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V.2.14. Carabid and Stahylinid communities as indicators of changes in floodplain forests in the area affected by the Gabčíkovo project

Zbyšek Šustek

General characteristics of Carabid and Staphylinid communities and their successional stages in Central Europe

The natural Carabid and Staphylinid communities in European floodplain forests represent a wide scale of communities consisting potentially of about 120 species of Carabids and about 100 species of Staphylinids. Because of the azonal character of these communities and the high proportion of species having a large range of geographical distribution (holarctic, panpalearctic, transpalearctic, Eurosiberian), these communities show a considerable uniformity of species composition throughout the western parts of the palaearctic subregion. In concrete localities, however, the natural communities of both families are not so rich in species. Species number are mostly in the range of around 30 species of Carabids and 30 species of Staphylinids occurring simultaneously in a locality. Only rarely does species number in a more or less homogeneous locality exceed 50 species of either family.

Depending on local conditions, especially the hydrological regime and character of floods, the communities show a high structural variability. This variability represents a wide gamma of states ranging between three idealized points **[16]**:

1. communities in floodplain forests with a high ground water level and flooded several times a year by water flowing through the stand and disturbing the herbage layer and litter,
2. communities in floodplain forests with high groundwater level and flooded periodically by stagnant water, usually in early spring,
3. communities in floodplain forests with deep ground water level, flooded only sporadically, situated at the margins of floodplains and representing a fluent transition to mesohygrophilous forest communities.

Each of these idealized states has its characteristic species composition with defined proportion of some characteristic species or ecological groups of species:

1. Forests with a dynamic character of floods are characterized by a predominance of the following species: Carabids *Europhilus fuliginosus, Europhilus micans, Patrobus excavatus, Asaphidion flavipes, Platynus assimilis* and Staphylinids *Oxytelus rugosus, Oxypoda spectabilis, Tachinus rufipes*. Occasionally species characteristic of muddy or sandy shores of different water bodies can occur and temporarily obtain a high dominance (*Bembidion femoratum, Bembidion dentellum*).
2. Forests with stagnant character of floods are characterized by a predominance of the following species: Carabids *Pterostichus anthracinus, Pterostichus nigrita, Agonum moestum (s.l.), Bembidion biguttatum* and Staphylinids *Staphylinus erythropterus, Philonthus decorus*. Species like *Europhilus micans, Patrobus excavatus* and *Platynus assimilis* also can reach a considerable quantitative represenation.
3. Sporadically flooded forests are characterized by a dominant occurrence of the following mesohygrophilous species: Carabids *Carabus coriaceus*, often *Carabus ullrichi* or *Carabus scheidleri, Abax ater, Abax parallelus* and Staphylinde *Philonthus decorus*

For all three types of communities the presence of *Carabus granulatus* is characteristic, this reaching a high dominance in the first two types of communities, while in the third type it is usually only admixed. Generally, even very little changes in structure ofthe Carabid community are among the first signs of changed moisture.

The borders between communities existing along the three ecological gradients are very flexible in time and space. They continuously shift according to the ecological requirements of individual species **[1, 2, 3, 4, 5, 7, 25, 26]**, momentary humidity in the locality (discharge, groundwater level, length and frequency of floods) and precipitation quantity and their temporal distribution even within a vegetation season. The distinctness of borders or the width of transitional zones also depends on the local configuration of terrain. Considerably different Carabid and Staphylinid communities can be found even on small elevations of 1-2 m or sharply cut terrain terraces, etc.

In general, succession of the Carabid and Staphylinid communities of floodplain forests after their artificial drying off can run in two principally different ways [14, 15, 19, 20]:

1. If the change in hydrological regime does not exceed the tolerance of the edificatory woody plants and if the spatial integrity of the forest is preserved, the succession can have three distinctive phases.
   - In the first phase the strongly hygrophilous species are gradually replaced by more tolerant species, among which 1-2 species (mostly *Patrobus atrorufus, Platynus assimille* or *Nebria brevicornis*) can reach a remarkable dominance and abundance [10, 13, 11, 12]. This phase is especially characteristic for some urban parks, floodplain forests on city margins or floodplain forests exposed to other forms of anthropogeneous pressure. It can represent a permanent stabilized state.
   - The second phase is characterized by a strikingly high dominance of a mesohygrophilous species (mostly *Carabus coriaceus*, less often by *Carabus violaceus*) provided with the opportunity of invading the dried floodplain forests [9, 13, 15] from surrounding mezohygrophilous forests, or they can also be drifted by occasional floods and then successfully reproduce in such places. This phase is characteristic for remnants of floodplain forest in free landscape with limited conditions for immigration of other mezohygrophilous species and can represent also a long-term stabilized state.
   - The third phase is characterized by the simultaneous spread of more mesohygrophilous species (*Carabus ullrichi, Catabus coriaceus, Abax ater, Abax parallelus, Abax carinatus, Carabus convexus*) inhabiting the adjacent forests lying out of the floodplain. The communities arisen in this way can obtain a structure, which would correspond to a natural or semi-natural state [15] in other places. This phase is characteristic of dried floodplain forest in free landscape where there exist suitable conditions for immigration of mesohygrophilous species. It means in such places, where tThe continuity of gradient between the forest in the floodplain and the surroundings has been preserved.

2. If the change in hydrological regime exceeds the tolerance of the edificatory trees, especially if it is also combined with other anthropogeneous interventions (timber exploitation) and the forests stand disintegrates, the succession results in an ecotonal community consisting of a relatively large number of species of very different ecological character, occurring mostly in a low number of individuals. This trajectory of community succession is characterized by penetration or sometimes even a high dominance of strongly expansive "field" Carabids like *Pseudophonus rufipes* or *Trechus quadristriatus* [13].

The real trajectory of the community succession often represents, however, a combination of these two principal possibilities.

Carabid and Staphylinid communities in floodplain forests in the area of the Gabčíkovo hydraulic structures

Pre-dam state

In a wider area of the zone actually or potentially influenced by the Gabčíkovo hydraulic structures, almost all generally described states of Carabid and Staphylinid communities of floodplain forests can be found. The habitats where they occur could be used as reference plots for long term monitoring. However, some of them occur in more remote places and are not in direct contact with the communities in the proper zone along the Danube main stream and the by-pass canal. The existence of the Gabčíkovo structures represents an obstacle inhibiting their function as an immigration resource of species into the bypassed area.

In the immediate vicinity of the Danube old stream and by-pass canal, two principal types of communities existed before the Gabčíkovo project was put in operation [6, 24].

The first type, with several varieties, was widely spread in the within-dike zone (Šuľany, Kráľovská Lúka, Istragov) and was characterized by co-dominance of Carabids *Patrobus atrorufus, Platynus assimilis, Carabus granulatus, Pterostichus strenuus, Pterostichus melanarius* and subdominant occurrence of strongly hygrophilous Carabids *Oxypselaphus obscurus, Europhilus fuliginosus* and *Europhilus micans* and Staphylinids *Oxytelus rugosus*, and *Tachinus rufipes*. In close vicinity of the pleisopotamal type arms the species *Agonum moestus* (s. l.), *Oodes helopioides and Bembidion biguttatum* enriched the communities.

The second type was characteristic for small remnants of floodplain forest out of the dikes and remaining out of any direct influence of floods (e.g. Kopáč, Rusovce, Čičov). In these forests, the species *Carabus ullrichi, Carabus coriaceus, Carabus scheidleri, Carabus granulatus, Pterostichus niger, Ptrostichus melanarius* were also either dominant or subdominant. Among the staphylinids, *Tachinus rufipes* and *Philonthus decorus* dominated.

In both types of communities the size of the one season catch in ten traps moved in the range of 900-1200 individuals.

Dunajské Kriviny represented an exceptional case among the monitored localities. The Carabid community here consisted almost exclusively of polyhygrophilous or even ripicolous species, but they always showed a considerably lower abundance (300-400 individuals) than in other localities due to the special character of the relief (small isolated islands of gravel mounds overgrown by trees and shrubs in a former Danube arm, the bottom of which was often filled with water).

State after damming

After the Gabčíkovo structures were put into operation, the Carabid and Staphylinid communities passed through three distinctive successional stages up to 1997, when this part of monitoring was stopped [23, 24].

The first stage in 1993-1994 was characterized by a strong increase (2-3x) in the number of individuals of two less hygrophilous or more tolerant Carabid species, *Pterostichus melanarius* and *Pterostichus niger*, and in some localities also by *Carabus granulatus* and *Pterostichus strenuus*. Simultaneously, the abundance of all other species, especially of *Platynus assimilis, Patrobus atrorufus Oxypselaphus obscurus, Europhilus fuliginosus, Europhilus micans* and of the Staphylinids *Oxytelus rugosus* and *Tachinus rufipes*, declined. The total size of the one season catch, however, increased even to as much as 3,000 individuals due to a very high abundance of *Pterostichus niger* and *Pterostichus melanarius* and in some places also *Carabus granulatus*. As these three species are relatively large (body length 16-23 mm, the biomass of the total catch increased 5-6 times to about 1 kg of dry biomass. The weighted average index of humidity preference of Carabids (expressed by an eight-degree scale, in which 1 means strongly xerophilous, 4-5 mezohygrohilous, 8 strongly hygrophilous [25], decreased by 0.6-0.8 in this stage (for example at Kráľovská lúka from 6.9 to 6.3, in Šuľany from 6.5 to 5.7).

The next stage in 1995-1996 was characterized by two contradicting tendencies. One tendency was a sudden drop in the abundance of *Pterostichus niger* and *Pterostichus melanarius* (and in some places also of *Carabus granulatus*) and the continuing decline in the abundance of other hygrophilous species [18]. The second tendency was the invasion and slight increase of moderately hygrophilous *Epaphius secalis* and

invasion of the xenocoenous *Trechus quadristriatus*, a frequent inhabitant of fields and ruderals [17]. The total size of the one-season catch declined back to about 1,000 individuals and the biomass of the total catch dropped suddenly to 70-200 g of dry biomass. The weighted average index of humidity preference of Carabids remained on the decreased level seen in 1993.

The third stage was represented only by the year 1997. In this year a slight re-appearance of hygrophilous species was observed in all localities. It was also reflected by the weighted average index of humidity preference of Carabids, whose values slightly increased (for example at Kráľovská lúka from 6.3 to 6.7, at Šuľany from 5.8 to 6.0), although they did not reach the pre-dam level. In spite of a certain improvement of community structure, the high proportion of *Trechus quadristriatus* was preserved, though its number slightly declined. The positive turn of the succession may be explained in two ways:

1. the simulated flooding as such had doubtless a positive effect,
2. the season 1997 was strongly rainy and accompanied by floods in Moravia and Austria and consecutively with increased discharge in the Danube and increased level of ground water. Both these factors might contribute to the creation of more favourable conditions for Carabids and Staphylinids, similarly as they did it in the remote floodplain locality Ranšpurk (confluence of the Dyja and Morava rivers) [21, 22]. A synergic effect of these natural factors and the simulated floods is probable. Unfortunately, the stop of monitoring in 1997 did not allow further development to be observed.

These stages were a little shifted in individual localities. A small delay in the effects described above was observed at Istragov, which is influenced by backwater from the tailrace canal [21, 23, 24].

Both last stages were characterised by limitation of the occurrence of some persisting polyhygrophilous species occurring originally over the whole vegetation season to the early spring months .

A special case was the monitoring plot at Dunajské kriviny, where the strong increase in the abundance of *Pterostichus melanarius* and *Pterostichus niger* did not occur at all. Here a strong decline or even total disappearance of hygrophilous species started already after the Danube damming and already from that time it was accompanied by invasion of xenoucoenous *Trechus quadristriatus* and *Harpalus rufipes*. In 1997 only a very slight indication of improvement in the community structure was observed. This community obviously tended (up to 1997) toward total degradation. Doubtlessly the special terrain configuration represented a significant predisposition to such a development, but there was also a combination of other reasons. The tree vegetation was covering only the gravel islands in the former river arms, whereas the "bottom" between them overgrew only by herbage vegetation during the first phases of vegetation succession after the end of the flood. This stimulated an invasion of xenocoenous species. The locality was excluded from the water supply from the intake-structure at Dobrohošť and was not artificially flooded. In addition, an enormously strong colony of ant *Lasius* sp. strongly inhibited the development of communities of any other soil surface animals [17, 18, 21, 23, 24].

General remark

The difference between adaptive succession at Dunajské Kriviny and at other localities in the within-dike zone showed the positive effect of supplying the arm system with water from the by-pass canal. This prevented the total, and probably very swift, degradation of ecosystems in the affected area. The final state of the community at Dunajské kriviny can be taken as an example of the probable state of communities on the major part of the within-dike zone, if the water supply of river arms would not have been constructed.

Possibility of restoring affected communities

The obviously high sensitivity of Carabid, and to a smaller extent also of Staphylinid communities, to changes in hydrological regime of floodplain forests and other floodplain habitats is compensated by their strong flexibility to temporal fluctuations in humidity and good ability to restore or even completely build up a (semi) natural community on previously completely devastated plots. This ability has been proven even in the condition of urban parks [10, 13]. For this reason, if the proposals for restoration [8] of the remnants of the Danube inland delta are to be applied, there is a strong chance of their success. Realisation of this concept would also provide a chance for restoration of temporal insect communities living on the denuded loamy, sandy or fine gravely convex shores of meanders. These communities consist of highly specialized ripicolous species of Carabidae (genera *Bembidion, Dyschirius, Cicindela littoralis*) and Staphylinidae (genera *Bledius, Troglophloeus, Stenus, Gnypeta, Atheta*), which belong to characteristic components of

natural riverine ecosystems. They were not a subject of systematic monitoring, but occasional faunistic data show their decline in the Danube floodplain in recent decades, and the present hydrological regime in the arms does not create suitable conditions for them.

Need for monitoring in future

The present situation is not only a result of the direct influence of the Gabčíkovo structures, but there is obviously a strong and now probably even more significant influence of secondary increasing human activities, in particular where recreation and silviculture are concerned, especially carried out by private land owners. In addition, strong climatic fluctuations are also acting, especially the tendency to warming and drying of the climate, which have a strong effect on the next succession of animal communities. A detailed knowledge of these processes is essential for correct interpretation of the observed changes and for corresponding management of this area, for harmonisation of all its functions and, foremost, for preventing any undesired changes in the geosystem of the surroundings of the Gabčíkovo structures. This monitoring, however, should not cover only the immediate vicinity of the hydraulic structures. A network should be built up of reference monitoring plots in similar ecosystems in more remote places or even in the floodplains of some tributaries of the Danube. This would allow the distinguishing of specific features of the succession of ecosystems in the area under direct influence of the Gabčíkovo hydraulic structures from general trends common at least for the whole Carpathian basin or Central Europe. This type of more widely build up system would considerably increase the quality and reliability of interpretation of the obtained data.

As to the **methods of monitoring** fauna, the monitoring should be carried out on two levels. The first level would be carried out on a relatively small number of selected monitoring plots by means (according to possibilities) of quantitative methods representative of particular animal groups (in the case of Carabidae and Staphylinidae by pitfall-trapping) and evaluated in the same way as the monitoring from the period 1992-1997. The only modification suggested is a certain reduction in the extent of quantitative sampling at each plot. One reason for this is a reduction of extensive loading of the populations monitored by destructive sampling methods; another reason is a decrease in the time required for laboratory processing and identification of the caught material and more effective use of the time capacity of individual specialists. This level of monitoring would also cover more remote localities.

The second level should include individual collectings or short-termed sampling by quantitative methods on a large number sites (habitats) selected *ad hoc* in different places. This method of monitoring could record very flexibly, and with minimal effort and costs, the presence or disappearance of some sensitive species and changes in their local distribution. It should be focused especially on different terrain depressions and arm shores, where strongly specialized hygrophilous or rare species can survive in the narrow zone around such water bodies (see above). Furthermore, this level of monitoring could supply operative information for modification of the network of permanently monitored plots.

However, in the opinion of the author, the monitoring of biota should not be limited merely to monitoring the ecological consequences of human activities in a relative small area, but an overall monitoring service of biota in Slovakia should be gradually built up. This concept would be analogous to the present meteorological service or the insect-pests signalising service in agriculture. It would not only have a practical significance for landscape management and nature protection, but could also continuously supply a lot of data important for theoretical research.

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V.2.15. Bird fauna and bio-monitoring concept of the Danube flood plain affected by the Gabčíkovo project

Mirko Bohuš

Analysis of changes in the composition of bird communities and of the abundance of individual bird species in the area influenced by the construction and operation of the Gabčíkovo structures, represents a problem due to the low level of compatibility of earlier data (before the structures were put into service) and present data (after operations were started). Defining the "initial state" or state of natural bird communities is also problematic due to the natural dynamics of the respective ecosystem. A relative small number of published relatively new data is available, but even available data are extremely heterogeneous from the viewpoint of applied methods and the intensity and extent of conducted investigations. Nevertheless, there are several topics that can be evaluated at least in a general sense. A general review of birds in the Gabčíkovo area is given by Rybanič **[25].**

Summary of main topics and results of recent investigations on the birds

Relatively complex data about the wintering population of wetland birds is available. A regular annual winter census of wetland birds has been carried out in Slovakia already for several decades. From 1991 the Institute of Zoology of the Slovak Academy of Sciences coordinated the census, but now it is coordinated by the Society for Bird Protection in Slovakia. However, the data have not been summarized or published in an adequate manner. Results of winter censuses from two winter seasons (19 January 1991 and 18 January 1992) were published by Darolová **[12, 13]**, who also published the level of coverage of the Danube by individual census-takers. After more than a decade, Ridzoň **[23]** published data from a census conducted in the winter of 2003/2004. The data published by both authors refer to individual stretches of the Danube in a different way and to a varied extent. Although to a large extent the nature of the census also makes it possible to define the local data, determining the species composition of communities and the abundance of individual species of wetland birds, as well as their spatial relationships, requires a different design of processing and presenting data than was applied in above cited papers giving summarized information. It is very probable that the census coordinators archived the collated data, and their interpretation should be possible even subsequently.

Building up an extensive body of the Čunovo reservoir (to a large extent not freezing) created suitable conditions for transmigrating and wintering waterfowl, which are dependent on large water tables. At present, the reservoir is one of the most important wintering areas of certain species of waterfowl, in particular the Tufted Duck (*Aythya fuligula*) and the Common Porchard (*Aythya ferina*), whose number reached 10330 in November 2003, **or 5110 individuals respectively, Ridzoň **[23]**. The established count of Mallards (*Anas platyrhynchos*), Coots (*Fulica atra*) and Common Goldeneyes (*Bucephala clangula*) were 5750; 4860 and 420, respectively. According to this author, in January 2004 on the whole of the Slovak or Slovakia adjacent stretch of the Danube there were 22422 Tufted Ducks, 9027 Common Porchards, 15884 Mallards, 6326 Coots and 11953 Common Goldeneyes. Darolová **[12]** gives the following numbers for the same species *Aythya fuligula, A. ferina, Anas platyrhynchos, Fulica atra* and *Bucephala clangula* in the winters 1991/1992: 721/1734, 607/131, 12496/17955, 448/310 and 1341/2015 individuals. Accounting for the different coverage of the Danube by census-takers it would be improper to define any trends on the basis of these data. These data provide information only about the state of wintering populations at the given time on the particular set of censed stretches of the Danube. In spite of the high number of wintering waterfowl, it is also necessary to consider the extraordinarily broken topography of the original river arm network. This made it impossible, and the preserved fragment of the arm system still makes it impossible, to achieve the level of accuracy that would be at least partially comparable to the census accuracy achieved on an open water surface like the Čunovo reservoir.

The applied line method of census, in combination with uniform timing of the census, produces relatively accurate data about the species composition of communities and the quantity of individual species. On the