Ecological restoration in the Danube Delta Biosphere Reserve/Romania
Reconstrucție ecologică în Rezervația Biosferei Delta Dunării/România

Evolution of Babina polder after restoration works

Evoluția incintei Ostrov Babina după execuția lucrărilor de reconstrucție ecologică

WWF

INSTITUTUL NAȚIONAL DE CERCETARE - DEZVOLTARE DELTA DUNĂRII - TULCEA

Evolution of Babina polder after restoration works

Agricultural polder Babina, a pilot project of ecological restoration

Evoluția incintei Ostrov Babina după execuția lucrărilor de reconstrucție ecologică

Incinta agricolă Babina un proiect pilot de restaurare ecologică

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The Danube Delta Biosphere Reserve is an area where governmental decision makers, scientists and local communities co-operate to develop a pilot programme for the administration of the territory and the waters. The objective is to harmonize the requirements of the local populations with the necessity for conservation of natural processes and biological resources.

Natural habitats and their biodiversity are the basis for natural, renewable resources. The restoration of the ecological balance and the redevelopment of natural hydrological, biogeochemical and ecological functions in floodplain wetlands that had formerly been transformed for agricultural purposes and thus deteriorated, are essential prerequisites for the development of natural resources. These represent the local populations' means of existence. The sustained use of natural resources is the basis for socio-economic stability in the Danube Delta.

Rezervația Biosferei Delta Dunării este un loc unde factorii de decizie guvernamentali, oamenii de ştiință şi comunitățile locale cooperează în dezvoltarea unui program model pentru administrarea teritoriului şi a apei, pentru rezolvarea necesităților umane împreună cu conservarea proceselor naturale şi a resurselor biologice.

Habitatele naturale cu biodiversitatea caracteristică lor, constituie baza existenței resurselor naturale regenerabile. Restabilirea echilibrului ecologic şi refacerea funcțiilor naturale – hidrologice, biogeochimice şi ecologice – în zonele umede deteriorate, consituie premiza dezvoltării resurselor naturale ca mijloc de existență pentru populația locală. Valorificarea durabilă a resurselor naturale este baza stabilității socio-economice în Delta Dunării.

Content

Introduction

Mainly during the last decades of the 20th century, the Danube Delta has suffered from human interventions that led to dramatic changes in some areas. These interventions consisted in the dyking of large areas for the purpose of agricultural use, intensive fish-farming and forestry, which resulted in dramatic alterations or disturbances of the water balance. This again had effects on the alteration of natural processes, the ecological balance as well as the characteristic functions of wetlands and led to a deterioration, or worse the loss of area-specific habitats. When the transformation measures were stopped in early 1990, the dyked area covered 97.408 ha (22 %) of the total 482.592 ha.

Upstream the Delta about 450.000 ha of a total floodplain area of 540.000 ha had been cut off from the river dynamics and was transformed into agricultural land. The floodplain loss on the Lower Danube upstream the Delta – an area acting among others as natural filter and spawning ground for fish – had negative effects on the Danube Delta all the same. The embankment and the separation from the river involved a drainage process, i. e. steppization and to some extent salinization of the soils. Moreover, the large water bodies operating as compensating factor for the local climate were lacking, which again led to a greater aridity in some areas. Parallel to the dyke constructions and the cutting off from the flood regime of the Danube, numerous artificial channels that had been

Introducere

Impactul antropic produs în special de indiguirea unor suprafeţe întinse în scopul utilizării pentru agricultură, piscicultură sau silvicultură au generat mutaţii importante în ecosistemele naturale din Delta Dunării. Intervenţiile au dus la modificarea regimului hidrologic, având la rândul său ca efect deteriorarea proceselor naturale, a echilibrului ecologic, a funcţiilor tipice zonelor umede şi a habitatelor caracteristice. In anul 1990, odată cu declararea Deltei Dunării ca Rezervaţie a Biosferei, lucrările prevăzute în planul de amenajare complexă a acesteia au fost sistate, indiguirile ocupând 97.408 ha, ceea ce reprezintă 20% din suprafaţa actuală a Deltei Dunării.

In lunca Dunării inferioare, amonte de delta, au fost scoase din circuitul natural, prin indiguire, în jur de 450.000 ha din totalul de 540.000 ha de zonă inundabilă. Pierderea luncilor cu suprafeţele lor acvatice şi palustre, cu rol important de filtru biologic şi locuri de reproducere şi hrănire pentru peşti şi păsări, a avut influenţe negative şi asupra Deltei Dunării. Indiguirile din Lunca şi Delta Dunării şi deconectarea de dinamica fluviului au avut ca efect aridizarea/stepizarea şi parţial sărăturarea solurilor. Totodată, din cauza indiguirilor şi implicit al pierderii unor suprafeţe mari de lucii de apă, ca factor de echilibru în umiditatea atmosferică, s-au produs schimbări în sensul aridizarii climei locale. Pe lânga indiguiri, alte schimbări în ecosistemele deltei sunt datorate reţelei de canale artificiale săpate

Fig. 1: Map of The Lower Danube (green: former and recent floodplain)
Coridorul Verde al Dunării inferioare

cut through the reeds involved further changes: unfiltered water from the river could directly pour nutrients and pollutants into the inner area of the Delta. This resulted in a relatively high nitrogen and phosphorus load and in some spots also in high oil concentrations. In some areas a gradual silting of the delta lakes could be observed (s. STARAŞ 2001).

prin stuf, care fac legatură scurtă între braţele fluviului şi lacurile limitrofe; acestea contribuie la importul direct de nutrienţi (compuşi cu azot şi fosfor), sedimente şi poluanţi – fără a fi filtrate prin stufărişuri – spre interiorul deltei (v. STARAŞ 2001).

Given the fresh impetus observed in Nature Conservation and Environmental Protection in Eastern Europe after 1990, both the Danube Delta and the Lower Danube could afford new possibilities and perspectives. Studies for rehabilitation/restoration measures were started in the Danube Delta immediately following its declaration as Biosphere Reserve in 1990. Restoration and the elaboration of concepts for the conservation of biodiversity and sustainable development are the priority tasks of the Danube Delta Biosphere Reserve Authority.

După 1990, odată cu noile impulsuri şi orientări pentru protecţia naturii şi a mediului înconjurător în Europa de est, s-au ivit noi posibilităţi şi perspective atât pentru Delta Dunării cât şi pentru Dunărea inferioară. Astfel, conceptul de restaurare/reconstrucţie ecologică a zonelor umede deteriorate constituie alături de cel de conservare a biodiversităţii şi dezvoltare durabilă, obiectivul prioritar al Administraţiei Rezervaţiei Biosferei Delta Dunării.

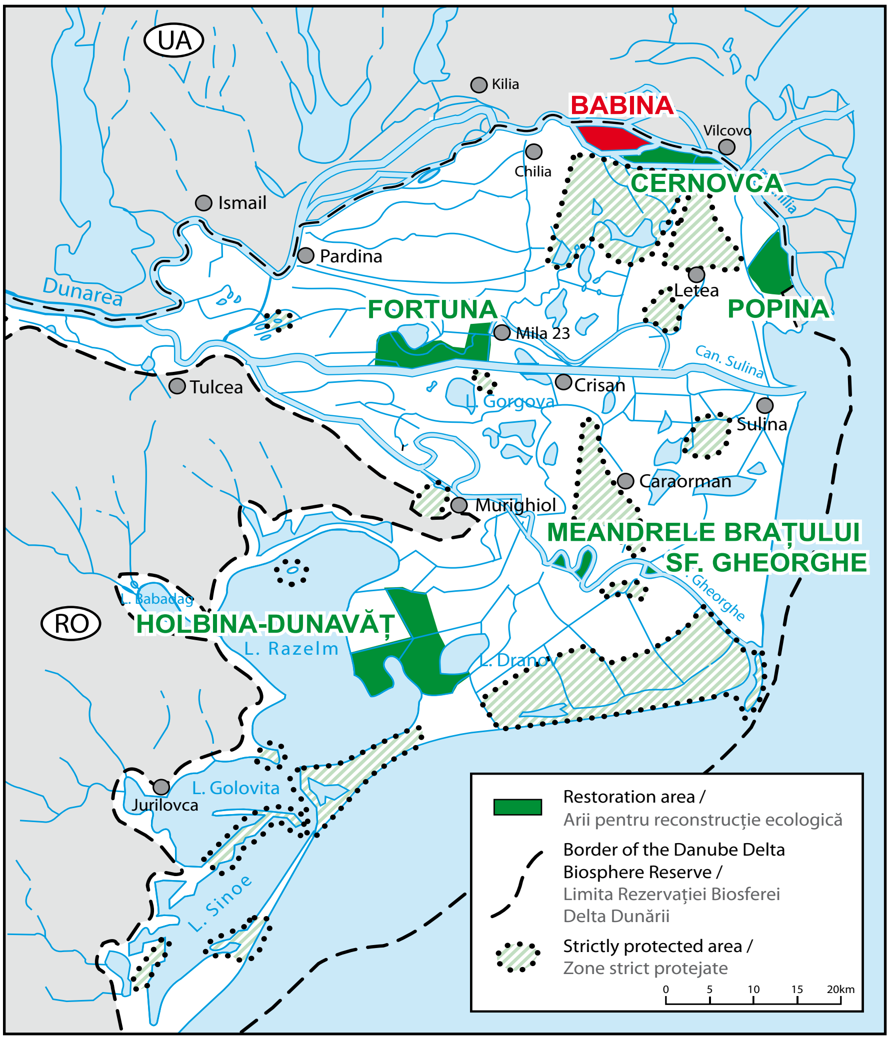


Fig. 2: Restoration areas in the Danube Delta Biosphere Reserve Romania
Arii de reconstrucţie ecologică în Rezervaţia Biosferei Delta Dunării România

The objectives of restoration in the Danube Delta Biosphere Reserve

Obiectivele reconstrucției ecologice în Rezervația Biosferei Delta Dunării

The objective of ecological reconstruction/restoration is to restore the natural, site-specific hydrological, biogeochemical and ecological functions, to ensure the redevelopment of the ecosystem and its functions and thus to promote the development of site-specific habitats and their biodiversity. Moreover, the redevelopment of the natural resources should enable the local populations to proceed to their sustainable, traditional use.

Given that the ecosystems of the Danube Delta depend on the dynamics of the Danube River, the re-establishment of the hydrological regime reveals to be the most important factor to be considered in restoration (Marin et. al. 1997, Schneider 2002). In the case of dyked and drained polders that are no longer useful for agricultural purposes, the reconnection to the flood regime of the Danube is the measure to be taken and the prerequisite for a successful restoration. Such measures do not re-

Refacerea funcțiilor naturale hidrologice, biogeochimice, ecologice, tipice zonelor umede care la rândul lor constitue baza pentru restaurarea complexului de ecosisteme, a biodiversității, a habitatelor naturale tipice locului, inclusiv cele ale unor specii periclitate, precum şi refacerea resurselor naturale existențiale spre beneficiul populației locale sunt obiectivele urmărite cu predilecție în cadrul proiectelor.

Delta Dunării fiind constituită dintr-un complex de 30 de tipuri de ecosisteme a căror funcționare este condiționată de oscilația nivelurilor apelor Dunării, restaurarea regimului hidrologic este factorul principal de care trebuie ținut cont în abordarea unor lucrări de reconstrucție ecologică (Marin et. al. 1997, Schneider 2002). In cazul incintelor indiguite neproductive, reconectarea la regimul hidrologic al Dunării este factorul cel mai important, constituind premiza succesului lucrărilor de

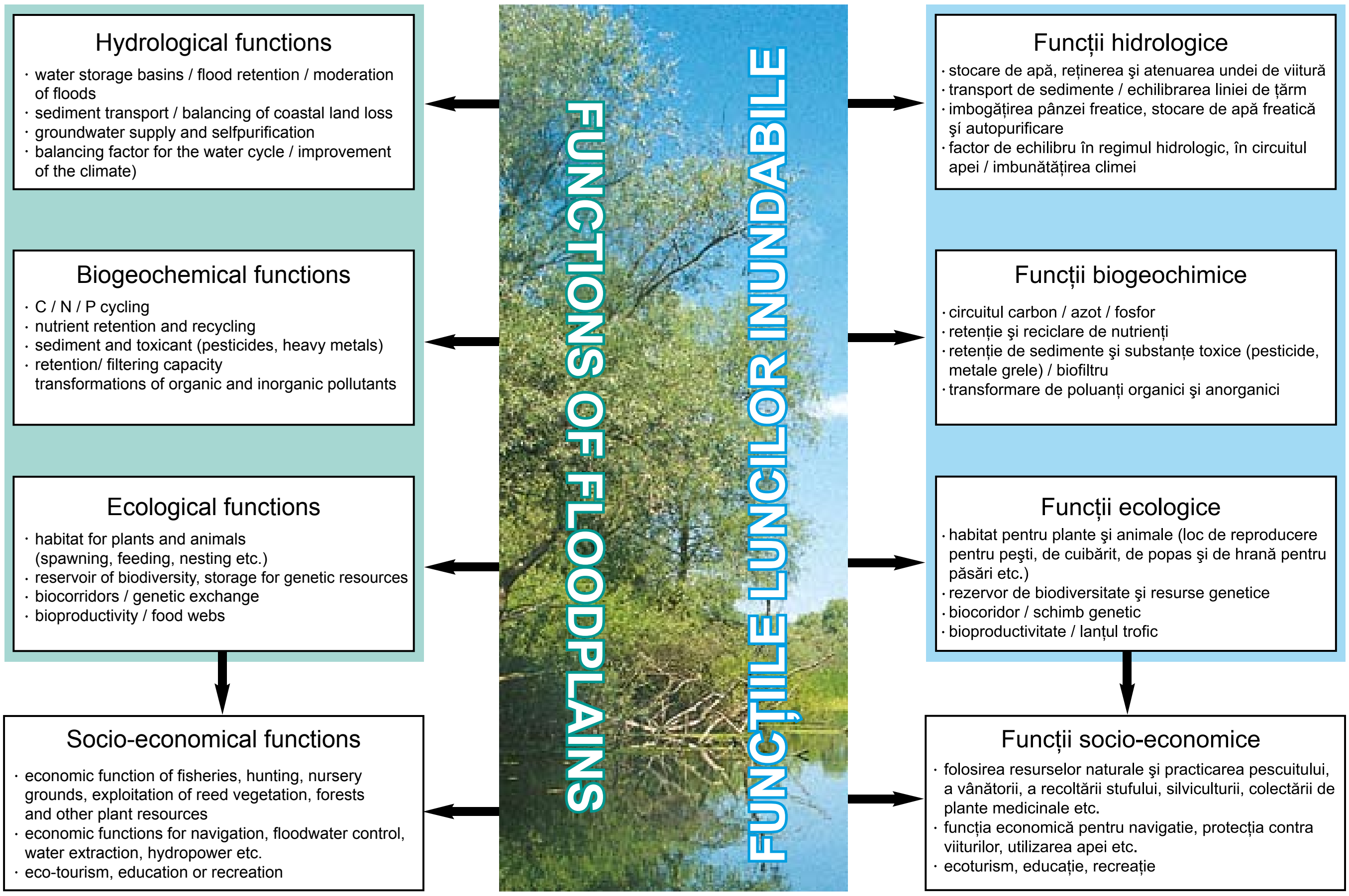


Fig. 3: Functions of floodplains
Funcțiile luncilor inundabile (Schneider 2002)

Fig. 4: The natural resources of the Delta are for the benefit of the inhabitants
Resursele naturale din deltă sunt în beneficiul localnicilor

store the original conditions of the time before the dyking, given that this would require a complete removal of the dams, which again reveals impossible in view of extremely high costs. However, the opening of the dams in specific hydrological and ecologically effective spots and the reconnection to the river dynamics could restore a better performance of the ecosystem. This again would assure the redevelopment of a site-specific biodiversity and the biological resources. The restoration of the hydrological regime may also, in some cases, involve the closing of channels most of all in those cases where unfiltered Danube waters flow directly from the main branches into the reed areas so as to finally reach the lakes in the heart of the Delta.

Restored natural functions allow the redevelopment of natural resources and values that are to the benefit of the local populations and of major importance for the local, regional and national economy. Given their natural functions and values that are traditionally used with regard to sustainability, the restored wetlands also satisfy fundamental socio-economic functions. For the local populations of the Delta the restoration of abandoned agricultural polders and fish ponds is a good option as compared to the abandoned polders that could not be used as planned.

restaurare, respectiv de reconstrucţie ecologică. Restabilirea exactă a situaţiei dinainte de indiguire presupune înlăturarea completă a digurilor, ceea ce este foarte greu de realizat, implicând costuri mari de execuţie. Deschiderea digurilor în anumite puncte cheie atât din punct de vedere hidraulic cât şi ecologic, poate asigura funcţionalitatea ecosistemului, care va permite la rândul său reinstalarea biodiversităţii tipice locului şi refacerea resurselor naturale regenerabile. Restaurarea regimului hidrologic poate însemna însă în unele cazuri calibrarea sau închiderea gurilor unor canale, atunci când prin aceste deschideri artificial create, apa din braţele Dunării (nefiltrată prin stuf) intră direct în lacuri.

Funcţiile naturale odată refăcute dezvoltă anumite valori existenţiale - resurse naturale şi ideale - de care pot beneficia localnicii, importante însă şi pentru economia locală, regională şi naţională. Prin aceste resurse şi valori folosite în mod tradiţional şi durabil zonele umede îndeplinesc importante funcţii socio-economice, asigurând baza materială pentru populaţia locală. In acest sens, restaurarea ecologică este o alternativă pentru incintele agricole şi piscicole abandonate, ce nu mai pot fi utilizate în scopul pentru care au fost destinate.

Fish resources play a decisive role as they constitute the local populations' fundamentals of life. Reed cutting and use, especially with respect to the traditional construction methods in the Danube Delta, are among the major occupations of the people living in the Delta. Moreover, eco-tourism is of increasingly high importance. The landscape of the Delta, with its mosaic of waters and large reed areas, white willow gallery forests, dunes, the characteristic fauna of varying habitats and in particular its avifauna with large mixed, species rich colonies, benefits from a constantly growing interest. The areas comprised in the rehabilitation programme may thus also contribute to the development of an environmentally friendly sustainable eco-tourism.

Resursa principală existenţială în deltă este cea piscicolă, pescuitul fiind ocupaţia tradiţională de bază a populaţiei locale. Recoltarea stufului este următoarea ocupaţie tradiţională, acesta fiind folosit ca material de construcţii în gospodăriile locuitorilor deltei. Pe lângă aceste ocupaţii tradiţionale, turismul rural va avea un rol din ce în ce mai important. Estetica peisajului mozaicat, a cărui frumuseţe rezultă din îmbinarea apei cu întinderile de stuf, zăvoaie, grinduri şi dune şi coloniile polispecifice de păsări constituie principala atracţie pentru recreere. Astfel, peisajele care au fost şi sunt incluse în programul de reconstrucţie ecologică pot contribui la dezvoltarea unui turism ecologic şi durabil în rezervaţie.

First plannings, first successes

A management master plan that had been elaborated in a first phase for the Danube Delta Biosphere Reserve comprised a number of areas to be restored, such as abandoned agricultural polders and unprofitable fish farms. Among these, the agricultural polders Babina (2100 ha) and Cernovca (1560 ha) were selected as pilot project areas for ecological restoration and were realized in a productive co-operation between the Danube Delta National Institute for Research and Development in Tulcea and the Institute for Floodplain Ecology of WWF Germany. Respective preparatory

Primele proiecte, primele succese

In planul cadru de management al Rezervaţiei Biosferei Delta Dunării elaborat în primii ani ai existenţei sale au fost desemnate pentru reconstrucţie ecologică incintele agricole şi piscicole abandonate ca neeficiente economic. Dintre acestea incintele agricole abandonate Babina (2100 ha) şi Cernovca (1580 ha) au fost alese ca arii pilot. Aceste proiecte au fost realizate în cadrul unei fructuoase colaborări între Institutul Naţional de Cercetare-Dezvoltare Delta Dunării din Tulcea/România şi WWF-Auen-Institut al Fondului Mondial pentru Natură WWF Germania.

Fig. 5: Satellite map (Kosmos KFA 1000, 1989)
Imagine satelitară

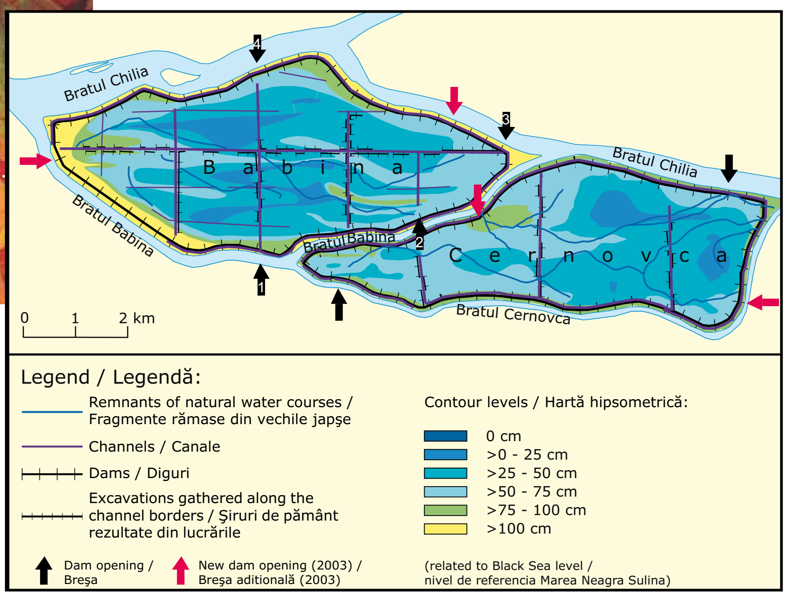
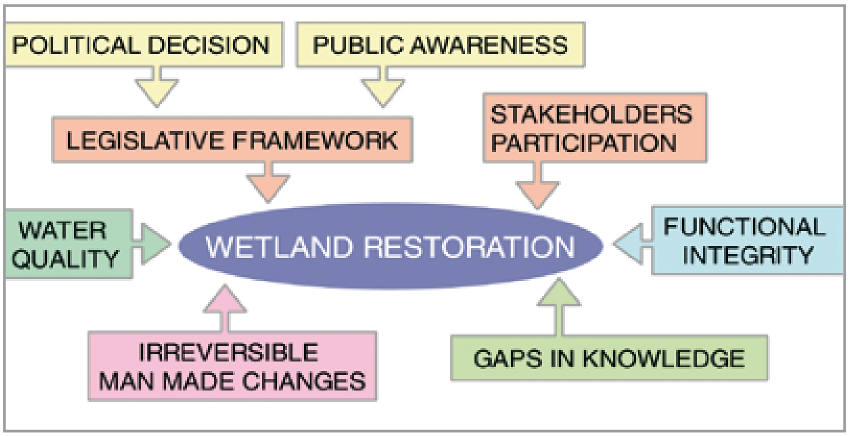


Fig. 6: Hipsometrical map of Babina and Cernovca with positioning of the openings
Harta hipsometrică a ostroavelor Babina şi Cernovca cu poziţionarea breşelor

Fig. 7: Floodplain restoration constraints (according to M. Staraş, 2001)

Factori de influenţă/constrângeri în procesul de implementare (M. Staraş, 2001)



studies were conducted from 1991, allowing first reconstruction/ restoration measures to be implemented already in 1994 in Polder Babina and in 1996 in Cernovca.

During the planning and implementation phase of the restoration projects a number of basic conditions and influencing factors had to be considered (Fig. 7).

The reconnection of polder Babina, formerly destined for agricultural purposes, to the flood regime of the Danube in April/May 1994 was followed by the reconnection of Cernovca polder in spring 1996. These projects launched a development that, as for its extent, stands almost alone in Europe. Fresh ground in terms of drained wetlands restoration was not only broken in the Danube Delta, nationally as well this project represented a significant step in a direction that found high approval on an international level. The reward of the General Association of Romanian Engineers AGIR (1995) was followed in the same year by the EUROSITE-reward of the European Union. In 1996, the first restoration project was awarded the WWF International "Award for Conservation Merit" (Fig. 8).

După studii prealabile începute în 1991 a fost implementat în 1994 prin reconectarea incintei Babina la regimul hidrologic al Dunării primul proiect pilot de reconstrucţie ecologică în Delta Dunării.

In realizarea proiectelor de reconstrucţie ecologică au existat şi există o serie întreagă de factori, respectiv condiţii cadru, de care trebuie ţinut cont, acestea influenţând procesul de implementare (Fig. 7).

Prin reconectarea incintei Babina la regimul hidrologic al Dunării în aprilie/mai 1994 urmată apoi de incinta Cernovca în primăvara anului 1996, a fost declanşat un proces, care prin amploarea sa n-a avut precedent în Europa, acest proiect fiind recunoscut ca unicat atât la nivel naţional cât şi internaţional. Premiului Asociaţiei Generale a Inginerilor din România AGIR a urmat în acelaşi an premiul Eurosite al Uniunii Europene, iar în 1996 primul proiect de reconstrucţie ecologică a fost distins cu premiul internaţional "Award for Conservation Merit" al Fondului Mondial pentru Natură WWF (Fig. 8).

Fig. 8: Prince Philip, Duke of Edinburgh, president of WWF International, handing over the "Award for Conservation Merit" to Ing. Romulus Ştiucă, Director of the Danube Delta National Institute of Tulcea/Romania, on the occasion of the WWF Annual Conference in Berlin (24.10.1996) as recognition for the first restoration project implemented in the Danube Delta Biosphere Reserve

Prinţul Philip, Duce de Edinburgh, Preşedinte al Fondului Mondial pentru Natură WWF oferă Directorului Institutului Delta Dunării din Tulcea Ing. Romulus Ştiucă în timpul Conferinţei Anuale WWF la Berlin (24.10.1996) diploma "Award for Conservation Merit" pentru meritele institutului în implementarea primului proiect de reconstrucţie ecologică în Rezervaţia Biosferei Delta Dunării

Results of the success control of restoration works

The evolution of the restored polder Babina – a long-term monitoring programme

The prerequisite for a restoration process to be started is a concise planning and implementation of the necessary measures to be taken. In spring 1994, polder Babina situated in the north-eastern part of the Danube Delta and formerly destined for agricultural purposes, was reconnected to the flood regime of the Danube River. By doing so, fresh ground was not only broken in terms of restoration of drained wetlands in the Danube Delta. Rather did many crucial questions arise as for the further development of the area. Regarding the development of the area, how long would it take characteristic habitats to re-emerge? When would this wetland area that had been drained years before be fully operative again and how long would it take Babina island to return to its characteristic functions?

The expectations and hopes of the local populations were mainly associated with the island's function as spawning ground and habitat for fish. These were among its main functions before the dyking and the restoration of this function was a major aspect for the fishermen living in this area. First hopes raised with the opening of dams, when large shoals of carp fish/cyprinids used the island as spawning ground. But only very concise and long-term studies conducted on this subject could document how rapidly the fish food basis developed.

A monitoring programme was elaborated and implemented so as to find answers to all major issues regarding restoration, to document the development subsequent to the re-flooding and to verify the success of the measures taken. This allowed to show development trends, evaluate the measures and, if required, to propose further corrective supplementary measures. First results as for the restoration of hydrological, biogeochemical and ecological functions have been published in 1997 in a comprehensive report elaborated in co-operation with the Danube Delta National Institute for Research and Development in Tulcea, Romania, and WWF Germany's Institute for Floodplain Ecology, Rastatt (recently integrated as chair in the Institute for Water and River Basin Management, University of Karlsruhe).
The data shown below represent a summary of the results obtained after a long-term monitoring starting from the opening of the dam up to the year 2001 as well as further expertise and observations gathered until 2005 during the evaluation of ecological functions and economical values. The point is mainly to document the re-establishment of the manifold functions of the island and the development of near-natural habitats with its site-specific biodiversity. The latter represents the basis for the re-development of the natural resources that are used by local populations. To secure an ecologically sound and long-term use of these natural resources a further scientific accompaniment of its development reveals necessary. The same is true for the respective management plans that have to be elaborated and adapted to the circumstances as and when required.

Fig. 9: Restored lake in the polder area with *Nymphaea alba*

Materials and Methods

The monitoring activities conducted regard both abiotic and biotic factors. As for the monitoring objectives, i.e. the collection of data on and evaluation of the redevelopment of the natural hydrological, bio-geochemical and ecological functions, of biodiversity and of the resources with its socio-economical functions, monitoring was focussed on the following aspects:

- analysis of the hydrological regime and sediment transport
- studies conducted on nutrient retention and transformation
- limnological studies conducted in consideration of phyto- and zooplankton, macrozoobenthos, phytophile fauna, fish and aquatic vegetation
- studies on semi-aquatic habitats with regard to their macroarthropode fauna and vegetation

These studies have been conducted from 1996 to 2001. In the ensuing years, further monitoring activities have been carried through in view of the opening of the restored areas allowing a traditional use of the resources by the local population. The objectives of this last monitoring project were the evaluation of the ecological functions and of the restored economic values. In this process particular importance was attached to the evaluation of the whole area's ecological functions. The values resulting from these could be transformed into resources for the local population. Additional measures taken were

- studies on nutrient retention and the role of the reed areas as biological filters;
- evaluation of the grassland and its usability by the local population;
- analysis with regard to a possible use of the agricultural potential for eco-tourism

Specific attention has also been paid to the site-characteristic biodiversity, especially in respect of habitat restoration and its importance for the NATURA 2000 network. In doing so a list specifying relevant species has been drawn, among which the European mink, the European otter, the European pond turtle and others. The occurrence of these species requires the establishment of specific protected areas.

Hydrological regime and morpho-hydrographical changes

Between 1996 and 2003 field measurements have been conducted in the Babina area to monitor:

- the hydrological regime;
- the morphohydrographical changes that occurred in this area;
- the area's filter function as for the solid matters suspended in the water.

The water level in the Babina zone is closely related to that of the Chilia and Babina branches. In order to calculate the water discharge
($Q[m^3/s] = A \cdot V$; A = cross-section area [m^2], V = stream velocity [m/s]) entering this zone through the two upstream openings in the contour dam (Figure 6), and to determine the degree of erosion or hydraulic sedimentation conditions, the flow velocity is measured by means of an electronic current meter, SEBA Universal Current Meter F1 type with propeller 125/300 on rod and signal counter Z10, instrument case. Data are processed in software Q, version 2.0 (Quantum Hydrometrie, http://www.quantum-hydrometrie.de), to obtain the velocity diagram in cross-section. The Current meter formulae for V are as follows:

I. $0.00 \leq n \leq 1.98$ $V = 1.93 + n \cdot 31.17$
V: stream velocity [cm/s].
II. $1.98 \leq n \leq 10.27$ $V = 0.19 + n \cdot 32.05$
n: number of propeller rotations per second
III. $10.27 \leq n < 15.00$ $V = -14.09 + n \cdot 33.44$.

The number of measurements per vertical depend on the water depth (e.g. for H=186 cm, 6 measurements are performed related to the water surface, as follows: for 5 cm depth, 40 cm, 80 cm, 120 cm, 150 cm and 168 cm). To obtain the water discharge (Q), an average value of V is calculated for each cross-section area.

As for water flow velocity measurements for the two distinguished hydraulic conditions, i.e. alluvial sedimentation and erosion processes, respectively, the water flow velocity shows critical values as follows:

- $V \geq 0.40$ m/s triggers the canal bed or side erosion condition, and
- $V \leq 0.25$ m/s the alluvial sedimentation one.

The cross-section value (A, [m^2]) results from the measurements occasioned by water flow velocity measurements.

The morphohydrographical changes have been studied by means of bathymetric measurements on the canal cross-sections and longitudinal bed elevation sections. The field measurements have been carried out with regard to water surface elevations (meter above Black Sea level) recorded in the Danube Delta gauge network.

Nutrient retention and transformation

To monitor the area's filter function as for the solid matters suspended in the water, water samplings are taken and the solid matters are weighed (in laboratory). The field measurement stations are shown in Fig 10.

To evaluate the quantity of nutrient input and output, the balance of the water volume flowing in and out of the polder has been calculated. These calculations were based on several factors such as the Danube River water levels, the dimensions of the openings and drainage channels and on the hypsometry of Babina and Cernovca islands. From this arose the capacity curves of both polders.
The nutrient concentration values measured in the water pouring out of the polder corresponded to the values obtained by extrapolation during field works in 1998. The nutrient concentrations corresponded to extrapolated values of a whole year, i.e. the relevance of the data was affected. Later on, the methods applied in other areas of the Danube Delta (OSTERBERG, HANGANU, MENTING, GRIDIN & TUDOR 1998) had been refined taking into account the vegetation type, the size of the flooded area and the duration of flooding. They could then be transferred accordingly to the situation on Babina as well.
To obtain most accurate estimations as for the retention of nutrients in the area, the studies were based on the model proposed by CONSTANTINESCU & BAKKUM (2001) on processes occurring in reed-covered areas including nitrate and phosphorous cycles (Modell DANUBS _ WQ). Based on spatial data, vegetation maps and surveys made on-site, the evaluations have been effected by application of the standardized retention rate of nitrate expressed in g/m²/day.

Aquatic habitats

Limnological survey - period and sampling sites

The limnological samples were taken within the frame of five field studies, together with the studies on terrestrial and aquatic macrophytes as well as terrestrial and semi-aquatic macroinvertebrates. The zoobenthos samples as well as physical-chemical measurements were taken between: 23.-24.7.1996, 29.-30.6. 1997, 1.- 4.6.1998,18.-22.6.1999, 23.-24.6.2000 and 20.6.2001.

The sampling sites of the studied area were determined in a way to include all types of waters (Fig. 10). The permanent waters are composed of a network of artificial channels, natural former branches, smaller water courses, the so-called „Gârla" and the shallow depressions of varying extend that are connected to them, a kind of shallow lakes. According to their connectivity the waters have to be evaluated differently.

The circular cannel situated beyond the dam (sampling spot B 1) developed at the moment of the dam construction and is isolated for the major part of its course from other waters in the centre of the island. One short section of the circular channel (sampling spot B 6) situated near the northern dam opening is strongly influenced by running waters. The main canals (e.g. CC2, sampling spot B 2) frequently show shallow inlets, i. e. the remains of the former „gârlas", that are continuously broadened by shore erosion (sampling spot B 3). The secondary canals (CS) (sampling spot B 7) are usually covered by floating leaf water plants. Two lakes (sampling spots B 5 and B 11) are situated in the eastern part of the island and are in some places connected to the canals by gaps in the reed belt.
At the outflow of the former Gârla (sampling spot B 4) large quantities of water pour out from the polder into the central canal.
Temporary waters develop along the borders of the reeds and rush reeds (sampling spots B 8 and B 10) as well as in the reed stands themselves (sampling spot B 9) at higher Danube water levels.

Phytoplankton sampling

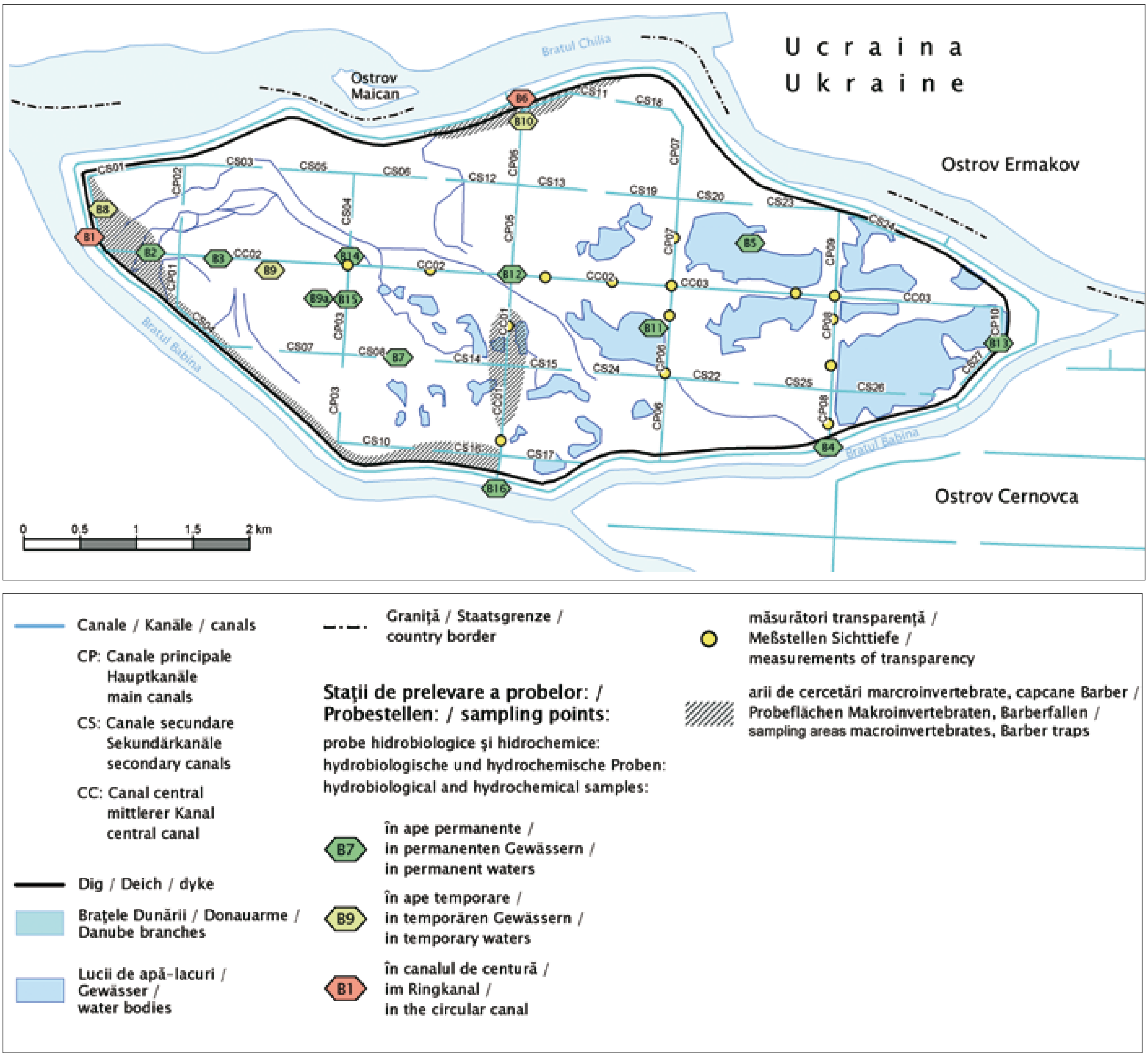
During the years 1997, 1998 and 2003 free-floating algae have been sampled in the upper layer of the water column in the reconstructed Babina area. Samples were taken once or twice a year, according to the methodology in 2-3 m depth in the case of shallow waters, subsurface samples were collected in 0.5 m depth (Standard Methods, 1989). The one-liter-samples were preserved with 3 ml of Lugol`s solution. Quantitative studies have been carried out with a Hloubka 0,10mm – 100mm² chamber using a light microscope (Laborlux) at low magnification (40X) and high-magnification methods estimating diatom amounts. In the latter case, the diatom abundance value was established by means of the “surface spread method” (Török 2004).

The species determination was performed according to Geitler, 1985; Hakansson, 2002; Komárková-Legnerová, 1994; Krammer et.al., 1986, 1988, 1991a, 1991b; Lange-Bertalot et.al., 1966; Nagy-Tóth et al 1998; Uherkovich, 1995
The value of the Shannon-Weaver index (Magurran, 1983) was established by using the following formula:

$$H' = - \sum \pi \cdot \ln(\pi)$$

The quantity pi is the share of individuals found for the species. The value of pi was estimated as ni / N, ni being the average abundance of every species and N the average of total abundance.

Fig. 10: Sampling Points
Staţii de prelevare a probelor



Zooplankton sampling

Zooplankton sampling was performed in June every year (1997 – 2001) using a vertical, conical plankton net (55 µm). 30 l of water were filtered, then zooplankton was resuspended in water and preserved with 85% alcohol in plastic bottles (100 ml).

Most of the sampling stations were chosen in open-water habitats rather than in the littoral side of shallow channels (B1, B4, B6, B7), medium-sized 'lakes' (B5) or deep channels (about 2 m). The outlet (B13) and inlet (B16) were sampled as well (Fig. 10).

The zooplankton was identified using the following keys: PONTIN (1978), NEGREA (1983), RUDESCU (1960), DAMIAN-GEORGESCU (1970), DUSSART (1969), SCOURFIELD & HARDING (1994).

Numerical analyses

Counting was carried out using a Sedgwick-Rafter counting chamber. Zooplankton density was calculated reporting the number of individuals to volume unit (l) based on the following formula:

No./l = C•V'/V"•V'"

Where:
C = number of organisms counted
V' = volume of the concentrated sample, ml.
V"= volume counted, ml, and
V'" = volume of the grab sample, l.

The species abundance was calculated for each group (Rotifera, Copepoda, and Cladocera) and the relation between abundance and biomass was analysed. The zooplankton community was qualitatively analysed using the frequency and species dominance.

F (%) = (p/P)•100

Where:
p- number of samples that contain a certain species
P- total number of samples

Based on their occurrence frequency, species are:
Constant species: F% > 50%
Additional species: F% : 25 – 50%
Accidental species: F% < 25%

The zooplankton biomass (wet weight) was calculated using tables with the wet weight average for each species (RUJINSCHI, 1994).

Macrozoobenthos sampling

The zoobenthos samples have been collected by means of a sweep net. For this purpose, separate samples were taken on various microhabitats of a sampling spot. Moreover, samples were taken from every single sampling spot with a time expenditure of 15 minutes. This semi-quantitative method allows to compare the number of species of the various spots with one another. The zoobenthos has been preserved on-site in 70%-alcohol and was classified and analysed later on in the laboratory. During the first field study in 1996, quantitative samples of the channel bottom (surface 225 cm²) have also been taken by means of grabs. However, the evaluation of these samples showed that the phytozoobenthos (i. e. macrozoobenthos using the surface of water plants as substrate) is much more important for the evaluation of the macrozoobenthos fauna of the waters. This is why this method was no longer used in the following.

A simple, quantitative method for the study of the zoobenthos on rosettes of water soldier (Stratiotes aloides) was used during the years 1998, 1999, 2000 on sampling spot B 7. The diameter of swimming rosettes was measured in the water. Later on, the rosette was lifted out of the water by means of a sieve (mesh size 0.5 mm, diameter of the frame 80 cm), put on a white tray and the macrozoobenthos was collected from the single leaves. The number of specimen was then calculated for a rosette with a diameter of 40 cm (most specimen belonged to this size category).

Not all groups of zoobenthos were treated the same. Difficult and time-intensive groups as for their taxonomic analysis (such as e.g. Diptera) have not been analysed up to the species level. This is true e.g. for some representatives of the aquatic insects, given that their larvae and nymphs could not be determined as a result of climatically varying years.

Parallel to the sampling of macrozoobenthos, physical–chemical values have been measured on the sampling spots as well: total depth of the water, transparency, water temperature, concentration and saturation of dissolved oxygen in the water and electric conductivity.

Fish and fish plankton sampling

For the evaluation of the fish resources in the Babina rehabilitation area, the fish fauna, inclusive of fish plankton and juvenile fish, was studied in June 1998. The data collected in 1997 have been considered all the same. However, fish plankton samples have also been collected and analysed in this area from 1996 to 2001. For the sampling of the total analysis, Swedish sampling methods have been used, with multi-mesh gill-nets of various mesh sizes, from 6 to 75 mm, and electro-fishing by means of a DEKA 7000 device. The fish plankton was collected by means of a fish plankton net with a mesh size of 1 mm.

The fish samplings carried out at night with multi-mesh gill-nets and the method of electro-fishing used during daytime were meant to determine the

Fig. 11: Sampling of fishfauna (1997)
Amplasarea staţiilor de eşantionaj a ihitiofaunei (1997)

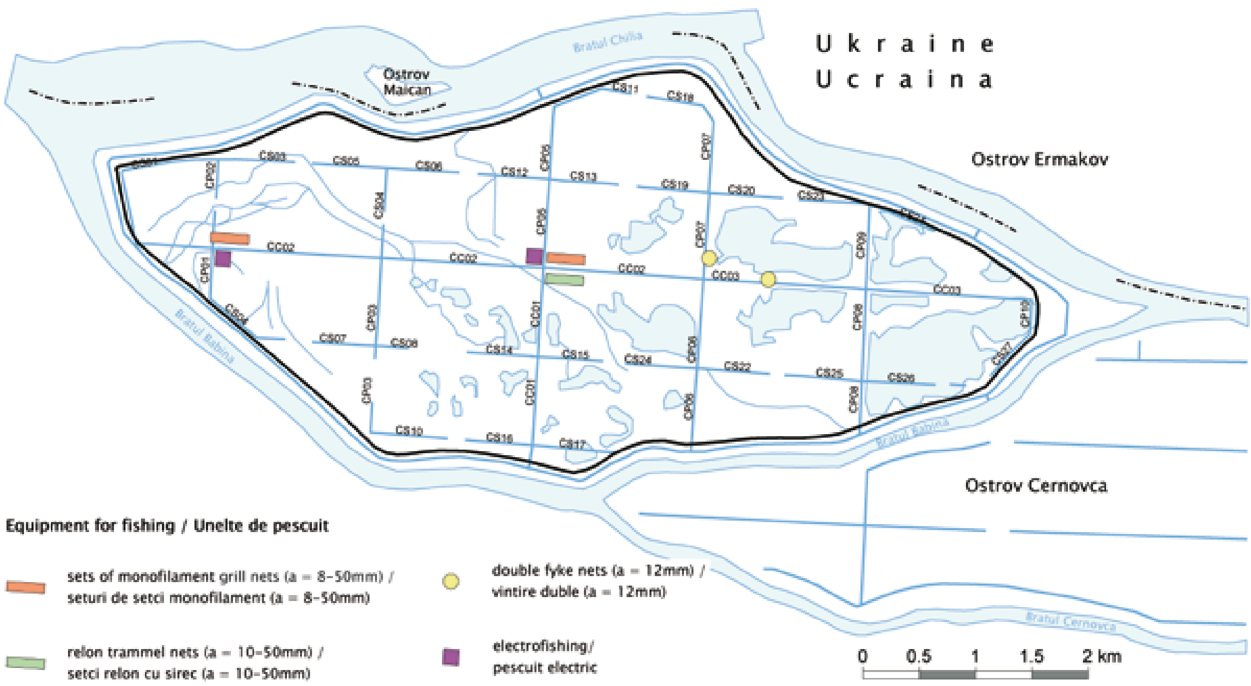


Fig. 12: Sampling of fishfauna (June 2001)
Amplasarea staţiilor de eşantionaj a ihitiofaunei (iunie 2001)

structure of the fish populations, the relative numeric abundance and the fish biomass. De Lury's method for subsequent fishing was adapted and used to estimate the absolute abundance. The principle of this method consists in the assumption that, in the case of subsequent fishing in a constricted area, the catches decrease in proportion to the abundance. The total fish amount of an area may thus be calculated by means of a regression analysis and does not require a radical fishing.

Water macrophyte sampling

The mentioned network of limnological sampling spots has also been used for the studies conducted on aquatic vegetation. Besides selective samplings, data have also been collected in the circumference of the sampling spots to allow a large-scale recording of the vegetation. The results have been illustrated in an aquatic vegetation map (Fig. 56). Moreover, data of the vegetation occurring alongside a number of water transects have been collected all the same to allow a better registration along ecological gradients. The collection of the aquatic vegetation data has been effected using the methods for the evaluation of species predominance and sociability according to Braun-Blanquet (1964). The yearly control of the sampling spots allowed to draw comparisons and made it also possible to show both the development trends of the vegetation and the annual fluctuations as for abundance-dominance relations. Moreover, the alterations resulting from morphodynamics could also be documented.

Fig. 13: First sorting of samples

Semiaquatic and terrestrial habitats

Semiaquatic and terrestrial vegetation

Changes in the vegetation after the opening and flooding of the polder Babina area have been obtained by the comparison of satellite images before and subsequent to the reconnection. They have been completed and verified subsequent to field studies and samplings by phytocoenological units. The sampling was realized using the phytocoenological methods of Braun-Blanquet with the abundance-dominance seven-degree scale. Supplementary data as for the terrestrian vegetation have been gathered in the course of resources evaluation studies conducted in the reed areas and grasslands.

Evaluation of reed and grassland ressources

The evaluation of reed areas available for sustainable use have been identified by means of remote sensing and on-site surveys. Spatial data of the TM Mapper type have been used for the investigation area. For the pixel calibration of the spatial data that correspond to the reed vegetation, field investigations have been implemented in all areas considered for possible reed harvesting purposes. The sampling sites have been selected according to the following principles:

- the pixel structure of the spatial data must be consistent (uniform) and representative of a specific reed rush in the area
- the number of pixels showing the same structure must exceed 8 in order to avoid any interference with the surrounding areas
- the reed areas have to be consistent as for their density and height

Subsequent to the calibration of the spatial data on-site and both the description and differenciation of the reed rush types, the data have been further processed with ArcView and PC Kayak XA to determine the surface of the areas for a possible reed harvesting. Reed samples have been taken on well-chosen spots and for each sample the whole biomass, the biomass of the green stipes, the stipes' density, the height and diameter at the base of the stipes and below the flower spike have been determined. The results obtained have been related to an area of 1 ha.

To determine moisture. stipe and flower spike samples of the last generation have been taken. The samples were weighed on-site, dried subsequently in the laboratory up to their weight constancy (80°C) to determine their oven-dry mass. To calculate the possible reed harvest yield, the dried biomass has been related to the biomass of 1 m^2 of reed assuming a moisture rate of 15 %, this rate applying as standard to the users. Afterwards deductions have been made from the calculated mass as for biodiversity, losses occurring during harvesting and bundling to obtain the actual harvest yield. The latter represents the actual productivity of the area related to the surface (in ha).

To evaluate the grasslands of the Babina area, surveys conducted within the frame of field studies were supposed to allow a quantifying of the production. By doing so, dominance and percentage involvement of the species were determined. On an area covering 100 m^2 the main species to be evaluated were Leguminosae, Cyperaceae and one category of further species. Moreover, on various well chosen and floristically very homogeneous areas of 1 m^2 respectively, the biomass has been harvested with the objective to obtain an analyzable mean value that could be related to a surface of 1 ha. The following indicators have been determined for the evaluation of the field data: fodder equivalent, indicator value for moisture and annual production.

Semiaquatic and terrestrial macroarthropods

The recording of the arthropode fauna occurring on the soil surface of the shore area was realized by means of Barber traps (Balogh 1958), the traps having been positioned on well-chosen and representative sites in groups of five traps respectively (Fig. 10). The quantitative Barber trap method was complemented by qualitative hand samplings in representative habitats. The samples taken have been evaluated taxonomically, faunistically and statistically in the laboratory (Janétschek 1982, Spang 1992).

After a first sorting the taxonomic classification of the samples was effected in the lab, generally up to the higher taxonomic levels (classes, orders, families). For a number of chosen groups the classification occurred up to the species level.

The attribution to ecological functional groups has also been effected merely for a certain number of chosen taxa (Müller-Motzfeld 2004).

The sampling spots have been chosen with regard to soil conditions and according to phytosociological criteria. The vegetation cover's primary production does not only safeguard the food basis of its consumers but organizes as well the spatial structure by microhabitats and determines the microclimatic conditions at ground level.
Within the timely bounds of the field works the aim was to obtain a most representative faunistic inventory by means of Barber traps and hand samplings in different investigation areas. These areas are situated in the western part of Babina island, in the north near opening 4 and in the south around the pumping station near opening 1 (Fig. 10). Towards the end of the main channel CC2 (Fig. 10), in the shallow bank areas and areas with fluctuating water levels one may find diversified mosaic complexes composed of permanent wet and temporarily flooded sites. Reeds and sedge rushes occur in the constantly moist to wet depressions, the areas beyond are covered with temporarily flooded, ruderalized grasslands in places composed of tamarisk bushes. Algae carpets and halophyte communities comprising halophile arthropode species develop around the shallow ponds that emerge after the flood. The circular dam is strongly overgrazed and ruderalized (*Artemisia* ssp., *Carduus* ssp, *Atriplex* ssp, *Hordeum hystrix*).The manure produced by grazing animals is used and decomposed by species-abundant synusias of coprophagous insect species.

The investigation areas in the north of Babina are arranged around the alluvial cone generated by the inflowing Danube waters. Besides the muddy and silty areas that are exempt of vegetation, broad pioneer sites and succession areas with annuals and tall herbaceous vegetation emerge after the flood. Gallery-like willow bushes extend along the circular channel and the dam, below which broad and shady banks of floodplain loam emerge at the moment of the floods. They offer favorable conditions to arthropode settlements.

The investigations areas situated around the pumping station in the south of Babina show poorer structures as compared to the other habitat complexes studied. They are situated along and inside the polder dam and are represented by tall herbaceous fringes of the banks as well as muddy areas with *Butomus umbellatus*. Young willow bushes have settled in places after the opening of the polder and tamarisk bushes occur here and there between the circular channel and the dam.

Amphibians and reptiles

No specific studies on all amphibians and reptiles have been conducted so far in this area. However, several important species as from the point of view of nature conservation respectively the NATURA 2000 Network have been studied, e.g. the European swamp turtle *Emys orbicularis* (Council Directive 92/43/EEC, Annex II), and have been evaluated with regard to the threats they are exposed to.

Birds

Studies on the area's avifauna have been conducted during the first monitoring period 1997 along transects (Marin & Schneider 1997). Within the frame of the evaluation of the area and its habitat functions for birds realised in 2003, qualitative and quantitative studies have been conducted on three transects positioned along main channels. In the course of these studies, birds living and resting in the area as well as migratory birds have been evaluated separately.

Mammals (European Mink and Otter monitoring)

As for reptiles, for mammals as well on the one hand the recording of rare species registered in the Habitat Directive was important, such as the European otter (*Lutra lutra*) and the European mink (*Mustela lutreola*) which are relevant for the NATURA 2000 Network (Council Directive 92/43/EEC, Annex II).

From March 17-19, 2004, live traps have been set to provide evidence on the occurrence of the European mink. Wire cage traps with sardine lures have been hidden along the banks and were subject to daily controls. One male specimen has been captured on Cernovca in the course of these days. The search for tracks and droppings remained unsuccessful. This method does indeed not allow to make up the difference between European mink and American mink, which would, however, be of prime importance in this case.
Otters have been determined by means of spraints, tracks and marking piles. Spraints is the specific expression for otter droppings or excrements. They usually contain thoroughly chewed remains of their prey. All findings of spraints have been subject to an age estimation to evaluate the categories of fresh (1 day old), medium (maximum of 7 days) and old spraints so as to find out whether the area is constantly used by the otter, just now and then respectively only once.

The otter's track, its paw print, is very striking and shows five pointed toes, usually around a small heel pad. Based on their size and the number of otters occurring in one place it was possible to draw a classification after tall male specimen, female and juvenile animals as well as average size otters. Average size tracks do thus originate either from adult females with no juveniles or from adolescent otters of both genders.

The otter's marking pile consists in pawed substrate available on the ground, on top of which the animal leaves a marking (spraint, urine, anal gland secretion). They consist either of sand, snow, foliage, soil or also of grass.

Other mammals has been inventoried, registered and evaluated during 2003 in the frame of a study on game potential.

Results of Monitoring

Hydrological regime and morpho-hydrographical changes

by Eugenia Cioacă

Hydrographical network and hydrological regime

Before the dyking Babina island disposed of a hydrographical network that regulated its hydrological balance. This network consisted of

- small water courses, the so-called "Japshe" which dried up in summer time and occasionally changed their flow direction,
- of lakes called "Ghioluri" and
- temporarily flooded areas.

In the centre of Babina island, the japsha "Horba" flood channel both supplied the lakes with water and allowed the flooding of the island. The hydrological regime of the island was determined by this water network depending on the hydrological regime of the Danube in the Chilia and Babina branches. The inundation of the island proceeded slowly from the downstream to the upstream end, though the island's entire surface was not covered every year (Marin & Schneider 1997). Only during high water levels the natural levees ("grinduri de mal") on the upstream part of the island where overflooded.

To conceive the processes that occurred in the Babina area it reveals necessary to consider them in their over-all scope. In this connexion one has to account for the fact that Babina island is situated in the north-eastern part of the fluvial delta (Fig 14) characterized by low fluvial processes as compared to the delta's upstream areas where these occur with a high intensity.

The most important factor for morphological changes in the Danube Delta hydrographical network is the Danube River hydrological regime, especially as consequences of high water levels and floods. These depend on stream bed and cross-section geophysics characteristics. Moreover, human intervention gave way to far-reaching changes in the Danube Delta hydrographical network.

The highest intensity of fluvial processes entailing morphologic changes of the hydrographical network proceed during the flood periods when large quantities of water and suspended solids expand into the inner areas of the Danube Delta. These floods generally occur twice a year. Beyond these periods, the Danube River water makes up only 5% of the Danube Delta hydrographical network.

The hydrological data of the Danube River's lowest stretch recorded between 1848 and 1990 at the hydrometrical station of Tulcea harbour (Bondar 1994) show the following results:

- a very high amplitude of water levels, between a minimum of 0.33 m (1947) and a maximum of 4.90 m (1970)
- water discharge average values increased continuously from 5980 m³/s (1858-1900) to 6980 m³/s (1961-1970) and 6210 m³/s (1981-1990)
- suspended solids discharges decreased from 72 kg/s (1858-1900) to –3 kg/s (1981-1990)

During the floods water flows over the natural fluvial levees of the delta's channels. This process takes place, mainly in the fluvial part of the delta, in the following conditions (Bondar 1994):

- the Danube river water levels recorded at the hydrometric station of Tulcea exceed 2.90 m (above Black Sea level);
- the water discharges exceed 9.100 m³/s;
- it preponderantly takes places in the fluvial delta (Fig. 14)

From the Danube water level data analysis recorded at the gauge of Tulcea for the period 1932-2003 (Cioaca 2001, 2002) the following aspects are characteristic:

Fig. 14: The limit between fluvial delta and the fluvial-marine delta

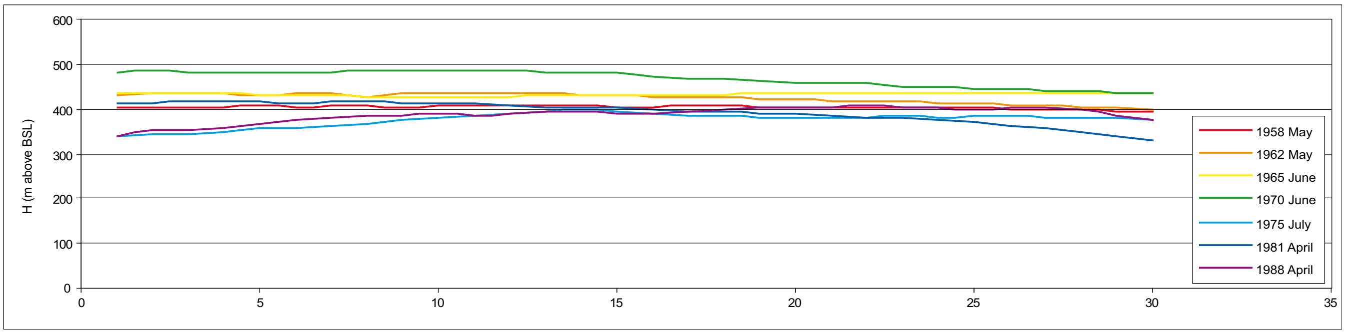


Fig. 15: The highest Danube River levels (H) recorded at the gauge of Tulcea harbour (analysed period 1932-2003)

Fig. 16: Number of inundation days for water levels exceeding 2,90 m (analysed period 1932-2003)

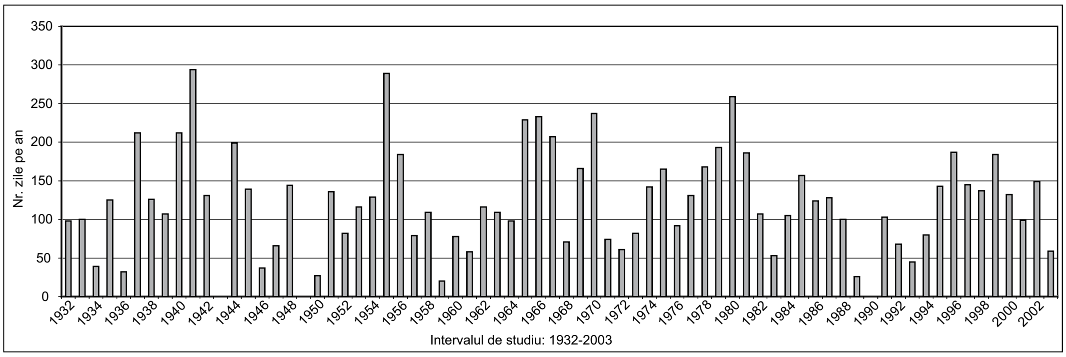
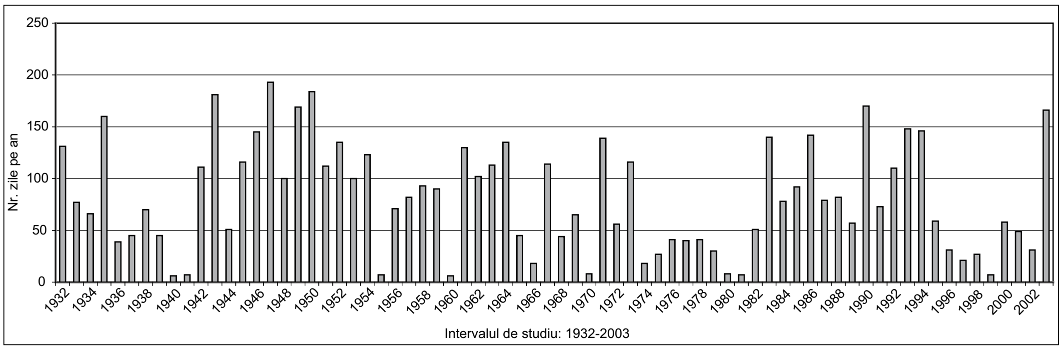


Fig. 17: Number of inundation days – for water levels exceeding 2,90 m (analysed period 1932-2003)



- the highest water level values occur from April to June and amount 3.50 m-4.90 m (above Black Sea level) (Fig. 15);
- inundation days are days with water levels exceeding 2.90 m. However, the recorded data also show inundation-free years (1943, 1949 and 1990) as well as prolonged inundation periods, i.e. 270-290 days (1941, 1955) (Fig. 16).
- for water levels lower than 1.50 m, the smallest and very shallow lakes “disappear” i. e. dry out in summer time, both due to low water levels and a high evaporation from the lake water surface (Fig. 17);
- the shortest inundation period (59 days) and a long one of low water levels has been registered in 2003 (166 days);
- water levels of 3,40 m are the most frequent (Fig. 18)

From a morphological-hydrographical point of view the Babina area shows very specific conditions as the actual canal network of the dyked island comprising primary and secondary canals has completely been constructed by man, changing the natural hydrological conditions. Within the years 1985-1994 the area has been under drainage regime in order to transform it in an agricultural polder. In 1994, as a result of ecological reconstruction action, the polder was reconnected to the Danube’s natural flood regime by openings in the surrounding dam (Fig. 6).

Morphological changes

The analysis and documentation of morphological changes in the network of water bodies of the Babina island area, based on hydraulic and bathimetrical measurements, was monitored between 1996 and 2003 being shown by cross-section hydraulic element evolution graphs (Fig. 19-21).

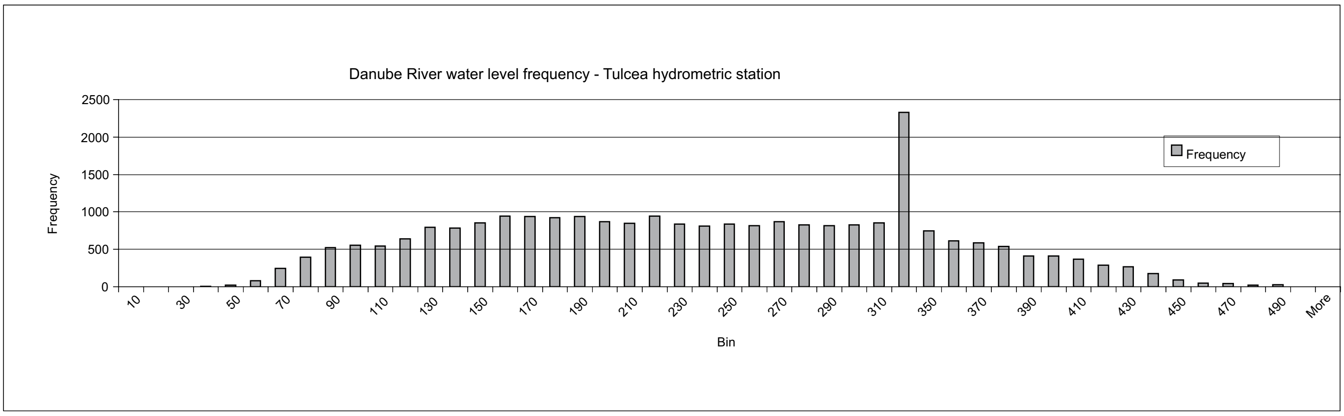


Fig. 18: The most frequent water level: 3.40 m (analysed period 1932-2003)

Following these graphs and field observations, some aspects have to be emphasized:

1. Due to the water‘s hydraulic energy and the general flowing direction in the Danube Delta, from west to east, the western side of a canal, at the contact with the larger stream, which it’s connected to, is subject to sedimentation with suspended solids. The eastern side is eroded. This process occurred on the first few meters of the connected canal (Cioaca 2001, 2002). Depending on the stream water velocity value, erosion or sedimentation occurs in the same cross-section of the inlet canal (Fig. 19). Sedimentation occurs if velocity is below a critical value. By contrast, for a value exceeding this critical velocity, erosion occurs. The critical value for water velocity depends on many elements (Chorley 1973, Constantinescu & Goldstein 1956, Wisler 1963). Among these, distribution of different grain sized sediments and the water‘s hydraulic energy are the most important.
2. The intensity of fluvial processes in a man-made canal network, sedimentation of suspended solids and erosion are significantly influenced by the fact that the deposits resulting from excavation and dragging works during the construction of the canal network were banked up along the canal sides.
3. The most significant morphologic changes occurred in the main inlet canal CC1 of the Babina area (opening/Breşa 1 and opening/Breşa 4, Fig. 6). This is a result of their immediate connection to the Chilia and Babina branches by upstream openings in the circular dam (Fig. 19, Fig 20). In the north-western part of the Babina island area at opening 4, the quantity of suspended solids was measured with 95-115 mg/l.
4. At the opening level (Fig. 19) the sedimentation of suspended solids formed a layer of 0.60-2.17 m height between 1996-2003. The erosion process is less intense. Solid matters resulting from erosion become sedimentation material for the next and longest part of the canal, where water velocity is low.
5. Fig. 20 shows the same feature: the main canal is most affected by sedimentation – CC1, as compared to CC3, which is not influenced by fluvial processes.

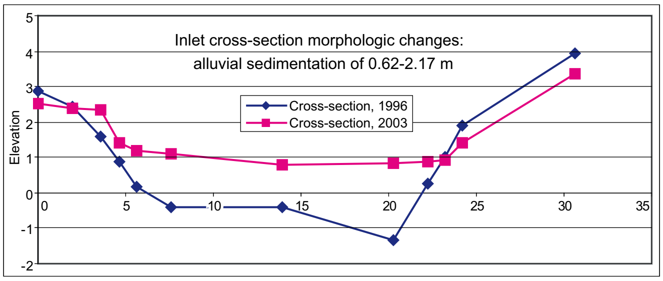


Fig. 19: Morphologic changes of the main area of water supply – cross section through the inlet opening in the contour dam in the north-western part of the Babina island area on the Chilia branch

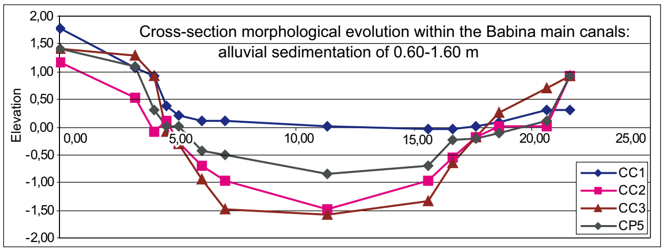


Fig. 20: The four main canals cross section changes between 1994 and 2003 – CC3 (unmodified) considered as reference section

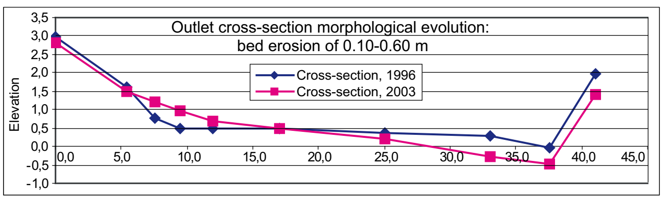


Fig. 21: Outlet opening cross-section morphologic change

6. Outlet openings are frequently subject to erosion processes (Fig. 21). To reach the two downstream openings in the circular dam the water flows through Babina's large reedbed surfaces and subsequent to this filtering process the water is clarified. In the discharge/ outlet section the suspended solids are reduced and are of 5-7 mg/l. The clear waters of the Babina area are mixed with the turbid waters of the Babina and Chilia branches (Fig. 22). This emphasizes the signigicant filter function of the Babina area for the whole downstream area and for the Black Sea.

Results and discussions

To evaluate the degree of the morphohydrographical changes, a comparison has been drawn with another ecological restauration area, Fortuna. Even though the two zones dispose of differing geographic and morpho-hydrographical conditions, some results can be emphasized thanks to intense sedimentation processes occurring in both ecological restoration areas.

The Babina area is located in the most downstream part of the fluvial delta where the sediment load is lower than in the upstream delta. Here the fluvial processes generally have a lower intensity than in the upstream areas of the delta, except for the canals directly connected to the Danube's arms, as CC1 canal is. In this artificial canal the sedimentation layer measured was of 0.80 - 1.50 m for the period 1994-2001 (see Fig. 28).
The Fortuna area is located in the upstream delta. Its canal network is not directly connected to the Danube's arms, only by means of the circular canal. Here the fluvial processes have a higher intensity than in the downstream fluvial delta. Under these conditions sedimentation is of 1.10 – 1.40 m (Fig. 24, 25, 26).

Due to the surrounding dams the natural morphohydrological features of Babina island are changed. Lateral connectivity is restored by the opening of the dams, the flood regime, however, differs from natural conditions before dyking. The functions of the former natural levees situated between river and floodplain are not restored. The natural levees do no longer accomplish their role at the moment of the spring floods as they are no longer overflown at the moment of increased Danube water levels. The only ways for the water to flow into the inner area, both at high or low water levels, are the new openings. But sedimentation processes occur faster in the restoration area than in the natural areas, maintenance expenses for the water inlet are expected in the short term (Staraş 2001). The sedimentation processes are like a tendency in natural areas to build levees, the so called "grinduri", but are located only near the openings.
Dynamic sedimentation processes also become apparent beyond the water bodies of the canals in the proximate shore areas where pioneer species settle on newly aggradated virgin soils. This begins to show especially by the white willow and tamarisk settlements occurring along the banks near opening 1 at the pumping station as well as by the occurrence of the named species along with ephemeral pioneer species on the aggradations near opening 4 in the north-western part of Babina island. The results on rhythm of bed process changes can provide useful information for decision - making in ecological restauration management plans within the wetlands and deltas.

Fig. 22: Mixing of clear, filtered water from polder Babina with sedimentrich Danube water

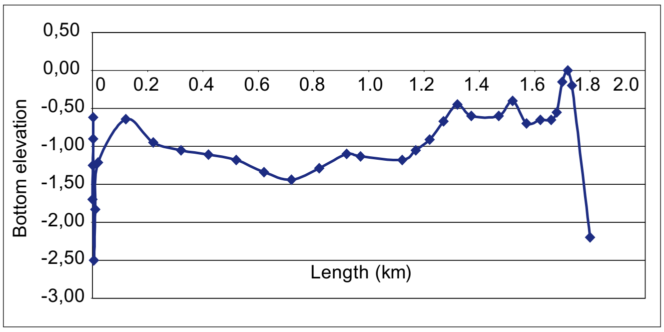


Fig. 23: Babina area main canal (CC1) longitudinal profile (2001) initial bed elevation: -1,50m

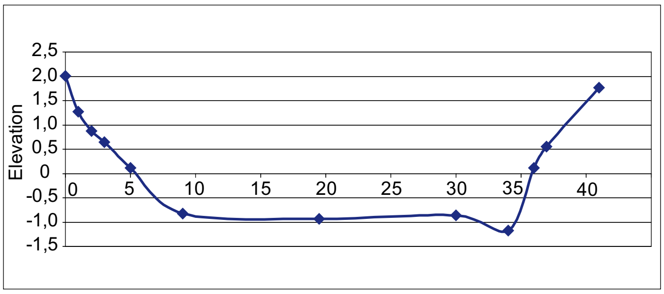


Fig. 25: Fortuna area – inlet cross-section modification (2001)

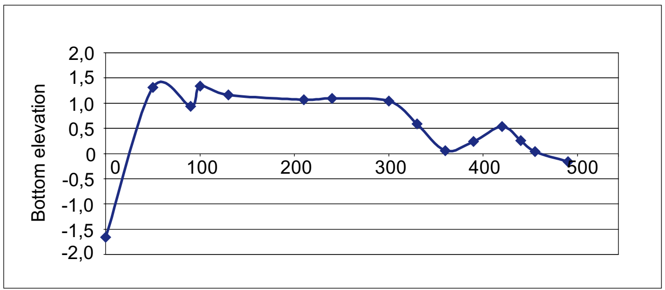


Fig. 24: Fortuna area – main canal (S 20) longitudinal profile (2001), initial bed elevation 0,50 m

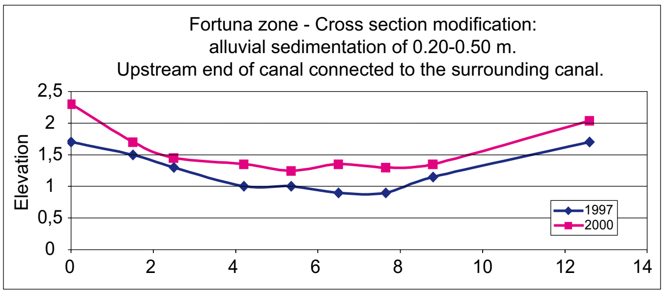


Fig. 26: Fortuna area. Outlet cross section unmodified by bed processes

Fig. 27: The Babina main inlet canal (CC1), partially clogged by reed vegetation developed on new sediment deposits (2001)

Nutrient retention

by Marian Tudor

The retention area of Babina island which has been reconnected to the dynamics of the Danube river just as the adjacent retention area of Cernovca island both definitely play an important biogeochemical role: with sediment retention, as biofilter, with nutrient retention and cycling. The suspended nutrients and solids respectively fine sediments are filtered in the broad reed areas and are retained in the bioaccumulative horizon.

The water flowing out of the polder is clear. The nutrients retained are subject to transformation processes. Due to the calculation mode described under 'methods', the following results have been obtained:

- total mineral nitrogen:
  - inflow 924766.8 kg/year
  - outflow 222612.3 kg/year
  - retention 702154 kg/year, corresponding to 334.4 kg/year/ha.
- total phosphorous:
  - inflow 64872 kg/year
  - outflow 34431.02 kg/year
  - retention 30441 kg/year, corresponding to 14.5 kg/year/ha.

Later on, while calculating nutrient input and outflow, factors such as surface of the flooded area, vegetation types and flood duration have been considered (Osterberg, Hanganu, Menting, Gridin & Tudor 1998). To do so, the calculations effected in the Mustaca area in the southern Danube Delta have also been applied in the Babina area. Based on these calculations, the authors mentioned above became aware of the fact that the reed beds do not act as phosphorous filter or if so, merely as a bad one. The data show that in early spring, at the moment of rising water levels, the reed bed acts as a phosphorous sink, the main reason for this being the sedimentation of sediment-bound phosphorous from suspended solids in the water. During the short period of high water levels a high phosphorous supply arrives in the reed bed and is retained there. However, in late spring and during summer, the reed bed acts as a phosphorus source, mainly in the form of Ortho-Phosphorous. This is highly relevant, as the phosphorus component is important for the growth of phytoplancton and macrophytes.

Moreover, the studies document the fact that the reed beds dispose of perfect nitrogen filter qualities and that about 70 % of the total nitrogen amount is retained in the reed beds. The mean retention rate was evaluated with 75 kg/ha (Osterberg, Hanganu, Menting, Gridin & Tudor 1998).

The definitely positive effect of nutrient reduction is a reduced eutrophication in the restoration area, which is also to the benefit of the Black Sea. To obtain nutrient retention values that are as accurate as possible in Babina and Cernovca areas, the following models have been applied: the model proposed by Constantinescu & Bakkum (2001) on processes occurring in reed-covered areas as well as the DANUBS_WQ model of nitrogen and phosphorous cycles. Based on spatial data, vegetation maps and the surveys effected on-site, the following results have been obtained for Babina and Cernovca using a standardized nitrogen retention rate expressed in gN/m²/day;

The total nitrogen retention on Babina and Cernovca polder islands amounts altogether 355.6 tons of nitrogen/year. The nitrogen is reduced by denitrification on a reed surface covering 2435.312 ha.

Tab 1.: Nutrient retention

Island polder	Reed type	Area (m²)	Standardized nitrogen retention gN/m²/day	Total Retention N Tons of N/year
BABINA	Reeds, sedges and bushes of grey sallow	32938		
	Reedbeds on salinized fluvial sediments	4802013		
	Reeds on acid organic soils or/and salinized soils	10875650		
	TOTAL BABINA	15710600	0.04	229.4
CERNOVCA	Rush reed, bulrush and sedges	4953890		
	Reeds on gley soils (river sediments)	3688632		
	TOTAL CERNOVCA	8642522	0.04	126.2
	Total retention area	**24353122**		**355.6**

Aquatic habitats:

Evolution of Phytoplankton Diversity

by Liliana Török

Results and discussions

The phytoplankton constitutes one of the most important groups of organisms of the aquatic ecosystem due to its capacity to generate oxygen and to convert inorganic nutrients and sunlight into vegetative matter. The freshwater food chains depend on their presence as a primary food source. It is essential for a monitoring program to conduct phytoplankton surveys to study water quality changes in a reconstructed area and to determine the efficiency of the reconstruction measures taken. Phytoplankton is the most significant biological indicator for water quality. Phytoplankton blooms may be a first sign for eutrophication.

The studies carried out in 1997, 1998 and 2003 show that the algae flora of the reconstructed Babina area comprises a total number of 251 species (Appendix 1) among which: 103 species of diatoms, 74 species of green algae, 29 species of blue-green, 9 species of Cryptophyta, 6 species of Chrysophyta, 23 species of Euglenophyta, 8 species of Dinophyta and 2 species of Xantophyta. Table 1 shows the distribution of the algae species number for the investigation period.

According to reference sources (Török 2001), the recorded diatoms in the reconstructed Babina area appear to have increased by 73 further species: *(Achnanthes clevei, delicatula, distincta, exigua, exilis, laevis, montana; Caloneis amphisbaena, bacillum, silicula, Cyclotella areolata, chaetoceras, distinguenda, stelligera, Cymbella affinis, asprea, minuta, Diploneis didyma, ovalis, interrupta, Entomoneis paludosa, Epithemia zebra, Fragilaria arcus, bidens, fasciculate, nanana, pulchella, Frustulia rhomboids, Gomphonema constrictum capitata, gracile, parvulum, ventricosum, Gyrosigma macrum, scalproides, Mastogloia brauni, Navicula cari, cincta, clementis, hasta, humerosa, oblonga, placentula, salinarum, subrhyncocephalla, veneta, cuspidate, halophila, hungarica, lanceolata, Neidium dubium, iridis, productum, Nitzschia constricta, pusilla, actinastroides, amphibia, angustata, aurarie, delicatula, fasciculate, fonticola, paleacea, triblionella var levidensis, vernicularis, Pinullaria gibba, subcapitata, Rhopalodia giberulla, Schelletonema costatum, subsalsum, Stauroneis anceps, Stenopterobia intermedia, Surirella brebisonii)*

The determination of the number of species occurring in a specific habitat is the easiest way to establish the ecological diversity. However, the Shannon-Weaver index allows to obtain a far more accurate evaluation of diversity. In 2003, the index values obtained in the reconstructed Babina area usually ranged between 2.3 and 3.7.

The abundance of the phytoplankton found shows that diatoms constitute a significant component of phytoplankton in the Danube Delta. They represented the predominant group of algae during the sampling period.

The analysis of the ecological status (Streble et al., 1982) of the recorded species revealed a predominance of meso-saprobous algae species (51.12%). We could, however, not finally conclude on the water quality class given that amongst the 251 species found only the saprobic indicator value is known for merely 53%.

For a more detailed evaluation the diatoms have been used as water quality indicators. This evaluation is based on the fact that all diatom species may indicate tolerance limits or optimum conditions and preferences as for their environment, including pH, salinity, oxygen requirements, organic pollution and nutrients.

In 1993, i.e. before the opening of the dykes, the analysis of the conditions leading to an increase in the number of the recorded species revealed that 64.43% of the species were either alkaliphilous - mainly occurring at pH > 7 values, or circumneutral - mainly occurring at pH values of about 7.

Tab. 2: Number of taxa

Species	1997	1998	2003	Total
Bacillariophyta	33	48	86	103
Chlorophyta	19	27	25	74
Cyanophyta	10	11	19	29
Cryptophyta	1	7	4	9
Chrysophyta	2	5	0	6
Euglenophyta	13	6	12	23
Dinophyta	4	2	4	8
Xantophyta	2	0	1	3

The highest abundance of common and relatively common species occurred in fresh brackish waters. 42.22% of the species were nitrogen-autotrophic taxa, tolerating increased concentrations of organically bound nitrogen. Oxygen requirements showed a very broad range and less than 50% (42.22%) were β-mesosaprobous. The assignment of the trophic state based on indicator values of the recorded taxa reveals very difficult because of high tolerances for trophic conditions (Török 2002)
In 1994, i.e. subsequent to the first reconstruction measures, no significant changes could be determined as for the species distribution in the ecological indicator classes.
During 1997-2003 there was no disturbance in pH, salinity and nitrogen uptake metabolism as compared to the situation recorded immediately after the opening of the dykes. Oxygen concentration requirements seem to have significantly increased in comparison to the previous situation. The species required moderate to fairly high dissolved oxygen concentrations.
The share of species preferring α- or β-mesosaprobus waters gradually decreased as from 2003, falling from 68.62% to 54.67%.
The same situation has been recorded for the share of eutraphentic species that decreased from 68.17% to 53.95%.

Conclusions

Based on the analysis of ecological indicator values we can establish that since 1997 the Babina area seems to have redressed the balance.
The natural evolution of the aquatic ecosystem reaches the mesotrophic stage.

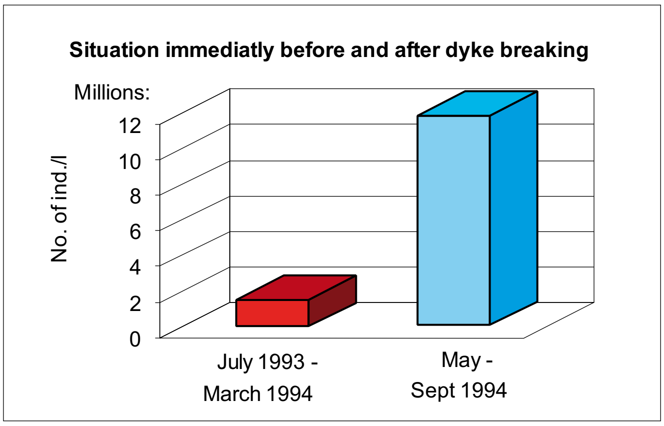


Fig. 28: Situation immediatly before and after dyke breaking

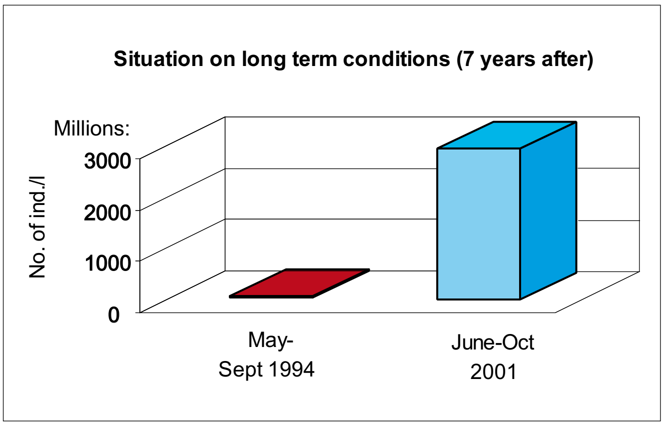


Fig. 29: Situation on long term conditions

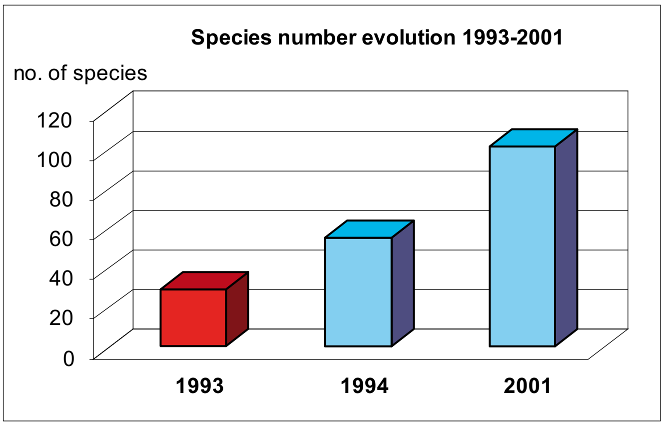


Fig. 30: Species number evolution

Evolution of Zooplankton Diversity

by Mihaela Tudor

Zooplankton is considered a good indicator of changes in water quality because the community is strongly influenced by and has a fast response to changes in environmental conditions (Gannon et. al., 1997). The community can be influenced by extreme spatial and temporal changes and a typical assemblage for all practical purposes cannot be adequately described. The species diversity is strongly dependent on the season. All samples from Babina were taken in the same month (June) every year between (1993–2001).
The number of taxa found during the study period varied from 9 (1993) when the polder was dry to 189 (2001), see Fig. 31.

A significant increase in the number of species took place after the flooding of the polder (1994), which became even more interesting over the last 4 years when the species number almost doubled every year from 24 species in 1998 to 189 species in 2001.

The lowest number of species was found in 1993 when the polder was dry. The dominant genus was *Brachionus spp*, represented by 6 taxa. After the flooding of the polder many indicator species of permanent waters occurred. The constant forms that occur every year are: Chydoridae (cladocera), Cyclopidae (copepoda) and Brachionidae (rotifera). All these families occur with a frequency of more than 50% in the years following the flooding.

The most abundant taxonomic groups recorded during the study were the rotifer species. The rotifer communities across all channels, lake and outlet was overwhelmingly dominated by *Brachionus spp*. (>50%, see Fig 32). These species are generally found in eutrophic waters (Berzins and Pejler, 1989). In terms of density, small herbivorous rotifers (e.g. *Keratella sp.* and *Aschomorpha sp.*)are the most abundant in the first year after flooding, these species being characteristic for eutrophic waters (Premazzi et al., 1992).

Between 1998 and 2001 the zooplankton community was dominated by large rotifers (e.g. *Asplachna sp.* and *Brachionus sp.*) living in permanent shallow waters with an abundant aquatic vegetation (Fig. 32). In 1998 eight families have been recorded and ever since the rotifer families occurred increasingly and constantly. In 2001 some 14 families preferring lakes with clear waters have been recorded.

In Babina polder, cladocerans from the families Chydoridae and Daphnidae contributed significantly to the zooplankton diversity . These families were represented by herbivore and predator species e.g. Polyphemidae, Leptodoridae (Fig. 33) living in open waters and assembled to the aquatic vegetation (*Nymphaea, Lemna, Ceratophyllum and filamentous algae*). These predator species are very important in the trophic chain, feeding on small size cladocerans (e.g. *Bosmina sp.*), some species of copepods and rotifers. These are in their turn preferred by predator fish species such as the pike (*Esox lucius*) (Fig 33).

The influence of vegetation on the distribution and density of these cladocerans families is higher in the years with abundant aquatic vegetation (1999–2001) e.g. *Myriophyllum, Ceratophyllum* (based on botanical observation).

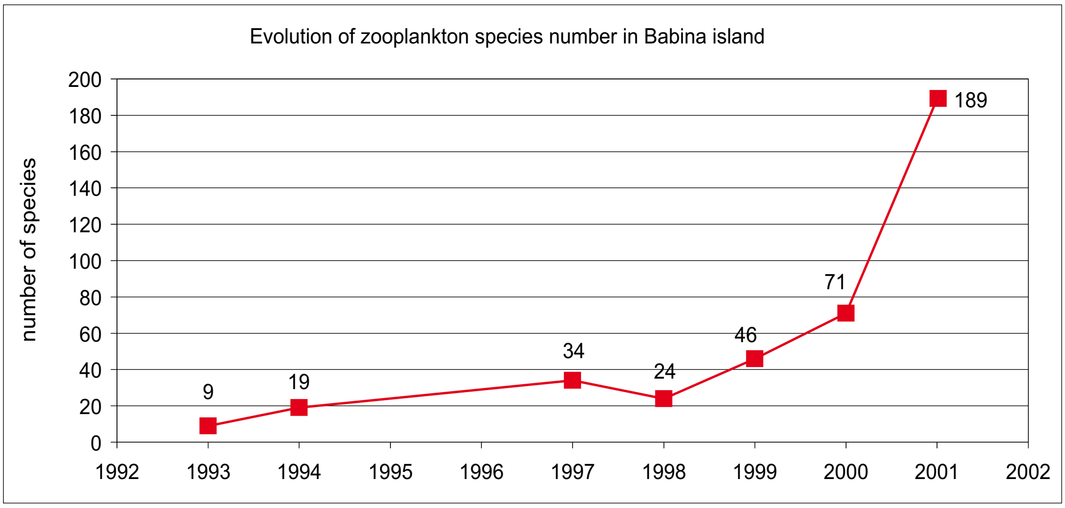


Fig. 31: Evolution of Zooplankton species number in Babina Island

Fig. 32: Frequency of rotifer families on Babina island

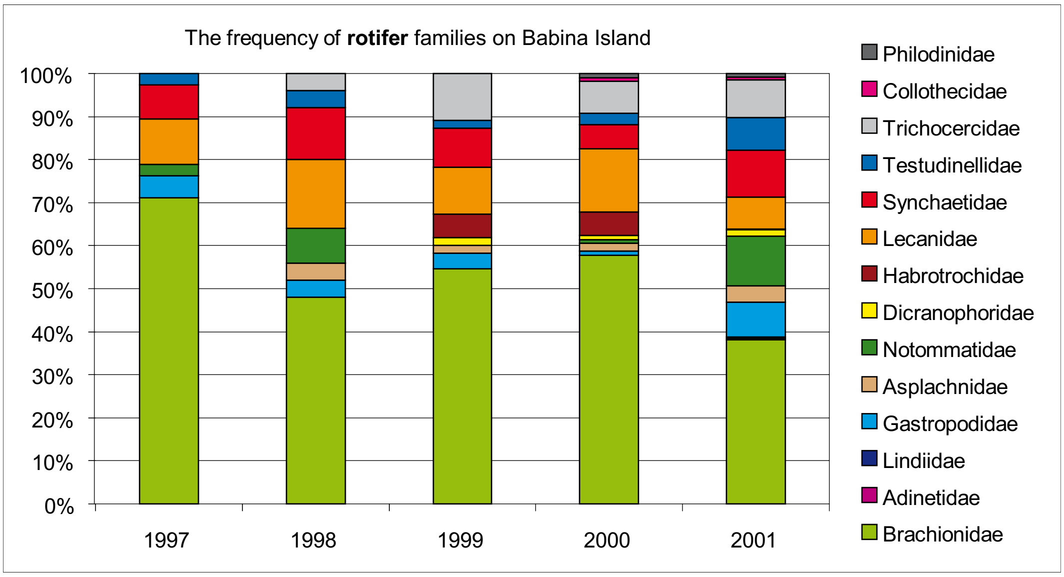


Fig. 33: Frequency of cladoceran families on Babina island

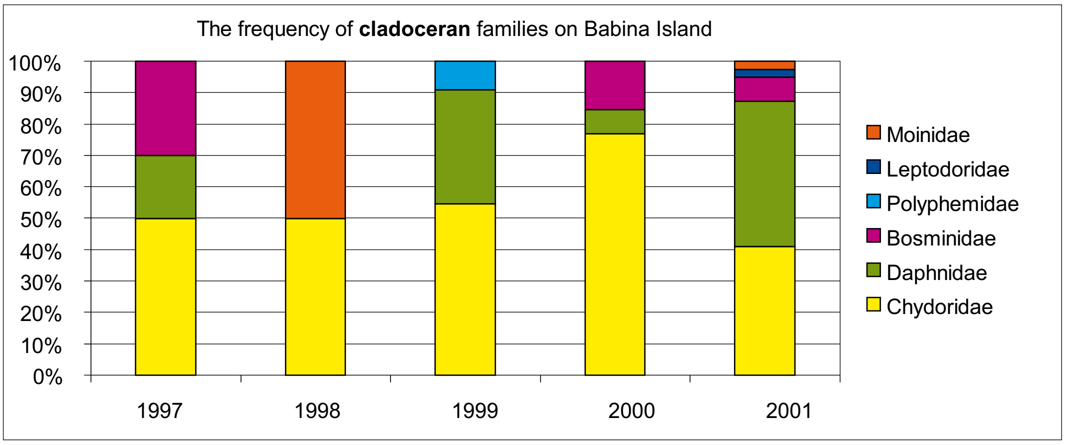
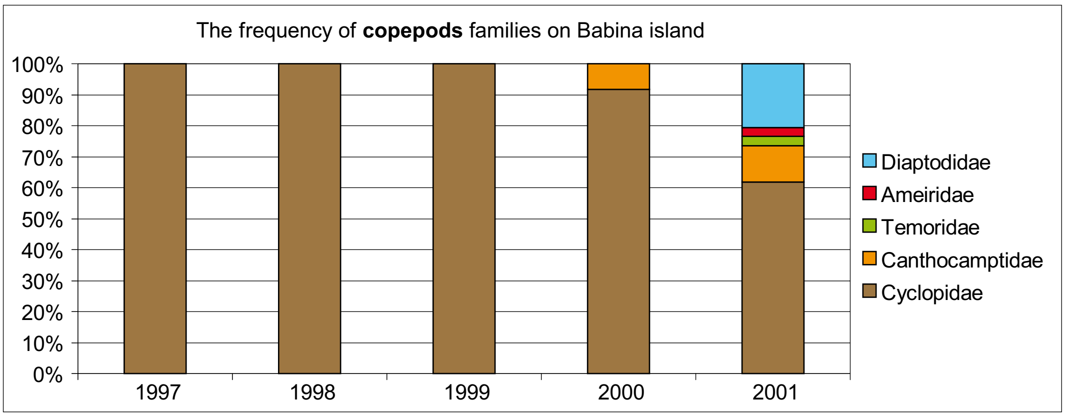


Fig. 34: Frequency of copepod families on Babina island



Three cladoceran genus (*Bosmina*, *Chydorus* and *Daphnia*) which account for a substantial proportion of total abundance (11 indiv./l mean values 1999-2001) are also indicators of clear water conditions similar to those encountered in the isolated lakes of the delta (e.g. Cuibul cu Lebede).

There is a high dominance of *Daphnia galeata* (48%) in 2001 in the shallow channels and Babina 'lake'. This species prefers clean waters with submerged vegetation and its dominance indicates an improvment of the water quality. This points out an evolution of the water quality in Babina towards the natural conditions that can be found in other parts of the delta. (fig 33)

After the flooding of Babina, Cyclopidae family occurred with a frequency of 100% but only juvenils life stages of Copepods.

In 1999 and 2001 Cyclopids are the most frequent (62%) comparing with the other families (Diaptomidae 20% and Harpacticoidae 5%, see Fig. 34). A peak in Copepods diversity was recorded in June 2001 overlapping the period of development of

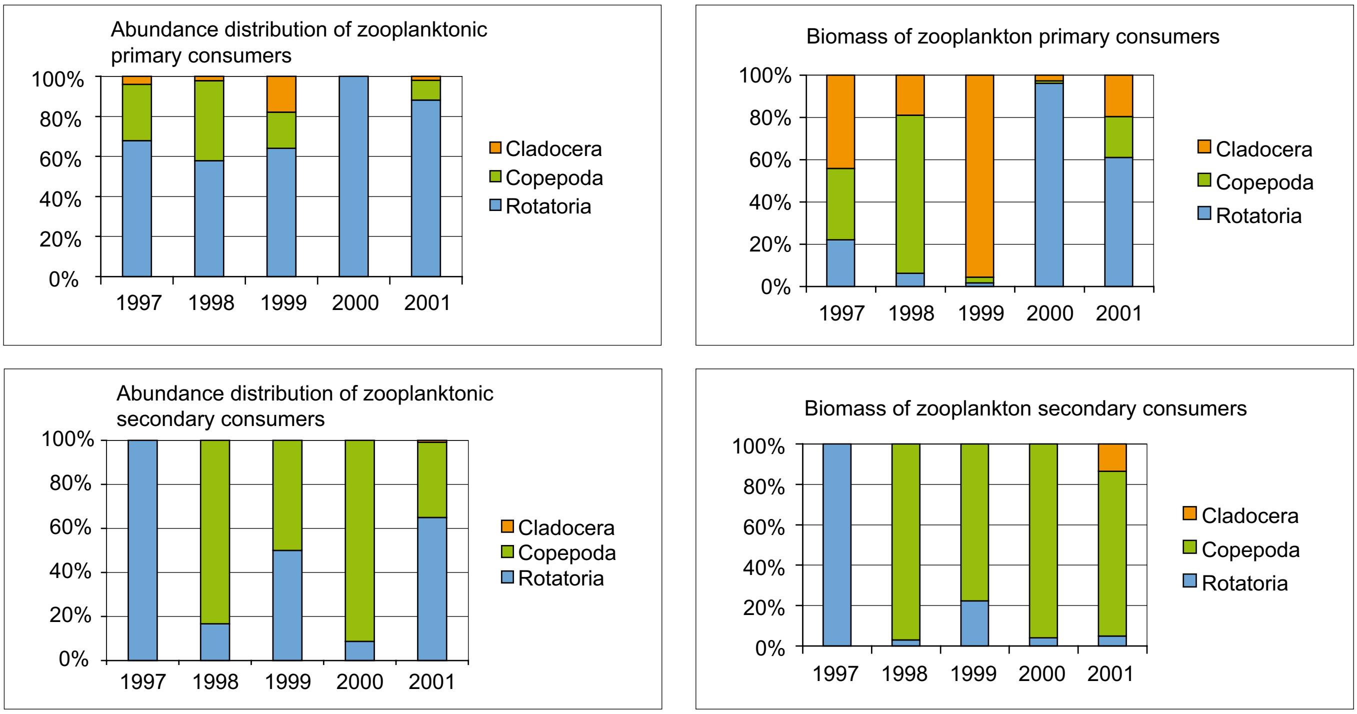


Fig. 35: Abundance and biomass of zooplankton

aquatic vegetation.
Rotifers and cladocerans as primary consumers (filtrators) dominate (60%) the functional structure of the zooplankton community while copepods (secondary consumers – predators) make up the rest.
The changes in community structure across the years (Fig. 35) are also reflected by a substantial increase in primary consumers (especially rotifers) that live in areas with abundant aquatic vegetation during in the summer. This situation is characteristic of moderately eutrophic waters.
The flooding of terrestrial ecosystems allows additional nutrients to enter the system. Following the flooding in 1994 the zooplankton community in Babina reached a peak of abundance (15703 ex./l) but diversity was low (19 species) according to yearly studies (contract de cercetare ştiinţifică nr. 18/1994). This is a particular situation, because in the following years abundance decreased and diversity increased (e.g. in 2001, 189 species were sharing an abundance of 2667 ex./l).

Dense vegetation and clear waters coincided with a low abundance of planktonic crustaceans during the day. Over the last years, high densities of Rotifera were found in channels and 'lake'. Planktonic crustaceans are dominant in shallow channels with oxygen saturation of more than 100%, dense vegetation and clear waters. However, these samples were dominated by plant-associated taxa that even during the summer were rarely found outside the vegetation.

Every year in June the highest frequency of Cladocera occurred in association with aquatic vegetation (e.g. *Ceratophyllum*) in shallow channels. *Chydorus sp.* accounted for about 75% of the total number of Cladocera. The Daphnidae family is the second most abundant cladoceran, makes up only about 15% of the total density.
In order to see the yearly differences in the zooplankton community we compared abundance and biomass in the five categories of permanent aquatic habitats (Fig. 36).

In 1997 at the island inlet (B1) rotifers accounted for 80% (240 indiv./l) of the total abundance but had a low biomass (58 µg/l). Data are lacking for 1998 and 1999. In 2000, within the group of plankton crustaceans, the most dominant as for abundance (60%) and biomass (97%) are the copepods. The community was almost exclusively represented by small rotifers in 2001 (e.g. *Brachionus sp.*, *Keratella sp.*).

In 1997 and 2000, in the deep channels the dominant species as for abundance and biomass were rotifers and copepods in 1998. In 1999 Cyclopida and Cladocera showed a high biomass (Cladocerans representing 82% of this biomass – 4096 µg/l) and rotifers were dominant as for their abundance (55% - 99 indiv./l). In 2000 rotifers reached a peak in abundance and biomass. The high abundance values of rotifers are maintained in 2001 too, but as for their biomass plankton crustaceans were dominant.

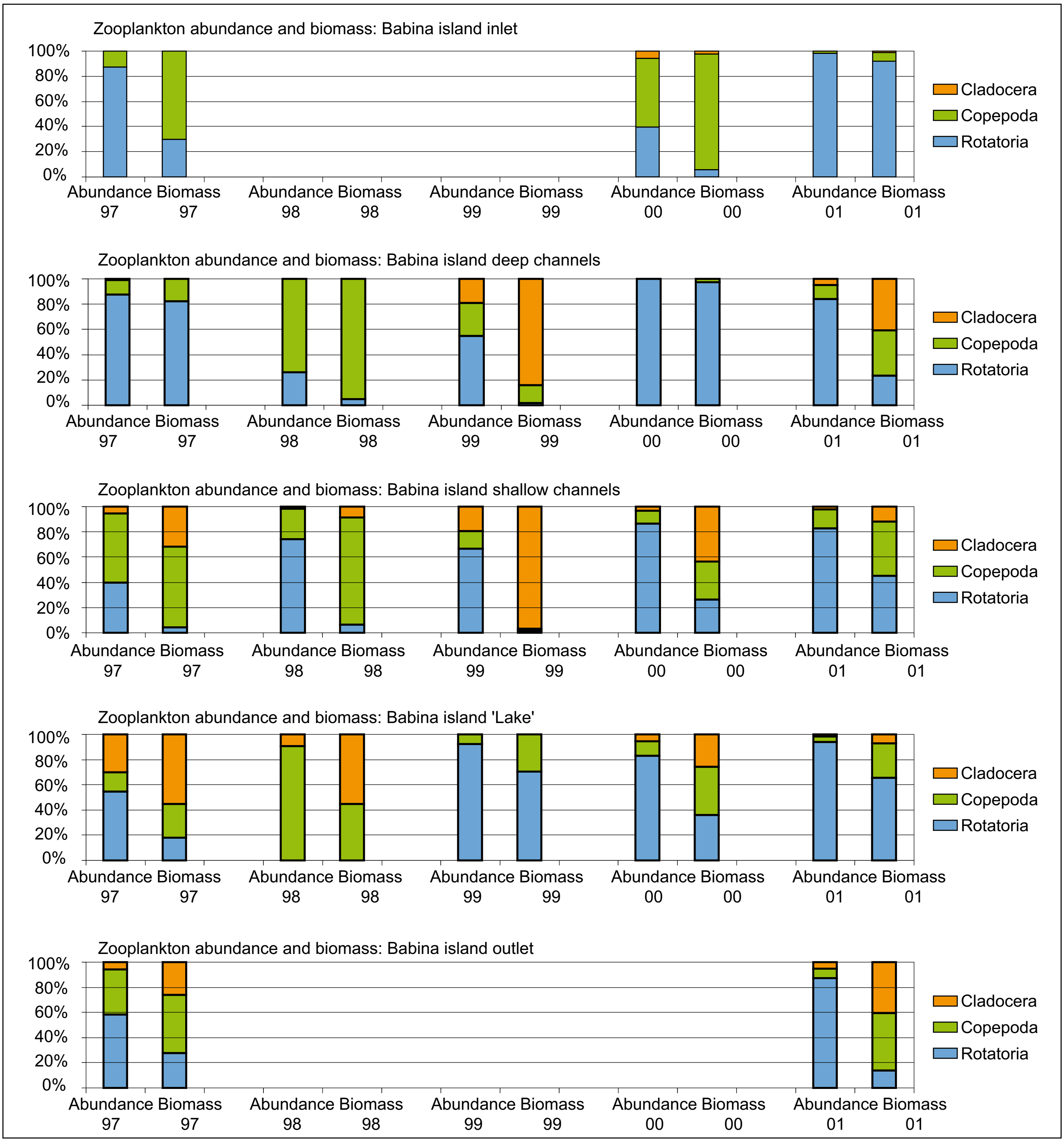


Fig. 36: Zooplankton abundance and biomass in different aquatic habitats

In shallow channels plankton crustaceans had the highest biomass values of all studied years. Cladocerans reached their maximum biomass in 1999 (6795 µg/l) due to a mass occurrence of *Bosmina longirostris, Chydorus sphaericus, Diaphanosoma brachiurum, Daphnia galeata*. Except for 1997 the rotifers are the most abundant group in these channels with two peaks in 2000 (99 indiv./l) and 2001 (118 indiv./l).

In the “lake” planktonic crustaceans have the highest abundance and biomass. They make a significant contribution to the biomass in 1997 and 2000 as well. Rotifers are abundant in all the years (>50%) except for 2000.

For the years 1998 to 2000, data are lacking for the outlet. The community structure of 1997 and 2001 is similar. Rotifers are dominant as for their abundance, plankton crustaceans as for their biomass.

They show a greater diversity as compared to the samples taken next to the inlet.
To find out to what extent the zooplankton species structure is similar or not to that of other, natural, lakes in the Danube Delta, we compared the results obtained in Babina 'lake' to those of the three natural lake types distinguished by OOSTERBERG et al, 2000, on the basis of hydrological connectivity and trophic status:
Type 1: lakes with an intermediate connectivity with the river, deep, turbid, sand-silt substrate and poor or lacking aquatic vegetation, dominance of phytoplankton;
Type 2: lakes with a high connectivity to the river, shallow, clay substrate, high transparency and abundant aquatic vegetation;
Type 3: isolated lakes, shallow, with organic-rich substrate, high transparency and abundant aquatic vegetation.

The three types of natural lakes are caracterized by the following zooplankton aspects:

The zooplankton community in lake type 1 was dominated by small rotifers (usually belonging to few genera), immature copepods and smaller populations of the cladoceran *Bosmina longirostris* and *Chydorus sphaericus*. These species prefer eutrophic, phytoplankton-abundant waters.
Lake type 2 is a clear lake with a highly abundant zooplankton community composed of a high species number with fewer individuals. Few species form abundant population. Rotifers are dominant, followed by cladocerans and immature copepods. Most of the species develop in areas with a dense aquatic vegetation.
Rotifers and cladocerans live assembled to the aquatic vegetation and predominate the zooplankton community in lake type 3 ("Cuibul cu lebede"). Their abundance is low compared to the other two lake types but the community is very diverse in Babina 'lake'.
Fig. 37 clearly shows that the zooplankton community of Babina 'lake' is composed by the same families and almost the same number of species as compared to Cuibul cu Lebede lake.
The most diverse family is that of the Brachionidae (7 species). This lake has organic-rich substrate, high transparency and abundant aquatic vegetation.

Conclusions

The reestablishment of the flood regime on Babina island induced an evolution process, starting from an early stage with huge density and low diversity (1994) to an equilibrium between number of species and density in summer (2001). This indicates that the water quality changed gradually towards a good status, approaching the natural conditions characteristic of clear water habitats, where the development of aquatic vegetation sustains a rich and abundant zooplankton community that provides an excellent food source to fish.

A significant increase in the number of species has been observed since the polder has been flooded. (Fig.31)

Cladocerans from the families Chydoridae and Daphniidae contributed significantly to the zooplankton diversity and were represented by herbivore and predator species, e.g. Polyphemidae, Leptodoridae. They live in open waters in proximity of aquatic vegetation (*Nymphaea, Lemna, Ceratophyllum* and filamentous algae). In 2001 the family Daphnidae is dominated by the species *Daphnia galeata* (48%) which prefers clean water with submerged vegetation and had been found in shallow channels and lake.

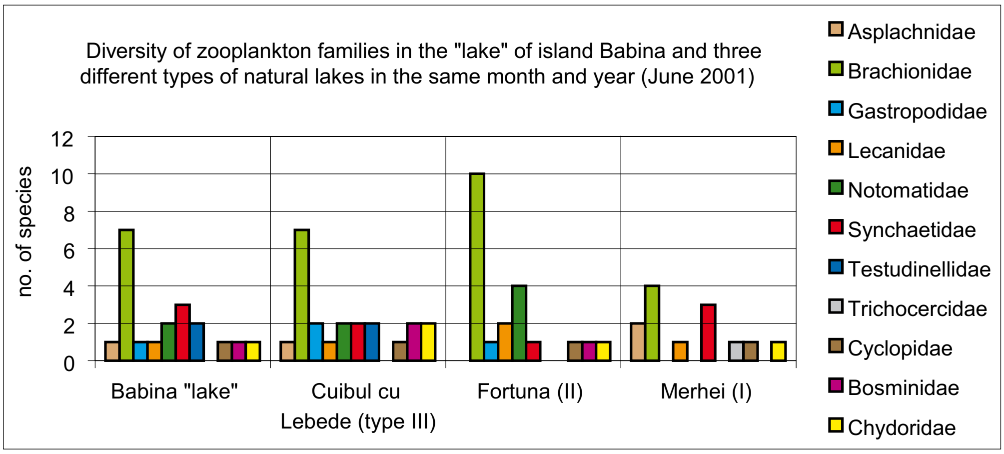


Fig. 37: Comparison between zooplankton families in Babina lake and other lake types.

Evolution of Macrozoobenthos

by Petr Obrdlik, Orieta Hulea & Orhan Ibram

For the waters of Babina island no limnological data that could be used for comparable studies are available, nor for the time of its pristine conditions nor for that of the existing polder. However, a six-year monitoring conducted after the opening allows both to make a summary evaluation of the development of the macrozoobenthos fauna and to give forecasts for further development trends.

Physical-chemical features

The parameters measured during the sampling serve as quality indicators of the former polder's surface waters. Water with high suspended loads spills from the Danube into the polder in two spots. The inflowing water is troubled, but as the distance to the inlet (Breşa) increases, transparency slowly grows.

The water flowing in through the opening (Breşa 1) flows north through the main channel CC1 and despite of a strong sedimentation (depth losses of channel CC1) transparency remains unchanged up to the crossing of the main channels CC1 with CC2/CC3. Here, the main water stream turns east (CC3) and turbidity decreases. In the secondary channels of the eastern part transparency grows up to 1 m. In the lakes cut off from the channels by the reed belt, the water body is transparent for its whole depth.

The emplacement of the northern opening (Breşa 4) is somewhat higher and dries out frequently. If water is flowing through, it will be connected to the circular channel carrying troubled water up to the eastern end of the island. If the water overflows at the northern opening, the troubled water comes up to the border of the reed belt (sampling spot B 10) and reaches sampling spot B 1 in the western part of the circular channel.

The waters situated west of main channel CC1 are clearer, transparency improves abruptly. In the main channel CC2 the transparency value amounted to between half and two thirds of the total depth of the water body. In the lateral channels transparency reaches up to the channel bottom (sampling point B 7). The temporary waters in the western part are very clear (sampling spots B 8 and B 9). This is illustrated by the presence of aquatic plant species that depend on clear waters such as ivy-leaved duckweed (*Lemna trisulca*), greater bladderwort (*Utricularia vulgaris*) and stonewort algae (Characeae).

If the water levels fluctuate the conditions described change only locally and are basically maintained. The distribution of transparency and electric conductivity are indicators for motion and stagnation of the water in the former polder. In this respect the western part with its lower water exchange reveals steadier as compared to the eastern part. An higher average electric conductivity also points to this fact (Tab. 3).

The temporary waters represent an exception to this. The small open waters in the rush reeds of the western part of the polder (sampling spot B 8) are subject to heavy evaporation. Moreover, they are situated in an area with salinization processes and thus show a high electric conductivity. However, in the temporary waters of the reed belt (sampling spot B 9), conductivity is among the lowest.

Tab 3: Electric conductivity at the sampling spots

Sampling spot	Electric conductivity	Sampling spot	Electric conductivity
Danube	420	B 5	410
B 1	960	B 11	420
B 2	770	B 4	440
B 3	460	B 8	1210
B 7	460	B 9	430

The lighting conditions of the permanent waters reveal to be favourable to the micro- and macrofauna as nutrient concentrations are high. These two factors are beneficial to a rich macrophyte development and to algae periphyton that is dependent on their substrate. The result is a high primary production (oxygen) and the production of plant biomass. The oxygen saturation of the Danube water does not fall below the 60 % limit. During the vegetation period, numerous permanent, oversaturated waters may be found on the island. The concentration in the main channels (sampling spot B 2) as well as in the lateral channels (sampling spot B 7) is of 7 to 14 mg/l O_2 on the surface for a saturation of 100 to 180 %. These waters are highly stratified. In a depth of one meter the values are halved, even lower layers are oxygen-poor or exempt of oxygen. The life of macrozoobenthos occurs during summer time in the upper layers up to a depth of 1.5 to

2 m. Comparable oxygen conditions may also be found in the western part of the circular channel (B1), which is completely covered with aquatic weeds in summer.

In the shallow lakes (sampling spots B 5 and B 11) and indentations of the channels (sampling spot B 3), the whole column of water is well supplied with oxygen respectively these waters are usually oversaturated. Given that even in the upper layers of the bottom oxygen conditions are good, bottom zoobenthos is more frequent in the lakes than in the deep channels. Extended open surfaces as well as low depth and wind allow a short circulation and whirling up of organic sediments, mostly of plant residuals. If these plant residuals enter the heated water column at the moment of increased temperatures, a rapid aerobic decomposition will take place and may lead to the complete consumption of the dissolved oxygen. This is why the lakes eutrophicate immediately. In summer 1999 this phenomenon, lethal for the macrofauna, could be observed on sampling spot B 11.

The sunny, temporary shallow water reaches (sampling spot B 8) are oversaturated and saturation sometimes exceeds 200 %. However, the shady, temporary water reaches in the reeds (sampling spot B 9) show low oxygen concentrations. Their oxygen regime is comparable to that of the oxygen-poor water flowing out of the reed and rush areas (sampling spot B 4)

Macrozoobenthos

The polder waters may basically be classified in two faunistic complexes. The first comprises the macrozoobenthos of the running waters, with a hard bottom substrate and lacking macrophytes. The second includes the phytobenthos of the stagnating, permanent and temporary waters.

The first group of the rheo- to limnophilous species is mainly determined by molluscs. The hard, loamy substrate next to the two inlets is densely populated by specimen of the snail species *Lithoglyphus naticoides* (up to 400 specimen/m²) assembled with Viviparus sp. and, in the case of existing willow root systems, even with Esperiana esperi. Moreover, there is the freshwater shrimp *Dikerogammarus villosus*, that bores itself into the loamy ground or hides under woody litter. The mussels *Unio pictorum, U. tumidus, Anodonta cygnea, A. anatina* and single specimen of *Pseudoanodonta complanata* and *Sinanodonta woodiana* occur in the muddy sediments of the openings. The latter also spreads in the lakes of the area. On the shells of the great mussel of the family of the Unionidae one may regularly find the zebra mussel (*Dreissena polymorpha*). This group of zoobenthos has not been analysed in greater detail as their habitat only covers a small share of the island's waters.

The second group – phytobenthos – is composed of the various, mainly limnophilous species of worms, snails, crustacea, water mites and aquatic insects. For taxonomic treatment a selection was made which is determined by the importance of the species in the studied ecosystems. Triclada, Hirudinea, Gastropoda, Araneae, Malacostraca, Ephemeroptera, Odonata, Heteroptera, Trichoptera, Lepidoptera, Diptera and Coleoptera species were studied and evaluated in greater detail, given that they constitute an important share of the food of benthopagous fish.

The circular canal – sections with standing water

The composition of the functional nutrition types reflects the conditions of eutrophicated, stagnating waters. The dominating species are shredders and detritus feeders (60 % in total), i. e. species consuming dead or living macrophyte tissue, as well as species combining this nutritional strategy with the scraping off and rasping of periphytuous algae (grazers) (Fig. 38). They are mainly represented by *Lymnaea stagnalis, Radix auricularia, Cloeon dipterum, Caenis robusta, Asellus aquaticus* and *Physella acuta*. The rich stands of herbivores support the high share of predators. Among these the most important are the larvae of the Coenagrionidae family and the aquatic bugs *Plea minutissima* and *Ilyocoris cimicoides*.

The zoobenthos of the permanent, standing water sections of the circular canal that are covered with aquatic weeds (sampling spot B 1) are treated separately because of their strong isolation and their inaccessibility for commercially significant fish species. The number of zoobenthos specimen fluctuates within a logarithmic order over the six studied years. In the years of low abundance, 1997 and 2001, the total zoobenthos fauna was almost completely composed of water insects (Fig. 39). The quantitative differences are mainly due to juvenile specimen of snails of the Lymneidae family and ephemera larvae of the *Caenis* genus. The abundance in the circular channel is higher on average as compared to the other permanent water types in the polder. One reason for this could be the lower fish number. The six year zoobenthos collection does not allow to anticipate a trend as for the formation and development of the zoobenthos. The fluctuations in abundance may be attributed to the climatic development before the sampling and to the hydrological conditions during and before the field studies conducted in the respective years.

The species composition is balanced.The total number of taxa fluctuated, except for 1997, between 21 and 25. Water insects dominate.

Permanent waters on the island (exclusive of the circular canal)

Similar to the circular canal, herbivore species and detritus feeders constitute the major part of the zoobenthos in macrophyte-abundant waters. Shredders and detritus feeders dominate and supply 1/3 to more than half of the fauna (Fig. 40). Together with the species that live on algae (group 3-mixed of the figure) they make up ¾ of the total fauna. Quantitatively speaking, Lymneidae (Lymnaea, Radix), Ephemeroptera (Cloeon, Caenis) and *Asellus aquaticus* are gaining ground. The third most important nutrition type is that of the predators, represented mainly by larvae of small dragonflies and water bugs. The situation is very similar to that in the circular canal.

The fluctuations of the specimen number of phytobenthos between the channels (sampling spots B 2, B 4, B 7), in their shallow indentations (sampling spot B 3) and in the lakes (sampling spots B 5, B 11) may be neglected (Fig. 41). Except for the year 1999, the share of aquatic insects is relatively high and steady. In that year the snails and *Asellus aquaticus* dominate the insects. On average the abundance is lower in these waters as compared to the circular canal.

The range of zoobenthos species in the island's channels and lakes is richer as compared to that of the circular channel. In all six investigation years water insects prevailed and were followed by Gas-

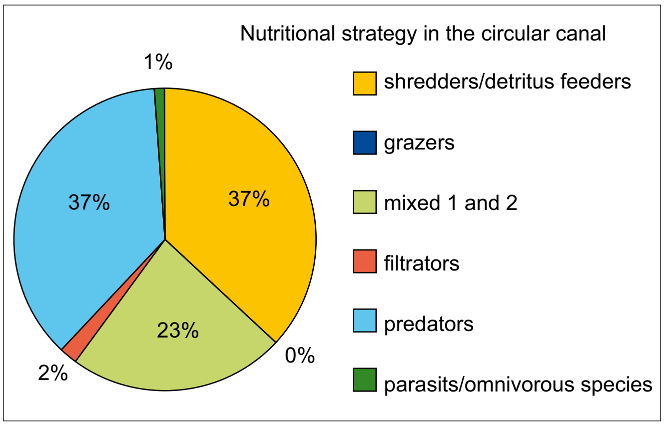


Fig. 38: Nutritional strategy in the circular canal

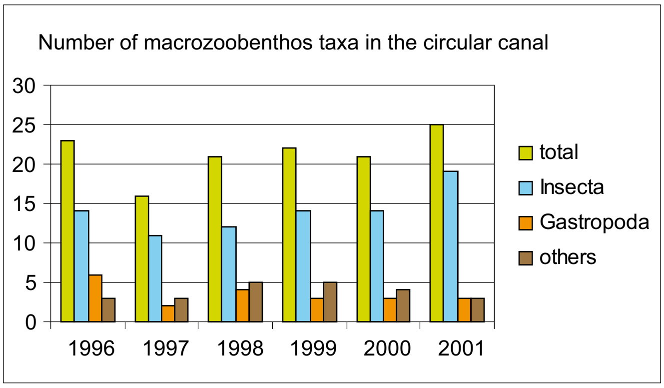


Fig. 39: Number of macrozoobenthos taxa in the circular canal

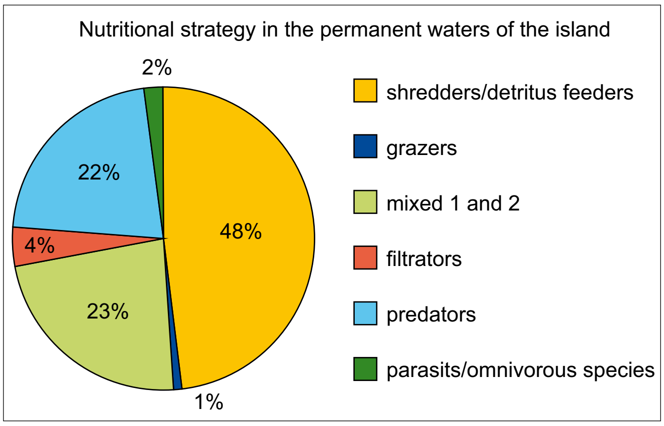


Fig. 40: Nutritional strategy in the permanent waters of the island

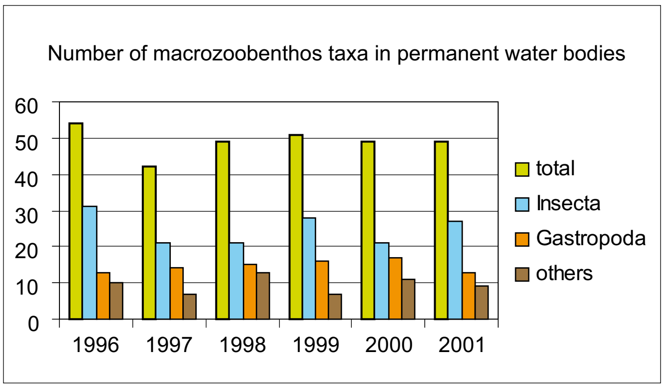


Fig. 41: Number of macrozoobenthos taxa in permanent water bodies

tropoda (Fig. 41). This is due to a higher microhabitat diversity. Differences do exist as for the macrozoobenthos' preference for fine- and coarse-leaved, submerged macrophytes and between the floating plant stands of different species. The reed stems along the channel fringes also show characteristic microhabitats.
The number of zoobenthos taxa in the main channel slowly increased between 1996 and 1999. The biggest share of insects in the total zoobenthos was recorded during the last two investigation years 2000 and 2001. (Fig. 42). The nymphs of big dragonflies prefer submerged reed stems. Viviparus also occurs on the same substrate in the island's standing waters.

The species composition in the secondary channels is comparable to that of the main channel (Fig. 43). This is where *Niphargus valachinus* appears frequently. The wind-sheltered water surfaces are often completely covered by water soldier (*Stratiotes aloides*) of the prevailing makrophyte species. The quantitative zoobenthos study of their rosettes conducted in the years 1998, 1999 and 2000 revealed the following results. The leaves of the rosette represent the motion and nutrition substrate for a characteristic biocenosis. An average of 473 zoobenthos specimen of the groups Triclada, Hirudinea, Gastropoda, Isopoda, Amphipoda and Insecta are living on a plant with a diameter of 40 cm (and a respective surface of 0.5 m²). Quantitatively decisive in this respect are crustacea (Malacostraca) and snails (Gastropoda) (Fig. 44). Steady but insignificant as for their abundance are rapacious leeches (Hirudinea). The abundance of the total zoobenthos on water soldier is underestimated, given that Oligochaeta have not been considered. On the rosettes, Malacostraca are mainly represented by *Niphargus vallachicus* and *Asellus aquaticus*. Gastropoda are represented by juvenile snails of the Planorbiidae and *Lymnea stagnalis* families.

The zoobenthos of the lakes is subject to more frequent and greater fluctuations as for the oxygen regime and lighting conditions. They eutrophicate during the vegetation period, which could be the explanation for the species-poor zoobenthos recorded in 1997 (Fig. 45). A comparable phenomenon could be observed in the island's other lake (B 11). In 1998 the only spot where species-abundant zoobenthos with dense *Sinanodonta woodiana* populations could be observed was on Babina island (except for the mouth areas of Breşa 1 and 2). During the 1999 field studies the lake eutrophicated, which led to massive Gastropoda kills. However, in the long term, the lake's zoobenthos number is comparable to that of the main and secondary channels.

Temporary waters

The fauna of the open, temporary ponds that are poorly populated with macrovegetation differs from the shady, temporary water reaches in the rush stands (Tab. 4). Whereas Gastropoda do prevail on the open sites (sampling spot B 8), the clear waters in the rushes are dominated by the water-louse. The open temporary waters also show

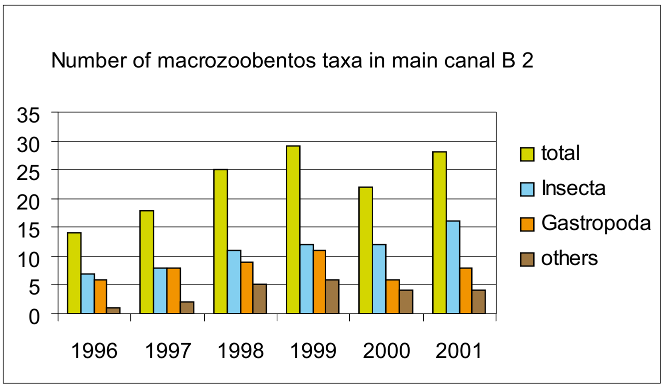


Fig. 42: Number of macrozoobenthos taxa in main canal B2

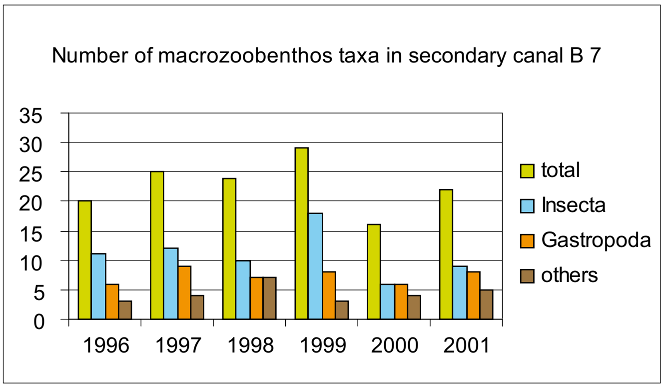


Fig. 43: Number of macrozoobenthos taxa in secondary canal B7

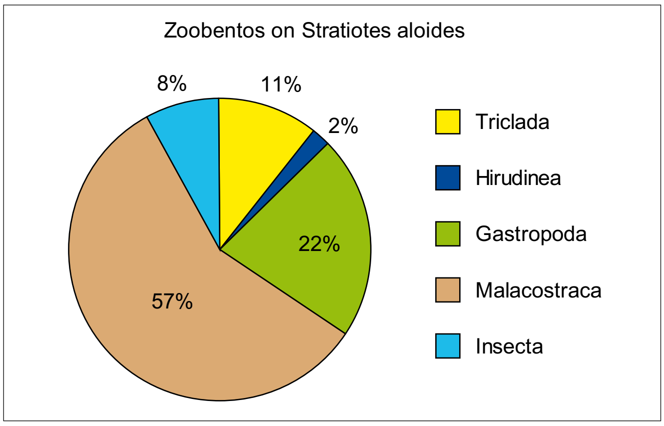


Fig. 44: Zoobenthos on *Stratiotes aloides*

a high abundance of the parasitic leech (*Hirudo medicinalis*). This is where it frequently encounters warm-blooded mammals, given that cattle and pigs are particularly fond of these sites as wallows.

The differences in the species' composition are due to the fact that the temporary waters of the rushes (sampling spot 9) persist longer as compared to the open and sunnier ponds that dry out more rapidly. This is why some Trichoptera larvae that could not complete their development in rapidly drying open ponds may e.g. be observed in the ponds of the rushes. These types of waters comprise the whole species inventory of the island.

Discussion

The zoobenthos fauna is dominated by phytophilous and mainly limnophilous species. The depressions (Gârla) represented on old maps and the pedological studies (Paun et al. 1994) lead to the assumption that the pristine fauna most probably comprised a higher share of rheo-limnophilous species. A comparable future development of the zoobenthos is not possible under present conditions. The polder is lacking morphological dynamics as erosion merely occurs immediately next to the openings. It has to be assumed that in former times huge water volumes flowed into the centre of Babina island. Indeed, this water also spread into the rushes by then, however, in the natural former river branches and smaller water courses that did not show the same uniform depth as do the artificial channels, manifold microhabitats could develop. This is why by then the pristine zoobenthos was richer in species.

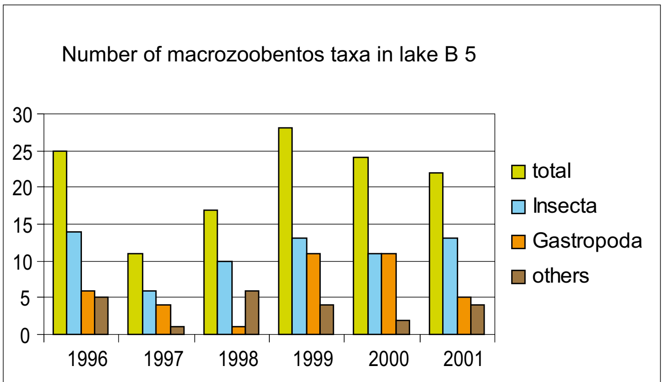


Fig. 45: Number of macrozoobenthos taxa in lake B5

Tab. 4:
Number of zoobentos specimens in temporary water bodies

	open temporary waters		closed temporary waters - B 28	
Year	**1998**	**1999**	**1998**	**1999**
Hirudinea	1	9		1
Gastropoda	322	102	48	26
Malacostraca	27	41	556	82
Ephemeroptera	2	3	72	5
Odonata		35	2	
Heteroptera	25	18	5	1
Trichoptera		1	6	2
Diptera	10	23	6	10
Coleoptera	14	11	2	1

The species composition of the Gastropoda - they constitute the firm and most significant zoobenthos share - reflects some of the most important characteristics as for the functioning of the rehabilitated wetlands of Babina island. The Gastropoda "traits" (Falkner et al., 2001) may be used for the evaluation of self-purification processes. The prevailing Gastropoda species live on dead macrophytes and thus contribute in the decomposition of plant biomass. They avoid a massive occurrence in the system and are thus also beneficial to aerobic conditions in the waters. The Gastropoda affinity for water trophic status is one more indicator for nutrient decomposition in the broad reed belts that may be subject to inundations. Something peculiar is the regular presence of "oligotrophic" Gastropoda in the outlet channel (sampling spot B 4) and in the shore area of the artificial canals, where the filtered water leaves the reed belt.

With the reconnection to the Danube River dynamics, the fish fauna of Babina island found its own level with 29 species (Navodaru & Staras, 2000). Among these, 21 species exclusively or mainly live on zoobenthos. A legitimate question is whether the zoobenthos of Babina island provides enough food for the fish and some aquatic birds. An exhaustive answer would require other sampling methods and a higher time expenditure. However, the results of the quantitative studies of the zoobenthos collected on the rosettes of the water soldier (Stratiotes aloides) allow a rough estimation. A water soldier floating in the water produces several layers in the water body. Its surface is thus comparable to multilayer stands of submerged macrophytes where only semi-quantitative collections did take place. One rosette with a diameter of 40 cm covers a surface of about 0.5 m², i.e. 1000 macrozoobenthos specimen occur on one square meter surface of floating and submerged macrophyte stands (floating leaf water plants such as pond and water lilies are almost always assembled to fine-leaved submerged species).

Such aquatic plant stands occur on Babina's main channels as 1-2 m and even wider littoral fringes. The lateral channels as well as the more or less large indentations along the channels are covered with macrophytes to almost 100 %. The situation of the great 'lakes' changes from year to year, but one may basically assume that the surface of the lake is covered up to 50 % by macrophytes.
If we keep in mind the total extent of the surfaces covered by aquatic plant stands in Babina it becomes clear that the zoobenthos of the permanent waters provides an enormous food potential.

Summary

The zoobenthos of Babina island has been studied within the frame of six summer field studies between 1996 and 2000.
The stagnating, permanent and macrophyte-rich waters are populated by a specimen- and species-abundant fauna. The predominating faunistic groups are Gastropoda, Isopoda and aquatic insects. The composition according to nutrition types confirms a well-operating interplay between macrophytes, macrozoobenthos and fish.

If the present hydrological conditions are maintained there will be no significant changes or infringements of the zoobenthos fauna in the short or medium term. In the long run, however, the insufficient water exchange in the water system of Babina will have indirect, negative effects on the macrozoobenthos.

Fig. 46: Sampling in a secondary canal dominated by Water Soldier (*Stratiotes aloides*)

Evolution of the ichthyofauna – Results of sampling and monitoring

by Ion Năvodaru, Mircea Staraş & Irina Cernişencu

Biodiversity of the ichthyofauna

According to the numbers obtained before the dyking of Babina island (Leonte-Teodorescu, Popescu & Leonte 1963), the ichthyofauna was composed of 13 mainly large and economically important species. During the existence of the polder, from 1985-1994, various specimen of gibel carp (*Carassius auratus gibelio*) and carp (*Cyprinus carpio*) were recorded in the main channels. After the re-flooding, 18 species have been recorded already between 1994 and 1996 (Marin & Schneider 1997). This number kept growing over the following years and the fish diversity of Babina island increased to 29 rheophilic and limnophilic fish species since the opening of the circular dam in 1994 (Tab. 5).
Considering both the limitations of the sampling methods used and the permanent connection to the Danube river dynamics, the number of fish occurring on the restored Babina island is probably even higher in the various seasons.

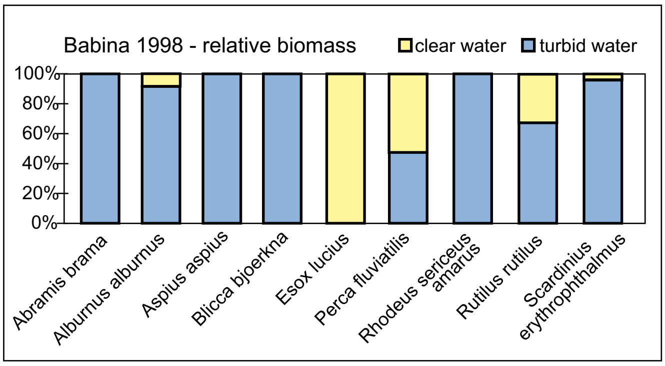


Fig. 47: Relative abundance according to ichthyofauna habitat types in the restored area of Babina island

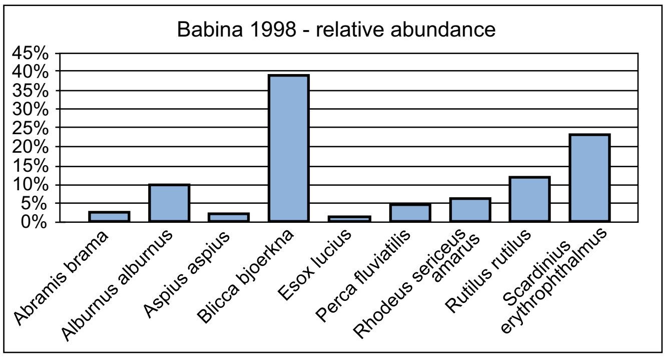


Fig. 48: Relative abundance of the ichthyofauna in the restored area of Babina island in 1998

Relative abundance of the ichthyofauna

The 1997 studies conducted by means of electrofishing (DEKA 7000) show a distinct numeric abundance of smaller species such as sunbleak (*Leucaspius delineatus*) and bitterling (*Rhodeus sericeus amarus*), as well as juvenile fish of rudd (*Scardinius erythrophthalmus*), perch (*Perca fluviatilis*) and pike (*Esox lucius*). As for the multi-mesh gillnets (6 to 75 mm bar mesh sizes) catches, the biomass structure was characterized by an equal domination of rudd and pike, followed by gibel carp (*Carassius auratus gibelio*) and perch (*Perca fluviatilis*) (Tab. 6).

The studies conducted with multi-mesh gillnets in 1998 prove that the ichthyofauna of Babina island is dominated as for its number by white bream (*Blicca bjoerkna*), followed by red eye, roach (*Rutilus rutilus*) and bleak (*Alburnus alburnus*) (Fig. 48).

In 1998, the greatest fish biomass consisted in rudd (*Scardinius erythrophthalmus*), followed by white bream (*Blicca björkna*), asp (*Aspius aspius*), perch (*Perca fluviatilis*), pike (*Esox lucius*) and roach (*Rutilus rutilus*).

The analysis of the relative biomass abundance in the two habitat types (channels with clear, standing waters and channels with turbid, slowly flowing water) shows that pike and perch prevail in clear waters. In turbid waters, however, the predominating species are white bream, bream, bitterling (*Rhodeus sericeus amarus*) and asp (*Aspius aspius*) (Fig. 49)

It may thus be concluded that the ichthyofauna of the restored polder Babina returned relatively rapidly and

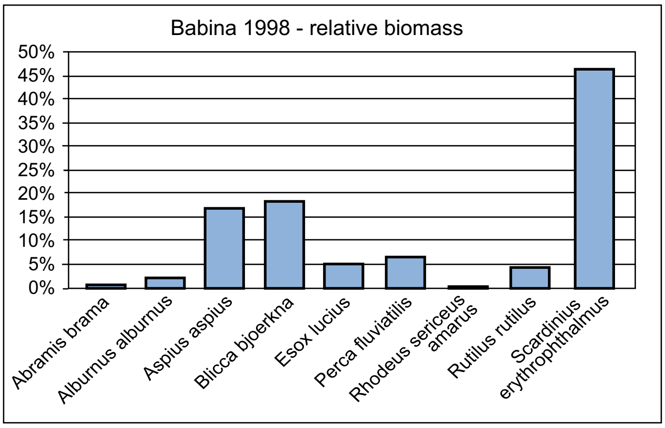


Fig. 49: Relative ichthyofauna biomass of Babina island in 1998

that it may be expected that both biodiversity and fish community structure will stabilize over the years to come. The following groups are to be expected:

- Indicator communities of eutrophic waters in the areas with stronger water circulation
- Indicator communities of mesotrophic waters in the more isolated areas
- Communities of rheophilic species in the feeding main channel's-community

Hydrological regime, water circulation and suspended load play the determining role in the development of the rehabilitated aquatic ecosystems and its fish communities.

Spawning grounds for fish

Fish have adapted to extremely varying spawning conditions. Given their specific reproduction characteristics and most of all their spawning habitat, they may be classified according to the following ecological groups: psamophilous, lithophilous, phytophilous, pelophilous and ostracophilous species.

The aquatic habitats of Babina island, with their floating leaf stands and submerged aquatic plants, offer ideal conditions for the reproduction of phytophilous species such as pike (*Esox lucius*), carp (*Cyprinus carpio*), rudd (*Scardinius erythrophthalmus*), roach (*Rutilus rutilus*), bream (*Abramis brama*) and white bream (*Blicca bjoerkna*) etc. The presence of mollusks provides the necessary spawning grounds e. g. for bitterling (*Rhodeus sericeus amarus*) (Tab.7).

Tab. 5: Evolution of fish diversity in the restored Babina island

• = presence

	Babina history					Sampling 1998					Ecology *		
Species	Leonte T.R et al., 1958	1985 - 1994	1994 - 1996	1997	Larvae 1997	Swedish gillnets	DeLury (gillnets + electric)	Migration (fykenets)	Larvae (fileua = 1mm)	Total 1994-1998	I (current): preference for specific water flow conditions	II (reproduction): preference of a specific spawning substrate	III (origin): Origin of the species
Abramis brama	•	dyked for agriculture	•	•	•	•				•	euritopic	phytophilous	native
Alburnus alburnus			•	•	•	•	•	•		•	rheophilous	phytophilous	native
Alosa caspia nordmanni			•							•	migratory	pelagophilous	native
Aspius aspius	•					•	•			•	rheophilous	phytophilous	native
Barbus barbus fluviatilis	•		•							•	rheophilous	lithophilous, psamophilous	native
Blicca bjoerkna	•		•	•	•	•	•	•	•	•	euritopic	phytophilous	native
Carassius carassius	•		•	•						•	limniphilous	phytophilous	native
Carassius auratus gibelio				•			•		•	•	euritopic	phytophilous	exotic
Cobitis sp.				•			•			•	rheophilous	psamophilous	native
Cyprinus carpio	•		•				•			•	euritopic	phytophilous	native
Esox lucius	•		•	•		•	•	•		•	euritopic	phytophilous	native
Gobius sp.								•		•	limniphilous		native
Gymnocephalus cernuus			•	•			•			•	euritopic	phytophilous	native
Hypophthalmichthys molitrix			•			•				•	euritopic	pelagophilous	exotic
Lepomis gibbosus			•	•			•			•	limniphilous	nests	exotic
Leucaspius delineatus				•	•		•		•	•	limniphilous	phytophilous	native
Leuciscus idus	•		•							•	rheophilous	phytophilous	native
Misgurnus fossilis				•						•	limniphilous	phytophilous	native
Perca fluviatilis	•		•	•	•	•	•	•		•	euritopic	phytophilous, lithophilous	native
Pomatoschistus caucasicus				•						•	limniphilous	ostracophilous	native
Protherorhinus marmoratus				•			•		•	•	euritopic		native
Pseudoraspora parva			•							•	limniphilous		exotic
Pungitius platygaster				•						•	limniphilous	nests	native
Rhodeus sericeus amarus				•	•	•	•	•	•	•	limniphilous	ostracophilous	native
Rutilus rutilus	•		•	•		•	•	•	•	•	euritopic	phytophilous	native
Scardinius erythrophthalmus	•		•	•	•	•	•		•	•	limniphilous	phytophilous	native
Silurus glanis	•		•	•						•	euritopic	phytophilous	native
Stizostedion lucioperca	•		•							•	euritopic	phytophilous	native
Tinca tinca				•		•				•	limniphilous	phytophilous	native
Total	13		18	20	7	11	15	7	7	29	** (acc. to Schiemer & Waidbacher 1992)*		

	Electrofishing				Fishing with gillnets					
Species		abundance		Species	abundance		Species	biomass	
		ex.	%		ex.	%		g	%
1	*L. delineatus*	2862	47.75	*S. eryth.*	907	67.39	*S. eryth.*	34009	36.94
2	*R.s. amarus*	1135	8.94	*R. rutilus*	183	13.70	*E. lucius*	32477	35.27
3	*S. eryth.*	890	14.85	*P. fluviatilis*	72	5.39	*C. a. gibelio*	16353	17.76
4	*P. fluviatilis*	524	8.75	*C. a. gibelio*	61	4.57	*P. fluviatilis*	4871	5.29
5	*E. lucius*	275	4.59	*E. lucius*	56	4.19	*R. rutilus*	2239	2.43
6	*R. rutilus*	94	1.57	*A. alburnus*	26	1.95	*T. tinca*	1314	1.43
7	*C.a. gibelio*	76	1.27	*B. bjoerkna*	23	1.72	*A. alburnus*	268	0.29
8	*B. bjoerkna*	71	1.18	*G. cernuus*	2	0.15	*S. glanis*	190	0.21
9	*L. gibbosus*	19	0.32	*L. gibbosus*	2	0.15	*B. bjoerkna*	162	0.18
10	*Cobitis sp.*	14	0.23	*T. tinca*	2	0.15	*L. gibbosus*	86	0.09
11	*P. marmoratus*	13	0.21	*C. carassius*	1	0.07	*C. carassius*	68	0.07
12	*P. platygaster*	11	0.18	*S. glanis*	1	0.07	*G. cernuus*	32	0.03
13	*S. glanis*	4	0.07	-	.	-	-	-	-
14	*G. cernuus*	3	0.05	-	.	-	-	-	-
15	*A. alburnus*	1	0.02	-	.	-	-	-	-
16	*M. fossilis*	1	0.02	-	.	.	-	-	-
	Total	5994	100.00	Total	1336	100.00	Total	92069	100.00

Tab. 6: Abundance and biomass of fishfauna in the restored area Babina in 1997 estimated by electrofishing and gillnets.

Given the proximity to the sea, the caspian shad (*Alosa caspia nordmanni*) also resides in this area for spawning (Tab. 5).

Juvenile fish specimen of less than 10 cm that were caught in nets with a small mesh-size (6-12 mm) represent a major share in the various fish samples. The share of juvenile fish thus fluctuates from 0.1% for bleak (*Alburnus alburnus*) to up to 40% for rudd (*Scardinius erythrophthalmus*) (Tab. 8)

It may be concluded from all this that the aquatic habitats that play an important ecological role as for the reproduction and nutrition of fish, especially for phytophilous species and species that spawn on mollusks, have been re-established on Babina island after its reconnection to the Danube river flood regime.

Usable potential of fish resources

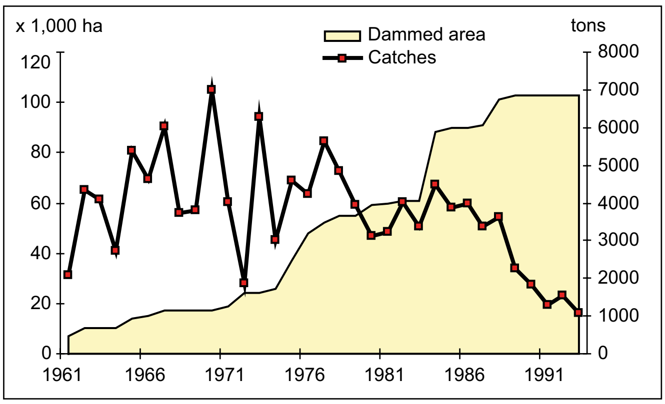


Fig. 50: Dynamics between dam construction and Cyprinid catches in the Danube-Delta (accord. to Staraş 1998)

For its major parts, fish farms as well as both agricultural and forestry polders were located in the flood areas that served as spawning, development and raising ground for juvenile Cyprinids.
The construction of dams in the Danube-Delta started in 1961 and reached its peak after 1970. This was when the regression of the Cyprinid populations has been observed (Fig. 50).

To determine the decline of fishery over the last 25 years, the dynamics of dam construction as compared to the volume of catches with economically significant Cyprinids has been analyzed.

The conclusions resulting from this showed that there is a close correlation between decreasing Cyprinid catches and growing polder areas, especially in the former reproduction areas.

For the period 1961-1973 a natural fluctuation of the volume of Cyprinid catches could be observed, given that the dyking of the 24,000 ha area passed off slowly and that its influence on the ichthyofauna was largely marginal. This was also in consequence of the fact that the areas dyked were relatively small (Fig. 50). However, the situation changed dramatically after 1973 with an intensified dynamics of the dyked areas and an increasing loss in reproduction areas which, after 1988, exceeded an area of 100,000 ha.

The analysis of the dependence between the volume of Cyprinid catches and the dyked areas shows

Tab. 7: Larvae and fry specimen occuring on Babina Island

	Sampling 1997				Sampling 1998			
		total length (mm)		Life stage		total length (mm)		Life stage
Species	ex.	mean	range		ex.	mean	range	
A. brama	5	22.4	22-24	fry				
A. alburnus	50	17.6	11-28	larvae, fry				
B. bjoerkna	24	15.9	11-24	larvae, fry	54	10.0	10-10	larvae
L. delineatus	361	17.1	8-41	larvae, fry	2			
P. caucasicus	1	17.0	17-17	fry				
R. s. amarus	81	16.2	10-28	larvae, fry	85	13.2	10-15	larvae, fry
R. rutilus	13	22.9	13-27	larvae, fry	9	13.9	11-16	larvae
S. eryth.	49	17.7	8-41	larvae, fry				
Total	589				150			

Tab. 8: Numerical abundance of juvenile fish (total length < 10), in the restored Babina area.

	1997	1998	total length (cm)	
Species	%	%	mean	range
A. brama		8.5	8.5	7.8 - 9.0
A. alburnus	0.17	8.5	8.1	7.3 - 9.0
B. bjoerkna	8.14	44.68	8.8	6.8 - 9.8
C. a. gibelio	0.85			
E. lucius	3.22	2.13	5.6	6.6 - 6.6
G. cernuus	0.34			
L. gibbosus	1.53			
P. fluviatilis	26.61	4.26	9.3	9.3 - 9.4
R. rutilus	19.15	12.77	9.1	8.5 - 9.8
S. eryth.	40.0	19.15	9.3	8.7 - 9.8

a negative correlation between both variables, which appears as a mathematical equation in the form of a simple linear regression (Staras 1998) (Fig 51).

The application of the linear relation between Cyprinid production and dyked area resulted in a fish production loss amounting 34 tons (34 kg/ha) for a dyked area with a surface of 1000 ha.

In the case of the restored polders Babina (2,100 ha) and Cernovca (1,580 ha), the economic benefit expressed in an increased volume of fish catches as a result of the re-flooding amounts 125 tons of

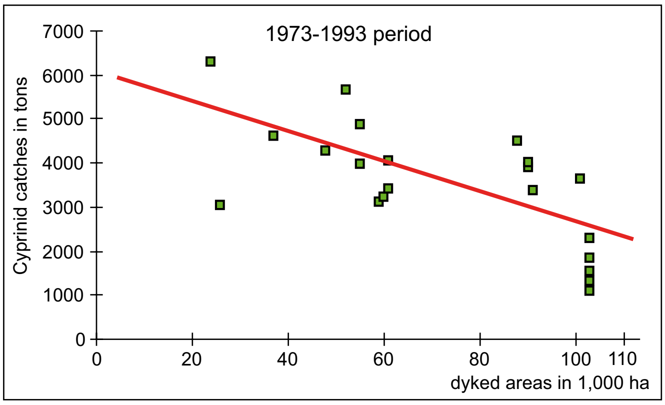


Fig. 51: Correlation between increased dyked areas and decreasing Cyprinid catches in the Danube-Delta between 1973-1993:
Y = 5966 - 34 X; r = 0.46 (P = 0.05), where
Y = Cyprinid catches in tons
X = dyked areas in thousands of ha.

usable fish resources for Cyprinids only.

Biomass evaluation (according to the De Lury method) has been realized by three successive catches in two channel sections that are cut-off, a first one with turbid water (0.1 ha) and a second one with clear water (0.05 ha). The catches obtained were C1, C2 and C3 (Tab. 9).

For both areas the calculation of the production was based on the regression equations of the successive catches (Fig. 52, 53).

The biomass for the two sample areas amounted to:

- B turbid water = 39.13 kg,
  respectively 391.3 kg / ha of the canal
- B clear water = 10.3 kg
  respectively 206 kg / ha of the canal

The average biomass value has been obtained by the section of the regressions in the cumulated cat-

Tab. 9: Results of successive catches in kg for the evaluation of biomass (DeLury method)

Babina	C1	C2	C3	Total
Canal east (clear waters)	4.255	3.252	0.890	8.397
Canal west (turbid waters)	11.218	7.444	6.040	24.702
Total	15.473	10.696	6.930	33.099

ches from the two different habitats (Fig. 54).

The evaluated biomass obtained in the cumulative catches of the two habitats amounts to:

B cumulated = 47.8 kg, respectively
318 kg/ha of the canal

It has to be noted that the fish biomass of the Babina polder canals has been evaluated where fish concentrations appeared to be extremely high for a given period. In the reed belts, however, with small, open lakes, the fish density is remarkably lower. This is why the results may not be extrapolated i. e. to the whole restored area.

Conclusions:

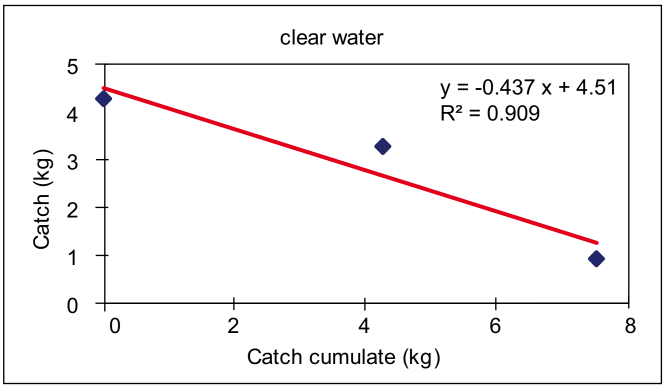


Fig. 52: Clear water habitat: regression of the successive catches

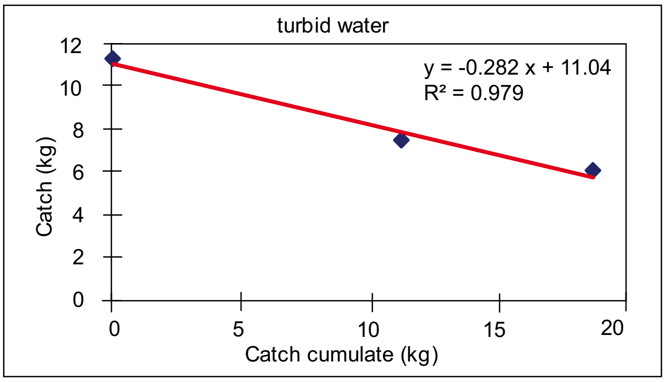


Fig. 53: Turbid water habitat: regression of the successive catches

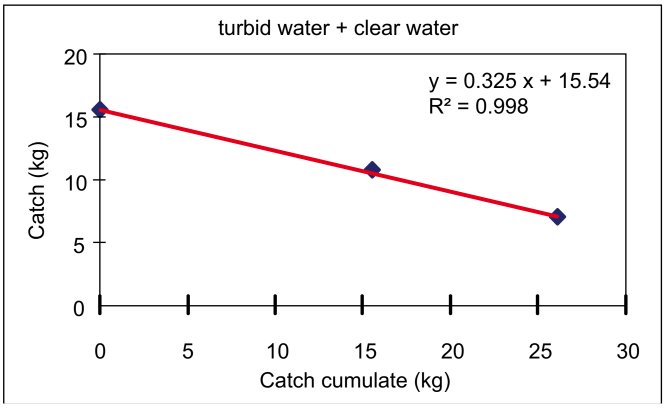


Fig. 54: Regression of the successive cumulated catches from the restored Babina polder

The economic benefit of the restoration of polder Babina island (2100 ha) has a socio-economic impact as for its fish resources

- More than 71.4 t/year of usable fish resources (more than 34 kg/ha)
- 10 jobs for fishermen (in addition to further jobs in the fish processing industry)

Ecological impact

- fish diversity (more than 29 species)
- as reproduction area for fish
- as feeding and raising ground for juvenile and adult fish
- as refuge area (for hibernation, under stress conditions)

The successful recolonization of the fish communities depends on the situation of the restoration area within the distribution area of the fish. It also depends on the fish presence in the neighbouring waters and the development of habitat quality. The Danube catchment area offers a diversified taxonomic spectrum of fish allowing the recolonization with fish species that occurred in the area before the implementation of the dyking measures, the fish community type depending on the habitat quality (Staraş & Năvodaru, 1995; Năvodaru et al., 1996, Năvodaru et al., 1998).

As for the populations' stability it can generally be stated that they are stable if size and age structure of the fish cover the life cycle of the most long-living species of the community (Trexler 1995). In Babina polder these conditions have been fulfilled more rapidly thanks to the eurytopic species arriving into the area from the Danube. This is why fishing can be practiced risklessly in the restored area, according to the basic principles of sustainable fishery. Ecological restoration can be considered as an economic alternative for the management of dyked and unprofitable or abandoned polders.

Water macrophytes and their communities

by ERIKA SCHNEIDER, MARIAN TUDOR & SILVIU COVALIOV

The development of water macrophyte associations in the opened Babina polder became clearly apparent already in 1995 with broad covers of Fringed Water Lily (*Nymphoides peltata*) in the northern area (near Breşa 4) as well as covers of Floating Salvinia (*Salvinia natans*), Giant Duckweed (*Spirodela polyrhiza*), Common Waterlens (*Lemna minor*) and some areas with covers of the European White Water Lily (*Nymphaea alba*). In the southern part next to the pumping station small stands of Frogbit (*Hydrocharis morsus ranae*) could be registered as well along the borders of small rushes consisting of the bulrush *Typha angustifolia*, water-archer (*Sagittaria sagittifolia*) and *Sparganium ramosum*.

The re-opened polder with its network of primary and secondary channels, reactivated flood channels and emerging lakes, offered colonization opportunities to a broad variety of water macrophyte communities. The major part of site-typical species and communities was already existent before 1997 (Tab. 10), even though some species did not record high abundance values. The Water chestnut (*Trapa natans*) e.g. developed bit by bit in the form of fringes along a number of canals as well as in the lake area (sampling spot B5). The Greater Bladderwort (*Utricularia vulgaris*) became apparent along the borders of the main canal CC2 from 1997, in those places where clear and filtered water drained from the reed stands.

In the subsequent year 1998 the Greater Bladderwort (*Utricularia vulgaris*) already showed higher abundance and dominance values (Tab.). In some lateral canals where the Water Soldier builds broad covers, the greater bladderwort occurred very frequently as well. The sporadic occurrence of *Aldrovanda vesiculosa*, a species which is comprised in Appendix II of the FFH-Directive, together with Greater Bladderwort in clear waters along the borders of a reed stand is remarkable (crossing of canals CC1 and CC2 (see Fig. 57).

The distribution of water macrophyte associations in both artificial main and lateral canals and in the area's lakes occurred as a function of:

- pH-values, the differentiation depending on water salinity
- nutrient content of the water
- suspended load and involved water transparency
- flow velocity
- water depth and involved water respectively channel bed warming
- subsoil (sandy, silty)

The following water macrophyte communities have been recorded in the area:

Tab. 10: Evolution of water macrophyte diversity in the restored polder Babina

	94	95	96	97	98	99	00	01	05
Aldrovanda vesiculosa						•			
Alisma lanceolatum		•		•					
Alisma plantago-aquatica		•	•	•			•	•	•
Azolla filiculoides		●	●	●	•	●			•
Ceratophyllum demersum		●	●	●	●	●	●	•	•
Chara contraria					●				
Chara globularis				•	●	●		•	
Chara vulgaris					•			•	
Elodea canadensis						●	•	•	•
Elodea nutalii					●	●	•	•	•
Hydrocharis morsus-ranae		●	●	•	•	●	●	●	●
Lemna minor	•	•	•	•	●	•	•	•	•
Lemna trisulca		•	•	•	•	●	•	•	•
Myriophyllum spicatum		•	●	●	●	●	•	•	•
Najas marina				●					•
Nuphar luteum									
Nymphaea alba		●	●	•	●	●	●	●	●
Nymphoides peltata		●	●		•	●			•
Polygonum amphibium	•	•	●	•	•	•	•	•	•
Potamogeton berchtoldii					•				
Potamogeton crispus	•	•	•	●	●	●	•	•	•
Potamogeton lucens		•	•	●	●	●	•	•	•
Potamogeton nodosus		•	•	•	●	•	•	•	•
Potamogeton pectinatus		•	•		•	●	•	•	•
Potamogeton perfoliatus				•					•
Potamogeton trichoides				•	●	●	●	•	•
Ranunculus circinatus			•		●	•	•	•	•
Ranunculus trichophyllus			●				•	•	
Sagittaria sagittifolia		•	•	●			•	●	●
Salvinia natans	●	●	●	●	●	●	●	●	●
Sparganium emersum				●	•	•	•	•	●
Spirodela polyrhiza		●	●	•	•	•	•	•	●
Stratiotes aloides		•	●	●	●	●	●	●	●
Trapa natans		•	•	●	●	●	●	●	●
Utricularia vulgaris				•	●	●	●	●	•
Veronica anagallis-aquatica		•	•		•	•	●	•	
Wolfia arrhiza		•			•	•			
Zannichellia palustris L. ssp. pedicellata		•	•	•	•	●	•	●	•

• presence / ● abundance

Duckweed communities (Lemnion minoris Tx 55)

These simply structured associations, i. e. in one or two layers, are composed of a floating carpet that may come along with a supplementary floating layer below the water surface. The latter comprised the Ivy-leaved Duckweed (*Lemna trisulca*) and occurred increasingly as from 1998 in the western part of the main canal CC2 and in parts of the lake (sampling spot B5). Moreover, an overlapping of duckweed covers with rooting water macrophyte stands, especially Hornwort associations (*Ceratophylletum demersi*), could be registered. The duckweed covers being free floating communities, they were usually subject to wash of the waves and drift caused by the wind. Besides the Common Duckweed (*Lemna minor*) and Giant Duckweed (*Spirodela polyrhiza*), Rootless duckweed (*Wolffia arrhiza*) could be registered in some spots.

- Giant Duckweed communities/Lemno-Spirodeletum polyrhizae (Kalkofer 15) W. Koch 54 em. Müll. et Görs 60
- Communities of Common Duckweed/Lemnetum minoris (Oberd. 57) Müller et Görs 60

Frogbit communities (Hydrocharition Rübel 33)

In the Babina area these associations are closely connected to the duckweed covers. Given the size of their species and the structure of their associations they are not drifted as much as duckweed associations. They developed in the area shortly after the opening. But only as from 1997 greater association-forming stands of Frogbit (*Hydrocharis morsus-ranae*) and Water Soldier (*Stratiotes aloides*) have been registered. Especially the Water Soldier covers broad, connected areas in lateral channels with still water characteristics. It also occurred along the Gârla that was cut in various sections at the moment of the polder construction. The group of Frogbit-associations is bound to clear, moderately nutrient-rich water sections. Floating Salvinia occurs predominantly and in some years (2005) it shapes the autumnal aspect of the canals and other waters that are covered for their major parts by this species.

Fig. 55: Water soldier community with Greater Bladderwort

The Atlantic azolla (*Azolla filiculoides*) occurs unsteadily. Given its tolerance against a moderate salinity in waters and soils it has been recorded mainly in the western part of Babina island, where soil salinization has indeed been reduced as a result of the reconnection to the Danube river, it is, however, still existent.

- Floating Salvinia-community/Spirodelo-Salvinietum natantis Slavnic 1956
- Frogbit-community/Hydrocharitetum morsus-ranae van Langendonck 1935
- Water Soldier-community/Stratiotetum aloidis Nowinski 1930 em.Midjian 1933
  - Facies with Greater Bladderwort / *Utricularia vulgaris*
- Greater Bladderwort/Lemno-Utricularietum vulgaris-community Soó (1928) 1938
- Atlantic Azolla-community/Lemno-Azolletum carolinianae Nedelcu 1964

Stonewort-Associations (Chara-globularis)

Among the Characea, *Chara globularis* has been registered in the western part of Babina at the end of canal CC2 as a species developing dominant stands. In some parts they were closely interlaced with stands of *Ranunculus circinatus*. In shallow waters they could also be found in loose stands of sea club-rush. Their characteristic sites have changed as a result of intensified cattle and pig grazing and the species disappeared as from 1998 even though it occurred in masses before.

Submerged Pondweed-communities (Potamion eurosibiricum Koch 26 p.p.)

The associations of this group developed and differentiated in the course of the years subsequent to the reconnection to the dynamics of the Danube River. They comprise a broad range of associations, reaching from those occurring in extremely eutrophic waters up to those with eutrophic-mesotrophic characteristics, from those occurring in habitats with clear waters up to those in turbid waters, in rapidly warming shallow waters up to deep and cool waters (deep main channels) (Tab.). They usually form a belt situated right in front of the reeds on the waterside. Moreover, they are frequently interlaced with Common Water Lily or Frogbit and Water Soldier communities or are overlaid by free floating covers, as e.g. the community of the Hornwort (*Ceratophyllum demersum*). Some species, among which e.g. the Pondweed (*Potamogeton pectinatus*), cover a broad ecological range. This species occurs both in stagnating and slowly running water sections and colonizes as well habitats with clear waters as those with a high sediment load. In the Babina area it occurs increasingly in the northern part of the circular canal and in the outlet area to the Chilia branch. It also occurs in shallow waters on the border of the main Danube Delta branches and right in front of the white willows respectively the reed belt on the waterside. *Potamogeton perfoliatus* present in the lake (sampling spot 5 and canal CP02), is a further species that occurs both in standing and in slowly running waters of the Delta. Among the more rare associations is that of *Potamogeton trichoides*, a species that is bound to deeper clear water areas. The Holly-leaf Naiad (*Najas marina*) is less widespread, over all the years it could only be registered in the lake (sampling spot 5).

An association prospering in waters with low salinity is the Pondweed (*Zannichellia palustris*) which, in the western part of Babina, occurs together with *Ranunculus circinatus*.

Altogether the communities are the following:

- Association of the Pondweed Potamogetonetum perfoliati W. Koch 1926 em. Pass. 1964.
- Pondweed association / Parvopotameto-Zannichellietum palustris (Baumann 1921)W. Koch 1926
  - Forms with *Ranunculus circinatus*
- Associations of the Pondweed Potamogetonetum lucentis Hueck 1931
- Fennel-leaved Pondweed-associations / Potamogetonetum pectinati Horvatic 1931
- Association of the Holly-leaf Naiad Potamogetono - Najadetum marinae (Oberd. 1957) Fukarek 1961
- Association of the Hornwort Ceratophylletum demersi (Soó 1927) Hild 1956
- *Elodea nutalii*-community
- Association of Small-leaved Pondweed Potamogetonetum trichoidis Freitag et al. 1956
- Association of the Pondweed Potamogetonetum crispi Soó 1927

Group of water Lily associations

The water lily associations (Nymphaeion) with floating leaves are fixed with their roots to the silty bottom of the water bodies. Larger covers of floating leaf plant associations, so e.g. Fringed Water Lily (*Nymphoides peltata*) and White Water Lily (*Nymphaea alba*), have already been registered one year after the opening.

They evolved over the following years and reached a relative constancy already by 1998. Differing associations may be found depending on the water depth. Fringed Water Lily carpets occur in shallow and rapidly warming waters and may even intrude creeping bent grass wetland meadows on dried-up

Fig. 56: Community of White Water Lily and Water Soldier

banks. White Water Lily carpets, however, have mainly been recorded in water sections with a water depth exceeding 1m. They cover broad surfaces in the area's lakes.
The Yellow Water Lily which frequently occurs in the floating leaf plant associations has not been recorded in the Babina area.

The alliance is composed of the following associations:

- Fringed Water Lily-community / Nymphoidetum peltatae (All.22) Bellot 1951
- Water Chestnut association / Trapetum natantis Müll. et Görs 1960
- community of Water lilies / Myriophyllo-Nupharetum W. Koch 1926
- community of the White Water Lily / Nymphaeetum albae
- community of the Water Milfoil / *Myriophyllum spicatum*

Fig. 57: Aquatic vegetation

Semiaquatic and terrestrial habitats:

Evolution of the characteristic wetland vegetation

by Erika Schneider & Silviu Covaliov

The evaluation of spatial data taken before and subsequent to the opening of Babina polder shows a distinct redevelopment of wetland characteristics in the opened polder. Given a higher elevation in the upstream area due to a natural levee, an incline may be observed from west to east as for the repartition of the plant communities. Whereas usable moderately moist to moist grassland develops in the elevated areas of the western section, the Eastern part is characterized almost exclusively by reed belts growing in constantly moist and water-covered areas.

Reeds

The badly growing reeds that were interspersed with disturbance indicators and even prospered during the period when the polder was cut off from the floods (see 1997 report) rapidly regenerated for the major part of their extension area. Already in 1994, i.e. in the year of the polder opening, they showed a luxuriant growth in some spots towards the end of the vegetation period. The reed stands grew even more densely in the subsequent year whereas ruderal species dramatically receded. Already in 1996 a rudimental redevelopment of floating reed vegetation could be observed in the central polder area. In an initial phase they mainly consisted of Water Soldier (*Stratiotes aloides*) and reed. In a overlying layer the reed stems took roots along the knots and enlaced the Water Soldier.

Whereas the broad reed areas showed a relatively high stability over the years, varying developments could however be observed in the border respectively the ecotone areas. Depending on water depth and dynamics, these stand out for the development of bulrush reeds, the reed *Scirpetum lacustris*, the Sea club-rushes *Sagittario-Sparganietum* emersi and *Glycerio-Sparganietum*, *Glyceria maxima* or reed canary grass. Reed mace (*Typha angustifolia*, *Typha latifolia*) and *Scirpus lacustris* as well as *Scirpus maritimus* achieved a great steadiness in areas with still ponds (western Babina area at the head of CC2 canal). As compared to these, *Sagittaria sagittifolia* and *Sparganium ramosum* occurred in both still ponds and running waters, *Glyceria maxima* and *Phalaris arundinacea* could, however, only be registered in running, dynamic sections near openings 2, 3, 4.

The reed associations (*Phragmition* W. Koch 1926) and sedges (*Magnocaricion* W. Koch 1926) listed in the following have been recorded in the Babina area. The latter could only be found on small spots in the reed border area. Their representatives are the Greater pond sedge (*Carex riparia*) in the southern area close to the pumping station as well as the Common Spikerush (*Eleocharis palustris*) community. In sections with running waters close to openings 2 and 3, one may also observe reed canary grass and arrow-head reeds.

Association group of *Schoenoplectus lacustris*- and *Typha*-communities:

- *Scirpetum lacustris* reeds Schmale 1939
- *Typhetum angustifoliae* Pign. Reeds 1953 (small-scale distribution)
- Great watergrass / *Glycerietum maximae* Hueck 1931 (small-scale distribution near dam openings)
- *Phragmitetum communis*-Reeds Schmale 1939 (extensive distribution in the whole area)

Association group of *Sparganium erectum* s. l.-Rushes:

- *Glycerio-Sparganietum*

Association group of halophilous reeds:

- Sea club-rushes / *Scirpetum maritimi* (Br.-Bl. 1931) Tx. 1937 (Tab.), different forms with *Rumex maritimus,* Creeping bent grass (*Agrostis stolonifera*), Greater Bladderwort (*Utricularia vulgaris*) or with Stonewort (*Chara globularis*)

Association group of *Butomus*-rich communities:

- Flowering rush reeds / *Butometum umbellati* (Konczak 1968) Phil. 1973
- Water-archer reeds / *Sagittario-Sparganietum* emersi Tx. 1953
- *Oenantho-Rorippetum* community Lohmeyer 1950

Sedge reeds:

- *Caricetum ripariae* rush Knapp et Stoffers 1962
- *Eleocharis palustris*-community Schennikov 1919
- Reed canary grass/*Phalaridetum arundinaceae* (W. Koch 1926 n.n.) Libbert 1931 (Oberdorfer et al. 1977, Sanda, Popescu & Barabaș 1998).

In consequence of the water level fluctuations in the center of the opened Babina polder, and even if these fluctuations occurred rather rarely, one could observe that associations of aquatic and terrestrial areas are interlaced. A close-knit relation could and may still be observed between Sea club-rushes (*Scirpus maritimus*) and Creeping bent grass stands (*Agrostis stolonifera*) which are closely interlaced thanks to the moistness of their habitat. A seesaw from moist to dry areas may be observed. This is why one may find forms of *Scirpus maritimus* with *Agrostis stolonifera*, but also *Agrostis stolonifera*-dominated stands comprising *Scirpus maritimus*. In some cases the stands of Sea club-rush occurring in very shallow waters of a few centimeter's depth also comprise a lower herbaceous layer which is due to its moist habitat. This layer consists of Stonewort *Chara globularis* (1998, Babina West, end of canal CC2). In 1998 an increasing occurrence of Water fennel (*Oenanthe aquatica*) and thread-leaved Water-crowfoot (*Ranunculus trichophyllus*) could be recorded in Sea club-rush depressions. The Greater Bladderwort (*Utricularia vulgaris*) has also been found in the lower herbaceous layer of Sea club-rush, provided that the site is characteristic of a shallow still pond for a major part of the vegetation period.

Besides the various forms of Sea club-rush (*Scirpetum maritimi*) that depend on flood moment, duration and height, flowering rush reeds (*Butometum umbellati*) are a distinct indicator for a beginning aggradation which emerged in the main canal CC1 near opening 1 and around opening 4 in the north.

Fig. 58: Reed communities in the southern part of Babina polder

Creeping bent grass (*Agrostis stolonifera*) occurring in the Sea club-rush border area shows distinct amphibian characteristics. This may lead to an intertwining of the Creeping bent grass stands of the terrestrial area with those of Water-lily (*Nymphoides peltata*) that are characteristic of shallow waters (canal CP4). Whereas Creeping bent grass (*Agrostis stolonifera*) stolons spread out up to the water surface borders and may even build a loose film and survive there for any length of time, the Fringed water-lily may thrive on dried up silty soils.
Due to the dynamics of the water levels, the shifting between dry and water-covered areas and vice-versa became mainly apparent in the western part of the island at the end of canal CC2, in the southern main canal CC1 and in the CS16 area. This is where a small-scale mosaic of various water macrophytes emerged in the ecotone area, the demarcations of which alternated from year to year. Among these plants are Frogbit (*Hydrocharis morsus ranae*), Floating Salvinia (*Salvinia natans*), Thread-leaved water crowfoot (*Ranunculus trichophyllus*), Small rushes with Sea club-rush (*Bolboschoenus maritimus*), Flowering rush (*Butomus umbellatus*), the rush *Schoenoplectus lacustris*, the bulrush *Typha angustifolia*, arrowhead (*Sagittaria sagittifolia*), *Sparganium ramosum* and moist turfs of Creeping bent grass (*Agrostis stolonifera*) as well as Quack grass (*Agropyron repens*).

In the western Babina area this mosaic is characterized by Fringed Water-lily stands (*Nymphoidetum peltatae*), Stonewort stands (*Charetum globularis*) which, however, do not develop every year, pondweed associations, sea club-rushes (*Scirpetum maritimi*) *Scirpetum lacustris* rushes and various pioneer surfaces with ephemeral species that may only develop in years with low water levels.

Characteristics and evaluation of reed production in the restauration area

In the areas of Babina and Cernovca islands the harvestable potential of the monodominant reed stands has been classified in three categories on the basis of biometric characteristics and substrate.

The vegetation maps of the Danube Delta provided the basis herefore (Hanganu et. al.). The three categories comprise reed stands on saline fluvial deposits (S-Fs), reed stands on acid organic and/or brackish soils (S-Pa) and reed stands on gleyey soils i.e. on fluvial deposits (SF):

Reed stands on saline fluvial deposits (S-Fs) with *Phragmites australis* reaching a cover ratio of 85% is characterized by Woody Nightshade (*Solanum dulcamara*), Peppermint (*Mentha arvensis*), Gipsywort (*Lycopus europaeus*), Marsh-bedstraw (*Galium palustre*), Spiked loosestrife (*Lythrum salicaria*), Marsh Woundwort (*Stachys palustris*) and Three-cleft Bur-marigold (*Bidens tripartita*). The medium density of the reed stands amount to 35 specimen/m², the medium height is of 3.5 m, the average stalk diameter of 0.9 cm and the medium biomass of 0.81 kg dm/m².

Reed stands on saline, organic soils (S-Pa) are characterized by a medium reed stalk density of 26 specimen/m², a medium height of 1.65 m and an average diameter of 0.8 cm. The total biomass is of 1.49 kg dm/m², the stalk share in the total biomass amounting to 65%.

Tab.11 Evaluation of the harvestable reed crop on Babina island (2004)

Type of reed stand	Reed stands on gley soils (fluvial sediments)	Reed stands on saline, organic soils
Symbol on vegetation map	S-Fs	S-Pa
Vegetation code	56	61
Surface	480.2 ha	1087.6 ha
Total harvestable surface	1567.8 ha	
Total harvestable crop	4306.8 t	
Height	3.5 m	1.65 m
Stalk diameter	1 mm	8 mm
Density (culms, stalks/m²)	35	26
Biomass of the green culms/stalks (according to moisture on site)	1.16 kg/m²	1.49 kg/m²
Biomass of the stalks (Dry material)	0.81 kg/m²	0.66 kg/m²
Harvestable potential (dry material, 65% of the stalk biomass)	0.53 kg/m²	0.43 kg/m²
Biomass related to standard moisture of 15% on delivery (dry material)	0.61 kg/m²	0.49 kg/m²
Medium harvestable potential (dry material)	0.5 kg/m²	
Real harvestable potential (-50%)	0.3 t/ha	
Harvestable potential on the total surface	2,7 t/ha	
* Variation from average la ± 20%		

Reed stands on gley soils (S-F) with *Phragmites australis* reach a cover ratio of 90%. The indicator species of these reed stands are *Cladium mariscus*, Water Mint (*Mentha aquatica*), *Scutellaria galericulata*, Marsh-bedstraw (*Galium palustre*).
The reed populations have a medium density of 57 specimen/m², a medium height of 3.8 m, an average diameter of 1.10 cm and a medium biomass of 1.66 kg dm/m². This reed type altogether has a total biomass of 92%, corresponding to 1.8 kg dm/m². The reed stalk share amounts to 72%, that of the leaves to 19 %.

It may be calculated from these figures that the medium productivity is of 2.7 t of reed/ha. The harvestable total reed amount is of 4306.8 t for a total reed surface of 1567.8 ha. (see Tab. 11)

It has to be considered that 60-75% of the reed stands on Babina island may not be harvested mechanically, given that the dried reed stalks of the previous year that have been sprained by the strong North wind and icing in winter are stuck between the new stalks and thus lower the quality of the harvested reed.

Grassland associations and their importance as pastures

As mentioned above, fluctuating water levels are the reason for a shifting towards moisture or dryness in the ecotone area around the oscillating shoreline: fringed water-lilies in a moist grassland association such as Creeping bent grass or vice-versa. Creeping bent grass on the water surface is thus no curiosity in the area.

For the grassland associations occurring one has to differentiate between moist and fresh grassland in the island polder as compared to dry areas existing along the dams. The latter, however, are not subject of our study. The grassland is more or less limited to the western part of the island with elevated areas, the area with the expanded natural levee called "Grind". The surface covered by grasslands is of altogether 780.5 ha inclusive of the dams and areas along the Danube riverbank.

Depending on the water levels and especially in the border areas of the grassland associations, rushes, mainly reed and sea club-rush, are used as pastures. These pastures expand over a surface of altogether 153.5 ha. The predominating species on these grasslands are mainly Creeping bent grass (*Agrostis stolonifera*), Creeping wheat (*Elymus repens*) or Dog's-tooth-grass (*Cynodon dactylon*), i. e. species that may rapidly expand vegetatively by means of stolons. This dispersal ability enables them also to cover dried up, open areas with their quickly growing runners after a flood.

Among the species mentioned above *Cynodon dactylon* is predominant and covers the broadest surfaces in the western part of the island. Both Dog's-tooth-grass (*Cynodon dactylon*) and some other companions such as Strawberry headed clover (*Trifolium fragiferum*), Narrowleaf bird's foot trefoil (*Lotus tenuis*), Marshmallow (*Althaea officinalis*) and the Lettuce (*Lactuca tatarica*) occur on sites with moderate salinity.

Besides the surfaces covered with dog's-tooth-grass, smaller surfaces are also colonized by extremely halophilous species. In pan-shaped depressions on silty saline soils, Reflexed Salt Marsh grass (*Puccinellia distans*) develops broad stands together with Sea Aster (*Aster tripolium*), the Orache *Atriplex tatarica, Spergularia salina* and *Suaeda maritima*. However, the saline surfaces reduced notedly after the reflooding of the area. The surfaces covered by halophilous vegetation reduce the quality of the pastures which is why it is merely of mediocre quality, the mean production of biomass being 8.4t/ha. The bearing capacity of the pastures is 0.61-0.80 animals/ha.

Creeping wheat (*Elymus repens*) is a characteristic species of alluvial meadow associations and occurs in broad stands even though not on a larger scale. It has also been recorded together with Creeping bent grass (*Agrostis stolonifera*). On sites similar to those of creeping wheat one may also find small-scale Reed Fescue (*Festuca arundinacea*) stands. Stands of this species could usually be found along the toe of the dyke in the southern part of the island next to the pumping station.

Creeping bent grass (*Agrostis stolonifera*) develops a dense grass cover in the transition zone of aquatic and terrestrial associations and shifts its limits, as described above, depending on the water levels. Altogether, the following grassland associations may be considered as being characteristic of the area:

- Creeping bent grass association / *Agrostidetum stoloniferae* (Ujv. 1941) Burduja et al. 1956
- Association of Creeping wheat / *Medicagini lupulinae-Agropyretum repentis* Popescu et al. 1980
- Reed fescue-community / *Festucetum arundinaceae* (Tx. 1937) Nordh. 1940
- Dog's-tooth-grass association / *Trifolio fragiferi-Cynodontetum* Br.-Bl. Et Bolos 1958
- reflexed salt marsh grass association / *Puccinellietum distantis* Soó 1937

In some places the relatively small pastures that are concentrated in the western part of the island are excessively exploitated and ruderalized as a result of grazing (horses, cattle, pigs, sheep) and of too many animals grazing in a relatively small area.

The same is true more or less for the secondary dam meadows, where Musk thistle (*Carduus nutans*) and Cotton thistle (*Onopordon acanthium*) expanded dramatically.

Pioneer associations

The reconnection to the dynamics of the Danube River went along with a re-deposition of substrate and the erosion and aggradation of sand and silt banks. These aggradations mainly occurred next to opening 1 in the south and about up to the crossing of the main canal CC1 with CC2. In this process

Fig. 59: Pioneer settlment of annual species on new emerged sediments (near opening/breşa 4)

Tab. 12: Habitat development during polder situation and after reconnection to the river dynamics

Before opening	After reconnection
Large areas with halophilous plant species, their communities and characteristic macroinvertebrates in the upstream area of the polder	Small areas with halophilous plants and their characteristic macroinvertebrate diversity in the upstream area of the polder
-	Temporarily flooded meadows
Dry meadows along the dams	Dry meadows along the dams
-	Pioneer vegetation on newly emerged sediment banks
-	Gallery-like softwood white willow stands and tamarisk bushes of various ages
Disturbed reed beds with weeds	Well developed reed beds
Poorly developed and species-poor communities of aquatic macrophytes in the artificial channels	Well developed communities of aquatic macrophytes, rich in species, in the newly emerged lakes and in the channels
Channels of various dimensions (main and secondary)	Channels of various dimensions (main and secondary)
-	Revitalized natural channels ("Gârla") with characteristic vegetation
-	Lakes
-	Temporary, standing waters
-	Temporary flood channels

the material raised at the moment of the canal construction was eroded and aggradated in another place. Moreover, aggradations with broad protosoil areas emerged around opening 4 in the northern part of the area. Fresh aggradations offered colonization opportunities for a number of ephemeral pioneer species such as *Chenopodium rubrum, Gnaphalium uliginosum, Pycreus flavescens, Juncus bufonius* and others. Moreover, shortly after the opening of the polder, the seeds of white willow and tamarisk emerged along the drift line. Young white willow galleries and tamarisk bushes developed from these along canal CC1. Similar developments could be registered in the north next to opening 4. Tamarisk and White Willow dispersed here as well.

Conclusions on the development of vegetation

While considering the whole dynamics of vegetation, fluctuations and altered surface ratios for several plant associations had to be registered, as mentioned before, in the ecotone area (mainly toe of dyke/inner polder border). The most dramatic shiftings and chronology of plant associations took however place around the inlets of opening 1 in the southern and opening 4 in the northern area, whereas the associations in the islands center, mainly reeds and less reed mace rushes, already achieved a high stability as for their structure and species composition after the first two or three years.

The changes that occurred around openings 1 and 4 mainly resulted from the Danube‘s sediment input and implied the formation of levees, „Grinduri“ which were raised as a result of the Danube River‘s floods and aggradations. However, given the openings' size, the aggradations occurred more or less punctually respectively on a smaller scale than would haven been the case for a natural island without circular dams.

In these dynamic areas a shifting from aquatic to swampy and finally terrestrial associations could be registered in the course of the years. These associations distinctly support these development processes. The emerging habitats may only develop under dynamic conditions and progress even further thanks to this dynamics.

Besides the development of macrohabitats, the vegetation that differentiated in the course of the years also provided the basis for a differentation of microhabitats. In their turn, these provided the possibilities to occupy a niche for a large diversity of various macro- and microorganisms, both in the terrestrial and in the semi-aquatic and aquatic areas.

Inventory and development of the epigeic Macroarthropod fauna

by Eckbert Schneider

The damming and drainage of the polder areas in the 1980ies had dramatic impacts on the epigeic invertebrate fauna. Given that the hydro-technical measures mainly affected the original wetland habitats, the result was a sharp decrease of the characteristic semi-aquatic and terrestrial fauna of both the floodplain areas and their fringe zones.

The opening of the dyke in 1994 did thus also take effect on the faunistic-taxonomic and ecological composition of the invertebrate fauna. It may be assumed that after the opening of the dyke and the renewed water logging, ecological conditions that correspond to the original conditions of the time before the construction of the dam have been reached. Especially the strongly expanding hygrophile species could rapidly resettle their original areas.

Results of Barber trap investigations Taxonomic biodiversity

The inventory of the epigeic arthropode communities obtained by means of Barber trap catches documents a very high population density and activity-density on the experimental plots. The high total abundance reflects a significant secondary production in the studied habitats. This illustrates the fact that sufficiently moist habitats situated in proximity of the banks or the groundwater show the highest population density.

Macroarthropods

The macro-arthropodes contained in the Barber trap catches belong to the following animal classes: arachnids (Araneae), harvestmen (Opiliones), isopods (Isopoda), Diplopoda, centipedes (Chilopoda) and most of all numerous insect orders.

The inventory drawn between 1996 and 2001 shows that the composition of the epigeic arthropode stands is subject to dramatic fluctuations (Fig. 60-64). The shifting of predominance ratios may be ascribed to concrete conditions of time and space in the investigation spots at the moment of the sampling and before. The most decisive

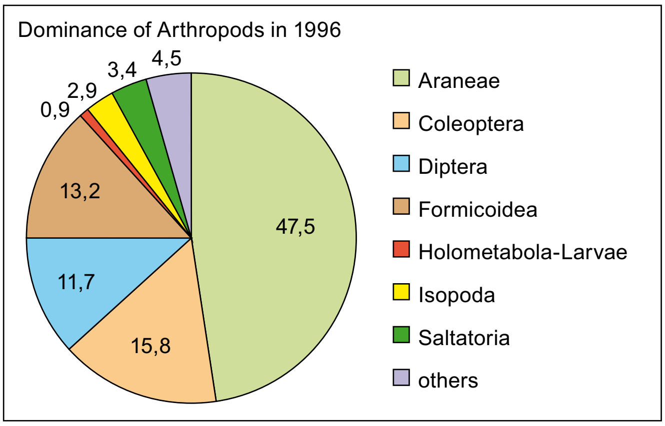


Fig. 60: Dominance of Arthropods in 1996 (Total catch: 5254 ex.)

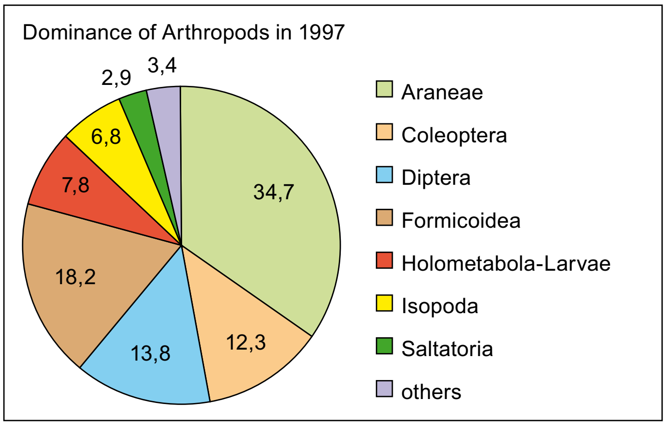


Fig. 61: Dominance of Arthropods in 1997 (Total catch: 6741 ex.)

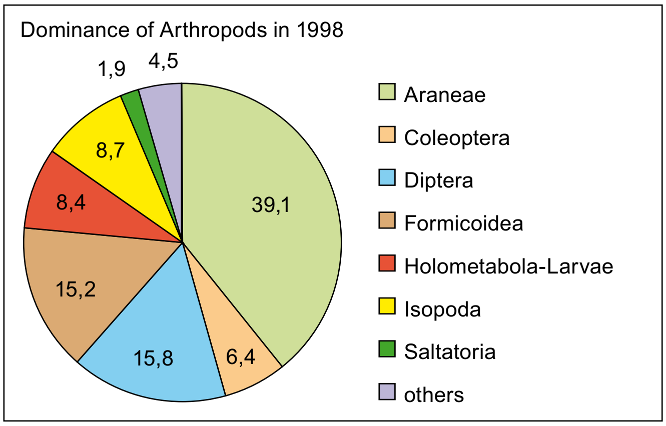


Fig. 62: Dominance of Arthropods in 1998 (Total catch: 10275 ex.)

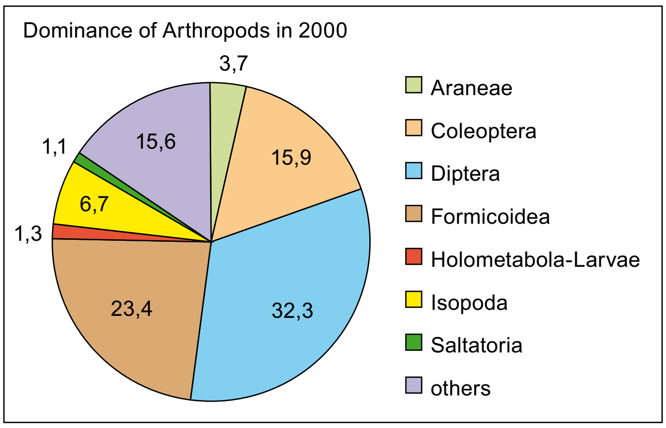


Fig. 63: Dominance of Arthropods in 2000 (Total catch: 11320 ex.)

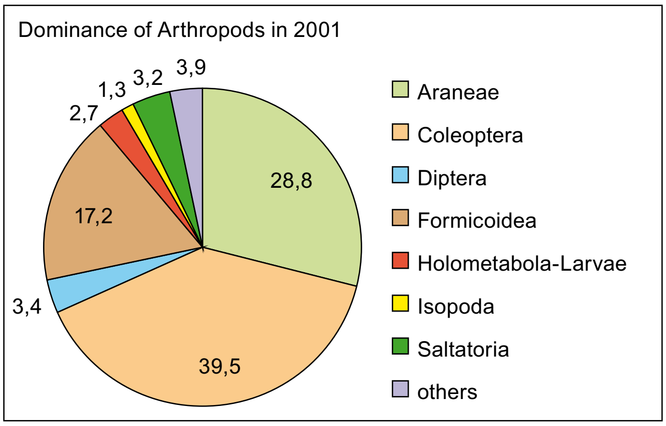


Fig. 64: Dominance of Arthropods in 2001 (Total catch: 3039 ex.)

elements in this respect are moisture, air and soil temperature as well as insolation. The predominant arthropods are mainly Araneae, beetles (Coleoptera), ants (Formicoidea) and flies (Diptera). The Araneae are a very mobile and expanding group of animals and achieve the highest predominance values in most of the catches (29-48%, exception in 2000). The beetles are the most species-abundant group of animals studied and are also predominant as for their number (up to 40%). Ecologically speaking, the zoophagous ants (Formicoidea) are of crucial importance as controlling element for phytophagous populations, with a constant predominant participation as for soil activity (13-23%).

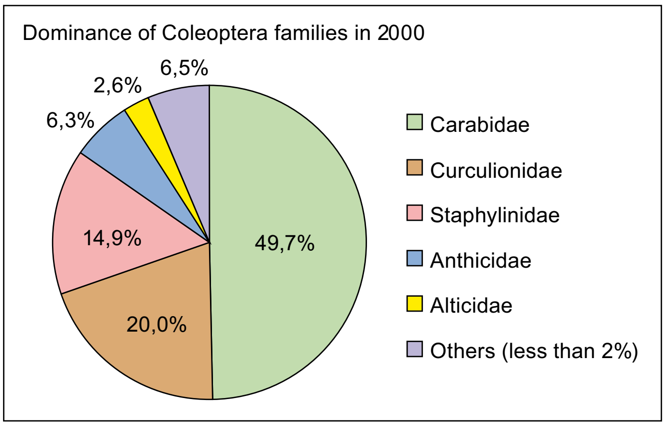


Fig. 65: Dominance of Coleoptera in 2000 (Total catch: 1797 ex.)

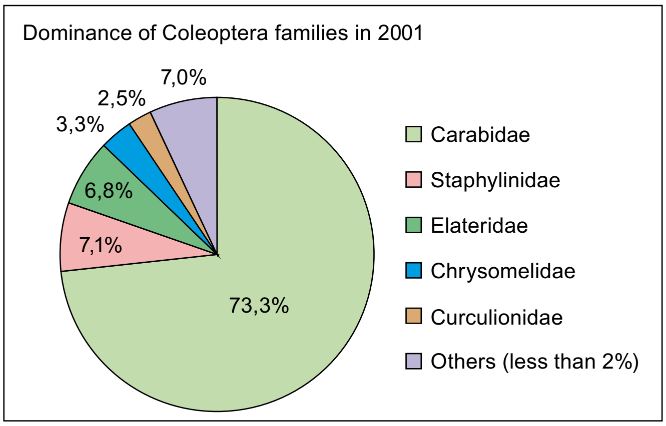


Fig. 66: Dominance of Coleoptera in 2001 (Total catch: 1219 ex.)

The species-abundant diptera that are ecologically characterized by an extremely differentiated way of life constitute a fluctuating share (up to 32%) of the samples

Beetles (Coleoptera)

In all investigation periods the beetles constituted the most species-abundant order of all insect orders recorded (Fig. 65-66). The predominant beetle families are the carabid beetles (Carabidae) and rove beetles (Staphylinidae), both without exception predatory beetles, followed by the exclusively phytophagous snout beetles (Curculionidae), Chrysomelidae and Elateridae. Characteristic residents of the banks are the mud-digging Heteroceridae beetles, the algaevorous Byrrhidae beetles, Anthicidae, Hydraenidae, water beetles (Hydrophilidae), representatives of the saprophagous Dermestidae, necrophagous carrion beetles (Silphidae), coprophagos dung beetles (Aphodius, Geotrupes, Onthophagus) and others. The representatives of these beetle families are epigeic species with a correspondingly high dispersal potential. Given their agility they may easily resettle marsh areas and banks that fall dry after a flood.

Carabid beetles (Carabidae)

Carabid beetles are among the most species-abundant beetle families and show an ecologically extremely differentiated way of living, they are perfectly suited for habitat characterizations and ecological evaluations.

The varying numbers of carabidae species in the sampling areas become apparent in Annex xx... and Fig 67-68. In the sampling areas Babina West, South and North, 62 Carabidae taxons were detected during the research years 1996 - 2001. Diversity and number of Carabidae species varied annually, however a steady increase of species diversity could be observed (see Fig.69). Given their high mobility they are especially well represented in the Barber trap catches and reach very high predominance values (50% of the Coleoptera in 2000, 73% in 2001).

Carabids depends on the varying habitat diversity and the microhabitats available. The most decisive elements are moisture, light and temperature conditions. In the investigation area, Carabids reach the highest number of species and the highest activity-density in moist habitats situated adjacent to waters. The species occurring along the banks and in the marsh areas are the most species- and specimen-abundant. Among these are the species of the *Chlaenius* genus, such as *Ch. festivus* und *Ch. spoliatus*. They are characteristic of the Danube Delta landscape, mostly species of the eastern Mediterranean and Pontic area that have perfectly adapted to the floods as from a morphological and physiological point of view and belong to the characteristic species of the South Eastern European floodplains. They represent indicator species for floodplain habitats with a natural water level dynamics and a dynamic substrate displacement They reach the highest dominance values in this kind of habitat. Chlaenius spoliatus reached a predominance of 24-35% of the Carabidae populations (Fig 67-68).

Open, vegetation-poor marsh and sand areas are mainly settled by numerous representatives of the *Bembidion* genus. The various species of this species-abundant Carabidae genus that are characteristic of these floodplain areas show differing preferences for specific sediment soils. Given their high agility they are frequently found in great number in Barber traps (up to 55% of the Carabidae in the year 2000).

Omophron limbatum is a sand-digging species living along the banks. Ombrophile species of the genera *Acupalpus*, *Pterostichus*, *Oodes*, *Stenolophus*, *Syntomus*, *Tachys* and others occur under the tall herbaceous vegetation growing along the banks. Characteristic genera of the ruderalized, temporarily moist grasslands are *Anisodactylus*, *Amara*, *Harpalus*, *Poecilus* and others. The species of the dry and vegetation-bare areas are the highly mobile *Cylindera germanica* and *Cicindela lunulata*, the predatory larvae of which occupy small vertical corridors they dug in the bank substrate. Epigeic and endogeic species are *Scarites terricola*, numerous *Dyschirius* species and the halophile *Clivina ypsilon*.

Locusts and crickets (Saltatoria)

As for their number of species and specimen they do not belong to the predominant animal groups of the investigation area, they do, however, with regard to their biomass. They reach their highest population density on relatively dry or temporarily

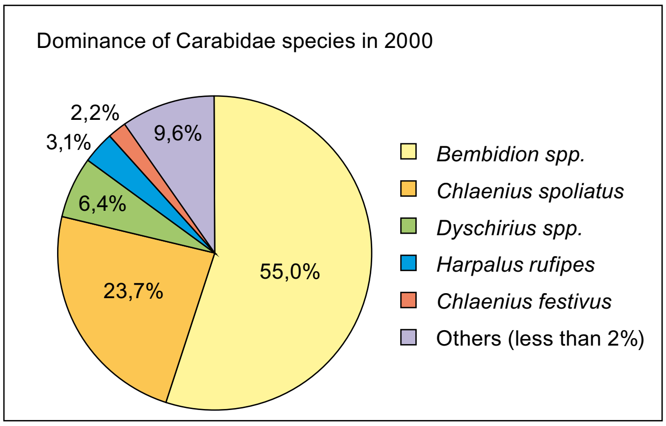


Fig. 67: Dominance of Carabidae in 2000 (Total catch: 891 ex.)

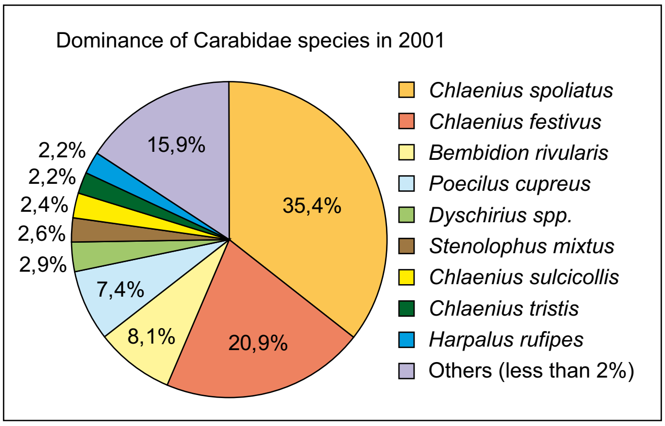


Fig. 68: Dominance of Carabidae in 2001 (Total catch: 892 ex.)

flooded meadows and grasslands in the Western part of the island. *Aiolopus thalassinus* is a characteristic species of this area. *Ruspolia nitidula* and *Conocephalus discolor* occur in reed stands whereas *Tettigonia caudata* are more xerophile. In the open, vegetation-poor shore areas one may find *Tetrix*-species (*Tetrix subulata, T. bolivari, T. ceperoi*), the extremely mobile *Xya pfaendleri* a digging species living in the sand areas, especially in the Western part of the island. Remarkable is the species abundance of the crickets: *Melanogryllus desertus, Tartarogryllus burdigalensis, Myrmecophila acervorum, Pteronemobius concolor* and in some places *Pteronemobius gracilis*, the latter being new for the Romanian fauna. Especially the

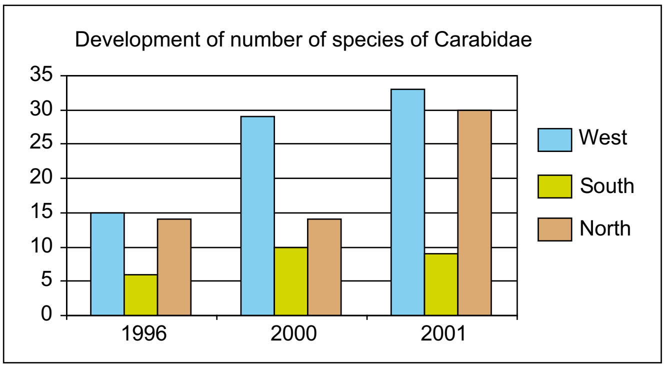


Fig. 69: Development of Carabidae species number 1996 to 2001

large, digging mole cricket (*Gryllotalpa gryllotalpa*) occurs frequently in the Delta and represents a demanded prey for feral pigs and insectivores (i.e. the European roller).

The Araneae spiders

Besides beetles (Coleoptera) and ants (Formicoidea) the spiders are among the predominant epigeic arthropodes of the studied sites. They have been documented quantitatively in all investigation areas and have been classified up to the species level in 1996 (processing by Ingmar Weiss).
43 Araneae spider species have been documented, among which 10 new species for the fauna of the Delta. Being an exclusively zoophagous species they play an important part in the trophic relations of the epigaion, especially on open sites (Weiss, Schneider & Andriescu 1998).

Special sites
Softwood floodplain (willows, poplars)

Various willow species (*Salix* spp.), most of all the white willow (*Salix alba*) offer habitats and the trophic basis for characteristic invertebrate floodplain species. In the course of the studies gradations (large-scale propagations) could be observed in some years for gipsy moth (*Lymantria dispar*) and willow ermine (Y*ponomeuta rorrella*). Phytophagous species living on willows are giant silkworm moth (*Saturnia pyri*), carpenter moth (*Cossus cossus*) and *Orgyia antiqua*, they have been documented in the area all the same. The butterfly *Apatura metis*, characteristic of the willow gallery forests of the Lower Danube and the Danube Delta has been documented regularly in the Babina area. The island's old willows are occupied by xylophagous beetle larvae, black carpenter ants (Formica species) and hornets. On wood leaving Polyporaceae occuring on wood shelter numerous mycetophagous insect species.

Tamarisk bushes

During the vegetation period Tamarisk bushes (*Tamarix ramosissima*) shelter a very abundant insect fauna. They represent host plants to many phytopagous insects. Monophagous insects living on tamarisks are the snout beetle *Coniathus splendidulus*, the cicada *Opsius* sp., the bugs *Tuponia prasina* and *Tuponia macedonica* (new for the Romanian fauna). They constitute fauna elements of the mediterranean to pontic-sarmatic region. Tamarisks constitute a perfect food source to many flower visitors, so e.g. by butterflies and moths, wild bees (Apoidea), wasps (Chrysididae) and beetles (Cantharidae, Malachidae, Cerambycidae, Scarabaeidae and others). Numerous fly species (Syrphidae, Stratiomyidae, Tabanidae and others) spending their larval stage in aquatic habitats, in mud and debris, require tamarisk flowers as food source. The area around the flowering tamarisk bushes represents a perfect hunting ground to predatory insects such as dragonflies, Asilidae, Sphecidae and Vespidae.

Conclusions

On the basis of the investigations carried out it may be stated that the restored polder Babina offers extremely diversified habitats at the present time. They consist in mosaic complexes and zonations showing extremely varying gradient factors between arid and moist habitats. Depending on hydric conditions they are dislocated and modified temporarily. The diversity of highly differentiated macro- and microhabitats in the terrestrial and semi-aquatic area allow the reactivation of an extremely high biodiversity, especially in the case of the arthropod fauna. Given that the larvae and imago stages of numerous insect species are bound to varying aquatic and terrestrial habitats in the course of their metamorphosis and consequently that they change habitat from aquatic to terrestrial, the co-existence of both habitats is vital. This prerequisite is given in the restored polder and allows an especially broad diversity of life-forms.

The dam openings and the renewed water logging of the dyked island implied already and will allow in the years to come an increase in moist to wet sites in the terrestrial and semi-aquatic area. Natural water level fluctuations, varying water levels and differing flow velocities lead to sediment dislocations, the formation of zonation complexes, pioneer sites and characteristic vegetation forms where the respective arthropod communities may settle. They play a significant part in this complex food network and regeneration cycle of wetland biocoenoses', as phytophagous, zoophagous, sapro- or detritophagous, coprophagous and necrophagous animals or parasites.

Results of bird monitoring on Babina island

by MIHAI MARINOV SEN, MIHAI MARINOV JUN, ALEXANDRU DOROŞENCU

Within the scope of an evaluation of habitat functions for various groups of species, the restoration of specific habitat functions for bird species has been studied all the same. Due to a persistent draught adherent to distinct low water levels in summer 2003, numerous smaller channels, flood channels and smaller lakes on Babina island (as well as on Cernovca) were subject to desiccation. Some flood channels, the so-called "japse", and lakes still bore water but were cut-off from the canals and isolated within the reed stands. The prevailing bird habitat consists in broad rush areas, mainly composed of reed, but also of bulrush and hard-stem bulrush reeds. The islands' border areas are lined with softwood floodplain stands mainly consisting of white willows, but in some places of white poplars as well. Along the natural, in parts very broad levees called "grinduri" in the islands' western areas, one may find stands of the tamarisk (*Tamarix ramosissima*). Even along the main cannals one may find white willows, tamarisk bushes as well as the false indigo (*Amorpha fruticosa*) on more elevated places

Ornithological observations on Babina island have been effected along the canals and in two lakes of its eastern part. In doing so, 60 species with altogether 4187 specimen belonging to 24 distinct families have been observed. Among these, 36 species with 2838 specimen stayed in the island area for a longer period, whereas 1349 specimen of 37 species have been recorded as merely passing by the area. Moreover, some species have been observed in both categories (Table 13).
To point out the groups prevailing in the studied area predominance has been calculated with respect to the families (Fig. 70).

Considerable bird conglomerates could be observed on the sparse water surfaces left over in the eastern part of Babina island. On both lakes a total of 2683 specimen belonging to 17 species could be determined. They represent 94.5% of the total number of 2838 specimen occurring in the area and staying there for some time (see Table 13, col. 5).
The observations of stationary birds on the surface of the Babina polder lakes indicate that the teal (*Anas crecca*) prevails with 2500 specimen and represents 88% of the total specimen number of all species occurring in the Babina area. The next species to follow in descending order are *Vanellus vanellus* with 60 specimen, *Fulica atra* with 28 specimen, *Anas querquedula* with 25 specimen *Anas platyrhynchos* with 20 specimen and *Philomachus pugnax* with 12 specimen etc.

Anas crecca, the teal, represents the predominant species on both lakes which constitute an adequate habitat for this duck species. Moreover, the observation period coincided with the autumn bird migration of this species.
155 specimen have been observed on the canals of

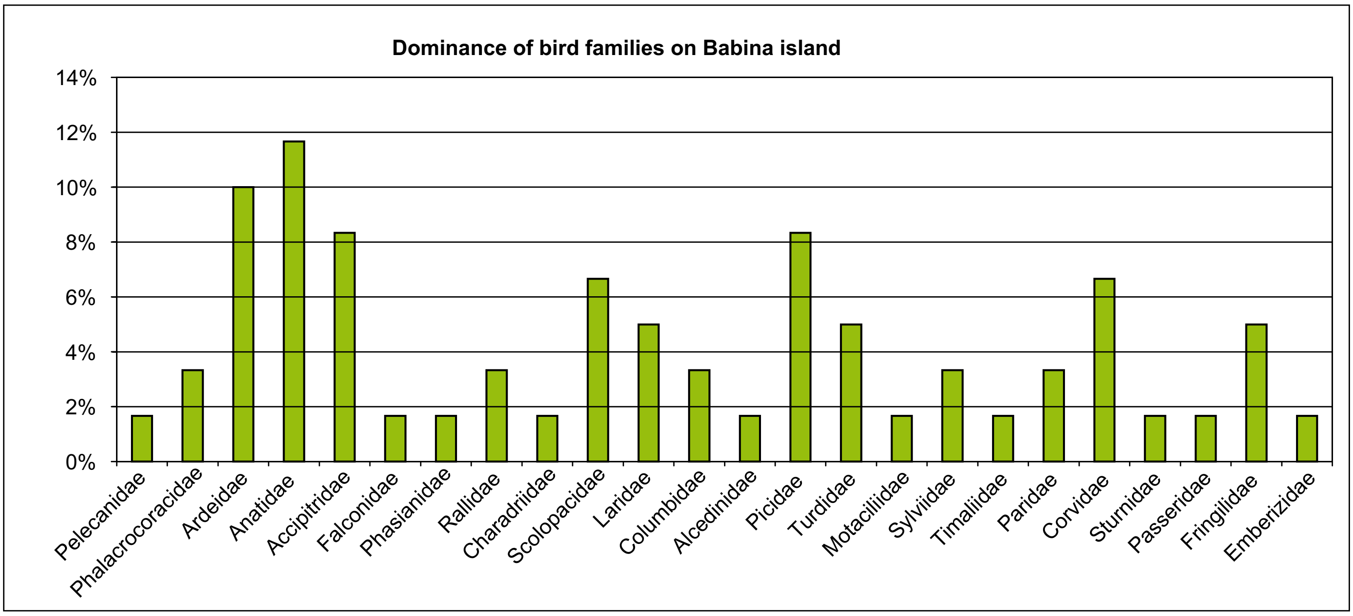


Fig. 70: Dominance of bird families on the Babina island

Tab. 13: Total number of bird species observed on Babina island; Stationary species observed on the canals and lakes of Babina island.

Species		Stationary habitat in the area	Passing the area	Total stationary and passing	Observed on the lakes of Babina island	Observed on the canals of Babina island
White pelican (*Pelecanus onocrotalus*)			28	28	(1)	
Great cormorant (*Phalacrocorax carbo*)		5	70	75		5
Pygmy cormorant (*Phalocrocorax pygmeus*)		3	14	17		3
Night Heron (*Nycticorax nycticorax*)		12		12		12
Squacco Heron (*Ardeola ralloides*)		4		4	4	
Little Egret (*Egretta garzetta*)		1	3	4		1
Great White Egret (*Egretta alba*)		3	5	8	1	2
Grey Heron (*Ardea cinerea*)		5	6	11	2	3
Purple Heron (*Ardea purpurea*)			2	2		
Mute Swan (*Cygnus olor*)		4	3	7	4	
Grey-lag Goose (*Anser anser*)			35	35		
Mallard (*Anas platyrhynchos*)		36	70	106	20	16
Gradwall (*Anas strepera*)			5	5		
Wigeon (*Anas penelope*)			4	4		
Teal (*Anas crecca*)		2500	75	2575	2500	
Garganey (*Anas querquedula*)		25	20	75	25	
Lesser Spot Eagle (*Aquila pomarina*)			3	3		
Marsh Harrier (*Circus aeruginosus*)			3	3		
Buzzard (*Buteo buteo ssp. vulpinus*)			5	5		
Honey Buzzard (*Pernis apivorus*)			36	36		
Sparrowhawk (*Accipiter nisus*)			1	1		
Saker Falcon (*Falso cherrug*)			1	1		
Pheasant (*Phasiasnus colchicus*)		2		2		2
Little Crake (*Porzana parva*)		1		1		1
Coot (*Fulica atra*)		28		28	28	
Lapwing (*Vanellus vanellus*)		60		60	60	
Redshank (*Tringa totanus*)		3		3	3	
Spotted Redshank (*Tringa erythropus*)		7		7	7	
Snipe (*Gallinago gallinago*)		15	25	40	5	10
Ruff (*Philomachus pugnax*)		12		12	12	
Black-headed Grull (*Larus ridibundus*)			16	16		
Common Grull (*Larus canus*)			4	4		
White-headed Grull (*Lanus cachinnans*)			9	9		
Wood Pigeon (*Columba palumbus*)			680	680		
Collard Turtle Dove (*Streptopelia decaocto*)		8	14	22		8
Kingfisher (*Alcedo atthis*)		1		1		1
Black Woodpecker (*Dryocopus martius*)		1		1		1
Grey-headed Woodpecker (*Picus canus*)		2		2		2
Great Spotted Woodpecker (*Dendrocopos major*)		1		1		1
Syrian Woodpecker (*Dendrocopos syriacus*)		2		2		2
Lesser Spotted Woodpecker (*Dendrocopos minor*)			1	1		
Robin (*Erithacus rubecula*)		1		1		1
White Wagtail (*Motacilla alba*)			25	25		
Song Thrush (*Turdus philomelos*)			3	3		
Blackbird (*Turdus merula*)		6		6		6
Willow warbler (*Phylloscopus trochilus*)		16		16		16
Chiffchaff (*Phylloscopus collybita*)		5		5		5
Great Tit (*Parus major*)		5		5	2	3
Blue Tit (*Parus caeruleus*)		13		13	3	10
Bearded Tit-Reedling (*Panurus biarmicus*)		34		34	6	28
Magpie (*Pica pica*)		2	5	7		2
Jackdaw (*Corvus monedula*)			8	8		
Rook (*Corvus frugilegus*)			80	80		
Raven (*Corvus corone cornix*)			7	7		
Starling (*Sturnus vulgaris*)			20	20		
Tree Sparrow (*Passer montanus*)		9		9		9
Chaffinch (*Fringilla caelebs*)			18	18		
Greenfinch (*Carduelis chloris*)		2		2		2
Hawfinch (*Cocothraustes cocothraustes*)			3	3		3
Reed Bunting (*Emberiza schoeniclus*)		4	12	16	1	3
Total: 60 Species	sum of specimen:	2838	1349	4187	2683	155

Babina island. They form part of 27 species representing 5.5% of the total specimen number of 2838 species benefiting of this area's habitats (Table 13, col 6).

As appears as well from the table, the predominant species bearded tit (*Panurus biarmicus*) with 28 specimen observed is followed by willow warbler (*Phylloscopus trochilus*) with 16 specimen observed, night heron (*Nycticorax nycticorax*) with 12 specimen, snipe (*Gallinago gallinago*) and blue tit (*Parus caeruleus*) with 10 specimen each.
The bearded tit (*Panurus biarmicus*) has been observed along the borders of the channels, i. e. in a habitat which is very characteristic for this species. The willow warbler (*Phylloscopus trochilus*) mainly occurred in places with adjacent tamarisks and white willows along the dykes. Likewise, the night heron (*Nycticorax nycticorax*) merely occurs in the willows along the channel borders. This habitat developed shortly after the reconnection to the river dynamics by natural regeneration of willows which in the course of time transformed into a white willow gallery forest. All night heron specimen observed were juvenile birds. Even though the night heron is a migratory bird, some juvenile bird specimen remain in the Delta up until late autumn and even hibernate in the Danube Delta and its adjacent areas.
During the incubation period 2157 specimen belonging to 60 bird species have been observed in the Babina island area.

Fig. 71: Little Egret (Egretta garzetta) in the restoration area

For all bird species observed during the incubation period their predominance has been calculated, resulting in the following numbers:
The prevailing species observed in the Babina island area during the incubation period is the white pelican (*Pelecanus onocrotalus*), representing 42.74%. It is followed by the greylag goose (*Anser anser*) with 13.30%, the mallard (*Anas platyrhynchos*) (5.74%), tree sparrow (*Passer montanus*) (3,33%), great cormorant (*Phalacrocorax carbo*) with 2,64%, white wagtail (*Motacilla alba*) (2.30%), European spoonbill (*Platalea leucorodia*) (1.85%), blue-headed wagtail (*Motacilla flava*) 1.56%, herring gull (*Larus argentatus*) 1.48%, black-tailed godwit (*Limosa limosa*) 1.40%, little egret (*Egretta garzetta*) 1.34%, great tit (*Parus major*) 1.25%, grey heron (*Ardea cinerea*) 1.11%, whiskered tern (*Chlidonias hybridus*) 1.09% and great white egret (*Egretta alba*) 1.06% For the other species their calculated presence ranges below 1%.

Species such as white pelican (*Pelecanus onocrotalus*), European spoonbill (*Platalea leucorodia*) and glossy ibis (*Plegadis falcinellus*) do not breed on Babina island, they do however use the area as feeding ground during the incubation period. Especially for the pelicans breeding in broad colonies south of Babina and Cernovca islands in the severely protected area of Rosca-Buhaiova, the restored areas are of major importance as feeding grounds. This means as well that the area disposes of a very good nutrient availability and that the ichthyofauna developed respectively. The glossy ibis (*Plegadis falcinellus*) also finds, a very adequate food supply on the shallow flooded grassland areas in the western part of Babina island in spring. Altogether it may be stated that the reflooding was of major importance for the site-specific bird species. It led to a redevelopment and diversification of their habitats, i. e. of their resting, breeding and feeding grounds, and nowadays shelters a very diversified species composition.

Studies on the European mink and the European otter in the restoration area Babina

by Andreas Kranz

Both the European mink (*Mustela lutreola*) and the European otter (*Lutra lutra*) are semi-aquatic mustelids. Their resting and raising grounds are situated along the river banks. They mainly feed upon fish, amphibians, crayfish, aquatic insects etc. in and along the waters, the otter being specialized on fish and the mink on amphibians. The weight of the otter is of about ten times that of the mink, a female otter weighs approximately 500g whereas the male easily attains 1kg. In ancient times the European mink was named Swamp-Otter, which reflects the resemblance of the two species. Moreover, its name also indicates the specific niche of the mink as it mainly occurs in swampland areas.

Both species are strictly protected in the EU (FFH Directive, Appendix II) and also in Romania (Law Nr. 462). The populations of the European otter had dramatically decreased until 1980 and do now show clear signs of recovery in various parts of Europe.

Contrary to this, the already low number of the European mink (Northern Spain, Southwest of France, Belarus and Russia) decreased even further as a result of the spread of the competitive American mink. After the Spanish lynx and the monk seal, the European mink is considered as being the third most endangered mammal in Europe. Worldwide, all three species are in acute danger of extinction.

Both otter and mink are species that cannot be observed easily as they are nocturnals and have a great ability to hide. Moreover, the riparian vegetation frequently impedes any direct observation of these animals. This is why field studies conducted on these two species are mainly based upon the tracks these animals leave in snow, sand or mud as well as on their excrements. The situation of the European mink is even somewhat more complicated because tracks and excrements cannot easily and clearly be allocated to one species in the case of a simultaneous occurrence of American mink or polecat. In this case live trapping is necessary to obtain evidence on the species living in a certain area.

Mink and otter in the Danube Delta

The Danube Delta provides a perfect natural habitat both for the European mink and the European otter, with numerous adequate feeding grounds, resting areas and shelters. As a result, the populations of both species are relatively dense in this area. The Danube Delta is very unique with its broad reed belts and up to the present day no detailed studies have been conducted on the use of its habitats. Presumably the closed reed areas provide little food and only limited shelter. The floating reed carpets and partly floating reed islands, the so-called “Plaur”, just as all areas where channels, former river branches and islands break open the closed reeds are more valuable in this regard.
The drainage and transformation of extended wetlands for agricultural purposes that took place in the Danube Delta in the early 1980ies (1983) implied the destruction of the habitats of otter and

Fig. 72: European mink (*Mustela lutreola*)

Fig. 73: European otter (*Lutra lutra*)

mink and withdrew their life resources. This has been the case for example on Babina and Cernovca islands.

Mink and otter in the restoration areas Babina and Cernovca

The reconnection of the islands to the flood regime of the Danube River implied the restoration of characteristic aquatic habitats and had considerable positive effects on the re-settlement with habitat-specific species. The biocenosis readapted to the periodic respectively permanent occurrence of water on large areas.

This also led to a recovery of the otter populations occurring in higher densities as compared to areas with an established population. This hypothesis was supported by the fact that during the 2002 and 2004 monitorings far more otter tracks have been found in the restored areas of Babina and Cernocva than in neighbouring areas. The same may be supposed for the European mink, however the tracks of this species may not that easily be found which is why we have no clear evidence for its increase. Merely one single European mink has been trapped in the area.

The restoration of Babina and Cernocva islands were decisive for the development of potential mink habitats since this species is bound to the Delta and its surrounding areas. This again is extremely important considering that this mink population is presumed to be the largest worldwide, with a dense number of species in a small area. Genetic studies have shown that the European mink living in the Danube Delta shows less variabilities as compared to those in Russia and Belarus.

Threats

The most dangerous threat for the European mink is the very competitive American mink. In the Romanian part of the Danube Delta the American mink has merely been proven by two specimen in the year 2000; however, in the Ukrainian part, there is evidence that the American mink has established a population east of the town of Ismail. A spreading towards the Romanian Danube Delta is to be expected.

Other threats for the European mink are by-catches in muskrat traps, cats, straying dogs and feral pigs that locally occur in high numbers. It has not yet been proven that the quick and noisy motor boats do significantly disturb the minks and thus confine them to remote areas of the Delta. However, if these boats affect the mink's prey animals, in particular amphibians, this will of course have severe impacts on the mink as well.

The otter does not face as many and serious threats in the Delta as compared to the European mink. The most serious concerns arise from fish traps which may lead to by-catches of otters and illegal killings by poachers for fur. The importance of this latter aspect may increase in the near future, since the fur market is recovering and the price of an otter fur is a great incentive for poachers.

Studies on further mammal species

by MIHAI MARINOV SEN.

Besides mink and otter, both deserving special attention from a nature conservation point of view as they figure among the endangered species, further mammals have been recorded within the scope of a game potential identification (2003) in the Babina and Cernovca areas. They should at least be mentioned to complete the project on biodiversity in the Babina area.

It has to be stated that the re-flooding was beneficial to water-bound species whereas other species receded.
Populations such as e.g. the deer (*Capreolus capreolus*) and the common hare (*Lepus europaeus*) receded by 60-80% after the opening of the polder in 1994, whereas the muskrat (*Ondatra zibethica*) experienced an increase of its populations by 300%. Most muskrat families build their lodges inside the dams respectively along the channel banks or in the reed and reed-mace rushes of flooded depressions. Even though the muskrat finds favorable living conditions its stands have severely suffered as a result of multi-mesh grill-net fishing. The animals get caught in the nets as these are disposed in the channels where the densest muskrat populations occur,

The wild pig (*Sus scrofa*) also experienced a growth in its local populations over the last 5 to 6 years. An evaluation carried out in 1998 showed a density of 7-8 specimen/1000ha, the evaluation made in autumn 2003 resulted in a doubled density of 13-16 specimen/1000 ha. This increase may be explained by the fact that the local families experienced a reproduction success subsequent to the restoration of their characteristic habitats and an improvement of their living conditions as a result of a favorable food supply. It may, however, also be explained by the settlement of specimen from neighboring southern and northern areas presenting less favorable conditions to wild pigs. They also have easier access to their food sources such as reed rootstocks, reed-mace roots, water chestut fruits etc at the moment of lower water levels.

Fox (*Vulpes vulpes*) and raccoon dog (*Nyctereutes procynoides*) are among the predators that find favorable living conditions with a diversified food supply as well as appropriate reproduction grounds. These are situated, just as for the wild pig, along the dams and in their immediate vicinity. The predatory raccoon dog mainly threatens the clutches of the European Pond Turtle (*Emys orbicularis*), it digs them out and eats them up. The raccoon dog thus represents a great threat to the survival of the Eurpean Pond Turtle populations in the Babina area.

The area also shelters ermine (*Mustela erminea*), weasel (*Mustela nivalis*) and polecat (*Putorius sp.*). Comparing the observation results obtained in 1998 and 2003 it has to be stated, however, that ermine and weasel present stable populations whereas the polecat (*Putorius sp.*) receded.

Fig. 74: Racoon dog (*Nyctereutes procynoides*)

Natura 2000 species and habitats in the restoration area of Babina

by Erika Schneider, Alexandru Doroşencu & Eckbert Schneider

The opening of the circular dam and the reconnection to the hydrological dynamics of the Danube River allowed the redevelopment of site-specific habitats as well as macro- and microhabitats on Babina island. Characteristic species resettled or could spread and redevelop from remaining populations. The monitoring activities carried out document this development and show that regular changes between floods and dry periods in consequence of the dynamics result in permanent displacements, even though a relative stability has been obtained. The latter mainly applies to the aquatic and terrestrial biocoenoses, the major changes and displacements usually occurring with the amphibian biocoenosis.

The restoration of wetlands is of major importance from the point of view of the Natura 2000 network as well, given that among the redeveloped habitats one may make up a few that are listed in Appendix I of the FFH Directive, Council Directive 92/43/EEC respectively figure in Appendix 2 of the Romanian Law Nr. 462/July 18th, 2001(Schneider & Drăgulescu 2005). They concern "Natural habitat types of community interest whose conservation requires the designation of special areas of conservation".

Fig. 75: Pasture with Tamarix bushes in the western part of Babina island

Among the species that have resettled or redeveloped numerous species are listed in Appendix II of the FFH Directive respectively in Appendix 3 of the Romanian Law 462. According to the specifications of the Flora Fauna Habitat Directive, Appendix II comprises "Animal and plant species of community interest whose conservation requires the designation of special areas of conservation". Along with them come species of Appendix I of the European Council Directive 79/409/EEC on the conservation of wild birds, which are also comprised in the Romanian Law 462, Appendix 3.

Natura 2000 habitat types in the restoration area

Among the habitat types listed in the European Council Directive on the conservation of habitats, Appendix I, the following have been recorded in the Babina area:

3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation

This habitat type redeveloped shortly after the opening of the polder and shelters, especially in the lakes, a considerable diversity of frogbit and pondweed communities as well as broad carpets of the common water lily (see chapter aquatic vegetation). This habitat type occurs frequently in the channels as well. The diversified plant communities of this habitat type offer many microhabitats respectively possibilities for aquatic animals to occupy a niche.

3270 Rivers with muddy banks with Chenopodion rubri p.p. and Bidention p.p. vegetation

This habitat type is bound to the dynamics of the water levels, as the banks consist in deposits of fine sediments and offer favorable conditions to pioneer settlements when uncovered at the moment of falling water levels. This kind of settlement occurred on a large scale in the northern part of the island where broad protosoil areas emerged directly adjacent to the dam opening (opening 4) as a result of sedimentation processes, comparable to the levees "grinduri".

On a small scale these favorable conditions occurred as well along the channel borders and allowed the development of this habitat type. Dependant on the water level, these pioneer settlements do not occur every year but merely emerge during distinct low water level periods.

92A0 Salix alba and Populus alba galleries

This habitat type is characteristic of the shore area of large rivers, especially in the Mediterranean zone. The gallery forests developing along the Lower Danube and in the Danube Delta may be attributed to this habitat type, notably as a special subtype occurring in the border area of this habitat type. Besides white willow and white poplar (*Populus alba*), Russian olive (*Elaeagnus angustifolia*) and tamarisk bushes (*Tamarix ramosissima*) are characteristic of this habitat type. In the Babina area this habitat type merely occurs on a small scale and is confined to the border areas of the island, especially in its upstream area section.

92D0 Southern riparian galleries and tickets (Nerio-Tamaricetea)

The habitat type of the tamarisk bushes is characteristic of pontic steppe areas as well as of the Mediterranean area. In the Lower Danube area and the Danube Delta, both belonging climatically and biogeographically to the pontic steppe areas, this habitat type occurs frequently in a number of places. Just as for the white willow, the tamarisk requires protosoils emerging as a result of the water level dynamics and the sediments for its natural succession. On Babina island, favorable conditions for white willow and tamarisk settlements were already given immediately after the opening of the dam (1994) along the main channel in the south (pumping station). A comparable settlement occurred as well on aggradations in the north, where they developed together with white willow and ephemeral pioneer species. Tamarisk bushes may also be found in the western part of the island on elevated river banks, the broader levees, where they alternate with grassland areas.

Natura 2000 species in the restoration area

Among the plant species listed in Appendix II of the FFH Directive, a small population of the greater bladderwort *Aldrovanda vesiculosa* (Droseraceae) has been documented in the area of Babina island (see Fig. 57). However, this species could merely be observed during one vegetation period (2000).

Among the diverse animal species that have settled this redeveloped mosaic of water and marsh areas, of white willow-white poplar gallery forests and grassland communities as well as tamarisk bushes, the following are listed in Appendix II of the FFH-Directive:

Vertebrates

Both the **European otter** and the **European mink** have been studied within the frame of research and monitoring activities regarding the populations of European otter and European mink in the Danube Delta.

Prior to restoration a remaining population of the **European pond turtle** could be observed in the circular channel outside the polder. As a result of restoration and the redevelopment of appropriate calm waters with muddy grounds, the European pond turtle could spread again in adequate habitats, provided that the necessary food supply consisting in crustaceans, worms, amphibians, juvenile birds, insects and snails was available. At the dyke toe respectively along the lower third of the slope, holes dug by the European pond turtle and comprising their clutches of eggs could be found in many

- Vertebrates
  - Mammals
    - Carnivora
      - Mustelidae family
        - European otter (Lutra lutra)
        - * European mink (Mustela lutreola)
  - Reptiles
    - Testudinata
      - Emydidae family
        - European pond turtle (Emys orbicularis)
  - Amphibians
    - Caudata
      - Salamandridae
        - Dobrogean Great crested Newt (Triturus cristatus dobrogicus)
    - Anura
      - Discoglossidae
        - Fire-bellied Toad (Bombina bombina)
  - Fish
    - Clupeiformes
      - Clupeidae
        - Alosa caspia nordmanni
    - Cypriniformes
      - Cyprinidae
        - Asp (Aspius Aspius)
        - Bitterling (Rhodeus sericeus amarus)
      - Cobitidae
        - Loach (Misgurnis fossilis)
- Invertebrates
  - Insects
    - Butterflies (Lepidoptera)
      - Lycaenidae
        - Large Copper (Lycaena dispar)

Fig. 76: Occuring NATURA 2000 Species

sunny spots reaching from the pumping station in the south up to the higher situated areas (Grind) in the western part of the island. It has been noticed repeatedly over the years of study that the raccoon dog scents out these clutches, digs them up and eats them up. This is why, in many places of the Danube Delta, the expansion of the raccoon dog represents a great threat to the European pond turtle populations. These concerns should therefore be met when converting management measures.
The abundant aquatic vegetation in the clear waters of the lakes and channels of Babina island provides appropriate habitats for the **Dobrogea Great crested Newt**. In autumn it migrates ashore and finds adequate hibernation places under tree roots and in the marsh vegetation. Before restoration, great crested newt populations could merely survive in the circular channel surrounding the polder. During a late sampling in early October 2001, at the moment of their migration from the water to their hiding places ashore, a considerable number of great crested newts could be observed on Babina. This means that the great crested newt finds both adequate habitats and appropriate food supply in this area, i.e. larvae of various water insects, small crustaceans, mainly Gammaridae and small fish.

The **Fire-bellied Toad** finds adequate habitats in the newly emerged and macrophyte-abundant lakes of the restoration area of Babina island. The area provides an abundant food supply with water insects and further invertebrates that redeveloped correspondingly to the redevelopment of the habitats.

Invertebrates

The characteristic butterfly species of the river floodplains, the **Large Copper** (Lycaena dispar) could spread thanks to the redevelopment of the wetland vegetation. Prior to the restoration of the polder this species occurred in small numbers along the reed fringes of the circular channel. The food plants of this butterfly's caterpillars are the great sorrel species such as Rumex hydrolapathum and Rumex limosus that occur along the water borders of the Babina restoration area, off the reeds on muddy grounds.

Birds

Among the bird species observed on the restored islands of Babina and Cernovca the species of Tab. 14 are listed in Appendix I of the European Council Directive on the conservation of wild birds 79/409/EEC.

It may be stated altogether that the restored Babina island is of major importance with regard to the Natura 2000 network given its numerous species listed in Appendix II of the FFH Directive as well as in Appendix I of the European Council Directive on the conservation of wild birds and given its habitats listed in Appendix I of the FFH Directive. These aspects should be considered when adjusting the management directives and the sustainable use of the resources in order to safeguard a long-term conservation of the species and habitats.

Tab. 14: List of FFH-bird species in the area

Pelecanus onocrotalus	White Pelican
Phalacrocorax pygmaeus	Pygmy Cormorant
Botaurus stellaris	Bittern
Ixobrychus minutus	Little Bittern
Nycticorax nycticorax	Night Heron
Ardeola ralloides	Squacco Heron
Egretta garzetta	Little Egret
Egretta alba	Great White Egret
Ardea purpurea	Purple Heron
Ciconia ciconia	White Stork
Plegadis falcinellus	Glossy Ibis
Platalea leucorodia	Spoonbill
Aythya nyroca	Ferruginous Duck
Aquila pomarina	Lesser Spotted Eagle
Circus aeruginosus	Marsh Harrier
Pernis apivorus	Honey Buzzard
Falco vespertinus	Red-footed Falcon
Falco cherrug	Saker Falcon
Porzana parva	Little Crake
Tringa glareola	Wood Sandpiper
Philomachus pugnax	Ruff/Reeve
Sterna hirundo	Common Tern
Sterna albifrons	Little Tern
Chlidonias hybrida	Whiskered Tern
Alcedo atthis	Kingfisher
Coracias garrulus	Roller
Dryocopus martius	Black Woodpecker
Picus canus	Grey-headed Woodpecker
Dendrocopus syriacus	Syrian Woodpecker
Lanius collurio	Shrike

Final conclusions

The restoration of Babina island was a significant step forward towards a sustainable development of this area. Both the redevelopment of the natural habitats and its biodiversity and the use of resources that are bound to traditional management methods stayed abreast of changes. After the political reversal in Romania, Babina island was the first project in the Danube Delta where new paths were stroke, away from an intensive, site-unspecific use back to near-natural structures, exemplar for nature conservation with an for man. It caused a change of mind and offered new incentives to restore further flood prone areas that had been altered by man, in the Danube Delta but also beyond.

The monitoring conducted over 10 years accounts for a relatively rapid development of the area, the hydrological regime with its fluctuating floods and dry periods representing the key factor for restoration. Flood conditions do, however, differ from the natural flood situation. Before the construction of the dams, i.e. under natural conditions, it occurred with a large-scale overflooding of the island. In the case of the dyked Babina island it merely occurs in the area of the dam openings (Staraş 2001).

Despite of these constraints the efficiency of the ecosystem has been reestablished by an opening of the dams in specific hydraulically and ecologically effective spots and the reconnection to the river dynamics. This ensured a redevelopment of the site-specific biodiversity and the resources.

The monitoring of the hydrological regime in close relation with morpho-hydrological changes revealed the alterations in the artificial canals.

Fig. 77: Restored lake on Babina island
Lac renaturat pe ostrovul Babina

Concluzii finale

Prin reconstrucția ecologică a fostei incinte agricole Ostrov Babina (1994) a fost realizat un pas important în direcția dezvoltării durabile a zonei, avându-se în vedere atât extinderea habitatelor naturale şi a biodiversității lor, cât şi refacerea resurselor naturale, în vederea folosirii lor tradiționale. Reconstrucția ecologică a incintei agricole Babina a fost primul proiect în Delta Dunării, în cadrul căruia a fost inițiată o nouă măsură de management diferită de cea a folosirii intensive şi neadecvate mediului natural specific zonelor umede. Proiectul marchează o reîntoarcere la structuri ale peisajului apropiate de cele naturale, în care omul coabitează cu natura, constituind astfel un exemplu pentru protecția naturii. Prin reconectarea fostei incinte agricole Ostrov Babina la regimul hidrologic al Dunării, a fost declanşat un proces general de reflectare asupra refacerii zonelor umede afectate prin lucrări de îndiguire în vederea practicării agriculturii şi pisciculturii, constituind un impuls nu numai pentru reconstrucția ecologică a altor zone afectate de activitatea umană din Delta Dunării, ci şi un model pentru alte zone umede transformate de om şi scoase din circuitul natural în Lunca Dunării.

Prin programul de monitoring desfăşurat pe o perioadă de mai bine de zece ani a fost documentată evoluția zonei, regimul hidrologic, cu schimbul între ape mari şi ape scăzute, constituind factorul cheie pentru renaturare / reconstrucție ecologică, chiar dacă situația inundării este puțin diferită față de cea în condiții naturale. Inainte de îndiguire, aceasta se desfăşura pe o suprafață mare, atunci când nivelul apei depăşea grindurile naturale de mal, pe când în cazul ostrovului indiguit inundarea incintei are loc numai prin breşele făcute în digul de contur (Staraş 2001). Cu toate aceste constrângeri, prin deschiderea digurilor în anumite puncte efective din punct de vedere hidraulic şi ecologic şi a reconectării la dinamica fluviului, s-a refăcut modul de funcționare al ecosistemului, ceea ce a permis redezvoltarea biodiversității specifice zonelor umede, asigurându-se prin aceasta şi refacerea resurselor naturale.

Prin monitoringul regimului hidrologic văzut în strânsă legătură cu schimbările morfo-hidrografice, au fost scoase în evidență schimbările care au

They show the rate of change of the discharge cross section as a result of sediment deposits. The major sediment share has been deposited in the area of the CC 1 channel opening at its connection with the Babina branch (Bresa 1) as well as in the north-western area (Bresa 4) at the opening situated near the Chilia branch. This led to an elevation of the sills at the openings situated upstream and, after four years, required further measures to be taken to improve water circulation and water exchange. The results on bed process rhythm can provide useful information for decision-making in ecological reconstruction management plans in the wetlands and deltas.

Both the retention area of Babina island which has been reconnected to the dynamics of the Danube River and the Cernovca area play an important biogeochemical role for nutrient retention and cycling. The reed beds dispose of perfect nitrogen filter qualities. For Babina and Cernovca islands the retention of nitrogen N amounts to a total value of 355.6 t N/year on a reed area covering a total surface of 2435.312 ha.
Phosphorus arrives in the area with the spring floods and is retained in the reedbeds. In summer time this phosphorus allows the growth of phytoplankton and macrophytes.

A definitely positive effect of nutrient reduction is a reduced eutrophication in the restoration area which is also to the benefit of the Black Sea.

The opening of the dams led to a redevelopment of site-specific macro- and microhabitats in the aquatic, semi-aquatic and terrestrial areas. It also led to a re-settlement with site-specific species that are arranged along ecological gradients and closely depend on duration, height, moment and frequency of the flood. Moreover, the opening led to the development and relative stabilization of the site-specific biodiversity.

Being highly sensitive to many environmental variables the phytoplankton, i.e. the algae in general and especially the diatoms, are considered as significant indicators for environmental changes. Based on the indicator values of diatoms which allowed to determine the trophic condition of water it can be concluded that since 1997 the balance has been redressed in the Babina area and the evolution of the aquatic ecosystem reaches

avut loc în canalele artificiale ale ostrovului. Ele demonstrează gradul de modificare a secțiunilor de scurgere în urma depunerii de sedimente, proces care se manifestă cel mai accentuat în canalul CC1, la punctul de legătură cu brațul Babina (Breşa 1), precum şi în nord-vestul ostrovului (Breşa 4) la deschiderea spre brațul Chilia. Acest lucru a dus la depuneri de sedimente la breşele din amonte, necesitând după patru ani de la deschidere măsuri suplimentare pentru îmbunătățirea circulației apei şi a schimbului de apă dintre incintă şi brațele adiacente. In acelaşi timp ritmul de modificare a secțiunilor canalelor furnizează informații importante pentru deciziile necesare în elaborarea planurilor de management ale ariilor de reconstrucție ecologică în zone umede şi delte.

Suprafața ostrovului Babina, reconectat la dinamica fluviului Dunărea, joacă, ca şi Cernovca, un rol important pentru funcția biogeochimică de reținere şi reciclare de nutrienți. Suprafețele de stuf dispun de importante calități ca filtre pentru azot. In cazul ostroavelor Babina şi Cernocva reținerea azotului se ridică la o valoare totală de 355,6 t azot / an, pe o suprafață totală de stuf de 2435,312 ha. Fosforul care intră în zonă în timpul apelor mari de primăvară este reținut în stufăriş, care funcționează vara drept sursă de fosfor pentru creşterea fitoplanctonului şi a macrofitelor.

Efectul pozitiv al reducerii de nutrienți se poate defini prin reducerea eutrofizării în aria de reconstrucție ecologică Babina (şi Cernovca), ceea ce este în beneficiul şi al Mării Negre, ostroavele reconstruite acționând ca filtre biologice.

Deschiderea digului de contur şi reinundarea a declanşat şi a favorizat redezvoltarea de macro- şi microhabitate specifice locului atât în mediul acvatic şi semiacvatic, cât şi în cel terestru. In acelaşi timp a dus la o repopulare cu specii caracteristice de zone umede, fiind aşezate de-alungul unor gradienți ecologici şi în strânsă dependență de durata, înălțimea, perioda şi frecvența inundării. De asemenea deschiderea a dus la dezvoltarea şi stabilizarea relativă a biodiversității specifice locului.

Fiind foarte sensibil la mai multe variabile ale mediului, fitoplanctonul, adică algele în general, dar în special diatomeele pot fi considerate indicatoare importante pentru schimbări ale mediului

meso-eutrophic conditions.
The reestablishment of the flood regime induced a process of rehabilitation of the plankton fauna comparable to permanent eutrophic waters with a significant increase in the species number. This proves that the water quality has gradually changed towards the positive approaching natural conditions that are specific of clear water habitats where the development of aquatic vegetation sustains a rich and abundant zooplankton community i.e. an excellent food source for fish.

Stagnating, permanent and macrophyte-rich waters are populated by a specimen- and species-abundant fauna of macrozoobenthos. The composition according to nutrition types confirms a well-operating interplay between macrophytes, macrozoobenthos and fish. If the present hydrological conditions are maintained there will be no significant changes or infringements of the zoobenthos fauna in the short or medium term. In the long run, however, the insufficient water exchange in the water system of Babina will have indirect, negative effects on the macrozoobenthos.

The reconnection to the Danube River and the linking up to the neighbouring ecosystems allowed the island to take up again its function as habitat and spawning ground for fish. The studies conducted prove that the redeveloped aquatic habitats play an important ecological role for reproduction and nutrition of fish. Especially phytophilous species and species spawning on molluscs have been reestablished on Babina after the island's reconnection to the flood regime of the Danube River.

Fig. 78: Traditional fishing with fish traps
Pescuit tradițional cu vintire

acvatic. Bazat pe valorile indicatore ale diatomeelor, care permit determinarea statusului trofic al apei, se poate trage concluzia ca începând cu 1997 pe ostrovul Babina s-a redresat echilibrul ecologic iar evoluția ecosistemului acvatic a ajuns în starea de mezo-eutrofie.

Restabilirea regimului inundabil a indus un proces de reabilitare a faunei planctonice similară cu ape permanent eutrofe cu o creştere semnificativă a numărului de specii. Aceasta ne indică schimbarea graduală a calității apei spre o stare bună, care se apropie de condițiile specifice habitatelor de apă limpede, în care dezvoltarea vegetației acvatice susține o bogată şi abundentă comunitate de zooplancton, o sursă excelentă de hrană şi refugiu pentru peşti.

Apele stagnante permanente, bogate în macrofite, sunt populate de o faună de macrozoobentos bogată în specii şi indivizi. Componența conform grupării pe tipuri nutriționale confirmă o relație bine funcțională între macrofite, macrozoobentos şi peşti. Dacă condițiile hidrologice existente în prezent vor fi menținute, nu vor avea loc în termen scurt sau mediu schimbări semnificative ale faunei bentonice. Pe termen lung schimbul insuficient de apă între ostrovul Babina şi brațele adiacente, din cauza colmatării breşelor de alimentare, va avea în mod indirect efecte negative asupra macrozoobentosului.

Prin reconectarea ostrovului la regimul hidrologic al Dunării şi interconectarea cu ecosisteme învecinate ostrovul a putut să-şi reia funcția ca habitat şi loc de reproducere pentru peşti. Cercetările documentează că redezvoltarea habitatelor acvatice joacă un rol ecologic important atât pentru reproducerea şi nutriția peştilor, cât mai ales pentru specii fitofile şi specii care depun icrele pe cochilii de moluşte, care s-au redezvoltat pe ostrovul Babina după reinundare.

Speciile de peşti existente în zonă sunt specii tipic euritope ale bazinului Dunării, găsindu-se atât în ape curgătoare, cât şi în ape stătătoare, precum şi specii limnofile, tipice pentru ape stătătoare, cele din urmă fiind dominante în apele ostrovului Babina.

Cercetările privind diversitatea şi structura populațiilor de peşti scot în evidență o faună

The species occurring in the Babina area are characteristic eutrophic species of the Danube catchment area that occur both in running and in stagnating waters. Other limnophilous species, characteristic of stagnating waters do occur as well, the latter being predominant in the Babina island area.

The studies on diversity and structure of the fish populations show an ichthyofauna characteristic of eutrophic waters. This is due to the fact that the area offers the respective habitats for their natural reproduction, adequate feeding and raising grounds for juvenile and adult fish. Diversity and structure of the fish communities vary from one habitat to another with the result that they may be considered as indicators for the ecological condition of the respective areas.
The development and stabilization of the fish populations involve the use of fish resources and their socio-economic significance for the local populations. Ecological restoration can be considered as an economic alternative for the management of dyked and unprofitable or abandoned polders.

The reconnection to the dynamics of the Danube River and the redevelopment of a mosaic of stagnant and running waters within the island led in their turn to a rapid redevelopment of the aquatic vegetation and its communities. This is why already during the second year after the flooding a major part of the aquatic vegetation occurred in the area of the island. From 1998 their stands incre-

piscicolă caracteristică pentru ape eutrofe, dar şi faptul că s-au redezvoltat habitatele caracteristice speciilor de peşti cu locuri de reproducere, hrană şi creşterea puietului. Diversitatea şi structura comunităţilor de peşti diferă de la biotop la biotop, astfel încât speciile pot fi considerate drept indicatori pentru starea ecologică a zonelor respective.

Dezvoltarea şi stabilizarea populaţiilor de peşti permite exploatarea resurselor piscicole crescând importanţa lor socio-economică pentru populaţia locală. Astfel reconstrucţia ecologică poate fi considerată ca o alternativă economică pentru managementul incintelor agricole neprofitabile şi abandonate.

Reconectarea la dinamica Dunării şi redezvoltarea unui mozaic de ape stătătoare şi curgătoare în zona ostrovului a dus la redezvoltarea în timp foarte scurt a macrofitelor acvatice şi a comunităţilor lor. Astfel, deja în al doilea an după reinundare, o mare parte a spectrului de specii caracteristice şi a comunităţilor de plante acvatice au fost deja prezente în aria ostrovului. Incepând cu anul 1998 comunităţile de macrofite acvatice s-au răspândit ajungând la o stabilitate relativă. Cu unele oscilaţii condiţionate de regimul hidrologic al Dunării, fitocenozele diferitelor asociaţii se conturează foarte clar fiind comparabile cu fitocenoze din zone naturale ale deltei.

Otrăţelul de baltă (*Utricularia vulgaris*), a cărui existenţă este legată de apă limpede, apare ca o bordură la marginea stufărişurilor, unde iese apa

Fig. 79: Landsat image of Babina Polder during flood, May 2006
Imagine Landsat a incintei Babina în perioada apelor mari, mai 2006

ased so that the plant communities became relatively stable. With a few fluctuations caused by the hydrological regime of the Danube the communities became distinctly apparent and are comparable to natural areas in the Delta.

The Greater Bladderwort *Utricularia vulgaris* which is bound to clear waters and spreads in straps along the reed stands proves the filter properties of the reeds. These became distinctly apparent from the third and fourth year after the reconnection.
The rapid development of the aquatic vegetation as a whole suggests that both the drift of plant parts and particularly the existence of plant diaspores in the area play a major role in resettlement.

Marsh vegetation and moist grasslands have rapidly redeveloped. Plants with a high seed potential as well as still existing rootstocks of plants in the soil and rapidly growing species that spread by means of stolons efficiently covered broad areas. Especially the surface-covering reeds quickly redeveloped stable stands and represent a major useable resource to the local population.
The saline vegetation was reduced by the flooding of the area, does however, even though on very small spots, occur in the western, upstream part of Babina island. The species developing there are mainly characteristic of soils with low salinity (*Bolboschoenus maritimus, Cynodon dactylon, Crypsis aculeata*).

Given a large-scale decrease of the halophilous vegetation, site-specific non-halophilous wet meadows and reeds could redevelop. They can now be used as pastures, as in former times and even better. Fluctuating water levels play a major role as for the development of the grasslands. Extreme floods cause a shifting towards the moist area and imply thus the predomination of the swamp vegetation. However, if floods are lacking over a longer period this lowers the biomass production.

The evaluation conducted reveals that the pastures of the Babina island area as well as in the total area of the Danube Delta biosphere reserve show mean value with an average production of 9.8 t/ha. The sustainable management and use of the grassland requires that the number of animals has to be adapted to the pasturing capacity. A concise documentation of the animal stands is essential.

filtrată, demonstrând astfel funcția de filtru a stufului şi crearea unor stațiuni caracteristice apelor limpezi. Aceste brâuri au apărut şi s-au conturat bine din al treilea şi al patrulea an după reconectare.

Redezvoltarea în timp foarte scurt a vegetației acvatice duce la concluzia că în acest proces driftul de plante sau segmente din plante, dar mai ales existența diasporilor / unităților de reproducere a plantelor din aria ostrovului joacă un rol important în repopulare.

Vegetația palustră limitrofă apelor şi pajiştile umede s-au redezvoltat de asemenea în timp relativ scurt. Plante cu mare potențial de semințe, rădăcini / rizomi de plante rămase în sol după indiguire şi specii higrofile cu înmulțire vegetativă prin stoloni, ce pot împânzi repede suprafața solului, s-au întins în scurt timp ocupând mari suprafețe. Stufărişurile s-au refăcut şi s-au revigorat repede stabilizându-se după o perioadă lungă de uscăciune cauzată de indiguirea şi drenarea terenului. Astfel refăcute, ele constituie o resursă importantă utilizabilă pentru populația locală.

Vegetația halofilă din partea vestică a ostrovului, care în incinta deconectată de apele Dunării se întinsese pe suprafețe relativ mari cu tendință de creştere, s-a redus prin reinundare şi spălarea parțială a sărurilor. Ea există totuşi şi în prezent pe suprafețe mai reduse. Acolo unde se dezvoltă, e reprezentată preponderent prin specii caracteristice pentru soluri cu conținut redus de sare (*Bolboschoenus maritimus, Cynodon dactylon, Crypsis aculeata*).

Dată fiind reducerea vegetației halofile a fost posibilă redezvoltarea de pajişti umede nehalofile specifice locului, amestecate şi cu rogozuri, permițând astfel folosirea pajiştilor ca şi înainte de îndiguire, poate chiar mai bine, pentru păşunat. Reinundarea şi oscilațiile de nivel ale apelor joacă un rol important pentru dezvoltarea pajiştilor din zonă. La evenimente extreme de inundare are loc o deplasare spre condiții mai umede, ceea ce se recunoaşte prin apariția mai multor specii caracteristice de zone umede. Lipsa inundării pe o perioadă de timp mai îndelungată provoacă uscarea suprafețelor ocupate de pajişti, ducând la o reducere a producției de biomasă şi prin aceasta a calității pajiştilor.

The high diversity of macro- and microhabitats in the terrestrial and semi-aquatic area allow the reactivation of an extremely high biodiversity especially with regard to the arthropode fauna. The species spread along ecological gradients that cover a broad range between arid and moist.

The re-flooding implied that the habitats of site-specific bird species, i. e. resting, breeding and feeding grounds have redeveloped and became more diversified. As a result the avifauna shows a multifaceted species composition. Observations document that the two islands Babina and Cernovca represent major feeding and resting grounds for birds living in the north-eastern part of the Delta or passing by.

The restoration of Babina and Cernovca islands and the reestablishment of site-characteristic habitats and food sources has also been to the benefit of both the European mink (*Mustela lutreola*) and the European otter (*Lutra lutra*).

The restored area is also of major relevance for the NATURA 2000 network, namely due to the existence of habitats that are listed in Appendix I of the FFH-directive and that require the classification as protected areas as well as to species listed in Appendix II of the FFH-directive and in the appendixes of the European Council Directive on the conservation of wild birds.

The redevelopment of characteristic wetland landscape values are of great interest to tourists visiting these areas and may thus benefit in various forms to ecotourism.

The success of such uses for tourism however depends on tourism development in the area of Chilia Veche, Perprava and C.A. Rosetti. Offers to tourists have to be diversified and the two restored islands of Babina and Cernovca with their manifold nature observation and recreation possibilities have to be integrated in the proposed trails.

The ecological effects observed after the restoration measures have been completed are new habitats for plants and animals, broader spawning grounds for fish as well as extended habitats for aquatic birds, hydrological dynamics and water storage, sediment retention, fixing of toxic sub-

Evaluarea efectuată scoate în evidenţă faptul că pajiştile pe raza ostrovului Babina, ca şi cele de pe teritoriul Rezervaţiei Biosferei Delta Dunării în general, au o valoare mediocră şi o producţie medie de 9,8 to/ha. Pentru aplicarea unui management corespunzător şi folosirea durabilă a acestor pajişti este necesar să se adapteze numărul animalelor la suportabilitatea terenului. Pentru aceasta este necesară o inventariere exactă a efectivelor de animale din raza ostrovului.

Marea diversitate a macro- şi microhabitatelor în ariile terestre şi semiacvatice a dus la refacerea unei biodiversităţi extrem de bogate în special în cazul faunei de artropode. In răspândirea lor speciile sunt repartizate dea lungul unor gradienţi ecologici, având o gamă largă între condiţii aride şi umede.

Prin reinundare s-au redezvoltat şi s-au diversificat habitatele pentru speciile de păsări caracteristice zonei, existând zone de popas, de cuibărit şi de hrană, pentru un spectru diversificat de avifaună. Observaţiile documentează că cele două ostroave Babina şi Cernovca constituie locuri importante de hrănire şi de popas pentru specii de păsări ce trăiesc în nord-estul Deltei Dunării sau care trec prin această zonă în timpul migraţiei.

Reconstrucţia ecologică a ostroavelor Babina şi Cernovca şi refacerea habitatelor caracteristice de zone umede cu resursele lor de hrană, au avut un efect pozitiv şi asupra populaţiilor de nurcă europeană (*Mustela lutreola*) şi a vidrei (*Lutra lutra*).

Aria renaturată are o importanţă deosebită şi pentru reţeaua NATURA 2000 şi anume prin prezenţa unor habitate listate în Anexa I şi a unor specii incluse în Anexa II a Directivei FFH. Atât habitatele cât şi speciile menţionate necesită desemnarea de arii speciale de conservare. Pe lângă acestea sunt prezente specii listate în Anexa I a Directivei de Păsări, aceste specii necesitând desemnarea de arii speciale de protecţie avifaunistică.

Redezvoltarea valorilor unui peisaj tipic de zonă umedă reprezintă atracţii turistice deosebite pentru vizitatorii acestor zone, astfel încât ele pot fi folosite pentru diferitele forme de ecoturism. Succesul unor astfel de folosinţe în scopuri turistice depinde însă de dezvoltarea turismului în general în zona

Fig. 80: Traditional house with thatched roof (Chilia Veche)
Casă tradițională cu acoperiş de stuf (Chilia Veche)

stances and an important function as biofilter for the Black Sea. All these effects have generated remarkable economic benefits. They result in considerable amounts of fish, reed, medicinal plants and interesting aquatic landscapes for tourists. The reestablishment of these functions entails the development of existential values such as natural biological resources, to the benefit of the local population and of major importance for the local, regional and national economy.

This is why these restored areas are a perfect showcase for the redevelopment and broadening of natural habitats for fish, birds and further species that may contribute to the expansion of the Natura 2000 network.

In this context the Danube Delta Biosphere Authority, as beneficiary of the ecological restoration measures and thanks to their management objectives, provides both for the protection and conservation of areas comprising natural habitats and a site-specific biodiversity and the use of the existing natural resources. The latter are used according to the local populations' consumer requirements within the limits of the natural biological potential and its regenerative properties.

Chilia Veche, Periprava şi C. A. Rosetti. Această dezvoltare se referă la diversificarea ofertelor turistice şi de includerea celor două ostroave renaturate Babina şi Cernovca în trasee turistice folosite pentru observații în natură şi recreere.

Efectele ecologice constatate după finalizarea lucrărilor - noi habitate pentru plante şi animale, extinderea zonelor de reproducere pentru peşti şi păsări acvatice, flux hidrologic şi stocare de apă, reținere de sedimente şi fixarea de substanțe toxice, biofiltru pentru Marea Neagră - au generat mari beneficii economice materializate în cantități importante de peşte, stuf, plante medicinale şi peisaje pentru ecoturişti.

Odată refăcute, funcțiile naturale dezvoltă anumite valori existențiale, ca resurse biologice naturale de care pot beneficia localnicii şi care sunt importante pentru economia locală, regională şi națională. Astfel, zonele renaturate urmare lucrărilor de reconstrucție ecologică, constituie un model pentru extinderea habitatelor naturale pentru specii de peşti, păsări şi alte specii, care pot fi incluse ulterior în rețeaua Natura 2000.

In acest context, Administrația Rezervației Biosferei Delta Dunării Tulcea - în calitate de beneficiar al lucrărilor de reconstrucție ecologică - asigură prin obiectivele de management, protecția şi conservarea unor zone de habitat natural şi a diversității biologice specifice, precum şi valorificarea resurselor naturale disponibile, potrivit cerințelor de consum ale populației locale în limitele potențialului biologic natural de regenerare a acestora.

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THE DANUBE RIVER AND DANUBE DELTA IN FIGURES

THE DANUBE RIVER
Is the 2nd longest river in Europe (after the Volga) with a length of 2 840 km (out of which 1 072 km in Romania)
Rises in the Black Forest (Germany) out of 3 springs (Breg, Brigach and Donau Quelle) and flows into the Black Sea (Romania) through 3 arms (Chilia, Sulina and Sf. Gheorghe) forming the Danube Delta
Has a catchment area of 817 000 km² (8% of Europe's area)
Most international river basin in the world
Flows through 10 countries (Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Republic of Moldavia and Ukraine), 4 capitals (Vienna, Bratislava, Budapest and Belgrade) and has tributaries in other 8 contries (Poland, Czeck Republic, Switzerland, Italy, Slovenia, Bosnia and Herzegovina, Macedonia and Albania)
For 80 milion people, it is home
Its medium discharge before forming the delta is of 6 350 m3/s with an arm distribution as follows: Chilia–58 %, Sulina–19 % and Sf.Gheorghe -23 %

THE DANUBE DELTA
Lies in Romania and Ukraine and has an area of 4 170 km² out of which 82 % (3 446 km²) in Romania and 18 % (732 km²) in the Ukrain.
With such an area it is the 22nd delta in the world and the 3nd one in Europe (after the Volga and the Kuban deltas)
One of the world's largest wetlands - as a water bird habitat
The largest dense reed area in the world - 1 560 km²
A real biodiversity museum - 30 ecosystems (23 natural and 7 anthropic ones)
1 839 flora species
3 541 fauna species (135 fish species and 331 bird species)
The place where one can see
the greatest European population of White Pelican (8 000 ex) and of Dalmatian Pelican (400 ex)
60 % of the world's Pygmy Cormorant population (6 000 ex)
50 % of the world's Red-breasted Goose population (40 000 in winter)
10 ”monument to nature” species: White Pelican, Dalmatian Pelican, Spoonbill, Great White Egret, Little Egret, Shelduck, Ruddy Shelduck, Black-winged Stilt, Raven and Egyptian Vulture
The only delta in the world that has been declared a BIOSPHERE RESERVE (out of the 531 UNESCO biosphere reserves from 105 countries)