

Book review

TUDORANCEA, C. & M.M. TUDORANCEA: *Danube Delta: Genesis and Biodiversity*: 2006, xvi and 444 pp., with 89 figures and 66 tables, hardbound; Backhuys, Leiden; ISBN 90-5782-165-6; (Biology of Inland Waters Series); 156.00 Euro.

My first international congress, organized by the Association of Aquatic Vascular Plants, led me in 1969 to Bucharest. My memory of many of the certainly interesting lectures read at the conference fails after so many years elapsed since, but I clearly remember an excursion to the Danube Delta. I had just returned from 20 months of field-work in the central Amazon floodplain with the conviction that European wetlands could no longer impress me. To my great surprise, I immediately changed my mind when I saw the vast delta, the incredible complexity of the habitats, the tremendous biodiversity, the large flocks of herons and pelicans, and the "plaus" of *Phragmites* recalling the floating islands in the Amazon. At present, the status of the Danube Delta as a biosphere reserve, Ramsar site, and World Natural Heritage emphasizes its importance in an international context.

One of the memories left by the conference was that many of the reprints distributed there were in Rumanian, so unfortunately of little use to me and most of my colleagues. Therefore, I welcome with great pleasure and satisfaction the publication of this book in English, which now makes comprehensive information available worldwide.

The book is divided into a preface, written by eminent Professor H.B.N. HYNES, and 16 chapters. Each chapter provides an ample list of references that allow specialists to obtain more information if required. The introduction (Chapter 1) provides general information about the delta and the objectives of the book. Chapter 2, on Danube Delta geology, geomorphology, and geochemistry, outlines the dramatic changes the delta underwent during the post-glacial era through the interaction of the sea, wind, Danube River and, finally, human activities.

Chapters 3 and 4 introduce the physiography, climate and hydrological regime. On the macro-scale, the hydrological system is simple. As the water level rises, the delta receives water from the channels, while as the water level falls, the delta devolves it to the channels. However, on smaller scales, the hydrology becomes very complex because the channels transport different amounts of water, fluxes vary between different parts of the delta, sediment deposition and aquatic macrophytes may temporarily or permanently block channels, and man-made channels and dikes interfere with the natural flood regime. Unfortunately, little importance is attributed to the impact of the Black Sea on the hydrology of the delta.

The complex hydrological conditions are reflected by changes in water chemistry. This is illustrated in Chapter 5, which deals with the chemistry of the Danube Delta. Four different classes are distinguished: (1) fluvial waters, (2) fluvial-deltaic waters, (3) deltaic waters, and (4) maritime-deltaic waters. Since the 1980s, increasing eutrophication has been observed as the consequence of an increased nutrient input from the entire Danube River basin. In the beginning of the 1960s, the input of pesticides and, in the 1980s, that of heavy metals rose. Their distribution patterns within the delta follows the sedimentation pattern. Different levels of retention capacity of the different ecosystems in the delta are demonstrated. Bio-accumulation of heavy metals in organisms within the delta is shown.

Chapter 6 provides information on the ecosystems of the Danube Delta. The authors delimit 10 units: Danube branches, shallow ponds and channels, lakes, lagoons, river banks, marshes, marine sand banks, land plains, marine shore, and calcareous islands, with many habitat types and subtypes. Emphasis is placed on description of palustrine and aquatic macrophyte communities, including the reed island

community ("plaur") and the related aquatic invertebrate fauna.

Chapter 7 focuses on phytoplankton and its primary production. An impressive number of 1098 algal species have been identified to date. This large number is attributed to habitat diversity. Algal biomass and primary production increased with increasing nutrient input from the watershed in the beginning of the 1980s, and blooms of cyanobacteria now occur frequently in some lakes. Special reference is made to the phytoplankton in the contact zone of the delta with Black Sea waters.

In Chapter 8, aquatic macrophyte communities are characterised according to their growth forms. Despite *Phragmites australis* being the dominant species, covering almost 160,000 ha, species diversity is high. Examples of changes in species composition of macrophyte communities are given, and their reasons discussed. Biomass and primary production values are provided that show the importance of macrophytes for carbon fixation in the delta. Special emphasis is placed on nutrient cycling and feed-back mechanisms.

Chapter 9 focuses on zooplankton structure and productivity. The taxonomic spectrum of the delta's lacustrine environment over a 20-year study period includes 562 species or subspecies. Rotifers and copepods play determinant roles in the diversity of the plankton community. The abundance is relatively low. Cladocerans, copepods and rotifers are dominant in zooplankton productivity. Examples show that large habitat diversity and intra-annual and inter-annual changes in environmental conditions lead to profound spacio-temporal variation and dynamics. Emphasis is placed on the complex interactions between aquatic macrophytes, phytoplankton and zooplankton. Anthropogenic eutrophication in the 1980s increased the phytoplankton production but decreased the number of aquatic macrophytes, the diversity, abundance, biomass and productivity of the zooplankton community.

Chapter 10 summarises the knowledge of the benthic fauna. The latter currently comprises 296 species, including palaeartic and holarctic forms introduced to the Danube River, Pontoazov-Caspian relicts, Mediterranean species, and a gastropod species from the southern hemisphere. The benthic communities vary between habitats, as shown by descriptions of the communities of the mainstream, lakes, ponds and new marine lagoons. Increasing eutrophication leads to a decrease in species diversity.

A special chapter (Chapter 11) is devoted to the Oligochaeta communities because they are nice indicators of changes in the environmental conditions and they also play important roles in food webs and in the recycling of nutrients. Increasing eutrophication led to an increase in the numbers and biomass of Oligochaeta in the impoverished benthic community. Special emphasis is placed on the impact of Oligochaeta populations on the recycling of nitrogen and phosphorus.

Aquatic macrophytes are well-known as representing an important habitat for aquatic invertebrates. However, methodological problems have limited the number of studies compared to those on zooplankton and benthos. Chapter 12 covers the weed-bed fauna and provides valuable information on this group. With 353 species, the weed-bed fauna is highly diverse. Temporal and spacial variation in species composition and abundance is large. Phytophile chironomids, gastropods, oligochaetes, gammarids and caddisflies are dominant groups. Of special interest is the migration of weed-bed species between bottom and macrophyte beds triggered off by the disappearance of macrophytes during the winter.

Books on wetland ecosystems only rarely provide information on microbial communities. Therefore, Chapter 13, which encompasses benthic microbial communities, is most welcome. The temporal and spatial evolution of heterotrophic microorganisms is shown to depend on seasonality and sediment type. A decrease in microbial numbers from the sediment surface to deeper sediment layers is documented. Organic matter decomposition in sediments take place mostly under anoxic conditions. Accumulation of organic matter exceeds decomposition.

There has always been a lot of interest in the ichthyofauna of the Danube Delta because of its importance for fishery. With 69 species known in the region and 47 species registered in 1992, fish diversity is very high by European standards. Natural interspecific hybridisation occurs. Several exotic species have been introduced, and about 10 have established permanent populations. The presence of 23 species of marine origins point to an interaction between the delta and the Black Sea. Different migrating behaviours of the species correspond to those in other large river deltas. Information is given on the age structure of the fish populations, individual growth rates, reproduction, as well as food and feeding behaviour. Fish yield decreased dramatically from the 1970s to the end of the 20th century not only

because of Danube regulation, industrial impoundments in the delta, and changes in its trophic status, but also because of overfishing, intentional reduction of predatory species, and changes in the composition of fish stocks. Some species face extinction.

The species-rich and abundant avifauna is most attractive for visitors to the delta. Of the more than 300 species present there, more than half breed in the delta. Furthermore, the delta is an important stepping stone for migrating species. After a description of important representatives of the breeding avifauna, the migrating species are characterised. An ample paragraph deals with biogeographical aspects, another with the bird fauna of different habitats. The latter part shows a link between habitat diversity and species diversity. During the 20th century, the delta lost 11 breeding species but gained 18 species which extended their ranges.

Of special interest is interpreting the data over a period of about a century by authors of most of the chapters, showing not only a decline but sometimes also recovery of plant and animal populations and linking them to natural and human-induced environmental changes. Chapter 16 discusses the human presence and activities in the delta since the first reports about 2500 years ago. Fishery has lost importance because of stock reduction. Agriculture has dramatically increased in the Danube floodplain and, to a minor extent, in the delta, being, together with other factors, a reason for the severe environmental changes. Reed harvesting has been a tradition for one century in the delta and is considered as an ecologically sound activity when properly managed. Ecotourism may become a future activity of economic interest and may help protect the Danube Delta. The international value of the delta has called attention to its protection. Plans to restore some modified parts of the delta are described. However, a considerable part of the problems derive from the impact of the large human population in the catchment area. The political challenge for the protection of the Danube Delta is to achieve international cooperation of the nine countries participating in the catchment area and to efficiently combine protection measures of the entire Danube River, its major tributaries, and their floodplains with national efforts to protect and restore the delta itself in Rumania and the Ukraine. The book illustrates the complex human impacts on wetland ecosystems and the need for long-term over-regional strategies to protect them.

This book provides an important contribution to the understanding of large European wetlands, and I enjoyed reading it. I recommend it not only to all students and scientists interested in the subject, but also to environmental managers and planners.

Prof. Dr. Wolfgang J. Junk
Tropical Ecology Working Group
Max-Planck-Institut for Limnology
Postfach 165
24302 Plön, Germany

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