4.2 Epiphytes and parasites of the Nitzschiaceae

4.2.1 Epiphytes

Living diatoms, especially slow-moving or non-motile or moribund cells, are frequently covered with bacteria. The salt-marsh diatoms Surirella gemma and Amphiprora alata often bear numerous filaments of bacteria, particularly near the raphe and on the girdle, and bacteria are also to be seen on species of the Nitzschiaceae: indeed, it is often difficult to eliminate them during attempts to establish axenic cultures (unpubl. obs.).

Apart from bacteria, few organisms are found as epiphytes of the Nitzschiaceae (except in the case of tube-dwelling forms), the only two species which are at all common being the diatoms Synedra parasitica and Amphora ovalis var. pediculus.

S. parasitica is a small diatom, 10-25 µm. long and 3-5 µm. wide (Hustedt 1930), in which Hustedt (1927-66) recognised two varieties, var. parasitica and var. subconstricta. He noted (1930) that this species occurs 'besonders auf grossen Arten der Gattungen Surirella und Nitzschia', and in the present study both varieties have been found as epiphytes of Nitzschia: var. parasitica was found on N. sigmoidea from a ditch at Shiplate, Co. Avon (F.334), and var. subconstricta on the same species, but from the Gloucester & Sharpness Canal at Framilode (F.320, 335). The Synedra cells may occur singly (F.320, 335), or in short chains of two or three cells (F.334), or several may radiate from a common point of adhesion to the host, which remains fully motile.

Amphora ovalis var. pediculus has been known to be an epiphyte of other diatoms for well over a hundred years. Kützing (1844) figured it (his 'Cymbella? pediculus': op. cit., T.6 f.7) growing epiphytically upon a sigmoid diatom, almost certainly N. sigmoidea. Later,

W.Smith (1853) stated that he had found it near Lewes 'parasitic on Nitzschia sigmoidea' and that Shadbolt had found it 'in ponds near London, parasitic on Nitzschia linearis.' A. ovalis var. pediculus is a small diatom (Hustedt 1930 gives a minimum size of 4 x 4 µm.), and occurs 'häufig an grossen Diatomeen (Nitzschia, Surirella) und anderen Pflanzen' (ibid.). I have found it on N. sigmoidea, from the Framilode site and from the River Axe at Bleadon (F.321, 333-5), and on N. tryblionella, from Framilode (F.166). The specimens observed were 10-15 µm. long and 8-12 µm. wide.

The numbers of epiphytic Amphorae and Synedrae, per cell of N. sigmoidea, are very variable. Many N. sigmoidea cells bear no epiphytes, but one cell from Framilode bore so many Amphorae that a large proportion of its surface area was covered (19 Amphora cells on one half of the cell alone: F.333). Such laden cells are still capable of movement since the epiphytes do not obscure the raphe. No evidence has been found that the epiphytes are detrimental to their hosts - A. ovalis var. pediculus and S. parasitica both have well-developed chromatopnores and appear to be fully photosynthetic - although they must diminish the total light energy reaching the Nitzschia plastids: the host cells possess chromatophores of normal appearance.

The two epiphytic species may occur together on the same Nitzschia cell (F.335), and it is questionable whether either exhibit any degree of host specificity beyond the need for a freshwater diatom of suitable size, snape and structure to allow attachment, which means that most Nitzschiaceae are unsuitable, except N. sigmoidea, N. tryblionella, N. linearis, N. vermicularis, Hantzschia spectabilis and perhaps a few others. As has already been noted, A. ovalis var. pediculus is reported as occurring on plants other than diatoms, although detailed study will be necessary to ensure that these forms are identical to those found on diatoms.

The tubes of tube-dwelling diatoms often bear epiphytes, espec-

ially diatoms of the genera Synedra, Licmophora, Grammatophora, Rhoicosphenia, etc. (Cox 1975c).

There is little information on any other epiphytic organisms. Cupp (1943) noted epiphytic protozoa (?Bicoeca mediterranea) growing on Nitzschia pacifica, but I am not aware of any other such reports.

4.2.2 Parasites

Various chytrids and Oomycetes are known to parasitize diatoms, (for list, see Sparrow 1960), but within the Nitzschiaceae published information is scanty. Only four or five taxa - Hantzschia amphioxys, N. linearis, N. sigmoidea and ?two unidentified Nitzschia species - are known to be parasitized. The fungi involved in these associations belong to three orders, the Chytridiales (Chytridiomycetes), the Lagenidiales or the Saprolegniales (Oomycetes: classification according to Webster 1970).

H. amphioxys is known to be parasitized by two chytrids, Olpidium hantzschiae Skvortzow and Phlyctidium irregulare de Wildeman (Sparrow 1960). Skvortzow (1925) found the first growing on H. amphioxys from damp earth: it has not been found on any other host. P. irregulare was found on H. amphioxys by Scherffel (1925b: his 'Rhizophydium irregulare (de Wildeman) Fischer'), but it occurs also on other diatoms, e.g. Gomphonema constrictum (Friedmann 1952).

Scherffel (1925a) described a new species of Lagenidium (Lagenidiales), L. brachystomum, which he found parasitizing Synedra ulna, Cymbella cymbiformis, G. constrictum and N. linearis: this constitutes the only record of parasitism in this species of Nitzschia.

Two unidentified Nitzschia spp. have been recorded as being parasitized, by Olpidiopsis gillii (de Wildeman) Friedmann (Lagenidiales) and Podochytrium emmanuelense (Sparrow) Sparrow & Paterson (Chytridiales), respectively (Sparrow 1960). In neither case is the fungus restricted to Nitzschia.

Most of the available information on fungal parasitism in the Nitzschiaceae, just as with epiphytism, concerns N. sigmoidea, probably because of the size and abundance of this species. Six fungal species, drawn from all three orders mentioned, are found in association with it, although in only one case is the parasite restricted to this diatom.

Two of these species are the chytrids Chytridium versatile Scherffel and Rhizophydium clinopus Scherffel. The first, described initially from Cymatopleura (Scherffel 1926), was found on N. sigmoidea by Canter (1947), who considered that her var. acaulis was restricted to this diatom. Later, however, it was suggested that this variety should be reunited with the type, since the diagnostic feature (presence or absence of a stalk to the sporangium) proved inconstant (see Sparrow 1960). Canter (1947) noted that 'the contents of the infested cells are little affected; the chromatophore retracts somewhat at the point of entry of the rhizoids but the movement of the host is not impaired', even though a cell may bear up to thirty individuals of the parasite. Canter's Pl.10, f.8, shows the retraction mentioned above, but in addition it is noticeable that the chromatophores are also considerably more contracted centrally than is usual - compare the upper, infected daughter-cell with the lower, uninfected one - leaving the nucleus clearly visible.

Aphanomycopsis bacillariacearum Scherffel and Aphanomycopsis sp. (Saprolegniales) were found on N. sigmoidea by Scherffel (1925a) and Friedmann (1952), respectively. The first is known also from Pinnularia, Epithemia and Cymbella (Sparrow 1960), while the second appears to be restricted to N. sigmoidea (Friedmann 1952). Ectrogella bacillariacearum Zopf, also of the Saprolegniales, was found 'in great abundance in Nitzschia sigmoidea .... at Beaufort, North Carolina' by Karling (1942): it also occurs in Synedra, Gomphonema, Pinnularia

and Meridion (Sparrow 1960).

Finally, Olpidiopsis gillii has been reported from N. sigmoidea as well as from Nitzschia sp., by de Wildeman (see Sparrow 1960).

It does not seem likely that the list given above will prove exhaustive. The species of Nitzschia and Hantzschia in which parasites have been observed are relatively large forms, not easily overlooked during light microscope observation of living diatom populations. The absence of parasitism in the vast majority of the Nitzschiaceae is almost certainly apparent, not real, and probably results in large part from the normal methods employed by diatomists, who rarely study samples intensively before acid-cleaning destroys all trace of organisms without silicified parts. Certain collecting techniques (e.g. the Eaton & Moss 1966 method for the separation and estimation of the epipelon) select for motility, which may in consequence prevent observation of parasitized cells (although N. sigmoidea does not seem much affected by Chytridium versatile, as noted above): this may be the reason why chytrids etc. have only rarely been observed in the present study.