THE EFFECTS OF SALINITY, LIGHT AND TEMPERATURE ON GYROSIGMA SPP

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THE EFFECTS OF SALINITY, LIGHT AND TEMPERATURE ON *GYROSIGMA* SPP.

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INTRODUCTION

Salt marshes are subject to periodic flooding by the sea and as such the dominant feature in any salt marsh is the fluctuating salinity and temperature regime. The diatoms in the marsh are submerged by the tide, but on retreat of the tide they are exposed to increasing salinity due to evaporation from the surface of the pans, or to decreasing salinity due to freshwater inputs from rainwater and land run-off. Diatoms are also exposed to wide thermal fluctuations as the temperature in shallow pans and on exposed sediments may rise by several degrees centigrade on a warm day.

An investigation into the ecological tolerances and morphological variability of salt marsh *Gyrosigma*ataceae, was initiated. The taxonomy of the *Gyrosigma* and *Pleurosigma* is in a state of flux with the specific limits of the genera being in dispute and the stability of the various diagnostic features of the valve being disputed (Stidolph 1988, Cardinal 1989, Sterrenburg 1990). Culturing taxa under different salinities, temperature and light regimes allows growth rates and valve morphology to be monitored under known controlled conditions. An understanding of the plasticity and/or stability of morphological features of the cells is essential to good taxonomy. This has already been illustrated by Syvertsen's (1979) study which showed that *Thalassiosira gravida* Cleve and *T. rotula* Meunier were temperature-specific expressions of the same species. Culture work also permits the determination of size-dependent shape variation, using different-sized cells of the same species (Cox 1983).

MATERIALS & METHODS

All samples were taken from two salt marshes on the Isle of Sheppey, Kent (Diagram 1). The marshes are situated on the south bank of the mouth of the River Thames and both are south facing. The two experimental marshes vary quite markedly in their topographic features. Marsh A is a very young salt marsh system with shallow pans and not very notable channels. The marsh is composed of a very soft fine sediment from station 3 to 8. Marsh B is a much firmer under foot and resembles station 1 of marsh A in its topographic features in that throughout the marsh it consists of well formed pans and deep channels. Samples from exposed and submerged stations (Table I) were collected by pressing a plastic drain pipe (3 cm in diameter), 1 cm
into the marsh sediment. If water depth was too great to permit this, samples were taken by drawing a plastic tube across the surface of the sediment so that a mixture of sediment and water from the same surface area as that collected from the core (Round 1953) was obtained. Three replicates were taken at each site. Temperature, salinity, pH and mv were measured at each site using a Jenway 3070 pH meter.

Table I. - Position of the stations in the two sites and specific descriptions with respect to physical and chemical environment.

<table>
<thead>
<tr>
<th>Station</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Top of marsh. Large salt pan</td>
</tr>
<tr>
<td>2</td>
<td>Interface between salt marsh proper and upper marsh.</td>
</tr>
<tr>
<td>3</td>
<td>Middle marsh pan.</td>
</tr>
<tr>
<td>4</td>
<td>Middle marsh surface mud from within vegetation.</td>
</tr>
<tr>
<td>5</td>
<td>Bottom of marsh, pan.</td>
</tr>
<tr>
<td>6</td>
<td>Bottom of marsh, channel at interface of mud flats and salt marsh</td>
</tr>
<tr>
<td>7</td>
<td>Channel in mud flat.</td>
</tr>
<tr>
<td>8</td>
<td>Surface mud, low tide.</td>
</tr>
</tbody>
</table>

Marsh B: Harty Ferry Inn TR015665

<table>
<thead>
<tr>
<th>Station</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Top of marsh, large pan.</td>
</tr>
<tr>
<td>10</td>
<td>Middle of marsh, deep channel.</td>
</tr>
<tr>
<td>11</td>
<td>Middle of marsh, small pan.</td>
</tr>
<tr>
<td>12</td>
<td>Bottom of marsh, small pan.</td>
</tr>
<tr>
<td>13</td>
<td>Bottom of marsh, deep channel.</td>
</tr>
<tr>
<td>14</td>
<td>Interface of mud flats and salt marsh.</td>
</tr>
<tr>
<td>15</td>
<td>Surface mud, low tide.</td>
</tr>
</tbody>
</table>

A small proportion of the sediment was weighed fresh and then dried in an oven overnight and reweighed to obtain the water content of the site.

The sediment samples were placed in Petri dishes and the living diatoms separated from the sediments using the lens tissue technique (Eaton & Moss 1966), fixed in Lugol's iodine, to count "live" cells. Only cells with well preserved chloroplasts were counted. These were presumed to represent the actively growing population at the moment of sampling.

Rough cultures were established in Petri dishes in GeZS media (Reid & Cox submitted). Unialgal cultures of *Gyrosigma* were established from the rough cultures using a fine capillary tube. The cultures were subjected to different salinities and light/temperature regimes (i.e. multifactorial design: salinity x light x temperature. Salinity 0, 7, 14, 21, 28, 35, 42 ppt.; Temperature 5-25°C; light intensity 8-45 μEm^{-2}sec^{-1}).

**RESULTS**

**Field Results**

The temperature profiles over the two marsh systems show seasonal variation (Fig. 1). Temperature variation along marsh system A shows the widest fluctuation in temperature, whereas the fluctuation along marsh B is relatively small.

The salinity profile for the two marshes does not show such a clear seasonality (Fig. 1). There is wider fluctuation in salinity along the marsh A profile. At both marshes the greatest fluctuation occurs in the middle of the marsh, stations 2-4 and 10-12. Water content is a significantly variable factor with wide fluctuation occurring between the replicates at each station and throughout the marshes (Fig. 1).

There is a significant difference in species composition between and within the stations along the marshes (F > 0.05). *Gyrosigma fasciola* has maximum cell densities at salinities of 22 parts per thousand and 10°C. It is mainly restricted to the winter months although it does occur in low numbers throughout the year, distribution range: middle to bottom of marsh, both systems.

*Gyrosigma spenceri* has maximum cell densities at 32 ppt showing a normal distribution within the salinity range 20-56 ppt. It occurs throughout the year with maximum numbers in the middle of the marsh (marsh A, station 4).

*Gyrosigma balticum* occurs mainly during the summer period with temperatures of 20°C and salinity 32 ppt, restricted mainly to the bottom of the marsh (marsh A, station 7).

*Gyrosigma litorale* occurs all the year round and is restricted to the middle/bottom of marsh zone, occurring in maximum numbers at station 13, 1.12.1993, 30 ppt and 6°C.

**Culture work on *G. fasciola***

*Gyrosigma fasciola* has died at salinities above 35 ppt; its maximum growth occurred at 21 ppt (Fig. 2). At lower salinities slight distortion in valve outline was observed.

**DISCUSSION**

The distribution of the edaphic diatoms is very sporadic, showing both inter-and intra-site variation in species composition and density. *G. balticum* shows an interesting seasonal pattern; it persists as isolated individuals throughout the year (Carter 1932), but with a maximum under parti-
Fig. 1. Graph showing variation in temperatures, salinity and water content between sites in the two salt marsh systems on different occasions; A – C marsh A; D – F marsh B.

cular conditions: salinity 32-36 ppt., 17-22°C, and water content 35-38%. The combination of factors is critical: blooms are possible when all these conditions are satisfied.

G. fasciola shows a marked seasonality which agrees well with Round 1960 and Carter 1932, occurring in the winter months. However it is quite an abundant species, occurring from the middle of the marsh to the mud flats. This is a wider distribution range than that reported by Round and Carter. The combination of environmental conditions is again the key to the distribution of G. fasciola; salinity 22 ppt, 8°C and a water content of 34-35%. This agrees well with culture experiments where optimum growth was achieved at 21 ppt. and 10°C. Variation in the shape of the valve under culture will be dealt with in another paper.

The distribution of G. spencerii contrasts with that found by Round (1960) and Carter (1932). Although it occurs throughout the marsh maximum numbers are found in the middle of the marsh. Again this can be related to the interaction of environmental conditions. Further work is needed here to elucidate the key components. Water content shows most significant inter- and intra-station fluctuation and may be a key feature affecting the uneven distribution of the diatoms.

In the past salinity has been regarded as a key influence on the distribution of edaphic diatoms (Kolbe 1927). Culture experiments using a wide range of salinities have shown that species can grow over a wider salinity range than observed in nature (pers. obs. and Cox 1994). The interaction of several environmental factors is the key to understanding the spatial distribution of edaphic diatoms.

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REFERENCES


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