FRESHWATER BIOLOGICAL ASSOCIATION

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Biological Environments of Larger UK rivers: Progress Report 1987

by C.S. Reynolds

Commissioned by The Department of the Environment

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Interim Progress Report to the Water Directorate, Department of the Environment on the Project Entitled:

Biological environments of larger UK rivers (DoE Contract PECD 7/7/200)

Progress Report for the 9 months from January 1987 to September 1987

Contract Start Date	20.6.1986	Current Contract Sum £165 000	
Completion Date	31.5.1989		
Percentage time elapsed	44%	DoE Contribution: not formalised,	35%

1. Staff employed during period

Grade	Number	Effort
SPSO	1	4.5 months
SSO	1	4.5 months
ASO	1	4.5 months

Items of capital equipment

Item	Cost
"Aquatracka"	£17 000

2. Objectives of Project. The conceptual basis of the present work was founded upon the contention (i) that hitherto-accepted models of fluvial flow are inappropriate for the estimation of dispersion rates of entrained solutes and particulate loads and (ii) that the existence of viable, self-replicating phytoplankton in rivers was paradoxical without the simultaneous and widespread existence in those rivers of physical mechanisms for retaining significant volumes of water against the general discharge (1, 2). The single, aggregated dead-zone-(or ADZ-) model (3) provided practical evidence that the ADZ-concept might furnish an important basis for the investigation of (i) and (ii) above: as viable, growing respondents of the physical environment of larger rivers, the dynamics of natural phytoplankton populations ought to furnish useful markers of the spatial- and short-term temporal- variability of the fluvial flow. The project was conceived to provide insights into the mechanisms by which populations of particles (in this instance, phytoplankton) behave in relation to fluvial flow and, thus, to better model the dispersive properties of rivers and the ecological principles governing the distribution of potamoplankton generally.

3. Progress in Period The previous report (1) referred to a desk-study/review of the paradoxes of current tenets about dispersion and particle suspension in rivers. This has now been prepared for publication (4) as a 'state-of-the-art' assessment and as a collation of the outstanding aspects requiring investigation. Thus, the apparently disparate parts of the present project can be clearly interrelated; each will furnish components to the eventual construction of a "large-river model". One such example has been a concise but intensive study on the suspension and settlement times against variations in velocity and depth of the FBA's circulating channels, at Waterson, Dorset. Collectively, the results have demonstrated convincingly that, within the ranges tested, > 90% of the variance was due to depth. The

regression fit to loss exponent vs column depth agrees with the corresponding component devised for turbulent, standing-water columns (5), so one component of particulate removal can be reasonably modelled.

So far as plankton is concerned, particle dynamics are influenced by in situ growth (replication of particles). An experimental study on the growth of Stephanodiscus hantzschii (a conspicuous and typical component of the plankton of larger rivers) in relation to temperature and photoperiod has been commenced, with the intention of model reconstruction of growth exponents in rivers.

Field studies at the Severn sites (see 4) were commenced in earnest during the spring. It has to be admitted that there have been considerable logistic and practical problems and progress has been rather slower than anticipated. Nevertheless, we have been able to show with dye-tracers that significant water retention in pool reaches occurs within the range of (low) discharges obtaining, in accord with the Aggregated Dead Zone model and to an extent comparable with streams and small rivers investigated previously (3, 4). Despite the extensive variation in the velocity structure within and between adjacent profiles, differences in chlorophyll fluorescence and algal populations have been generally found to be insignificant. However, close to river banks and bed and in certain other localities where velocity is reduced towards zero, significant deviation has been detected. A good example is illustrated in Fig. 1: the apparent localization of enhanced chlorophyll fluorescence, presumed to be due, in part, to the longer residence of growing phytoplankton provides the first direct evidence to support the hypothesis that potamoplankton development in rivers is dependent upon within-reach retention nodes. The plot (Fig. 1) also shows an interesting gradient of chlorophyll, suggestive of transport of algae across the shear-zone between zero and maximal flow. We believe we have identified a storage mechanism in the river: we now need to determine the longevity of such tangible storage zones and to gain an insight into the rates of fluid exchange between the storage zone and the main flow.

Finally, a programme of monthly sampling to determine spatial and temporal differences in the phytoplankton standing crop along the upper- and middle-reaches of the Severn has been initiated. Already, the data show some consistent patterns of distribution among the benthic, limnetic and truly fluvial plankton and some migratory boundaries in the selective processes which influence the make up of the suspended algal load.

4. Outline plans (for next 6 months). The major activity during the next six months will be a continuation of the present programme to discern the behaviour of velocity structure, reach retention and phytoplankton maintenance during the period of increased winter discharge levels and their vernal subsidence. Later in 1988, the intention is to progress from detailed behaviour of individual reaches to a more general view of a series of adjacent reaches. Development of models applicable to other rivers is still a target for the present contract period but further work on testing and refinement could be the subject of a subsequent contract.

5. Dissemination of information. The literature review described in the December, 1986 report has been completed and is to be submitted for publication, as (4). A manuscript describing the results of the study of the suspension-velocity-depth relation, undertaken in the experimental channels, is at an early stage of preparation. No other external presentation of results or their discussion has been undertaken.

6. References

(1) Freshwater Biological Association (1986). Progress Report, Biological environments of larger UK rivers, April-December 1986.

(2) Water Authorities Association (1986). Water pollution from farm waste. W.A.A., London. (see esp. p.13).

(3) Young, P.C. & Wallis, S.G. (1987). The aggregated dead-zone model for dispersion in rivers. Proceedings of the Conference on Water Quality Modelling in the inland natural environment. (in press). BHRA, Cranfield.

(4) Reynolds, C.S. (in press). Potamoplankton: paradigms, paradoxes and prognoses. Essays in Phycology. Biopress, Bristol.

(5) Smith, I.R. (1982). A simple theory of algal deposition. Freshwat. Biol. 12, 445-449.

Fig. 1. Sections through a pool reach of the Severn near Montford Bridge, Shropshire, contoured in terms of velocity (above) and <u>in-vivo</u> chlorophyll fluorescence.