

similarity between its subraphe construction and that found in Amphiprora (q.v.). The resemblance between these taxa was noted by Kitton (1874), who remarked however that 'the absence of the sigmoid keel and central nodule distinguishes it' (i.e. Perrya) 'from that genus.' Amphiprora's closest relatives among the Nitzschiaceae would seem, however, to be N. ocellata and N. oamaruensis.

#### 4.6.6.6 The section Insignes

The sect. Insignes was founded by Grunow (in Cleve & Grunow 1880) to include several species, some of which had previously been placed in the sect. Scalares; others were then described for the first time. Since 1880, however, no further species have been added to the group except N. pennata (Brun & Tempère 1889). Indeed, our knowledge of this group seems to have advanced very little in the last ninety years. Some of Grunow's species have been thought unworthy of specific status and have accordingly been reduced to being varieties of others, but these changes have not been made as the result of new investigations. There have been very few alterations in the diagnoses or descriptions of species given by Grunow, and this must surely be ascribed not to the comprehensiveness of Grunow's study, comparatively thorough as this was, but to the lack of work done on the marine littoral (where these organisms live) since his time (see also the sects. Panduriformes and Spathulatae).

The species recognised by Grunow have been listed, together with information concerning their dimensions, etc., in Table 16. N. adriatica, N. smithii and N. spathulifera were considered by Peragallo & Peragallo (1897-1908) to be varieties of N. insignis, while Grunow noted (in Cleve & Grunow 1880) that N. scaligera is 'vielleicht Varietät der N. Gründleri.' Here all are left as separate species.

SPECIES	Length μm.	Width μm.	Fibulae no. in 10 μm.	Costae no. in 10 μm.	Source of information
<u>N. adriatica</u>	120-160	11	2.5-4	11.5	c
<u>N. grandis</u>	230-500	40	3-5	8	c
<u>N. grundleri</u>	210-270	?	3-4	11-14	b, c
<u>N. insignis</u>	? -680	6.5	2-6	9.75-14	c
<u>N. pennata</u>	185	?	4	14	a
<u>N. scaligera</u>	108	11	3-6	15	c
<u>N. smithii</u>	? -380	8	2-3(6)	10-14	c, d
<u>N. spathulifera</u>	130-350	?	2-4	11-11.5	c, e

a = Boyer (1927)

b = Cleve (1878)

c = Cleve &amp; Grunow (1880)

d = Cleve-Euler (1952)

e = Peragallo &amp; Peragallo (1897-1908)

In the present investigation N. spathulifera, obtained from the marine intertidal at St. Martin's, Isles of Scilly, has been examined using the LM and SEM.

The valve of N. spathulifera is linear and has an eccentric raphe system (F.774, 777). The proximal mantle is high and of the same structure as the remainder of the valve (F.776-7). There is also a small distal mantle, but this is not well differentiated from the valve face (F.778-9).

Unfortunately it has not been possible to view the inside of the valve with the SEM. However, from observations of the outside and from LM observations it is clear that the valve construction is of type 1 (F.214, 774-80). Externally the costae do not project appreciably beyond the frets: there are no sterna, nor is there a marginal ridge. The poroids are large and round (approx. 0.5  $\mu\text{m}$ . in diameter) or somewhat elongated transapically (F.776, 778, 780). In each poroid, and lying very near its external aperture, is a siliceous occlusion (F.780), which is probably a hymen although TEM observations will be necessary to confirm this: in such large poroids one might expect cribra or other such structures to be present in addition to the hymen (see section 4.5.7.1). Certain transapical costae are depressed below the others (or are thinner?), so that the valve face has a corrugated appearance (F.775-9). There does not appear to be any regularity in the positioning of these costae: they are separated from each other by 2-5 striae.

The raphe is not interrupted centrally. The external fissure opens onto the crest of a very narrow ridge (F.214, 776, 780), which is much extended outwards near the poles so that the intact frustule is spathulate, as in N. spathulata (sect. Spathulatae) (F.214, 774, 779; compare F.247, 816). In N. spathulifera, however, there are no external flaps of silica (F.778), and a close link with the sect. Spathulatae is

unlikely. The light microscope reveals a thickening of the valve at the poles, which lies close to the valve margin and probably represents the helictoglossa (F.214). The external fissure is bent near the helictoglossa and then continues parallel to and close to the valve margin, ending on the distal side (in the specimens observed: in other valves a proximal curvature may exist) of the valve (F.775). The final portion of the terminal fissure is shallow and slightly expanded.

The transapical striae continue onto the walls of the subraphe canal, which is fairly well defined, but the poroids here are smaller than those of the valve face (F.778, 780).

The fibulae are extended across the valve to a lesser or greater degree (F.214): each represents a single subraphe costa. There are usually 3-6 striae between each pair of fibulae; the positions of the fibulae may be correlated with the inward folds of the valve face mentioned earlier and if so would constitute the first instance of such a phenomenon in the Nitzschiaceae. There is no sign of flange-like developments at the outer edges of the fibulae like those present in the sect. Grunowia (q.v.).

The first band seems to have but a single transverse row of poroids (F.214). Grunow's illustrations (in Van Heurck 1880-5, Pl.61 f.3) indicate, however, that each band bears several transverse rows of poroids: clearly further research is necessary.

The remainder of the taxa included within the Insignes seem to be very similar to the above. All are large forms (most with a minimum length of over 100  $\mu\text{m}$ .) with relatively robust, coarsely structured valves: none have more than 15 striae in 10  $\mu\text{m}$ . Some have sigmoid frustules, this being apparent only in girdle view (Peragallo & Peragallo 1897-1908, Pl.75, 76). In all the fibulae represent single subraphe costae and are extended considerably across the valve, although

never across the whole of the valve face. In none is there any sign of a 'central nodule' or other structure which would betray the presence of central raphe endings.

It would appear, therefore, that the sect. Insignes needs no division and that no species need be removed from it. The forms classified in the section are all very similar to one another (this being demonstrated very clearly in Peragallo & Peragallo's illustrations - 1897-1908, Pl.75 f.3-13) and it is impossible at present to suggest where species boundaries should be drawn.

It is interesting that both N. spathulata and N. spathulifera, which occur in the same types of habitat (e.g. marine intertidal sand flats) have spathulate frustules. These forms have little else in common, and perhaps this development of the raphe system facilitates life in a psammic environment, though it is hard to see how.

Addendum: Hustedt (1955) figured some forms which he referred to N. adriatica (his 'N. insignis var. adriatica'). These forms, however, possessed 15-17 striae in 10  $\mu\text{m}$ ., whereas Grunow's specimens had 11.5 in 10  $\mu\text{m}$ ., and they were asymmetrical about the apical plane (ibid., Pl.15 f.20), unlike N. adriatica sensu Grunow (in Van Heurck 1880-5, Pl.61 f.2; Peragallo & Peragallo 1897-1908, Pl.95 f.11, 12). In fact it is likely that Hustedt's 'N. insignis var. adriatica' is Hantzschia segmentalis (Brun 1895): specimens of this species from Barnstable, Mass., U.S.A., observed during the present investigation, had 19 striae in 10  $\mu\text{m}$ ., and had the same shape and fibula morphology as depicted by Hustedt (F.122-8). In further support of this suggestion it may be noted that on the distal side of the valve in Hustedt's specimens the poroids are somewhat irregularly and widely spaced, relative to their spacing on the proximal side of the valve: this feature is present in H. segmentalis (F.122, 125, 127; Brun 1895, Pl.17 f.109-10), but not in N. adriatica (Peragallo & Peragallo, op. cit.). The relationship

between H. segmentalis and Nitzschia sect. Insignes should, however, be given further consideration.

#### 4.6.6.7 The section Scalares

This is the smallest section of Nitzschia, including as it does only one, or possibly two, species. The Scalares grouping was first recognised in 1862 by Grunow, who included within it N. scalaris, N. gigantea, N. insignis, N. virgata and N. smithii. Of these, N. insignis and N. smithii were subsequently transferred to the sect. Insignes (by Grunow, in Cleve & Grunow 1880) and N. virgata to Hantzschia (Grunow 1877). 'N. gigantea', based apparently upon Synedra gigantea Ehrenberg, which Synedra is illegitimate since a different species had previously been given the same name by Lobarzewsky (teste Kützing 1844), is not mentioned again after Grunow's 1862 paper. Perhaps this will turn out to be a second species of the section, but it will in any case require renaming. So far as I am aware, no other species has ever been referred to this group except N. scaligera (Grunow 1880), and this was soon transferred elsewhere (to the sect. Insignes; see Cleve & Grunow 1880). The Scalares were not given any definite rank when first described by Grunow (1862), but were later assigned sectional status (Grunow 1880).

N. scalaris has not been observed during the course of this study, but many details of the frustule morphology can be gleaned from the illustrations of Grunow (in Van Heurck 1880-5, Pl.60 f.14, 15), Peragallo & Peragallo (1897-1908, Pl.75 f.1, 2), Hustedt (in A.Schmidt Atlas, T.333 f.1-3) and Van der Werff & Huls (1957- ).

The valve of N. scalaris is long and straight - Hustedt (1930) gave dimensions of 150-500 x 18-28  $\mu\text{m}$ ., with 3-5 fibulae and 9-11 striae in 10  $\mu\text{m}$ . A type 1 valve construction is present, the poroids being easily visible using the LM. There does not appear to be a