

On the genus *Pliocaenicus* Round & Håkansson (Bacillariophyceae) from the Northern Hemisphere

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INTRODUCTION

The genus *Pliocaenicus* Round & Håkansson is a relict freshwater diatom genus currently containing eight species. Its optimum occurrence took place in the Pliocene, however it is known from the late Miocene till the Recent. Up to date, it is only reported from the Northern Hemisphere. The recent populations are represented by one species (*P. costatus*) and have been traced only in the Asian arctic and alpine zones.

In this study, we are summarising light (LM) and scanning electron microscopic (SEM) observations of the main morphological characters and providing a taxonomic key for the species within the genus *Pliocaenicus*. In addition, we are recombining one taxon into this genus and compile the currently known biogeographical distribution of this genus.

MATERIAL & METHODS

We studied material from eight localities: Omarsky Pochinok, Prikamje (E. I. Loseva Collection); Zhidini-570, Latvia (G. K. Khursevich Collection); the borehole 515, sediment depth 44 m (sample #189), the Eravinsky region, the Vitim Plateau (A. I. Moisseeva Collection); Maloye Leprindo, station 21, sampling depth 0–5 cm, Siberia (E. M. Vishnevskaya Collection); Lake Jana, the Verkhojansk Mountains (AWI-Potsdam Collection); Lake Nikolay in the Arga Island, the Lena River Delta (AWI-Potsdam Collection); Lake El'gygytyn (AWI-Potsdam Collection); roadcut exposure in Washoe County (sec. 18, T19N, R19E), Nevada, USA (W. N. Krebs Collection).

Morphological peculiarities of various members of *Pliocaenicus* were studied with light (LM) and scanning electron microscopy (SEM). The same procedure as in Stachura-Suchoples (2006) was performed. Additionally, literature data was included in our studies (see Table 1). From this study we excluded *P. pantocsekii* (Fricke) Round & Håkansson, nom. inval. as this species should be probably transferred to genus *Tertiarius* Håk. & Khurs. (see also Khursevich & Stachura-Suchoples accepted).

Table 1. Literature data included in this study.

Species	References
<i>Pliocaenicus costatus</i> (Loginova, Lupikina & Khurs.) Flower, Ozornina & A.I.Kuzmina sensu lato (in Flower et al. 1998)	Skabitchevsky 1953, Seczkina 1956, Genkal & Popovskaya 1984, Loseva & Makarova 1977, Loseva 1982, Loginova et al. 1984, 1986, Khursevich 1989, Khursevich et al. 1989, 1992, Genkal 1990, Flower et al. 1998, Tanaka & Kabayasi 1999, Genkal & Bondarenko 2001, 2004, Genkal et al. 2001, Popovskaya et al. 2002, Stachura-Suchoples 2006, Cremer & Van de Vijver 2006
<i>Pliocaenicus hercynicus</i> Round & Håk.	Round & Håkansson 1992
<i>Pliocaenicus undulatus</i> Round & Håk.	Round & Håkansson 1992
<i>Pliocaenicus nipponicus</i> H.Tanaka & Nagumo	Tanaka & Nagumo 2004
<i>Pliocaenicus omarensis</i> (Kuptsova) Stachura-Suchoples & Khurs.	Kuptsova 1962, Gasse 1980, this study
<i>Pliocaenicus cathayanus</i> G.Wang	Wang 1999
<i>Pliocaenicus jilinensis</i> G.Wang	Wang 1999

RESULTS & DISCUSSION

When Round & Håkansson (1992) created the genus *Pliocaenicus* to accommodate two new species, they transferred a number of species from *Stephanodiscus*, *Cyclotella* and *Cyclostephanos* to *Pliocaenicus*. Unfortunately the recombination of *St. omarensis* was invalid and is here validated.

***Pliocaenicus omarensis* (Kuptsova) Stachura-Suchoples & Khurs., comb. nov.**

Basionym: *Stephanodiscus omarensis* Kuptsova in Botanicheskie Materialy Otdela Sporovykh Rastenij, Institute of Botany, AN SSSR 15: 37-38, fig. 1-11. 1962.

≡ *Cyclotella omarensis* (Kuptsova) Loseva & I.V.Makarova in Novosti sistematiki nizshikh reastenij. 14: 29. 1977

– *Cyclostephanos omarensis* (Kuptsova) Khurs. & Loginova in Dokl. Akad. Nauk Belorussk. SSR 29(5): 446. 1985.

≡ *Cyclostephanos omarensis* (Kuptsova) Khursevich & Loginova in Khursevich et al., Bot. Zhurn. 74(8): 1180. 1989.

– *Pliocaenicus omarensis* (Kuptsova) Round & Håk. in Diatom Research 7: 123. 1992, nom. inval. (McNeill et al. 2006, Art. 33.4).

Type locality: In mass in the Omarsky horizon of the late Pliocene, near Omarsky Pochinok, Mamadyshsky (former Kamsko-Polyansky) district, Tatarskaya ASSR.

Round & Håkansson (1992) differentiated the taxa within the genus *Pliocaenicus* by four important characters: valve undulation, absence of externally domed interfascicles, a distinct border between areolae on the valve face and mantle, absence of spines but small granules may be present. Flower et al. (1998) pointed out the following features: either smooth or colliculate valve face area and arrangement of valve face areolae in curved rows. Genkal et al. (2001) noticed that valves can be flat, slightly concave or transversely undulated, as well as spines can be present or absent.

Our observations define seven more variable features important for the genus *Pliocaenicus*:

1. rimoportula structure (fan-shaped, sessile or raised);
2. alveolae structure on the valve mantle (simple, or both simple and complex alveolae);
3. the subdivision of the valve mantle into fascicles consisting of vertical rows of fine puncta, separated by wide interfascicles (costae), which reach the valve edge, or by narrow interfascicles, which do not go to the valve edge;
4. the location of mantle fuloportulae on either thick or thin recessed internal costae;
5. the presence of “fenestrate”, pseudo-fenestrate structure or its lack on the valve face/mantle junction;
6. the availability of the ligula-like segment in the cingulum structure;
7. the presence of external openings of valve face fuloportulae lacking tubuli, or valve face fuloportulae with external short tubes placed in small depressions.

Interestingly, a constant character in one species can be a variable character in others. More studies on (1) morphological variability of characters on single population levels and on (2) ultra-structural features as the main diagnostic features are necessary to understand its taxonomical significance.

Comparative studies on the morphology of seven taxa within *Pliocaenicus* resulted in a key for determination of *Pliocaenicus* species (see also the emended description of the genus *Pliocaenicus* in Khursevich & Stachura-Suchoples accepted).

Key for the taxonomic determination of *Pliocaenicus* species

I. Valves elliptical and round, transversely undulate. Alveolae simple. Valve face and mantle fuloportulae with two satellite pores. A single fan-shaped rimoportula in the middle or in the submarginal zone of the valve face surface ***P. costatus***

II. Valves round, rarely elliptical, transversely undulate. Alveolae simple or both simple and complex. Valve face and mantle fuloportulae with two or three satellite pores. One sessile or raised rimoportula near or at the base of an internal costa or in the chambered region.

1. Alveolae simple. Diameter of valves 3.5–21 μm . Externally broad interstriae (costae) on the mantle go to the valve edge. Internally, mantle fuloportulae located on every thick costae.

A. Diameter of valves 3.5–9 μm . Number of areolae 20–30 in 10 μm . Valve face and mantle fuloportulae with three satellite pores ***P. undulatus***

- B. Diameter of valves 10–21 μm . Number of areolae 12–35 in 10 μm . Valve face and mantle fulcra with two satellite pores.
- a. Number of areolae more than 20 (30–35) in 10 μm . Number of interstriae (costae) on the mantle is 10 in 10 μm ***P. hercynicus***
- b. Number of areolae less than 20 (12–16) in 10 μm . Number of interstriae (costae) on the mantle is 5–6 in 10 μm ***P. nipponicus***
2. Alveolae both simple and complex. Diameter of valves 5–47 μm . Externally narrow interstriae (costae) on the mantle do not go to the valve edge. Internally, mantle fulcra located on thick or thin recessed costa.
- A. Internally, mantle fulcra are located on thick costae ***P. omarensis***
- B. Internally, mantle fulcra are located on thin recessed costae
- a. Diameter of valves 7–19 μm ***P. jilinensis***
- b. Diameter of valves 14–44 μm . Fenestrate structure on the valve face/ mantle junction ***P. cathayanus***

Temporal and spatial distribution

Pliocaenicus costatus sensu lato is known from the late Miocene: the Taigonos Peninsula, Russia (Flower et al. 1998), from the Pliocene: the Vitim Plateau, Russia (Moisseeva 1995). The Pleistocene occurrences are known from Latvia (Loginova et al. 1986), the Central Kamchatka Depression, Russia (Flower et al. 1998), Japan (Tanaka & Kobayasi 1999) and St. Michael's Island in Alaska, USA (Flower et al. 1998). The Holocene and Recent distribution of *P. costatus* sensu lato is restricted to Asian arctic and alpine zone (Seczkina 1956, Flower et al. 1998, Genkal & Bondarenko 2001, 2004, Popovskaya et al. 2002, Cremer & Van de Vijver 2006, Stachura-Suchoples 2006, Genkal & Yarushina 2006, Robinsson et al. accepted). *Pliocaenicus omarensis* was widespread species in the Pliocene. Its occurrence is known from Eurasia: Bulgaria (Temniskova-Topalova & Ognjanova-Rumenova 1997, Ognjanova-Rumenova 2006), European part of Russia (Kuptsova 1962, Loseva & Makarova 1977), Japan (Tanaka & Kobayasi 1999), and Africa: Ethiopia (Gasse 1980). A variety of *Pliocaenicus omarensis* (as *Cyclotella omarensis*) was found in the Neogene of Kamchatka (Lupikina pers. comm., in Loseva 1981), *Pliocaenicus* sp. aff. *omarensis* (as *Cyclotella* sp. aff. *omarensis*) in Eemian deposit in Finland (Niemelä & Tynni 1979), and *Pliocaenicus* aff. *omarensis* from the upper Pleistocene in NE Europe (Loseva 2001). *Pliocaenicus nipponicus* is reported from the Pliocene sediment from Japan (Tanaka & Nagumo 2004), and the species apparently closely related to *P. nipponicus* was found in Pliocene deposits in Nevada (USA) (Khursevich pers. com.) *Pliocaenicus undulatus* and *P. hercynicus* were found in the Pliocene diatomites within the Harz Mountains in Europe (Round & Håkansson 1992). *Pliocaenicus cathayanus* and *P. jilinensis* occurred in the Pliocene deposit from the Jilin Province in China (Wang 1999).

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