Taxonomy, Morphology and Distribution of a Rare Species, *Navicula schmassmannii* Hust. (*Bacillariophyta*)*

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ABSTRACT: As a result of this scanning electron microscopy study, a rare species, *Humidophila schmassmannii*, has been discovered for the first time in phytoplankton from waterbodies and water courses in the far north of Western Siberia (the Yamal and Tuzovsky peninsulas). The morphological study has shown that this species has a high variability of the main diagnostic features that justifies a more elaborate description of *H. schmassmannii*.

KEY WORDS: phytoplankton, far north of Western Siberia, *Bacillariophyta*, morphology, electron microscopy, *Humidophila schmassmannii*

INTRODUCTION

Navicula schmassmannii Hust. is a rare species (Krammer and Lange-Bertalot, 1986; Fallu et al., 2000; Werum and Lange-Bertalot, 2004; Antoniades et al., 2008) which was first described using materials from alpine lakes of Switzerland (Hustedt, 1943). Later, this species was transferred to the genus *Naviculadicta* Lange-Bert. – *N. schmassmannii* (Hust.) M. Werum & Lange-Bertalot (Werum and Lange-Bertalot, 2004), but recently it has been assigned to the genus *Humidophila* – *Humidophila schmassmannii* (Hust.) Buczkó et Woital (Buczkó et al., 2015). In Russia this species has been recorded in waterbodies and water courses in the European Northeast and the Far East of the country (Loseva et al., 2004; Genkal and Kharitonov, 2010; Kharitonov and Genkal, 2012; Genkal et al., 2015). The study of the morphological variability of *N. schmassmannii* was conducted with extensive material from the deep ultra-oligotrophic Lake Elgygytgyn (Genkal and Kharitonov, 2010), which made it possible to reveal some morphotypes and further identify

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the species. Later, other researchers also investigated the morphological variability of this species from Holocene deposits of a small lake of glacial origin (Brazi) in the alpine Retezat Mountain Mass (Southern Carpathians) and refined its description (Buczkó et al., 2015). *N. schmassmannii* belongs to a North-Alpine species, which prefer oligotrophic, weakly mineralized waterbodies (Krammer and Lange-Bertalot, 1986; Fallu et al., 2000; Werum, Lange-Bertalot, 2004; Antoniades et al., 2008; Kharitonov and Genkal, 2012).

The aim of this work is to specify the morphological variability of *H. schmassmannii* and describe its range in Russia based on the study of new materials.

MATERIALS AND METHODS

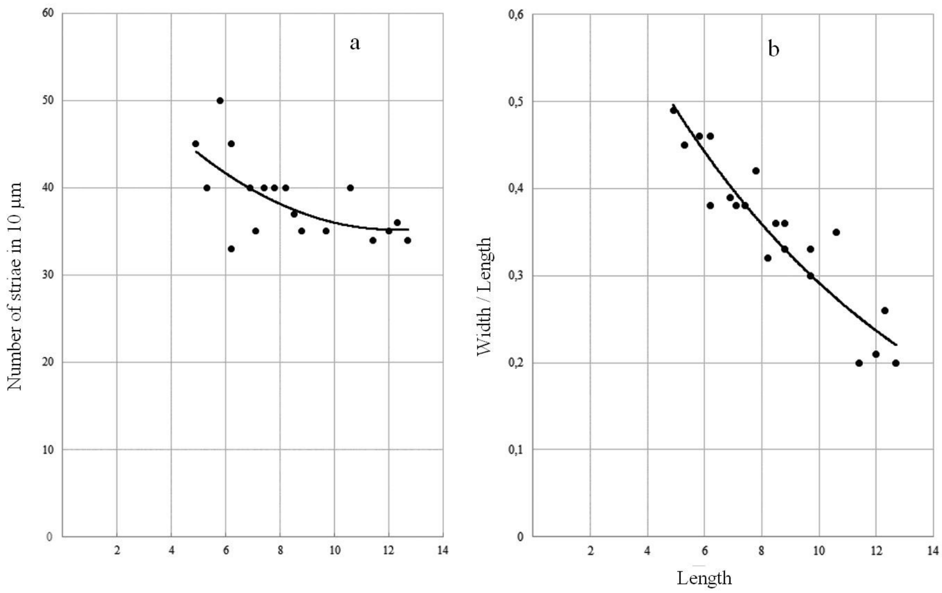
Phytoplankton samples collected in 2004–2006 from aquatic ecosystems in the far north of Western Siberia (the Yamal and Tuzovsky peninsulas) served as material for this study (Table 1). Diatom frustules were released from organic matter by cold burning (Balonov, 1975). Specimens were examined under a JSM-25S scanning electron microscope.

TABLE 1: Some morphometric and hydrological characteristics of the watercourses under study

Date of collection	Name of the reservoir	Geographical coordinates	Parameters (length, width, depth), km, m	Temperature of water, ºC	Trans-parency, m
Yamal Peninsula, basin Mordyyakha River					
07.08.2005	A nameless channel between two lakes on the right bank of the Khangolovayakha River	N 70º21'37" E 68º31'17"	Length 1 km, width 5–7 m, depth 1.5 m	12	0.5
Tazovsky Peninsula					
01.09.2006	Sobetyakha River left-bank tributary stream of the Poilovayakha River	N68º05'68" E75º38'48"	Length 58 km, width 6–9 m, depth 2 m	11	1.9
06.07.2004	Nelikopoylovayakha River	N67º56' E76º05'	Length 89 km, width 6.5 m, depth 1.5 m	9	1.2
06.07.2004	Canal of Mongoyuribey River	N67º51' E77º11'	Length 2 km, width 15–20 m, depth 2 m	10	1.0
02.09.2006	Eligoyakha River	N68º03'452" E76º04'666"	Length 19 km, width 3 m, depth 1.5 m	7	1.0

RESULTS AND DISCUSSION

In our material, the range of variability of quantitative diagnostic features does not differ from the published data (Table 2). The highest variability of quantitative characteristics is recorded in the Sobetiyakha River (Table 2). Variations in the valve outline are significant (Plate I, II). According to the description, the valve shape varies from elliptic to linear-elliptic with strongly capitate ends (Krammer and Lange-Bertalot, 1986; Buczkó et al., 2015). Other research found valves of a similar shape (Antoniades et al., 2008). In our material, valves of such shapes are absent but there are linear-elliptic and elliptic valves with elongated ends without pronounced capitation, (Plate I), elliptic (Plate II, *1–5*) and teratological valves of elliptic shape with one narrowed end (Plate II, *6*, *7*). Werum and Lange-Bertalot (2004) also give illustrations of *Naviculadicta schmassmannii* elliptic valves with elongated apices and without pronounced capitation. Valves with similar shapes, as in the type material and elliptic valves with protracted ends and without pronounced capitation, are found in Lake Brazi (Buczkó et al., 2015). The highest variability in valve shape, including the presence of one type, is recorded in Lake Elgygytgyn. Three types of valves are suggested (Genkal and Kharitonov, 2010). The analysis of eight samples from that lake and waterbodies of its basin shows a different composition of these morphotypes (Genkal and Kharitonov, 2010). An inverse correlation is found – as the valve length decreases, its width/length ratio increases, and short valves are elliptic (Genkal and Kharitonov, 2010). Similar findings are observed in our material (Figure).



Correlation between valve length and number of striae in 10 µm (*a*) and valve width/to-length ratio (*b*)

According to the diagnosis, the axial area is narrow; the central area varies from lanceolate-elongate to strongly widened (Krammer and Lange-Bertalot, 1986; Buczkó et al., 2015). Similar variations in the shape of the central area are recorded in our material (Plate I, II) and in Lake Brazi (Buczkó et al., 2015). Valves almost without a central area are observed in Lake Elgygytgyn (Genkal and Kharitonov, 2010). Striae are simple slit-like alveoli but in our material they are sometimes separated by thin septa (Plate I, *1*, *3*). Striae are usually parallel in the middle part of the valve and radially closer to its ends; they are rarely parallel along the entire valve (Werum and Lange-Bertalot, 2004; Genkal and Kharitonov, 2010; Buczkó et al., 2015). Similar patterns are observed in our material (Plate I, II). Valve length and the number of striae per 10 µm are inversely correlated: as the valve length increased, the number of striae in 10 µm decreased (Figure). A similar correlation is observed in *Centrophyceae* as well as in *Pennatophyceae* representatives and associates with cells exchanging with the environment (Genkal, 1983, 1984; Genkal et al., 2007).

Previous investigations in the far north have not detected *Humidophila schmassmannii* in waterbodies and water courses of that region (Lange-Bertalot and Genkal, 1999; Genkal and Vekov, 2007; Genkal and Yarushina, 2014a, b, 2016), so our findings are the first.

TABLE 2: Variability of morphological characteristics in *Humidophila schmassmannii*

Length of valve, µm	Width of valve, µm	Number of striae in 10 µm	References
6–10	2.5–3.0	30	Krammer, Lange-Bertalot, 1986*
11–13	3–4	20–24	Antoniades et al., 2008*
3.1–13.6	2–4.5	20–50	Genkal and Kharitonov, 2010*
5.7–13.6	2.9–4.0	23–50	Genkal et al., 2015**
4.6–13.4	2.1–3.8	36–46	Buczko et al., 2015; Lake Brazi
8.8–10.4	2.6–3.2		Buczko et al., 2015; Type material
Original data			
6.2–8.8	2.4–2.9	33–35	A nameless channel between two lakes
6.2–10.6	2.9–3.7	37–45	Eligoyakha River
4.9–12.3	2.3–3.2	34–45	Sobetyakha River

* – Given as *Navicula schmassmannii*, ** – as *Naviculadicta schmassmannii.*

Our investigations, including already published results (Kharitonov and Genkal, 2012; Genkal et al., 2015), have shown a higher morphological variability of the species as compared to the literature data (Table 2), which provides the need tocontinue its description.

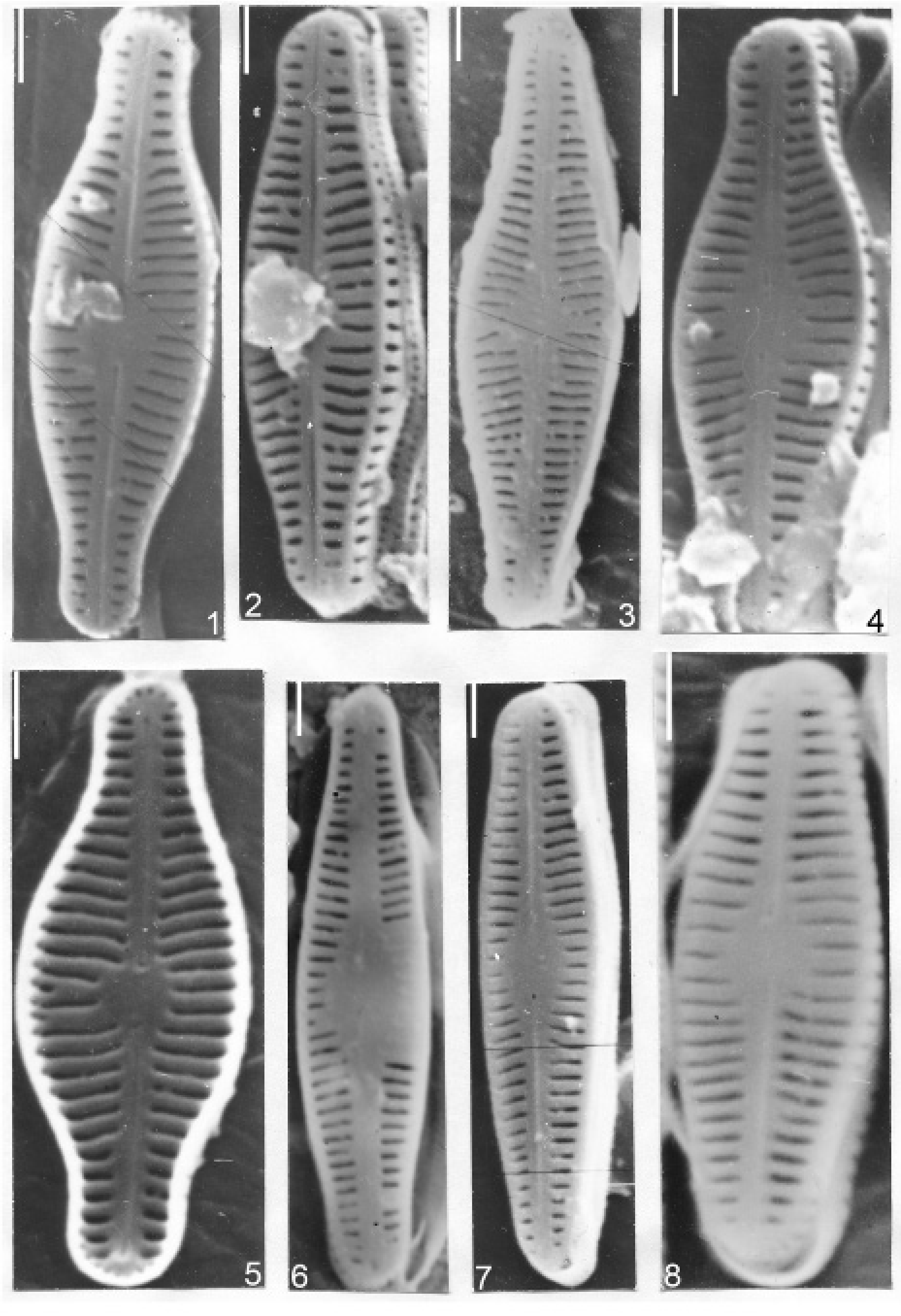


PLATE I: Electron micrographs of *Humidophila schmassmannii* valves (SEM): *1–4*; *6–8* – valves, external view; *5* – valves, internal view. Scale *1–8* – 1 µm

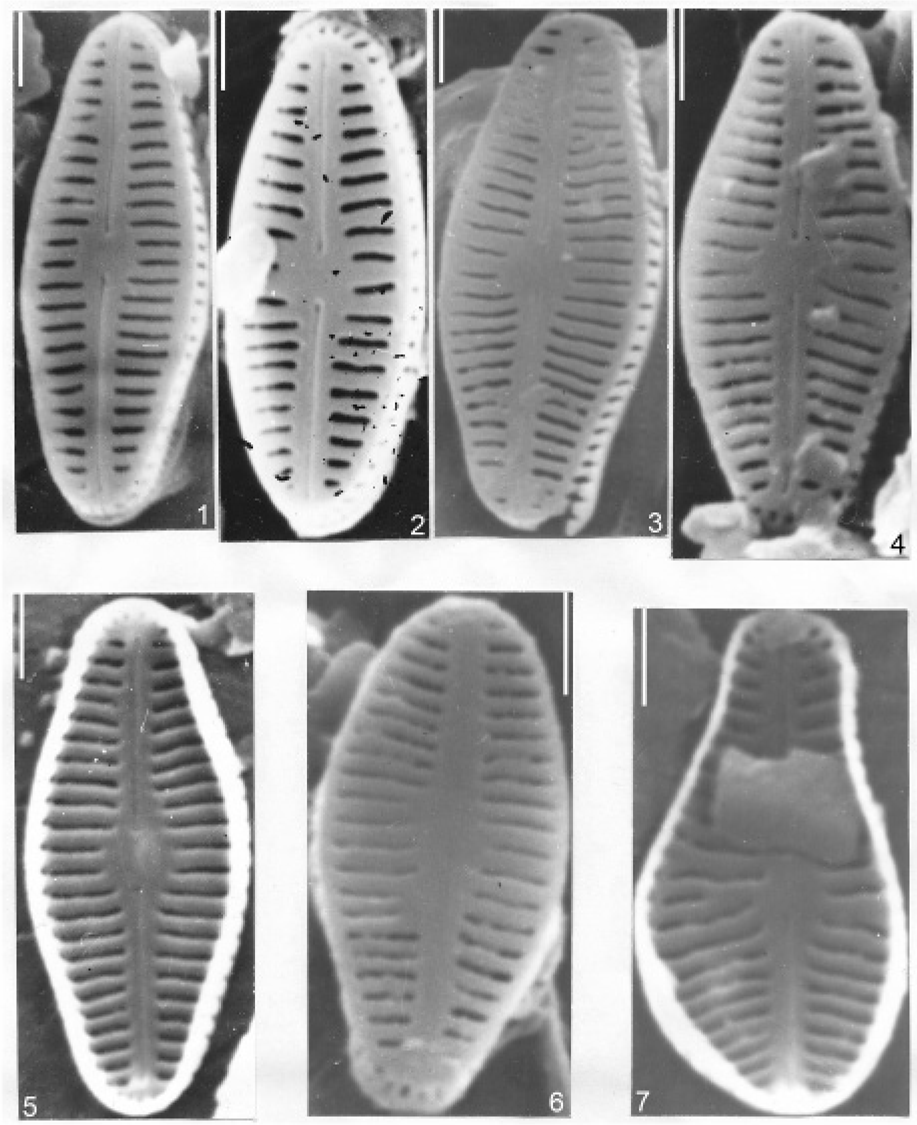


PLATE II: Electron micrographs of *Humidophila schmassmannii* valves (SEM): *1–4*; *6* – valves, external view; *5*, *7* – internal view. Scale *1–7* – 1 – µm

Humidophila schmassmannii (Hust.) Buczkó et Wojtal emend. Genkal.

Basyonym: *H. schmassmannii* (Hust.) Buczkó et Wojtal (Buczkó et al., 2015: 46 (1). p. 31, Figs 1–37).

Valves are elliptic and linear-elliptic with strongly capitate ends or elongate rostrum ends, or elliptic, 3.1–13.6 µm in length and 2–4.5 µm in width. Valve face is separated from its mantle by a hyaline area. Raphe is filiform with distant central pores. Internally, raphe ends end with small helictoglossa. The central area varies from lanceolate-elongate to strongly widened, sometimes asymmetric, the widening is rarely absent. Striae are parallel or slightly radial, composed of slit-like alveoli, 20–50 in 10 µm. Short striae are located on the mantle; their number is the same as on the valve face. There are non-perforated intercalary bands.

Distribution: Europe, far north of Western Siberia, Far East, Canada.

Found as a North-Alpine species, in oligotrophic weakly mineralized waterbodies.

CONCLUSIONS

A rare species, *Humidophila schmassmannii,* characterized by a high morphological variability of quantitative characteristics (valve length and width, number of striae in 10 µm) as well as its valve shape, has been recorded for the first time in phytoplankton from waterbodies and water courses in the Yamal and Tuzovky peninsulas. The observed patterns of variability of some characteristics are true for other representatives of diatom algae. The present study and published data serve as a basis for further identification of *H. schmassmannii* and specifying its range.

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