

ISSUES CONCERNING THE CONSERVATION OF BIOLOGICAL DIVERSITY IN THE PRUT RIVER FLOODPLAIN (REPUBLIC OF MOLDOVA)

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Abstract. The evaluation concerning the environmental state of the representative ecosystems within the Prut River floodplain showed that the area serves as habitat for many superior and inferior plants species, fungi, mammals, migratory and sedentary birds, ichtio-, batraco-, and malacofauna. The study identified habitats that ensure survival and reproduction for many rare species that are nationally and internationally protected. It was concluded that the forest meander Pererata (Briceni district) and the floodplain near the village Antonesti (Cantemir district) requires specific protection regime, which corresponds to the categories Forest Nature Reserve and Area with multifunctional management / Floodplain with wetland vegetation respectively.

Keywords: biological diversity, representative ecosystems, habitats, valuable species, protected area.

Rezumat. Aspecte privind conservarea diversității biologice în lunca râului Prut (Republica Moldova). În rezultatul evaluării stării ecologice a ecosistemelor reprezentative din lunca râului Prut s-a constatat că sectorul dat servește drept habitat pentru numeroase specii de plante superioare și inferioare, ciuperci, mamifere, păsări călătoare și sedentare, ihtio-, batraco- și malacofaună. Au fost stabilite habitate ce asigură supraviețuirea și reproducerea multor specii rare, protejate la nivel național și internațional. S-a conchis că pădurea din Meandrul de la Pererâta (raionul Briceni) și lunca inundabilă din preajma satului Antonești (raionul Cantemir) necesită un regim de protecție special, care corespunde categoriilor de Rezervație Peisageră și respectiv, Arie cu management multifuncțional / Luncă inundabilă cu vegetație de baltă.

Cuvinte cheie: diversitate biologică, ecosisteme reprezentative, habitat, specii valoroase, arie protejată.

INTRODUCTION

Currently, the consequences of human activities on environment quality can be felt more frequently than ever. An indicator of human impact is the reduction of biodiversity livestock as a result of habitat destruction and pollution, illegal collection of plant species, capture and devastation of many animal species. In the created context, regulatory documents are needed and welcomed, including international environmental conventions, which are designed to call people of the world to conserve biological diversity in all possible ways.

Conservation seeks long-term protection and management of natural resources, registration of changes, prediction of phenomena and rational use of these. Restoration, preservation, diversification, and expansion of habitat areas are one of the essential measures for the conservation of plants and animals – an approach which is considered to be an option as long as it is possible to maintain the natural balance. In accordance with the provisions of European Council Directives 92/43/EEC - Conservation of natural habitats and of wild fauna and flora and 79/409/EEC - Conservation of wild birds, for some species of birds it is necessary to take special conservation measures concerning their habitats in order to ensure their survival and reproduction. Thus, in order to establish a coherent framework, measures must be coordinated and well directed.

Most favourable conditions for restoration and conservation of biological diversity can be ensured by compliance to regulations on protected natural areas. On this purpose, scientific research is required that would provide scientific arguments, proposals and possibilities for solving problems concerning biodiversity conservation. In this respect, the Prut River floodplain may serve as a good example. Although there are already published data (COVALI, 2009; LIOGCHII et al., 2010), the listed areas remain fragmentary studied. Knowing the value of biological diversity and of species that find their habitat in the Prut River floodplain could serve as a basis for effective protection and sustainable management of biological diversity.

METHODS

The research was carried out during 2004-2009. Flora-fauna studies were carried out seasonally, recording flora and fauna species and registering their protection status.

The systematic belonging of species was determined by using specialized determination books (BEGU et al., 2005; GHEIDEMAN, 1975; IVAN & DONIȚĂ, 1975; MUNTEANU & LOZAN, 2004). The Register concerning representative species of vegetation and animals, rare species, species protected at national and international level, was prepared taking into account The Red Book of Moldova (RBM), the Red Book of Ukraine (RBU), Romanian Red List (RRL), European Red List (ERL), annexes of international environmental conventions and other regulatory documents. The protected areas passports were elaborated in accordance with the existing methodological guidance (POSTOLACHE et al., 2004).

RESULTS

The Prut River floodplain is characterized by certain relief, climate, soil conditions and hydrological regime, which changes along the water course and thus influences the emergence of specific vegetation. Nevertheless, significant changes followed by reduction of biological diversity are caused by human impact.

The vegetation of the ecosystems of the Prut River floodplain is dominated by meso- and hygrophytic forms, which are subject to periodic flooding, caused by the Prut River, 1-2 times a year, i.e. sometimes the water layer reaches a height of about 2 m from the ground. After the withdrawal of water, plants benefit from a favourable hydrological regime, due to reserves created in soil and ground water level, which can be reached easily by the root system of plants.

Taking into consideration the Law on Fund of Natural Areas Protected by State and the provisions of relevant international conventions, the state of the flora and fauna of the following ecosystems within the Prut River floodplain were evaluated: Forest Meander Pererata, Landscape Reserve Valea Mare, Forest Nature Reserve Nemteni, Dancu, Sarata-Rezesi and the meadow of the Prut River floodplain.

The proposed objects for research belong to different categories of protection and are located in different geographic areas, thus, along with similar characteristics and presence of the same species, they have some specific features that distinguish them and give value in terms of biological diversity.

Forest Meander Pererata is located near the village Pererata, Briceni district and presents an increased diversity and abundance of ephemeroide plants, scrub, and trees. *Quercus robur* (L.) was recorded as the dominant tree species and respectively subdominant - *Cerasus avium* (L.) MOENCH, *Populus canescens* (AIT. SMITH.) and *Salix sp.* (L.) were recorded in areas near the river. Optimal soil condition, moisture of substrate and presence of air contribute to the development of different plant groupings, especially of *Galanthus nivalis* (L.), which has multiple protection statutes (refer to table) and *Lilium martagon* (L.), which is a rare species in the country and is included in the RBU and ERL. The *Equisetum hyemale* (L.) was abundant and in a good growing state. The presence of valuable plant species – *Neottia nidus* (L.) RICH., *Ornithogalum refractum* (SCHLECHT), and *Clematis vitalba* (L.), which were not registered in other ecosystems of the floodplain, was specific for this ecosystem. An important role in identifying certain species within this ecosystem is also, probably, played by the fact that the forest is located at altitude (approximately 120 m).

The Forest Meander Pererata, with an area of 200 hectares, contributes well to biodiversity conservation and establishment of the National and European Ecological Network. The cognitive and scientific importance is represented by the presence of rare plants and animal species protected at national, regional and international levels. The most important of them are listed in the table.

Table. Flora and Fauna species with national, regional, and international protection state.
Tabel. Specii de floră și faună cu statut național, regional și internațional de protecție.

No.	Name of species	State of Protection	Representative Ecosystems of the Prut River floodplain					
			Forest Pererata	LR Valea Mare	FNR Nemteni	FNR Dancu	FNR Sarata Rezesi	Meadow Antoneshti
PLANTAE								
EQUISETOPSIDA								
1.	<i>Equisetum telmateia</i> (EHRH.)	RSM			+			
MAGNOLIOPSIDA								
2.	<i>Anemonoides nemorosa</i> (L.) HOLUB	RSM	+	+				
3.	<i>Clematis vitalba</i> (L.)	RSM	+					
4.	<i>Berberis vulgaris</i> (L.)	RSM					+	
5.	<i>Vitis sylvestris</i> (C. C. GMEL.)	RSM, RBM			+	+	+	
6.	<i>Lunaria annua</i> (L.)	RSM, RBM		+				
7.	<i>Pulmonaria officinalis</i> (L.)	RSM		+			+	
8.	<i>Scrophularia vernalis</i> (L.)	RSM, RRL		+				
9.	<i>Viburnum opulus</i> (L.)	RSM			+			
LILIOPSIDA								
10.	<i>Convallaria majalis</i> (L.)	RSM		+	+	+		
11.	<i>Galanthus nivalis</i> (L.)	RSM, RBM, RRL, RBU, Wash. C	+					
12.	<i>Leucojum aestivum</i> (L.)	RSM, RBM, RBU		+	+	+	+	
13.	<i>Ornithogalum oreoides</i> (ZAHAR.)	RSM, RBM, RBU, ERL					+	
14.	<i>O. refractum</i> SCHLECHT.)	RSM, RBU	+					
15.	<i>Crocus reticulatus</i> (STEV. EX ADAMS)	RSM, RRL, RBU					+	
16.	<i>Carex elongata</i> (L.)	RSM			+			
17.	<i>Juncus atratus</i> (KROCK.)	RSM						+
18.	<i>Allium ursinum</i> (L.)	RSM, RBU		+				
19.	<i>Asparagus officinalis</i> (L.)	RSM			+			
20.	<i>Fritillaria meleagroides</i> (PATRIN)	RSM, RBM, RBU					+	

	EX SCHULT. ET SCHULT. FIL)								
21.	<i>Lilium martagon</i> (L.)	RSM, RBU, ERL	+						
22.	<i>Neottia nidus - avis</i> (L.) RICH.	RSM, RRL, RBU, Wash. C	+						
ANIMALIA									
ARTHROPODA									
1.	<i>Mantis religiosa</i> (LINNAEUS 1758)	RSM, RBM						+	
2.	<i>Coenagrion mercuriale</i> (CHARPENTIER 1840)	RSM, RBM, Bern C							+
3.	<i>Lucanus cervus</i> (LINNAEUS 1758)	RSM, RBM, Wash. C	+						
4.	<i>Iphiclides podalirius</i> (LINNAEUS 1758)	RSM, RBM						+	
AMPHIBIA									
5.	<i>Bombina variegata</i> (LINNAEUS 1758)	RSM, Bern C						+	
6.	<i>Hyla arborea</i> (LINNAEUS 1758)	Bern C					+		
REPTILIA									
7.	<i>Lacerta viridis</i> (LAURENTI 1768)	Bern C							+
8.	<i>Coronella austriaca</i> (LAURENTI 1768)	RSM, RBM, Bern C						+	
9.	<i>Vipera berus</i> (LINNAEUS 1758)	RSM, RBM						+	
10.	<i>Emys orbicularis</i> (LINNAEUS 1758)	RSM, RBM, RRL							+
AVES									
11.	<i>Botaurus stellaris</i> (LINNAEUS 1758)	RSM, Bern C			+				+
12.	<i>Ciconia nigra</i> (LINNAEUS 1758)	RSM, RBM, RRL, Wash. C, Bern C, Bonn C			+	+		+	+
13.	<i>C. ciconia</i> (LINNAEUS 1758)	RSM, RRL, Bern C, Bonn C			+	+		+	+
14.	<i>Cygnus cygnus</i> (LINNAEUS 1758)	RSM, RBM, Bern C				+			
15.	<i>Anas crecca</i> (LINNAEUS 1758)	Wash. C							+
16.	<i>Buteo buteo</i> (LINNAEUS 1758)	RSM, Wash. C, Bern C, Bonn C						+	
17.	<i>Phasianus colchicus</i> (LINNAEUS 1758)	RSM			+	+			
18.	<i>Fulica atra</i> (LINNAEUS 1756)	Bonn C							+
19.	<i>Grus grus</i> (LINNAEUS 1758)	RSM, Wash. C						+	
20.	<i>Columba oenas</i> (LINNAEUS 1758)	RSM, RBM, Bern C							+
21.	<i>Streptopelia turtur</i> (LINNAEUS 1758)	Wash. C, Bern C							+
22.	<i>Bubo bubo</i> (LINNAEUS 1758)	RSM, RBM, Bern C				+			+
23.	<i>Upupa epops</i> (LINNAEUS 1758)	RSM, Bern C			+			+	
24.	<i>Dendrocopos major</i> (LINNAEUS 1758)	Bern C							+
MAMMALIA									
25.	<i>Spermophilus citellus</i> (LINNAEUS 1766)	RSM, RBM, Bern C				+			
26.	<i>Vulpes vulpes</i> (LINNAEUS 1758)	RSM, Wash. C			+	+		+	+
27.	<i>Mustela eversmanni</i> (LESSON 1827)	RBM, Bern C						+	
28.	<i>Martes martes</i> (LINNAEUS 1758)	RSM, RBM, Bern C						+	
29.	<i>Meles meles</i> (LINNAEUS 1758)	RSM, Bern C			+	+	+		
30.	<i>Lutra lutra</i> (LINNAEUS 1758)	RSM, RBM, RRL, Wash. C, Bern C						+	+
31.	<i>Felis silvestris</i> (SCHREBER 1775)	RSM, RBM, Wash. C, Bern C			+	+	+	+	+
32.	<i>Sus scrofa</i> (LINNAEUS 1758)	RSM, Wash. C			+	+	+		+
33.	<i>Capreolus capreolus</i> (LINNAEUS 1758)	RSM, RRL			+	+	+	+	
34.	<i>Cervus elaphus</i> (LINNAEUS 1758)	RSM, Wash. C, Bern C, Bonn C				+			

Explanatory note:

LR - Landscape Reserve

FNR - Forest Nature Reserve

RSM- Rare species on the Republic of Moldova territory

RBM – The Red Book of Moldova

RRL – Romania Red List

RBU – The Red Book of Ukraine

ERL – European Red List

Wash. C - Washington Convention

Bern C - Bern Convention

Bonn C - Bonn Convention

+ - Present in the ecosystem

According to the Law on the Fund of Natural Areas Protected by State (no. 1538-XIII from February 25, 1998), an area of 5 hectares is considered under the state protection, consisting of the Prut River bank, which enter into this region and which, in accordance with the International Union for the Conservation of Nature (IUCN) classification,

was assigned the category of Geology and Paleontology Nature Monument (GPNM). The findings of our research argue the need to extend the protected area, with the inclusion of the above-described forest. Thus, the surface of the protected area from Pererata may be extended from 5 hectares (GPNM) up to about 200 hectares, the category of protection being in accordance with geological and forest features - Landscape Nature Reserve.

In this context, in order to minimize the human impact on in this sector, it is necessary to prohibit hunting of animals, reduce chemical treatment of orchards, noise related to agricultural machinery and road transport, regulate the grazing and mowing etc.

The Landscape Reserve Valea Mare - has an area of 373 hectares and is located south of Ungheni city; Valea Mare village belongs to Ungheni Forest surroundings. It is situated at an altitude of approximately 90-100 m, with south-west exposition. The forest vegetation includes three types of forests: "White poplar park of middle productivity", "Willow Park of middle productivity", and "Meadow and steep oak of middle productivity". Among the dominant tree species, we mention – *Populus alba* (L.), *P. nigra* (L.), *Salix sp.* (L.), *Quercus robur* (L.), as well as other species such as: *Acer negundo* (L.), *A. campestre* (L.), *Cerasus avium* (L.) MOENCH, *Fraxinus excelsior* (L.), *Pyrus pyraeaster* (BURGSD.). The most common species of shrubs were *Corylus avellana* (L.), *Cornus mas* (L.), *Crataegus curvisepala* (LINDM.), *Euonymus verrucosa* (SCOP.) etc.

Being located in the Prut River floodplain, the herbaceous vegetation is thus specific to meadow areas. The following recorded species – *Stellaria media* (L.) VILL., *Aegopodium podagraria* (L.), *Ranunculus cassubicus* (L.) etc. are frequent and plentiful. On altitude and sun-exposed areas, there were recorded valuable species, such as: *Anemonoides nemorosa* (L.), *Lunaria annua* (L.), *Scrophularia vernalis* (L.) etc. Among fauna species were recorded *Sus scrofa* (LINNAEUS 1758), *Vulpes vulpes* (LINNAEUS 1758), *Phasianus colchicus* (LINNAEUS 1758) and certain rare species such as: *Cervus elaphus* (LINNAEUS 1758), *Spermophilus citellus* (LINNAEUS 1766) – the value of which is expressed through multiple protection status (Table). Within "Cucoana" and "Pichet" reed glade, where the Prut River is flowing into during the spring time forming pools, *Ciconia nigra* (LINNAEUS 1758) has found a favourable habitat to populate. There were recorded 10 to 12 exemplars of this species, which have also been recorded annually. The duration of their stay in the habitat is primarily determined by the year climatic conditions. Common for this reserve is *Capreolus capreolus* (LINNAEUS 1758), which can be encountered frequently as well in other forest ecosystems of the Prut River floodplain.

The Forest Nature Reserve Nemteni is located near the village Nemteni, Hincesti district, which has an area of 20.9 hectares and is part of Onesti Forest surroundings. The reserve is located at an altitude of approximately 95-100 m, with south-west exposition. Under the state protection, we find areas where the dominant species is *Populus alba* (L.). With insignificant frequency is *Quercus robur* (L.) and *Salix alba* (L.). The grass is developed abundantly, being formed especially of specific meadow species such as: *Chelidonium majus* (L.), *Ficaria verna* (HUDS.), *Geum urbanum* (L.), *Iris pseudacorus* (L.), *Lysimachia nummularia* (L.), *Polygonum hydropiper* (L.), *P. latifolium* (DESF.), *Polygonatum officinale* (ALL.), *Symphytum officinale* (L.), *Scilla bifolia* (L.), *Stellaria media* (L.) VILL., *Viola odorata* (L.), *Aegopodium podagraria* (L.), *Butomus umbellatus* (L.), etc.; among all these many are valuable (Table). The reserve is important due to the fact that *Vitis sylvestris* (C. C. GMEL.) grows abundantly here. Fauna is also diverse, consisting of common and rare species, listed in the table.

The Forest Nature Reserve Dancu covers an area of 131 hectares and is located in Carpineni Forest. The land holder is the State Forest Enterprise Hincesti-Silva. The protected areas altitude varies from 30 to 50 m. The reserve includes an area of forest composed primarily of *Populus alba* (L.), *Salix alba* (L.), with minor presence of *Quercus robur* (L.) and *Ulmus laevis* (PALL.). Shrubs are well developed; among them, the most frequent species are *Amorpha fruticosa* (L.), *Crataegus curvisepala* (LINDM.), *Euonymus europaea* (L.), *Rosa canina* (L.), *Swida sanguinea* (L.) OPIZ, *Tamarix ramosissima* (LEDEB.) etc.

Herbaceous plants grow abundantly and both common and valuable species were recorded. Among them, we mention *Asparagus verticillatus* (L.), *Calamagrostis arundinacea* (L.) ROTH, *Chamaenerion angustifolium* (L.) HOLUB, *Chelidonium majus* (L.), *Euphorbia amygdaloides* (L.), *Ficaria verna* (HUDS), *Galium verum* (L.), *Iris pseudacorus* (L.), *Lavatera thuringiaca* (L.), *Lysimachia nummularia* (L.), *Symphytum officinale* (L.), *Typha latifolia* (L.), *Urtica dioica* (L.), *Valeriana officinalis* (L.), *Trifolium rubens* (L.), *Ranunculus arvensis* (L.), *Capsella bursa-pastoris* (L.) MEDIK. The reserve is characterized by rich diversity of rare plant and animal species, valued and protected by state and environmental conventions, being the only one in the country where *Leucojum aestivum* (L.) can be met very frequently and abundantly. Many valuable species of animals found their shelter in this habitat (Table). FNR Dancu presents cognitive and scientific interests and can serve as habitat to conduct scientific research, environmental education, and biological diversity conservation measures and contribute to the ecological balance within the Prut River floodplain.

The Forest Nature Reserve Sarata-Razesi occupies an area of 33.9 hectares; it is located within the "Bazinic" forest, Carpineni Forest surroundings, at about 50 m altitude. The land holder is the State Forest Enterprise Hincesti-Silva.

The vegetation is composed of *Quercus robur* (L.), *Populus alba* (L.), *P. nigra* (L.), *P. tremula* (L.), *Fraxinus excelsior* (L.), *Acer campestre* (L.), *A. negundo* (L.), *Cerasus avium* (L.) MOENCH, *Pyrus pyraeaster* (BURGSD.). Shrubs are well developed; among them, the most frequently encountered are *Crataegus curvisepala* (LINDM.), *Sambucus nigra* (L.), *Euonymus europaea* (L.).

Herbaceous layer was developed and abundant in the following species: *Sambucus ebulus* (L.), *Aristolochia clematis* (L.), *Aegopodium podagraria* (L.), *Anemone ranunculoides* (L.), *Asperula odorata* (L.), *Campanula sibirica* (L.), *Tanacetum vulgare* (L.), *Chamaenerion angustifolium* (L.) HOLUB, *Chaerophyllum aromaticum* (L.), *Chelidonium majus* (L.), *Corydalis solida* (L.) CLAIRV, *Ficaria verna* (HUDS.) *Melampyrum nemorosum* (L.), *Scrophularia vernalis* (L.), *Sedum maximum* (L.), *Scilla bifolia* (L.), *Stellaria media* (L.) VILL., *Stipa capillata* (L.), *Symphytum officinale* (L.), *Veronica montana* (L.), *V. chamaedrys* (L.), *Vinca herbacea* (WALDST. & KIT.), *Polygonatum latifolium* (DESF.), *Viola odorata* (L.) and many other rare plant species (Table). The reserve has also recorded rich fauna species, including valuable species (Table), which demonstrate that FNR Sarata-Razesii is a favourable habitat for the preservation and conservation of many flora and fauna species (NEGRU et al., 2002; OLTEAN et al., 1994).

The meadow of the Prut River floodplain is located in the western part of the Antonesti village, Cantemir district. The land holder is the Antonesti district hall. According to the cadastral plan no. 2110108002, the ecosystem is registered as land under water. Being located in the close vicinity of the Prut River and formed as a result of flooding, this land has turned into a flood-meadow with a large lake in the centre. Over the past 10-12 years this field has expanded over an area of 168 hectares and its entity is primarily maintained by regulating locks.

The studied ecosystem is in good environmental state. The lake has clear transparent water, with small islands of reed, where many species of ducks, swans, and other sedentary and migrating birds have found shelter. Due to favourable hydrological regime, the vegetation of the ecosystem is well developed. The study of the ecosystem revealed that the flora is characterized by wetland vegetation, hydro-, hygro- and mesophytic, dominated by species from the following families: *Cyperaceae*, *Typhaceae*, *Alismataceae*, *Juncaceae* and *Poaceae*. Among the most frequently recorded were: *Typha latifolia* (L.), *Typha angustifolia* (L.), *Butomus umbellatus* (L.), *Alisma Plantago-aquatica* (L.), *Juncus atratus* (KROCK.), *Phragmites communis* (TRIN.) etc.

Fauna research has established that the area is preferred as habitat by many species of animals, especially migratory birds (see table).

Proceeding from the importance of valuable species and the IUCN classification, the **flood-meadow with wetland vegetation** around Antonesti village requires a specific protection regime, which corresponds to the category **Area with multifunctional management/Representative area with meadow vegetation**, contributing to the achievement of the provisions of European Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora and 79/409/EEC – on the Conservation of wild birds.

The analysis of the results presented in the table allows us to see that the flora and fauna of the investigated ecosystems is specific to meadow areas. Some species have been recorded only in one ecosystem (i.e. *Galanthus nivalis* (L.), *Clematis vitalba* (L.) – within the Forest Meander Pererata; *Lunaria annua* (L.), *Spermophilus citellus* (LINNAEUS 1766), *Cervus elaphus* (LINNAEUS 1758) – LR Valea Mare; *Cygnus cygnus* (LINNAEUS 1758) - FNR Nemteni; *Fulica atra* (LINNAEUS 1756), *Anas crecca* (LINNAEUS 1758) - Antonesti Meadow), while the others (i.e. *Leucojum aestivum* L., *Felis silvestris* (SCHREBER 1775), *Ciconia nigra* (LINNAEUS 1756) etc.) have a higher prevalence and frequency, being registered in the majority of investigated ecosystems. This primarily depends on the particular ecological and geographical conditions, as well as of the ecosystem they inhabit.

The results of the investigation concerning the biological diversity, the value of flora and fauna represents an important scientific argument for granting adequate protection to Meander Pererata and the flood-meadow from Antonesti and organization of further effective management of those already protected by state. The investigated objects can serve as well as connecting elements in the national and European Ecological Network, establishing connections with biotic habitats similar to those on the right bank of the Prut River. The results were used to supplement the information from the protected ecosystems passports.

CONCLUSIONS

The investigated ecosystems present apparent similarities concerning flora, fauna, as well as edaphic-climatic characteristics, which facilitates the development of management measures.

The unquestionable value of the investigated ecosystems emerges as well from the fact that the ecosystems serve as refuge habitats for many nationally protected species - included in the Red Book of Moldova, regional - protected in neighbourhood countries (Romania and Ukraine) and international – listed on Annexes of environmental conventions on the protection of biological diversity.

The investigated representative ecosystems may serve as corridors connecting neighbourhood countries, similar habitats and may be the adequate background for the creation of protected interstate areas.

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