Floristic Changes in the River Tees

by

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The River Tees was the subject of a very thorough survey made by the Water Pollution Research Board during 1929—33. This is still the most detailed account of a British River for certain features, in particular the description of the algal flora. A number of changes in the factors affecting the river have been made in recent years, and further important ones are planned for the future. The present authors undertook a survey in 1963—65 in order to provide an interim account of the condition of the river. The present paper summarizes the floristic changes which have occurred in the non-tidal reaches since 1933.

The 1929—33 survey dealt with the whole river and also part of the main tributary, the River Skerne. The most comprehensive account of the chemistry and biology of the non-tidal reaches is given by BUTCHER in BUTCHER, LONGWELL & PENTELOW (1937). Parts of the botanical work were published also as separate papers by BUTCHER (1932, 1933). The R. Tees above the entry of the R. Skerne is relatively unpolluted, so the detailed part of the present survey was not extended in the R. Tees far upstream of the entry of the R. Skerne.

DESCRIPTION OF THE AREA

A full description of the geological, physical and most important chemical factors influencing the Rivers Tees and Skerne is given in BUTCHER, LONGWELL & PENTELOW (1937). The most important features of these rivers may be summarized as follows. The R. Tees throughout the whole reach is very fast flowing and subject to rapid rises and falls in level. At any season of the year it may be subject to very severe flooding. The water above the entry of the R. Skerne is

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only moderately hard, and is frequently coloured brown due to materials derived from upland drainage areas. The R. Skerne on the other hand has only a moderate rate of flow, is subject to rapid changes in level only infrequently, and is not coloured brown. The water of the R. Skerne is very hard, as the river both drains the magnesian Limestone in the centre of Country Durham, and also is extremely polluted by the time it reaches the R. Tees. One major source of pollution, the outflow from Darlington sewage works, enters the R. Skerne only 250 metres before its entry to the R. Tees. Further information on the hydrology and chemistry of these rivers may be found in the annual reports of the Wear and Tees River Board, 1951—65, and in the Wear and Tees Hydrological Survey (1961).

In spite of the volume of data collected in 1929—33, it is only possible to state in general terms what physical and chemical changes have taken place in these rivers since then. There has in recent years been a decrease in suspended matter transported by R. Skerne due to reduction in coal washings. At the same time there has been an increase in nutrients resulting from organic pollution transported by the R. Skerne into the R. Tees. However the rate of recovery of the R. Tees from this pollution source is now much greater. The nitrate – N levels in the polluted reach of the R. Tees have apparently more than doubled between 1931 and 1964, with average values having risen from about 1 mg/l NO_3 – N to about 2.5 mg/l NO_3 – N. Very few phosphate determinations were made in 1929—33, but, judging from these few, it seems likely that there has been a relatively greater increase in phosphate than nitrate. During the present survey concentrations of PO_4 – P from 0.006 – 0.052 mg/l were found in the R. Tees above the entry of the R. Skerne, and from 0.023—0.540 mg/l at sites below its entry. No silicate determinations were made in 1929—33. In the present survey values from 0.06—7.2 mg/l were recorded above the entry of R. Skerne, and from 0.4—10.8 mg/l at sites below its entry.

Methods

Monthly records were made of the main features of the vegetation at each of 9 sites between January 1964 and October 1965 (Fig. 1). These sites include all those dealt with by Butcher, Longwell & Pentelow. In addition less detailed records were made from these and other sites at intervals between October 1963 and September 1966.

Samples of diatoms representative of various substrata and the parkton were collected from sites 1, 3, 4, 6, 7, 9 (Fig. 1) for all

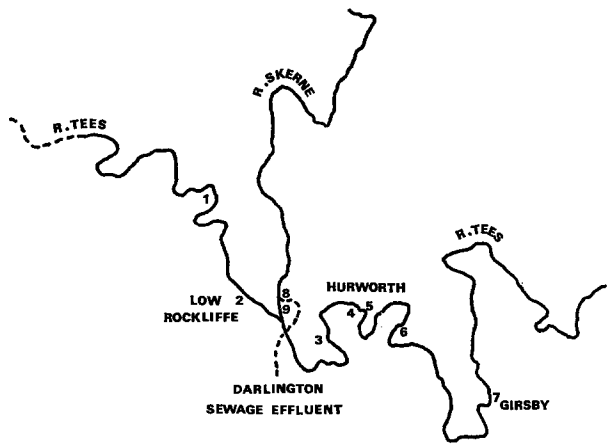

Fig. 1. Map of the reaches of the Rivers Tees and Skerne covered by the present survey. Sampling stations are: – 1. Blackwell Bridge. 2. Croft, above Skerne inflow. 3. Low Rockliffe. 4. Hurworth mainstream. 5. Hurworth sidestream. 6. Neasham. 7. Girsby. 8. Skerne above Darlington sewage inflow. 9. Skerne below sewage inflow.

months between January 1964 and July 1965, with the exception of February 1965 when the river was in such flood that no rocks could be reached. Permanent preparations were made of the cleared frustules, and the species composition of 200 cells determined from each site for each month.

Results

Angiosperms

There has been no change in the specific composition of angiosperms since 1933. The data of Butcher in Butcher, Longwell & Pentelow indicates the probability that *Elodea canadensis* was formerly more abundant in the river, but otherwise it is not adequate for quantitative comparisons of any of the species. Local information suggested the possibility that *Ranunculus fluitans* may have increased in amount since about 1962 at one site (Low Rockliffe) and that 1964 was the first year at which it had flowered at that site.

Bryophyta

There have been no losses since 1933, and several species were recorded for the first time, though these would seem likely to have been merely ignored by Butcher. *Fissidens* spp. were relatively common in summer when the river was in low flow.

Charophyta

Nitella opaca, which was recorded by BUTCHER as 'rare' at one site only (Low Middleton Ford) has now almost certainly disappeared.

Chlorophyta

All the Chlorophyta found by BUTCHER were re-found, and occurred in approximately similar amounts to those found by him. There were several minor additions to his list (*e.g. Closterium peracerosum*), and one important addition, *Enteromorpha intestinalis*. BUTCHER has recently confirmed to one of the authors his view that this species was not present in non-brackish reaches during his investigation. Yet, in the late summers of 1964—66, *Enteromorpha* was frequent or abundant in the lower reaches of the R. Skerne, and occasional plants were also present in the R. Tees. In the R. Tees it occurred only in slow-flowing reaches away from the main current, but in the R. Skerne it grew abundantly in the main stream. Here the lower parts of the tubes are entangled in dense growths of *Potamogeton pectinatus*, whilst the upper parts float along the surface of the river.

BUTCHER reported that one of the most noticeable phenomena of the R. Tees is the annual development below Croft of enormous quantities of *Cladophora glomerata*. Large growths were again found in May—June in 1964—66, but apparently in much less amount than that reported by the River Board for summer 1959. During this hot summer the river sank very low, and some aspect of the massive growth of *Cladophora* apparently resulted in a large fish mortality.

Myxophyta, Rhodophyta, Euglenophyta, Xanthophyta, Chrysophyta

Again, all the species recorded by BUTCHER were re-found in approximately similar amounts to those recorded by him. Further species of Myxophyta and Euglenophyta were recorded, but these are of little significance, as BUTCHER'S list must have been incomplete for these organisms. *Rhodochorton violaceum*, which was not on BUTCHER'S list, was relatively frequent on *Eurynchium riparioides* during late summer and autumn in 1964 and 1965. This species was described in detail after BUTCHER'S work (DREW, 1935), so presumably this was overlooked as a chantrantsia stage of *Lemanea*.

Cryptophyta

A surprising omission from BUTCHER'S list is that of Cryptophyta, as small (c. 10μ long) cryptomonads, usually bluish in colour, were frequent in squeezings from some angiosperms in late summer.

Bacillariophyta

A detailed list of diatom species found in 1964—65 is compared

TABLE 1

Comparison of diatoms recorded from the Rivers Tees and Skerne in 1964–1965 with those in 1929–1933.

	1929–1933	1965–1965	Species not recorded in 64–65: Only found outside survey region	Species not recorded in 64–65: Recorded as rare in 29–33	Species not recorded in 64–65: Possible taxonomic difficulty	Species not recorded in 64–65: Possible loss	Species not recorded in 29–33: Recorded as rare in 64–65	Species not recorded in 29–33: Possible taxonomic difficulty	Species not recorded in 29–33: Possible real gain	Other possible reduction in importance	Other possible gain in importance
	1	2	3	4	5	6	7	8	9	10	11
Achnanthes affinis GRUN.											
A. brevipes AGARDH											
A. conspicua A. MAYER											
A. delicatula KÜTZ.											
A. exigua GRUN.											
A. exilis KÜTZ.											
A. lanceolata BRÉB.											
A. linearis W. SM.											
A. microcephala KÜTZ.											
A. minutissima KÜTZ.											
A. minutissima var. cryptocephala GRUN.											
Amphipleura pellucida KÜTZ.											
Amphora ovalis KÜTZ.											
Anomoeoneis sphaerophora (KÜTZ.) PFITZNER											
Asterionella formosa HASS.											
Calonеis amphisbaena (BORY) CLEVE											
C. bacillum (GRUN.) MERESCHKOWSKY											
C.? schumanniana (GRUN.) CLEVE											
Ceratoneis arcus KÜTZ.											
Cocconeis flexella JAN & RABH.											
C. pediculus EHR.											
C. placentula EHR.											
Cyclotella bistriatiana THWAITES											
C. meneghiniana KÜTZ.											
Cymatopleura elliptica (BRÉB.) W. SM.											
C. solea (BRÉB.) W. SM.											
Cymbella affinis KÜTZ.											
C. cistula (HEMPR.) GRUN.											
C. cuspidata KÜTZ.											
C. delicatula KÜTZ.											
C. gracilis (RABH.) CLEVE											
C. helvetica KÜTZ.											
C. lanceolata (EHR.) V. HEURCK											
C. microcephala GRUN.											
C. prostrata (BERKELEY) CLEVE											
C. pusilla GRUN.											
C. sinuata GREG.											
C. ventricosa KÜTZ.											
Diatoma anceps (EHR.) GRUN.											
D. elongatum AGARDH.											
D. hiemale (LYNG.) HEIBERG											
D. vulgare BORY											
Didymosphenia geminata (LYNG.) M. SCHMIDT											
Diploneis ovalis (HILSE) CLEVE											
Epithemia hyndmanni W. SM.											
E.? sorex KÜTZ.											
E. turgida (EHR.) KÜTZ.											
E. zebra (EHR.) KÜTZ.											
Eunotia arcus EHR.											
E. exigua (BREB.) GRUN.											
E. lunaris (EHR.) GRUN.											
E. polydentula BRUN.											
E. robusta RALFS											
E. tenella (GRUN.) HUST.											
E. trioderia KRASSKE											
Fragilaria brevistriata GRUN.											
F. capucina DES.											
F. construens (EHR.) GRUN.											
F. gracillima MAJOR											
F. harrisonii W. SMITH											
F. intermedia GRUN.											
F. pinnata EHR.											
F. virescens RALFS											
Frustulia rhomboides (EHR.) DE TONI											
F. vulgaris THWAITES											
Gomphonema acuminatum EHR.											
G. angustatum KÜTZ.) RABH.											
G. constrictum EHR.											
G. intricatum KÜTZ.											
G. lanceolatum EHR.											
G. longiceps EHR.											
G. olivaceum (LYNG.) KÜTZ.											
G. parvulum (KÜTZ.)											
Gyrosigma acuminatum (KÜTZ.) RABH.											
G. attenuatum (KÜTZ.) RABH.											
G. scalproides (RABH.) CLEVE											
G. spencerii (W. SM.) CLEVE											
Hantzschia amphioxys (EHR.) GRUN.											
Melosira italica (EHR.) KÜTZ.											
M. variani AGARDH											
Meridion circulare AGARDH											
Navicula anglica RALFS											
N. bacillum EHR.											
N. cincta (EHR.) KÜTZ.											
N. cryptocephala KÜTZ.											
N. gastrum EHR.											
N. gracilis EHR.											
N. heufleriana (GRUN.) CLEVE											
N. hungarica GRUN.											
N. lanceolata (AGARDH) KÜTZ.											
N. minima GRUN.											
N. molesta KRASSKE											
N. mutica KÜTZ.											
N. pelliculosa (BRÉB.) HILES											
N. pupula KÜTZ.											
N. radiosa KÜTZ.											
N. salinarum GRUN.											
N. totaeana (RABH.) GRUN.											
N. schonfeldii HULST.											
N. subminuscula MANGUIN											
N. viridula KÜTZ.											
Neidium affine (EHR.) CLEVE											
N. dubium (EHR.) CLEVE											
N. iridis (EHR.) CLEVE											
Nitzschia acicularis W. SM.											
N. acuta HANTZSCH											
N. amphibia GRUN.											
N. denticula GRUN.											
N. dissipata (KUTZ.) GRUN.											
N. filiformis (W. SM.) HUST.											
N. fonticola GRUN.											
N. hungarica (W. SM.) GRUN.											
N. linearis W. SM.											
N. palea (KÜTZ.) W. SM.											
N. paleacea GRUN.											
Nitzschia recta HANTZSCH											
N. sigma (KÜTZ.) W. SM.											
N. sigmoidea (EHR.) W. SM.											
N. sublinearis HUST.											
N. subtilis KÜTZ.											
Pinnularia divergentissima (GRUN.) CLEVE											
P. gibba EHR.											
P. gracillima GREG.											
P. microstauron (EHR.) CLEVE											
P. substolaris GRUN.											
P. viridis (NITZSCH) EHR.											
Rhoicosphenia curvata (KÜTZ.) GRUN											
Rhopalodia gibba (EHR.) O. MÜLL.											
Stauroneis anceps EHR.											
S. pygmaea KRIEGER											
S. smithii GRUN.											
Stephanodiscus astraea (EHR.) GRUN.											
Surirella angustata KÜTZ.											
S. linearis W. SM.											
S. ovata KÜTZ.											
S. tenera GREG.											
Synedra acus KÜTZ.											
S. affinis KÜTZ.											
S. amphicephala KÜTZ.											
S. capitata EHR.											
S. nana MEISTER											
S. pulchella KÜTZ.											
S. rumpens KÜTZ.											
S. tenera W. SMITH											
S. ulna (NITZSCH) EHR.											
S. vaucheriae KÜTZ.											
Tabellaria fenestrata (LYNG.) KÜTZ.											
T. flocculosa (ROTH.) KÜTZ.											

with BUTCHER'S list in Table I. The total number of species recorded from the R. Tees is now 148. It can be seen that there have been few changes since BUTCHER'S survey. Marked differences in relative abundance indicate that there are probably a few real differences between the floras at the two periods. Possible gains are *Cymbella prostrata*, *Nitzschia amphibia* and *Eunotia tenella*, whilst a possible loss is *Achnanthes exilis*. In addition there has apparently been a decrease in the relative importance of *Pinnularia viridis*. The dominant diatoms of the reaches studied are unchanged since 1933: *Cyclotella meneghiniana*, *Cocconeis placentula*, *Navicula molesta*, *N. viridula*, *Rhoicosphenia curvata*. There was relatively little difference between the species composition of diatoms immediately above the entry of the R. Skerne, and sites below its entry. This is in marked contrast to the striking differences in macrophyte growths described by BUTCHER and found again by the present authors.

DISCUSSION

The striking feature of the survey is that, in spite of the passage of over forty years during which considerable further eutrophication has occurred, there have been so few changes in the species composition of the Rivers Tees and Skerne. Of 148 species of diatoms so far described from the rivers, there were only 5 obvious changes in abundance between the two surveys, none of them involving dominant species. In fact the only important floristic change in the rivers would seem to be the presence of *Enteromorpha intestinalis* in each year of the recent survey and its absence during the earlier survey. As the two surveys together cover seven summers, this may represent a genuine invasion of a new organism rather than periodic fluctuations in its abundance.

SUMMARY

The floristic composition of the Rivers Tees and Skerne in 1963—1966 was compared in detail with that recorded by a previous worker in 1929—1933. In spite of the long time interval during which considerable changes have taken place in the rivers there was only one marked change in the flora. This is the apparent invasion of *Enteromorpha intestinalis*. Other changes were very few and did not involve common species.

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