

Foreword

The direction of science is often driven by methodological progress, and the topic of this book is no exception. I remember sitting with a visitor on the terrace of a hotel overlooking Lake Constance in the early 1970s. We were discussing the gravimetric method of measuring total lipids in zooplankton. A few years later, as a visitor in Clyde E. Goulden's lab, I was greatly impressed by the ability of an instrument called an Iatroscan to discriminate and quantify specific lipid classes (e.g., triacylglycerols, polar lipids, wax esters). At that time, food web analysis was mainly concerned with bulk quantitative aspects. For example, lipids, because of their high energy content, were considered mainly as an important food source and storage product.

Nearly a decade ago, when Michael Arts and Bruce Wainman edited the first volume entitled "Lipids in Freshwater Ecosystems" (Springer), the focus had already changed. Fatty acid analysis had become more mainstream, because new, less expensive, instruments had become available for ecological laboratories and because ecology, in general, was diversifying and integrating with other disciplines. Hence, there was increased emphasis on studies which dealt with the qualitative aspects of lipid composition. The concept of lipids in ecosystems was no longer restricted to just providing fuel; lipid composition had, by then, already been recognized as a factor controlling the flow of matter and the structure of food webs. In his foreword to the first book, Robert G. Wetzel defined a rapidly evolving field that he called "biochemical limnology" and identified lipid research as one of its facets. Judging from the ever increasing numbers of published papers and congress contributions the field is presently evolving even more rapidly.

However, progress was not restricted to limnology. In fact, methods of lipid and fatty acid analysis were probably more advanced in marine ecology, and essential fatty acids were an important factor in marine aquaculture. Lipid research in aquatic organisms profited also from the growing connections to human nutrition science interested in the importance of highly unsaturated fatty acids (HUFA; fatty acids with ≥ 20 carbons and ≥ 3 double bonds) originating from fish and shellfish. This became very evident at the 2002 summer meeting of the American Society of Limnology and Oceanography in Victoria, British Columbia, when Michael A. Crawford delivered an unusual, but fascinating plenary lecture entitled

"The evolution of the human brain." Consequently, this new volume has broadened its scope from freshwater to "aquatic ecosystems." It is, thus, a contribution to finding common principles in marine and freshwater systems.

My personal interest in fatty acids has been stimulated again in recent years by the controversy over food quality factors controlling the growth of zooplankton, which used to be more a topic in limnology than in marine ecology. Two schools developed at about the same time, one proposing that zooplankton growth was limited by the availability of essential fatty acids, the other one developing the concept of zooplankton growth controlled by inorganic nutrient stoichiometry. In principle, both groups of resources can be limiting as they must be taken up with the same food package and cannot be completely synthesized by the consumer itself. Unfortunately, the empirical data were contradictory, and there was support for both concepts. As usual, this resulted in a heated debate; however, we are now on the way to a concept incorporating both groups of resources as limiting factors. The controversy had a striking effect on aquatic lipid research; it stimulated discussion, created new ideas, and fostered methodological progress. Lipids and fatty acids are now regular topics of special sessions at aquatic science conferences.

Robert Wetzel's statements in the earlier foreword are still valid and up-to-date, but the field has broadened considerably in the past decade. The "classical" studies on lipids as storage products and carriers of lipophilic contaminants are continuing. Research on lipids as nutritional factors now concentrates on the role of essential components, e.g., polyunsaturated fatty acids (PUFA) and sterols, in modifying the growth and reproduction of animals. This includes studies on biosynthesis and metabolic pathways in food organisms and the characterization of fatty acid profiles in organisms at the base of food webs and in allochthonous material. Spatial and temporal variations in lipid composition need to be investigated to reach the goal of a mechanistic prediction of food web structures under changing environmental conditions. Finally, specific fatty acids and ratios of fatty acids are being developed as biomarkers to aid in the identification of key food web connections.

Evolutionary ecology is beginning to explore adaptations of organisms to the changing availability of essential fatty acids in their food, e.g., the evolution of life histories, provision of offspring with PUFA, and the timing of diapause. However, lipid production may also be considered as an adaptation by algae and bacteria against their consumers. Evidence is accumulating indicating that not all fatty acids are beneficial to consumers. Some are toxic or are precursors of toxic products, and the question therefore now arises as to why organisms produce such costly products.

Finally, lipid and fatty acid research has gained considerable applied importance as humans are often "top predators" and also depend on essential dietary nutrients. Public awareness of healthy nutrition is increasing, and this relates to both acquiring necessary food compounds and avoiding toxic contaminants. Lipids play a key role in these processes.

The past 10 years have seen a rapid increase in our knowledge about the ecological importance of lipids. As with all progressive scientific initiatives this new knowledge has also generated new questions. It is thus time for a new synthesis.

This book addresses most of the topics mentioned above; hence it is a timely book. I am sure it will not only summarize the status quo; it will also stimulate new research within the important and exciting field of biochemical aquatic ecology as well as foster new and fruitful connections with the field of human nutrition.

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