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Late Cretaceous Representatives of the Superorder Phaeodaria (Radiolaria)

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Abstract—In Russia Late Cretaceous Phaeodaria have been discovered for the first time. Two new species, *Protocystis naibiensis* sp. nov. and *Challengeria (?) sakhalinica* sp. nov., are described.

INTRODUCTION

The class Radiolaria is usually subdivided into two subclasses: Acantharia and Euradiolaria. Acantharians have celestine skeletons. The subclass Euradiolaria consists of two superorders, Polycystina and Phaeodaria, both of which have skeletons of amorphous silica. Skeletal elements of representatives of the orders Spumellaria and Nassellaria (Superorder Polycystina) compose thick deposits of bottom sediments, whereas phaeodarian skeletons are rarely preserved in sediments (Bjorklund, 1984). Reschetnjak (1966) believes that this difference in resistance of skeletons of Phaeodaria and Polycystina to dissolution is due to different modifications of silica of which they are composed. Petrushevskaya (1986) also believes that "the morphological differences between siliceous skeletons of Phaeodaria and Polycystina may be due to as yet unknown differences in their chemical composition and molecular structure."

This can explain why finds of fossil Phaeodaria are so uncommon. Dumitrica (1972) detected some phaeodarians in Mediterranean Pleistocene deposits. A year later Dumitrica (1973) reported finds of Phaeodaria from many stratigraphic levels (Oligocene to Quaternary) of the southwestern Pacific region. Among the described species there are representatives of the genera *Protocystis* and *Challengeria*. Their oldest forms have been discovered in upper Miocene deposits. Phaeodaria are also known from the upper Eocene (Vitukhin, 1993) and Miocene (Runeva, 1974) of the Kamchatka Peninsula.

Phaeodaria are distinguished from other representatives of Euradiolaria by the following features: (1) the presence of three apertures in the central capsule (the principal systematic feature of Phaeodaria); (2) the presence of a two-layered central capsule the outer layer of which is composed of chitin (Haeckel, 1879) or pseudochitin (Dogel', 1950) material; (3) the development of an aboral end (Dumitrica, 1972); and (4) the mode of skeleton formation. Gradual silicification of the skeleton occurs in sarcodictyum. The phaeodarian skeleton usually develops through the formation of a surface network of primary spines. A secondary silicification produces a finely porous wall. Phaeodarians demonstrate diverse forms of the skeleton: spiny shells, lattice spheres, and cortical bivalve shells with a medullary shell.

Since the first two of thses distinctive features characterize nonpreservable soft body, they cannot be identified. So, fossil forms of Phaeodaria and Polycystina should be differentiated by means of skeletal features. The fact that Phaeodaria lack an initial skeleton in the form of a spicule or a microsphere but have a peristome and pylome (Dreyer, 1889) frequently edged with spines is one such feature. The peristome is a peculiar shell projection, that bears the pylome at the distal end. Some representatives of Cannosphaeridae have a double outer skeleton consisting of an external complex lattice and internal simple sphere (Reschetnjak, 1966). This skeletal structure is similar to that of Spumellaria. A smooth-margined pylome is characteristic of representatives of the families Cannosphaeridae (e.g., *Coelacantha*) and Castanellidae (e.g., *Castanarium*).

MATERIAL

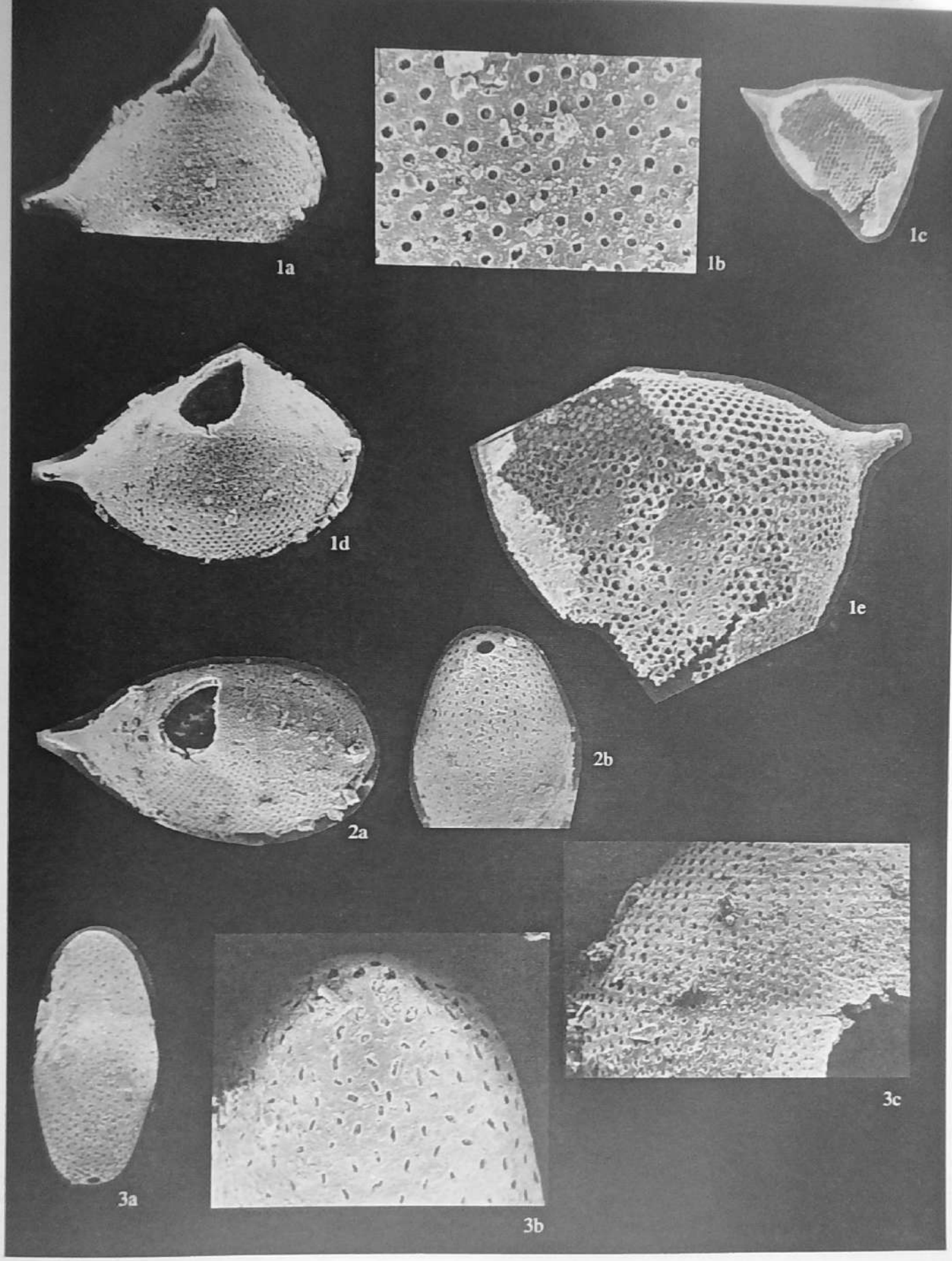
In 1987 O.A. Schmidt gave me some samples from the Malye Kurily Formation of Shikotan Island. These samples contained an abundant and diverse radiolarian

Explanation of Plate I

Figs. 1 and 2. *Protocystis naibiensis* sp. nov.: (1) holotype no. 4686/1: (1c) cavity inside the aboral-ventral spine, (1d) two-layered structure of the shell (1a, 1c, and 1d, ×200), (1b and 1e) size and location of pores (1b, ×1000; 1e, ×500); Upper Cretaceous, upper Cenomanian, Naiba River; (2) specimen no. 4823: (2a) ×200; (2b) ×500; Upper Cretaceous, Campanian–Maastrichtian, Shikotan Island, Malaya Kuril'skaya Ridge.

Fig. 3. *Challengeria (?) sakhalinica* sp. nov.: holotype no. 4868/2; (3a) aboral end, ×200; (3b) general view, ×200; and (3c) size and location of pores in the upper part of the shell, ×1000; Upper Cretaceous, upper Cenomanian, Southern Sakhalin, Naiba River.

Plate 1



assemblage of the Campanian–Maastrichtian age (Bragina, 1991) that included some taxa that resembled phaeodarians in morphology. Field works conducted in 1992 on Sakhalin (southern Sakhalin, the Naiba reference section) yielded fairly rich radiolarian assemblages. A representative assemblage of late Cenomanian radiolarians that included phaeodarians was discovered in Member 1 of the Bykov Formation.

Since fossil Phaeodaria are poorly preserved, their diagnosis is based on the systematics of living species.

The collection no. 4868 is stored in the Geological Institute of the Russian Academy of Sciences (GIN).

SYSTEMATIC PALEONTOLOGY

Superoder Phaeodaria Haeckel, 1879

Family Challenheridae Murray, 1876

Subfamily Lithogramiinae Haeckel, 1887

Genus *Protocystis* Wallich, 1869

***Protocystis naibiensis* Bragina, sp. nov.**

Plate 1, figs. 1a–1e, 2a, 2b

Etymology. From the Naiba River, where the species was first discovered.

Holotype. GIN, no. 4868/1; southern Sakhalin, Naiba River basin; upper Cenomanian, Member 1 of the Bykov Formation, beds with *Cuboctostylus trifurcatus–Cassideus yoloensis*.

Description. The shell has the form of an isosceles triangle with two hollow radial spines: longer aboral-ventral and shorter aboral-dorsal. The narrow peristome is tapering distally to form a small triangular pylome. The shell surface is densely dotted with numerous pores of nearly equal sizes that are arranged in quincuncial patterns. The pores slightly decrease in size toward the bases of poreless aboral spines.

Measurements, in μm. The shell diameter is 300; the length of the aboral-ventral spine, 40; the length of the aboral-dorsal spine, 35; and the pore diameter, 2–4.

Comparison. Differs from the living species *Protocystis vicina* Reschetnjak (Reschetnjak, 1955) in the absence of peristomal denticles, a less pronounced difference between the lengths of the aboral-dorsal and aboral-ventral spines, and in having shorter aboral spines.

Material. Four specimens from two localities.

Subfamily Lithogramiinae Haeckel, 1876

Genus *Challengeria* Haeckel, 1879

***Challengeria (?) sakhalinica* Bragina, sp. nov.**

Plate 1, figs. 3a–3c

Etymology. From the Naiba River, where the species was first discovered.

Holotype. GIN, no. 4868/2; southern Sakhalin, the Naiba River basin; upper Cenomanian, Member 1 of the Bykov Formation, beds with *Cuboctostylus trifurcatus–Cassideus yoloensis*.

Description. The shell is lens-shaped and slightly compressed near the rounded top and slightly swollen in the middle. The aboral end shows a round pylome without marginal denticles. The pores are small and vary in form from rounded at the aboral end to strongly elongated and angular-oval at the top. The largest diameters of oval pores are variably oriented.

Measurements, in μm. The shell diameter is 130; the shell length from the top to the aboral end, 240; and the pore diameter, 2–10.

Comparison. Differs from *Challengeria naresi* Murray, 1876 (Reschetnjak, 1966) in the more elongated lenticular shape, absence of a conical tooth, and in having finer and loosely set pores of strongly elongate oval form near the top.

Material. Four complete and several incomplete specimens from the type locality.

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