

A comprehensive three-year herpetological survey in the Gemenc Region of the Duna–Dráva National Park, Hungary

By

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Abstract. This study summarizes the results of the first general herpetological survey of the Gemenc Region of the Duna (=Danube)–Dráva National Park. Altogether nine amphibian and four reptile taxa were recorded in the diverse riparian habitats. The reproductive success of the common amphibian species was greatly influenced by the water level fluctuation of the Danube. The amphibian community size of Gemenc District was estimated to fluctuate between 16 and 238 million individuals. The occurrence of deformities in the protected area is a cause of concern.

The study of amphibians in protected areas is an important task of modern conservation as this class disappears faster than other vertebrate classes from temperate and tropical ecosystems (Griffith & Beebee, 1992) and they seem to be more endangered than e.g. birds or mammals. (As an example see Fig. 1 modified from Abramovitz, 1996.) Often, species disappear without any obvious natural or anthropogenic cause (Blaunstein & Wake, 1990; Wake, 1991; Wyman, 1990) and in general, there is an obvious and statistically significant amphibian decline in the Northern Hemisphere (Houlahan et al., 2000). In most documented cases the disappearance or considerable decline of amphibians is primarily caused by habitat destruction or degradation (Vial & Sailor, 1993), but other factors, such as water management, agriculture, forestry, tourism, the introduction of foreign species, acid rain, road mortality, collection, the introduction of fish into small water bodies as well as human brutality can also have a serious effect (Cooke, 1995; Corbett, 1989; Drost & Fellers, 1996; Petranka, 1994; Puky, 1991).

Several amphibian species are sensitive due to their basic biological characteristics (e.g. complex habitat requirements and moderate colonisation capacity). As a result, even temporary adverse negative effects can lead to the disappearance or decline of populations (Young, 1981). Besides, amphibians are also characterized by a considerable population size fluctuation. Therefore

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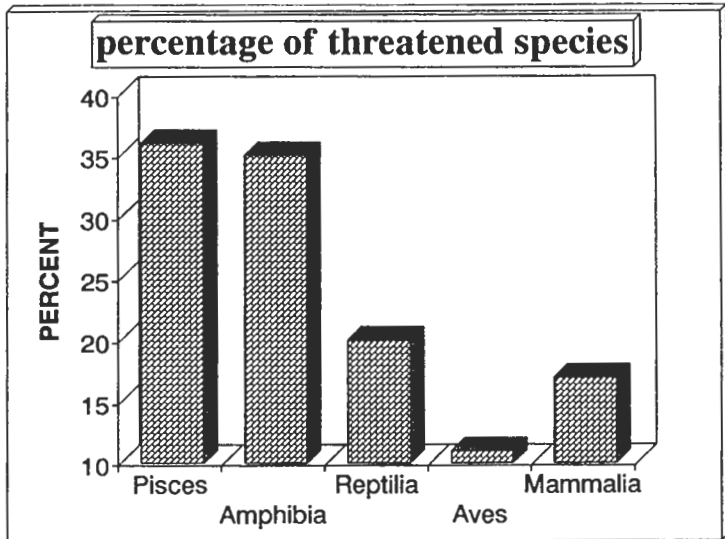


Fig. 1. The conservation status of vertebrate classes

several authors e.g. Grossenbacher (1995) and Pechman and Wilbur (1994) emphasize the importance of long-term herpetological studies in relatively undisturbed, protected areas.

In spite of these known facts, amphibians are rather badly studied, several species become extinct before they are described, especially in the tropics (but a new species, *Rana pyreneica* was also described in the 1990's even in Europe; Serra Cobo, 1993). The development of taxonomy changes the status of several taxa (including some living in Hungary), also affecting conservation needs due to the listing of new taxa in conservation treaties (IUCN, 1996). However, the lack of up-to-date information makes the effective use of these guidelines impossible. Besides, no special management plans are worked out for most amphibian species, which would be needed for the long-term conservation of amphibians (Gasc, 1997).

The distribution of reptiles in Hungary is moderately known (Gasc, 1997). Most species are sparse, studies are relatively few and local (with the exception of those on *Vipera ursinii rakosiensis*). What is more, the processing of the available data is very inadequate given that reptiles in general are more threatened than birds or mammals.

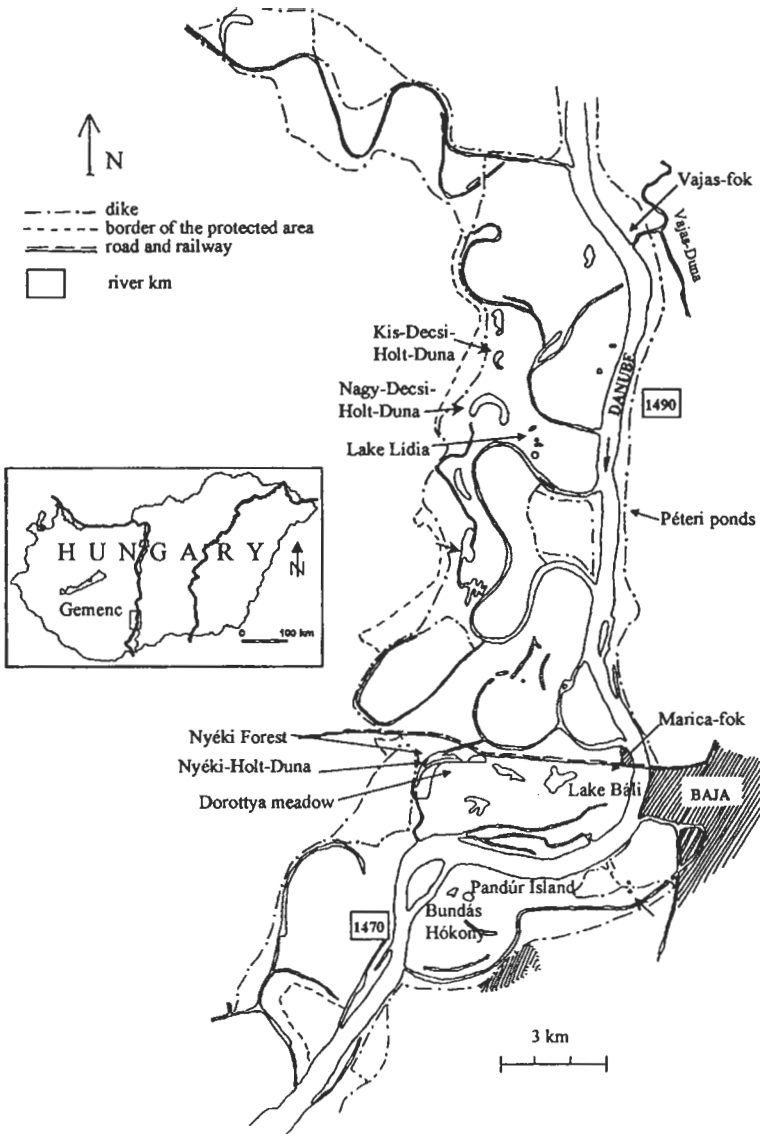


Fig. 2. Map of Gemenc

Table 1. Main sampling sites in the Gemenc Region of the Duna-Dráva National Park*

Sampling site	Short characterization
Lake Báli	A temporarily water covered area south of the No. 55. public road. A long-term sampling site
Bárányfok	An area with several small water bodies at the northern destination of the forest railway, the northernmost sampling site on the right side of the Danube
Bundás Hókony	The outer, regularly flooded part of Pandúr Island opposite to Kádár Island. A long-term sampling site
Kis-Decsi Holt-Duna	A permanent oxbow lake near the forester's house at Szomfova
Marica-fok	An area with several small water bodies east of the forester's house at Felsőpörböly, south of the No. 55. public road
Lake Lidia	A permanent water body between the Gemenc Holt-Duna and the Rezéti Holt-Duna
Nyéki-Holt-Duna	A permanently water-covered oxbow lake south to the No. 55. public road, a natural water body also having been incorporated into the floodplain water supply system constructed during the study period. Two long-term sampling sites, Nyéki Forest and Dorottya meadow are situated on opposite sides of it
Pandúr Island	Danube and Sugovica surrounded this island on the left bank of the Danube
Péteri ponds	Permanent ponds between Érsekcsanád üdülőtélep and the Sámán farm on the left bank of the Danube
Vajas-fok	A protected area conserving diverse water types, the northernmost sampling site on the left bank of the Danube

* Several further samples were also collected from a number of small, temporary or permanent water bodies.

One of the most important purposes of the 49,479 hectare Duna-Dráva National Park is the conservation of riparian habitats. It consists of several separated units mainly along the River Danube and the River Dráva. Amphibians are one of the most characteristic animal group in those habitats so their conservation is especially important there. A precondition for this goal is to carry out a basic herpetological survey with modern methods. However, as in other protected areas in Hungary, this had not been done before the present survey started in 1997.

This study was carried out to survey the herpetofauna of Gemenc, record temporal changes and describe the regional importance of different threats.

Sites and methods

With its 17,800 hectares, Gemenc is the largest protected unit in the Duna-Dráva National Park. It is situated at the western edge of the Great Hungarian Plain. It is dominated by the Danube with its 2,260 m³ s⁻¹ water

discharge and 5–7 m water level fluctuation mainly regulated by ice and snowmelting in the Alps (Bulla, 1962). Usually there is a moderate flood in March–April followed by another with the highest annual water level in June. Due to water management and its natural consequences in the last century the duration of floods is shortened and several water bodies were permanently or temporarily separated from the main arm of the Danube. However, Gemenc is still a most intact part of the Hungarian Danube section.

Samples were collected between 11th September, 1997 and 1st October, 1999. Four sampling sites (Bundás Hókony, Lake Báli, Nyéki Forest, Dorottya meadow, the latter two were situated on the opposite sides of Nyéki-Holt-Duna) were selected for long-term investigations but the whole protected area (Fig. 2) was sampled including habitats on the left side of the Danube. The main characteristics of the most important sampling sites can be found in Table 1.

Six internationally accepted methods were used to study amphibians (Fellers & Freel, 1995; Griffiths & Raper, 1994; Heyer et al, 1994; Olson et al, 1997).

Visual encounter surveys were carried out at each site. In spring mainly breeding sites were selected while in summer and autumn other habitats were also visited.

Audial surveys were always carried out when those were possible as a useful additional method. Certain species (e.g. *Hyla arborea*) are easier to detect with this method and distinguishing between the taxa in *Rana esculenta* „complex” is also possible on the basis of differences in sounds.

Road transects (e.g. determining and counting living and dead amphibians on hard surface roads) are commonly used in Northern Europe and America. Though it can only be used in areas where the road network is developed it is especially useful to record species such as *Pelobates fuscus*. In Gemenc the Baja–Pörböly and the Érsekcsanád–Érsekcsanád Údülőttelep public roads sections together with the right side (western) dikes were surveyed.

Torching and netting were done to collect newts in their aquatic phase by night and by day, respectively.

The transect method was used to estimate the number of individuals at the long-term sampling sites (Bundás Hókony, Lake Báli, Nyéki Forest, Dorottya meadow).

In autumn the growth characteristics of common species were also recorded together with the occurrence of development malformations. 51–101 individuals were studied at each site in every occasion. Length was measured with a spring balance, weight with KERN 462–41 digital scales.

Data were collected on standardised questionnaires, species and habitats were also documented by photography.

Table 2. Occurrence of amphibian and reptile species in Gemenc

Species	Right bank, northern part*	Right bank, southern part*	Left bank, north to Baja	Pandúr Island
AMPHIBIA				
<i>Triturus vulgaris</i> L.	+	+	+	
<i>Triturus dobrogicus</i> K.	+	+		
<i>Bombina bombina</i> L.	+	+	+	+
<i>Bufo bufo</i> L.	+	+	+	+
<i>Bufo viridis</i> L.	+	+	+	
<i>Pelobates fuscus</i> L.	+	+	+	
<i>Hyla arborea</i> L.	+	+	+	+
<i>Rana dalmatina</i> B.	+	+	+	+
<i>Rana esculenta</i> c.**	+	+	+	+
REPTILIA				
<i>Lacerta agilis</i> L.	+	+	+	+
<i>Natrix natrix</i> L.	+	+	+	+
<i>Elaphe longissima</i> L.		+		
<i>Emys orbicularis</i> L.				+

* Areas north or south of the No. 55. public road on the right side of the Danube

** Explanation see in the text

Results and discussion

Faunistic results

Altogether nine amphibian and four reptile taxa (species) were recorded in Gemenc. Their overall distribution can be found in Table 2. The water bodies in the protected area are functionally very well connected as floods enable amphibians to cover greater distances than in other habitats. Because of this phenomenon the data in Table 2. are from larger areas, which involve several different breeding sites (Figure 3).

Rana esculenta „complex” is the commonest of the amphibian taxa in the region. (Audial results indicated the presence of *Rana lessonae*, which was also supported by the study of Prof. Beebee, University of Sussex, who also proved the dominance of *Rana lessonae* by mitochondrial DNA analysis). *Hyla arborea* was also quite common.

From a conservation viewpoint, the presence of three International Red Data Book species (*Hyla arborea*, *Bombina bombina*, *Triturus dobrogicus*) is the most important feature (IUCN, 1996) so the ratio of internationally important, threatened species is high in Gemenc. Due to zoogeographical considerations, *T. dobrogicus* is the most valuable of the three internationally listed species in Gemenc (Nöllert & Nöllert, 1992). It is a member of the *Triturus cristatus* group and according to modern data (Arntzen et al., 1997),



Lake Báli in March, 1998



Lake Báli in September, 1997



Lake Nyéki in July, 1998



Lake Báli in July, 1999

Fig. 3. Key habitats and herpetofauna species in Gemenc

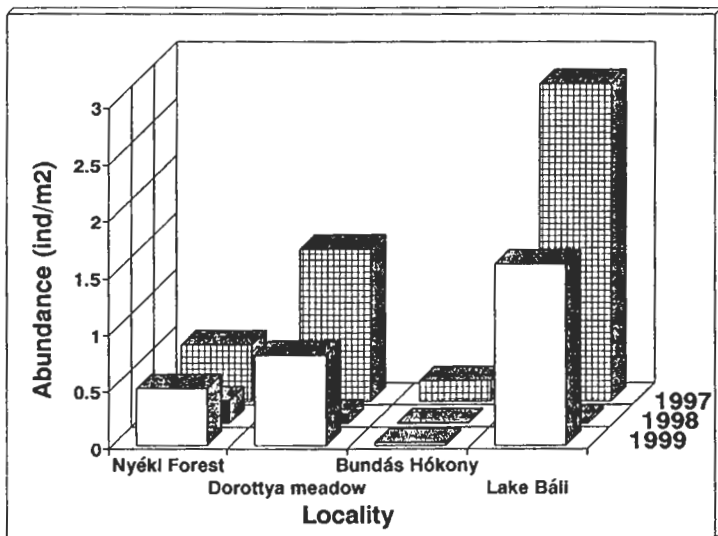


Fig. 4. Abundance of juvenile *Rana esculenta* „complex” individuals in 1997-1999

most Hungarian records should belong to *T. dobrogicus*. However, except for one Hungarian record in a general paper, there are no earlier studies on *T. dobrogicus* distribution in Hungary in spite of its central position in the distribution area. What is more, as a result of taxonomical misunderstandings and inadequate data a number of incorrect records were published. As a consequence, detailed investigations are urgently needed to clarify its distribution and status in the country. The present survey supports this hypothesis as all large newts caught so far in Gemenc belonged to *T. dobrogicus*.

As the species list indicates the Danube floodplain is not an optimal habitat for most Hungarian reptiles. This is mainly due to the regular floods. However, the colour variation of species is worth mentioning. Both *Lacerta agilis* var. *rubra* and the melanistic form of *Natrix natrix* are present in Gemenc.

In the future some other species may also be added to the herpetofauna of Gemenc. *Rana arvalis* and *Coronella austriaca* may well be present.

Similarity of the herpetofauna of the different areas (Table 2) also supports the hypothesis of exceptionally good functional connection due to regular floods between the different areas in Gemenc (when amphibians can travel in the flood). The exception is the distribution of *Emys orbicularis*, which only occasionally occurs in other parts of the region than indicated (Béla Kalocsa, pers. comm.).

The effect of water level fluctuation on amphibian populations

The reproductive success of *Rana esculenta* „complex”, the commonest taxon, was studied at the long-term monitoring sites (Bundás Hókony, Lake Báli, Nyéki Forest, Dorottya meadow). The abundance of juveniles was closely correlated with the water level fluctuation of the Danube (Fig. 4). The recorded abundance was higher than had been published in the literature (Sebela, 1993), which indicates the great carrying capacity of the area.

While spring floods formed large, shallow, temporary water bodies in 1997 and 1999, which existed till the autumn, in 1998 the river did not overflow into its floodplain in Gemenc (Fig. 3). As a result, potential breeding sites diminished so there was a considerable decrease in the number of juvenile *Rana esculenta* „complex”. individuals. An especially striking decline (of nearly a hundred times) was recorded at Lake Báli, where there is no permanent oxbow or side arm only temporary water bodies.

The study of relative abundance emphasizes the special importance of aquatic habitat diversity pattern for amphibians and their adaptation to its changes. The highest individual number of *Rana esculenta* „complex” was recorded around puddles especially if the adjacent vegetation was at least 30-40 cm high. Though these microhabitats are only temporarily available, they have two important characteristics for young *Rana esculenta* „complex” (which rapidly colonise shallow water bodies formed after floods or heavy rain). On the one hand they provide new, often large, additional feeding grounds, on the other hand by their size and separation from permanent waters they help avoid the predation of cannibalistic adults. *Bombina bombina* juveniles and adults also use these microhabitats, which were only proved to be important earlier in areas where the water supply was less favourable (Dodd, 1992). According to our study, this phenomenon is also characteristic in Gemenc, i.e. in the semi-natural floodplain of a large river.

In 1997 the length-weight relation of juvenile *Rana esculenta* „complex” individuals was similar at Lake Báli and in Bundás Hókony but strikingly different at the two sides of the Nyéki-Holt-Duna, in the Nyéki Forest and the Dorottya meadow. Also, the average length of forest individuals was nearly identical (Nyéki Forest: 2.51 cm, Lake Báli: 2.52 cm, Bundás Hókony: 2.56 cm). At the Dorottya meadow the average length and weight was 9.2 % and 38.4%, smaller than in the Nyéki Forest. Several causes can be listed for this difference, the most probable is the different food supply but the presence of

Table 3. Local importance of different factors threatening amphibians in Gemenc (The evaluation is made according to the special needs of the amphibian fauna and not the general conservation importance of the individual factors)

Threat	Local importance
Collection	Perhaps occasionally damaging but its effect is diminished by natural recruitment
Human brutality	Present locally, not very important
Eutrofication	Mainly in shallow waters
Habitat destruction	Certain forestry management practices can harm the terrestrial habitats even in protected areas
Lack of information	It is one of the most important threats
Predation by domestic animals	Due to the distance of settlements from the protected area it is not considerable
Fish introduction	It does not occur, the diversity and extent of natural waters counter-balance the egg and tadpole predation of fish
Foreign amphibians	None
Isolation, fragmentation	It is not characteristic due to the structure and dynamics of the habitats
Desiccation	In years with no floods it affects valuable breeding sites but wet years compensate
Road mortality	Locally important on the No. 55 public road and on the dikes
Pollution	Usually not considerable, but pollution can not be excluded as the cause of the strikingly high deformity rate occurring in 1999
Ultraviolet radiation	No available data

different breeding areas and consequently of some isolation can not be excluded, either.

As in 1997, in 1998 the growth rate of juvenile *Rana esculenta* „complex” individuals was slower in the Dorottya meadow than in the Nyéki Forest. In 1998 the isolation of forest habitats could be seen on growth curve differences, too.

Figs. 5 and 6 show the length-weight relationship in two different habitat types. At Nyéki-Holt-Duna, which is permanently wet, although the individual number of *Rana esculenta* „complex” juveniles decreased in 1998, their growth and body condition was similar in the three years investigated. In contrast, at Lake Báli not only did the number of individuals drop but also the colonising individuals belonged to a different cohort, i.e. they metamorphosed a year earlier (they were significantly longer and heavier and could consequently migrate over greater distances).

The hydrological and meteorological conditions improved the reproductive success of *Bufo viridis* in 1998. The lack of floods and the fast drying out of several, usually water-covered areas favoured the fast colonising species. As a result, in July 1998, numbers never previously recorded (up to 50,000 individuals in a night) crossed the right dike of the Gemenc floodplain. Their average length and weight was 2.84 ± 0.22 cm és 2.1 ± 0.6 g, respectively, so newly metamorphosed individuals moved out from the floodplain. During the whole migration, a strikingly high, more than

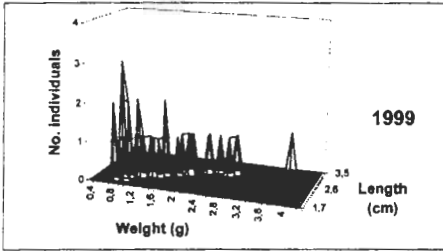
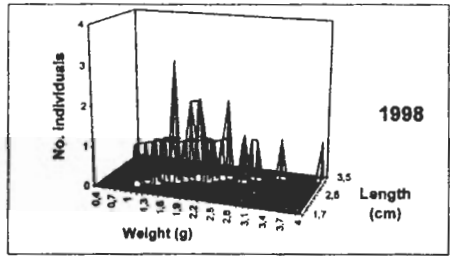
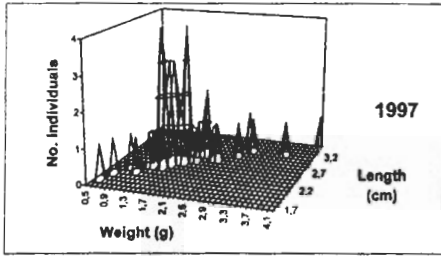


Fig. 5. Length-weight relationship of juvenile *Rana esculenta* „complex” individuals in the Nyéki Forest in 1997–1999

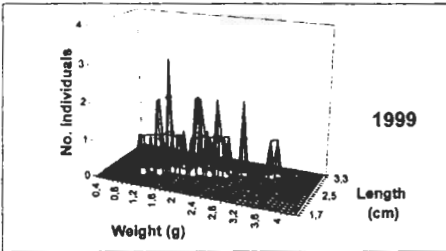
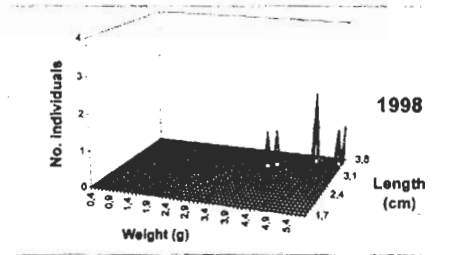
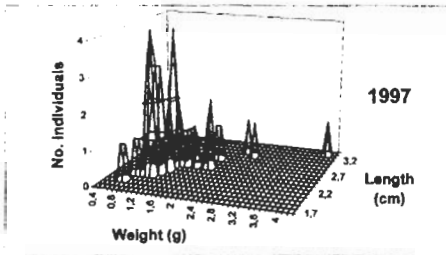


Fig. 6. Length-weight relationship of juvenile *Rana esculenta* „complex” individuals at Lake Báli in 1997–1999

100,000 (!) animals were estimated to be killed by the low traffic (less than five cars in an hour) on the dike. The road kill was especially high as approximately 6 % of the animals were also found feeding along ant paths on the hard surface. A nature conservation action plan should be worked out to avoid a similar mass mortality under similar circumstances.

Amphibian community size estimation for Gemenc

Considering the individual number, the amphibian populations greatly fluctuate even under relatively stable environmental conditions (Grossenbacher, 1995). The amphibian community, its size and biomass was estimated from the individual numbers, abundance and weights recorded in 1997-99. The following preconditions were used:

1. The floodplain amphibian community is mostly (90%) *Rana esculenta* „complex”. The proportion of other species is calculated as 10%.
2. The number of juveniles greatly exceeds adults. The total individual number contains 95% juvenile amphibians.
3. The selected sampling sites are representative and just two main habitat types are distinguished (forest, meadow), 95% of the total area is assumed to be forest, the remaining 5 % meadows. The abundance of amphibians is considered uniform within the habitat types.
4. The biomass of *Rana esculenta* c. is 90% of the total amphibian biomass.
5. The weight of juveniles is 52% of the total biomass of the species.

In the given conditions the total amphibian community size of Gemenc was estimated to be 238 million individuals in 1997, 16 million in 1998 and 145 million in 1999. The total amphibian biomass in the last third of September was calculated to be 654 tons in 1997, 67 tons in 1998 and 497 tons in 1999.

The 1997 data proved that the amphibian abundance was outstandingly high at the sampling sites. In 1998 a 90% decrease was detected while in 1999 it considerably increased (Fig. 3). The processes described above were closely correlated with the annual water level fluctuation of the Danube especially with the occurrence of floods, and the formation and duration of temporary waters in the floodplain.

The particular floodplain conditions that under special circumstances (e.g. during floods) threaten the survival of even amphibians (Bosman et al., 1997), also make the Gemenc floodplain an unfavourable habitat for reptiles in general. The characteristics discussed previously, i.e. the great diversity and variability of water cover not only provide an unpredictable environment for the terrestrial species but also threaten aquatic species, which also lay their eggs on land (e.g. by the flooding of eggs). As a consequence, reptiles are present in low numbers, which could not be accurately estimated.

Occurrence of amphibian deformities in Gemenc

Amphibians are good indicators (Khangarot et al., 1985) of environmental changes. One of the reasons is their complex development, which can react fast and with easily detectable deformities to unusual conditions. Deformities also occur under natural or semi-natural conditions e.g. following unsuccessful attacks of predators (Viertel & Veith, 1993), but in the Northern Hemisphere amphibian deformities are recorded increasingly frequently (Dubois, 1979; Gardiner & Hoppe, 1999; Quellet et al., 1997). 1-2% deformity with some variation between species is considered to be the natural background value (Vershinin, 1989, Hoppe, 1999), but today values of 10-30% are also quite common. In certain conditions, e.g. after water pollution with pesticides, this proportion can reach even 69-80% (Dubois, 1979; Quellet et al., 1997; Vershinin, 1989). The first discovery of mass deformity (30%) in North America was followed by extremely extensive research in the last decade. However, the cause of only one type of deformity was detected so far (Sessions & Ruth, 1990; Johnson et al., 1999), unless the pollution source was obvious.

In Gemenc mass amphibian deformities were first described by Jászberényi (1995). In September, 1999 an extremely high deformity level was detected in two semi-aquatic species. At Bundás Hókony 70% of *Bombina bombina* juveniles had eye, hind or front leg deformities. With *Rana esculenta* "complex" this proportion was 30% in the same habitat. To a lesser extent this phenomenon was also present in other parts of the protected area in Gemenc (Béla Kalocsa, pers. comm.).

Threats for amphibians in Gemenc

Table 3 summarizes the importance of different threats for amphibians in Gemenc. At present the most important practical tasks seem to be to carry out further general studies, and to describe in detail the occurrence of deformities and its possible causes.

Summary

The Gemenc floodplain of the Danube provides a unique habitat mosaic for amphibians in Hungary. It is mainly due to its semi-natural condition, size, special aquatic conditions, habitat diversity and sophisticated ecological relationships. Haslam (1997) suggests a 200 m wide riparian corridor as an optimal habitat size around the breeding site for amphibians. In Gemenc it is often more than ten times wider. However, the local herpetofauna was poorly studied and known, the European Herpetological Atlas (Gasc, 1997) only

mentions one species (*Hyla arborea*) from a 50 × 50 km unit overlapping the area.

The herpetological study of the Gemenc Region of the Duna-Dráva National Park recorded valuable fauna in the area. Altogether nine amphibian and four reptile taxa were recorded. With the exception of *Rana arvalis*, all typical Hungarian lowland amphibians (Dely, 1967) are present. Three "International Red Data Book"-amphibians live in the area, the most important was the new record of *Triturus dobrogicus*. The further study of its distribution in Hungary is an internationally important conservation task.

The reptile fauna of Gemenc is also mainly determined by the water level fluctuation of the Danube and the resulting water cover pattern. As their individual number is lower by several orders of magnitude than amphibian individual number and the effect of water level fluctuations is more dramatic, no reliable qualitative estimations could be made at this group.

Amphibian individual number and biomass estimations were made on the basis of three-year-data sets. Under strikingly different hydrological conditions the individual number and biomass at Gemenc fluctuated between 16 and 238 million and 67 and 654 tons, respectively.

The reproductive success of *Rana esculenta* "complex" is greatly influenced by the presence of floods and the consequent temporary waters. In 1998, due to the lack of floods, the individual number greatly declined and the length and weight values were also smaller than in 1997 and 1999 (usually significantly).

The especially successful reproduction of *Bufo viridis* in 1998 led to a very high road mortality calculated to reach a total of 100,000 individuals (when juveniles crossed the dikes). A conservation action plan should be worked out to avoid a similar situation.

Parallel to the general survey of amphibians and reptiles, possible threats were also listed, investigated and ranked. On the basis of our 1997-99 studies it is important to continue the survey of the herpetofauna in Gemenc with special emphasis on the occurrence of amphibian deformities and the herpetological investigation of the total Danubian section of the Duna-Dráva National Park.

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