Are phytoplankton dynamics in rivers so different from those in shallow lakes?

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Abstract

This paper introduces a series of contributions to the ninth meeting of the International Association of Phytoplankton Taxonomy and Ecology, held in Belgium during July, 1993. It draws from the original papers a synthesis which supports the view that the successful species in rivers and turbid shallow lakes are selected primarily on their ability to survive high-frequency irradiance fluctuations as they are circulated through steep light gradients. The selective distinction is less than that which discriminates between plankton of deep lakes and shallow lakes or even between clear and turbid shallow ones. River plankton is, however, dependent on fast growth rates but its survival in rivers is aided by a suite of water-retentive mechanisms. The ecology of turbid systems is dominated by physical interactions, those biotic interactions traditionally believed to regulate limnetic communities being suppressed and rarely well-expressed.

Introduction

The ninth meeting of the International Association of Phytoplankton Taxonomy and Ecology was convened at the Station Scientifique des Hautes Fagnes (SSHF), the field station of the Université de Liège, Mont Rigi, Ardennes, Belgium, between 10 and 18 July, 1993. The original purpose of the meeting was to consider the taxonomy, physiological adaptations and population dynamics of planktonic algae that inhabit rivers and shallow lakes, on the premise that both kinds of habitat are to be readily perceived as being characteristically ‘turbulent’ and often also ‘turbid’. The supposedly strong environmental constraints of these habitats might guide wholly analogous selective interactions towards the assembly of analogous community structures. The pre-meeting circular invited contributors to address their papers to the validity, or otherwise, of this contention. The task of this introductory article might then have been simply to provide an editorial context for the collected presentations and to relate the individual contributions to the overall thesis. In fact, few of the contributed papers attempted to quantify the physical character of the location concerned (just how turbulent was it?) or, for that matter, the level of turbidity (just how murky was it?), which would permit useful, reasonable comparison to be made among the selection of habitats considered by the authors collectively. That this is so does not disappoint the editors; it is simply a recognition that these are concepts which are not well-formed beyond intuitive acceptance and that biologists are only ready or willing to treat them in qualitative terms. Our task is therefore altered to one of seeking patterns, of identifying unresolved problems and of setting future objectives for ecological research into these interesting and important habitats.

The volume includes seventeen original papers, nine of which are devoted to rivers, four to standing waters of differing relative transparency and another two examine the impact of impoundments in river catchments. The remaining two attempt to generalise over both turbid lakes and rivers. The contributions are variously taxonomic (what lives there?), functional (how does it do so?) or synthetic (what generalisations can be made?). Little is made of the environmental differences between rivers and shallow lakes, perhaps
again because, self-evidently, they are different. This is problematical, for if we suppose that planktonic bio-
ta in either kind of habitat are mutually similar, then we must ask whether they respond to similar proper-
ties of the immediate environment or, if in responding
to some other property of the water or its movement,
why flow does not ultimately distinguish more clearly
between the plankton of rivers and shallow lakes.

Rivers and lakes – the turbidity link

First, then, we need to be able to separate lakes from
rivers. In general, this should not be a problem – either
water flows or it does not! Given that, with a few clas-
sical endorheic exceptions, lakes are special cases of
flowing drainage systems in which hydraulic residence
is protracted, the distinction is not straightforward.
Indeed, it is a question which has been discussed at
length in classical limnology. Welch’s (1952) consid-
ered definitions – of lotic and lentic systems, according
to whether the water moves unidirectionally or not –
have been accepted generally in the past. Alternatively,
it may be that whereas the level of a lake is perceived
to be finite and stable (plus or minus a relatively small
fluctuation), that of a river, though scarcely less finite,
is characteristically graded from source to outfall. The
implication is that the movement of the water is pre-
dominantly unidirectional; the potential energy at the
head of the river is realized principally as turbulent
kinetic energy (TKE), which is dissipated, inter alia,
through friction with the bed and the resuspension and
re-entrainment of sedimented particles that cause the
evident turbidity. Reynolds (1994, this volume) argues
that the turbulent shear in lotic systems (streams and
rivers) does not greatly exceed that frequently generat-
ed by wind at the surface of lentic ones (lakes and seas).
If the lakes are simultaneously shallow (allowing TKE
to penetrate to the bottom) and if the bottom is also
soft (composed of uncompacted fine and resuspend-
able particles) then the immediate environmental con-
ditions are often not dissimilar from those in lowland
river reaches. Reynolds distinguishes among rivers and
lakes according to whether shear is originated predom-
nantly through the gravitational mass transport of the
water or through the action of wind upon the surface
of the water column.

Secondly, we need to reiterate the supposition that
there is commonality between the representation of
phytoplankton species in rivers and shallow lakes. Papers in this volume reveal a greater floristic overlap,