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DISCUSSION

A Response to S.V. Zyabrev's Critical Paper Entitled "On the Biostratigraphy of Accretionary Complexes of the Far East: A Critical Review of Several Papers"

I. V. Kemkin and A. N. Filippov

Far East Geological Institute, Far East Branch, Russian Academy of Sciences, Vladivostok, 690022 Russia
e-mail: kemkin@fegi.ru

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Judging from the title suggested by S.V. Zyabrev, the readers of the Journal *Pacific Geology* (including us) could have anticipated that the author would consider in his paper really important and topical problems of biostratigraphic studies of such intensely dislocated sedimentary complexes as fragments of old accretionary prisms. Biostratigraphy, as stratigraphy, is known to be the basis both for tectonic reconstructions and for the formation of correct ideas about the geological structure of individual regions of the Earth's crust. This is especially urgent for the Far East region, which, according to numerous data of the past decades [4, 8, 9–12, 14, 15, 18, 19, and others], is interpreted as a collage of genetically heterogenic terranes of different ages that were accreted to the eastern edge of the Siberian and Sino–Korean cratons in the Mesozoic–Cenozoic. It is evident that the establishing of the structure of different terranes on the basis of the biostratigraphic data (as well as the time of their involvement into the continent's structure) and the age of the overlying complexes joining the terranes is a necessary and important condition for solving such fundamental problems as the geodynamic evolution of the Pacific margin and Asia and the correlation of the geological processes in the zone transitional from the Eurasian continent to the Pacific Ocean.

In this connection, one might expect that S.V. Zyabrev in his paper would bring to the attention of geologists new techniques and approaches for carrying out biostratigraphic studies of intensely dislocated complexes; new methods elaborated by him for extracting microfossils that improve the qualitative and quantitative characteristics of paleontological materials for the more precise determination of the time of their mutual coexistence; refined data on the time ranges for individual radiolarian species, which is also of importance for substantiating the age of the sedimentary rocks enclosing them; or results of the latest or his own biostratigraphic investigations improving (changing) our understanding about the geological structure of a certain region. S.V. Zyabrev, however, gave preference to quite another version of "biostratigraphic studies," namely, revision of data obtained by other researchers. It should be noted that such a version is available in the geological practice, but it is used in cases when earlier biostratigraphic scales underwent essential transformations by virtue of refinement of the time ranges for individual fauna species, or revision of the systematics of some of them, or by virtue of the inconsistency of the time intervals determined using different fauna groups for the same sedimentary complexes. However, the author of the paper under discussion mentioned other reasons. The principal among them are the following: incorrect diagnostics of microfossils by other researchers, the use of different biostratigraphic scales for establishing the age of radiolarian assemblages, the interpretation of dislocated stratigraphic successions as practically continuous, the narrowing of the time interval at the expense of the time intervals of the underlying and overlying deposits, and some others.

When reading the arguments suggested by S.V. Zyabrev for each of the mentioned points, it becomes evident that the claims made by him are subjective and unsubstantiated. It is easy to show by the example of even one (let it be the first) of the papers under criticism, which was written by researchers from the Far East Geological Institute about the volcanogenic–siliceous complexes in the lower reaches of the Amur River [17]. Thus, S.V. Zyabrev casts doubt on the correct identification of the species *Orbiculiforma* cf. *cachensis* Pessagno by the authors of the mentioned paper and refers to the fact that it was difficult for him to find the first description of the species (to do so one should have only looked into the work by E. Pessagno [26]) and that it is only in L. O'Doherty's work [24] that he could find mention about the species in the list of synonymy for the species *Dactyliospaera acutispina* (Squinabol). Even when it is taken into account that both species are the same thing, the range of the spe-

cies *Dactyliospaera acutispina* (Squinabol) is the middle Albian–early Cenomanian and not the Barremian. It is likely that, because of this, he writes further that part of images is akin to the species *Godia tecta* (Tumanda). Evidently, it is an unproved statement for a person who calls himself an expert in radiolarian biostratigraphy. A strong specialist would outline which morphological features caused him to think so. To analyze the morphostructure of a shell, it is necessary to have original images of the radiolarian skeletons (which he lacks) and not copies made using a poor polygraphic base. With the same easiness, one could identify this species as *Patellula heroica* O'Doherty, but, to S.V. Zyabrev's regret, the range of the species is the early Turonian, which does not fall within the scheme he devised. In a similar manner, i.e., without presenting a morphological analysis, he also re-identifies *Acaeniotyle* sp. into the species *Archaeospongoprunum patricki* Jud, which is probably more "convenient" for his further substantiation of the age. Why not into *Dicroa rara* (Squinabol), whose range is the middle Albian–Cenomanian and bears similarities in appearance both to *Acaeniotyle* sp. and *Archaeospongoprunum patricki* Jud? In this case, S.V. Zyabrev absolutely hushes up information about the species *Orbiculiforma* cf. *maxima* Pessagno and *Orbiculiforma belliatula* Wu renamed by L. O'Doherty [24] into the species *Dactyliospaera maxima* (Pessagno), the range of which is also the middle Albian–early Cenomanian. What is more important is that he does not take into account the data to the effect that the disk-shaped radiolarians (*Orbiculiforma*, or let it be *Dactyliospaera* or even *Godia*) and other spumellarians make up only 15% of the total abundance of the radiolarians in the assemblage under discussion. Eighty-five percent of the assemblage is represented by multicyrtide radiolarians not established in the Cretaceous marine deposits of the Tethys and the Pacific Rim and not yet described in the literature, except for the species *Stichomitra mediocris* (Tan). For a researcher who is really an expert in radiolarian biostratigraphy, the information would point to the fact that the representatives of the disk-shaped radiolarians of this assemblage were at the terminal stage of their evolution, whereas the representatives of the multicyrtide radiolarians were at their blossoming stage. Hence, when establishing the age of the assemblage, one should basically rely upon the ranges of the latter.

Now, in regard to the different biostratigraphic scales we used for establishing the age of the radiolarian assemblages. S.V. Zyabrev sets great hopes on only one scale of unitary radiolarian assemblages—the scale proposed by L. O'Doherty and J. Guex [25], which combines the unitary assemblage scales proposed by L. O'Doherty [24] and R. Jud [22]. He adds, "This scale is the only one, in which the full stratigraphic ranges are given." Though, he forgets to say that all three scales were elaborated for the western Mediterranean region, i.e., for the pelagic and hemipelagic deposits of the Tethyan paleobiogeographic province. However, in the Cretaceous, radiolarians existed not only in the Tethys paleoocean but in the Atlantic and Pacific paleooceans as well. So far nobody has proved that one and the same radiolarian species in these paleooceans existed within similar time intervals. Having appeared in the Tethys, some species could later have occurred in the Pacific paleoocean and vice versa. The time intervals of their evolution in the different paleooceans could be diverse. Therefore, the time of the first appearance and the time of the last occurrence of one and the same species in different paleobiogeographic provinces may differ. The siliceous and siliceous–clayey complexes discussed in our papers represent fragments of the sedimentary cover of the Paleopacific; therefore, in establishing the age of the radiolarians enclosed in them, the use of biostratigraphic scales of this paleobiogeographic province (scales of Russian, American, and Japanese geologists) is more preferable. However, not all the radiolarian species are present in these scales. For some of them, data on the lower and upper range limits are unavailable. That is the reason why not one but several biostratigraphic scales should be used for a more or less objective age determination for the assemblage. It is along this pathway that paleontologists–radiolarists from the Asian–Pacific region, including Russian specialists from the Geological Institute of the Russian Academy of Sciences, are working [1–3, 13, 16, and others].

The next claim is the interpretation of faulted stratigraphic sequences as continuous is not serious at all. In our earlier works [6, 7, 23, and others], we presented the description of the structure, composition, and age of those rare fragments from the section of paleo-oceanic complexes in accretionary prisms in which the primary (sedimentation) sequence of lithofacies was retained. Simplified, it is as follows (from the bottom to top): pelagic cherts, hemipelagic siliceous–clayey rocks, terrigenous siltstones, and sandstones of the near-continental area of sedimentation. Such sedimentation sequences are referred to as Oceanic Plate Stratigraphy Sequences [20, 21, 27], i.e., a set of deposits of an oceanic plate that accumulated on it in the course of its drifting from the site of generation (spreading zone) to the site of burial (subduction zone). Clearly, due to subduction and consequent accretion, the primary sequence becomes dislocated in the course of multiple imbrication, underthrusting, and duplexing of the original cover of the oceanic plate, which results in the formation of the imbricated–thrust structure. Therefore, for the most part, accretionary prisms represent complicated tectonic–sedimentation complexes (tectonic packages) composed of repeatedly alternating tectonic slices and blocks made of oceanic (pelagic and hemipelagic deposits and fragments of seamounts and rises), marginal–oceanic (sandy–shaly sequences), and chaotic (mélange and olistostromes) bodies. The data of bios-

tratigraphic studies do allow us to reconstruct the primary (not faulted) sequence and interpret it as a fragment of the sedimentary cover of a certain area of the accreted oceanic plate.

One more claim is the narrowing of the age interval at the expense of the age intervals of the underlying and overlying deposits. Everything is so evident here that it does not seem to need clarification. Nevertheless, we will clarify. There are two successive layers. Let us assume that, based on the radiolarians found, the upper age limit in the lower layer is similar to the upper layer or even exceeds it. Clearly, we take the lower age limit of the upper layer as the upper age boundary of the lower layer, since the radiolarians limiting the lower age boundary of the upper layer are missing from the lower layer. For instance, the lower layer was dated to the early Bajocian–early Bathonian and the upper layer, to the late Bajocian–early Bathonian. Clearly, we have to restrict the age of the lower layer to the late Bajocian. It is evident. It should be noted that such an approach is also widely used by paleontologists who take up macrofauna—Stenon's law (the higher the younger) has not yet been abandoned. S.V. Zyabrev himself determined the age boundaries of the cherts and siliceous mudstones in the Kiselev section in a similar way [5].

Finally, regarding the program BioGraph v. 2.3., it is evident from the example cited by S.V. Zyabrev (even when not going into a detailed compilation of the algorithms) that it is contradictory to the unitary association scale pretending, in his opinion, to be unique and the most complete. It is quite clear that each sample taken for radiolarians will yield its own unitary association, which will occur between the unitary associations of the mentioned scale (as in our case) or completely or partially overlap some of them. Hence, with each new sample, the unitary associations will increase in abundance in this unique and most complete scale. It is not necessary for them to be successive; they may overlap between each other and by the basic associations distinguished by L. O'Doherty and J. Guex [25]. Then, what does the uniqueness of this scale of unitary associations reside in?

To sum up, it should be recognized that, as the southern part of the Far East (including the radiolarian biostratigraphy) has not yet been adequately explored, errors are quite possible in the interpretation of its geological structure. It is only by joint efforts on obtaining new data and in the process of fruitful discussion (and not unsubstantiated criticism) that our knowledge about the geological structure and history of the region's evolution can be brought to a new, higher level.

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