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— SHORT COMMUNICATION —

Transfer of four taxa of genus *Nitzschia* Hassal to genus *Psammodictyon* D.G. Mann (Bacillariophyceae)

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The following four diatom taxa found in hydrothermal sites of Milos island – three of them representing new records for the Greek diatom flora – are transferred from genus *Nitzschia* Hassall 1845 to the recently described genus *Psammodictyon* D.G. Mann in Round *et al*. 1990: *Psammodictyon constrictum* f. *parvum* (Grunow) Belegratis, Louvrou & Economou-Amilli comb. nov., *Psammodictyon panduriforme* var. *latum* (O.N. Witt) Louvrou & Economou-Amilli comb. nov., *Psammodictyon panduriforme* var. *peralbatum* (H. Peragallo & Peragallo) Louvrou & Economou-Amilli comb. nov., *Psammodictyon subconstrictum* (Grunow) Louvrou & Economou-Amilli stat. nov., comb. nov.

Key words: *Psammodictyon*, *Nitzschia*, combinatio nova, epipsammic diatoms, hydrothermal vents, Greece.

INTRODUCTION

The fine structure of the diatom valves as examined mainly by scanning electron microscopy has led to the description of new genera giving space to taxonomic revisions of many older taxa. Besides, the molecular data clearly show that some genera are paraphyletic and need revision, such as *Nitzschia sensu lato* (Lundholm & Moestrup, 2000, 2002; Lundholm *et al*., 2002; Trobajo *et al.*, 2006; Pniewski *et al.*, 2010). The rather newly established genus *Psammodictyon* D.G. Mann in Round *et al*. (1990) is closely related to *Nitzschia* Hassall 1845 and *Tryblionella* W. Smith 1853, and formerly was included in *Nitzschia* as sect. *Panduriformes* Grunow. This taxonomic revision has not been unanimously adopted and instead (e.g. Krammer & Lange-Bertalot, 1997) a subgeneric status for *Psammodictyon* and *Tryblionella* was proposed with the principal argument that the criteria for distinguishing between particular sections are still unclear (see also Witkowski *et al*., 2004). However, genus *Psammodictyon* is characterized by clear diacretic features as seen by light and electron microscopy, and its separation from the related genera is largely made by the combination of valve structure, raphe and fibula structure, and to a lesser extent by habitat, valve shape and plastid position (Round *et al*., 1990). Additionally, molecular sequence data (Sims *et al*., 2006) show a divergence (at a high support, pp = 0.98) between the type species of *Psammodictyon*, i.e. *P. panduriforme* (Gregory) Mann, and the taxa of the order Bacillariales Hendey included in the analysis. Furthermore, these data showed that *P. panduriforme* is apparently more closely related to *Undatella* sp. of Thalassiophysales D.G. Mann than to Bacillariales Hendey; however, these relationships may be a function of the available taxa of Bacillariales included in the analysis. According to other phylogenetic trees (Sinninghe Damsté *et al*., 2004; Connolly, 2006; Sorhannus, 2007), but with poor or undetermined support, *P. panduriforme* shows a closer affinity to species of Achnanthales Silva and to one species of Thalassiophysales D.G. Mann than to some species of Bacillariales.

In this paper, four taxa of genus *Nitzschia* Hassall related to sect. *Panduriformes* Grunow found in marine epipsammic samples at hydrothermal sites of Milos Island, are transferred herein to genus *Psammodictyon* D.G. Mann.

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MATERIALS AND METHODS

Milos Island is situated in the middle of the Hellenic Volcanic Arc with ~35 km^2 of geothermally active seabed (Dando *et al*., 1995). Palaeochori Bay (36° 40′11′′N, 24°31′00′′E) on the southeastern Milos is one of the most active geothermal submarine areas of the Aegean Sea (Wenzhöfer *et al*., 2000). The hydrothermal fluids of the submarine vents in Palaeochori are warm (max. 115°C), acidic (min. pH = 3.54), highly saline, generally enriched over seawater in chloride, calcium, strontium, barium, sodium, potassium, lithium, silicon, iron, manganese, zinc, cobalt, lead, nickel, yttrium, vanadium but depleted in magnesium and sulphate (Valsami-Jones *et al*., 2005). The gases in these fluids contain mainly carbon dioxide up to 91.9%; methane, hydrogen, and hydrogen sulphide are also released at concentrations of up to 9.7%, 3.0%, and 8.1%, respectively (Dando *et al.*, 1995).

Sediment samples were collected from submarine hydrothermal vents at a depth of 7 m in Palaeochori Bay during two multidisciplinary field trips organized by institutions from England, Italy, Germany, Monaco, Danemark and Greece (University of Wales – Bangor, Oceanographic Station and Marine Environment Recearch Centre – La Specia, International Atomic Energy Authority and Marine Environmental Centre – Monaco, Universities of Kiel and Karlsruhe, Max Planck Institute for Marine Biology – Bremen, National Environmental Research Institute – Silkeborg, University of Athens and University of Patras) in June 1996 and June 1997 in the framework of EU-funded programmes (Contract no: MAS3-CT95-0021). The collected samples for algal analysis were preserved in formaldehyde solution and were partly used for a PhD thesis (Louvrou, 2007). Material was oxidized and slides were prepared for diatom analyses according to standard procedures (Simonsen, 1962). Observations were made using Zeiss Axiolab microscope equipped with a Sony DSC-S85 digital camera.

RESULTS AND DISCUSSION

Four taxa of genus *Nitzschia* Hassall related to sect. *Panduriformes* Grunow are transferred herein to genus *Psammodictyon* D.G. Mann, i.e. *Psammodictyon constrictum* f. *parvum* (Grunow) Belegratis, Louvrou & Economou-Amilli comb. nov., *Psammodictyon panduriforme* var. *latum* (O.N. Witt) Louvrou & Economou-Amilli comb. nov., *Psammodictyon panduriforme* var. *peralbatum* (H. Peragallo & Peragallo) Louvrou & Economou-Amilli comb. nov., *Psammodictyon subconstrictum* (Grunow) Louvrou & Economou-Amilli stat. nov., comb. nov. Apart from the habitat (sandy substrata) and the "panduriform" valve outline, these taxa share the following generic diacretic features discernible even under the light microscope: valve face sinusoidal in transverse section, valve structure loculate and puncta in hexagonal array, presence of an oval nodule separating the central raphe fissures, and striae interrupted by an axial sternum in the two larger taxa (Fig. 1B & C).

Psammodictyon constrictum f. *parvum* (Grunow) Belegratis, Louvrou & Economou-Amilli comb. nov. (Fig. 1A).

BASIONYM

Nitzschia constricta (W. Gregory) Grunow nom. illegal. f. *parva* Grunow in Van Heurck 1880-1885, p. 173, fig. 58/8 (1881).

DESCRIPTION

Valves panduriform, with a slight middle constriction and cuneate slightly produced apices, 20-21 μm in length and 7-7.5 μm in width. Transapical striae 15-18 in 10 μm composed by distinct hexagonal areolae. Raphe system eccentric, fibulae indistinct.

TAXONOMIC REMARKS

The above features generally correspond to the type description of *Nitzschia constricta* (Kützing) Ralfs f. *parva* Grunow in Van Heurck 1880-1885, p. 173, fig. 58/8 (see also De Toni, 1892, p. 503; Van Heurck, 1896, p. 386, fig. 15/502; Proschkina-Lavrenko, 1950, p. 325). This form differs from the type species *N. constricta* (Kützing) Ralfs mainly in the smaller size (type form: up to 10.5 μm, type species: up to 50 μm). The deviation observed in our material –with individuals having a larger size (≤ 22 μm)– concides with that observed by other authors (e.g. Economou-Amilli, 1980; Foged, 1985a, 1986; Danielidis, 1991; Belegratis, 2002; Louvrou, 2007), and can be considered within type variability.

The above features constitute generic characters of genus *Psammodictyon* D.G. Mann in Round *et al*. (1990). Moreover, *N. constricta* (W. Gregory) Grunow nom. illegal. has already been transferred to *Psammodictyon* as *P. constrictum* (W. Gregory) Mann in Round *et al.* (1990). Therefore, we propose herein the following taxonomic combination: *Psammodictyon constrictum* f. *parvum* (Grunow in Van Heurck 1880-1885) Belegratis, Louvrou & Economou-Amilli comb. nov.

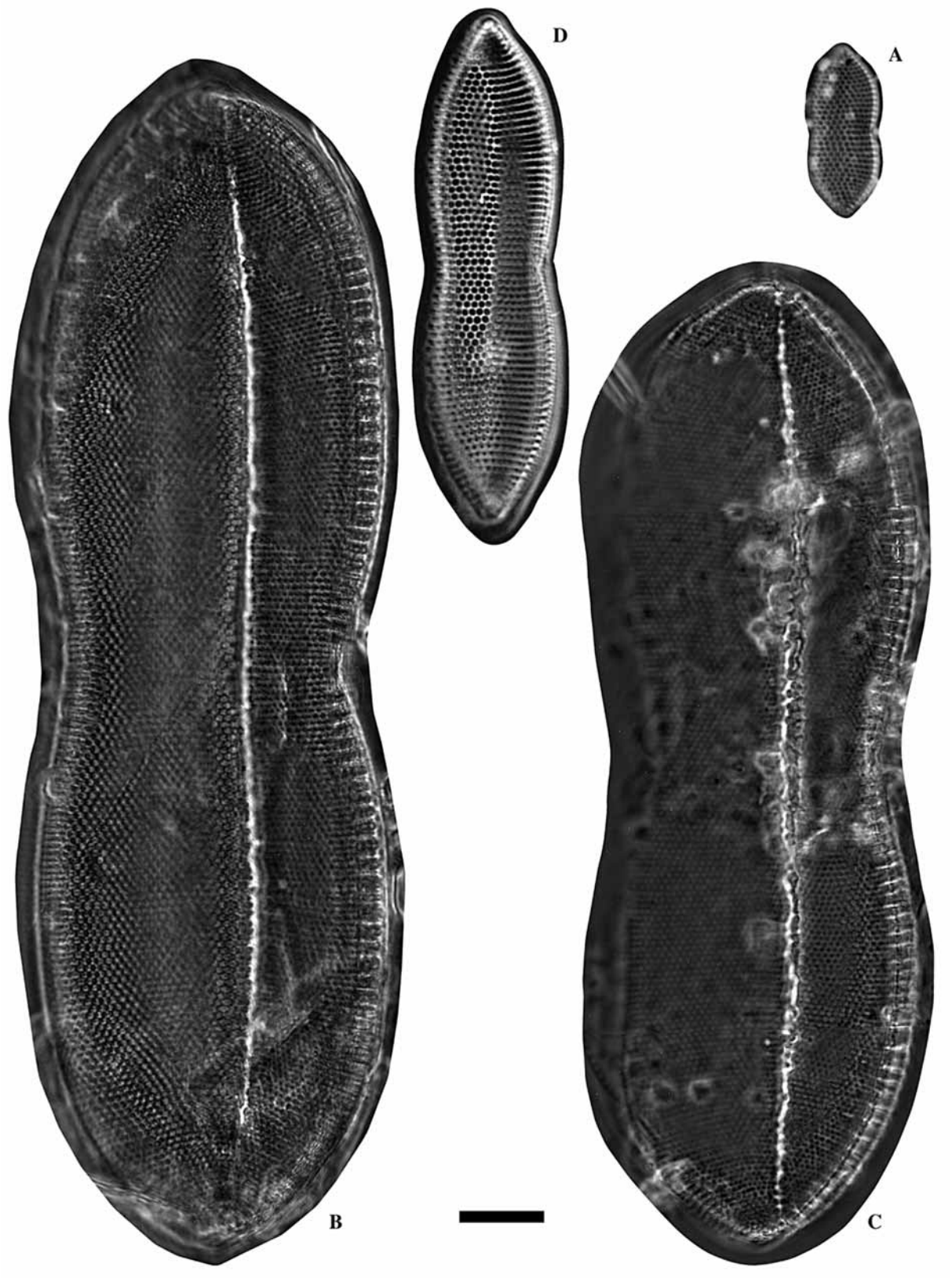

FIG. 1. A) *Psammodictyon constrictum* f. *parvum* (Grunow) Belegratis, Louvrou & Economou-Amilli comb. nov., B) *Psammodictyon panduriforme* var. *latum* (O.N. Witt) Louvrou & Economou-Amilli comb. nov., C) *Psammodictyon panduriforme* var. *peralbatum* (H. Peragallo & Peragallo) Louvrou & Economou-Amilli comb. nov., D) *Psammodictyon subconstrictum* (Grunow) Louvrou & Economou-Amilli stat. nov., comb. nov. Scale bar = 10 μm.

DISTRIBUTION

Psammodictyon constrictum f. *parvum* is a diatom already known from the Greek diatom flora, but not from other hydrothermal sites except Milos: in the gulf of Saronikos (Economou-Amilli, 1980), Pagasitikos (Foged, 1986), Evoikos (Belegratis, 2002), the lagoons of Messolongi (Danielidis, 1991), and in the islands of Kos, Kalymnos (Foged, 1985a) and Samos (Foged, 1985b).

Psammodictyon panduriforme var. *latum* (O.N. Witt) Louvrou & Economou-Amilli comb. nov. (Fig. 1B).

BASIONYM

Tryblionella lata O.N. Witt 1873, p. 66, 8/6.

SYNONYMS

Nitzschia panduriformis var. *lata* (O.N. Witt) Cleve & Möller 1878, No 147; Grunow in Cleve et Grunow 1880, p. 71.

Nitzschia lata (O.N. Witt) Lagerstedt 1876, p. 27

Nitzschia panduriformis sensu Hustedt 1921 in Schmidt *et al*. 1874-__, 331/20 (nec al.) (non 331/19, 21).

DESCRIPTION

Valves panduriform, longitudinally undulate, with a slight middle constiction and widely rounded apices, 95-140 μm in length and 33-36 μm in width. Transapical striae 15 in 10 μm composed by hexagonal areolae crossed by a distinct eccentric and longitudinal hyaline area irregular in shape. Raphe system eccentric, keeled, fibulate. Fibulae 6 in 10 μm, transapically elongated.

TAXONOMIC REMARKS

The above features correspond to the type description of *Nitzschia panduriformis* var. *lata* (O.N. Witt) Cleve & Möller, No 147 (see also Grunow in Cleve & Grunow, 1880, p. 71; De Toni, 1892, p. 501; Peragallo & Peragallo, 1897-1908, p. 269, fig. 70/1, Hustedt in Schmidt *et al.*, 1874-__, fig. 331/20). This variety differs from the type species *N. panduriformis* W. Gregory 1857 in the widely rounded apices, the slighter middle constriction of the valves (as seen in Peragallo & Peragallo, 1897-1908, fig. 70/1) and the larger size.

The above features constitute generic characters of genus *Psammodictyon* D.G. Mann in Round *et al.* (1990). Moreover, *N. panduriformis* W. Gregory 1857 has already been transferred to *Psammodictyon* as *P. panduriforme* (W. Gregory) D.G. Mann in Round *et al.* (1990, p. 676). Therefore, we propose herein the following taxonomic combination: *Psammodictyon panduriforme* var. *latum* (O.N. Witt) Louvrou & Economou-Amilli comb. nov. It is noted that an illegitimate combination *Psammodictyon panduriformis* var. *lata* (Greg.) Mann is reported by Siqueiros Beltrones & López Fuerte (2006) since var. *lata* was not established by W. Gregory; also '*Psammodictyon panduriformis* var. *lata* (Witt.) D.G. Mann' reported by Siqueiros Beltrones & Sánchez Castrejón (1999) should be considered as not compiled by Mann.

DISTRIBUTION

Psammodictyon panduriforme var. *latum* is a new variety for the Greek diatom flora; it was previously recorded mainly from the Mediterranean coasts of France (Peragallo & Peragallo, 1897-1908), the British Islands (Hartley *et al*., 1996), the Indian Ocean (De Toni, 1892), the Pacific Ocean (Foged, 1987) and, erroneously (or without description or photographic documentation), from lagoons of Mexico (Siqueiros Beltrones & Sánchez Castrejón, 1999; Siqueiros Beltrones & López Fuerte, 2006) but not from hydrothermal sites.

Psammodictyon panduriforme var. *peralbatum* (H. Peragallo & Peragallo) Louvrou & Economou-Amilli comb. nov. (Fig. 1C).

BASIONYM

Nitzschia panduriformis var. *peralbata* H. Peragallo & Peragallo 1897-1908, p. 269, 70/2 (1899).

DESCRIPTION

Valves panduriform, longitudinally undulate, with a slight middle constriction and widely rounded apices, ~117 μm in length and ~29 μm in width. Transapical striae 15-16 in 10 μm composed by hexagonal areolae crossed by a distinct eccentric and longitudinal hyaline area, irregular in shape and reaching the apical valve margin. Raphe system eccentric, keeled, fibulate. Fibulae strong, 6-7 in 10 μm, transapically elongated.

TAXONOMIC REMARKS

The above features correspond to the type description of *Nitzschia panduriformis* var. *peralbata* H. Peragallo & Peragallo 1897-1908, p. 269, fig. 70/2. This variety differs from the type species *N. panduriformis* W. Gregory 1857 in the widely rounded apices, the slighter middle constriction of the valves, the narrow keel, and the hyaline area reaching the apical valve margin.

The deviation observed in our material, with individuals having a wider keel (transapically elongated fibulae) can also be considered within the type variability, since this rare variety has been established as a new taxon based only on a single specimen.

The above features constitute generic characters of genus *Psammodictyon* D.G. Mann in Round *et al*. (1990). Moreover, *N. panduriformis* W. Gregory 1857 has already been transferred to *Psammodictyon* as *P. panduriforme* (W. Gregory) D.G. Mann in Round *et al.* (1990, p. 676). Therefore, we propose herein the following taxonomic combination: *Psammodictyon panduriforme* var. *peralbatum* (H. Peragallo & Peragallo) Louvrou & Economou-Amilli comb. nov. It is noted that the combination '*Psamodictyon panduriformis* v. *peralbata* (Per.) D.G. Mann', reported by Siqueiros Beltrones & Sánchez Castrejón (1999), should be considered as not compiled by Mann.

DISTRIBUTION

Psammodictyon panduriforme var. *peralbatum* represents a new taxon for the Greek diatom flora; it was mainly recorded from the type locality in Villefranche (France) and, without description or photographic documentation, from lagoons of Mexico (Siqueiros Beltrones & Sánchez Castrejón, 1999), but not from hydrothermal sites.

Psammodictyon subconstrictum (Grunow) Louvrou & Economou-Amilli stat. nov., comb. nov. (Fig. 1D).

BASIONYM

Nitzschia constricta (W. Gregory) Grunow nom. illegal. var. *subconstricta* Grunow in Cleve & Grunow 1880, p. 71; Grunow in Van Heurck 1881, 58/7.

SYNONYM

Nitzschia subconstricta Desikachary & Prema 1987, p. 8, 304/4.

DESCRIPTION

Valves panduriform, longitudinally undulate, with a slight middle constriction and apiculate to rounded cuneate apices, ~65 μm in length and 14.5 μm in width. Transapical striae 12 in 10 μm composed partly by hexagonal areolae. Raphe system eccentric, keeled, fibulate. Fibulae 12 in 10 μm.

TAXONOMIC REMARKS

The above features correspond to the type description of *Nitzschia constricta* var. *subconstricta* Grunow in Cleve & Grunow 1880 p. 71 (see also Grunow in Van Heurck, 1881, fig. 58/7; De Toni, 1892, p. 502; Proschkina-Lavrenko, 1950, p. 325; Cleve-Euler, 1952, p. 55. fig. 1426c; Krammer & Lange-Bertalot, 1988, fig. 39/1) which should be considered as a separate species, still sharing generic characteristics of genus *Psammodictyon* D.G. Mann in Round *et al.* (1990). Therefore, we propose herein the following taxonomic combination: *Psammodictyon subconstrictum* (Grunow) Louvrou & Economou-Amilli stat. nov., comb. nov.

It is noted that (i) *Psammodictyon mediterraneum* (Hustedt in Schmidt *et al*. 1874-__) D.G. Mann in Round *et al*. (1990) represents a similar taxon characterized, in its first description by Hustedt (1921 in Schmidt *et al.*, 1874-__, fig. 331/22), by a longitudinal fold having an irregular hexagonal structure as compared to the remaining valve surface (see also Simonsen, 1987, fig. 73/1-4); this feature has been observed only at a certain extent in our specimens, (ii) *Nitzschia subconstricta* Desikachary & Prema 1987 must be considered as an illegitimate name since *N. constricta* var. *subconstricta* Grunow represents an earlier synonym and, thus, the legitimate proposal should have been *Nitzschia subconstricta* (Grunow) Desikachary & Prema, and (iii) a diatom provisionally named by Grunow as *Nitzschia subconstricta* represents a different taxon, currently regarded as a taxonomic synonym of *Nitzschia ligowskii* Witkowski, Lange-Bertalot, Kociolek & Brzezinska in Witkowski *et al*. (2004).

DISTRIBUTION

Psammodictyon subconstrictum is a new species for the Greek diatom flora; it was previously recorded from the Adriatic Sea but not from hydrothermal sites, as *Nitzschia constricta* var. *subconstricta* (Cleve & Grunow, 1880; De Toni, 1892; Krammer & Lange-Bertalot, 1988).

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