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Institute of Freshwater Ecology

Zooplankton Interactions in the River Thames

Final Report

J.A.B.Bass, L. May, G.F. Esteban & G.D. Collett

Report To: The Environment Agency (Thames Region)
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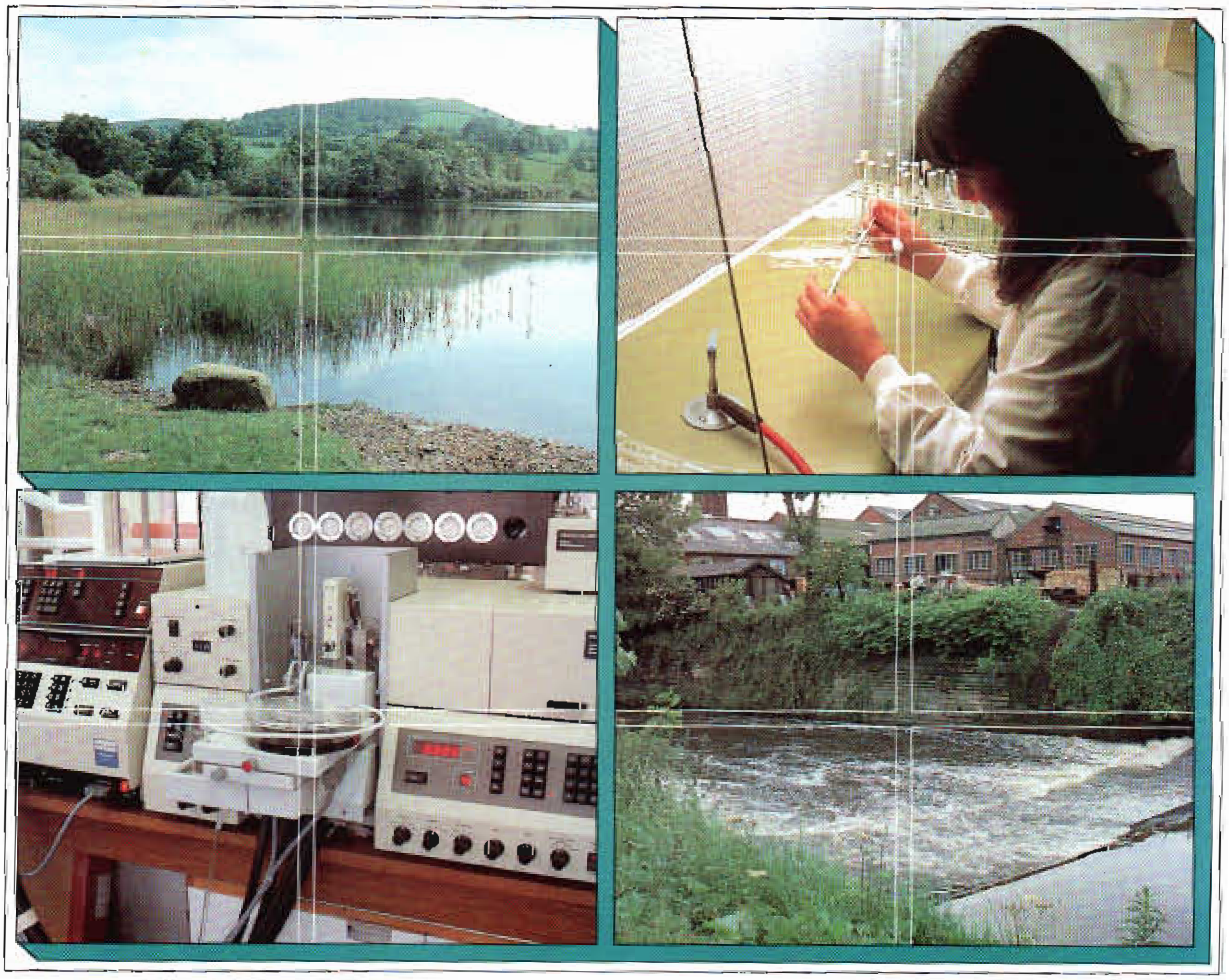

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Report to the Environment Agency (Thames Region) - June 1997

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Statement of Use

This document is one in a series of reports which investigate various aspects of a proposed Severn to Thames Transfer.

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EXECUTIVE SUMMARY

This report describes a study undertaken by the Institute of Freshwater Ecology on the zooplankton of the middle reaches of the River Thames from April-November in 1996. Seasonal changes in the abundance of individual taxa and the plankton community composition are described. The five sampling sites on the middle River Thames were at Inglesham (NGR SU20409840), Radley College Boathouse (NGR SU53809880), Abingdon Lock (NGR SU50609700), Wallingford Bridge (NGR SU61008950) and Caversham Lock, Reading (NGR SU72107420).

Parallel work on the available biological data in the middle reaches of the River Thames, descriptions of within-river habitats, diet studies on young fish and water chemistry characteristics relating to a possible Severn-Thames transfer are reported elsewhere and an overview of the conclusions from these studies will be the subject of a separate report.

The zooplankton study included collection of data on water temperature, water clarity, suspended chlorophyll$_a$, the microbial community, rotifers, copepods and cladocerans. The microbial community was enumerated in a range of size classes and functional categories. The relative scales of abundance within the planktonic microbial food webs present were typical of eutrophic freshwaters. Although 40 species of ciliates were recorded they were always the least abundant component of the microbial community at the five sites. An overall downstream increase in rotifer abundance occurred in parallel with increases in chlorophyll$_a$ concentration in the river water. This suggested that rotifer abundance was controlled primarily by food availability, as chlorophyll$_a$ levels reflect algal biomass, and most rotifers feed on algal cells. Preliminary calculations of grazing rates (section 5.8.1) indicate River Thames rotifers removed only about 4% of the algal biomass each day in 1996 and would have had little effect on overall phytoplankton abundance. However it is stressed that these extrapolations from laboratory clearance rates remain imprecise.

Earlier analyses of fish guts (Mann, *et al*, 1995) confirmed that rotifers were an important food source for larval fish in the River Thames, therefore two rotifer sampling methods were compared. These were (1) a settlement method using 500ml water samples which recovered all rotifers of significance as phytoplankton grazers; (2) a size-selective sieving method utilising 20 litres or 5 litres of water which was suitable for quantitative assessment of the larger rotifers and less frequent micro-crustaceans ingested by young fish.

In May and June the cross-channel population densities of large rotifers showed varying patterns in relation to depth and location within the river channel at Radley and Wallingford. There were very few copepods and cladocerans recovered from the River Thames zooplankton subsamples at all five sites and on all dates in 1996. Contemporary data on the gut contents of young fish at the Radley site (Mann, *et al.*, 1997) indicated cladocerans were more numerous in other habitats within the river.

Taking account of previous studies on other rivers and the results from this seven month study of the River Thames zooplankton, it was established that a seasonal and downstream sequence of rotifer population development occurred which reflected changes in phytoplankton biomass but not algal cell numbers.

In the context of a possible Severn-Thames transfer, studies on water mixing (House *et al.*, 1996) and the potential transfer of suspended sediment from the Severn (Talbot, *et al.*, 1997) concluded there would be no major changes in plant nutrients or elevated concentrations of pollutants but uncertainties remain with respect to the intermittent transfer of trace pollutants. On the basis that a Severn-Thames transfer would reduce reach-retention time downstream from the input point at Buscot it is concluded that the River Thames plankton community would be altered in the close vicinity of Buscot. In order to predict changes to the plankton dynamics additional data are required on the growth and loss rates of planktonic organisms and the hydrological characteristics of the river channel at Buscot. The impacts of a Severn-Thames transfer on the plankton further downstream would be small owing to the scale of increased channel size and river discharge around Oxford.

It is recommended that future research (which might include collaboration between the Institute of Freshwater Ecology, the Institute of Hydrology and The Environment Agency) should focus on further elucidation of the phytoplankton loss-processes in the middle reaches of the River Thames. The primary aim being to optimise summer discharge management in relation to water quality, whilst safeguarding components of the River Thames food web regarded as beneficial to conservation and fisheries.

The main areas identified as requiring further research are :

- reach-retention time within the middle reaches of the River Thames (particularly between Buscot and Oxford) under a range of hydraulic conditions relevant to operation of a Seven-Thames transfer.

- characteristics and population densities of zooplankton which would be transferred from the River Severn to the River Thames, during operation of a Severn-Thames transfer.

- model the impacts of grazing on dominant phytoplankton taxa by planktonic rotifers in the middle reaches of the River Thames.

- calculate population growth rates of the planktonic rotifer species which are important as algal grazers and food for young fish in the middle reaches of the River Thames.

GLOSSARY

Autofluorescence - displayed by naturally occurring fluorescing pigments within an organism.
Autotrophs - an organism capable of utilising inorganic sources of carbon and/or nitrogen.
Biomass - the weight, volume or energy equivalent of living organisms, often expressed per unit area.
Biovolume - the volume of a living organism. Generally calculated from a simple geometric form equivalent. May be converted to biomass using a known weight per unit volume factor.
Ciliates - single-celled organisms bearing cilia for locomotion and/or feeding.
Cladocerans - micro-crustaceans (<4mm), most species with a laterally flattened carapace.
Chlorophyll$_a$ - easily degraded photosynthetic pigment found in plants.
Copepods - segmented micro-crustaceans (<3mm).
Copepodites - juvenile copepod without segmentation.
Diatoms - algae incorporating a structural support of silica
Eutrophic - water bodies rich in plant nutrients.
Flagellates - single-celled organisms bearing a flagellum for locomotion.
Heterotroph - organism capable of obtaining energy from organic sources.
Infraciliature - the within-organism pattern of cilia on a ciliate.
Microplankton - all planktonic organisms not visible to the eye without magnification.
Ml (megalitres) - volume of water, 100 Ml day^{-1} is equivalent to 1.16 m^3 sec^{-1}.
Nanoplankton - small plankton, generally within the size range 2-25μm.
Picoplankton - very small plankton, including bacteria less than 2μm.
Phaeopigments - intermediate degradation products of photosynthetic pigments.
Phagotroph - feeding by the ingestion of whole organisms
Phototrophic - organisms utilising light in their metabolism.
Phytoplankton - planktonic plants.
Rotifers - small (10-1000μm) aquatic animals with a "wheel organ" feeding apparatus.
Secchi disc - metal plate which is lowered through the water to gauge water clarity.
Sedgwick-Rafter chamber - microscope slide with a counting grid within a 1ml chamber.
UV excitation - enhanced visibility on exposure to ultra-violet light.

1.0 BACKGROUND

1.1 Main conclusions of the river zooplankton literature review

The Environment Agency commissioned a review of published studies on river zooplankton (Bass & May, 1996a), the main conclusions are summarised below -

1) The overriding influence of river discharge on plankton density is widely reported in the scientific literature, with planktonic populations inhibited or diluted as retention time decreases with increasing river flows. The role of "dead zones" or "storage zones" within river channels, contributing to the delay of downstream displacement, has been demonstrated in a range of rivers in Britain (e.g. Reynolds and Glaister, 1992). The vast majority of studies are confined to the phytoplankton and do not address the zooplankton or bacterial (picoplankton) components.

2) Rotifers are often mentioned in river zooplankton research studies but in most cases sampling strategies were designed primarily for the study of larger crustacean zooplankton. Published studies indicate that rotifers have the greatest potential for influencing phytoplankton dynamics but few studies have assessed the role of rotifers in controlling phytoplankton abundance and species composition in large rivers.

3) Planktonic copepods are represented in rivers predominantly by the juvenile stages (copepodites and nauplii). With a few notable exceptions, planktonic cladocerans appear to be disfavoured by riverine conditions and frequently occur in comparatively very low population densities for much of the year.

4) Static waterbodies connected to rivers with similar water chemistry and nutrient status, frequently maintain higher phytoplankton and zooplankton populations through the summer, indicating the potential for greater plankton development in rivers should water retention time increase.

5) Recent studies on the habitat utilisation and gut contents of juvenile cyprinid and percid fish in rivers indicated that zooplankton contribute a sequence of prey, increasing in size as the fish grow, with rotifers providing the main prey in the first few weeks of life after fish absorb their yolk sack.

1.2 Proposed Severn-Thames transfer: implications for zooplankton trophic interactions in the River Thames -

On the basis that future river management may change flows in the River Thames, the zooplankton literature review (Bass & May, 1996a) concluded that:

1) During spring and early summer the release of augmentation flows or river transfer flows that substantially reduce retention time within the river would inhibit plankton development.

2) In spring diatoms derived from a reservoir or river transfer would be readily utilised and transferred to other trophic levels including zooplankton in the River Thames but inputs of larger algae, such as filamentous blue-greens in summer are likely to impact on other components of the system, such as filter-feeding macroinvertebrates, rather than the river zooplankton.

3) During autumn and winter months with typically high river flows and low temperatures, additional inputs containing a significant algal component are not likely to promote the development of river zooplankton which is universally reported to occur at low population densities at this time.

1.3 Proposed River Thames zooplankton sampling regime

In order to establish the current situation with regard to River Thames zooplankton, the following sampling regime was proposed (Bass & May, 1996b):

- 1) Relatively large sample volumes of river water should be collected from discrete depths with a small battery-powered submersible pump.
- 2) Thc abundance of small common organisms (eg rotifers, Protozoa and bacteria) and large comparatively infrequent taxa (eg cladocerans and copepods) should be separately monitored.
- 3) Contemporary and seasonal differences in zooplankton should be examined at 5 river sites.
- 4) Spatial differences in zooplankton populations should be studied at 2 river sites, to establish the variability of: a) grazing pressure on phytoplankton; b) food resource availability to other dependant fauna.

Sampling was undertaken fortnightly by the Institute of Freshwater Ecology from April to November 1996. The results from this study, together with contemporary data supplied by The Environment Agency, were intended to provide the basis for conclusions on the role of zooplankton in the River Thames and the possible consequences of transferring water from the River Severn to the River Thames.

2.0 INTRODUCTION

The present studies of zooplankton in the River Thames, including the literature review of riverine zooplankton (Bass and May, 1996a) and the review of river transfers (Mann & Bass, 1995), were initiated as part of The Environment Agency (Thames Region) development of long term, strategic planning of water resources . It was anticipated at the outset that future river management schemes, such as the construction of new reservoirs or the transfer of water from other catchments, would change the present flow regime and water quality in the middle reaches of the River Thames resulting in direct and indirect impacts on the biota. This report describes work undertaken by the Institute of Freshwater Ecology on the River Thames in 1996 to investigate the abundance, composition and seasonal occurrence of zooplankton which develops under the present flow regime in the middle reaches of the river. Technical terms used in the report are defined in the glossary at the end of the Appendices.

Parallel work on the available biological data on the middle reaches of the River Thames and descriptions of within-river habitats, diets of young fish and water chemistry are the subject of separate reports. An overview of the conclusions from these studies will be presented separately.

The present study provides:

- \- baseline data describing the River Thames zooplankton
- \- an assessment of the current status of this community
- \- an interpretation of its relationship to the River Thames phytoplankton

Sampling was undertaken at five locations on the middle reaches of the River Thames over a six month period (beginning April 1996). The fauna that was examined included planktonic rotifers, copepods and cladocerans. An investigation of the planktonic microbial food web and its seasonal development in the Thames was also included in the study. Bacteria, nanoplankton (microalgae and heterotrophic flagellates) and ciliates were enumerated. The types of microbial food webs present were characterised and the natural variation in abundance within the component groups of organisms were described.
At the request of The Environment Agency, water clarity (Secchi disc depth), the concentration of suspended chlorophyll$_a$ and spot temperature readings were also recorded, complementing similar data obtained on alternate weeks in 1996 by The Environment Agency. It was the intention that such baseline information and its interpretation would assist with the future assessment and monitoring of water quality and water resource management.

3.0 PROJECT OBJECTIVES

The main objectives were:

- **- sample the range of zooplankton categories**
- **- identify the main zooplankton taxa present**
- **- establish broad, seasonal patterns of abundance**
- **- enable the detection of future change**
- **- determine the abundance of the different components of the microbial food web**
- **- describe the microbial food web**
- **- consider the impacts of the proposed Severn-Thames transfer**

4.0 SAMPLING SITES AND METHODOLOGY

4.1 Sampling Activities

Zooplankton sampling was undertaken at five sites on the River Thames, taking account of The Environment Agency sampling sites and sampling procedures for phytoplankton and fish. On each sampling date spot water temperature readings and water transparency (using a Secchi disc) were recorded and a one litre sample of river water was taken to measure chlorophyll$_a$ and its phaeopigment breakdown products. The methanol extraction method for chlorophyll$_a$ (Marker, 1994) was adopted.

During the initial site visit IFE staff were accompanied by an Environment Agency representative and the suitability of the five selected sites and precise sample locations for long-term monitoring were confirmed. The most upstream site (Inglesham) and the second site (Radley) were a considerable distance apart; this was in order to overcome the potentially confounding influences of the variable localised inputs from a number of major tributaries in the Oxford area (Fig. 1).

4.2 Sampling Locations

IFE River Thames zooplankton sampling sites

Site Name	National Grid Reference
Inglesham	SU20409840
Radley College Boathouse	SU53809880
Abingdon Lock	SU50609700
Wallingford Bridge	SU61008950
Caversham Lock (Reading)	SU72107420

Access to all sites was arranged by The Environment Agency.

Inglesham (Plate 1)(Fig. 1) was selected as the upstream sampling site for zooplankton in 1996. It is situated 1.5km upstream from Lechlade and approximately 4km upstream from Buscot, the input point for the proposed Severn-Thames transfer. Samples were taken 1m from the east bank, adjacent to the boathouse. Care was required to obtain samples without disturbing adjacent vegetation (*Sparganium emersum*) or associated fine sediment. During the sampling period (April to November, 1996) river discharge at Buscot fell from around 10 m^3 sec^{-1} in April to 2.5 m^3 sec^{-1} in June and remained below the latter value until November. Water level and water velocity (<0.1m sec^{-1}) remained fairly constant throughout the sampling period. The river channel at the sampling point was 17m wide. Water depth across the channel was not measured. At the sampling point water depth was about 0.8m. Submerged vegetation occupied a higher proportion (c. 40%) of the river channel than at the remaining downstream sampling sites and the effects of boat activity were less noticeable at this upstream site.

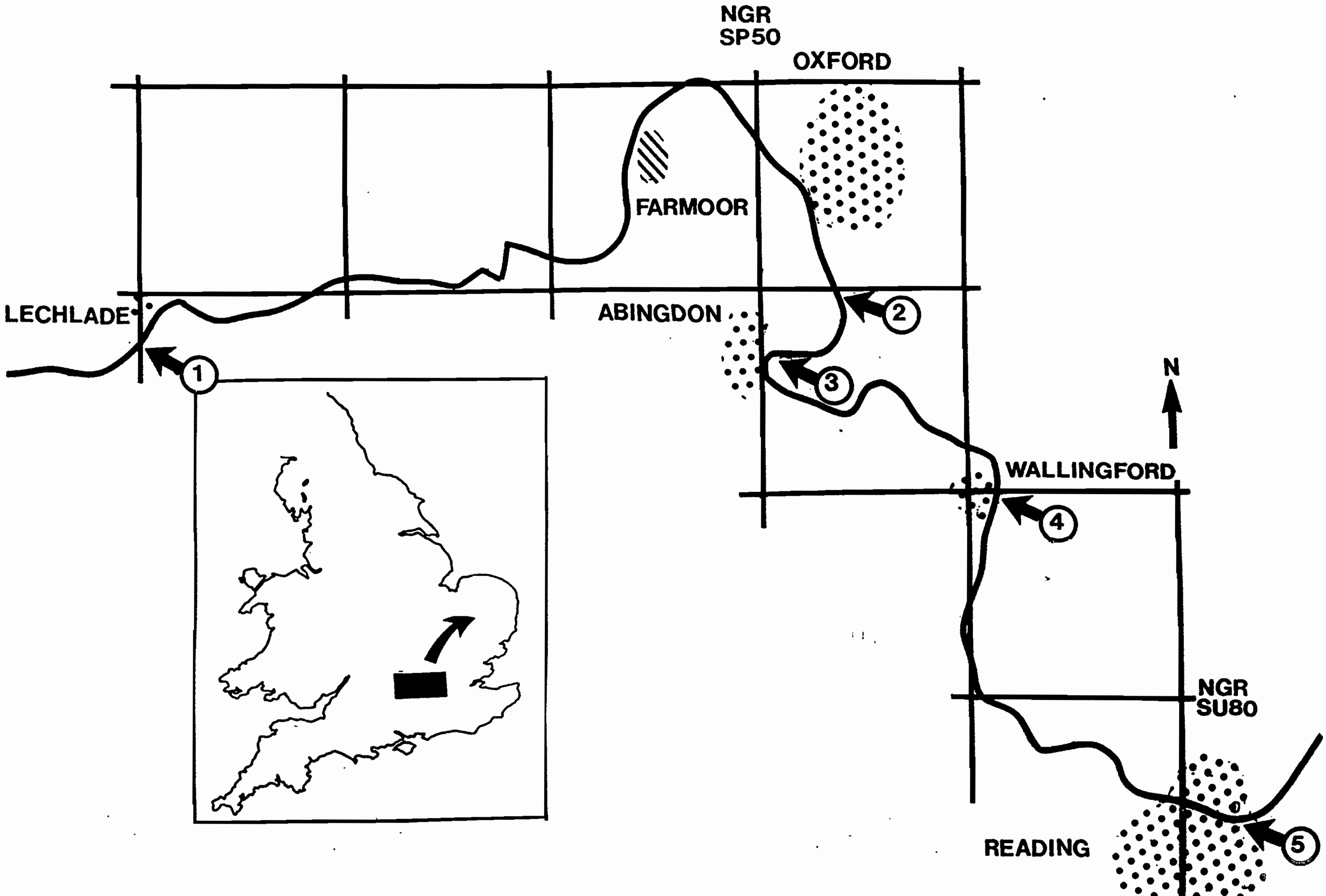


FIGURE 1: River Thames zooplankton sampling sites in 1996, 1 - Inglesham, 2 - Radley, 3 - Abingdon, 4 - Wallingford, 5 - Caversham Lock (Reading).

Radley College Boathouse (Plate 2)(Fig. 1) is situated about 3km upstream from Abingdon. Samples were taken at five locations across the River Thames approximately 30m upstream from the Radley College boathouse complex. Within 3m of both banks emergent stands of *Schoenoplectus* (*Scirpus*) *lacustris* and *Acorus calamus* were present throughout the sampling period in 1996 and submerged *Nuphar lutea* extended beyond the emergent vegetation for 2-3m. Water depths ranged from 0.3-0.6m in the river margins to >3m in the main channel at distances >8m from both banks. The river was approximately 40m wide at the sampling site. Water velocity in mid-river was of around 0.2m sec^{-1} in April and May but slower later in the year. Boating activity which disturbed bankside sediment and plant stands was most evident in July and August.

Abingdon Lock (Plate 3)(Fig. 1) on the outskirts of Abingdon was sampled upstream of the lock from the lock island at 1m from the river bank. The River Thames is about 50m wide at this point. During 1996 extensive deposits of dredging spoil were placed on the opposite (west) bank. Owing to the wide channel at this point water velocity was negligible except during lock operation. No aquatic vegetation was evident. Channel depth was not measured but at the sampling point the water depth was about 2.5m. Boating activity was most evident in July and August.

Samples were taken at five points across the River Thames about 200m upstream from **Wallingford Bridge** (Plate 4)(Fig. 1) on the outskirts of Wallingford. The river was about 40m wide with overhanging vegetation on the west bank and isolated bankside trees on the east bank. Water velocity in mid-river was around 0.2m sec^{-1} in April and May but slower later in the year. Water depth was about 1.5m close to the west bank and <0.5m within 3m of the east bank. Water depth in the remaining part of the river channel was around 3m. Aquatic vegetation was confined to some submerged *Nuphar lutea* 3-6m from the east bank. Boating activity was most evident in July and August.

At **Caversham Lock (Reading)** (Plate 5)(Fig. 1), samples were taken from the upstream side of the footpath crossing the weir. The River Thames was about 50m wide at this point, with the main channel divided from the lock cut by an island. Water velocity was around 0.3m sec^{-1} on most sampling occasions owing to the close proximity of the weir. No aquatic vegetation was present. Water depth at the sampling point was 3.2m. Boats were excluded from the proximity of the weir but disturbance to the sampling site occurred when vessels manouvered just upstream from the sampling location.

PLATE 1: Inglesham 1996 zooplankton sampling site (NGR SU20409840), sample location indicated.

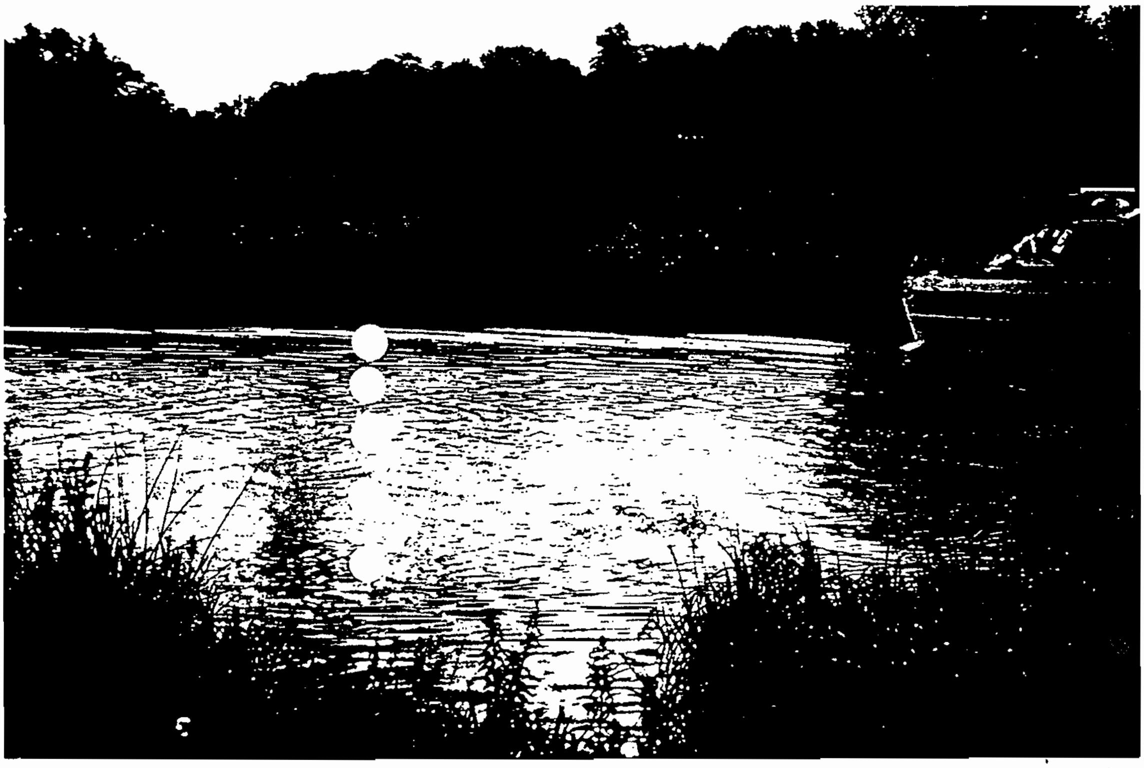


PLATE 2: Radley 1996 zooplankton sampling site (NGR SU53809880), sample locations indicated.

PLATE 3: Abingdon 1996 zooplankton sampling site (NGR SU50609700), sample location indicated.

PLATE 4: Wallingford 1996 zooplankton sampling site (NGR SU61008950), sample locations indicated.

PLATE 5: Reading 1996 zooplankton sampling site (NGR SU72107420), sample location indicated.

The Environment Agency River Thames phytoplankton sites: 1992-1996

Site Name	Grid Reference
Somerford Keynes	SU01809480
*Inglesham	SU20409840
Newbridge	SU40300140
Folly Bridge	SP51400550
Radley College Boathouse	SU53809880
*Abingdon Lock	SU50609700
Days Lock	SU56809350
Wallingford Bridge	SU61008950
Goring Lock	SU59608080
*Caversham Lock	SU72107420
*Romney Lock	SU97307810
Below Ravens Ait	TQ17406770

*From September 1994 The Environment Agency sampled phytoplankton at the four sites indicated: Inglesham, Abingdon, Caversham and Romney.

4.3 Sampling Dates (1996)

IFE sampling schedule in 1996:

April 9th and 22nd
May 6th and 20th
June 3rd and 17th
July 1st, 15th and 29th
August 12th and 26th
September 9th and 23rd
October 7th and 21st.
Modifications: Bank Holidays Mondays were avoided in May and August by sampling on the Tuesday.

4.4 Additional Samples

From April until November 1996 the zooplankton samples were taken from a fixed predetermined point at each river site. Additionally at two river sites (Radley and Wallingford) the degree of spatial variability within the larger zooplankton taxa was investigated. The variability in numbers of these larger taxa over short (5 minute) intervals at a single bankside location was compared with variability at five points across the river at two depths. The stratified samples were obtained using a boat and each sample was derived from 5 litres of river water. Samples, were taken 0.3m from the water surface ("surface") and at 2m depth, or 0.3m from the river bed ("bottom"), where the river was shallower than 2m. When riverbed sediment or plant debris contaminated the sample it was discarded and the sample was repeated.

4.5 Sample Size

Individual size of organisms and population densities that may be attained by different taxa within the plankton, varies widely. These factors were important considerations when determining sampling methods and sample size. Volumes of water that were sampled for the major groups of organisms were as follows:-

- Picoplankton and nanoplankton - 100ml
- Total rotifer counts - 500ml
- Identification of living rotifers - 100ml
- Large rotifers, copepods, cladocerans - 20 litres.
- Large rotifers, copepods, cladocerans - additional samples, 5 litres.

In general, small taxa (within the picoplankton and nanoplankton) are found in greater abundance than the larger fauna. Examination of live material was necessary for accurate identification of components of the picoplankton, nanoplankton and rotifers. Consequently, sampling needed to take place early in the working week, to allow adequate time for transport and sample examination to be completed.

4.6 Sample Collection Methods

Samples from predetermined water volumes were obtained using a battery-powered pump and ancillary equipment as follows:-
A small submersible bilge pump (eg Aquaflow, Aquamarine, Southampton), capable of delivering over 400 litres (using one battery) at c.15 litres per minute (with height of "lift" <2m) was used to obtain the water samples This was powered by a rechargeable 12 volt battery (fully sealed lead/acid gel type).
Clear, semi-rigid and smooth plastic tubing, of c. 2cm internal diameter, was attached to each end of the pump. About 20cm of the clear tubing was fitted to the intake to minimise pump-avoidance by mobile taxa. Four metres of similar tubing were attached to the outlet and the pump and first 1.5m of outlet-tubing were strapped to a rigid pole graduated to indicate depth. An on/off switch was fitted on-line between the battery and the pump. The sample was directed from the outlet-pipe into a graduated container. For the larger taxa the water was delivered via a 63 μm sieve. Bottrell *et al.*, (1976) indicate that up to 80% of smaller rotifers may be lost through the use of nets and sieves with mesh sizes as small as 45 μm, with 50% of these animals passing through the mesh and up to 30% adhering to it.

Samples for living and formalin-preserved picoplankton (bacteria), nanoplankton (algae and heterotrophic flagellates) and ciliates were obtained by transferring 50ml of river water to each of two sterile culture flasks, one containing a small volume of formalin added in the laboratory using a fume cupboard*. Samples were stored and dispatched with freezer-packs to minimise changes in transit and examination was completed within 36 hours.

Samples of live rotifers were taken by enclosing 100ml of river water in a clean, leak-proof, polyethylene container. Samples were stored and dispatched with freezer-packs to minimise changes in transit and examination was completed within 36 hours. Larger samples of preserved rotifers were also taken. These consisted of 500ml of water to which 5ml of 0.2g $litre^{-1}$ propaine hydrochloride* was added as a relaxant and preservative. Formaldehyde* (4% final concentration) was added the following day, for long-term preservation.

Copepods, cladocerans and the larger rotifers (from 20 litres and 5 litres) were retained on a 63µm sieve. The animals were then directed to the edge of the sieve using a jet of water from a washbottle and transferred into a labelled container using a second washbottle containing 70% ethanol (Industrial Methylated Spirit*) for storage prior to identification in the laboratory.

* Following the specific Code of Practice, relating to safe handing and storage of the material.

4.7 Counting Techniques

The study of the microplankton included the examination of the different functional categories of the microbial food web and their cell sizes. The categories are as follows:

- 1- Picoplankton: bacteria, size < 2µm

- 2 - Phototrophic nanoplankton: algae in the size range 5 to 25 µm

- 3 - Heterotrophic nanoplankton: flagellates, amoebae, and small ciliates. Size range 5 to 25 µm.

- 4 - Ciliated protozoa

Categories 1, 2, and 3 were counted after fixation with formalin and staining using DAPI (4',6-diamidino-2-phenylindole). This stain binds the microorganisms' DNA, making them visible under the fluorescence microscope. The micro-organisms were concentrated by gentle vacuum filtration onto black, 0.2 µm Nucleopore polycarbonate membranes. Blue excitation was used to visualise the nanoplankton (resulting in red autofluorescence by chlorophyll-bearing autotrophs and green fluorescence by heterotrophs). Picoplankton were detected using UV excitation, which produces blue-white fluorescence from bacteria. Counts of the ciliated protozoa were based on three replicates of 1 ml fresh sample containing the living organisms. For this purpose a Sedgewick-Rafter chamber was used. Living ciliates were identified as far as possible, and thereafter, following silver carbonate impregnation of infraciliature (Fernández-Galiano, 1976).

Preserved rotifers were identified and counted using a microscope-mounted counting chamber, following concentration by settlement and sub-sampling when appropriate. Preserved copepods and cladocerans were identified and counted using a microscope-mounted counting chamber (Sedgewick-Rafter type). Sub-sampling resulted in the examination of either 1%, of twenty litre samples, or 4%, of five litre samples, both yielding counts equivalent to numbers in 0.2 litres, which were then converted to numbers per litre.

4.8 Quality Assurance

The identification and enumeration of live material limited the number of samples that could be processed within a realistic timescale and little time was available for retrospective checks on accuracy. Material that remained after enumeration and identification of preserved rotifers, copepods and cladocerans was retained for possible future reference. Established standard techniques for enumeration were used throughout the study.

5.0 RESULTS AND INTERPRETATION

5.1 Water Temperature

Spot measurements of surface water temperatures were obtained at each of the five sampling sites, starting at the upstream (Inglesham) site around 09:00 and concluding with the Caversham (Reading) site between 15:00 and 16:00. Temperatures below the seasonal average were encountered in May (Fig. 2) and weather on the sampling dates was typical of the stable but cool conditions occurring throughout May 1996. On each sampling date from June until September slightly higher temperatures were recorded sequentially from early morning (Inglesham) until late afternoon (Caversham Lock), as sampling activity progressed downstream (Fig. 2). N.B.: Radley was not visited on the first sampling date, due to difficulties over site access .

5.2 Water Clarity and River Thames Discharge

Secchi disc measurements of water clarity (transparency) were undertaken at the four downstream sites (Fig. 3a). The upstream IFE (Inglesham) site was too shallow at the river margin to provide a secchi disc reading adjacent to the bank but secchi disc readings from Inglesham Bridge were made available by The Environment Agency (Fig. 3b). No explanation was apparent for the generally lower water clarity recorded by The Environment Agency at coinciding sites on alternate weeks through 1996. On three sampling occasions light readings were obtained at a range of depths using a light sensor and data logger, with a view to comparing the results with Secchi disc values. However, the data logger suffered from persistent breakdowns and the light sensor could not be used to obtain light attenuation profiles during conditions of varying cloud cover which thwarted useful comparisons. Repeated light sensor profiles through the water column can be averaged to reduce problems associated with variable cloud cover and surface ripple but there was insufficient time to conduct them within the constraints of the present study.

Following rainfall events in mid- and late April 1996, there was a temporary increase in the river discharge and turbidity. With below average rainfall throughout the catchment, the River Thames discharge declined and remained low over the remaining sampling period (Appendix I) and prevailing conditions would have prompted operation of the proposed Severn-Thames transfer during 1996. Changes in water clarity (Fig. 3a) were considered to be associated with plankton development (May and June onwards), increased boat movements (mid-summer) and reduction in boat movements (from mid-September). Water clarity decreased downstream on the majority of sampling occasions, this was most pronounced during the chlorophyll$_a$ (phytoplankton) maxima in June and the peak in boat activity during July and August.
N.B.: Radley was not visited on the first sampling date, due to access difficulties.

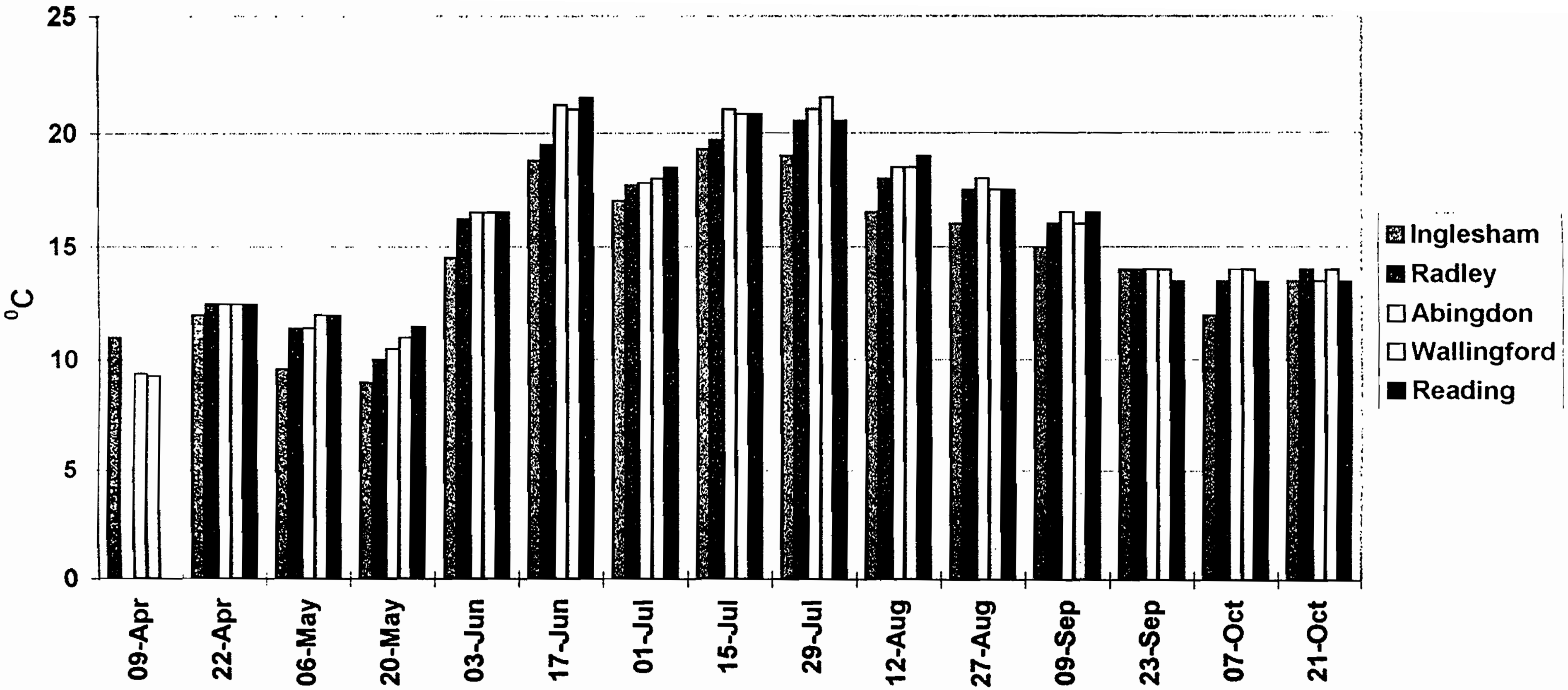


FIGURE 2: River Thames surface water temperature (^{0}C) recorded during zooplankton sampling in 1996.

Fig 3 a

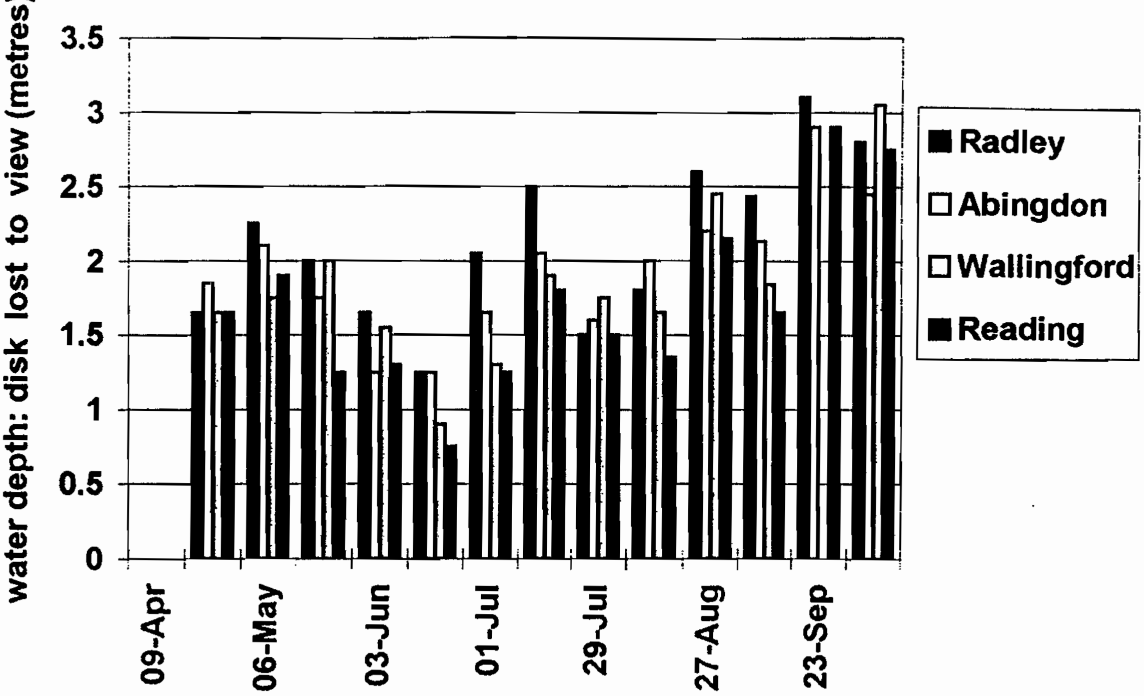


Fig 3 b

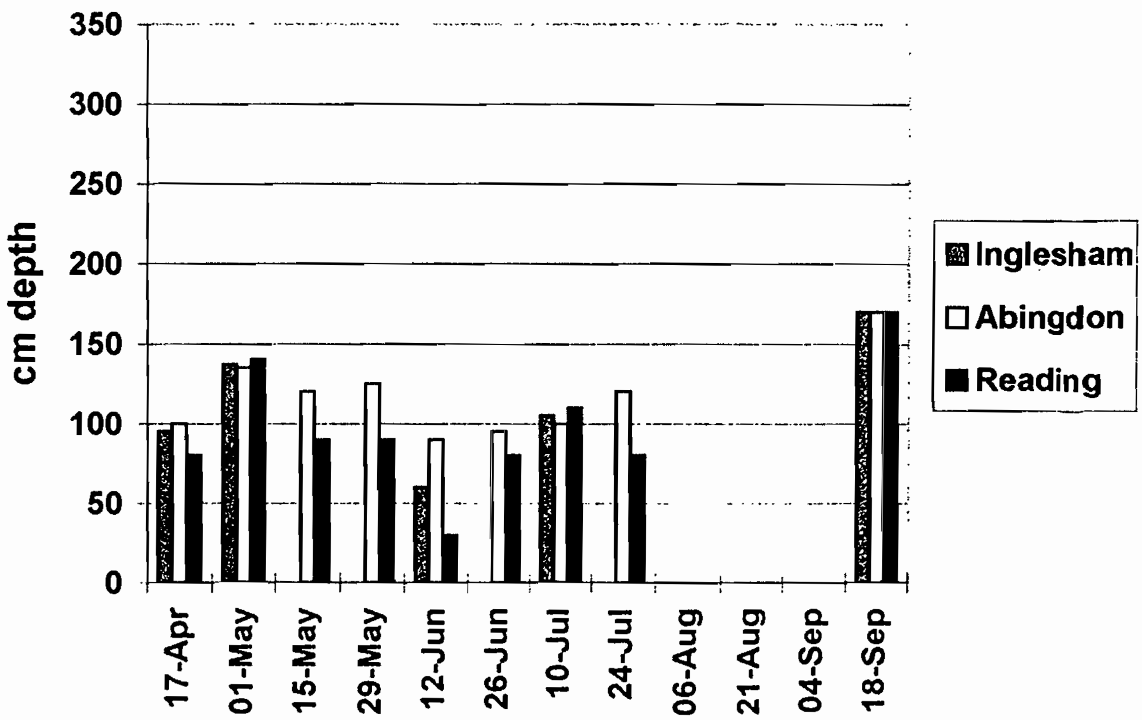


FIGURE 3: River Thames water clarity using a Secchi disc;
a) recorded during zooplankton sampling in 1996
b) the Environment Agency results obtained on alternate weeks

5.3 Suspended Chlorophyll$_a$ and River Thames Discharge

Maximum chlorophyll$_a$ concentrations were recorded in June with values increasing downstream on most sampling dates (Figs 4 & 5). The main exception to this trend was towards the end of the main chlorophyll$_a$ peak, in mid- to late June, when the Wallingford chlorophyll$_a$ values exceeded those further downstream at Reading. Chlorophyll$_a$ values during April may have been influenced by detached benthic algae since small amounts of this material were noted in contemporary zooplankton samples. Uniformly low chlorophyll$_a$ values were recorded after June. These results were closely similar to data obtained for corresponding sites on alternate weeks by The Environment Agency. Despite summer increases in the number of phototrophic nanoplankton, particularly at downstream sites, the concentration of suspended chlorophyll$_a$ remained low. Possible explanations for this phenomenon are discussed later (sections 5.5 & 5.8). In recent years the relationships between River Thames phytoplankton and physico-chemical variables have been investigated seasonally (Reynolds & Glaister, 1992) and over several years (Ruse & Hutchings, 1996 and unpublished data) providing the foundation for a closer understanding of river plankton dynamics.

In 1996 the concentrations of chlorophyll$_a$ breakdown products (phaeopigments) showed a similar seasonal and downstream pattern to the chlorophyll$_a$ (Fig. 6a) but when phaeopigments were expressed as a proportion of the pigments present the Inglesham site clearly had much higher values than downstream sites (Fig 6b). A possible explanation may be the more extensive areas of submerged plants at this upstream site which may have contributed dislodged epiphytic algae, including entrained dying cells.

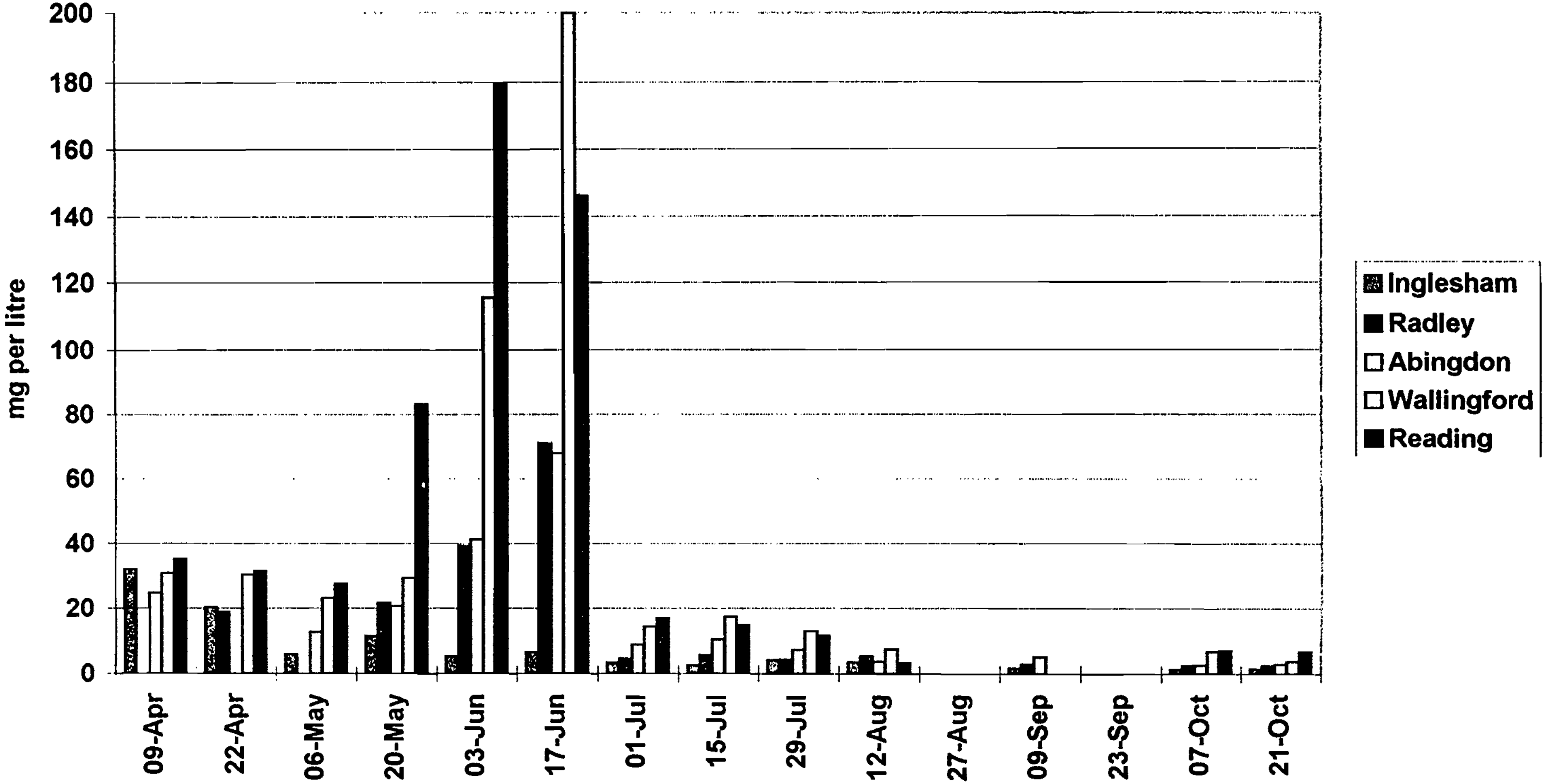


FIGURE 4: River Thames Chlorophyll$_a$ concentrations recorded at zooplankton sampling sites in 1996

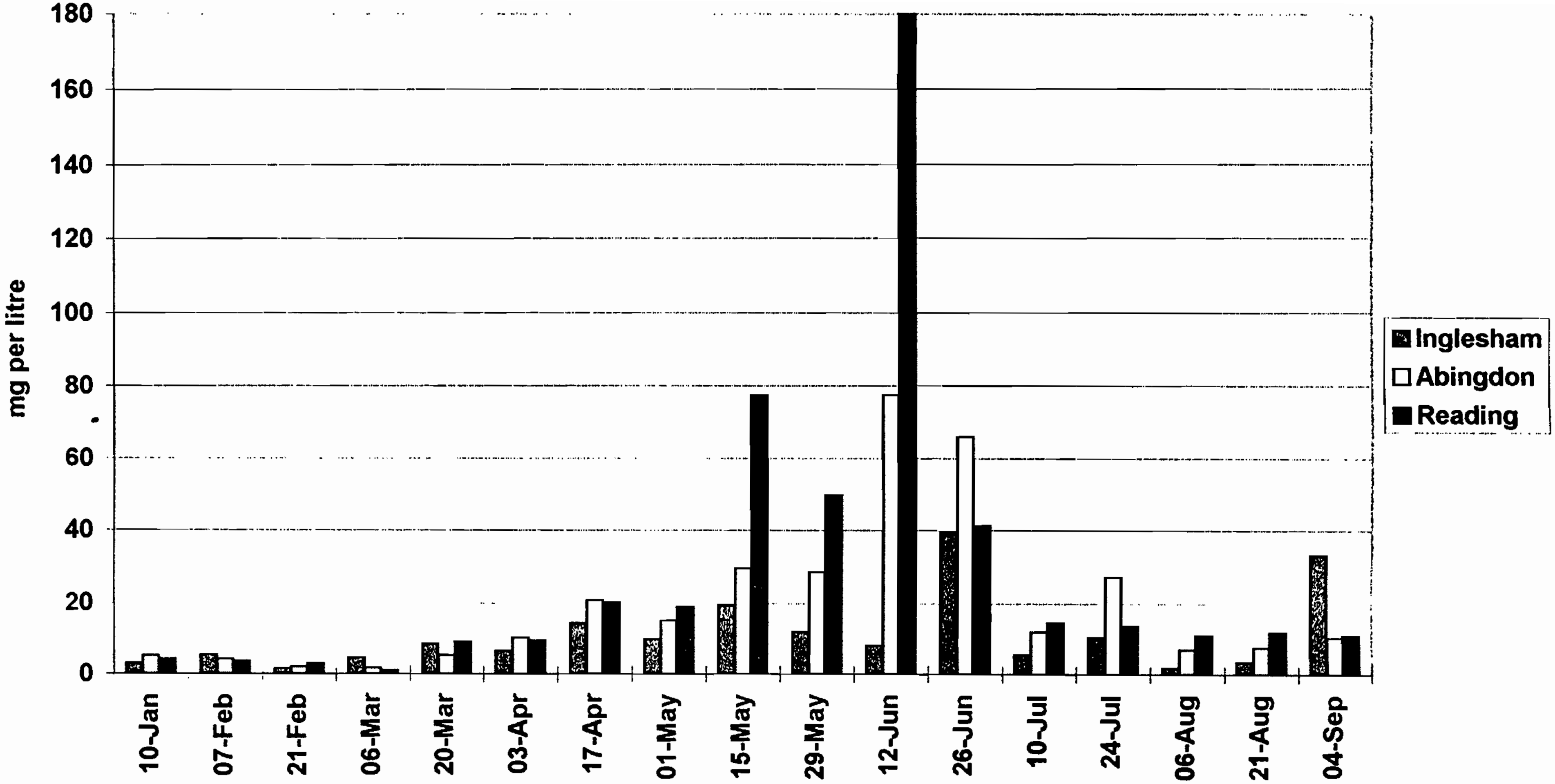
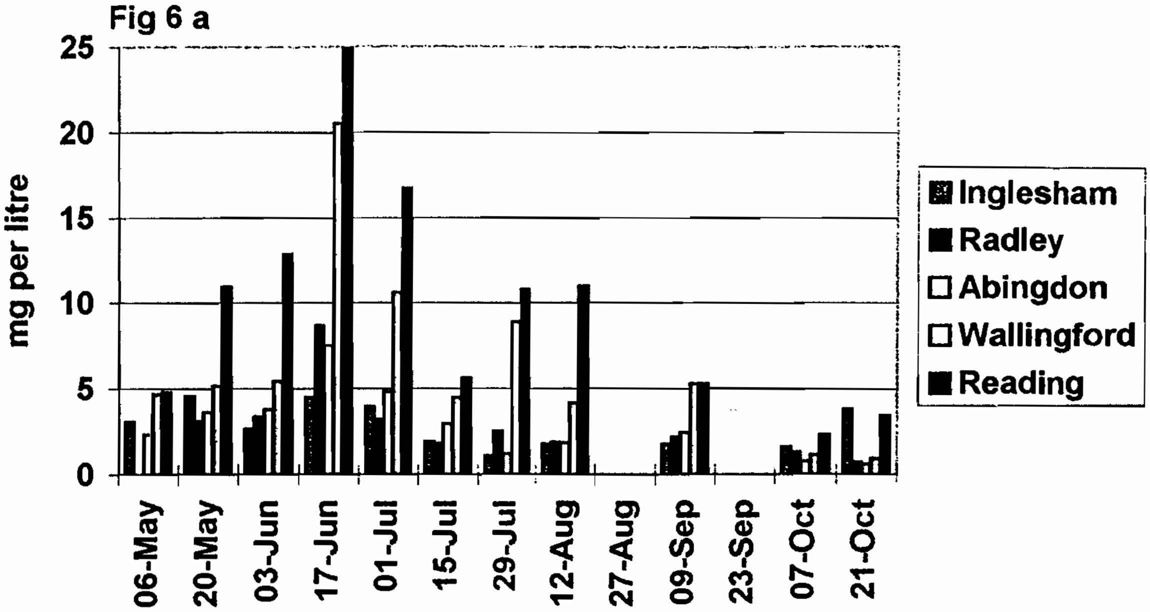


FIGURE 5: River Thames Chlorophyll$_a$ concentrations recorded by the Environment Agency in 1996 (only sites coinciding with zooplankton sampling are illustrated)



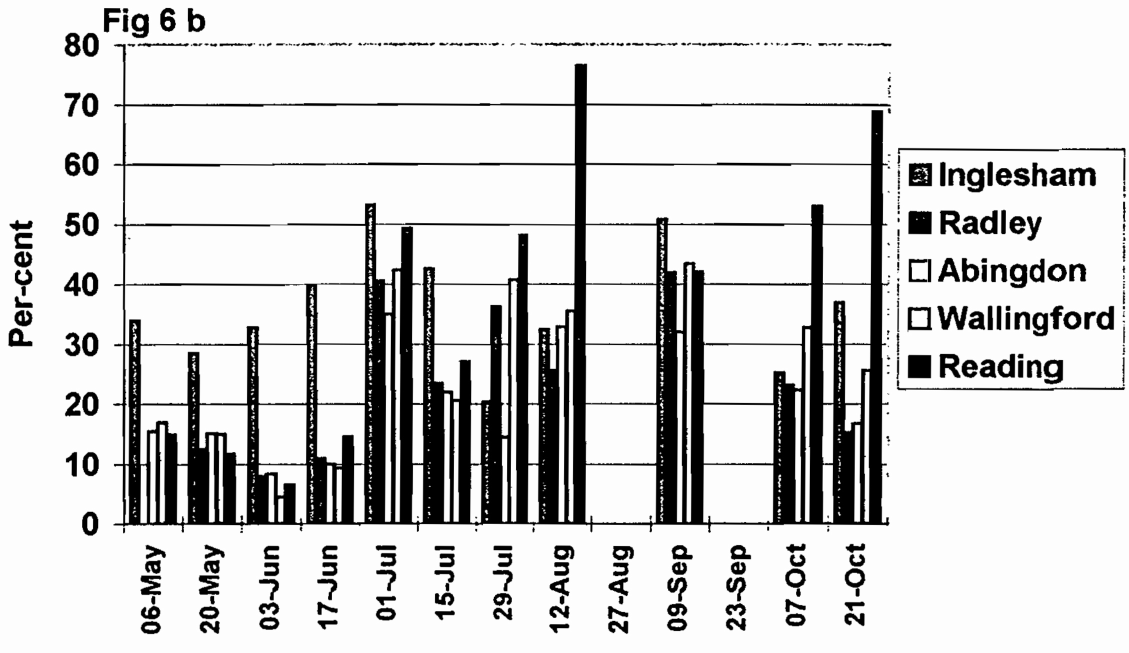


FIGURE 6: River Thames Chlorophyll$_a$ breakdown products recorded at zooplankton sampling sites in 1996

a) concentrations of Phaeopigments (mg l^{-1})

b) proportion of algal pigment breakdown products (%)

The proposed Severn-Thames transfer would discharge 200-400Ml per day to the River Thames near Buscot (Fig. 1), a few kilometres downstream from the Inglesham site. In 1996 chlorophyll$_a$ concentration was consistently lower at this site than at sites further downstream, suggesting that phytoplankton was comparatively disfavoured by the prevailing conditions at the upstream site. Addition of water bearing plankton from the River Severn could potentially change this pattern. However the volume of the receiving watercourse, reach retention time and possible changes to nutrients, turbidity and phytoplankton loss-processes have to be considered in relation to the variable river flow pattern before robust predictive models can be generated. Characteristics of the River Severn phytoplankton have been studied (Reynolds and Glaister, 1992) but we not aware of any information on River Severn zooplankton. The period for which River Severn water was held in settlement/mixing reservoirs and pipelines prior to discharge would dictate the scale of changes to the plankton present before discharge (Furse *et al.*, 1997).

N.B.:

a) Data for Radley were unavailable on 9.4.96.
b) The following chlorophyll samples were lost during processing:
Abingdon, 22.4.96 and Radley, 6.5.96.

5.4. Picoplankton

The numbers of bacteria found at the five sampling sites in the River Thames are typical of the values found for other water bodies worldwide i.e. between 10^6-10^7 cells/ml (Fig. 7). These results remained relatively constant (maximum absolute variation, one order of magnitude) throughout the sampling period, with slightly higher abundances in summer.

5.5. Nanoplankton

The phototrophic nanoplankton (PNANO) release a proportion of the carbon they fix by photosynthesis as dissolved organic carbon. The heterotrophic nanoplankton (HNANO) are dominated by flagellates and small ciliates. They are particularly important because they sieve bacteria from relatively large volumes of water. They also have high specific excretion rates of nitrogen and phosphorous. Temporal variation in abundance of PNANO and HNANO at the five sampling sites generally lay in the range 10^4-10^5 cells ml^{-1} at the three upstream sites with larger numbers (10^4-10^6 cells ml^{-1}) recorded downstream at Wallingford and Reading (Fig. 7). These figures are close to the middle of the global range for nanoplankton abundance (Berninger *et al.* 1991).

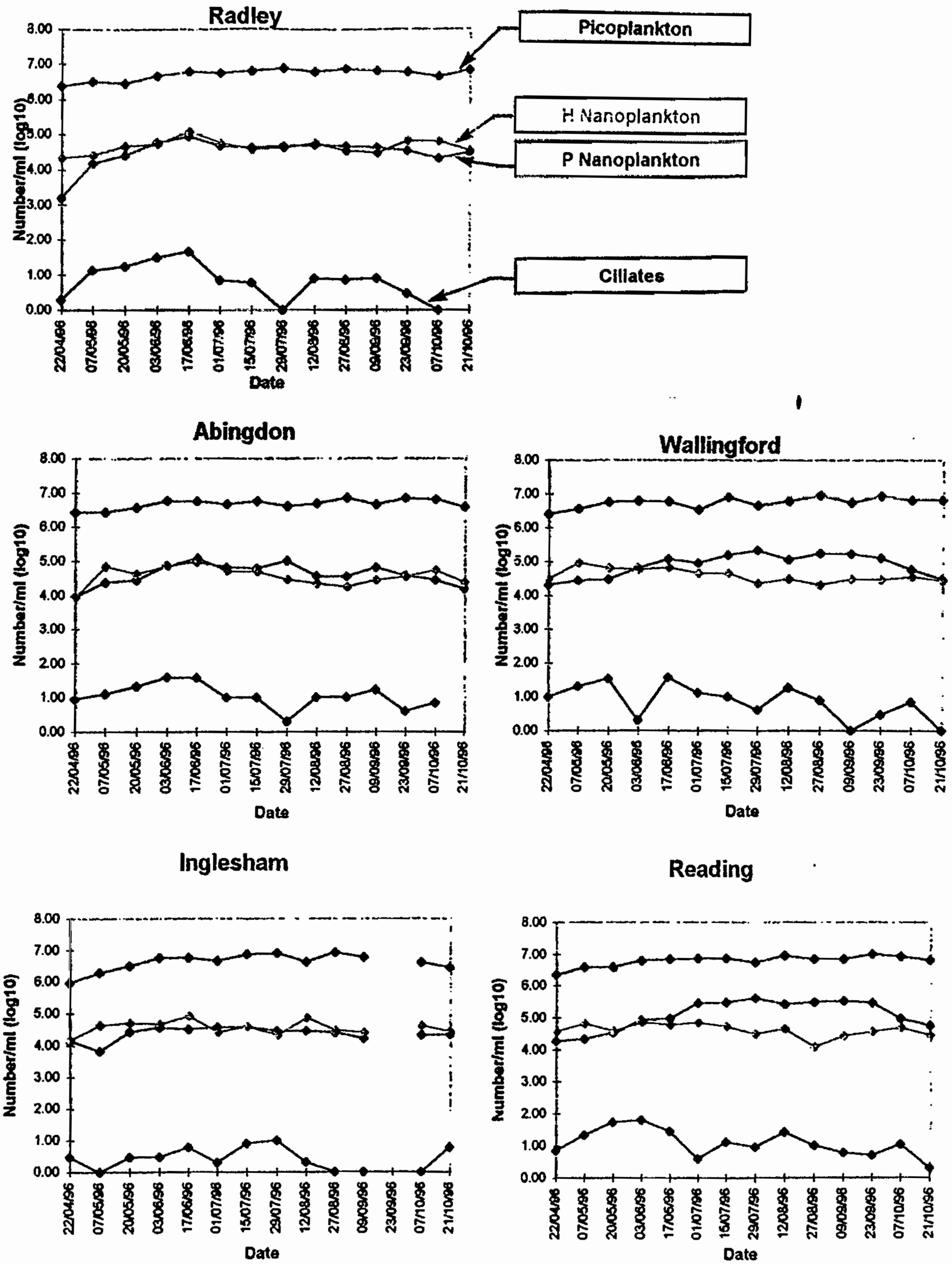


FIGURE 7: Temporal variation the Picoplankton and Nanoplankton components at the five sampling sites.

The number of pico- and nanoplankton is also a measure of biological productivity. A combination of the number and size of organisms present provided estimates of biovolume and biomass. Seasonal variation in productivity is illustrated in Figs. 8 and 9, where it is apparent that summer values are significantly higher.

5.6. Ciliates

Ciliated protozoa are unicellular organisms with specialised structures forming a "mouth" through which they ingest bacteria, unicellular algae, and other microbes (Fig. 10). They are therefore phagotrophs, that depend on the abundance of the other plankton components. Their phagotrophy underpins their ecological importance in microbial food webs. In the open water of lakes and oceans (Berninger *et al.*, 1991), in anoxic sediments (Fenchel and Finlay, 1995), and sandy sediments in rivers (Finlay *et al.*, 1993), they are quantitatively the most important consumers of other micro-organisms. In the case of the River Thames (as in most other aquatic habitats) the degree of variation in ciliate abundance was greater than that of the other microbial components of the plankton (Fig. 7). Their numbers were always lower than 50 cells ml^{-1} and usually around 10-20 ml^{-1}.

Ciliate species are commonly used as indicators of water quality and perturbations due to pollution. A total of 40 ciliate species were found (Table 1). With few exceptions, the same species were found at all five sites in the River Thames. The ciliate communities were diverse and typical of planktonic systems such as ponds and lakes. The majority of species were bacteria feeders, especially during the cold months. Other predators present in the samples, particularly during warm periods, were algal-feeding species, of which the commonest were four different species of the ciliate genus *Urotricha*.

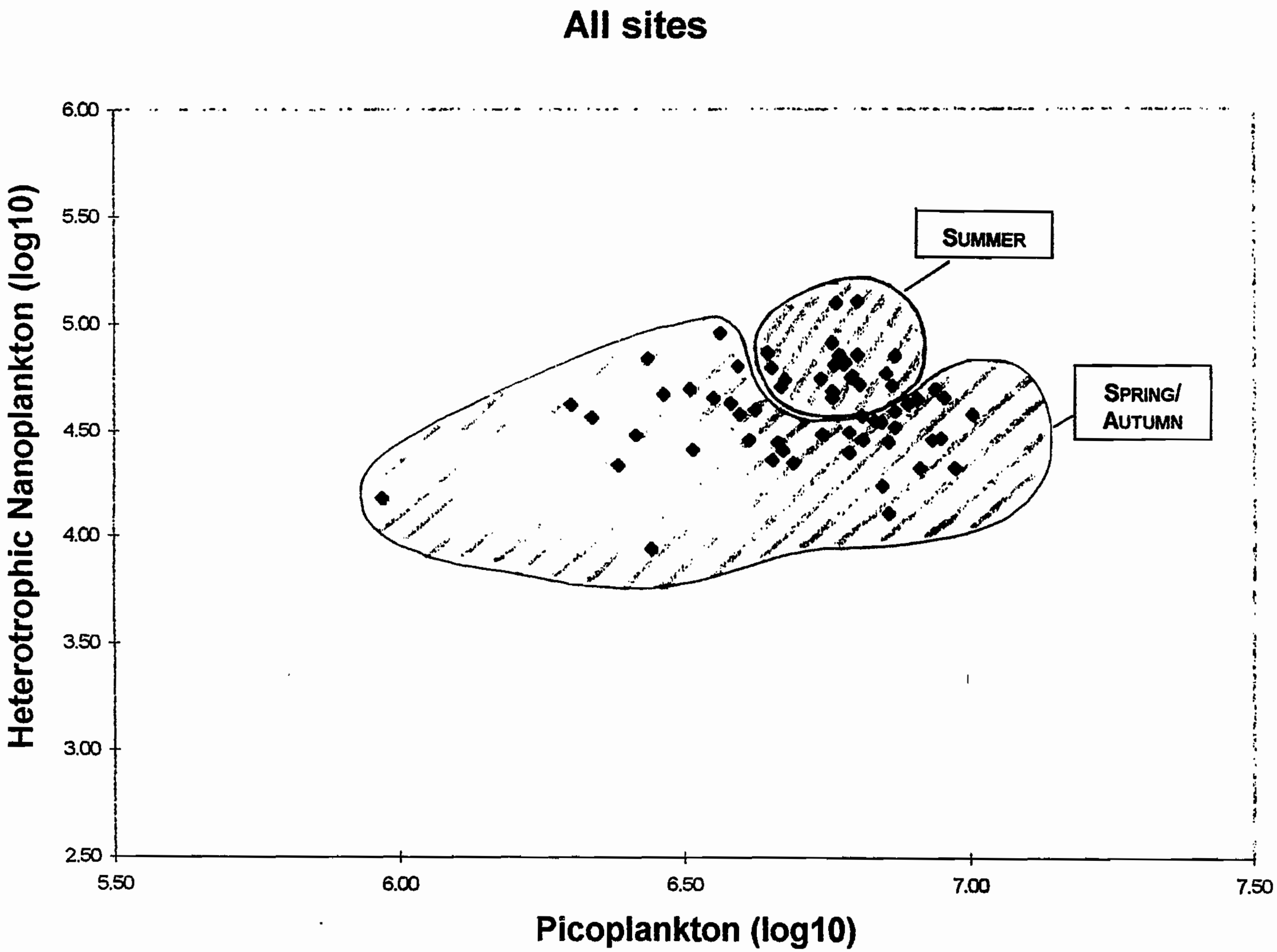


FIGURE 8: Seasonal variations of productivity measured as abundance of Picoplankton and Heterotrophic Nanoplankton. Both components of the microplankton were more abundant in summer than in spring/autumn.

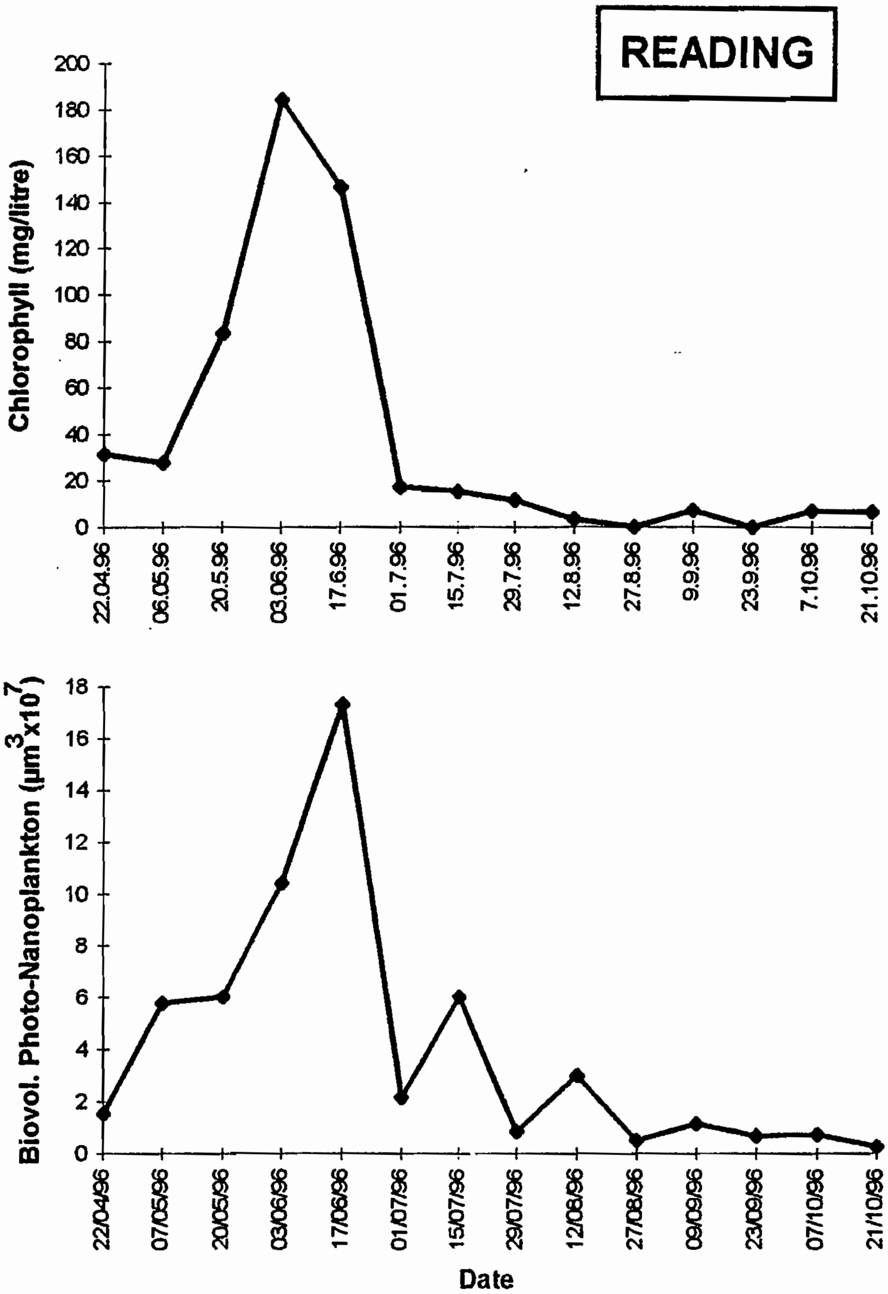


FIGURE 9: The biomass is an indicator of productivity and can be characterised as chlorophyll a. Maximum values were in summer (especially June). A parallel increase in the biovolume of phototrophic organisms was also observed.

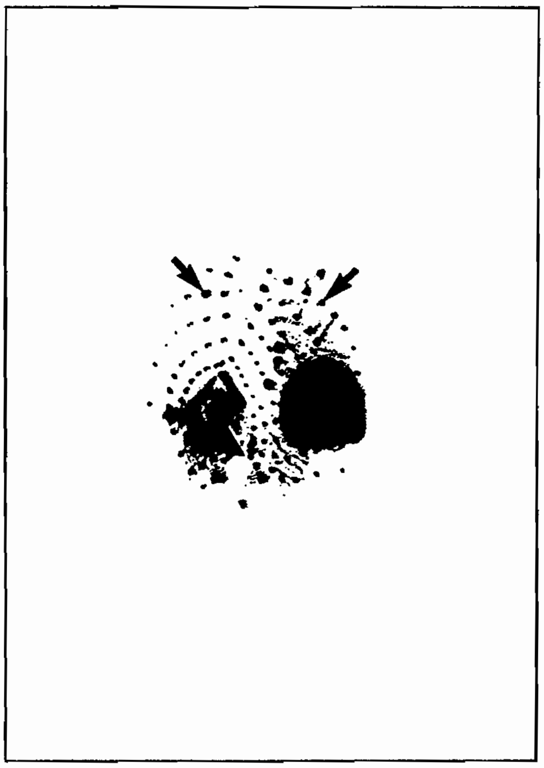


FIGURE 10: *Cinetochilum margaritaceum*, a common ciliated protozoon in the River Thames. Arrows to the rows of cilia; arrowhead to the oral aperture. Cell size: 30 µm.

TABLE 1: Species of ciliated protozoa found in the River Thames at the five sampling sites.

Actinobolina radians
Askenasia sp.
Aspidisca sp.
Astylozoon sp.
Balanion planctonicum
Bursaridium sp.
Cinetochilum margaritaceum
Coleps sp.
Colpidium campylum
Colpidium colpoda
Ctedectoma acanthocrypta
Cyclidium glaucoma
Cyclidium plouneouri
Drepanomonas revoluta
Epistylis sp.
Euplotes patella
Glaucoma scintillans
Halteria grandinella
Lagynophrya rostrata
Litonotus lamella
Mesodinium velox
Monodinium rostratum
Oxytricha sp.
Paranophrys thompsoni
Phascolodon vorticella
Pleuronema sp.
Strobilidium minimum
Strobilidium sp.
Strobilidium velox
Strombidium humile
Strombidium viride
Stylonychia sp.
Tetrahymena pyriformis
Tintinnidium fluviatile
Urotricha agilis
Urotricha furcata
Urotricha globosa
Urotricha pelagica
Vorticella natans
Vorticella sp.

Total = 40 species

5.7. Microbial Food Web - Discussion

The fundamental characteristics of aquatic microbial food webs are represented in Fig. 11. The dissolved organic carbon (DOC) released by phototrophic nanoplankton is taken up by bacteria (picoplankton) which are grazed by heterotrophic nanoplankton (flagellates and ciliates) which serve as food for larger ciliates and other micro-zooplankton (e.g. rotifers). The loop is completed with the mineralization of ingesta and the excretion of P, N, and other nutrients which can be re-used by phototrophs.

Evidence from lakes, ponds and rivers (Berninger *et al.*, 1991) indicates that the number of algae, bacteria, flagellates, and ciliates living in a water mass tend to be correlated with each other. In an attempt to provide a general picture of the microbial food web and its seasonal development in the River Thames we enumerated bacteria, nanoplankton, and ciliated protozoa from five sampling sites over a period of six months (April-October). Examination of winter samples would complete the general picture of the natural variation of the microbial loop in the River Thames.

Bacteria and nanoplankton were enumerated in a range of size classes and functional categories. The results provided a baseline characterisation of the types of microbial food webs present in the River Thames and of the natural variation in abundance within the component groups of organisms. The same component groups of organisms in the microplankton were retained over the sampling period, with slight seasonal variations in the abundance of different components.

The four components of the microplankton varied together (Fig. 12): picoplankton (bacteria) were always the most abundant; the phototrophic and the heterotrophic nanoplankton oscillated independently, the ciliates were always the least abundant at the five sampling sites. This relationship was retained throughout the sampling period April-October. Abundance within each group varied within the limits expected for freshwater systems. Of particular note is the positive correlation between picoplankton and heterotrophic nanoplankton abundance. Their numbers consistently differed by two to three orders of magnitude. The sampling sites of Wallingford and Reading were the most productive, with the highest numbers of phototrophic nanoplankton.

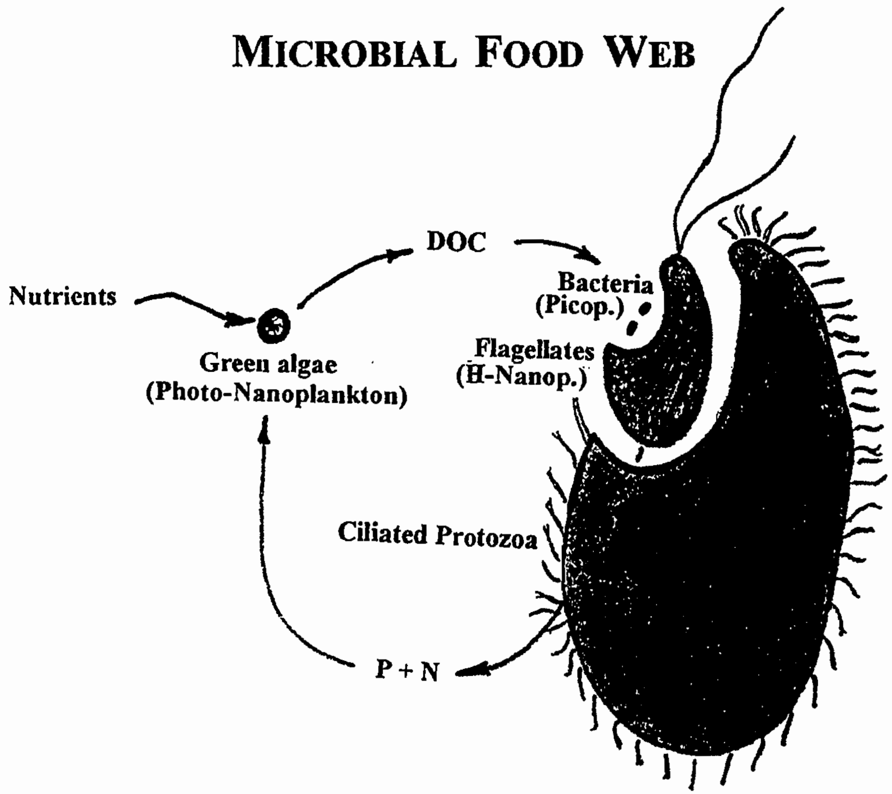


FIGURE11: The **microbial food web**. The Phototrophic Nanoplankton release dissolved organic carbon (DOC) as a product of photosynthesis. This is taken up by the Picoplankton (bacteria), which are grazed by the Heterotrophic Nanoplankton (mainly flagellates and small ciliates). These are grazed by larger ciliates and other micro-zooplankton (rotifers). The loop is completed with the mineralization of ingesta and the excretion of P, N, and other nutrients which will be used by the phototrophs.

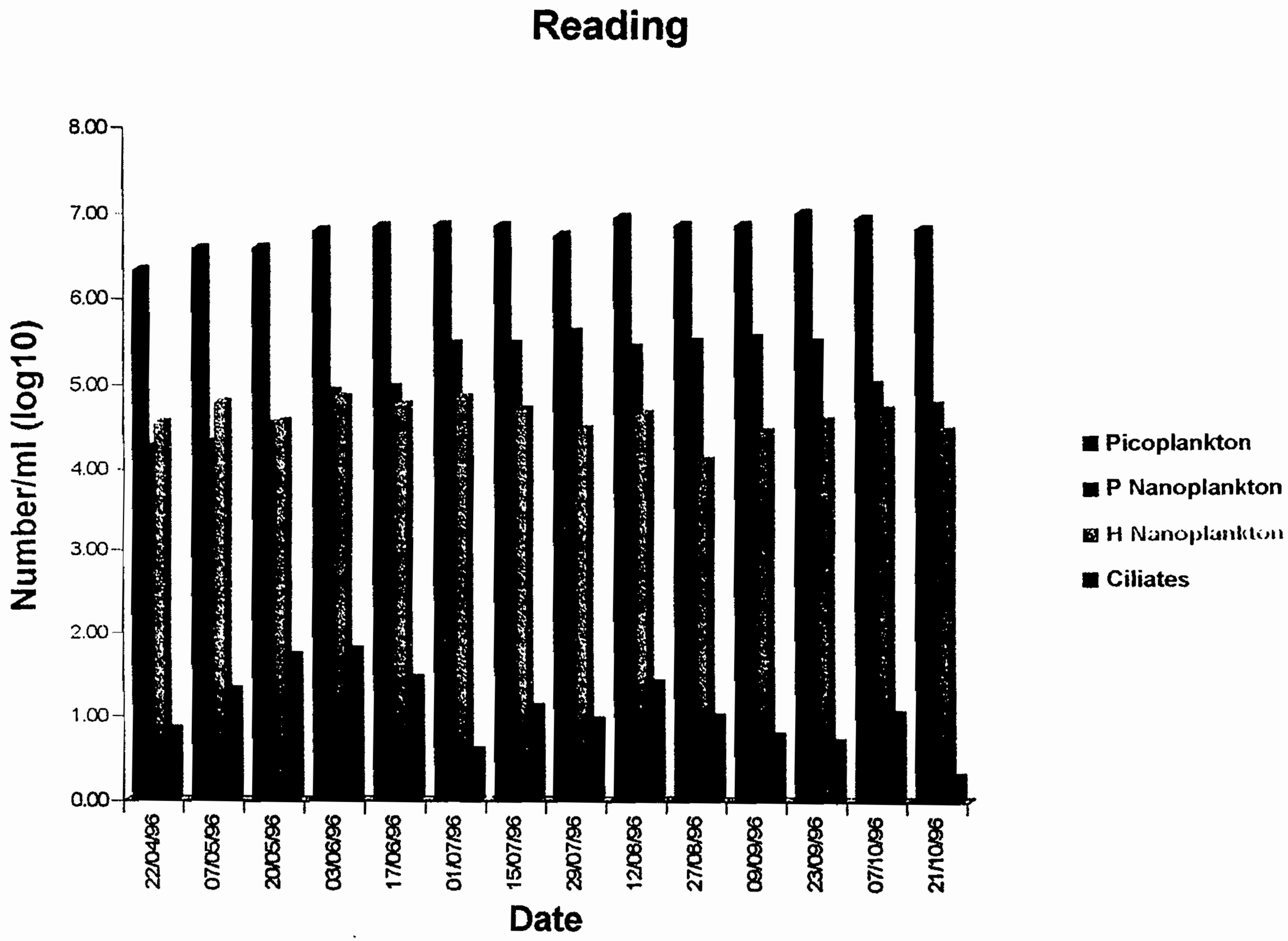


FIGURE 12 The four components of the microplankton varied together: The Picoplankton (bacteria) had always the highest abundance; the Phototrophic and Heterotrophic Nanoplankton oscillated independently but they kept similar abundances; the ciliated protozoa (predators) were the least abundant.

In conclusion, the microbiological system works as follows:

More plant nutrients (e.g. P) = more algae = more DOC = more heterotrophic bacteria = more flagellates = more ciliated protozoa

Under eutrophic conditions of unlimited plant nutrient availability the downstream increase in some components of the River Thames plankton was considered to result from the accumulation of plankton biomass as the increased retention time became more significant than the combination of loss-processes and loss rates operating.

5.8 Rotifers

5.8.1 Rotifer species and total abundance (method 1)

More than 30 species of rotifer were recorded in the River Thames between the beginning of April and the end of July, 1996 (Table 2). Seven of these species were relatively abundant, achieving mean population densities in excess of 25 individuals l^{-1} over the study period. These were, in order of importance, *Keratella cochlearis*, *Synchaeta oblonga*, *Polyarthra dolichoptera*, *Keratella quadrata*, *Brachionus angularis*, *Euchlanis dilatata* and *Brachionus calyciflorus* (Fig. 13). The remaining species were relatively scarce. Many of the species recorded are generally considered to be indicators of eutrophic conditions. These include *Brachionus angularis*, *Euchlanis dilatata*, *Filinia longiseta*, *Keratella cochlearis* f. *tecta*, *Keratella quadrata*, *Lecane lunaris* and *Trichocerca pusilla* (Bērziņš & Pejler, 1989).

Many rotifer species occurred at all of the sites sampled (Table 2), especially the more abundant species. Most of those species which were not recorded at all sites were found in very low numbers and so, no conclusions could be drawn about their horizontal distribution. The exception to this was *Trichocerca pusilla* which, in late July, was absent from the upstream sites (Inglesham, Radley, Abingdon) and relatively abundant at the downstream sites (Wallingford, Reading) (Fig. 14). The reasons for this are unclear but may be linked to diatom availability as this species both feeds and lays its eggs on filamentous diatoms such as *Melosira* sp. (May, 1983).

Table 2. Rotifer species found in the River Thames, April - July 1996.

Species	Presence/Absence				
	Inglesham	Radley	Abingdon	Wallingford	Reading
Anuraeopsis sp. Lauterborn				✓	
Brachionus angularis Gosse	✓	✓	✓	✓	✓
Brachionus calyciflorus Pallas	✓	✓	✓	✓	✓
Bdelloids	✓	✓			✓
Brachionus urceolaris Müller)	✓				
Colurella adriatica Ehrenberg	✓	✓	✓	✓	✓
Cephalodella gibba (Ehrenberg)	✓				
Colurella sp. Bory de St Vincent	✓	✓		✓	✓
Cephalodella sp. Bory de St Vincent	✓	✓	✓		✓
Euchlanis dilatata Ehrenberg	✓	✓	✓	✓	✓
Euchlanis dilatata f. *larga* (Kutikova)	✓		✓		✓
Filinia brachiata (Rousselet)					✓
Filinia ?longiseta (Ehrenberg)	✓		✓	✓	✓
Gastropus sp. (Imhof)	✓	✓			
Keratella cochlearis f. *tecta* (Gosse)	✓	✓	✓	✓	✓
Keratella coclearis f. *typica* (Gosse)	✓	✓	✓	✓	✓
Keratella quadrata (Müller)	✓	✓	✓	✓	✓
Lecane ?candida Harring & Myers	✓				✓
Lecane sp. Nitzsch	✓	✓			
Lepadella sp. Bory de St Vincent	✓				
Lecane lunaris (Ehrb.)	✓	✓	✓		
Notholca acuminata Ehrenberg	✓	✓	✓	✓	✓
Notholca squamula (Müller)	✓	✓	✓	✓	✓
Polyarthra dolichoptera Idelson	✓	✓	✓	✓	✓
P. dolichoptera f. *aptera* (Hood)	✓	✓			✓
Proales sp. Gosse	✓				
Rhinoglena frontinalis Ehrenberg	✓			✓	
Synchaeta oblonga (Müller)	✓	✓	✓	✓	✓
Synchaeta ?pectinata Ehrenberg		✓	✓	✓	✓
Trichocerca ?cylindrica (Imhof)	✓		✓	✓	✓
Testudinella patina (Hermann)					✓
Trichocerca pusilla (Lauterborn)				✓	✓
Trichocerca sp. Lamarck	✓	✓	✓		✓
Trichotria tetractis (Ehrb.)	✓	✓		✓	✓

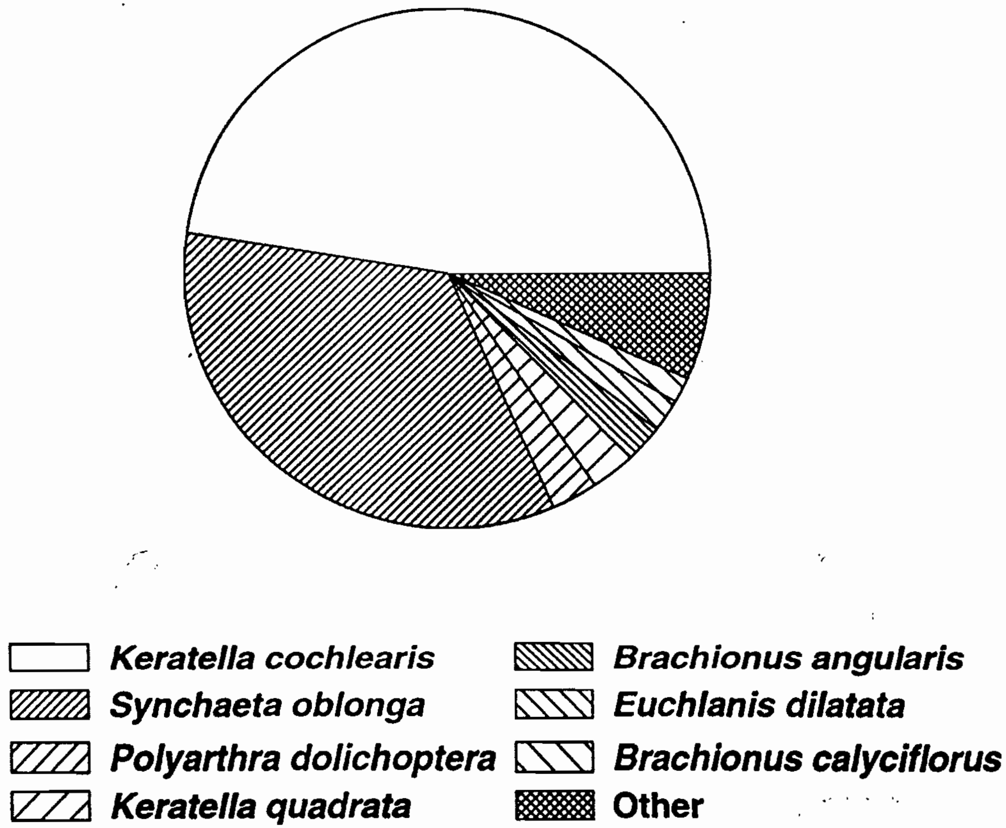


FIGURE 13: Relative abundance of different rotifer species in the River Thames, April to July, 1996.

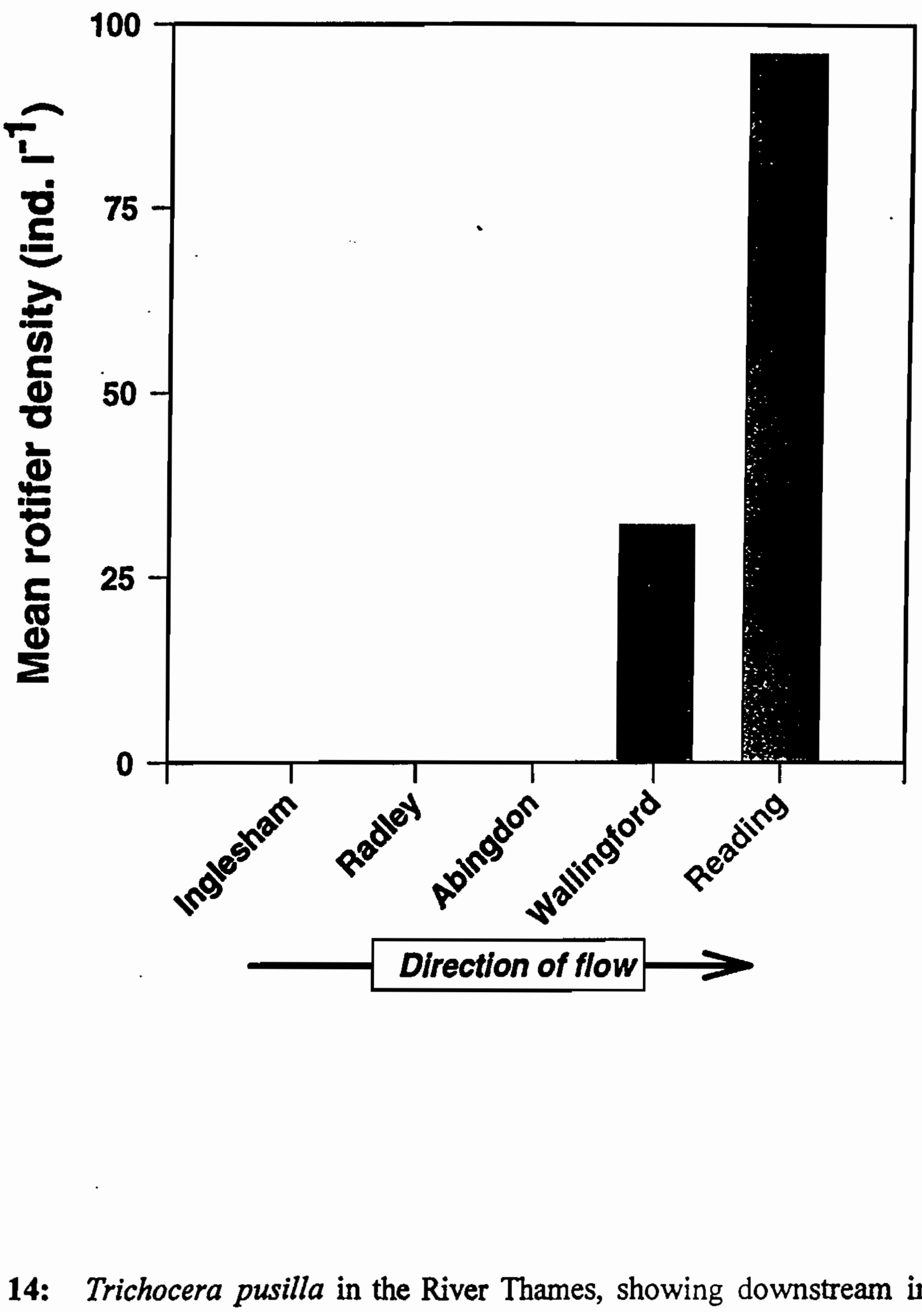


FIGURE 14: *Trichocera pusilla* in the River Thames, showing downstream increase in abundance on 27 July 1996.

When rotifer densities were low (ie April and May) there was little difference in rotifer abundance between sites (Fig. 15). However, as densities increased a marked downstream increase in abundance developed (Figs 15 and 16). At Inglesham, the most upstream site, the mean rotifer density was only 13 ind. l^{-1}. In contrast at Reading, the most downstream site, a mean rotifer density of more than 1000 ind l^{-1} was recorded. In addition, the species dominance changed between the upstream and downstream sites (Fig. 16). *S. oblonga* was dominant at the upstream sites (Inglesham, Radley, Abingdon) while *S. oblonga* and *K. cochlearis* were present in almost equal numbers further downstream at Wallingford while at the furthest downstream site (Reading) *K. cochlearis* was dominant and *S. oblonga* was sub-dominant.

Individual rotifer densities were very high on some sampling occasions, especially for *K. cochlearis* and *S. oblonga*, which respectively attained maximum population densities of 3664 ind. l^{-1} on 29 July 1996 and 1367 ind. l^{-1} on 17 June 1996. The maximum total rotifer density recorded was 4,160 ind. l^{-1} on 29 July 1997. These population maxima were recorded at the Reading sampling site. Such high rotifer densities in lakes are generally associated with eutrophication.

In general, the overall increase in rotifer abundance recorded downstream seemed to occur in parallel to increases in chlorophyll$_a$ concentration in the river water (Fig. 17). This suggests that rotifer abundance is controlled primarily by food availability since chlorophyll$_a$ levels reflect algal biomass and most rotifers feed on algal cells. However, many rotifers are specialist feeders, preferring one algal size category or species over another so comparing total rotifer numbers with an index of total phytoplankton abundance, though useful for showing general trends, probably masks many of the complex species interactions which occur within the rotifer and phytoplankton communities. A comprehensive assessment of such interactions requires detailed information on algal species abundance in 1996, which was not available at the time of writing this report.

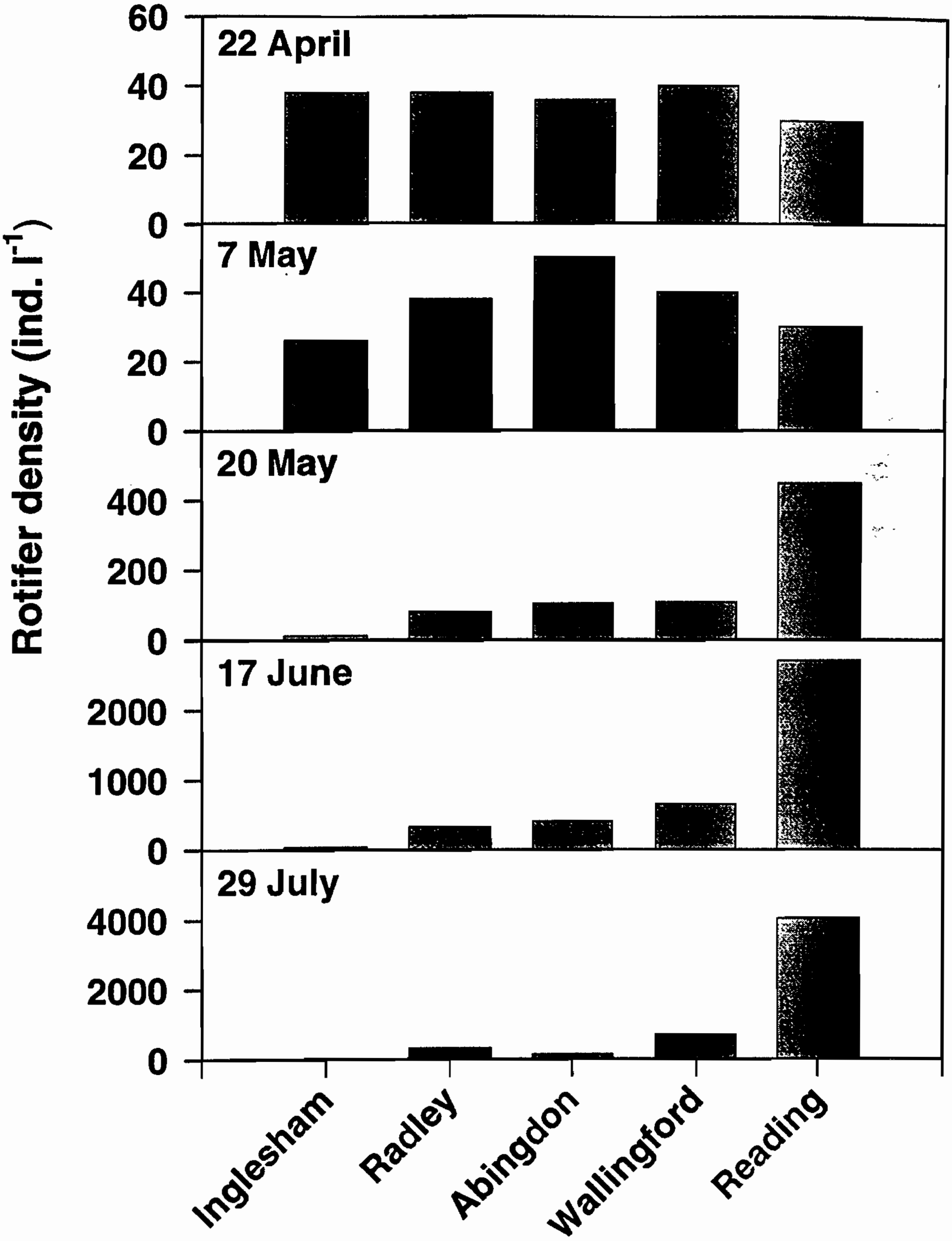


Figure 15: Horizontal distribution of rotifers along the River Thames, April - July 1996.

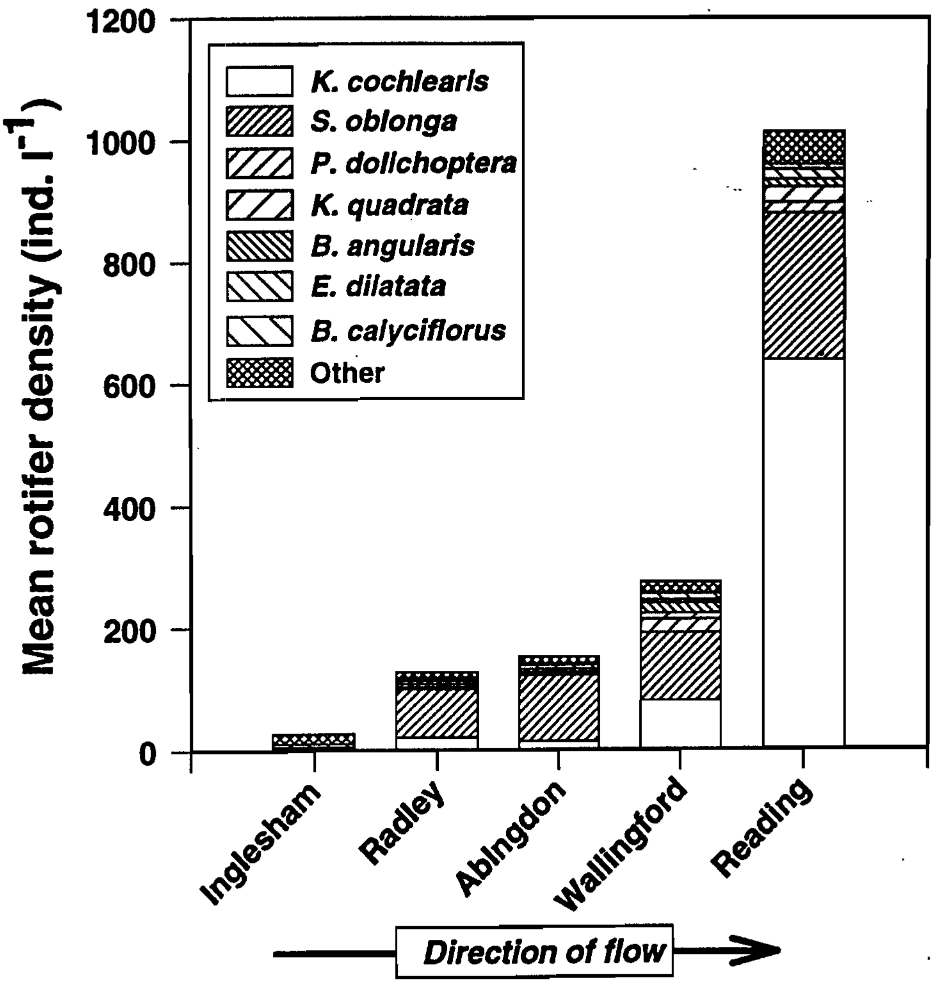


FIGURE 16: Mean rotifer density at each sampling site on the River Thames, showing relative abundance of the most important species.

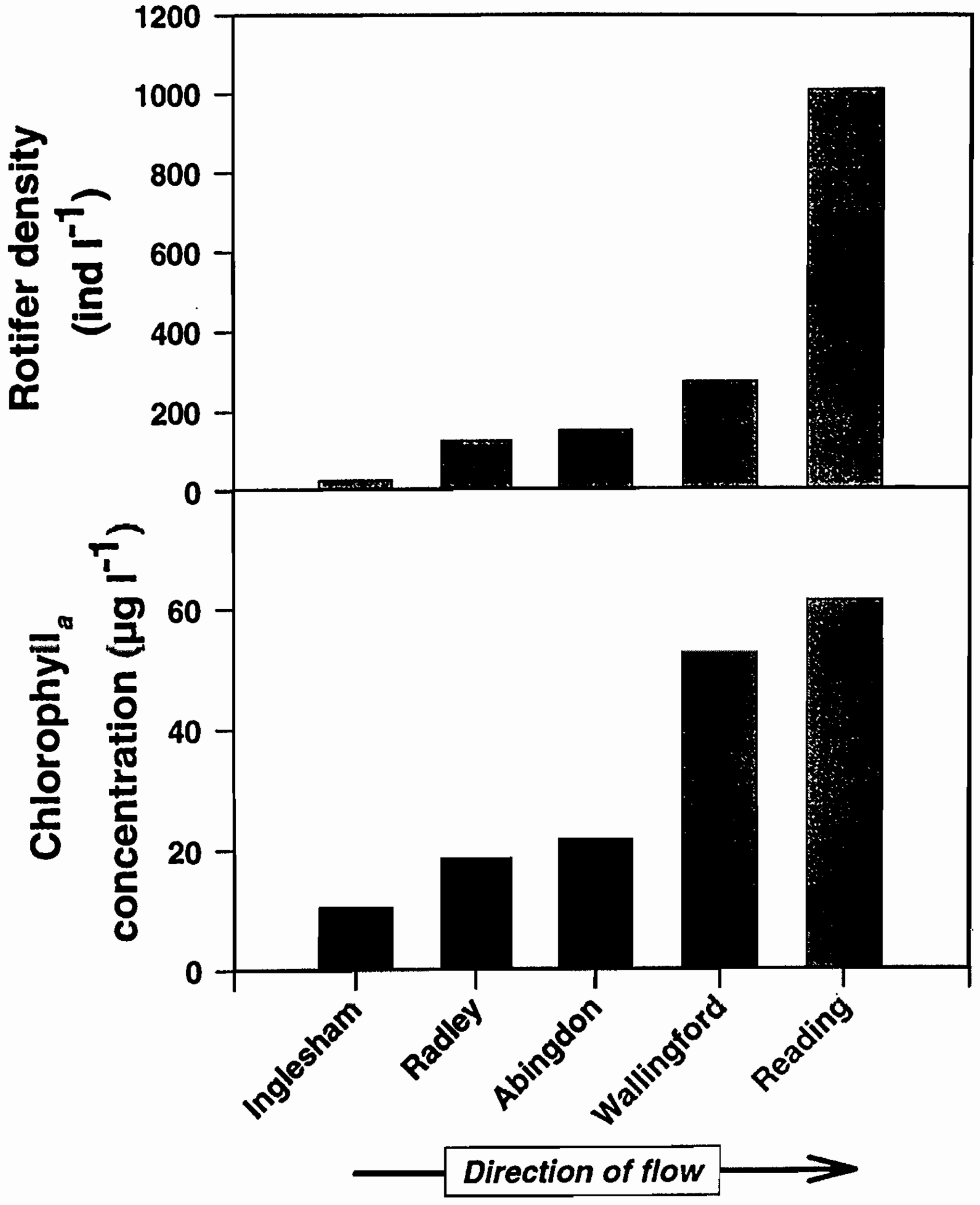


FIGURE 17: Mean chlorophyll$_a$ concentration and rotifer abundance at each sampling site on the River Thames, April-July 1996.

Rotifers are generally preyed upon by other invertebrates, such as copepods and very young larval fish, but this is very difficult to quantify. Predatory planktonic invertebrate numbers in the River Thames are low and so are unlikely to reduce rotifer numbers significantly. However, fish gut analyses have confirmed that rotifers are an important food source for larval fish. The occurrence of spined forms of the rotifer *Brachionus calyciflorus* (Fig. 18) from mid-June until mid-July coincides with appearance of larval fish, tending to support this hypothesis. This is because this species is known to produce posterior spines in response to, and possibly as a defence against, predation (Stemberger & Gilbert, 1987).

Water temperature is another environmental factor which probably affects species composition and abundance within the rotifer community. For example, *Notholca* spp., which are known to be cold water species (May, 1980, 1983; Laxhuber & Hartmann, 1988), were only found in the River Thames during April and May, when the water temperature was less than about 15°C (Fig. 19). As the water temperature rose above this level in late May, these species were no longer recorded in any of the samples collected. In addition, increases in the relative abundance of the tail-less '*tecta*' form of *K. cochlearis* in comparison with the tailed '*typica*' form, were also recorded as the water temperature increased (Fig. 20). This phenomenon is well documented for the genus *Keratella*, and may also be associated with increased food availability (Pejler, 1980).

In general, rotifer numbers were low throughout the study, rarely reaching densities greater than 1000 ind. l-1. The likely impact of their grazing activity on algal biomass was estimated using published data on rotifer clearance rates. These suggested that, under laboratory conditions, the clearance rate of *Keratella cochlearis* was about 1.8 μl animal^{-1} h^{-1} (Bogdan & Gilbert, 1987). For the purposes of this study, other rotifer species were assumed to have similar clearance rates. The data suggested that the clearance rate of the rotifer community, even at unusually high population densities of 1000 rotifers l^{-1}, was probably only about 40 ml d^{-1}. This would remove only about 4% of the algal biomass each day, having little effect on overall phytoplankton abundance. However, these figures are based on clearance rates determined in the laboratory under favourable food conditions and at 20°C. In reality, with lower rotifer densities, cooler temperatures and less favourable food conditions, the actual impact of rotifer grazing on the phytoplankton in the river was probably much lower than this for most of the time. If so, rotifer grazing probably has little effect on algal abundance or water quality.

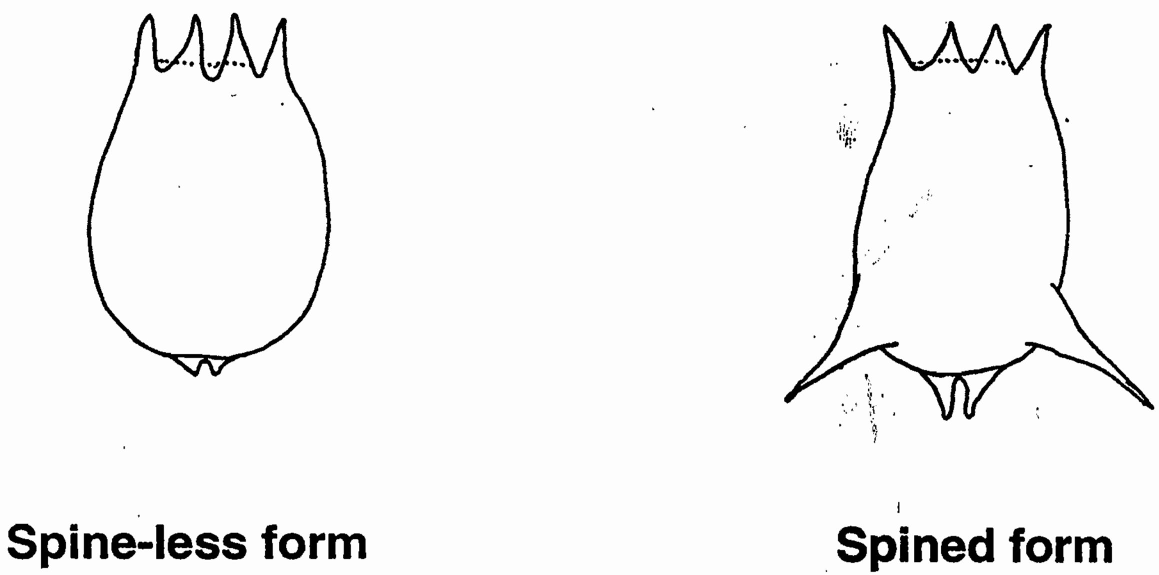


FIGURE 18: Spined and spine-less forms of *Brachionus calyciflorus*.

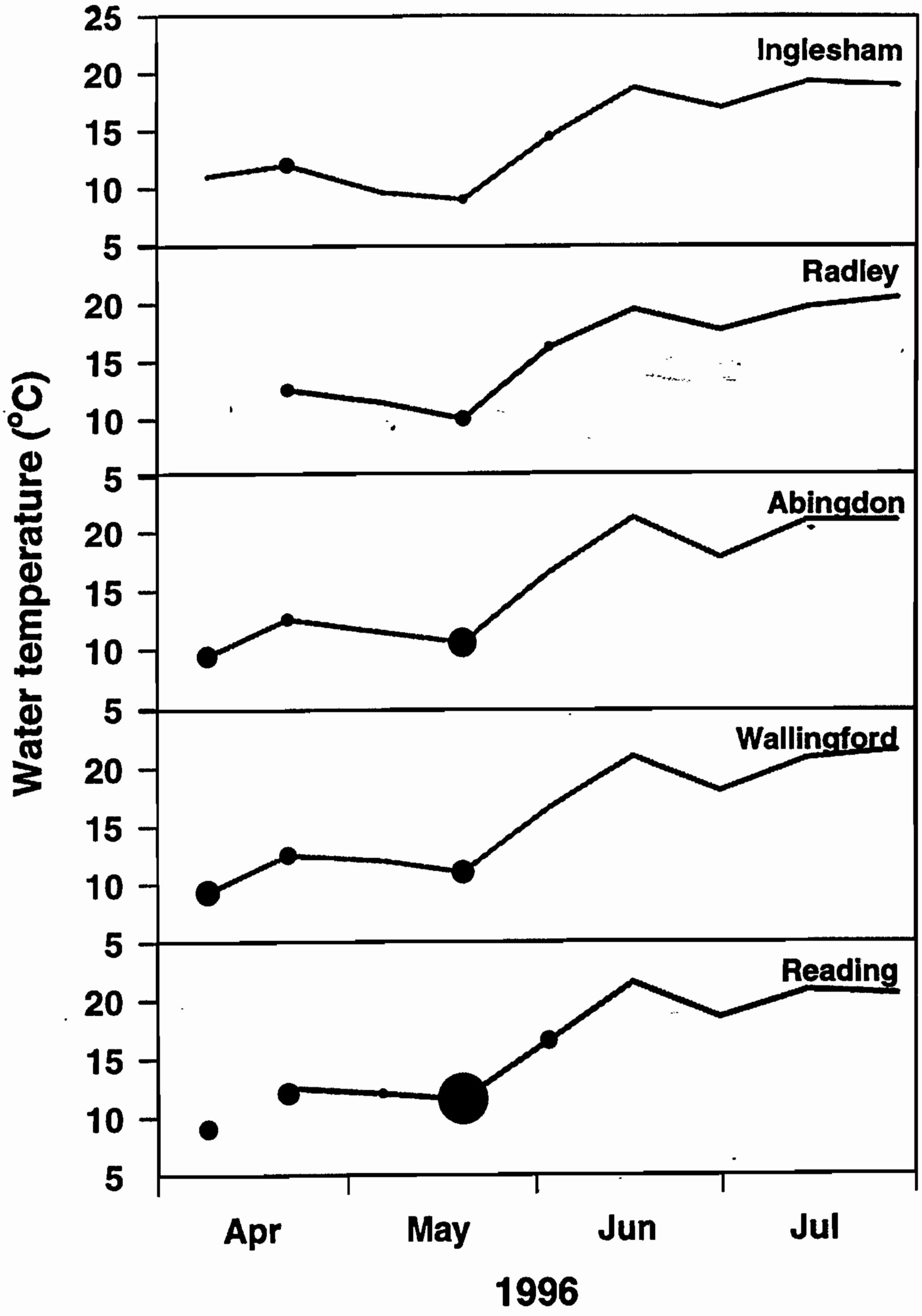


FIGURE 19: *Notholca* densities (•) in relation to water temperature at each sampling site along the River Thames, April - July 1996. (*Notholca* densities are proportional to the area of the shaded circles.)

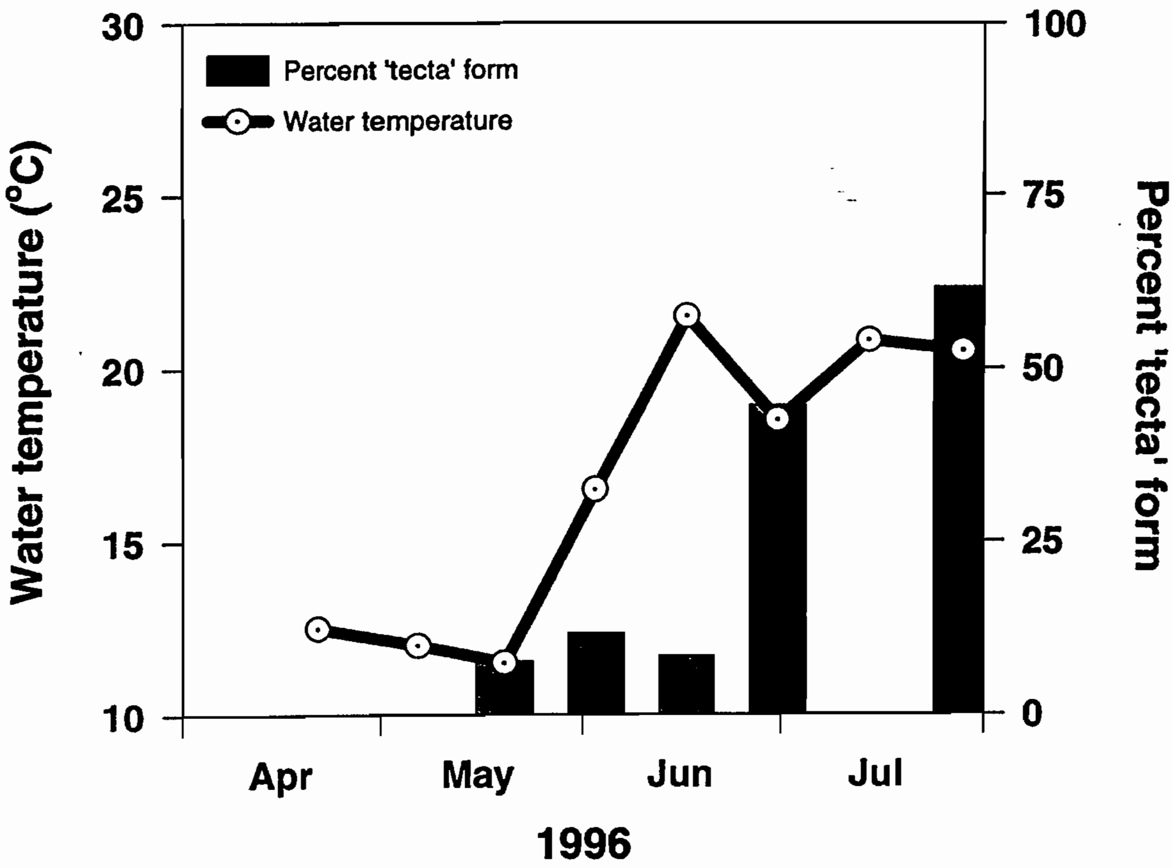


FIGURE 20: The relationship between water temperature and the percentage of 'tecta' forms of Keratella cochlearis in the River Thames at Reading, April - July 1996.

5.8.2 Comparison of rotifer sampling techniques

It is well known that collecting rotifers with relatively coarse nets and sieves leads to serious underestimates in population densities, especially among the smaller species. Bottrell *et al.* (1978) suggested that up to 80% of small rotifers could be lost through mesh sizes greater than 45 μm in aperture. In 1996 rotifers were collected by two different sampling methods to assess the effects of sampling method on estimates of rotifer numbers. These methods were (1) the collection of whole water samples which were concentrated by a sedimentation technique in the laboratory and (2) retention of organisms on a 63 μm mesh sieve, from a measured water volume. A comparison of rotifer numbers in the River Thames using these two approaches and the maxima recorded by Bottrell (1977) from the River Thames at Reading (Fig. 21) indicated that effective monitoring of the total rotifer numbers required adoption of the sedimentation technique. However, assessment of the utilisation (Mann *et al.*, 1996) and availability (present study) of large rotifers to young of the year fish required a size-selective approach to assess prey abundance.

Figure 22 shows the numbers of rotifers collected at each sampling site using methods (1) and (2). Method (1) often resulted in population density estimates which were more than double those recorded using method (2), although losses using method (2) could be as high as 90% on some occasions (e.g. 29 July 1996 at Reading). The magnitude of these losses differed from site to site, and from one sampling occasion to another. This probably reflected the size structure of the rotifer community, as small rotifers pass through the sieve more readily than large ones. On some occasions, the number of rotifers collected by method (2) exceed those collected by method (1). This only occurred early in the season, when rotifer densities were low. The preponderance of small rotifers in June and July (Fig. 22) may result from both size-selective predation by juvenile fish and the changing size-spectrum of rotifer prey.

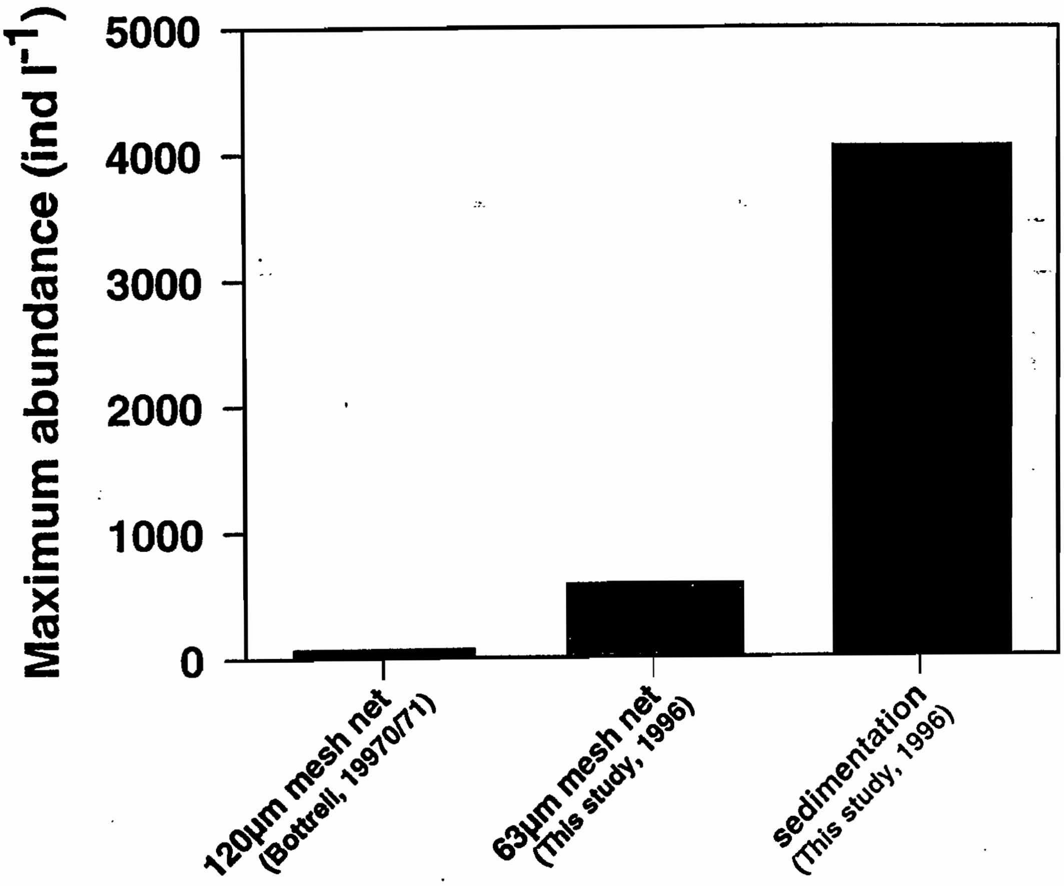


FIGURE 21: Comparison of rotifer density estimates obtained using 3 different techniques for concentrating samples.

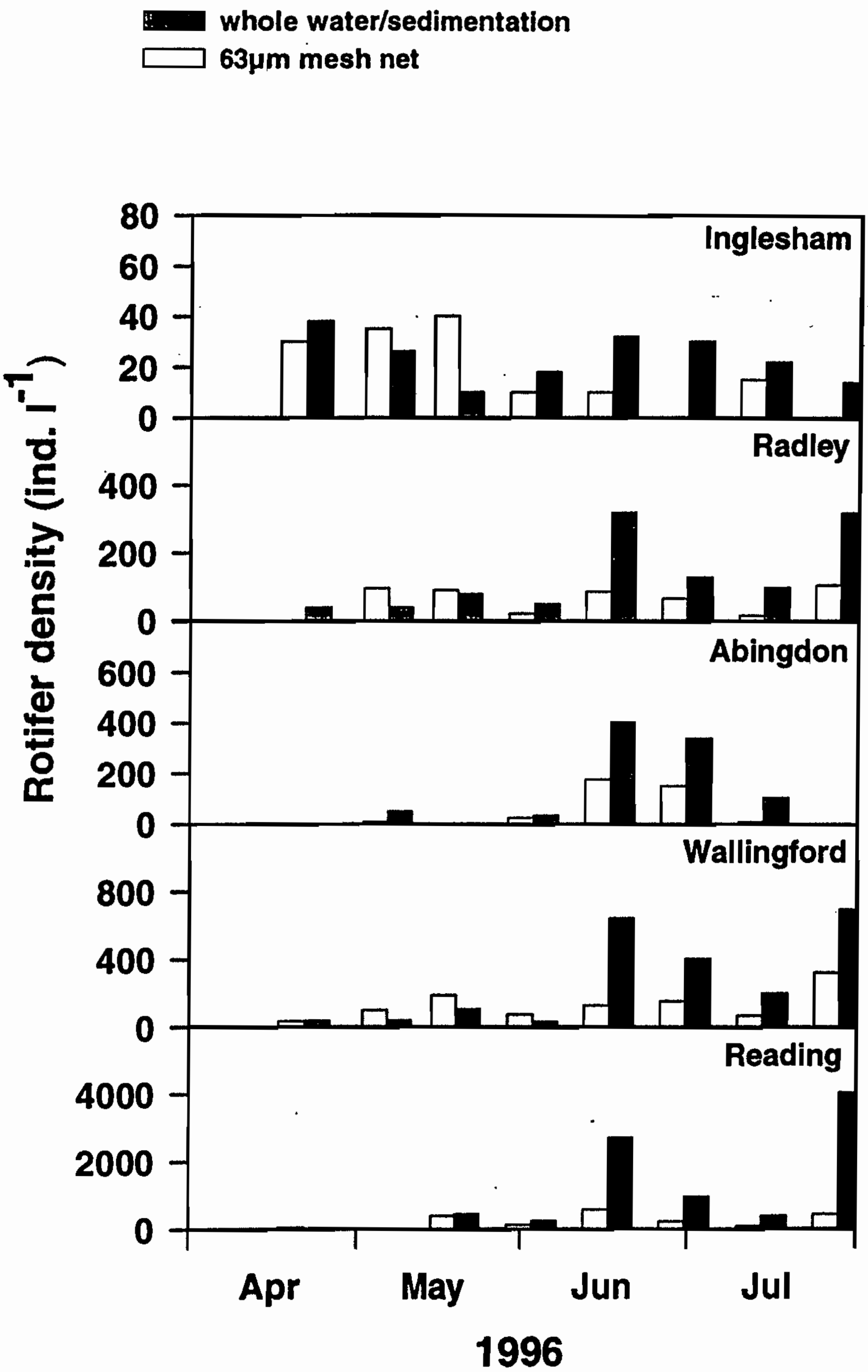


FIGURE 22: Comparison of rotifer density estimates obtained by two different methods.

To gauge rotifer grazing impacts on planktonic algae, sampling method (1) is the more suitable, as it provides estimates of the total number of rotifers, their size distribution and the rotifer community structure. Contemporary data on algal species and numbers, together with information on their physiological requirements, are also necessary. On the other hand, in order to assess the numbers of rotifers of suitable size for ingestion by juvenile fish at a point in time or location, method (2) is more appropriate.

5.8.3 Large Rotifers (method 2)

Large rotifers - seasonal trends between sites

Subsamples equivalent to 200ml of filtered (63µm sieve) river water provided counts of the large rotifers at each river site on each sampling date, with the exception of Radley (9.4.96). No clear trends between sites and dates were apparent in April and early May, whilst on the 20th May a downstream increase in numbers was recorded. Large rotifers fluctuated in number over the mid-summer period, with a downstream increase apparent on most dates and maxima of 325 $litre^{-1}$ at Wallingford (29.7.96) and 580 $litre^{-1}$ at Reading (17.6.96). However, in mid-August and early September peak numbers (230 & 200 $litre^{-1}$) occurred at the Abingdon site (Fig. 23). Temporary declines in large rotifer numbers (early June and mid-July) did not correspond to a decline in chlorophyll (Figs 4 & 5)(section 5.3) and no flood events occurred. There was a subsequent chlorophyll increase in late June (Figs 4 & 5) but this did not occur following the second fall in large rotifer numbers in late July.

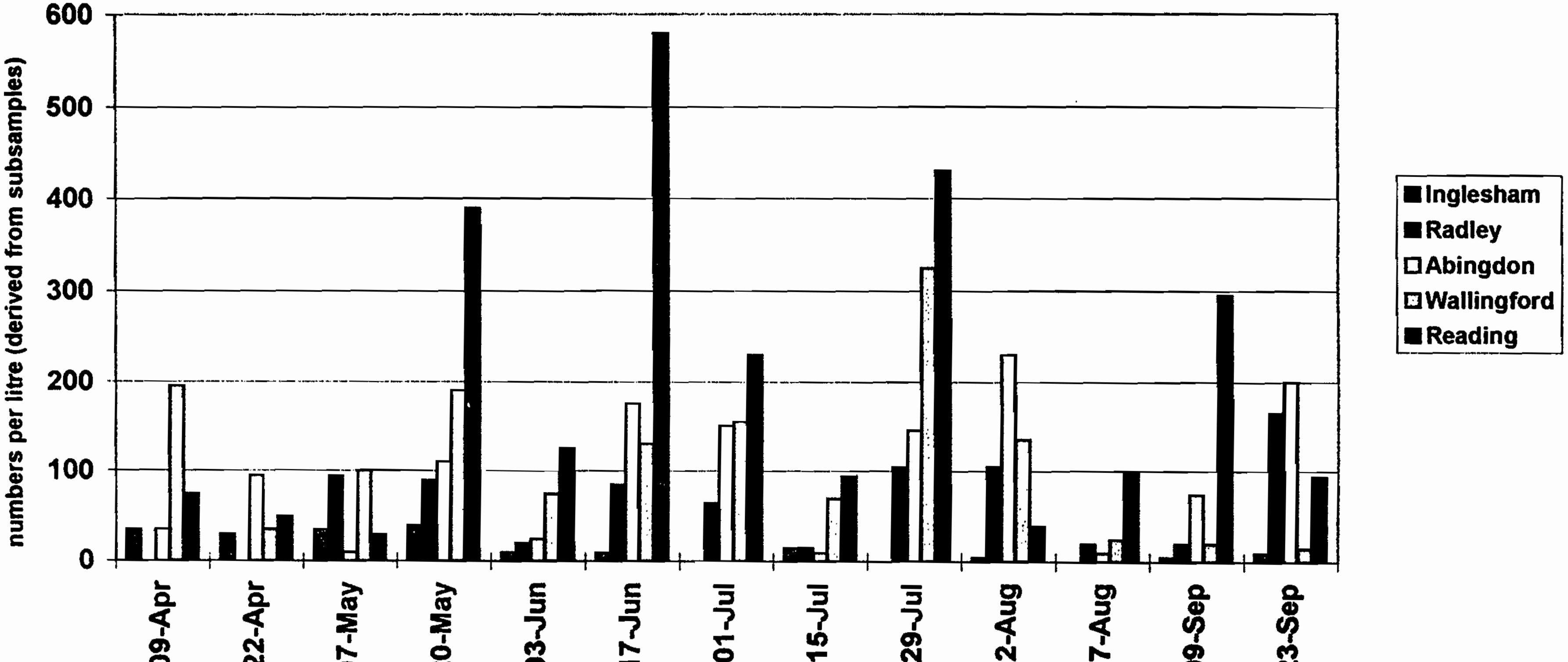


FIGURE 23: Changes in the number of "large" rotifers recorded at the five River Thames zooplankton sites in 1996.

An earlier study of rotifers in the River Thames was carried out by Bottrell (1977). One of the most marked differences between Bottrell's study and the present one is in the maximum number of rotifers recorded. Viewed in isolation, these results suggest a massive increase in productivity of the river between 1977 and 1996. However, when considered in relation to the sampling method used in the earlier study (120 µm mesh net), it seems probable that Bottrell (1977) significantly underestimated total rotifer densities in the river due to the loss of individuals through the net used (section 5.8.2). It is therefore more appropriate to compare his maximum density of 65 rotifers litre^{-1} (in May) with the estimates of large rotifer numbers recorded by the method (2) of the present study.

Population densities of large rotifers estimated for the site just downstream from Abingdon (late May until late September) achieved a similar level of abundance in 1995 (Mann, Collett, Bass & Pinder, 1995) to that observed in 1996 (35-510 litre^{-1}). Whilst densities of large rotifers in the River Trent at Newark were at a peak of 370 in mid-May 1995 with <30 litre^{-1} recorded during the rest of the summer (McCollin, 1995). Considerably higher numbers were recovered in the River Great Ouse (1989-1993), where large rotifers peaked in April, May or June with maximum densities ranging from around 1,135 (1991) to >10,000 litre^{-1} (1990). Periods with over 500 large rotifers litre^{-1} persisted in the River Great Ouse from 2 weeks to 8 weeks in 1989 and 1990 respectively (Bass, Leach & Pinder, 1997).

The co-occurrence of relatively high numbers of large rotifers and peaks in suspended chlorophyll were noted in all the previous studies, with the scale of between-year differences in rotifer numbers following the extremes in chlorophyll recorded on the River Great Ouse (Bass *et al*, 1997a; Marker and Collett, 1997b). The seasonal relationship between suspended chlorophyll$_a$ and rotifers is probable similar in the River Thames, though this cannot be confirmed by this one year study. The consequences of an increase in river discharge during late spring and early summer, from the proposed Severn-Thames transfer or unseasonable flood events, would be a rapid depletion in rotifer numbers. Recovery of the rotifer population would be dependant on the subsequent phytoplankton development.

Large rotifers -spatial trends at sites

Previous studies on the River Thames (Bottrell, 1977) indicated that zooplankton was evenly dispersed across the river but considerable variation within the channel of the River Great Ouse was found in recent years, particularly when population densities reached their early summer seasonal peaks (1990-1994, IFE unpublished data).

To establish the spatial distribution of zooplankton within the main channel of the River Thames some additional samples were obtained at two of the five sites, Radley and Wallingford. On each sampling date, samples were taken at two depths, at a series of points across the channel (both sites) and over short time intervals at a single point near the river bank at Radley. Each sample consisted of five litres of water. The number of large rotifers in bankside samples, which were taken at 5 minute intervals, ranged between 70 and 135 large rotifers litre^{-1} at Radley in mid-June (Fig. 24). Corresponding counts across the river channel on the same day, yielded a similar range with slightly lower numbers (50-120 litre^{-1}). Over the summer the cross-channel population densities of large rotifers showed varying patterns in relation to depth and location (Figs 25 & 26). On some occasions the large rotifers were at higher densities in deeper water, away from each bank at Radley (20.5.96) and Wallingford (17.6.96). The reverse situation was recorded at Radley in early June (3.6.96).

Such variability suggests an absence of stable zooplankton "hot spots" at the Radley and Wallingford sites, such "hot spots" have been noted in and adjacent to marinas, e.g. Abingdon on the River Thames, (Mann *et al.*, 1995) and similar locations on the River Great Ouse (Bass *et al.*, 1997a). Nevertheless, the scale of variation in density indicated that this should be taken into account in the estimation of zooplankton populations and their influence on other trophic levels (e.g. in modelling the impact of grazing on phytoplankton and availability as food resources for other aquatic fauna).

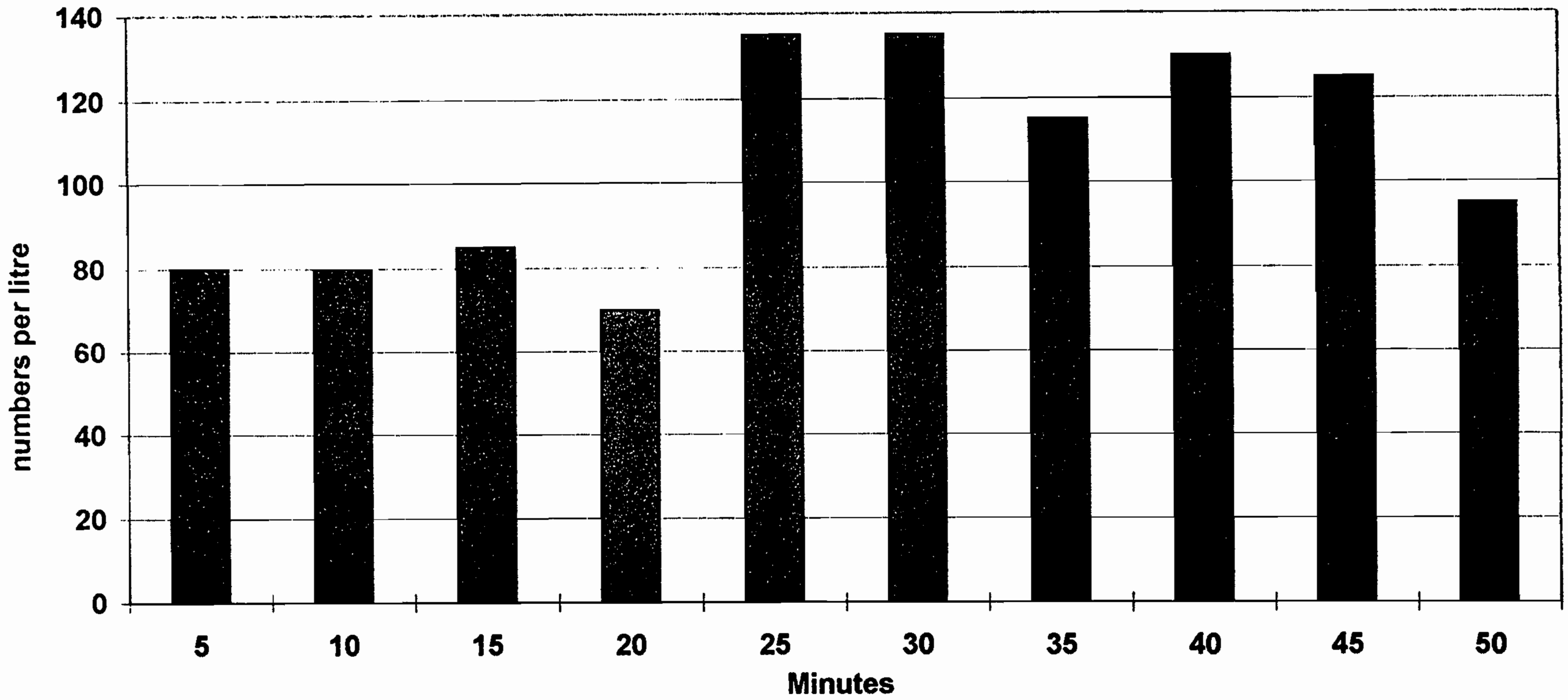


FIGURE 24: Short-term variation in the numbers of "large" rotifers recorded at the Radley (River Thames) site on a single date (17/6/96); samples were taken at five minute intervals from the same marginal location.

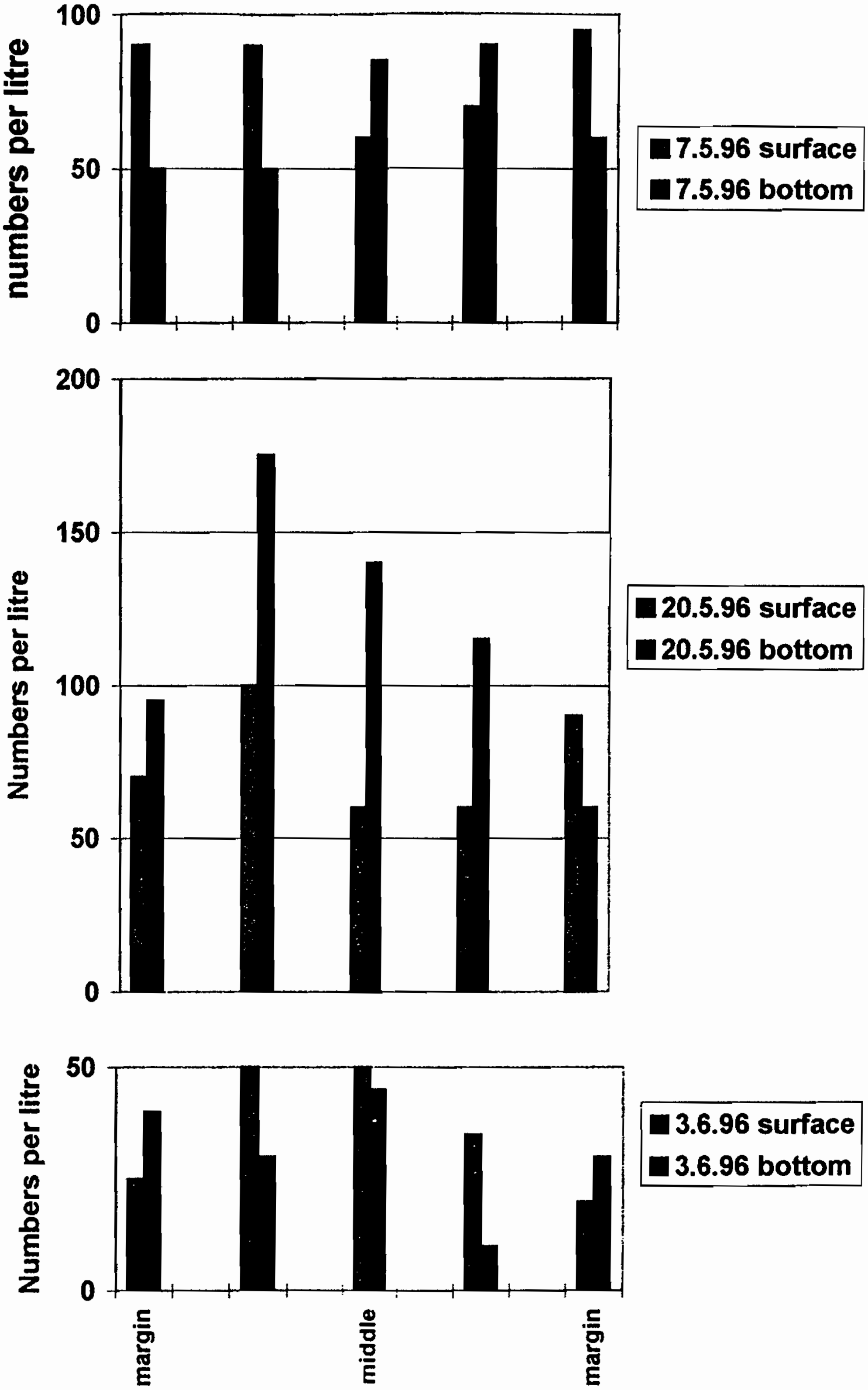
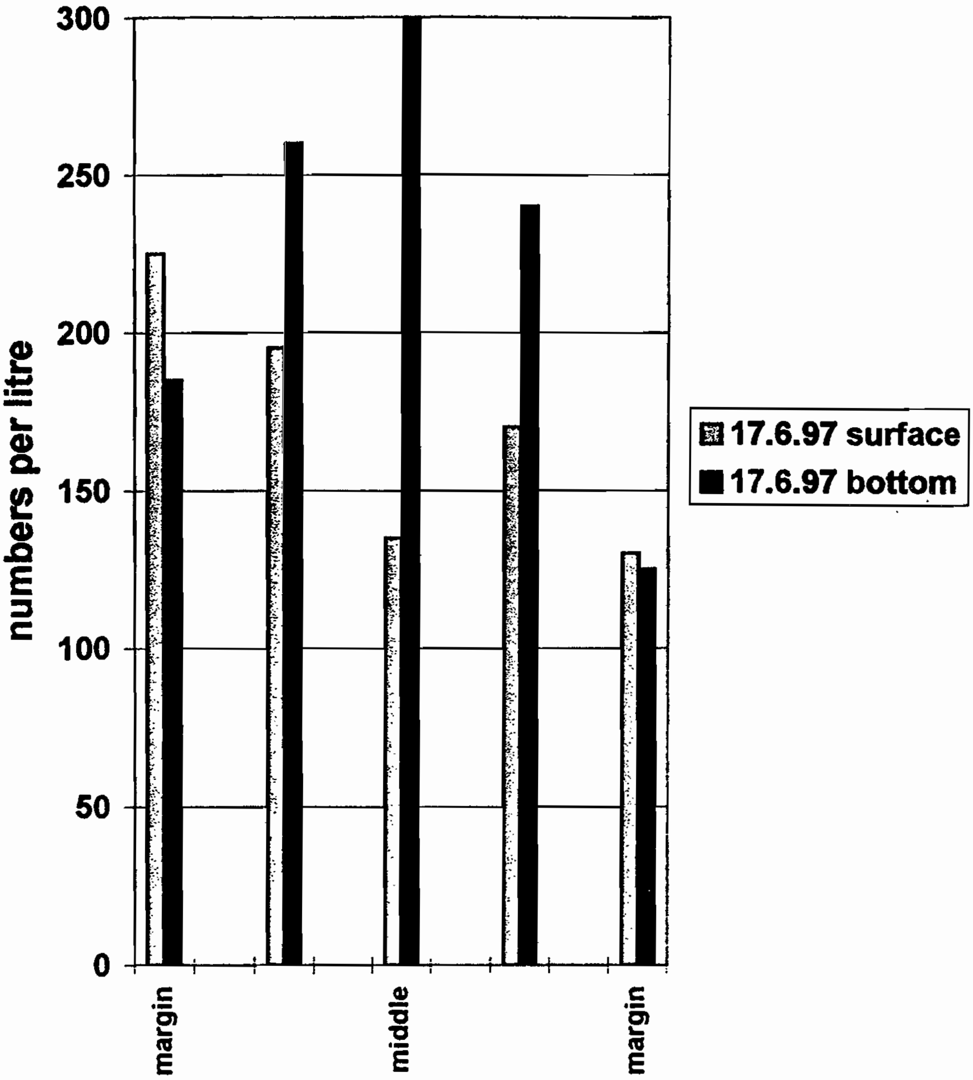


FIGURE 25: Examples of spatial variation in the numbers of "large" rotifers recorded at five locations across the River Thames at Radley in 1996.



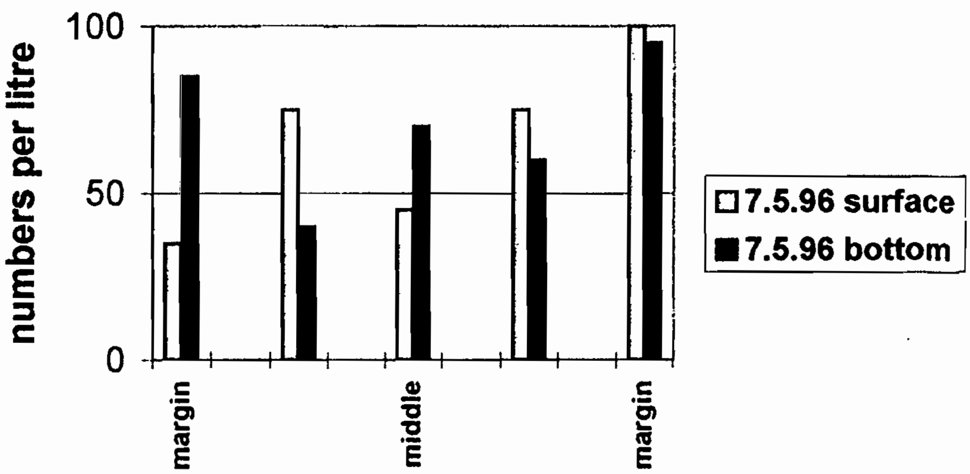


FIGURE 26: Examples of spatial variation in the numbers of "large" rotifers recorded at five locations across the River Thames at Wallingford in 1996.

5.9 Copepods

Following the results of the literature review on river zooplankton (Bass & May, 1996a), it was anticipated that low numbers of copepods would occur within the River Thames plankton samples and this was the case (Fig. 27). However, localised high population densities have been reported from within submerged marginal plant stands on the River Thames (Bottrell, 1977) and River Great Ouse (Garner *et al.*, 1996; Bass *et al.*, 1997b) and also from extensively impounded rivers such as the Upper Mississippi (Pillard & Anderson, 1993) and Ohio River (Thorp, *et al.*, 1994). Copepods may be flushed into the plankton during flood events, as widely reported in other river systems (River Rhine, Vranovsky, 1995; River Danube, Neumann, *et al.*, 1994). Results from an experimental study (Richardson, 1992) indicated that planktonic copepods were better than rotifers and cladocerans at maintaining position in flowing water and numbers were thus less liable to be severely depleted as a result of increased discharge. The numbers of copepods recovered from the River Thames samples in 1996 were invariably very low and no spatial trends in population densities were detected. If the 1996 data were typical for the middle River Thames transfer of water from the River Severn would not have an adverse effect on populations of planktonic copepods. It should be noted that considerably higher populations of planktonic copepods occur in marinas connected to the main river.

5.10 Cladocerans

Few cladocerans were present in any of the River Thames zooplankton subsamples in 1996 (Fig. 28) and no spatial trends in numbers were detected. Contemporary data on the gut contents of young fish at the Radley site indicate that cladocerans are numerous in other habitats (Mann, *et al.*, 1997) and this is discussed more fully in the next section (5.11). Cladocerans have been reported to evade fish predation in a Norfolk river by retreating within plant stands during daylight hours (Timms & Moss, 1984). In the middle reaches of the River Thames such refugia are present to a limited extent and the proposed Severn-Thames transfer has the potential to influence cladocerans as a result of impacts on plant stands (Bass *et al.*, 1997b). Marinas connected to the river frequently support high numbers of cladocerans (and copepods) which can enter the river as water levels fall following high discharge events. In an exceptionally dry year, no major changes in discharge occurred throughout the sampling period (April-November 1996).

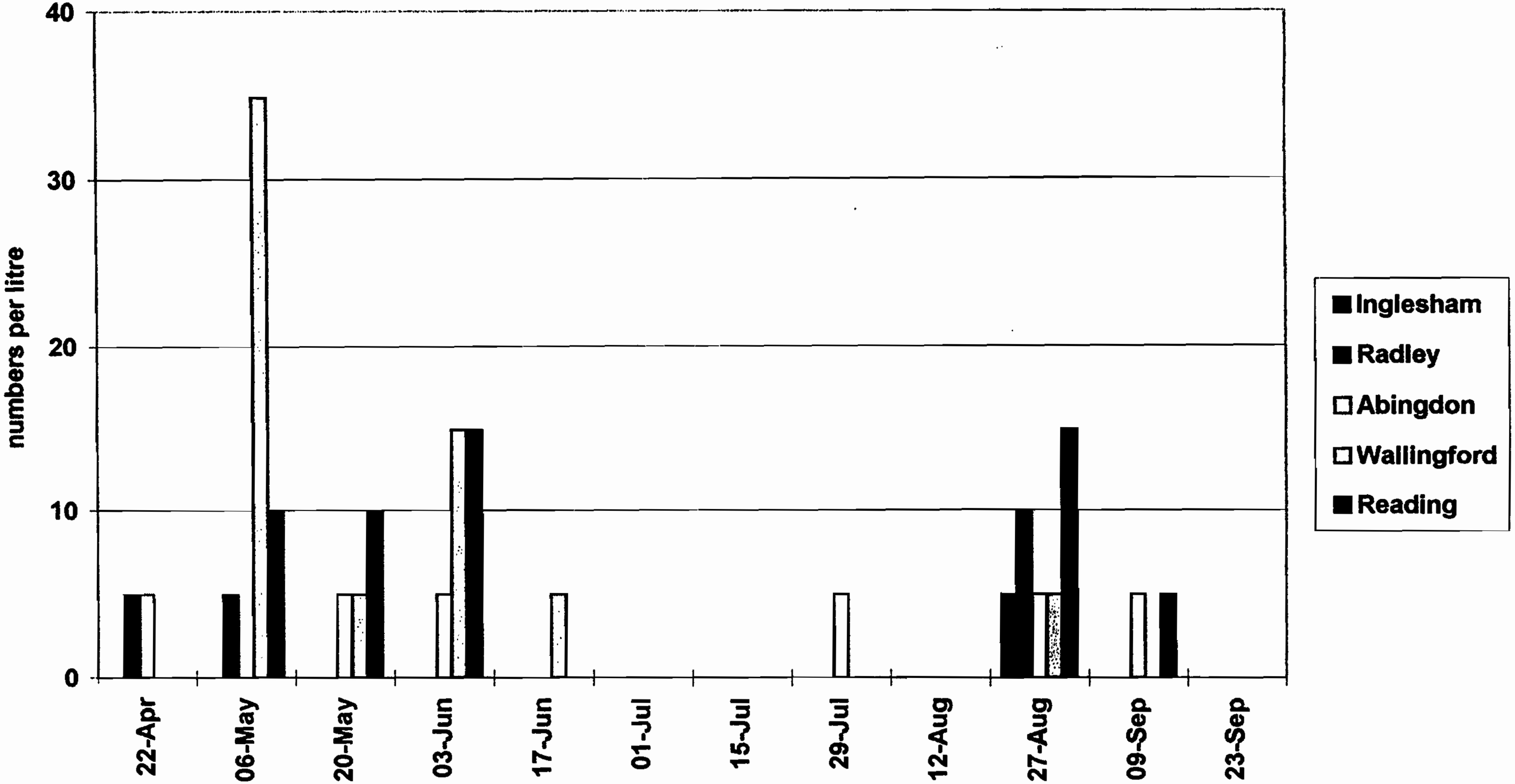


FIGURE 27 : Copepods (including all life stages), retained by a 63µm sieve, recorded from zooplankton samples at the River Thames zooplankton sites in 1996.

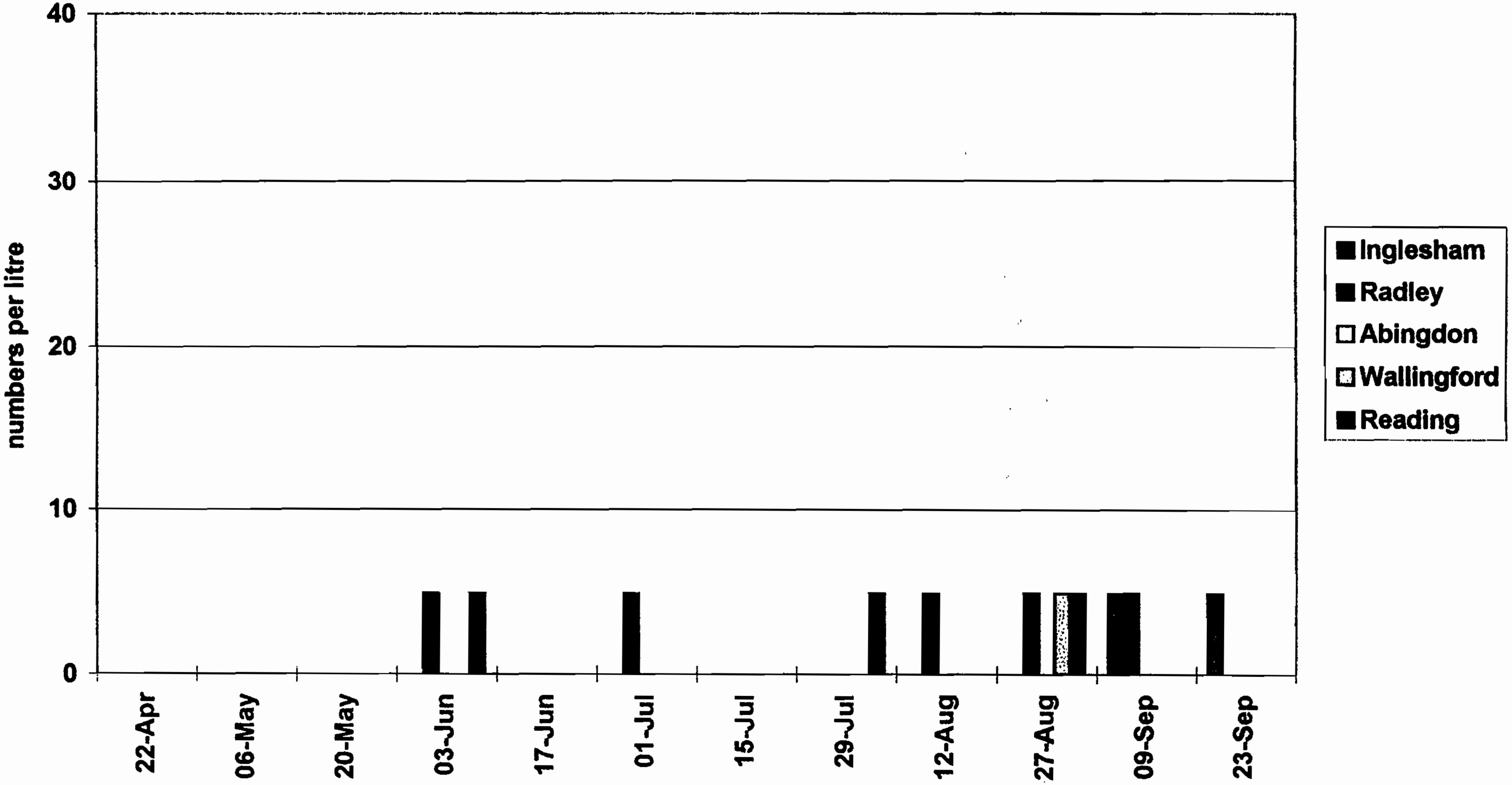


FIGURE 28 : Cladocerans (all species), retained by a 63µm sieve, recorded at the five River Thames zooplankton sites in 1996.

5.11 Zooplankton Availability to Juvenile Fish

Rotifers

The first food ingested by young of the year cyprinid fish in the River Thames consists of planktonic rotifers. In the first few weeks after the yolk sac has been absorbed the young fish depend on suspended food organisms that are sufficiently small to be ingested whole and easily captured. Planktonic rotifers are present throughout the water column, at varying densities. They range in size from about 20-400μm, depending on species, life stage and season. Monitoring zooplankton of suitable size as prey for young of the year fish was undertaken using a 63μm sieve to retain the larger individuals (Bass *et al.*, 1997a). Zooplankton samples were taken along with young fish for dietary analysis, at a single site downstream from Abingdon in 1995 (Mann *et al.*, 1995). In the present study the more wide-ranging zooplankton samples coincided with young of the year fish sampling at Radley, a few miles upstream of Abingdon (Mann *et al.*, 1997).

In both 1995 and 1996 the majority of young River Thames roach (the most common fish captured) fed predominantly on rotifers for about one month, from late May until early July (Mann *et al.*, 1995; Mann *et al.*, 1997). Other fish species, hatching over the early- to mid-summer period, also initially fed on rotifers but switched to other prey more rapidly. The continuous presence of suitable rotifer prey throughout the critical period of early development for fish species, spawning at different times in the River Thames is noteworthy. Though the concentrations of rotifers within the River Thames were sub-optimal for maximum growth, as determined in fish culture (Kestemont, & Awais, 1989), the within-river early growth rates of juvenile roach in the River Thames and River Great Ouse (Mann, 1997), generally match those derived from experimental studies in which fish were supplied with unlimited food (Mooij & Van Tongeren, 1990).

As noted in section 5.8.2 (- spatial trends at sites), the population densities of rotifers varied across the river and down through the water column. Young fish, though constrained by size-related swimming ability (Mann & Bass, 1997), may select areas with higher concentrations of rotifers than those which were detected during stratified sampling. In some fish species, size differences have been observed between habitats on the same date (Mann *et al.*, 1995), though at present it is not clear whether these differences resulted from habitat selection by fish of a particular size, or differing growth rates whilst occupying individual habitats.

Previous studies on alternative sources of rotifers for young of the year fish, such as the river bed or submerged plants, indicated insufficient numbers to influence the planktonic species available in the River Great Ouse (IFE, unpublished data) and this is also likely to apply in the River Thames. In contrast, the comparatively high rotifer densities present in marinas connected to the River Great Ouse provided better feeding conditions for fish. Flushing of zooplankton-rich water during periods of elevated discharge or as a result of the regular operation of adjacent boat locks, also enhanced feeding conditions for fish in the adjacent river channel. Similar conditions apply to some parts of the River Thames such as the reach adjacent to the marina at Abingdon.

Copepods

Copepods were very infrequent in all of the samples taken from the River Thames in 1996. During previous studies on the River Great Ouse [Bass *et al.*, 1997a & b) it was noted that all copepod life stages were comparatively much more abundant within submerged plant stands than in the plankton and that the nauplii (the youngest life stage) were recorded most frequently in the plankton. The copepods have comparatively effective predator escape mechanisms, enabling them to evade capture by the smallest young of the year fish. However, fish species with a wide gape and/or large buccal capacity, such as perch, gudgeon and bream, occasionally ingest high numbers of copepods. Whether these specialist copepod-feeding fish obtain prey from the open water plankton or only from benthic and submerged plants sources has not been definitively established. A comparison of young of the year fish diets between different plant habitats at Abingdon in 1995 revealed very few copepods in roach and on one occasion (25 July, 1995), from a mixed young of the year fish catch within *Nuphar lutea* (yellow waterlily), the most abundant species (roach) had ingested no copepods whilst gudgeon, chub and perch yielded about 34, 11 and 21 per fish, respectively (Mann *et al.*, 1995). As with the rotifers, copepods have been recorded in great abundance in off-river marinas (Bass *et al.*, 1997) and their virtual absence from the open water of the main channel of the River Thames underplays their contribution to the diet of some of the common fish species in their first year of life.

Cladocerans

Cladocerans were also very infrequent in all of the samples taken from the River Thames in 1996. Few cladoceran species are truly planktonic in rivers (exceptions include the family Bosminidae and many of the Daphniidae). Most riverine species live predominately within the flocculent material on plant surfaces and the upper layers of riverbed sediment (Chydoridae, Macrothricidae, Sididae, *Ilyocriptus* spp). Others swim actively but are intimately associated with plant stands (*Ceriodaphnia* spp, *Scapholeberis* spp) or are restricted to the outer margins of plant stands (Polyphemidae). All cladocerans are consumed by young fish but their abundance is seasonally variable and they have different size ranges and effective or less effective predator defence mechanisms. Therefore the availability of cladocerans to young of the year fish changes throughout the summer as the fish grow and utilise different habitats. Opportunistic short-term changes in the diet of young of the year roach were observed following a weed cut on the River Great Ouse. In this situation, the area providing refuge from predation was greatly reduced, cladocerans became concentrated in the marginal zone and were rapidly consumed by the fish (Garner *et al.*, 1996). Similar opportunistic feeding is likely to occur in the River Thames following displacement of cladocerans during increased river discharge but no flood events occurred during the summer of 1996. Nevertheless young fish in the River Thames consumed large numbers of cladocerans in both 1995 (at Abingdon, Mann *et al.*, 1995) and 1996 (at Radley, Mann *et al.*, 1997). Since cladoceran densities were universally low in the open water it was concluded that the fish containing cladocerans were feeding close to aquatic plants. As cladocerans were the second most numerous taxa consumed by young of the year cyprinids their virtual absence from the zooplankton was particularly noteworthy and highlighted the seasonally varying importance of food sources from different habitats, as young of the year fish increase in size and switch from rotifer feeding to cladoceran feeding.

6.0 CONCLUSIONS

General Comments

As noted in the recent river zooplankton review (Bass & May, 1996a), there have been few attempts to quantify the grazing pressure exerted by river zooplankton on phytoplankton. In the absence of significant crustacean zooplankton populations (as on the middle reaches of the Thames), the rotifers and heterotrophic nanoplankton have previously been reported to respond to, rather than control, gross changes in river phytoplankton (River Rhine, Admiraal *et al.*, 1994 and River Meuse, Gosselain *et al.*, 1994). Other loss-processes associated with channel form, discharge and reach retention time were considered to be of greater importance in controlling phytoplankton development. These conclusions are reinforced by the results obtained in the present study.

Studies of phytoplankton by Reynolds and colleagues (e.g. Reynolds, 1988; Reynolds, 1995; Reynolds & Glaister, 1992), on UK rivers including the River Thames and River Severn, indicated that downstream displacement and depletion of populations occur more slowly than theory would predict - even without accounting for zooplankton grazing pressure. The results of modelling temperature-dependant algal growth rates, cell settlement rates and hydraulic reach-retention, all point to the importance of "dead zones" or "storage zones" within the river, which reduce phytoplankton loss rates. The reach-retention capacity or 'time of travel' experienced in the middle Thames under a range of hydrological conditions needs to be addressed but calculations are complicated by changes to weir gate settings which prevent the use of a simple stage discharge relationship.

The Microbial Loop

Evidence from lakes, ponds and rivers (Berninger *et al.*, 1991) indicate that the number of algae, bacteria, flagellates, and ciliates living in a water mass tend to be correlated with each other and this was the case in the River Thames. The abundance of pico- and nanoplankton is also a measure of biological productivity. In the Thames abundance varied within the limits expected for freshwater systems, though it is acknowledged that there is a dearth of comparable published data for British rivers.

The microbiological system, occasionally referred to as a "microbial loop" works as follows: nutrients promote algal growth which releases dissolved organic carbon, this is utilised by bacteria which are grazed by flagellates and these in turn are consumed by ciliates. Nutrients liberated during metabolism and excretion are cycled back round the system by the algae and bacteria.

Rotifers

In general an overall increase in rotifer abundance was recorded downstream in the River Thames in parallel with increases in chlorophyll$_a$ concentration in the river water. This suggests that rotifer abundance is controlled primarily by food availability. However, many rotifers are specialist feeders, preferring one algal size category or species over another. So comparing total rotifer numbers with an index of total phytoplankton abundance probably masks many of the complex species interactions which occur. Some rotifers are seasonally restricted by temperature requirements. Preliminary calculations of grazing rates (section 5.8.1) indicate River Thames rotifers removed only about 4% of the algal biomass each day in 1996 and had little effect on overall phytoplankton abundance. However it is stressed that these extrapolations from laboratory clearance rates remain imprecise.

A comparison of two sampling techniques indicated there were variable sampling losses associated with method (2) and this probably reflected the size structure of the rotifer community. Small rotifers would pass through the seige that was used more readily than large ones. Method (2), using comparatively large water volumes, permitted assessment of the distribution large rotifers which are utilised by juvenile fish.

The cross-channel population densities of large rotifers at Radley and Wallingford showed varying patterns in relation to depth and location. Such variability suggests an absence of stable zooplankton "hot spots" at the Radley and Wallingford sites, such as those that have been noted adjacent to marinas at Abingdon on the River Thames (Mann *et al.*, 1995) and similar locations on the River Great Ouse (Bass *et al.*, 1997a).

Copepods and cladocerans

The numbers of copepods and cladocerans recovered from all River Thames samples in 1996 were very low and no spatial trends in their population densities were detected. Consequently, under the conditions prevailing in 1996, the grazing impact of crustacean zooplankton occupying the open water would have been negligible. The density and potential impact of filter-feeding crustaceans inhabiting littoral submerged macrophytes was not included in this study. The most numerous cladoceran group (Chydoridae), as detected in juvenile fish guts, remain in close association with flocculent sediment on plant surfaces and therefore have no direct impact on the open water phytoplankton.

The lack of planktonic copepods and cladocerans observed in the middle reaches of the River Thames under low flow conditions suggests that increased flows generated by a Seven-Thames transfer would have little scope to further depress these populations. The potential transfer of zooplankton from the River Severn requires investigation (see below).

Diets of young fish

In both 1995 and 1996 the majority of young of the year roach (the most common fish captured) in the River Thames fed predominantly on rotifers for about one month, from late May until early July (Mann *et al.*, 1995; Mann *et al.*, 1997). Later in the summer cladocerans were the second most numerous taxa consumed by all young of the year cyprinids and the virtual absence of cladocerans from the River Thames zooplankton is particularly noteworthy and highlights the seasonally varying importance of food sources from different habitats, as the young fish increase in size.

Zooplankton in the context of the proposed Severn-Thames transfer.

The consequences of an increase in river discharge during late spring and early summer, whether resulting from unseasonable flood events or a transfer of water from the River Severn, would be a corresponding depletion of the rotifer population. Recovery of the rotifer population in the River Thames would be dependant on the subsequent phytoplankton development. No data on zooplankton in the River Severn are thought to be currently available and therefore their potential impact (on transfer) is unknown. Assessment of the contribution of River Thames zooplankton to other trophic levels has focused within this study on the dependence of young of the year fish on rotifers during their early life. It should be noted that other riverine fauna, such as benthic macroinvertebrates including particularly bivalves, sponges, bryazoans, some insects and crustacea will also contribute to plankton loss processes. Changes to the plankton community and its seasonal occurrence as a result of transferring water from the River Severn could potentially have wide-ranging impacts. The response of River Thames zooplankton to the chemical quality of transferred Severn water would depend on the concentrations of intermittent trace pollutants rather than the background levels of major nutrients, which are fairly similar to those occurring in the River Thames (House, *et al.*, 1996; Talbot, *et al.*, 1997).

On the basis that a Severn-Thames transfer would reduce reach-retention time downstream from the input point at Buscot it is concluded that the River Thames plankton community would be altered in the close vicinity of Buscot. In order to predict changes to the plankton dynamics additional data are required on the growth and loss rates of planktonic organisms and the hydrological characteristics of the river channel at Buscot. The impacts of a Severn-Thames transfer on the plankton further downstream would be small owing to the scale of increased channel size and river discharge around Oxford.

Recommended future work on zooplankton

Within the present study it was the intention to provide additional interpretation of seasonal zooplankton community changes, by examining Environment Agency data on phytoplankton species and their responses to physico-chemical conditions. However there was a delay in the receipt of contemporary algal data and the 1996 river discharge data for Caversham (Reading).

The Environment Agency have been examining the relationship between phytoplankton, river discharge and nutrients in the middle reaches of the River Thames (eg Ruse & Hutchings, 1996). The monitoring of zooplankton in a single growing season (1996) provided limited scope for conclusions on the phytoplankton-zooplankton relationship. However the exceptionally stable river discharge over this period provided data illustrating the downstream and seasonal relationships between components of the plankton in the absence of disruption from flood events.

Preliminary calculations of zooplankton grazing impacts, using published filtration rates of common rotifer species occurring in the River Thames, indicated clearance rates by the populations recorded in 1996 were insufficient to have a major influence on the phytoplankton biomass. Uncertainties remain with respect to the mechanisms controlling the River Thames plankton populations and the precise changes that would result from a Severn-Thames transfer.

It is recommended that future research (which might include collaboration between the Institute of Freshwater Ecology, the Institute of Hydrology and The Environment Agency) should focus on further elucidation of the phytoplankton loss-processes in the middle reaches of the River Thames. The primary aim to optimise summer discharge management in relation to water quality, whilst safeguarding components of the River Thames food web regarded as beneficial to conservation and fisheries.

The main areas identified as requiring further research are :

■(1) reach-retention time within the middle reaches of the River Thames (particularly between Buscot and Oxford) under a range of hydraulic conditions relevant to operation of a Seven-Thames transfer.

■(2) characteristics and population densities of zooplankton which would be transferred from the River Severn to the River Thames, during operation of a Severn-Thames transfer.

■(3) model the impacts of grazing on dominant phytoplankton taxa by planktonic rotifers in the middle reaches of the River Thames.

■(4) calculate population growth rates of the planktonic rotifer species which are important as algal grazers and food for young fish in the middle reaches of the River Thames.

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APPENDIX I

River Thames - daily records of discharge at Buscot, Eynsham, Days Weir and Caversham in 1996 (Environment Agency)

Flows in the River Thames 1996 (cumecs) - supplied by The Environment Agency

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
01/01/96	20.50	29.30	56.60	68.70
01/02/96	21.20	31.40	57.50	69.10
01/03/96	20.50	31.40	60.60	72.80
01/04/96	19.20	28.10	56.30	69.80
01/05/96	18.50	26.30	54.70	65.00
01/06/96	18.90	26.50	54.90	66.40
01/07/96	22.80	31.80	63.40	76.40
01/08/96	22.80	34.00	77.90	95.40
01/09/96	32.10	41.70	101.00	113.00
01/10/96	29.90	43.00	109.00	124.00
01/11/96	25.00	37.00	97.60	123.00
01/12/96	23.70	33.70	84.10	108.00
01/13/96	26.70	33.40	77.80	101.00
01/14/96	23.40	32.40	69.40	85.40
01/15/96	20.70	27.90	59.30	74.50
01/16/96	19.20	27.40	54.80	64.80
01/17/96	18.50	25.80	50.40	62.50
01/18/96	17.60	24.50	46.50	57.40
01/19/96	17.00	24.50	45.60	56.60
01/20/96	16.30	23.70	44.30	53.20
01/21/96	15.30	21.70	41.10	51.70
01/22/96	14.60	20.40	37.40	45.70
01/23/96	14.30	20.70	37.90	46.60
01/24/96	14.40	20.90	38.40	46.90
01/25/96	13.60	19.80	37.60	47.20
01/26/96	12.60	17.50	33.70	43.10
01/27/96	11.70	17.00	32.90	39.30
01/28/96	11.30	16.10	26.80	37.60
01/29/96	11.00	16.20	26.50	36.40
01/30/96	10.80	15.00	26.30	36.40
01/31/96	10.70	15.00	26.10	34.90
02/01/96	10.50	14.30	25.80	34.80
02/02/96	10.20	14.00	24.20	32.90
02/03/96	9.74	13.40	24.20	32.70
02/04/96	9.47	12.50	22.60	30.80
02/05/96	9.33	12.50	22.40	29.70
02/06/96	9.49	13.00	24.00	31.40
02/07/96	9.18	12.60	24.00	31.60
02/08/96	8.70	11.90	23.60	30.50
02/09/96	12.40	13.00	30.70	37.30
02/10/96	17.30	25.90	53.60	61.50
02/11/96	14.20	23.40	57.20	72.10
02/12/96	16.80	36.70	81.60	94.70
02/13/96	27.70	46.70	99.80	122.00
02/14/96	19.00	33.10	90.20	114.00
02/15/96	16.80	23.10	64.10	89.80
02/16/96	13.70	22.60	53.90	72.60

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
02/17/96	12.80	22.10	48.00	59.50
02/18/96	12.80	22.40	48.40	59.40
02/19/96	12.70	22.40	47.70	58.30
02/20/96	12.00	20.30	40.70	50.10
02/21/96	11.60	16.90	38.50	47.10
02/22/96	12.00	15.60	37.10	44.80
02/23/96	12.10	16.20	37.20	47.50
02/24/96	24.10	26.70	59.00	73.70
02/25/96	29.00	41.40	95.40	114.00
02/26/96	24.70	38.40	92.50	120.00
02/27/96	17.60	26.40	73.70	109.00
02/28/96	15.00	20.90	59.10	86.80
02/29/96	13.70	19.40	43.60	61.30
03/01/96	13.10	18.50	42.60	56.50
03/02/96	12.70	17.30	40.40	50.30
03/03/96	12.30	17.10	39.10	50.60
03/04/96	11.90	17.60	38.60	48.10
03/05/96	11.50	17.30	37.70	46.90
03/06/96	20.00	16.50	33.80	40.80
03/07/96	20.00	16.60	33.70	41.20
03/08/96	20.90	16.30	33.50	41.30
03/09/96	23.00	18.40	35.00	43.40
03/10/96	20.60	17.60	35.90	45.40
03/11/96	20.00	16.40	33.30	41.80
03/12/96	13.10	18.00	34.60	42.20
03/13/96	11.80	18.30	36.00	43.90
03/14/96	10.80	16.60	35.20	43.60
03/15/96	10.70	15.80	32.00	39.60
03/16/96	10.40	15.40	31.10	37.90
03/17/96	9.74	14.20	30.60	36.90
03/18/96	9.48	14.10	25.50	32.10
03/19/96	9.21	14.00	27.30	33.20
03/20/96	9.13	13.40	26.70	33.20
03/21/96	9.97	13.60	26.80	33.40
03/22/96	12.10	14.30	27.80	35.10
03/23/96	13.80	18.40	33.90	39.90
03/24/96	12.00	18.10	36.40	43.60
03/25/96	11.30	15.50	32.50	40.60
03/26/96	19.60	23.00	34.20	39.80
03/27/96	15.40	24.40	45.90	53.10
03/28/96	12.50	17.70	33.30	41.80
03/29/96	11.10	15.00	32.30	33.60
03/30/96	10.40	14.00	26.30	32.90
03/31/96	9.99	14.10	25.50	32.70
04/01/96	9.77	13.50	24.80	33.10
04/02/96	9.40	13.30	21.80	29.10
04/03/96	9.10	11.40	21.10	29.70
04/04/96	8.84	12.00	20.80	27.20

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
04/05/96	8.59	11.80	21.10	28.10
04/06/96	8.43	11.60	20.80	27.40
04/07/96	8.29	11.30	20.50	27.10
04/08/96	8.12	11.10	20.10	25.70
04/09/96	7.95	12.10	20.10	26.50
04/10/96	8.06	12.40	21.50	28.40
04/11/96	7.87	11.40	22.50	29.40
04/12/96	11.40	13.70	22.50	28.90
04/13/96	17.20	27.00	48.40	57.60
04/14/96	11.60	16.60	40.60	54.50
04/15/96	10.50	14.00	31.50	37.30
04/16/96	9.30	12.10	26.40	32.30
04/17/96	9.01	11.30	24.70	30.90
04/18/96	8.63	10.40	21.10	27.00
04/19/96	8.95	12.80	23.90	26.50
04/20/96	8.01	12.60	24.40	30.20
04/21/96	7.70	12.30	23.50	28.80
04/22/96	7.81	10.80	25.20	33.00
04/23/96	12.50	15.70	35.10	39.40
04/24/96	11.70	17.70	42.80	56.30
04/25/96	9.59	12.70	26.80	32.40
04/26/96	8.07	10.90	25.00	32.10
04/27/96	7.75	10.60	22.00	26.80
04/28/96	7.38	9.74	21.70	26.60
04/29/96	7.14	9.53	20.60	25.00
04/30/96	7.40	9.29	20.50	25.10
05/01/96	7.91	10.10	20.40	24.90
05/02/96	7.33	11.80	23.20	27.40
05/03/96	6.91	8.06	19.30	24.90
05/04/96	6.46	7.36	13.10	17.10
05/05/96	6.23	6.94	13.90	19.80
05/06/96	6.01	7.86	15.50	19.50
05/07/96	5.89	8.85	15.50	19.60
05/08/96	5.70	9.15	16.40	20.30
05/09/96	5.60	8.32	15.50	19.60
05/10/96	5.52	8.21	14.20	17.90
05/11/96	5.39	8.00	14.10	18.10
05/12/96	5.26	7.83	14.20	17.60
05/13/96	5.15	7.47	14.10	18.10
05/14/96	5.04	7.36	13.80	17.50
05/15/96	4.88	6.94	13.90	17.50
05/16/96	4.81	6.85	13.30	17.20
05/17/96	4.82	6.86	13.20	16.80
05/18/96	4.85	6.86	13.20	17.20
05/19/96	5.93	7.17	14.10	18.40
05/20/96	5.13	7.78	13.90	17.60

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
05/21/96	5.05	7.23	13.90	17.80
05/22/96	4.98	7.05	13.40	17.10
05/23/96	5.57	7.47	14.00	17.40
05/24/96	7.09	8.53	19.50	23.10
05/25/96	5.85	9.09	15.30	19.50
05/26/96	5.12	7.64	15.70	21.30
05/27/96	5.10	6.48	13.10	17.30
05/28/96	4.61	6.77	12.80	16.70
05/29/96	4.26	6.09	12.80	16.80
05/30/96	4.15	5.59	11.10	14.60
05/31/96	3.81	5.72	11.00	14.40
06/01/96	3.52	5.15	11.00	14.10
06/02/96	3.37	4.92	8.85	12.80
06/03/96	3.32	4.10	9.25	12.40
06/04/96	3.22	4.19	9.16	13.20
06/05/96	3.14	3.81	9.13	13.40
06/06/96	3.12	3.73	8.86	13.00
06/07/96	3.29	3.89	10.10	12.10
06/08/96	5.02	4.60	14.60	20.90
06/09/96	3.50	5.73	11.80	17.40
06/10/96	3.12	4.13	11.20	16.00
06/11/96	3.02	4.10	9.19	12.30
06/12/96	2.95	4.02	8.88	12.00
06/13/96	2.73	3.71	8.41	12.30
06/14/96	2.50	2.80	7.44	10.20
06/15/96	2.82	1.62	5.88	9.26
06/16/96	2.75	1.35	6.24	9.43
06/17/96	2.71	1.81	6.02	9.41
06/18/96	2.71	1.13	5.98	8.86
06/19/96	2.75	0.99	5.99	8.98
06/20/96	2.73	1.05	5.97	8.45
06/21/96	2.75	2.62	5.93	8.48
06/22/96	2.66	2.64	6.13	8.23
06/23/96	2.48	2.32	5.99	8.55
06/24/96	2.40	2.23	5.66	8.63
06/25/96	2.44	1.96	5.51	8.35
06/26/96	2.44	0.32	5.48	8.07
06/27/96	2.47	0.48	4.66	7.29
06/28/96	2.41	0.69	4.97	6.82
06/29/96	2.51	0.62	5.57	7.11
06/30/96	2.38	0.65	5.52	7.53
07/01/96	2.41	0.50	5.38	7.45
07/02/96	2.38	0.64	5.49	7.52
07/03/96	2.51	0.68	5.32	7.77
07/04/96	2.52	0.75	5.14	7.54

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
07/05/96	2.57	0.64	5.17	8.11
07/06/96	2.38	0.81	6.05	8.40
07/07/96	2.58	0.97	5.64	8.42
07/08/96	2.08	2.58	5.04	7.69
07/09/96	1.89	2.16	5.27	7.17
07/10/96	1.85	0.87	5.41	7.76
07/11/96	1.83	0.80	3.87	6.68
07/12/96	1.69	1.23	5.50	6.50
07/13/96	1.47	1.53	4.73	6.52
07/14/96	1.60	1.35	3.87	6.24
07/15/96	1.50	1.42	3.94	6.34
07/16/96	1.40	1.34	3.81	6.04
07/17/96	1.49	1.16	3.82	5.50
07/18/96	1.46	1.06	3.70	4.84
07/19/96	1.34	1.47	2.65	5.36
07/20/96	1.32	1.28	3.21	5.00
07/21/96	1.32	1.24	3.72	5.27
07/22/96	1.24	1.20	3.35	5.25
07/23/96	1.33	1.32	3.26	4.63
07/24/96	1.43	1.21	3.21	4.49
07/25/96	1.45	1.34	3.20	4.88
07/26/96	1.39	1.40	3.27	4.95
07/27/96	1.30	1.41	3.43	4.75
07/28/96	1.39	1.51	4.00	4.84
07/29/96	1.66	1.39	5.48	6.35
07/30/96	2.26	1.61	4.62	6.22
07/31/96	2.08	1.12	3.95	5.70
08/01/96	2.11	1.11	3.97	5.50
08/02/96	1.41	1.33	3.71	5.68
08/03/96	1.34	1.35	3.64	5.39
08/04/96	1.26	1.16	3.63	5.35
08/05/96	1.26	1.06	3.43	5.24
08/06/96	1.25	1.04	3.20	4.67
08/07/96	1.22	0.99	3.06	4.49
08/08/96	1.28	1.04	2.75	4.48
08/09/96	1.26	1.11	2.76	4.53
08/10/96	1.27	1.21	3.72	4.94
08/11/96	2.32	1.30	4.85	6.24
08/12/96	2.77	1.45	4.32	6.30
08/13/96	2.26	1.59	4.22	6.15
08/14/96	2.12	0.84	3.79	6.12
08/15/96	2.15	0.81	3.68	5.82
08/16/96	1.34	1.03	3.38	5.70
08/17/96	1.26	1.07	3.34	5.45

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
08/18/96	1.23	1.13	2.85	4.79
08/19/96	1.23	1.17	2.84	4.74
08/20/96	1.32	1.18	2.94	4.52
08/21/96	1.32	1.36	3.17	4.57
08/22/96	1.37	1.13	3.34	5.32
08/23/96	2.90	1.19	5.34	5.20
08/24/96	2.13	1.51	6.82	5.90
08/25/96	2.25	1.27	7.11	6.43
08/26/96	2.07	1.21	4.79	6.80
08/27/96	1.67	1.13	3.80	6.05
08/28/96	2.04	1.10	3.96	5.83
08/29/96	2.25	1.37	3.21	5.34
08/30/96	2.07	1.16	3.59	4.97
08/31/96	1.55	0.98	4.18	5.33
09/01/96	1.43	0.96	3.73	5.41
09/02/96	1.36	1.09	3.05	5.26
09/03/96	1.35	1.12	2.77	4.55
09/04/96	1.42	1.06	2.70	4.35
09/05/96	1.32	0.80	3.12	4.35
09/06/96	1.28	0.91	3.10	4.75
09/07/96	1.24	1.09	3.06	4.65
09/08/96	1.22	1.25	2.98	4.48
09/09/96	1.22	1.23	2.97	4.39
09/10/96	1.18	1.11	2.88	4.29
09/11/96	1.23	1.58	2.99	4.17
09/12/96	1.18	1.55	3.22	4.37
09/13/96	1.18	1.09	3.25	4.61
09/14/96	1.17	1.07	3.02	4.51
09/15/96	1.28	1.21	2.94	4.39
09/16/96	1.08	1.19	2.84	4.30
09/17/96	1.17	1.24	3.18	3.97
09/18/96	1.18	1.20	2.50	4.22
09/19/96	1.21	0.93	2.62	3.93
09/20/96	1.19	1.06	2.91	4.16
09/21/96	1.27	1.18	2.90	4.18
09/22/96	1.19	1.19	2.85	4.17
09/23/96	1.21	1.14	2.85	4.21
09/24/96	1.21	1.38	3.15	4.48
09/25/96	1.28	1.04	3.66	4.79
09/26/96	1.66	1.25	3.75	4.94
09/27/96	1.38	1.49	3.30	4.65
09/28/96	1.32	1.14	3.34	4.48
09/29/96	1.47	1.24	3.37	4.66
09/30/96	1.78	1.43	3.35	4.68
10/01/96	1.74	1.61	4.12	4.93

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
10/02/96	1.40	1.11	3.96	5.25
10/03/96	1.32	1.03	3.55	5.01
10/04/96	1.27	1.02	2.86	4.42
10/05/96	1.24	1.06	3.09	4.20
10/06/96	1.25	1.05	3.06	4.40
10/07/96	1.33	1.10	3.04	4.45
10/08/96	1.38	1.20	3.30	4.59
10/09/96	1.57	1.34	4.11	4.86
10/10/96	1.99	1.29	3.25	5.61
10/11/96	1.48	1.39	2.98	5.04
10/12/96	1.41	1.16	3.52	4.95
10/13/96	1.39	1.07	3.43	5.03
10/14/96	1.39	1.11	3.13	4.71
10/15/96	1.44	1.22	3.17	4.44
10/16/96	1.66	1.26	3.22	4.44
10/17/96	1.50	1.30	3.42	4.61
10/18/96	1.54	1.13	4.29	4.99
10/19/96	1.93	1.23	4.03	5.50
10/20/96	1.81	1.46	3.21	5.18
10/21/96	1.97	1.18	3.68	5.19
10/22/96	1.99	1.42	3.50	5.44
10/23/96	1.57	1.38	3.38	5.25
10/24/96	1.53	1.15	3.41	5.22
10/25/96	1.55	1.07	3.01	4.74
10/26/96	2.01	1.05	3.53	4.52
10/27/96	2.19	1.66	4.12	5.39
10/28/96	3.23	2.29	3.87	5.07
10/29/96	2.63	1.58	4.67	5.38
10/30/96	1.82	1.22	4.56	5.94
10/31/96	1.47	0.98	3.24	5.71
11/01/96		1.28	3.52	4.92
11/02/96		1.20	4.02	5.40
11/03/96		1.22	4.06	6.07
11/04/96		2.09	7.28	7.87
11/05/96		4.00	6.88	8.79
11/06/96		2.10	8.28	10.80
11/07/96		1.88	5.62	8.47
11/08/96		3.20	5.35	6.35
11/09/96		1.80	6.45	7.72
11/10/96		0.98	5.81	10.10
11/11/96		1.15	3.21	4.28
11/12/96		1.69	4.47	5.23
11/13/96		1.19	5.48	6.58

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
11/14/96		1.26	4.59	6.49
11/15/96		1.38	4.34	5.99
11/16/96		1.44	5.24	6.44
11/17/96		1.58	6.39	9.71
11/18/96		2.42	5.90	8.98
11/19/96		3.02	10.70	15.00
11/20/96		4.46	11.60	17.10
11/21/96		3.63	11.40	15.50
11/22/96		2.59	10.70	15.20
11/23/96		2.14	9.08	11.90
11/24/96		3.15	8.33	11.80
11/25/96		4.94	11.90	15.10
11/26/96		5.63	11.90	15.40
11/27/96		4.49	12.60	16.50
11/28/96		3.70	10.30	13.30
11/29/96		3.43	10.10	13.00
11/30/96		3.99	9.39	12.60
12/01/96		4.02	10.00	12.60
12/02/96		3.73	9.97	12.80
12/03/96		4.42	11.10	14.40
12/04/96		7.19	12.60	15.00
12/05/96		6.64	15.40	18.80
12/06/96		5.75	13.50	17.20
12/07/96		4.39	11.20	15.00
12/08/96		3.81	9.31	11.50
12/09/96		3.78	9.32	12.10
12/10/96		3.92	8.87	11.30
12/11/96		3.92	8.81	11.20
12/12/96		3.79	8.84	10.90
12/13/96		3.94	8.34	10.50
12/14/96		3.58	8.14	9.92
12/15/96		3.50	8.50	10.30
12/16/96		3.67	8.02	10.10
12/17/96		3.49	8.43	10.20
12/18/96		3.67	8.02	10.30
12/19/96		6.07	10.50	11.80
12/20/96		7.72	12.90	15.80
12/21/96		7.04	15.00	18.20
12/22/96		5.94	14.30	17.70
12/23/96		4.72	12.10	15.80
12/24/96		5.11	10.10	12.30
12/25/96		4.89	10.70	12.80
12/26/96		4.65	10.10	12.80
12/27/96		4.40	9.53	11.90

Date	Buscot SU230981	Eynsham SP445086	Days Weir SU569936	Caversham SU718741
12/28/96		4.49	8.34	10.50
12/29/96		4.49	8.72	10.60
12/30/96		4.73	9.03	11.30
12/31/96		4.19	8.83	11.40

APPENDIX II

Data obtained during 1996

Zooplankton - R.Thames data
Zero indicates no value available; negative values indicate a sample processing error.

Site	Apparent chl 09-Apr	22-Apr	06-May	20-May	03-Jun	17-Jun	01-Jul	15-Jul	29-Jul	12-Aug	27-Aug	09-Sep	23-Sep	07-Oct	21-Oct
Inglesham	34.2	18.9	7.9	14.3	7.1	9.6	6.0	3.8	5	4.7	0	2.8	0	2.4	3.7
Radley	0.0	17.4	13.2	23.6	41.2	76.5	6.7	7.0	6	6.6	0	4.3	0	3.6	3.3
Abingdon	27.2	20.3	14.2	22.8	43.6	72.6	12.0	12.4	8.2	4.9	0	6.7	0	3.2	3.4
Wallingford	33.7	28.3	25.9	32.6	119.0	211.7	21.1	20.2	18.6	10.1	0	10.2	0	4.6	4.3
Reading	38.4	28	30.4	90.0	192.0	161.9	27.6	18.6	18.5	10.2	0	10.6	0	8.3	8.9

chlorophyll

	09-Apr	22-Apr	06-May	20-May	03-Jun	17-Jun	01-Jul	15-Jul	29-Jul	12-Aug	27-Aug	09-Sep	23-Sep	07-Oct	21-Oct
Inglesham	32.0	20.3	6.0	11.4	5.5	6.8	3.5	2.6	4.3	3.6	0	1.7	0	1.4	1.6
Radley	0.0	18.9	0.0	21.7	39.1	71.1	4.7	5.9	4.4	5.5	0	3.0	0	2.7	2.7
Abingdon	24.6	0.0	12.7	20.5	41.3	67.9	9.0	10.5	7.4	3.8	0	5.2	0	2.7	3.0
Wallingford	30.7	30.3	23.0	29.4	115.6	198.9	14.4	17.4	13	7.5	0	6.9	0	3.9	3.9
Reading	35.4	31.5	27.4	83.1	184.0	146.3	17.2	15.1	11.7	3.4	0	7.3	0	6.9	6.5

Phaeopigments

	09-Apr	22-Apr	06-May	20-May	03-Jun	17-Jun	01-Jul	15-Jul	29-Jul	12-Aug	27-Aug	09-Sep	23-Sep	07-Oct	21-Oct
Inglesham	3.5	-2.2	3.1	4.5	2.7	4.5	4.0	1.9	1.1	1.7	0	1.74	0	1.61	3.8
Radley	0.0	-2.4	0.0	3.1	3.4	8.7	3.2	1.8	2.5	1.9	0	2.16	0	1.33	0.7
Abingdon	4.1	0.0	2.3	3.6	3.8	7.5	4.8	3.0	1.2	1.8	0	2.44	0	0.78	0.6
Wallingford	4.9	-3.2	4.7	5.2	5.4	20.5	10.6	4.5	8.9	4.2	0	5.28	0	1.17	0.9
Reading	4.8	-5.5	4.8	10.9	12.8	24.9	16.7	5.6	10.8	11.0	0	5.28	0	2.31	3.4

Zooplankton - R.Thames data
Zero indicates no value available; negative values indicate a sample processing error.

% of degradation pigments

	09-Apr	22-Apr	06-May	20-May	03-Jun	17-Jun	01-Jul	15-Jul	29-Jul	12-Aug	27-Aug	09-Sep	23-Sep	07-Oct	21-Oct
Inglesham	9.9	-12.1	33.9	28.4	32.7	39.8	53.1	42.5	20.3	32.4	0	50.8	0	25.1	36.9
Radley	0.0	-14.6	0.0	12.5	7.9	10.9	40.6	23.5	36.3	25.5	0	41.9	0	23.1	15.2
Abingdon	14.4	0.0	15.4	15.0	8.4	9.9	35.0	22.0	14.4	32.9	0	32.0	0	22.2	16.7
Wallingford	13.7	-11.9	16.9	15.0	4.5	9.4	42.4	20.5	40.7	35.5	0	43.4	0	32.7	25.5
Reading	12.0	-21.1	14.8	11.6	6.5	14.5	49.3	27.0	48.1	76.4	0	42.0	0	53.0	68.7

temp. (C)

	09-Apr	22-Apr	06-May	20-May	03-Jun	17-Jun	01-Jul	15-Jul	29-Jul	12-Aug	27-Aug	09-Sep	23-Sep	07-Oct	21-Oct
Inglesham	11	12	9.6	9	14.5	18.8	17	19.3	19	16.5	16	15	14	12	13.5
Radley	0	12.5	11.4	10	16.2	19.5	17.7	19.7	20.5	18	17.5	16	14	13.5	14
Abingdon	9.4	12.5	11.4	10.5	16.5	21.2	17.8	21	21	18.5	18	16.5	14	14	13.5
Wallingford	9.3	12.5	12	11	16.5	21	18	20.8	21.5	18.5	17.5	16	14	14	14
Reading	0	12.5	12	11.5	16.5	21.5	18.5	20.8	20.5	19	17.5	16.5	13.5	13.5	13.5

Secchi (m)

	09-Apr	22-Apr	06-May	20-May	03-Jun	17-Jun	01-Jul	15-Jul	29-Jul	12-Aug	27-Aug	09-Sep	23-Sep	07-Oct	21-Oct
Inglesham	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Radley	0	1.65	2.25	2	1.65	1.25	2.05	2.5	1.5	1.8	2.6	2.43	3.1	2.8	2
Abingdon	0	1.85	2.1	1.75	1.25	1.25	1.65	2.05	1.6	2	2.2	2.13	2.9	2.45	2.2
Wallingford	0	1.65	1.75	2	1.55	0.9	1.3	1.9	1.75	1.65	2.45	1.84	0	3.05	2.3
Reading	0	1.65	1.9	1.25	1.3	0.75	1.25	1.8	1.5	1.35	2.15	1.65	2.9	2.75	1.85

Date			22/04/96	07/05/96	20/05/96	03/06/96	17/06/96	01/07/96	15/07/96	29/07/96	12/08/96	27/08/96	09/09/96	23/09/96
Site	Category													
Inglesham	picoplanktc x10 6	No/ml	0.93	2	3.23	5.73	5.73	4.71	7.4	8.16	4.42	8.6	6.15	No sample
Inglesham	nanoplankt phototroph	No/ml	14,481	6,389	26,517	35,135	31,305	37,694	38,972	28,111	27,473	24,917	15,972	No sample
Inglesham	nanoplankt heterotropt	No/ml	15,049	42,486	50,472	46,000	82,417	25,555	39,611	21,083	74,112	28,750	24,917	No sample
Inglesham	ciliates	No/ml	3	0	2.6	3	5.5	2	8	9.5	1.5	1	1	No sample
Radley	picoplanktc x10 6	No/ml	2.42	3.27	2.9	4.74	6.34	5.47	6.47	7.78	6.21	7.4	6.5	6
Radley	nanoplankt phototroph	No/ml	1,550	15,333	26,163	60,694	89,444	47,265	42,167	47,278	51,751	45,362	42,167	33,862
Radley	nanoplankt heterotropt	No/ml	21,685	25,875	47,597	55,583	127,765	56,222	37,694	42,805	58,140	33,223	28,750	65,807
Radley	ciliates	No/ml	2	14	18	32.5	48	7	6	1	8	7	8	3
Abingdon	picoplanktc x10 6	No/ml	2.76	2.72	3.81	5.89	5.83	4.67	5.73	4.1	4.9	7.01	4.6	7
Abingdon	nanoplankt phototroph	No/ml	9,086	23,958	27,472	76,028	93,978	67,083	63,250	102,861	36,417	34,501	63,890	37,695
Abingdon	nanoplankt heterotropt	No/ml	8,802	69,958	43,125	72,194	125,511	51,750	49,194	28,750	22,362	17,250	28,112	35,139
Abingdon	ciliates	No/ml	8.5	13	20.5	38.5	38	9.5	9.5	1.5	10	10	17	4
Wallingforc	picoplanktc x10 6	No/ml	2.59	3.65	5.78	6.18	6.05	3.55	8.1	4.51	6.14	9.4	5.5	8.9
Wallingforc	nanoplankt phototroph	No/ml	20,334	27,792	29,708	65,167	121,389	90,722	161,000	218,500	118,197	182,086	169,947	133,530
Wallingforc	nanoplankt heterotropt	No/ml	30,501	91,361	65,486	56,861	67,083	46,000	45,361	23,000	31,306	21,084	30,667	29,389
Wallingforc	ciliates	No/ml	9.5	19.5	32.5	71.5	38	12.5	10	3.5	19	8	0	3
Reading	picoplanktc x10 6	No/ml	2.18	3.92	3.95	6.34	7.14	7.4	7.3	5.51	9.02	7.2	7.2	10.1
Reading	nanoplankt phototroph	No/ml	18,457	21,083	34,500	84,972	95,194	297,722	298,361	401,222	266,421	311,783	345,006	307,311
Reading	nanoplankt heterotropt	No/ml	36,913	64,528	38,333	72,833	59,417	71,555	52,389	30,667	46,001	12,778	28,112	38,334
Reading	ciliates	No/ml	6.5	20.5	54	63.5	29	3.5	13	9	25.5	10	6	5

River Thames 1996 - "large" rotifers retained on a 63um sieve - expressed as numbers per litre
Subsample (1%) counts from 20 litres (preserved samples)

date	site	site comparisons (no./litre)	cross-channel comparisons									
			west bank		1/4 across		mid-river		3/4 across		east bank	
			surface	bottom	surface	bottom	surface	bottom	surface	bottom	surface	bottom
9.4.96	Inglesham	35									35	
9.4.96	Radley	no sample									no sample	
9.4.96	Abingdon	50									50	
9.4.96	Wallingford	195									195	
9.4.96	Reading	75									75	
22.4.96	Inglesham	30									30	
22.4.96	Radley	90									90	
22.4.96	Abingdon	95									95	
22.4.96	Wallingford	35									35	
22.4.96	Reading	50									50	
7.5.96	Inglesham	35									35	
7.5.96	Radley	95	90	50	90	50	60	85	70	90	95	60
7.5.96	Abingdon	10									10	
7.5.96	Wallingford	100	35	85	75	40	45	70	75	60	100	95
7.5.96	Reading	30									30	
20.5.96	Inglesham	40									40	
20.5.96	Radley	90	70	95	100	175	60	140	60	115	90	60
20.5.96	Abingdon	110									110	
20.5.96	Wallingford	190									190	
20.5.96	Reading	390									390	

date	site	site comparisons (no./litre)	cross-channel comparisons west bank surface	bottom	1/4 across surface	bottom	mid-river surface	bottom	3/4 across surface	bottom	east bank surface	bottom
3.6.96	Inglesham	10									10	
3.6.96	Radley	20	25	40	50	30	50	45	35	10	20	30
3.6.96	Abingdon	25									25	
3.6.96	Wallingford	75									75	
3.6.96	Reading	125									125	
17.6.96	Inglesham	10									10	
17.6.96	Radley	85	70	110	55	60	85	80	115	50	85	120
17.6.96	Abingdon	175									175	
17.6.96	Wallingford	130	225	185	195	260	135	300	170	240	130	125
17.6.96	Reading	580									580	
1.7.96	Inglesham	0									0	
1.7.96	Radley	65	85	40	95	95	85	85	85	125	65	75
1.7.96	Abingdon	150									150	
1.7.96	Wallingford	155	150	270	260	420	220	295	310	295	155	390
1.7.96	Reading	230									230	
15.7.96	Inglesham	15									15	
15.7.96	Radley	15	10	35	20	45	30	40	70	55	15	40
15.7.96	Abingdon	10									10	
15.7.96	Wallingford	70	45	90	40	210	65	80	85	90	70	70
15.7.96	Reading	95									95	

date	site	site comparisons (no./litre)	cross-channel comparisons									
			west bank surface	bottom	1/4 across surface	bottom	mid-river surface	bottom	3/4 across surface	bottom	east bank surface	bottom
29.7.96	Inglesham	0									0	
29.7.96	Radley	105									105	
29.7.96	Abingdon	145									145	
29.7.96	Wallingford	325									325	
29.7.96	Reading	430									430	
12.8.96	Inglesham	5									5	
12.8.96	Radley	105									105	
12.8.96	Abingdon	230									230	
12.8.96	Wallingford	135									135	
12.8.96	Reading	40									40	
27.8.96	Inglesham	0									0	
27.8.96	Radley	20									20	
27.8.96	Abingdon	10									10	
27.8.96	Wallingford	25									25	
27.8.96	Reading	100									100	

date	site	site comparisons (no./litre)	cross-channel comparisons west bank surface	bottom	1/4 across surface	bottom	mid-river surface	bottom	3/4 across surface	bottom	east bank surface	bottom
9.9.96	Inglesham	5									5	
9.9.96	Radley	20									20	
9.9.96	Abingdon	75									75	
9.9.96	Wallingford	20									20	
9.9.96	Reading	295									295	
23.9.96	Inglesham	10									10	
23.9.96	Radley	165									165	
23.9.96	Abingdon	200									200	
23.9.96	Wallingford	15									15	
23.9.96	Reading	95									95	

sequence of 10 margin samples - Radley (large rotifers/litre)

17.6.96	80	80	85	70	135	135	115	130	125	95

River Thames 1996 - Total rotifer counts - expressed as numbers per litre

Site	Date	Dayno	Anurae	Ba	Bc	Bdell	Bu	Ca	Cg	Col sp.	Cx	Ed	Edl	Fb	Fl	Gastr	Kcu	Kcy	Kq	L?c	Lec	Lep	Ll	Na	Ns	Pd	Pda	Pro s	Rf	So	Sp	Tc	Te p	Tp	Tr sp.	Tri tetr	Unid	Total
Inglesham	09/04/96	35164	0	0	0	2	2	0	2	2	4	18	0	0	0	0	0	4	0	0	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	4	44
Inglesham	22/04/96	35177	0	0	0	4	0	0	0	0	0	6	0	0	0	0	0	2	2	4	2	0	0	0	6	2	0	0	0	6	0	0	0	0	0	0	8	42
Inglesham	07/05/96	35192	0	0	0	2	0	2	0	0	0	4	0	0	2	0	0	6	6	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4	0	0	28
Inglesham	20/05/96	35205	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	2	2	10
Inglesham	03/06/96	35219	0	0	2	0	0	2	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	6	0	0	0	0	0	0	0	20
Inglesham	17/06/96	35233	0	0	0	0	0	0	4	0	2	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	8	0	0	0	0	8	32
Inglesham	01/07/96	35247	0	0	0	0	0	0	2	0	14	2	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	2	0	4	30
Inglesham	15/07/96	35261	0	0	0	0	0	0	0	0	8	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	8	22
Inglesham	29/07/96	35275	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	14
Inglesham	12/08/96	35289	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	14	16
Inglesham	27/08/96	35304	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Inglesham	09/09/96	35317	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	18
Inglesham	23/09/96	35331	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	24
Inglesham	07/10/96	35345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11
Inglesham	21/10/96	35359	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	44
Site total			0	0	2	8	8	10	8	2	33	44	2	0	4	2	2	12	8	6	7	5	8	4	6	4	2	0	0	24	0	12	0	0	6	2	126	
																	14																					
Site Mean			0.0	0.0	0.1	0.5	0.5	0.7	0.5	0.1	2.2	2.9	0.1	0.0	0.3	0.1	0.1	0.8	0.5	0.4	0.5	0.3	0.5	0.3	0.4	0.3	0.1	0.0	0.0	1.6	0.0	0.8	0.0	0.0	0.4	0.1	8.4	23.8
																	0.9																					
Site	Date	Dayno	Anurae	Ba	Bc	Bdell	Bu	Ca	Cg	Col sp.	Cx	Ed	Edl	Fb	Fl	Gastr	Kcu	Kcy	Kq	L?c	Lec	Lep	Ll	Na	Ns	Pd	Pda	Pro s	Rf	So	Sp	Tc	Te p	Tp	Tr sp.	Tri tetr	Unid	Total
Radley	09/04/96	35164	*No sample*																																			
Radley	22/04/96	35177	0	4	2	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	2	2	4	0	0	0	10	0	0	0	0	0	0	10	44
Radley	07/05/96	35192	0	12	4	0	0	0	0	2	0	2	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	2	54
Radley	20/05/96	35205	0	14	14	0	0	0	0	0	0	2	0	0	0	0	0	14	22	0	0	0	0	4	2	4	0	0	0	26	0	0	0	0	2	0	2	106
Radley	03/06/96	35219	0	2	8	0	0	2	0	0	0	0	0	0	0	0	2	18	12	0	0	0	0	2	0	2	2	0	0	6	0	0	0	0	0	0	2	58
Radley	17/06/96	35233	0	0	2	0	0	0	0	0	0	2	0	0	0	0	14	34	6	0	0	0	0	0	0	4	0	0	0	254	0	0	0	0	0	2	2	320
Radley	01/07/96	35247	0	6	0	2	0	2	0	0	0	4	0	0	0	0	2	34	4	0	0	0	0	0	0	5	0	0	0	70	0	0	0	0	0	0	6	135
Radley	15/07/96	35261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	38	0	0	4	0	8	0	0	12	0	0	0	14	0	0	0	0	0	0	6	98
Radley	29/07/96	35275	0	0	0	0	0	4	0	0	0	0	0	0	0	0	4	8	0	0	0	0	0	0	0	4	0	0	0	296	0	0	0	0	0	0	2	318
Radley	12/08/96	35289	0	0	0	5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	827	0	0	0	0	0	0	108	0	0	0	9	0	0	9	963
Radley	27/08/96	35304	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	20
Radley	09/09/96	35317	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	8	0	0	0	12	0	8	0	0	0	0	8	40
Radley	23/09/96	35331	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	75	0	5	0	0	0	0	0	85
Radley	07/10/96	35345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5
Radley	21/10/96	35359	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	11
Site total			0	38	30	7	0	8	0	2	0	25	0	0	0	2	42	152	44	0	4	0	835	8	4	48	2	0	0	931	0	13	0	9	2	2	49	
																	194																					
Site Mean			0.0	2.7	2.1	0.5	0.0	0.6	0.0	0.1	0.0	1.8	0.0	0.0	0.0	0.1	3.0	10.9	3.1	0.0	0.3	0.0	59.6	0.6	0.3	3.4	0.1	0.0	0.0	66.5	0.0	0.9	0.0	0.6	0.1	0.1	3.5	161.2
																	13.9																					

Site	Date	Dayno	Anurae	Ba	Bc	Bdell	Bu	Ca	Cg	Col sp.	Cx	Ed	Edl	Fb	Fl	Gastr	Kcu	Kcy	Kq	L?c	Lec	Lep	Ll	Na	Ns	Pd	Pda	Pro s	Rf	So	Sp	Tc	Te p	Tp	Tr sp.	Tri tetr	Unid	Total
Abingdon	09/04/96	35164	0	0	0	0	0	0	0	0	14	22	0	0	0	0	2	0	0	0	0	0	0	2	10	0	0	0	0	30	2	4	0	0	0	0	2	88
Abingdon	22/04/96	35177	0	8	2	0	0	2	0	0	0	14	0	0	2	0	2	2	2	0	0	0	2	0	4	0	0	0	0	0	0	0	0	0	0	0	6	46
Abingdon	07/05/96	35192	0	2	2	0	0	0	0	0	0	2	2	0	0	0	2	0	2	0	0	0	0	0	0	2	0	0	0	38	0	0	0	0	0	0	2	54
Abingdon	20/05/96	35205	0	18	8	0	0	0	0	0	0	6	0	0	4	0	4	8	8	0	0	0	0	14	8	8	0	0	0	34	0	0	0	0	2	0	6	128
Abingdon	03/06/96	35219	0	0	6	0	0	0	0	0	4	4	0	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	40
Abingdon	17/06/96	35233	0	0	6	0	0	0	0	0	0	8	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	390	0	0	0	0	0	0	0	408
Abingdon	01/07/96	35247	0	4	2	0	0	0	0	0	0	0	0	0	0	0	10	22	2	0	0	0	0	0	0	6	0	0	0	298	0	0	0	0	0	0	0	344
Abingdon	15/07/96	35261	0	8	0	0	0	0	0	0	0	0	0	0	0	0	16	22	4	0	0	0	0	0	0	10	0	0	0	52	0	0	0	0	0	0	0	112
Abingdon	29/07/96	35275	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22	2	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	136
Abingdon	12/08/96	35289	0	0	0	0	0	10	0	0	0	0	0	0	0	0	10	0	0	0	10	0	0	0	0	20	0	0	0	400	0	0	0	0	0	0	40	490
Abingdon	27/08/96	35304	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	11	0	0	0	48	0	0	0	0	0	0	11	81
Abingdon	09/09/96	35317	0	0	0	11	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	11	107
Abingdon	23/09/96	35331	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	240	5	0	0	0	0	0	0	250
Abingdon	07/10/96	35345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	8	0	0	0	0	0	0	0	12
Abingdon	21/10/96	35359	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	0	4	0	0	0	0	4	59
Site total			**0**	**40**	**26**	**11**	**0**	**12**	**0**	**0**	**18**	**56**	**2**	**0**	**6**	**0**	**57**	**84**	**37**	**0**	**10**	**0**	**2**	**16**	**22**	**62**	**4**	**0**	**0**	**1791**	**7**	**8**	**0**	**0**	**2**	**0**	**82**	
																	141																					
Site Mean			**0.0**	**2.7**	**1.7**	**0.7**	**0.0**	**0.8**	**0.0**	**0.0**	**1.2**	**3.7**	**0.1**	**0.0**	**0.4**	**0.0**	**3.8**	**5.6**	**2.5**	**0.0**	**0.7**	**0.0**	**0.1**	**1.1**	**1.5**	**4.1**	**0.3**	**0.0**	**0.0**	**119.4**	**0.5**	**0.5**	**0.0**	**0.0**	**0.1**	**0.0**	**5.5**	**157.0**
																	9.4																					
Site	Date	Dayno	Anurae	Ba	Bc	Bdell	Bu	Ca	Cg	Col sp.	Cx	Ed	Edl	Fb	Fl	Gastr	Kcu	Kcy	Kq	L?c	Lec	Lep	Ll	Na	Ns	Pd	Pda	Pro s	Rf	So	Sp	Tc	Te p	Tp	Tr sp.	Tri tetr	Unid	Total
Wallingford	09/04/96	35164	0	0	0	0	0	6	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	16	2	0	0	4	0	0	0	0	0	0	0	4	44
Wallingford	22/04/96	35177	0	0	2	0	0	6	0	2	0	10	0	0	0	0	0	4	0	0	0	0	0	4	4	0	0	0	0	4	0	0	0	0	0	0	6	42
Wallingford	07/05/96	35192	0	0	12	0	0	2	0	0	0	4	0	0	0	0	0	2	8	0	0	0	0	0	0	4	0	0	0	10	0	0	0	0	0	0	10	52
Wallingford	20/05/96	35205	0	8	12	0	0	0	0	0	0	14	0	0	4	0	0	2	18	0	0	0	0	8	6	2	0	0	0	48	0	0	0	0	0	4	0	126
Wallingford	03/06/96	35219	0	0	4	0	0	0	0	0	0	6	0	0	0	0	2	6	6	0	0	0	0	0	0	4	0	0	0	6	0	0	0	0	0	0	2	36
Wallingford	17/06/96	35233	0	8	0	0	0	0	0	0	0	0	0	0	0	0	104	218	18	0	0	0	0	0	0	4	0	0	0	294	2	0	0	0	0	0	4	652
Wallingford	01/07/96	35247	0	0	8	0	0	0	0	0	0	0	0	0	0	0	28	32	10	0	0	0	0	0	0	2	0	0	0	332	0	0	0	0	0	0	0	412
Wallingford	15/07/96	35261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	32	0	0	0	144	0	8	0	0	0	0	0	202
Wallingford	29/07/96	35275	2	136	56	0	0	0	0	0	0	0	0	0	0	0	154	146	30	0	0	0	0	0	0	148	0	0	0	156	18	0	0	32	0	0	12	890
Wallingford	12/08/96	35289	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	53	0	0	0	5	0	0	0	68
Wallingford	27/08/96	35304	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	12	0	0	0	24	0	0	0	0	0	0	0	40
Wallingford	09/09/96	35317	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	76	0	0	0	0	0	0	8	88
Wallingford	23/09/96	35331	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	12	0	0	0	0	0	0	4	24
Wallingford	07/10/96	35345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	4	16
Wallingford	21/10/96	35359	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	88	0	0	0	0	0	0	0	100
Site total			**2**	**152**	**94**	**4**	**0**	**14**	**0**	**2**	**0**	**46**	**0**	**0**	**4**	**0**	**288**	**441**	**94**	**0**	**4**	**0**	**0**	**12**	**26**	**223**	**0**	**0**	**4**	**1259**	**20**	**8**	**0**	**37**	**0**	**4**	**54**	
																	729																					
Site Mean			**0.1**	**10.1**	**6.3**	**0.3**	**0.0**	**0.9**	**0.0**	**0.1**	**0.0**	**3.1**	**0.0**	**0.0**	**0.3**	**0.0**	**19.2**	**29.4**	**6.3**	**0.0**	**0.3**	**0.0**	**0.0**	**0.8**	**1.7**	**14.9**	**0.0**	**0.0**	**0.3**	**83.9**	**1.3**	**0.5**	**0.0**	**2.5**	**0.0**	**0.3**	**3.6**	**186.1**
																	48.6																					

Site	Date	Dayno	Anurae	Ba	Bc	Bdell	Bu	Ca	Cg	Col sp.	Cx	Ed	Edl	Fb	Fl	Gastr	Kcu	Kcy	Kq	L?c	Lec	Lep	Ll	Na	Ns	Pd	Pda	Pro s	Rf	So	Sp	Tc	Te p	Tp	Tr sp.	Tri tetr	Unid	Total
Reading	09/04/96	35164	0	0	0	0	0	0	0	1	4	34	0	0	0	0	0	0	0	0	0	0	0	2	7	0	0	0	0	2	0	1	0	0	0	0	1	52
Reading	22/04/96	35177	0	0	0	4	0	0	0	0	0	0	2	0	2	0	0	2	2	2	0	0	0	0	12	0	0	0	0	0	0	4	0	0	0	0	4	34
Reading	07/05/96	35192	0	2	4	0	0	0	0	0	0	6	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	16	0	2	0	0	0	0	2	36
Reading	20/05/96	35205	0	20	12	0	0	0	0	0	0	90	8	0	2	0	2	24	20	0	0	0	0	38	34	5	0	0	0	200	0	4	0	0	0	6	16	481
Reading	03/06/96	35219	0	8	4	0	0	0	0	0	0	8	0	0	0	0	4	30	8	0	0	0	0	4	4	4	0	0	0	172	0	0	0	0	0	0	8	254
Reading	17/06/96	35233	0	0	11	0	0	22	0	0	0	11	0	0	22	0	100	1089	67	0	0	0	0	0	0	22	0	0	0	1367	0	0	0	0	0	0	11	2722
Reading	01/07/96	35247	0	6	12	0	0	0	0	0	0	0	0	0	0	0	348	432	132	0	0	0	0	0	0	12	0	0	0	18	0	0	0	6	0	0	6	972
Reading	15/07/96	35261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	0	34	0	0	0	315	0	0	0	0	0	0	4	391
Reading	29/07/96	35275	0	80	32	0	0	0	0	0	0	0	0	16	0	0	2256	1408	0	0	0	0	0	0	0	80	16	0	0	80	0	0	0	96	96	0	0	4160
Reading	12/08/96	35289	0	6	2	2	0	0	0	0	0	0	0	0	0	0	10	36	0	0	0	0	0	0	0	40	0	0	0	32	0	0	0	0	0	0	2	130
Reading	27/08/96	35304	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	20	0	0	0	0	0	0	0	12	0	0	0	20	4	0	0	0	0	0	4	64
Reading	09/09/96	35317	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	874	0	0	0	0	0	0	0	890
Reading	23/09/96	35331	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	128	0	0	0	0	0	0	0	132
Reading	07/10/96	35345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	490	0	0	0	0	0	0	8	498
Reading	21/10/96	35359	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0	0	0	0	0	10	150
Site total			0	122	77	6	0	22	0	1	4	149	10	16	26	0	2724	3081	229	2	0	0	0	46	57	229	16	0	0	3854	4	11	0	102	96	6	76	
																	5805																					
Site Mean			0.0	8.1	5.1	0.4	0.0	1.5	0.0	0.1	0.3	9.9	0.7	1.1	1.7	0.0	181.6	205.4	15.3	0.1	0.0	0.0	0.0	3.1	3.8	15.3	1.1	0.0	0.0	256.9	0.3	0.7	0.0	6.8	6.4	0.4	5.1	731.1
																	387.0																					
Grand total			2	352	229	36	8	66	8	7	55	320	14	16	40	4	3113	3770	412	8	25	5	845	86	115	566	24	0	4	7859	31	52	0	148	106	14	387	
																	6883																					

Key to species codes for rotifers in the River Thames, 1996

Rotifer species list for the River Thames - 1996	
Species	**Code**
Anuraeopsis sp. Lauterborn	Anurae
Brachionus angularis Gosse	Ba
Brachionus calyciflorus Pallas	Bc
Bdelloids	Bdell
Brachionus urceolaris (Müller)	Bu
Colurella adriatica Ehrenberg	Ca
Cephalodella gibba (Ehrenberg)	Cg
Colurella sp. Bory de St Vincent	Col sp.
Cephalodella sp. Bory de St Vincent	Cx
Euchlanis dilatata Ehrenberg	Ed
Euchlanis dilatata f. *larga* (Kutikova)	Edl
Filinia brachiata (Rousselet)	Fb
Filinia ?longiseta (Ehrenberg)	Fl
Gastropus sp. (Imhof)	Gastr
Keratella cochlearis f. *tecta* (Gosse)	Kcu
Keratella coclearis f. *typica* (Gosse)	Kcy
Keratella quadrata (Müller)	Kq
Lecane ?candida Harring & Myers	L?c
Lecane sp. Nitzsch	Lec sp.
Lepadella sp. Bory de St Vincent	Lep sp.
Lecane lunaris (Ehrb.)	Ll
Notholca acuminata Ehrenberg	Na
Notholca squamula (Müller)	Ns
Polyarthra dolichoptera Idelson	Pd
P. dolichoptera f. *aptera* (Hood)	Pda
Proales sp. Gosse	Pro sp.
Rhinoglena frontinalis Ehrenberg	Rf
Synchaeta oblonga (Müller)	So
Synchaeta ?pectinata Ehrenberg	Sp
Trichocerca ?cylindrica (Imhof)	Tc
Testudinella patina (Hermann)	Te p
Trichocerca pusilla (Lauterborn)	Tp
Trichocerca sp. Lamarck	Tr sp.
Trichotria tetractis (Ehrb.)	Tri tetr