4.6.3 Raphe and associated structures

In Nitzschia the raphe is usually to some extent eccentric, but in a few taxa it is virtually central. The degree of eccentricity of the raphe, together with valve shape and fibula morphology, has traditionally been one of the characters used in the division of the genus into sections. Thus, for example, Hustedt (1930) used the eccentricity of the raphe to separate the Tryblionellae/Dubiae/Lanceolatae from the Bilobatae/Dissipatae/Lineares in his key to the sections.

The raphe system maintains a constant position on the valve throughout its length, except at the centres of the valves of N. obtusa and its allies, where it is deflected towards the distal margin (F.289, 293-4, 297). Nowhere is there the biarcuate disposition found in Hantzschia virgata var. intermedia, H. marina and H. distinctepunctata. When the valves or frustules of certain Nitzschia species, e.g. N. dubia or N. bilobata, are observed in girdle view, the raphe system appears to be biarcuate (F.184, 190, 194, etc.), but while this is true in one sense, yet it is not so in the sense in which this term is applied in Hantzschia. The two raphe-slits of N. dubia lie in the same plane, a fact which is demonstrable in suitably tilted valves, whereas those of H. virgata var. intermedia do not (Mann 1977).

As in Hantzschia, the raphe may be interrupted centrally, or may be continuous from pole to pole. Even in those species where central endings occur these may be very difficult to observe, even with the SEM; this is the case in, for example, N. linearis, where the interraphe distance is tiny and the endings are partly obscured by the ridges which run parallel to, and close to, the external raphe fissure in this species (F.898). Nevertheless, the presence of central raphe endings can almost always be established using the light microscope, even though the raphe itself may be unresolvable, by the detection of a small thickening of the silica centrally: this appears as a slightly darker area of the subraphe-canal wall (bright field optics),

but is quite easy to miss in the smaller Nitzschiae (F.153, 171-4, 194, 202, 269, 305, 319, 355, 358, 367, 379, etc.).

The raphe-slit is 'kinked' in cross section, as in Hantzschia (unpubl. obs.). In N. sigmoidea the kink comes at the inner end of a slit, which is very deep because of the presence on either side of flanges which extend out from the canal wall (F.838).

4.6.3.1 Internal polar raphe endings

Within Nitzschia there is a monotonous sameness in the morphology of the internal polar raphe endings. In every case the internal fissure ends in a helictoglossa; this is placed near the valve margin, but sufficiently far away from it that, in vivo, the pars interior of the first band would not obscure the helictoglossa (F.711, 730, 738, 761-2, 768, 773 etc.). In some species, e.g. N. sinuata, the internal polar endings are difficult to observe because of the valve morphology; nevertheless, here too a helictoglossa is present (F.792).

4.6.3.2 External polar raphe endings

The external fissure is, in most cases, bent ± abruptly above the helictoglossa (e.g. F.706, 786, 801; Text F.4A) and then continues as a blind groove, usually curving to one side or the other. This terminal fissure is unbranched and, as in Hantzschia, its final portion is shallow and somewhat expanded (e.g. F.706), except in a few species where it reaches to the valve margin. In Nitzschia the direction of curvature of the terminal fissure does not appear to be constant within species. For example, in N. sinuata some valves have terminal fissures which curve towards the distal margin (F.785-6), while in others they curve towards the proximal margin (F.787-8). The two polar endings of a single valve, however, are always similar (e.g. F.785-6). This phenomenon has been observed in several other taxa, e.g. N. hantzschiana N. communis, N. mollis, etc.

4.6.3.3 External central raphe endings

In most cases the external central raphe endings are coaxial, but not in the N. obtusa group (F.865), nor in N. debilis (F.727): in virtually all they are symmetrical (Text F.4B). The endings of N. obtusa and its allies are very characteristic; each external fissure is sharply bent above the internal raphe endings and continues as a blind groove - a 'central fissure' comparable with the terminal fissure (F.865). The two central fissures continue towards the distal margin, extending beyond the limits of the subraphe canal. They converge slightly, and each is shallow and expanded terminally. Where the fissures extend onto the valve face the normal pattern of transapical costae and frets is interrupted. This was noted by Cholnoky (1963a, f.104) in N. vidovichii (and see F.292, 296, 298). N. debilis is similar in layout, but the external fissures remain in the wall of the subraphe canal.

4.6.3.4 Internal central raphe endings

These also are usually coaxial-symmetrical (Text F.4B), though in the N. obtusa group, because of the deflection of the raphe system, they are not quite coaxial (F.863, 871). Most often the central endings together form a structure which resembles a double helictoglossa (e.g. F.770, 852, 870, 956, etc.). This structure can be no more than a feeble inward thickening of the canal wall, but it may be so strongly developed that it forms a prominent beak projecting into the cell. It is this thickening which betrays to the light microscopists that central raphe endings are present (see above).

4.6.3.5 Fibulae and subraphe canal

The fibulae exhibit a great variety of form, surpassing that present in Hantzschia. The following categories may be recognised:

a. Fibulae not extended across the whole width of the valve.

i. Each fibula represents a single subraphe costa. Portulae, if

present, not as in iv. below (e.g. F.894).

ii. Each fibula represents several fused subraphe costae. No poroids present in the fibulae (e.g. F.866, 899, 906, 910).

iii. Fibulae as in ii., except that poroids are present within each fibula, in rows between the adjacent subraphe costae, which are, therefore, only partially fused. The poroids connect the valve interior with the subraphe canal (F.721, 730).

iv. Each fibula represents a single subraphe costa, as in i., but the outer edge of each fibula is expanded bilaterally into flanges which extend towards the adjacent fibulae; these flanges thus delimit small oval portulae at the entrance to the subraphe canal (e.g. F.791).

v. Several fibulae borne on each transapical costa (as in sect. Perrya, q.v.).

vi. Fibulae are long, thin flat sheets of silica, separated by smallish, oval or circular interspaces/portulae, and apparently not representing fused subraphe costae (F.963).

vii. Relationship between fibulae and subraphe costae obscure but fibula morphology not as in vi. above (F.831, 956-7), or transapical costae, as such, not present (as in the sect. Panduriformes).

b. Some or all of the fibulae extended across the whole width of the valve.

viii. Each fibula represents one or several subraphe costae; fibulae not as in ix. below. Some 'interspaces' blocked by flanges of silica extending from fibula to fibula. Portulae very irregular in shape (F.342, 807, 959).

ix. Fibulae each represent single subrapne costae. Outer edges of

fibulae expanded into flanges as in iv., delimiting circular or oval portulae (F.985).

Some of these groups are narrowly circumscribed, e.g. iv., vi., while others, especially ii. and vii., contain a great variety of fibula morphologies; within the latter groups it should be possible, after further study, to distinguish further categories. The details of fibula construction in various species will be given later, in the taxonomic section.

Proximal and/or distal ridges (Text F.5A) may be present joining the fibula bases. The subraphe canal wall, where a canal may be distinguished, is usually perforate, but it is entire in members of the sections Fragilariopsis and Pseudonitzschia (F.971-3), and in some of the sect. Lanceolatae (see Hasle 1964, 1965a, b), and of the sect. Tryblionella.

4.6.4 Cincture

As in Hantzschia, few generalizations may be made about the structure of the cincture. In many species the girdle bands are very thin and delicate; thus, the SEM is of limited use because of its relatively poor resolution and because specimen penetration becomes limiting, while little information can be gained from TEM studies because of the opacity of silica to electrons. Carbon replica studies may prove to be helpful, but are unlikely to aid the determination of whether a particular band is open or closed; this is because, except where the cincture of a diatom is known in great detail, such determinations must be made on complete frustules, and it is just where carbon replicas rarely yield much useful information, at the poles of the frustule (see Dawson 1972), that the open ends of bands usually occur.

So far only open bands have been observed, but very few species