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Institute of Freshwater Ecology

Natural Environment Research Council

INSTITUTE OF FRESHWATER ECOLOGY

Eastern Rivers Laboratory
Institute of Freshwater Ecology
Monks Wood Experimental Station
c/o Institute of Terrestrial Ecology
Abbots Ripton, Huntingdon,
Cambridgeshire, PE17 2LS.

Turbidity and plant growth in large slow-flowing lowland rivers.

Progress Report: April 1990 - October 1990
Dr A.F.H. Marker

Project leader	A.F.H. Marker BSc PhD
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The Institute of Freshwater Ecology is part of the Terrestrial and Freshwater Sciences Directorate of the Natural Environment Research Council.

1. SUMMARY

This is the fourth progress report on this contract but the first to be submitted directly to the National Rivers Authority on the causes and biological effects of turbidity in large lowland rivers. Estimating of phytoplankton and turbidity weekly has continued at twelve sites on the River Great Ouse and significant differences have been observed between 1989 and 1990 as low discharges continued for most of the period. 1990 was significantly different from 1988 and 1989 in that the spring outburst in the river started earlier and had a relatively prolonged maximum before declining from mid-summer. A similar pattern was found at all nine main river and side channel sites. All three marinas sampled in 1990 showed major differences from the river sites with high chlorophyll concentrations from mid- to late summer. Detailed measurements of light prenetration (at seven points in the visible spectrum) confirmed severe light attenuation for much of the active growing season, particularly at shorter wavelengths. Analysis of periphyton on submerged surfaces of <u>Nuphar</u>, <u>Scirpus</u> and <u>Phragmites</u> has continued in 1990. The remaining months of the contract will be concerned with the examination of preserved samples, analysis of data and report writing.

2. INTRODUCTION

This research contract is centered on the middle reaches of the River Great Ouse, one of several highly managed large lowland rivers in eastern England. It drains rich arable land in the midlands and eastern England and for much of the year the clarity of the water is poor. Although many of the river channels have been dredged for flood control and for recreational boating, there is a great variety in the size and morphology of these channels. The purpose of this contract is to investigate the seasonal variations and causes of turbidity and its effect on aquatic plants and the associated periphytic organisms. Particular attention is being paid to the distribution of macrophytes and the seasonal variation of periphytic organisms in relation to channel size and structure.

3. METHODS

Methods have been fully described in the previous progress reports.

4. FIELD SAMPLING, RESULTS AND DISCUSSION

4.1. Phytoplankton. Striking differences in concentration have been observed between 1989 and 1990 at all river and side channel sites. One example is illustrated here (Fig. 1, Huntingdon, TL243714). In 1990, populations developed earlier (April) and extended into mid-June before dropping off. In all the three years studied during this project there was a marked drop off in chlorophyll a and turbidity in the later summer (after June). Last year we reported contrasting results from a marina where concentrations were high through August and September. This year sampling covered three marinas and, although concentrations were very variable with differences between the three sites, all showed high concentrations in the late summer in contrast to the main river (Fig. 2). Monthly chemical analyses are being carried out by the National Rivers Authority at Peterborough.

4.2.2. Light attenuation. An excellent set of data for over two years has been obtained with the quantum sensors measuring photosynthetically available radiation (400-700nm). Differences between 1989 and 1990 appear clearly in Fig.3 and show that, although attenuation decreases during the latter part of the summer as the phytoplankton declines, defferences between the two years were still apparent at the end of September. In addition, specific information on light attenuation within the visible spectrum has also been obtained using broad band interference filters (40nm band pass) at 400, 450, 550 and 650 nm. This set covers 18 months. In addition, data this year have been supplemented using seven narrow band interference filters (10 nm band pass) approximately once per month. This data set illustrates very clearly the virtual absence of

Table 1

River Great Ouse: % transmission of visible radiation at one metre depth at specific points in the visible spectrum.

1990	400-700nm	410nm	440nm	488nm	520nm	560nm	626nm	680nm
Apr 4	14.4	0.6	1.2	4.8	9.1	18.1	20.0	10.6
May 5	7.1	<0.1	0.3	1.4	4.0	9.7	9.4	3.7
May 24	6.9	0.1	0.3	1.6	4.7	10.8	8.3	4.3
Jun 6	4.7	<0.1	0.2	0.8	2.9	5.9	6.0	2.6
Jun 26	8.9	0.1	0.5	2.2	5.5	10.1	11.4	7.3
Jul 10	14.8	0.4	1.4	5.8	11.1	18.6	18.2	15.2
Aug 20	19.9	0.9	2.7	10.3	16.6	25.5	23.4	22.4
Sep 11	25.6	1.5	4.2	14.9	23.7	34.1	30.2	29.6

photosynthetically important "blue light" (440 nm) even at one metre depth for vitually all the spring and summer (table 1).

4.3. Channel morphology and macrophyte mapping was repeated this September for the six sites studied in 1989. A further pair of sites was added this year (main river and adjacent side channel) further down stream between Huntingdon and St Ives (NGR TL285715).

4.4.1. Periphyton biomass. Sampling of Scirpus, Nuphar and Phragmites was continued during 1990. Scirpus and Nuphar were sampled from May and new Phragmites stems from April. Dead Phragmites stems were sampled from February although January was missed due to high water levels. Periphyton chlorophyll a data are shown in Tables 2 and 3 for Scirpus and Phragmites and, although the data set is incomplete at the time of writing, comparisons between 1989 and 1990 can already be made.

Scirpus Periphyton densities are initially low and only rise significantly after mid-summer. In part this is due to turbid water in the late spring (see Table 1) but also because the stems are only available from May onwards.

Phragmites Old stems did not persist for as long in 1990 and, indeed only four stem samples were taken in July. However it is clear that a substantial biomass develops in March and April and persists to some extent into the summer. The high chlorophyll levels recorded in 1989 were not apparent this year on either new or old stems and may, in part, have been due to the lack of light penetration.

Table 2

Comparison between 1989 and 1990 in the monthly variation in chlorophyll a on *Scirpus* stems in the River Great Ouse. Values are expressed as $\mu g\ cm^{-2}$ and are the mean of 15 samples.

	Lees Brook		Huntingdon	
	1989	1990	1989	1990
May	0.05	2.77	0.24	0.63
June	3.38	6.37	1.73	2.05
July	9.38	7.31	17.19	6.63
August	6.02	12.96	8.95	29.53
September	19.03	19.57	16.51	19.53
October	11.22	na	14.33	na
November	19.54	na	6.86	na

Table 3

Comparison between 1989 and 1990 in the monthly variation in chlorophyll a on *Phragmites* stems in the River Great Ouse. Values are expressed as $\mu g\ cm^{-2}$ and are the mean of 15 samples, except * n=7, ** n=4 and *** n=2.

	Old Stems		New stems	
	1989	1990	1989	1990
February	6.58	2.45	----	----
March	na	19.09	----	----
April	19.94	10.07	0.89	2.06
May	11.60	(15.34)*	2.87	(7.82)***
June	31.55	9.50	28.26	7.37
July	56.41	(21.58)**	19.30	15.72
August	35.54	-----	15.08	17.85
September	-----	-----	7.28	20.97
October	-----	-----	3.37	na
November	-----	-----	3.74	na

na Samples not taken at the time of this report.

4.4.2. Periphyton population structure.

Scirpus During the spring, when periphyton biomass is low, diatoms dominate. As the biomass increases an encrusted population of green algae, which frequently form a closely adhering pseudo-parenchymatous layer with small filamentous outgrowths, becomes increasingly important. This population cannot be readily identified without extensive culturing facilities (D.M. John, British Museum) but include _Gongrosira_ and the basal plates of _Stigeoclonium_ spp. In its earliest stage this community is similar to the _Ulvella_-_Cocconeis_-_Chamaesiphon_ association described by R.W. Butcher over 50 years ago in other rivers. During the later summer the much more diffuse population of algae, which grows out from this encrusted layer, appears intially as filaments of _Oedogonium_ spp, _Cladophora_ sp and _Stigeoclonium_ sp but eventually become covered with silt and diatoms. Towards the end of the summer _Chantransia_-stage Rhodophyceae appear amongst the underlying encrusted layer.

Phragmites The overwintering stems retain the encrusted algal layer and diatoms, particularly, grow profusely in March and April. From May onwards diatoms are only a minor component and the encrusted population is increasingly invaded by the Cyanobacteria _Pleurocapsa_ spp and _Chamaesiphon_ spp. Mature stages of Rhodophyceae have also been found on _Phragmites_. _Batrachospermum_ and _Thoria_ both develop on old stems in the late winter (February and March) and _Thoria_ has also been found on new stems in October and November. In contrast, the new stems contain proportionately greater quantities of diatoms with lesser quantities of the Chlorophyceae and Cyanobacteria. Detailed analysis of the flora will be shown in the final report.

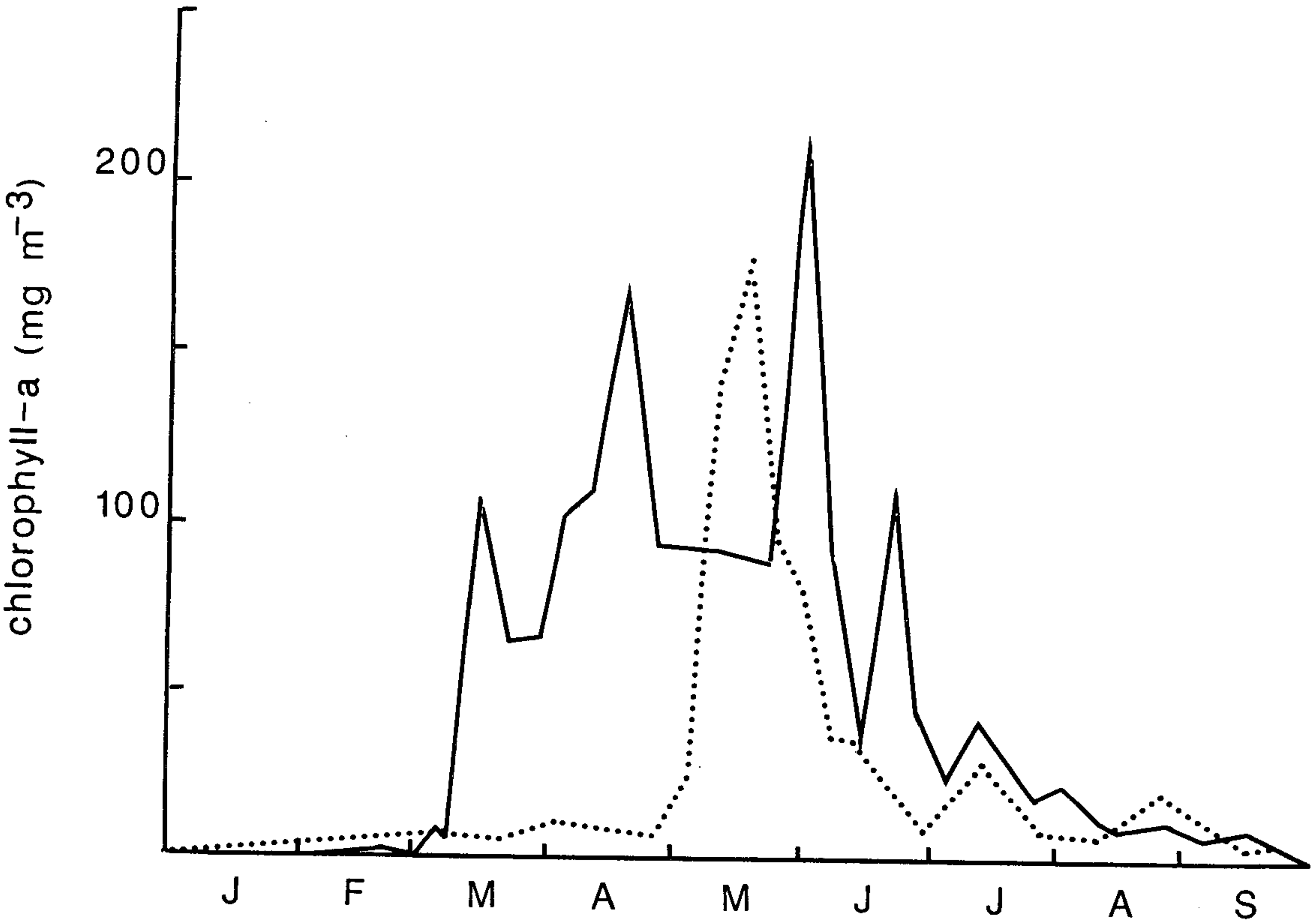
Programme from October 1990 to March 31st 1991

1. Sampling of Scirpus and Phragmites will continue until November 1990 and phytoplankton until December 1990.
2. Microscopic examination of preserved material.
3. Data analysis.
4. Preparation and submission of report.

Fig. 1. Comparison of the seasonal variation in the River Great Ouse phytoplankton at Godmanchester Road Bridge, Huntingdon, between 1989 and 1990.

1989 ....

1990 ————————



chlorophyll-a (mg m-3)
200
100
J
F
M
A
M
J
J
A
S

Fig. 2. Comparison of the seasonal variation in phytoplankton in three boating marinas in 1990.

(A) Buckden marina,

(B) Hartford marina,

(C) Needingworth marina.

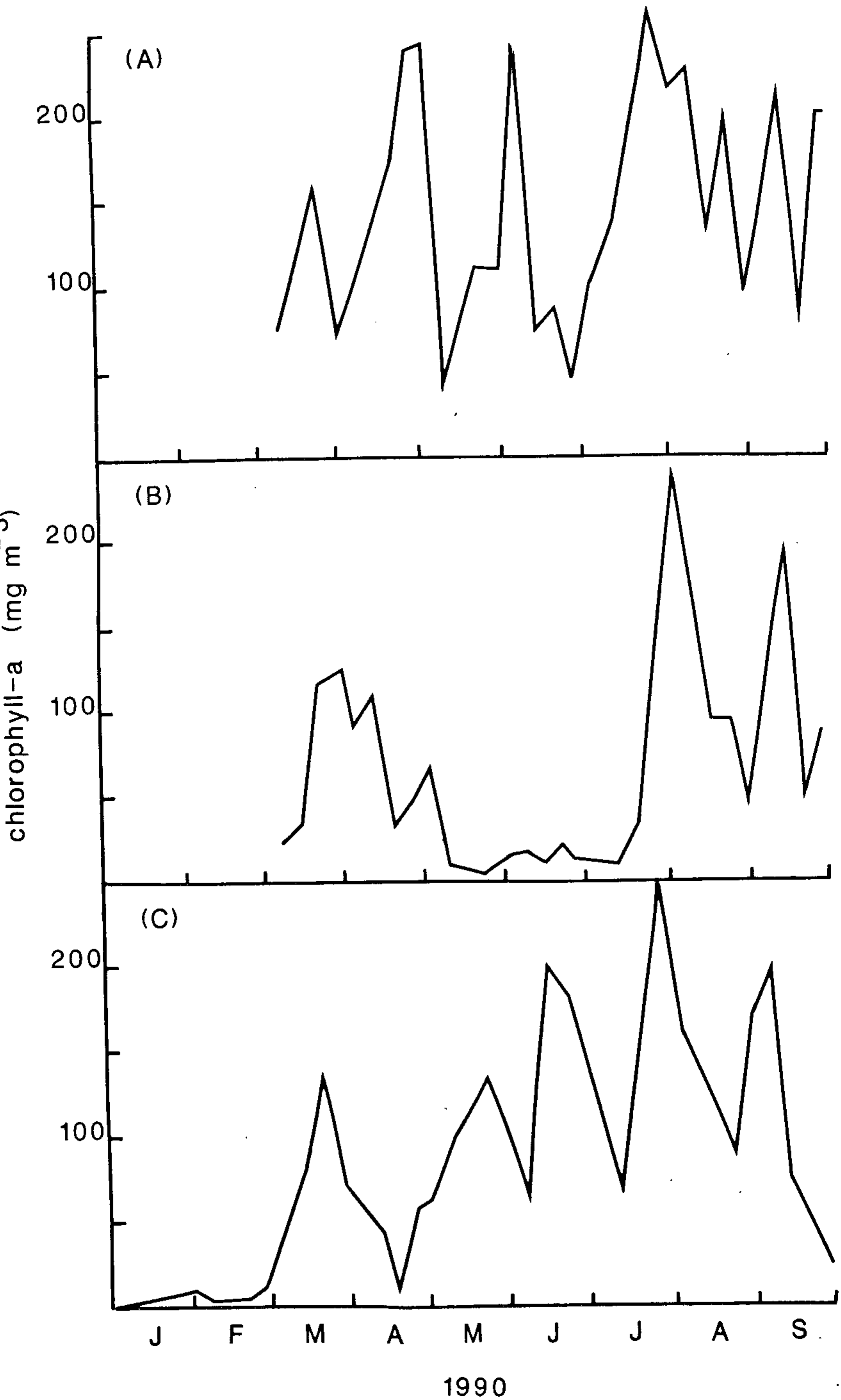
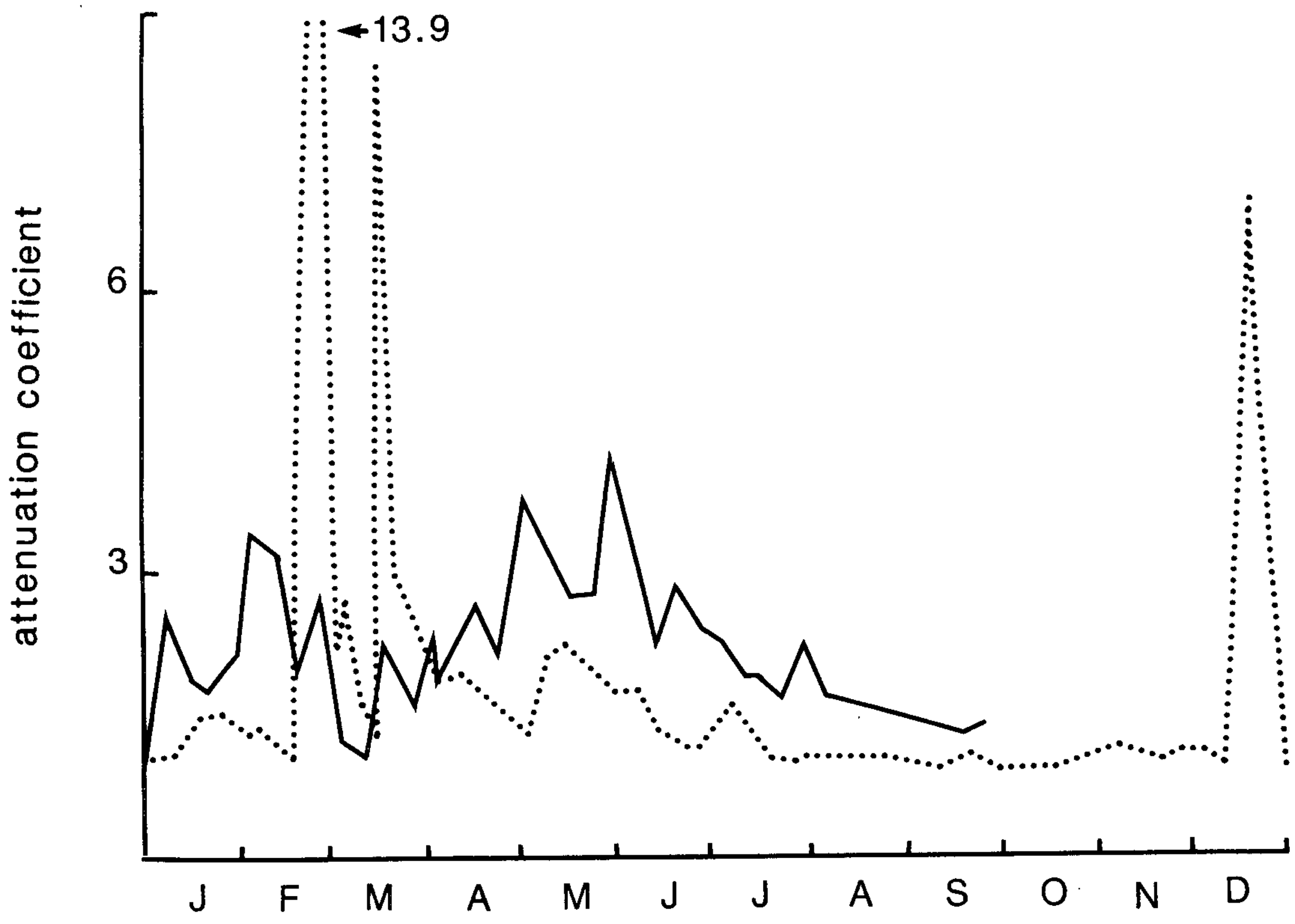

(A)
(B)
(C)
200
100
chlorophyll-a (mg m^{-3})
J
F
M
A
M
J
J
A
S
1990

Fig. 3. Variations in the attenuation coefficient ($\ln I/I_o$) for photosynthetically available radiation (PAR --- 400-700nm) during 1989 and 1990 in the River Great Ouse at Huntingdon.

1989 ••••••••••••••••

1990 ————————


13.9
attenuation coefficient
6
3
J
F
M
A
M
J
J
A
S
O
N
D

Natural
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