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River Continuum Concept and New Paradigm Shift

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SUMMARY

The article reviews that it is a model for classifying and describing flowing water from headwater to mouth, in addition to the classification of individual sections of waters after the occurrence of indicator organisms. RCC provides a paradigm for integrating predictable and observable biological features of lotic system. This theory is based on the concept of dynamic equilibrium in which river forms balance between physical parameters, such as width, depth, velocity, and sediment load, also taking into account biological factors. It offers the introduction to map out pure living communities and various food types, but also an explanation for their sequence in individual divisions of water. This allows the structure of the river to be more predictable as to the biological properties of the water.

INTRODUCTION

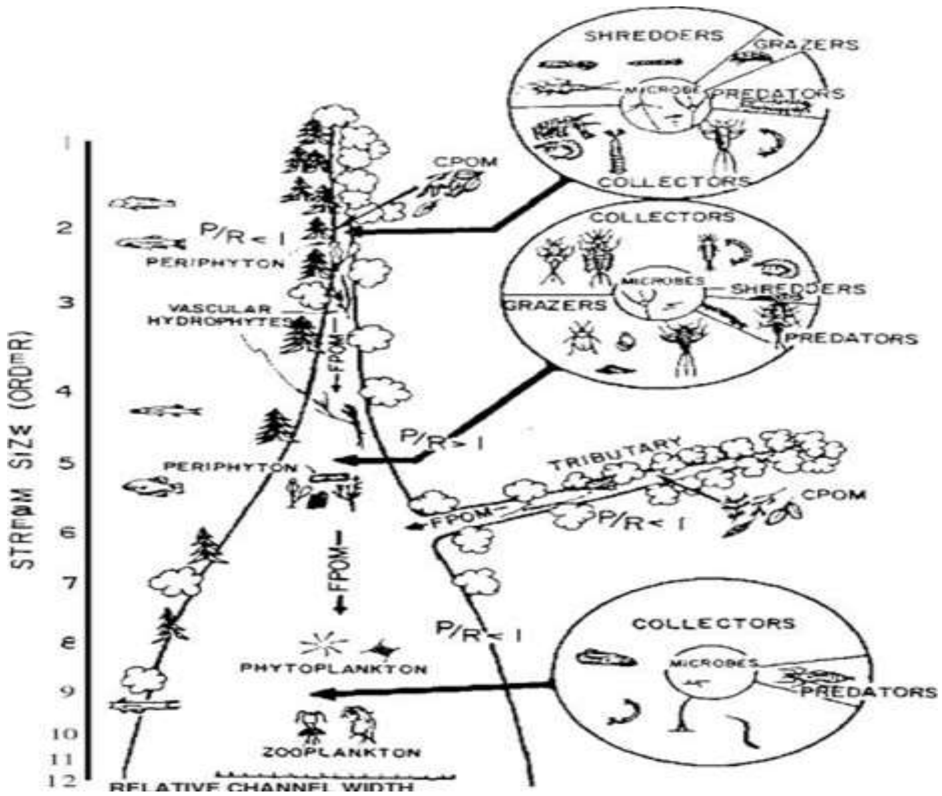
The four scientists who collaborated with Dr. Vannote were Drs. Wayne Minshall (Idaho State university), Kenneth W. Cummins (Michigan State University), James R. Sedell (Oregon State university), and Colbert E. Cushing (Battelle-Pacific Northwest Laboratory). The group studied stream and river ecosystems in their respective geographical areas to support or disprove tenets of their original theory. The research resulted in the publication of 33 scientific papers (see attachment to Bibliography). The original 1980 paper received the John Martin Award from the association for the Sciences of Limnology and Oceanography (formerly the American Society of limnology and Oceanography) that recognizes papers still relevant ten years after their publication. Subsequent research related to the RCC by these scientists has resulted in several more scientific papers that amplify parts of the original RCC.

Physical Environment

Streams naturally enlarge as they move downstream and take up more water from a wider watershed. As we move downstream, depth and width also rise along with the volume of water (discharge). The discharge, expressed in cubic meters or feet per second, is calculated as breadth times depth times current velocity. More importantly, discharge is nearly always the most accurate indicator of stream size. Furthermore, as we proceed downstream, the substrate—the rocks, sand, silt, and organic debris at the stream's bottom—becomes smaller, the temperature rises, and the amount of oxygen in the substrate drops as a result of the rising temperature. (Jason G. Freund, 2021).

Living communities and food types

Holistic view of rivers, which permits a broad zonation of river systems based on the utilization of energy through the orderly processing of organic matter by the resident biota. Upstream, the river receives allochthonous material from adjacent and overhanging vegetation, supplying coarse particulate organic matter. This is broken down by 'shredder' organisms in a system that is largely heterotrophic ($P/R < 1$, see production/respiration ratio), because it operates in deep shade. The shredders produce fine particulate organic matter. This is carried downstream, where it is processed by 'collectors' (Vannote. Et al., 1980). As the stream widens, primary productivity increases and the shredders are replaced by grazers, living alongside collectors. Collectors predominate once more under mainly heterotrophic conditions still further downstream, where the river widens and becomes too deep for benthic plants. Predators occur throughout. The concept cannot be applied to all rivers (e.g. to those that originate above the tree-line) and breaks down when a river is blocked or passes through a lake (Vannote. Et al., 1980). In 1980 Robin L. Vannote and other co-workers created the concept of RCC at the Stroud water Research Centre. The continuous differences of properties within the river are dependent primarily on the specific composition of the organisms in different sections of the water. (Basic biology,2016,). Throughout the continuum of the river, the proportion of the four major food types; shredders, collectors, grazers (scrapers) and predators change. With the exception of the predators, all these organisms feed directly from plant material (saprobes) (Curry, 1972).



Vannote et al. (1980) and Minshall ct al. (1985)

Divisions of the riverine

The River Continuum Concept assigns different sections of a river into three rough classifications. These classifications apply to all river waters, from small streams to medium sized and large rivers and lakes.

Headwaters (Crenon) - upstream order (1 to 3) = P/R<1.

Here shredders play a major role in breaking down coarse plant material. In this area, the largest diversity of organic material can be expected. (stout III, ben M, 2003)

Midwaters (Rhithron) - midstream order (4 to 6) = P: R> 1.

Collectors and grazers make up a majority of the macro invertebrate structure in this area, with the predator's share remaining unchanged. (stout III, ben M, 2003)

Lower waters (Potamon) - low stream order (>6) = P: R <1.

The living community in these areas are made up of almost exclusively collectors, as well as a small share of predators. (stout III, ben M, 2003)

Problems and modifications

Although it is accepted theory, it is limited in its applicability. Disturbances such as congestion by dams or natural events such as shore flooding are not included in the model. Various researchers have since expanded the River Continuum Concept to account for such irregularities.

Author	Concept	Explanations
J. V Ward & J. V Stanford	Serial discontinuity concept (1983)	Geomorphologic disorders such as congestion and integrated inflows
J. V Ward & J. V Stanford	Hyporheic Corridor concept (1993)	The vertical (in depth) and lateral (from shore to shore) structural complexity of the river were connected.
W. J Junk (1988)	Flood pulse concept-developed	--
PB Bayley (1990) & K Tockner (2000)	Flood pulse concept-modified	The large amount of nutrients and organic material that makes its way into a river from the sediment of surrounding flooded land

Future predictions

RCC Predictions of Carbon Dynamics for Large Rivers

The original RCC was not specific in its predictions of the behaviour of large rivers. Most subsequent discussion focused on smaller -river systems, and the cataplexy of large rivers was overlooked

Prediction I- Carbon Sources

- Large rivers receive the majority of their fine particulate organic carbon (FPOC) load front upstream processing of dead leaves and woody debris because the inundate effects of adjacent riparian vegetation are Inimical. Thus, the ratio of coarse to fine particulate organic carbon is expected to be very small (CPOC/FPOC < 0.001).
- Fine particulate detritus is also entrained fron1 the floodplain during floods and through lateral migration of the channel.
- Aquatic primary production is limited by depth and turbidity, so respiration exceeds production (P/ R < l).

Prediction 2 — Carbon Processing

- The heterotrophic use and physical absorption of labile dissolved organic carbon (DOC) are rapid in headwater regions; thus, DOC in the larger downstream rivers should have higher molecular weights and be more refractory. A similar pattern of increasing refractivity would be expected for POC.
- The rate of within-system processing increases and the rate of storage and export decreases with increasing substrate quality and duration in the river.

Prediction 3 — Stability of Energy Flow

- The minimization of the variance in energy flow is the outcome of overlapping seasonal variations of detrital and primary production inputs, adjustment of functional groups over time, and the organic and inorganic matter transport and storage characteristics of rivers. As the sum of these factors, within-river oxidation is relatively constant over time and space.
- Few studies on large rivers have been conducted with sufficient resolution to test these concepts. We now consider two large-river systems with sufficient data to do so

CONCLUSION

Our work reveals that the River Continuum Concept (Vannote et al. 1980) since its publication has considerably advanced the basic and applied knowledge in stream ecology. Although the RCC does not apply to all river types and biomes, its worldwide implementation has been and continues to be important. In fact, a number of relevant theories and concepts blossomed from its application, which aimed at accounting for context-dependent conditions and the importance of the spatial complexity, filling the gap on the variability of lotic ecosystems at large spatial scales (i.e., river network). In addition, a breadth of studies has adopted a functional approach by measuring the deviation of abundances and (or) relative proportions of FFGs from the RCC predictions (Bredenhand and Samways 2009; Miserendino 2009). We hope that reflecting on the RCC will spur novel approaches to examine stream ecosystems that have the potential to result in a paradigm shift in stream ecology towards river network modelling along environmental gradients.

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