of this bulletin. For instance, feeding on the deep parts of the substrate seems to be a strategy successful in crises (Mikuláš 1994 a). For many other comments see, e.g., the work of Boucot et al. (1990), where also the reliability classes of different behavioural evidences (including the trace fossils) are proposed.

2. How the refugia which acted during various types of the crises can be classified (their capacity, prosperity, openness for migration)?

The ichnology seems to be able to help with answering this question. Besides the conclusions from individual ichnotaxa and ichnoassemblages, semiquantitative methods (ichnofabric index of Droser and Bottjer 1986) are at a disposal. However, I do not know any ichnological study solving this problem.

3. What is the extent of connecting of reaction of organisms in crises with their phylogenetical history? How is it exemplified?

In this question, ichnological research coincides with the topic perhaps in case of the oldest (Upper Proterozoic to Earliest Cambrian) traces only. Here the traces represent, because of the lack of body fossils, a substantial source of information not only of the activity, but also of the probable morphology and phylogenetical history of the tracemakers. Bergström (1990) interprets the Cambrian evolutionary explosion "as true adaptive radiation, an event similar to Phanerozoic radiation events in principle, but unique in its possibilities. The major niches that became filled have never been occupied before and never became emptied afterward". The joined crisis of Precambrian biota is not well known. Besides Bergström (1990), Seilacher (1985) and Crimes (1992) and many others stated more about the problem. The relevant interval of geological time is not adequately recorded in the Bohemian Massif.

4. How the variability inside the biospecies changes in the process of crisis and recovery?

Because of character of the studied record, the ichnology does not give a reply of this answer. The variability inside the ichnospecies, i.e. the variability of behaviour within the framework of (mostly) one biospecies, is another question. This variability seems to be rather less in crises where very monotonous ichnoassemblages are usual (the Kačák event as documented in the Middle Devonian of the Bohemian Massif followed by origin of monotonous Chondrites-Planolites assemblages, can be an example). The uniformity of composition of the assemblage is accompanied by a little variability within the individual ichnotaxa.

Another else problem is the change of character of the trace (size, variability, morphology) in a geological time of crises (e.g., change of size of Zoophycos menisci described by Marintsch and Finks /1978/ or the study of Mikuláš /1992, 1994 b/ on the ichnogenus Asteriacites can be examples). On a basis of such studies we can try to answer the question: Can the biospecies (or evolutionary linked species) dispose of a crisis by change of some aspects of its behaviour (way of feeding, dwelling, resting, crawling, escaping, a.o.)?

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