angled at the raphe (which is central) and the raphe is again interrupted centrally (Heiden & Kolbe 1928, T.7 f.146). In contrast to N. ocellata, the fibulae are arranged in a single row which runs at a constant distance from the raphe; in girdle view the fibulae appear as 'kurze Striche' (Cleve & Grunow 1880). The subraphe construction would seem, therefore, to be like that of, for example, N. bilobata.

There seems no good reason for classifying N. ocellata and N. amphiprora in the same group, except for their common possession of central raphe systems and very acutely angled valves. Neither of these characters, however, provides grounds for a satisfactory separation from the sect. Dubiae, and I consider that N. amphiprora would be better placed in that group. N. ocellata, however, with its curious subraphe structure and elongate poroids, seems to belong elsewhere, possibly in a section of its own, possibly in the sect. Perrya, or perhaps in a new genus.

4.6.6.5 The section Perrya

In 1874 Kitton described several new species of diatom from a dredging made off the Panama coast. Among these was one which 'somewhat resembles Nitzschia' but which Kitton considered to be sufficiently distinct from that genus to warrant the erection of a new genus, which he called Perrya. Since Kitton originally described only one species under Perrya, this species, P. pulcherrima, must be the type of the genus.

Four years later Cleve (1878) published the descriptions of two other species which he placed in Nitzschia, while noting, however, that these forms, N. weissflogii and N. grundleri, were close to Kitton's P. pulcherrima: the descriptions themselves were supplied by Grunow, and hence the citation should be 'Grunow in Cleve' or simply 'Grunow'

(see I.C.B.N. 1972, Rec.46D). Grunow (1880) demoted Perrya to the rank of a section of Nitzschia, where it has since remained, although in a note appended to Grunow's paper Kitton affirmed his continued belief in the distinctness of his genus. At the same time Grunow described another species, namely N. febigerii.

Three species, all of which are apparently referrable to this section, have been described from the Upper Eocene diatomite deposit at Oamaru, New Zealand. These are N. groveana (= N. antiqua of Grove & Sturt 1887: this name is illegitimate since it was preceded by Pantocsek's N. antiqua of 1886 - teste Mills 1933-5), N. grovei (= Grove & Sturt's Amphiprora rugosa - see Grunow 1888), and N. oamaruensis, which was described by Schrader (1969), who also provided illustrations of N. groveana and N. grovei.

In T.351 of the A.Schmidt 'Atlas der Diatomaceenkunde' (published 1924) Hustedt described two new species, N. amoena (f.5) and N. gladiformis (f.6, 7), which may be referred to the sect. Perrya: he also illustrated N. weissflogii (f.2, 3), N. grovei (f.8) and N. pulcherrima (T.350 f.1, 2). Hustedt also described, from Kitton's material, a diatom which he called 'N. Hustedti Debes' (after himself?), a species which was probably one of the 'two or three other species' mentioned as existing in Kitton's samples, but not described by him (see Kitton 1874). Later (1952) Hustedt described N. rectangulata, which he placed in the 'Untergattung' Perrya.

None of the species mentioned above are common, most being known only from a handful of tropical or subtropical sites (e.g. Colon, in Panama; Campeche Bay, Mexico), or from fossil deposits. As a consequence, no species of this group has been encountered during the present investigation and, as in the sect. Pseudoamphiprora, the discussion must centre around information derived from the literature. The dimensions, stria densities, etc. of the various Perrya species are given

Nitzschia sect. Perrya TABLE 15

SPECIES	Length µm.	Width* µm.	Fibulae* no. in 10 µm.	Costae no. in 10 µm.	'A'*	'B'*	Source of information
N. amoena	175	20	10-11	10-11	?0	M	g
N. febigerii	134	8	3-6	20-21	0	M	b d
N. gladiformis	140-154	15-16	13	25-26	0	M	g
N. groveana	400	18-20	7.5	?not present	0	?M	c h
N. grovei	60-165	11-13	2-3	18	+	S	g h
N. hustedti-debes	163	20	2-3	10-11	0	M	g
N. oamaruensis	176	23	8	8	+	M	h
N. pulcherrima	229-508	38	2-3	7-8	0	M	f g
N. rectangulata	50-55	5	6	20-24	+	?S	e
N. weissflogii	155-320	?	18	?not present	0	S/M	a g

* 'Width' = width in girdle view (i.e. depth of valve)
'Fibulae..'= no. of transapical rows of fibulae in 10 µm.
'A' = presence (+) or absence (0) of central raphe endings.
'B' = one (S) or many (M) levels of fibulae.

a = Cleve (1878)
b = Cleve & Grunow (1880)
c = Grove & Sturt (1887)
d = Grunow (1880)
e = Hustedt (1952)
f = Kitton (1874)
g = A.Schmidt Atlas (Hustedt)
h = Schrader (1969)

in Table 15.

Kitton (1874) gave as a description of his new genus 'free, elongated, frustules compressed, sometimes slightly constricted, extremities rounded, striae transverse moniliform' and remarked that 'this genus is distinguished from Nitzschia, its nearest ally, by the absence of a keel, and also by its very much compressed valve.' Grunow (in Cleve & Grunow 1880) gave further information: 'Schaalen hochgewölbt, mit scharfen fast centralem Kiel, in der Mitte nicht verengt. Die Kielpunkte bestehen meist aus kürzeren oder längeren Strichen, welche bei N. weissflogii bisweilen, bei N. pulcherrima immer vielfach unterbrochen sind, so dass sie bei letzterer Art Querreihen grober länglicher Punkte ähneln.' Neither description is adequate, however, if the species listed in Table 15 are all to be considered to belong in this section. Thus, for instance, N. amoena has an eccentric raphe system (A.Schmidt Atlas, T.351 f.5), while N. grovei has a distinct central nodule lying in a central constriction of the valve (op. cit., f.8; Schrader 1969, T.17 f.5). It is necessary, therefore, to review the range of variation present within this section, and hence to determine what characters, if any, are common to most or all of its members.

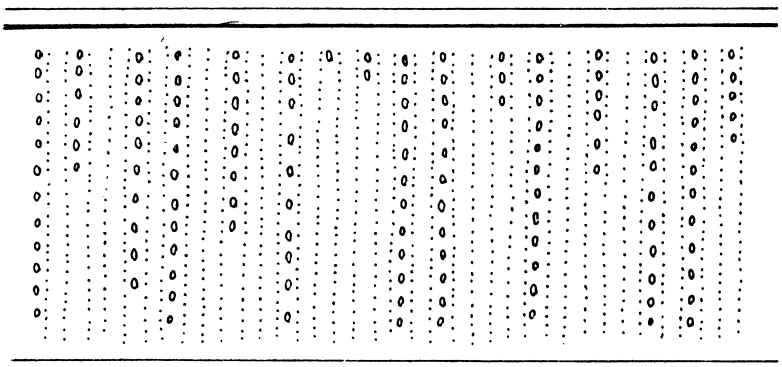
Considering first the overall shape of the valve and frustule, it is clear that all are united in possessing a very narrow, deep valve, and that as a consequence the valves or frustules always lie in girdle view, unless deliberately manipulated into other positions (see also Kitton 1874). The frustules of some species (N. pulcherrima, N. febigerii, N. groveana, N. gladiformis, N. hustedti-debes) are not constricted centrally (girdle view), whereas in other species they are, to a lesser (N. weissflogii) or greater extent (N. amoena, N. grovei, N. oamaruensis, N. rectangulata). The cincture, where it is known, is quite wide relative to the valve depth (e.g. in N. pulcherrima, N. grovei and N. rectangulata).

In most of the sect. Perrya the valve construction would seem to be like that characteristic of the majority of Nitzschia species (a type 1 construction). Hustedt's (1952) illustration of N. rectangulata, however, suggests that this species has a different valve structure, since Hustedt used a method of representation which he otherwise reserved for such genera as Epithemia or Rhopalodia, where the structure is unlike that in any species of the Nitzschiaceae investigated to date (see elsewhere). N. groveana and N. weissflogii, on the other hand, have scattered 'puncta' instead of orderly rows of poroids, but whether these 'puncta' are poroids, or optical artefacts (see Hustedt's 1930 comments on N. circumsuta), or solid structures, is not known. Even if they prove to be areolae of some type, however, it seems unlikely that they would be the only perforations through the valve, since so few as are illustrated by Cleve (1878, T.4 f.23a, b) or by Hustedt (in A.Schmidt Atlas, T.351 f.2, 3) would surely be insufficient to allow the necessary fluxes of nutrients and metabolites into and out of the cell.

With regard to the raphe system, there is a division between species which possess central raphe endings (N. grovei, N. oamaruensis, N. rectangulata) and those which do not. In the absence of electron microscopic observations the course of the raphe at the poles and centre is unknown: the helictoglossae appear, however, to be placed very close to the valve margin (A.Schmidt Atlas, T.350 f.1, 2, T.351 f.3). In most taxa the raphe is bordered by flanges of silica as in N. spathulifera (see Nitzschia sect. Insignes): indeed, in N. febigerii there is even a 'spathulate' development of the flanges at the poles.

Within the section there is variation in the fibula morphology and arrangement. In most species the fibulae are arranged as in N. ocellata (sect. Pseudoamphiprora), i.e. the fibulae are borne at several levels, at various distances from the raphe. One transapical

costa may thus bear several fibulae (see also Amphiprora, Chapter 6). In N. pulcherrima, where this phenomenon is exhibited at its most extreme, a single transapical costa may bear 10 or more fibulae, although many bear only 2-3 (A.Schmidt Atlas, T.350 f.1, 2).



N. pulcherrima (redrawn after Hustedt, in A.Schmidt Atlas) - part of valve, in girdle view (raphe at top).

In N. amoena, N. febigerii and N. gladiformis the maximum development of fibula 'levels' occurs near the ends of the valves. Thus, in N. amoena (ibid., T.351 f.5) centrally there is only one level of fibulae, whereas near the poles there may be three or four: in N. gladiformis (ibid., f.6, 7) and N. febigerii (Grunow 1880, Pl.13 f.15) there are two levels centrally and three near the poles. N. oamaruensis is similar.

In N. weissflogii vars. subglabra and sparsa, but not in var. interrupta, all the fibulae are at approximately the same distance from the raphe, but there is a differentiation of fibulae into short and long types, the latter being less frequent and separated from each other by one to five shorter fibulae (Cleve 1878, T.4 f.22, 23a). Var. interrupta (ibid., f.23b) has fibulae at several levels like N. pulcherrima etc., although its appearance is otherwise very similar to that of the other varieties of N. weissflogii. N. grovei has simple fibulae, each of which appears to represent a single subraphe costa: they are borne at one level only.

In N. rectangulata one row of fibulae lies immediately adjacent to the subraphe canal, but there is another row of 'puncta', lying near the valve margin (Hustedt 1952, f.21), which may represent a second row of fibulae: proof of this awaits SEM examination.

The remaining species, N. groveana, has not been illustrated sufficiently well to enable discussion of its subraphe structure.

The cinctures of N. grovei and N. rectangulata have been figured by Hustedt (in A.Schmidt Atlas, T.351 f.8 and 1952, f.21 respectively) and show that the girdle structure is not constant within the section. In N. grovei there are many transverse rows of poroids per band, whereas in the other only the first band is porose, this bearing a single transverse row of poroids.

Thus, it appears that the sect. Perrya, as this is presently understood, contains a diversity of forms: it is not easy to find characters which are ± constant throughout, and there seems to be no reason why, for instance, N. grovei and N. pulcherrima should be classified together, unless the shape of the valve in transapical section is taken to be of overriding importance. Within Perrya, however, there appears to be one natural grouping, including N. amoena, N. febigerii, N. gladiformis, N. hustedti-debes and N. pulcherrima. In these the valve shape is similar, central raphe endings are absent, and fibulae occur at several levels beneath the raphe. N. weissflogii may also belong here.

N. oamaruensis seems similar to N. ocellata, a species at present classified in the sect. Pseudoamphiprora. N. groveana and N. rectangulata require further study urgently, while N. grovei, with its simple fibula arrangement, appears to be a fairly 'normal' Nitzschia, belonging perhaps to the sect. Dubiae.

The first group (which, since it contains N. pulcherrima, is by definition typical of the sect. Perrya) is of interest because of the

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.