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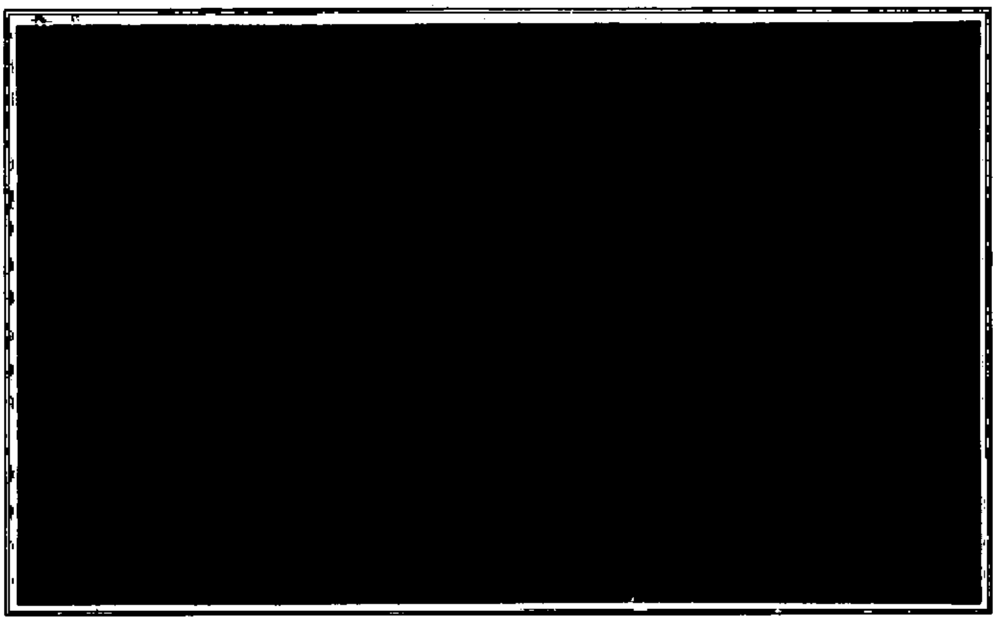
Institute of Freshwater Ecology



Natural Environment Research Council

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

Progress Report: October 1989 - March 1990

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1. SUMMARY

This third progress report covers the completion of sampling during the 1989 season and the commencement of sampling for the 1990 season. Estimates of river turbidity, suspended solids and phytoplankton have continued throughout the autumn and winter at ten sites. Notable differences were observed in 1989 between high summer chlorophyll a concentrations in a marina and relatively low chlorophyll concentrations in the adjoining river. Three marinas have therefore been included in the 1990 programme. Estimates of light penetration are now being enhanced using an extended range of narrow-band interference filters (410, 440, 488, 520, 560, 626 and 680nm). The large scale sampling programme of the last summer was gradually wound down as the macrophytes died off. The last samples were taken in October for Nuphar and in November for Scirpus. However, Phragmites was sampled throughout the winter when water heights allowed.

2. INTRODUCTION

The River Great Ouse is a highly managed large lowland river in eastern England. It drains rich arable land in the Midlands and Eastern England and over the years nutrient concentrations have increased and there is a general perception that the clarity of the water has decreased. The main river channels have been dredged a number of times partly for flood control reasons but also for recreational boating and navigation activities. The purpose of the contract is to investigate the seasonal variations and causes of turbidity and their effects 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 first and second progress reports (October 1988 - March 1989 and April - October 1989). Minor changes and recent additions are included in section 4 below but one general major change is given here: Chlorophyll a and other plant pigments are now extracted in ethanol. Due to the introduction of COSHH regulations, we believe that ethanol will be a much more "user friendly" solvent when large quantities are required. Careful tests are underway comparing the efficiency of ethanol with methanol as extraction solvents.

4. FIELD SAMPLING, RESULTS AND DISCUSSION

4.1. Phytoplankton. Seasonal variations in the chlorophyll a concentrations in the main river and side channels for 1989 were described in thee last progress report. Unlike the main river, the marina at Needingworth (Site 10) developed a large phytoplankton population in the late summer (Fig. 1). Since these marinas are linked to the main river by navigation channels, the conditions under which these populations will develop may have considerable implications to the management of the main river. In addition to the ten sites listed in the last progress report, we have now included two additional marinas. The three marinas now being sampled are:

Site 10. Needingworth National Grid Ref. TL359713

Site 11. Buckden TL213674

Site 12. Hartford TL264725

4.2 Light Attenuation. Weekly measurements have continued throughout the winter using the quantum PAR sensor and the multiple sensor fitted with four broadband interference filters at with transmission maxima at 400, 450, 550 and 650 nm. More recently seven narrow-band (10nm) interference filters have been fitted to this sensor and attenuance can now be measured at 410, 440, 488, 520, 560, 626 and 680 nm. Blocking of IR radiation to 1200 nm has been carefully checked and calibration against a manual ISCO spectroradiometer is being undertaken. Detailed results will be reported in the next progress report but preliminary data confirm substantial, although declining attenuance throughout the 400nm-region.

4.3. Channel morphology. Macrophyte mapping at six sites will be repeated in 1990 and some new sites will be included for comparative purposes.

4.4. Periphyton Sampling. The distribution and seasonal variations in periphyton densities for three macrophytes, with contrasting growth habits, are shown in Figs 2-4. Data are expressed in terms of chlorophyll a cm^{-2} of macrophyte surface; although corrections have not yet been made for the presence of degradation products, phaeopigment levels are unlikely to exceed 20-30% with equivalent downward corrections for chlorophyll itself. The overall patterns of periphyton distribution shown in Figs 2-4 are therefore correct.

4.4.1 Scirpus (Fig. 2). Scirpus shoots start to emerge in April and by May there are sufficient emergent plants to sample. Periphyton densities are low at that time partly because the substrata is so new but also because the shoots grow from the base forcing newly colonized surfaces above the water line. During this emergent period periphyton could be clearly seen well above the water line.

Scirpus produces a very open canopy and, during the summer, populations between 5 and 20$\mu g\ cm^{-2}$ chl a were found. Similar patterns of growth occurred both at the main river site at Huntingdon and in the side channel at Lees Brook. All these samples were taken from the outer part of the stand, near to the water line (5-25 cm) and hence exposed to near maximum light. Some samples were also taken from other parts of the reed bed:

1. At the outer fringe of the weed bed at,

(i) 5 - 25 cm below the water line,

(ii) 75 -100 cm below the water line.

2. Inner part of the weed bed (0.5 m within),

(iii) 5 - 25 cm below the water line.

It is clear that dense periphyton populations are confined to the narrow outer fringe of the weed bed (Table 1).

Table 1. Distribution of algal epiphytes within a Scirpus weed bed (expressed as $\mu g\ cm^{-2}$ chlorophyll a.

Date	outer stems		inner stems
	5 - 25 cm	80 - 100 cm	5 - 25 cm
22/08/89	13.43	6.60	0.72
02/10/89	12.97	7.97	0.53

4.4.2 Phragmites (Fig. 3) Samples were taken from this emergent macrophyte at the main river site only for comparative purposes. Its growth form differs from Scirpus in three important ways:

(i) Old stems overwinter and are therefore available for colonization by periphyton throughout the spring.

(ii) There is a more stable initial colonization phase for the periphyton because the macrophyte extends by apical growth.

(iii)There is a dense canopy of overhead leaves in mid-summer.

Algal populations are well developed on the older stems (1988 growth) by spring and they continue to develop until mid-summer. During these warm months the stems gradually weaken, due to fungal and bacterial decay, and there is a gradual loss of material that can be readily sampled. The last samples were taken in August. The new stems (1989 growth) were well developed by mid-summer and already supporting substantial periphyton growths. The gradual decline of this periphyton (in contrast to Scirpus) probably had three causes. Firstly an intense aphid attack on the macrophyte killed many of the first stems to emerge and the new ones, which took their place, had low periphyton densities and thus reduced the overall population density. Secondly, there must have been increasing shading as the summer canopy developed and, thirdly, older submerged leaves died off and the leaf sheaths were graduallt sloughed off shedding the periphyton at the same time.

4.4.3 Nuphar The common water lily has a quite different growth habit and is not confined to a narrow fringe along the river bank. It will develop several metres out from the river bank, up to a depth of about 1.5 metres. It is therefore absent from the main river channel. New leaves start to grow in March and April from the underground rhizomes. Sampling is generally only possible from May when sufficient numbers have grown and also when they are visible through the relatively dense phytoplankton. Periphyton densities are generally lower (Fig. 3) than on Scirpus and Phragmites but, due to the abundance of this particular macrophyte, the overall contribution of this source of periphyton to the ecosystem is significant. From June, surface Nuphar leaves were also sampled. Significant, although smaller periphyton populations were found on the under surfaces of the surface leaves. This is of some ecological interest because little light (ca 5%) penetrates through the leaves and it may be that back-welling radiation from the sub-surface turbid waters is of considerable significance to these algal populations.

Programme from April 1990 to October 1990

1. Sampling of periphyton will continue to confirm the relative distributions between *Phragmites*, *Nuphar* and *Scirpus*.

2. Work will be carried out to confirm the differences in phytoplankton between the main river and adjacent marinas. Local differences in phytoplankton will be investigated during extended dry periods should they occur.

3. Work on light attenuation will continue.

4. Analysis of preserved samples.

Fig. 1. Seasonal variation in the Great Ouse phytoplankton; conparisons between concentrations in the main river (at two sites) with concentrations in an adjoining marina. Corrections have not been made for the presence of degradation products.

Needingworth marina ————————

Main river at Needingworth - - - - - - - - -

Main river at St.Ives — — — — —

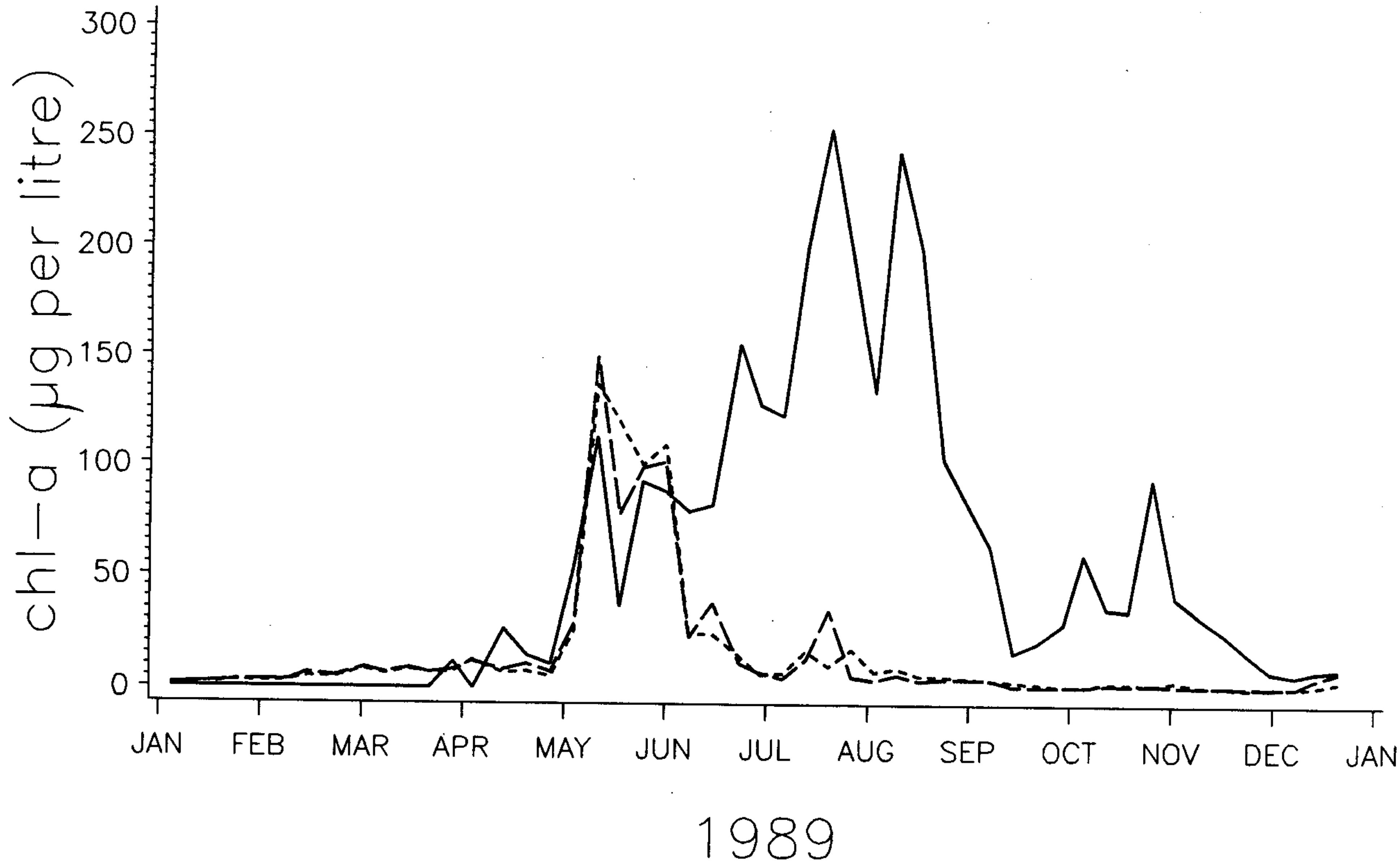
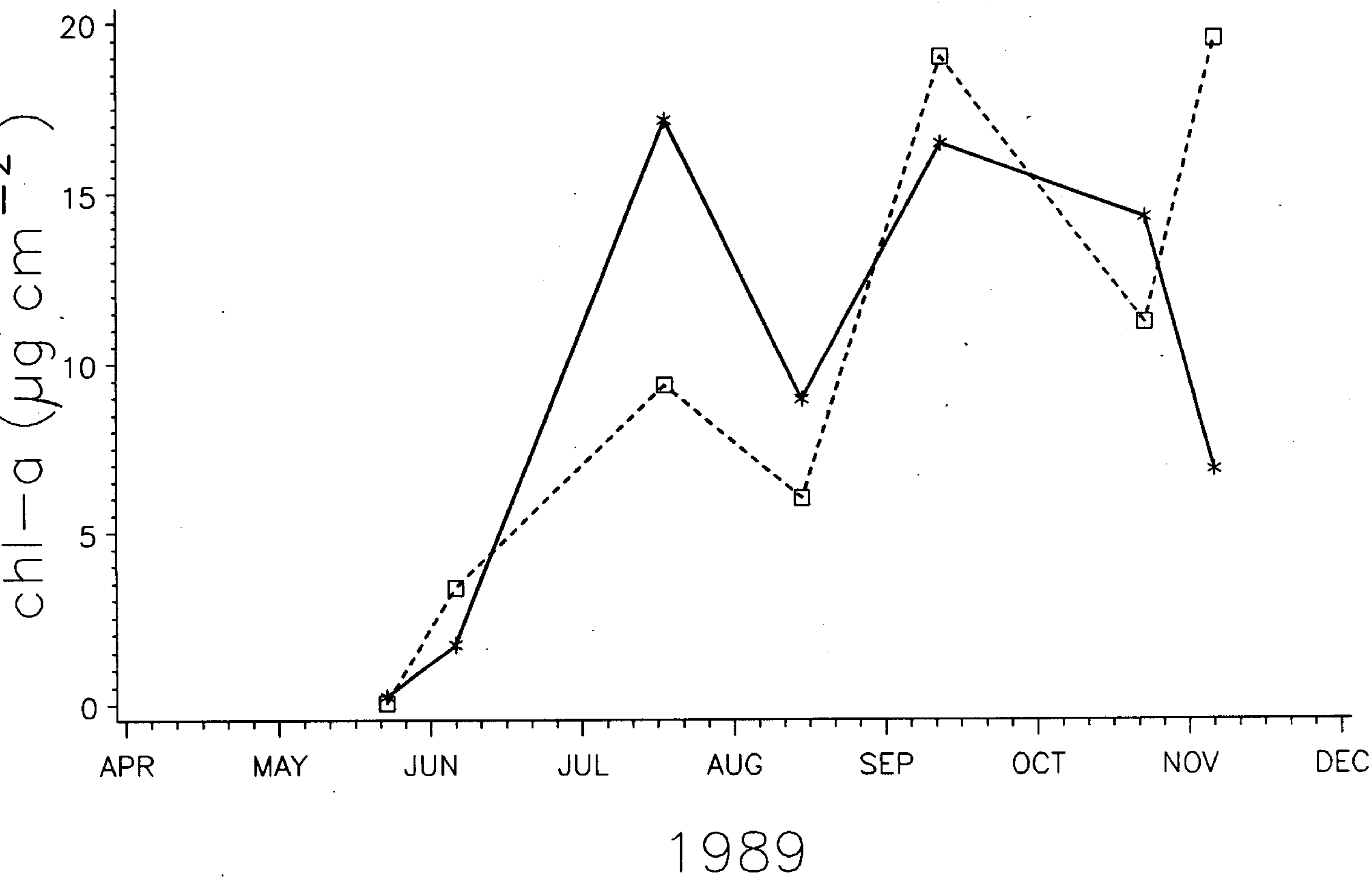

chl-a (µg per litre)
0
50
100
150
200
250
300
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
1989

Fig.2 Seasonal variation in the epiphytic algae growing on <u>Scirpus</u> in the main river at Huntingdon and a side channel at Lees Brook. Corrections have not been made for the presence of degradation products.

Main river at Huntingdon ———*———

Side channel --- Lees Brook -----□-----



chl-a (µg cm^{-2})
0
5
10
15
20
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1989

Fig.3 Seasonal variation in the epiphytic algae growing on Phragmites in the main river at Huntingdon; comparing epiphytic growth on old stems (1988 growth) with new stems (current growth). Corrections have not been made for the presence of degradation products.

New stems ——✱——

Old stems - - - - -⊡- - - -

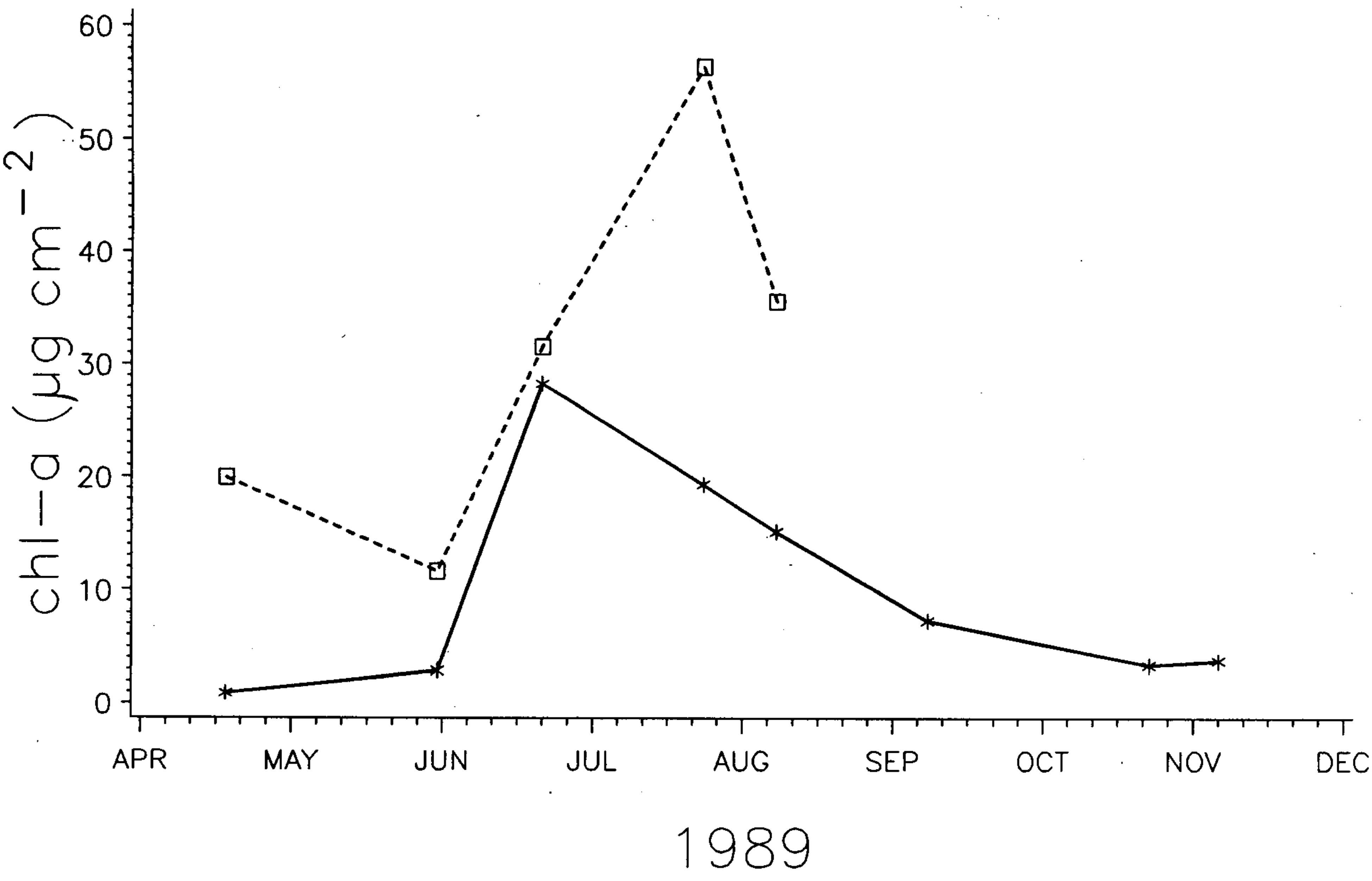
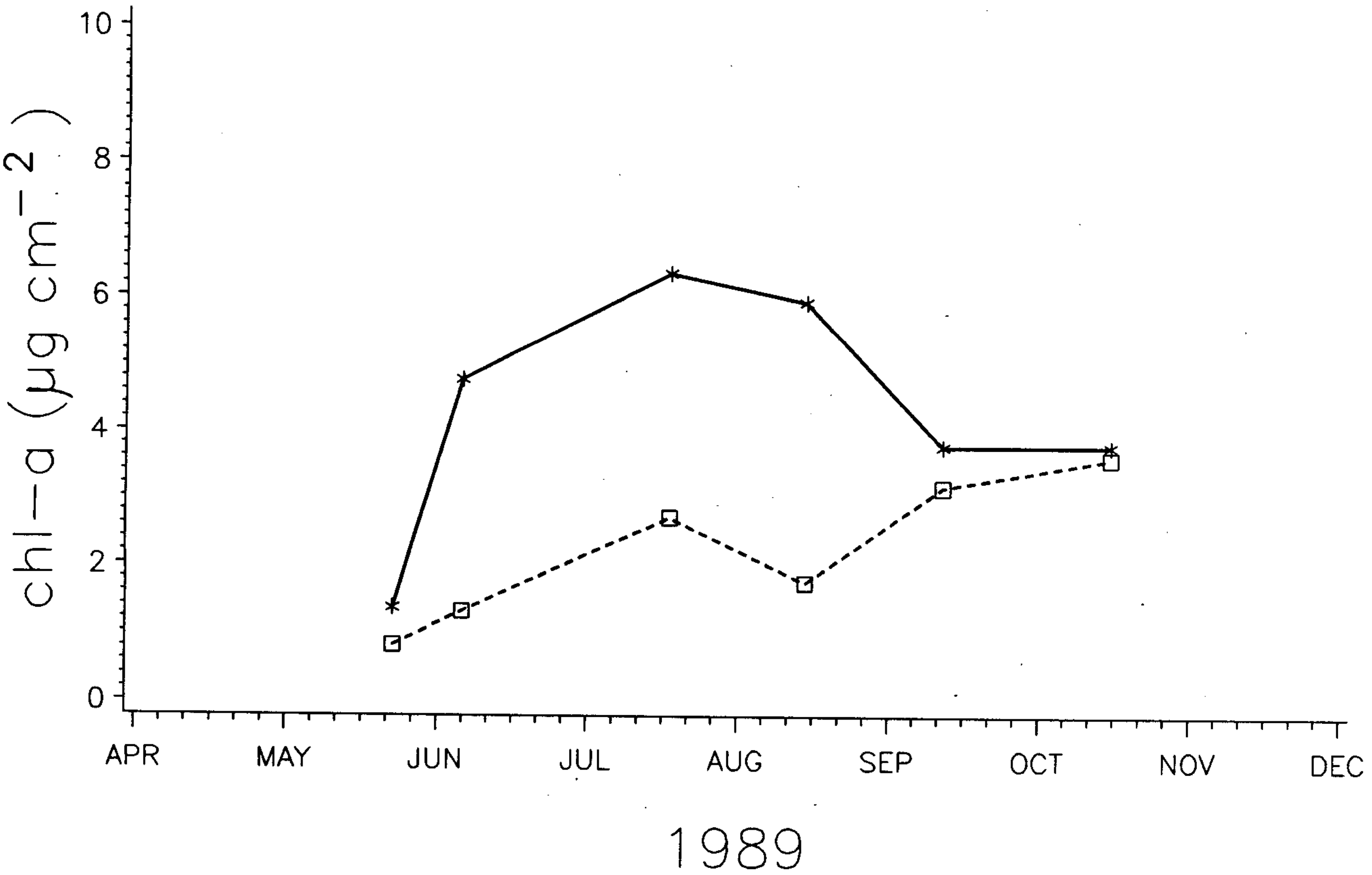

chl-a (μg cm⁻²)
60
50
40
30
20
10
0
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1989

Fig. 4 Seasonal variation in the epiphytic algae growing on submerged leaves of Nuphar in the main river at Huntingdon and a side channel at Lees Brook. Corrections have not been made for the presence of degradation products.

Main river at Huntingdon ——✳——

Side channel --- Lees Brook ----⊟----


chl−a (μg cm⁻²)
0
2
4
6
8
10
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1989

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