

## AN INTEGRATED APPROACH CONCERNING FLORISTIC, PHYTOCOENOLOGICAL AND ORNITHOLOGICAL DIVERSITY ON SOMOVA-PARCHES LACUSTRINE COMPLEX: ASPECTS OF THEIR CONSERVATION

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### Abstract

*The aim of this study represents a complex approach regarding the analysis of the flora, aquatic and palustre vegetation as well as the diversity of nesting bird species on Somova-Parches Lacustrine Complex. Aquatic and palustre vegetation conveys 23 vegetation assemblages, five habitats of national interest, and three community habitats featuring a well-represented floristic (87 taxa) and cenotic structure. The amount of phytogeographic elements is conferred by Eurasian phytotaxa 50.7%, European and Central-European 5.7%, Nordic-Circumpolar 18.4% and Cosmopolitan 18.4%. Adventitious and Mediterranean elements comprise a scarce percentage, merely 1.1%. As regards vegetation diversity, there has as well been identified an ornithological fauna typical of the aquatic habitats existing within the study area. There were found 65 bird species, the majority being water birds (60%). From the water bird species, 63% are summer guests and nesting ones. The Great Cormorant (*Phalacrocorax carbo*) is a prevailing species in the area, most of its individuals nesting in Morun Lake colony. The Great Crested Grebe (*Podiceps cristatus*), the Great White Pelican (*Pelecanus onocrotalus*) as well as all observed ducks are subdominant species. The conservation state of the flora and nesting birds within the study area enables a sustainable development.*

**Keywords:** *Aquatic plants; Cormorant; Biodiversity; Conservation.*

### Introduction

The Danube Delta, the second European Delta in terms of length, is a natural environment enjoying its specific features and endowed with a genuine avifaunistic and botanical heritage which harbours palustrine and aquatic habitats of high conservative value [1].

The study zone, encompassing Parches, Telincea, Rotundu lakes as well as Cormorant Colony pertaining to Morun Lake area, belongs to Somova-Parches Lacustrine Complex. Somova-Parches Lacustrine Complex is included in the Danube Delta Biosphere Reservation, lying in the Western site of the Reservation [2]. Of the lakes comprised by the lacustrine complex, only Rotundu Lake enjoys specific protection status being designated as an expanse

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with complex protection status (along with other 17 areas sharing the same status). Rotundu Lake is representative owing to the conservation of the component biocenoses as habitats which enable aquatic avifaunistic and Cyprinidae freshwater fish fauna.

The avifauna and different ecosystems along the Danube Delta has been thoroughly studied over the years. Apart from monographic studies or researches elaborated by *G. Andone et al* [3], *M. Marinov and D. Hulea* [4], *C. Tudorancea and M.M. Tudorancea* [5], *A. Papadopol* [6], *M. Paspaleva et al* [7], *M. Platteeuw et al* [8], *D. Radu* [9], there are other articles which tackle only one species or a systematic group present in the Danube Delta. Moreover, there is a wealth of data regarding the bird species of the adjacent areas to the Danube Delta, prevalent being those in the former flooding meadow of the Danube [10].

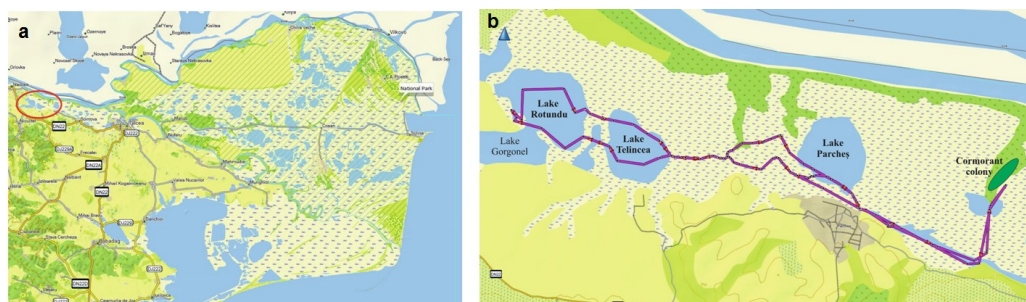
As a special protection avifaunistic area (ROSPA 0031), the Danube Delta represents the sole aquatic zone in our country featuring tremendous high incidence of biodiversity. In Natura 2000 Standard Data Form (2011) were designated 80 bird species which are included in Annex I of the Bird Directive and 131 species which, though not comprised in the Bird Directive, still enjoy a regular presence in the Danube Delta throughout migration periods [10-11].

Furthermore, the studied zone is significant from a botanic standpoint due to the vegetation and faunistic diversity which develops under the conditions of a natural habitat [12] unaltered by hazardous anthropic activities [13] and is inhabited by two vegetal species threatened at European level: *Trapa natans* and *Salvinia natans*, according to Berne Convention (criterion A) [14].

As regards the studied area, encompassing Parches, Telincea, Rotundu lakes as well as Cormorant Colony pertaining to Morun Lake area, there were not found direct bibliographic references. Considering these aspects, through this study we aimed at designing an integrated analysis of the aquatic and palustrine flora and vegetation, and assessing mainly the aquatic ornithofauna in the zone engulfing Parches, Telincea, Rotundu lakes as well as Cormorant Colony upon Morun Lake.

## Material and methods

In accordance with the established objectives and activities of this study, identifying the plant species, analysis of phytocenoses and monitoring aquatic bird species typical of the Parches, Telincea, Rotundu lakes as well as Cormorant Colony pertaining to Morun Lake area were performed in-between April-July-November 2017 and January-March 2018 (Fig.1). Field trips were undertaken by boat, and the route was recorded by virtue of GPS (Garmin Montana 680t).



**Fig. 1.** The location of the study area within the Danube Delta Biosphere Reserve (a) and routes (b) (processed after Garmin BaseCamp V. 4.7.0)

Nomenclature of plant species complies with Flora Europaea according to *T. G. Tutin and V. H. Heiwood* [15] and *T.G. Tutin et al* [16], correlated with the data of “Flora of the Romanian Popular Socialist Republic; Romanian Socialist Republic”, volumes I-XIII,

Academiei R.S.R. Publishing House, București 1952-1976 [17] and the determinators of *Al. Beldie* [18] and *V. Ciocârlan* [19].

For the study of the vegetal carpet within the ecosystems conveyed by the zone under scrutiny we employed the approach of Zurich-Montpellier Phytocoenologic School also known as the Sigmatist approach. This method was perfected by *J. Braun-Blanquet* [20]. The distribution of the sample surfaces was performed randomly within the habitats. The surveying was established once the study area had been assessed. There were used squares of the following dimensions: for grassy species (including graminees) and saplings, 25-50 m<sup>2</sup>; for shrubs and trees 500 m<sup>2</sup> [21]. To classify the assemblages there were used works of synthesis upon the vegetation in Romania elaborated by *V. Sanda* [22] and for habitats works elaborated by *R. Popa et al* [23].

Ornithologic data and observations resulted after field trips were introduced in a databasis which enabled swift assessment of the monitored bird species from a systematic, biological and ecological viewpoint. The statistic interpretation of data was undertaken by means of Microsoft Excel 2016, following the mean and confidence level ( $\sigma$  95.0%) for each species in turn. As well, there were calculated the abundance (Ab%), incidence (F%) and the index of ecological significance of the aquatic bird populations (W%, Dzuba index) according to *M. W. Lutz et al.* [24]. To establish the conservation status were utilized terms employed at European level by Bird Life International [25-27] and at global level by International Union for Conservation of Nature [28-29].

## Results and discussion

The negative relief within the studied area is prevalent being characterised by the presence of swampy flat lands, canals, brooks and lacustrine areas (backwaters, river estuaries, deltaic lakes). These lakes feature an outline in ongoing change due to the oscillating water level but also due to the influence of the reed islet. Enough spread, hydromorphic soils are of two types: gleic (typical, swampy) and limnosoils consisting of mineral formations devoid of vegetation. The unevolved soils are represented by typical alluvial proto soils and gleic soils, whereas the organic ones are covered in palustrine and aquatic vegetation [30-31].

There were identified and determined a series of 87 species of plants (Table 1) pertaining to Pteridophyta and Spermatophyta phylum, as follows: 67 genus of 41 families (phanerophyte and grassy). Identified plant distribution was analysed within the natant emergent environment throughout the area of the water surface (sand banks, river banks) but also upon the floating islands (reed islet).

### *Analysis of biological forms (bioforms)*

Analysis of biological forms from the studied area highlights the presence of some vegetating species within various biotopes belonging to the aquatic and palustrine ecosystems (Fig. 2). The highest amount is featured by hydrophytes and helohydatophytes – 45 species, 51% respectively, then hemicryptophytes 15 species (17%), phanerophytes 10 species (11.5%), therophytes 9 species (10.3%), geophytes (8.0%) and chamaephytes one species (1.1%).

### *Analysis of phytogeographic elements*

For the analysis of phytogeographic elements we accounted for the amount of floristic elements and their aspect. The flora under scrutiny analysed from a geographic-area aspect, taking into account the phytogeographic elements, displays certain traits. Therefore, it is noted that these developed under the influence of the Eurasian climate (50.7%), European and Central-European only 5.7% and Nordic-Circumpolar (18.4%), and Cosmopolit (18.4%), respectively. Mediterranean and adventive elements are in the most reduced percentage only 1.1%. The mentioned species fall into 7 categories of phytogeographic elements (Fig. 3).

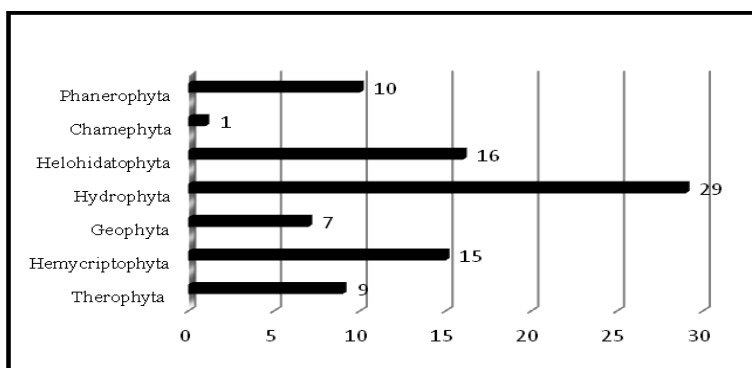
Table 1. List of aquatic and palustre flora

No	Family	Genus	Species/author	Popular name	National/ international Statute
1	Equisetaceae	Equisetum	<i>Equisetum palustre</i> L.	marsh horsetail, humpback	-
2		Thelypteris	<i>Thelypteris palustris</i> Schott	marsh fern	-
3	Salviniaceae	Salvinia	<i>Salvinia natans</i> (L.) All.	floating fern, water butterfly wings	Taxon threatened *BC
4	Apiaceae	Cicuta	<i>Cicuta virosa</i> L.	lesser water-parsnip	-
5		Berula	<i>Berula erecta</i> (Huds.)	lesser water-parsnip	-
6		Oenanthe	<i>Oenanthe aquatica</i> (L.) Poir.	water dropworts	-
7	Asteraceae	Artemisia	<i>Artemisia absinthium</i> L.	artemisia, chamefita	-
8		Cirsium	<i>Cirsium arvense</i> L.	thistles	-
9		Eupatorium	<i>Eupatorium cannabinum</i> L.	hemp-agrimony	-
10	Brassicaceae	Xanthium	<i>Xanthium strumarium</i> L.	cocklebur	-
11		Rorippa	<i>Rorippa amphibia</i> (L.) Besser	great yellowcress	-
12	Ceratophyllaceae	Ceratophyllum	<i>Ceratophyllum demersum</i> L.	hornwort, rigid hornwort	-
13			<i>Ceratophyllum submersum</i> L.	soft hornwort	-
14	Ranunculaceae	Ranunculus	<i>Ranunculus rionii</i> Lager	water crowfoot	-
15			<i>Ranunculus sardous</i> Crantz.	hairy buttercup	-
16	Rubiaceae	Galium	<i>Galium palustre</i> L.	common marsh-bedstraw	-
17	Urticaceae	Urtica	<i>Urtica kioviensis</i> Rogow	nettle	-
18	Caryophyllaceae	Myosoton	<i>Myosoton aquaticum</i> (L.) Moench	giant-chickweed	-
19	Primulaceae	Lysimachia	<i>Lysimachia vulgaris</i> L.	garden loosesstrife	-
20	Polygonaceae	Polygonum	<i>Polygonum hydropiper</i> L.	marsh pepper	-
21			<i>Polygonum lapathifolium</i> L.	pale smartweed	-
22			<i>Polygonum amphibium</i> L.	longroot smartweed	-
23		Rumex	<i>Rumex hydrolapatum</i> Hudson	giant water dock	-
24	Fabaceae	Glycyrrhiza	<i>Glycyrrhiza echinata</i> L.	eastern European licorice	-
25		Amorpha	<i>Amorpha fruticosa</i> L.	false indigo-bush	-
26	Rosaceae	Rubus	<i>Rubus caesius</i> L.	-	-
27		Potentilla	<i>Potentilla reptans</i> L.	-	-
28	Plantaginaceae	Plantago	<i>Plantago major</i> L.	plantain	-
29			<i>Plantago lanceolata</i> L.	plantain	-
30	Elaeagnaceae	Elaeagnus	<i>Elaeagnus angustifolia</i> L.	bugwoodwiki	-
31	Haloragaceae	Myriophyllum	<i>Myriophyllum verticillatum</i> L.	whorled water milfoil	-
32	Menyanthaceae	Nymphoides	<i>Nymphoides peltata</i> (SG Gmelin) O.Kuntze	fringed water-lily	-
33	Trapaceae	Trapa	<i>Trapa natans</i> L.	water chestnut	Taxon Vulnerable *RL
34	Euphorbiaceae	Euphorbia	<i>Euphorbia palustris</i> L.	marsh spurge	-
35	Salicaceae	Salix	<i>Salix alba</i> L.	white willow	-
36			<i>Salix fragilis</i> L.	brittle willow	-
37		<i>Salix cinerea</i> L.	grey sallow	-	
38		Populus	<i>Populus alba</i> L.	white poplar	-
39			<i>Populus nigra</i> L.	the black poplar	-
40	Oleaceae	Fraxinus	<i>Fraxinus angustifolia</i> Vahl.	narrow leaved ash	-
41	Solanaceae	Solanum	<i>Solanum dulcamara</i> L.	bittersweet	-
42	Convolvulaceae	Calystegia	<i>Calystegia sepium</i> (L.) R.Br.	larger bindweed	-
43	Boraginaceae	Symphytum	<i>Symphytum officinale</i> L.	true comfrey	-
44	Lamiaceae (Labiatae)	Mentha	<i>Mentha aquatica</i> L.	water mint	-
45			<i>Mentha pulegium</i> L.	squaw mint	-
46			Stachys	<i>Stachys palustris</i> L.	marsh woundwort
47	Lythraceae	Lythrum	<i>Lythrum salicaria</i> l.	purple loosesstrife	-
48			<i>Lythrum virgatum</i> L.	purple loosesstrife	-
49	Scrophulariaceae	Gratiola	<i>Gratiola officinalis</i> L.	hedgelyssop	-
50			Veronica	<i>Veronica anagaloides</i> L.	-
51	Malvaceae	Althaea	<i>Althaea officinalis</i> L.	-	-
52			Abutilon	<i>Abutilon theophrastii</i> Medik	velvetleaf
53	Lentibulariaceae	Utricularia	<i>Utricularia vulgaris</i> L.	greater bladderwort	Taxon Rare *RL
54	Nymphaeaceae	Nymphaea	<i>Nymphaea alba</i> L.	european white waterlily	-
55			<i>Nymphaea candida</i> C. Presl	dwarf white water lily	Taxon Rare *RL
56		Nuphar	<i>Nuphar luteum</i> (L.) Sibth et Sm.	european white waterlily	-
57	Butomaceae	Butomus	<i>Butomus umbelatus</i> L.	flowering rush	-
58	Alismataceae	Alisma	<i>Sagittaria sagittifolia</i> L.	arrowhead	-
59			<i>Alisma gramineum</i> Lej.	narrow leaf water plantain	-
60			<i>Alisma plantago aquatica</i> L.	european water plantain	-
61		Hydrocharis	<i>Hydrocharis morsus-ranae</i> L.	frogbit	-
62	Hydrocharitaceae	Elodea	<i>Elodea nuttallii</i> (Planch.) H.St.John	western waterweed	-
63			Stratiotes	<i>Stratiotes aloides</i> L.	water soldier
64	Potamogetonaceae	Potamogeton	<i>Potamogeton crispus</i> L.	curly-leaf pondweed	-
65			<i>Potamogeton lucens</i> L.	shining pondweed	-
66			<i>Potamogeton pusillus</i> L.	least pondweed	-
67			<i>Potamogeton pectinatus</i> L.	sago pondweed	-
68	Iridaceae	Iris	<i>Iris pseudacorus</i> L.	yellow iris	-
69	Cyperaceae	Schoenoplectus	<i>Schoenoplectus lacustris</i> (L.) Palla	bulrush	-
70			Eleocharis	<i>Eleocharis palustris</i> (L.) Roem et Schult	common spike-rush

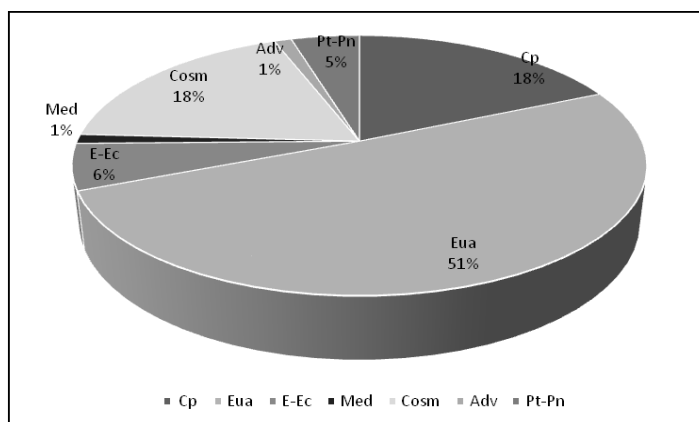
**INTEGRATED APPROACH ON FLORISTIC, PHYTOCOENOLOGICAL AND ORNITHOLOGICAL DIVERSITY**

71		<i>Eleocharis acicularis</i> (L.) Roem et Schult	needle spikerush	-
72		<i>Cyperus fuscus</i> L.	brown galingale	-
73		<i>Cladium mariscus</i> (L.) Pohl.	saw-sedge	-
74		<i>Carex acutiformis</i> L.	lesser pond sedge	-
75		<i>Calamagrostis epigeios</i> (L.) Roth	chee reedgras	-
76		<i>Glyceria maxima</i> (Hartm) Holmb	great manna grass	-
77	Poaceae (Gramineae)	<i>Phragmites australis</i> (Cav) Trin et Steudel	common reed	-
78		<i>Phalaris arundinacea</i> L.	-	-
79		<i>Typha angustifolia</i> L.	lesser bulrush	-
80	Typhaceae	<i>Typha latifolia</i> L.	bulrush	-
81		<i>Typha laxmannii</i> Lepechin	graceful cattail	-
82	Sparganiaceae	<i>Sparganium erectum</i> L.	simplestem bur-reed	-
83		<i>Lemna minor</i> L.	common duckweed	-
84		<i>Lemna trisulca</i> L.	star duckweed	-
85		<i>Lemna gibba</i> L.	gibbous duckweed	-
86	Lemnaceae	<i>Spirodela polyrhiza</i> (L.) Schleid	greater duckweed	-
87		<i>Wolffia arrhiza</i> (L.) Wimm.	spotless watermeal	Taxon endangered *RB
Total	41	67	87	-

Legend: BC- Berna Convention, Important Plant Areas (IPA-s) in Romania A(ii) [14];RL- red list in Romania [32]; RB- red book of plants in Romania [33].



**Fig. 2.** Analysis of biological forms



**Fig. 3** Phytogeographical spectrum of identified phytotaxons  
(Legend: Eua - Eurasian; E-Ec - European and central european; Cp - Circumpolar; Pt-Pn - Pontic-pannonian; Adv - Aadvventitious; Cosm - Cosmopolitan; Med -Mediterranean)

Analysis of bioforms and phytogeographic elements can be considered in premiere because in similar studies [13] only pedo-phytocoenological aspects were addressed. We mention that out of the 87 taxa identified and determined by our panel of researchers, 3 species are cited

in the Red Lists according to *M. Oltean et.al.* [32]: *Stratiotes aloides* L. (vulnerable taxon), *Trapa natans* L. (vulnerable taxon), *Utricularia vulgaris* L. (scarce taxon), *Nymphaea candida* C. Presl (scarce taxon). Moreover, *Wolffia arrhiza* L. Horkel ex Wimm was also signalled, species cited in the Red Book according to *Ghe. Dihoru and G. Negran* [33] enjoying a good conservation status.

Even though the taxon *Salvinia natans* L. is cited in “Areas inhabited by threatened European taxa” – A(ii), Berne Convention, “Special Areas for Plants Protection and Conservation in Romania”, we can state that precisely this taxon features a profuse spread within the studied area and a sustainable development condition. From the adventive species quite frequent a presence is *Amorpha fruticosa* L., mainly in the areas temporarily flooded and upon reed islet and in the area comprised by the lakes was signalled a phanerophyte of culture, *Elaeagnus angustifolia* L.

Upon sand banks there established a type of vegetation of anthropic nature consisting of coppices of willow, ash tree, poplar plantations and a series of herbaceous plants [34]. Our researches comply with the data from specific literature [34-35] and have led to identifying 23 vegetal assemblages with a very-well represented floristic composition and coenotic structure, as follows: *Lemnetum minoris* Soó 1927, *Lemno minoris–spirodeletum* W. Koch 1954, *Lemno–Utricularietum vulgaris* Soó 1928, *Lemno–Hydrocharietum morsus–ranae* (Oberd.) Pass. 1978 (incl. *Salvinio - Hydrocharietum* Oberd. 1957) Boscaiu 1966), *Stratiotetum aloidis* Nowinski 1928, *Potamogetonum crispum* Soó 1927, *Potamogetonum pectinati* Carstensen 1955, *Potamogetonum lucentis* Hueck 1931, *Ceratophylletum submersum* (Soó) 1928 Den Hartog et Segal 1964, *Trapaetum natanti* Kárpáti 1963, *Nymphoidetum peltate* (Allorage 1922) Bellot 1951, *Trapa-Nymphoidetum* Oberdorfer 1957, *Nymphaeetum albae* Vollmar 1947, *Nymphaeetum albae-candidae* Pass. 1957, *Myriophillio verticillati-Nupharetum luteae* Koch 1926, *Eleocharietum palustris* Schennikov 1919, *Phalarietum arundinaceae* (Koch 1926) Libbert 1931, *Oenanthe-Rorippetum* Lohmeyer 1950, *Schoenoplectetum lacustris* Chourad 1924, *Typhetum angustifoliae* Pignatti 1953, *Thelypterido-Pragmitetum* Kuiper 1958, *Scirpo-Phragmitetum* W. Koch 1926, *Salicetum albae* Issler 1924 s.l. .

The existing palustrine and aquatic vegetal assemblages encompass well-built habitats typical of Deltaic wetlands. Hence, correlating the data from the specialty literature were identified five habitats of domestic interest [23, 36] and three habitats of community interest [14, 34, 37 -39], further on succinctly displayed.

#### **Habitats of domestic interest**

*R5302 - Mezohygrophile Danubian communities* characterised by *Eleocharis palustris* has a moderate conservative value, in the study area it is scarcely represented and is embodied by the vegetal assemblage *Eleocharietum palustris* Schennikov 1919.

*R5303 - Danubian communities* featuring *Oenanthe aquatica* and *Rorippa amphibia*. In the study area this type of habitat is less represented and is characterised by the presence of the vegetal assemblage *Oenanthe-Rorippetum* Lohmeyer 1950, and it also bears a moderate conservative value.

*R5305 - Danubian communities* profuse with *Typha angustifolia* and *Typha latifolia*. This type of habitat is frequently met in the area considered for study, it is present throughout the entire route undertaken and is conveyed by the vegetal assemblage *Typhetum angustifoliae* Pignatti 1953.

*R5308 - Danubian communities* with *Phragmites australis* and *Thelypteris palustris*. In the study zone this kind of habitat is flimsily represented and is rendered via the vegetal assemblage of *Thelypterio-Phragmitetum* Kuiper 1958, which often forms reed islet of various dimensions.

*R5309 Danubian communities* featuring *Phragmites australis* and *Schoenoplectus lacustris*. In the research zone the habitat is embodied by the floral assemblage *Scirpo-Pragmitetum* Koch 1926, whose floristic structure and composition is tremendously well-

rendered and with quite a wealth of species. The prevalent species which as well confirms the presence of the habitat is *Phragmites australis* (AD 5). This kind of habitat is the most frequently encountered within the study zone and is conspicuous along the entire premises of the study zone.

**Habitats of local interest**

*Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation.* Up to this moment in the area under scrutiny were identified the following vegetal assemblages: *Lemnetum minoris* Soó 1927, *Lemno-Spirodeletum* Koch 1954, *Statiottetum aloideis* Nowinski 1930, *Lemno-Utricularietum vulgaris* Soó 1928, *Lemno- Hydrocharietum morsus – ranae* (Oberd.) Pass. 1978, *Potamogetonetum lucentis* Hueck 1931, *Potamogetonetum pectinati* Carstensen 1955.

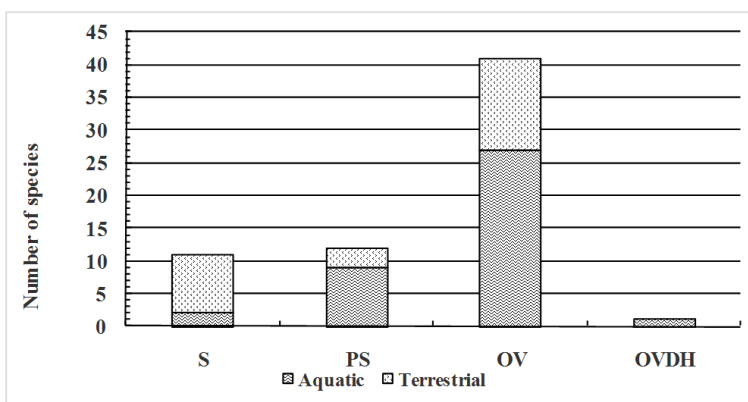
*Natural dystrophic lakes and ponds.* The research undergone highlighted the following vegetal assemblages: *Nymphaetum albae* Vollmar 1947, *Nymphaetum albae-candidae* Pass. 1957, *Myriophyllo verticillati-Nupharetum luteae* Koch 1926, *Trapo-Nymphoidetum* Oberdorfer 1957, *Nymphoidetum peltate* (Allorage 1922) Bellot 1951.

*92A0-Salix alba and Populus alba galleries.* This type of habitat is the only forestry habitat encountered within the studied zone and is present throughout the whole route considered. This habitat harbours the vegetal assemblage *Salicetum albae* Issler 1924 s.l.

All types of habitats extant within the area concerning this research bear a high degree of representation, featuring a moderate or great conservative value given by the presence of certain taxa existing on the national Red Lists [32]. These entwine and complete one another reciprocally, allotting a landscape-like aspect of high aesthetic value. Its current condition of conservation of the mentioned habitats is good, the exerted anthropic impact being quite reduced.

Our ornithological research highlights a number of 65 bird species pertaining to 30 families and 13 orders. From the total number of species, 39 are aquatic (60%) and 26 terrestrial (40%) (Figs. 4 and 5). The aquatic species belong to eight orders, the majority engulfed in the inferior part of the taxonomic scale. The orders with the most aquatic species are Pelecaniformes, Anseriformes and Charadriiformes (Fig. 5).

As concerns the phenologic type, were found four groups: sedentary (11 species, 17%), partially sedentary (12 species, 18%), summer guests (41 species, 63%) and summer guests wandering for food (1 species, 2%) (Figs. 4, 5 and 6). Water species are mainly summer guests or partially sedentary consequent of the changes that appear in the aquatic ecosystems during the cold season.



**Fig. 4.** Ecological structure on phenological types of bird species in the study area.

Legend: S- sedentary; PS- partially sedentary; OV- summer guests; OVDH- summer guests away from feeding.

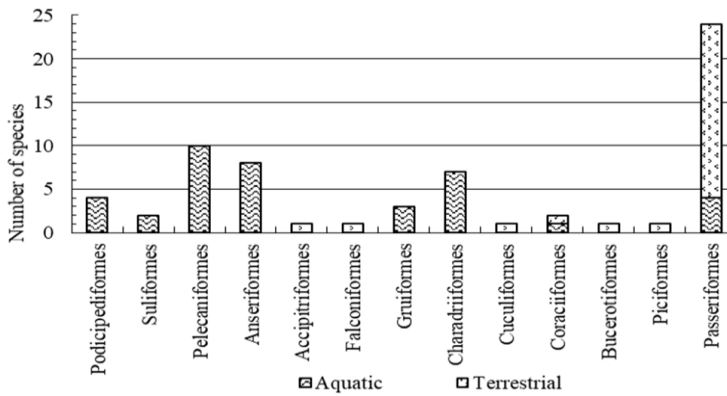


Fig. 5. Ecological structure on the order of the bird species in the study area

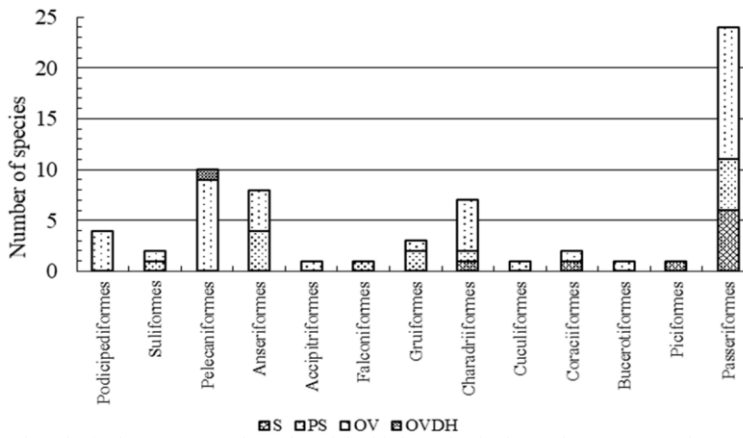


Fig. 6. Phenological structure on the order of the bird species in the study area. Legend: S- sedentary; PS- partially sedentary; OV- summer guests; OVDH- summer guests away from feeding.

From the reproductive viewpoint, 48 are nesting within the area (74%), 15 potentially nesting (23%), and 2 not-nesting (3%) (Fig. 7).

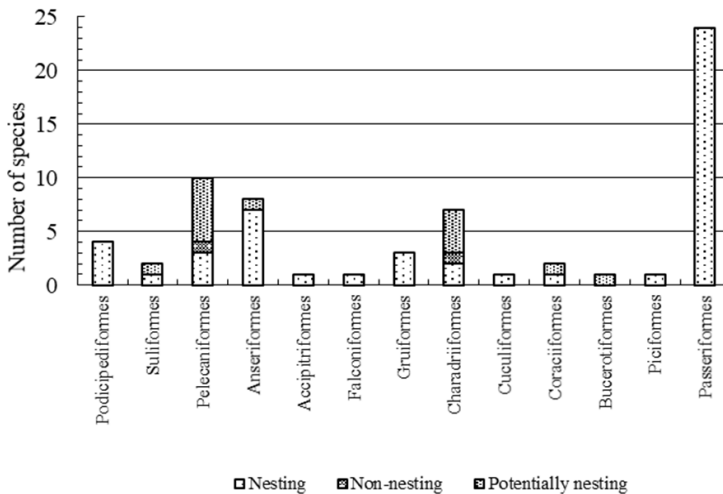


Fig. 7. Reproductive structure on the order of the bird species in the study area



Most of the observed aquatic species nest within the studied zone, except only the two species: the Great White Pelican (*Pelecanus onocrotalus*), being in the area merely on food wandering (OVDH) and the Northern Lapwing (*Vanellus vanellus*), which had a fortuitous presence. For a number of 14 water species their nesting in the area could not be confirmed, but accounting for their reproductive behaviour, as well as the habitat requirements they need in their nesting achievement, they were acknowledged as potentially nesting species in the zone under scrutiny. As regards the reproductive behaviour, a special aspect bears the Great Cormorant (*Phalacrocorax carbo*), which nests in Morun Lake colony. It is a simple colony, not being signaled other species to nest along with the great cormorant. During the first stage of the observations we assumed as well the possible presence of the Pigmy Cormorant (*Microcarbo pygmaeus*) in this colony, but this thing was not further confirmed. On the other hand, Pigmy Cormorant was noticed in very small effectives of merely few exemplaries. In Morun Lake colony a number of 300-350 Great Cormorant pairs were estimated. During our field trip throughout the colony in the months of April and May, all nests were inhabited and each had an average of 2-3 fledglings. On the last field trip, dated 20<sup>th</sup> June, a part of the Cormorant population, adults and juveniles alike, was already during their flight learning and independent feeding acquisition, whereas the rest of the population was still in the colony area.

Of the seven zoogeographic types depicted for Romania, there were identified five of these within the research area: European (34 species, 52%), Mediterranean (8 species, 12%), Transpalearctic (17 species, 26%), Mongol (5 species, 8%) and Chinese (1 species, 2%) (Fig. 8).

For the aquatic species in the zone, most of them belong to the European type of fauna (E, 44%), followed by Transpalearctic (TP, 26%), Mediterranean (M, 18%), Mongol (M, 10%) and Chinese (CH, 2%) (Fig. 9). If we superimpose the areas of European, Mediterranean and Transpalearctic zoogeographic origin, we actually reach a great region which can broadly be outlined as the current Europe territory. This thing leads us to a zoological re-settlement of observed water birds and to consider that 88% of these belong to a common territory, European in the geographic sense of the word, which perhaps confirms once again the presence of these birds within the research site (and not only).

Compliant with the criteria established by BirdLife International (2000, 2004, 2017), as well as by *International Union for Conservation of Nature* (IUCN 2012), the most signaled species hold a steady population status (S – 63% or LC – 95%) (Table 1 and Fig. 10a and b). Between the two systems there are no significant differences, but in turn each is based upon other assessment criteria of population status.

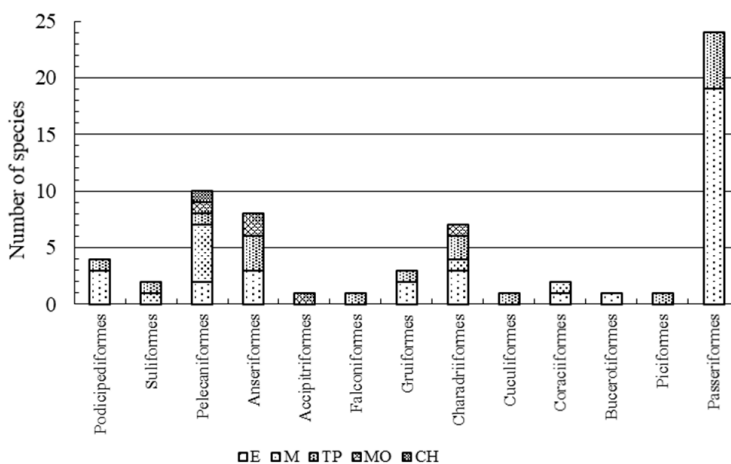
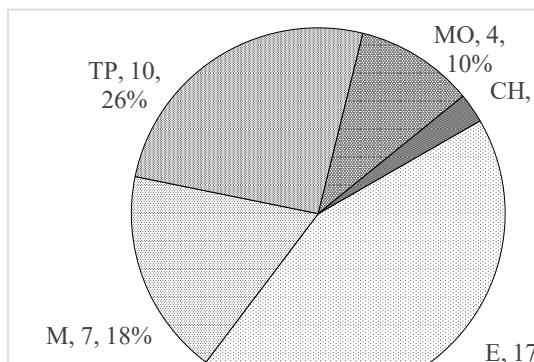
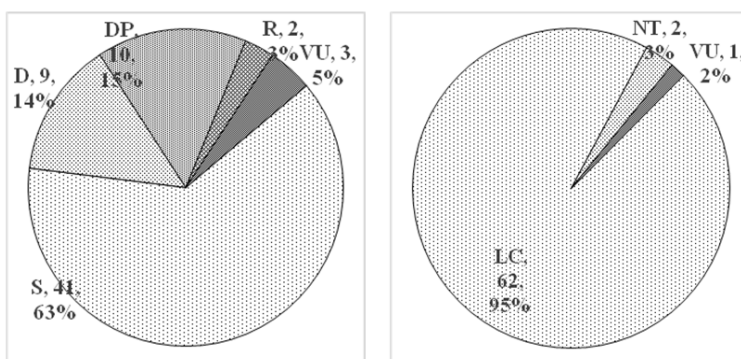


Fig. 8. Zoogeographical structure on the order of the bird species in the study area. Legend: E-european; TP-transpalearctic; M-mediterranean; CH- chinese; MO-mongolian



**Fig. 9.** Zoogeographic structure of aquatic bird species in the study area.  
Legend: E-european; TP-transpalearctic; M-mediterranean; CH- chinese; MO-mongolian



**Fig. 10.** Status of bird species reported in the study area according to criteria established by BirdLife International [25-27]: (a), and *International Union for Conservation of Nature* [28, 29] (b).  
Legend: S-LC- stable; VU - vulnerable, NT - near threatened; R - rare; DP - depleted; D - declining

According to the criteria set in BirdLife International (2004) (Table 2), there are some waterfowl species which feature certain unsteadiness at European level:

- The Great White Pelican (*Pelecanus onocrotalus*) and the Eurasian Spoonbill (*Platalea leucorodia*), are still infrequent species (R) at European level. As regards the Common Cormorant it is known that the highest nesting population number lies precisely in the Danube Delta, whereas for the Spoonbill, Romania and mainly the Danube Delta represent the second region in Europe, after Russia, where this species reproduces;
- The Common Litter Bittern (*Ixobrychus minutus*), Black-Crowned Night Heron (*Nycticorax nycticorax*), Gadwall (*Mareca strepera*), Whiskered Tern (*Chlidonias hybridus*), Black Tern (*Chlidonias niger*) and Common Kingfisher (*Alcedo atthis*) are species with low numbers (DP), which have recorded a steady decline and throughout a very long period of time. According to the new estimates regarding bird populations at European and domestic level (BirdLife International 2017), the Common Kingfisher was included in the group of vulnerable species for Romania;
- The Squacco Heron (*Ardeola ralloides*), Purple Heron (*Ardea purpurea*), Glossy Ibis (*Plegadis falcinellus*) and Common Pochard (*Aythya ferina*) are species with a downfall in number of population;
- The Ruddy Shelduck (*Tadorna ferruginea*), Ferruginous Duck (*Aythya nyroca*) and Northern Lapwing (*Vanellus vanellus*) are vulnerable species with lower numbers reaching a minimal threshold of survival.

Table 2. The European conservation status of bird species observed in the study area

ID	Scientific Name	SPEC Category	European Threat BLI 2004 (BLI 2000)	Red list IUCN 2012 (IUCN in BLI 2004)	EU Wild Birds Directive	Bern Conven.	Bonn Conven.
1	<i>Tachybaptus ruficollis</i>	Non-SPEC (1994: -)	S (1994: S)	LC			
2	<i>Podiceps cristatus</i>	Non-SPEC (1994: -)	S (1994: S)	LC			A III
3	<i>Podiceps grisegena</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	A II
4	<i>Podiceps nigricollis</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	
5	<i>Phalacrocorax carbo</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A III	
6	<i>Microcarbo pygmaeus</i>	SPEC 1 (1994: 2)	S (1994: V)	LC (NT: A2c; A3c)	A I	A II	A II
7	<i>Pelecanus onocrotalus</i>	SPEC 3 (1994: 3)	R (1994: R)	LC	A I	A II	A I/II
8	<i>Icthyophaga cincta</i>	SPEC 3 (1994: 3)	DP (1994: V)	LC	A I	A II	A II
9	<i>Nycticorax nycticorax</i>	SPEC 3 (1994: 3)	DP (1994: D)	LC	A I	A II	
10	<i>Ardeola ralloides</i>	SPEC 3 (1994: 3)	D (1994: V)	LC	A I	A II	
11	<i>Egretta garzetta</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A I	A II	
12	<i>Ardea alba</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A I	A II	
13	<i>Ardea cinerea</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A III	
14	<i>Ardea purpurea</i>	SPEC 3 (1994: 3)	D (1994: V)	LC	A I	A II	A II
15	<i>Plegadis falcinellus</i>	SPEC 3 (1994: 3)	D (1994: D)	LC	A I	A II	A II
16	<i>Platalea leucorodia</i>	SPEC 2 (1994: 2)	R (1994: E)	LC	A I	A II	A II
17	<i>Cygnus olor</i>	Non-SPEC <sup>E</sup> (1994: -)	S (1994: S)	LC	A II-2	A III	A II
18	<i>Anser anser</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A II-1/III-2	A III	A II
19	<i>Tadorna ferruginea</i>	SPEC 3 (1994: 3)	VU (1994: V)	LC (VU, crit. A2b)	A I	A II	A II
20	<i>Mareca strepera</i>	SPEC 3 (1994: 3)	DP (1994: V)	LC	A II-1	A III	A II
21	<i>Anas crecca</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A II-1/III-2	A III	A II
22	<i>Anas platyrhynchos</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A II-1/III-1	A III	A II
23	<i>Aythya ferina</i>	SPEC 2 (1994: 4)	D (1994: S)	VU: A2ab+3b+4ab	A II-1/III-2	A III	A II
24	<i>Aythya nyroca</i>	SPEC 1 (1994: 1)	VU (1994: V)	NT (NT: A2c, d; A3c, d)	A I	A III	A I/II
25	<i>Circus aeruginosus</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A I	A II	A II
26	<i>Falco tinnunculus</i>	SPEC 3 (1994: 3)	D (1994: D)	LC		A II	A II
27	<i>Rallus aquaticus</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A II-2	A III	
28	<i>Gallinula chloropus</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A II-2	A III	
29	<i>Fulica atra</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A II-1/III-2	A III	
30	<i>Vanellus vanellus</i>	SPEC 2 (1994: -)	VU (1994: S)	NT (VU: A2b)	A II-2	A III	A II
31	<i>Larus ridibundus</i>	Non-SPEC <sup>E</sup> (1994: -)	S (1994: S)	LC	A II-2	A III	
32	<i>Larus cachinnans</i>	Non-SPEC <sup>E</sup> (1994: -)	S (1994: S)	LC	A II-2	A III	
33	<i>Chlidonias hybridus</i>	SPEC 3 (1994: 3)	DP (1994: D)	LC	A I	A II	A II
34	<i>Chlidonias niger</i>	SPEC 3 (1994: 3)	DP (1994: D)	LC	A I	A II	
35	<i>Chlidonias leucopterus</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A I	A II	A II
36	<i>Sterna hirundo</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	A II
37	<i>Cuculus canorus</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A III	
38	<i>Alcedo atthis</i>	SPEC 3 (1994: 3)	DP (1994: D)	LC	A I	A II	
39	<i>Merops apiaster</i>	SPEC 3 (1994: 3)	DP (1994: D)	LC		A II	A II
40	<i>Upupa epops</i>	SPEC 3 (1994: -)	D (1994: S)	LC		A II	
41	<i>Dendrocopos major</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	
42	<i>Hirundo rustica</i>	SPEC 3 (1994: 3)	DP (1994: D)	LC		A II	
43	<i>Motacilla alba</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	
44	<i>Troglodytes troglodytes</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	
45	<i>Erithacus rubecula</i>	Non-SPEC <sup>E</sup> (1994: 4)	S (1994: S)	LC		A II	A II
46	<i>Luscinia megarhynchos</i>	Non-SPEC <sup>E</sup> (1994: 4)	S (1994: S)	LC		A II	A II
47	<i>Phoenicurus phoenicurus</i>	SPEC 2 (1994: 2)	DP (1994: V)	LC		A II	A II
48	<i>Acrocephalus schoenobaenus</i>	Non-SPEC <sup>E</sup> (1994: 4)	S (1994: S)	LC		A II	A II
49	<i>Acrocephalus scirpaceus</i>	Non-SPEC <sup>E</sup> (1994: 4)	S (1994: S)	LC		A II	A II
50	<i>Acrocephalus arundinaceus</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	A II
51	<i>Sylvia curruca</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	A II
52	<i>Sylvia communis</i>	Non-SPEC <sup>E</sup> (1994: 4)	S (1994: S)	LC		A II	A II
53	<i>Sylvia atricapilla</i>	Non-SPEC <sup>E</sup> (1994: 4)	S (1994: S)	LC		A II	A II
54	<i>Cyanistes caeruleus</i>	Non-SPEC <sup>E</sup> (1994: 4)	S (1994: S)	LC		A II	
55	<i>Parus major</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	
56	<i>Sitta europaea</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	
57	<i>Lanius collurio</i>	SPEC 3 (1994: 3)	DP (1994: D)	LC	A I	A II	
58	<i>Pica pica</i>	Non-SPEC (1994: -)	S (1994: S)	LC	A II-2	A III	
59	<i>Corvus corone cornix</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A III	
60	<i>Sturnus vulgaris</i>	SPEC 3 (1994: -)	D (1994: S)	LC	A II-2	A III	
61	<i>Passer domesticus</i>	SPEC 3 (1994: -)	D (1994: S)	LC		A III	
62	<i>Passer montanus</i>	SPEC 3 (1994: -)	D (1994: S)	LC		A III	
63	<i>Fringilla coelebs</i>	Non-SPEC <sup>E</sup> (1994: 4)	S (1994: S)	LC		A III	
64	<i>Carduelis carduelis</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	
65	<i>Emberiza schoeniclus</i>	Non-SPEC (1994: -)	S (1994: S)	LC		A II	

Note: BLI-BirdLife International; IUCN- International Union for Conservation of Nature; S/LC-stable species; R- rare species; DP - Depleted species; D - declining species; VU - vulnerable specie; NT - near threatened; SPEC - Species of European Conservation Concern.

Following the criteria set by the International Union for Conservation of Nature (IUCN 2012), only three species have been identified that require increased attention in terms of their protection:

- the Ferruginous Duck (*Aythya nyroca*) and the Northern Lapwing (*Vanellus vanellus*) are Near Threatened species (NT), in a situation of becoming vulnerable species if there are no global conservation measures;
- the common pochard (*Aythya ferina*) is included in the Vulnerable species group (VU). With regard to the measured ecological indices, the situation stands as follows (Table 3):

**Table 3.** Ecological indices calculated for the species reported in the study area

ID	Scientific Name	T	M	SE	-	$\sigma$ 95%	+	Ab%	F%	W	
1	<i>Tachybaptus ruficollis</i>	25	6.25	5.6	-11.58	17.83	24.08	0.49	Ab1 50	F2 0.24	W2
2	<i>Podiceps cristatus</i>	267	66.75	11.52	30.06	36.68	103.43	5.28	Ab4 100	F4 5.28	W4
3	<i>Podiceps grisegena</i>	5	1.25	1.25	-2.72	3.97	5.22	0.09	Ab1 25	F1 0.024	W1
4	<i>Podiceps nigricollis</i>	45	11.25	5.2	-5.3	16.55	27.80	0.89	Ab1 100	F4 0.89	W2
5	<i>Phalacrocorax carbo</i>	1098	274.5	153.22	-213.12	487.62	762.12	21.72	Ab5 100	F4 21.72	W5
6	<i>Microcarbo pygmaeus</i>	12	3	1.35	-1.3	4.3	7.3	0.23	Ab1 100	F4 0.23	W2
7	<i>Pelecanus onocrotalus</i>	184	46	18.34	-12.37	58.37	104.37	3.63	Ab3 75	F3 2.72	W3
8	<i>Ixobrychus minutus</i>	12	3	1.47	-1.68	4.68	7.68	0.23	Ab1 75	F3 0.17	W2
9	<i>Nycticorax nycticorax</i>	33	8.25	2.86	-0.87	9.12	17.37	0.65	Ab1 75	F3 0.48	W2
10	<i>Ardeola ralloides</i>	24	6	2.19	0.99	6.99	12.99	0.47	Ab1 100	F4 0.47	W2
11	<i>Egretta garzetta</i>	26	6.5	1.7	1.06	5.43	11.93	0.51	Ab1 100	F4 0.51	W2
12	<i>Ardea alba</i>	8	2	0.57	0.16	1.83	3.83	0.15	Ab1 100	F4 0.15	W2
13	<i>Ardea cinerea</i>	15	3.75	1.65	-1.5	5.25	9	0.29	Ab1 75	F3 0.22	W2
14	<i>Ardea purpurea</i>	2	0.5	0.28	-0.41	0.91	1.41	0.03	Ab1 50	F2 0.01	W1
15	<i>Plegadis falcinellus</i>	25	6.25	5.6	-11.58	17.83	24.08	0.49	Ab1 50	F2 0.24	W2
16	<i>Platalea leucorodia</i>	2	0.5	0.5	-1.09	1.59	2.09	0.03	Ab1 25	F1 0.009	W1
17	<i>Cygnus olor</i>	129	32.25	4.44	18.11	14.13	46.38	2.55	Ab3 100	F4 2.55	W3
18	<i>Anser anser</i>	15	3.75	1.18	-0.01	3.75	7.5	0.29	Ab1 100	F4 0.29	W2
19	<i>Tadorna ferruginea</i>	1	0.25	0.25	-0.54	0.79	1.04	0.01	Ab1 25	F1 0.004	W1
20	<i>Mareca strepera</i>	33	8.25	3.35	-2.41	10.66	18.91	0.65	Ab1 100	F4 0.65	W2
21	<i>Anas crecca</i>	35	8.75	3.81	-3.39	12.14	20.89	0.69	Ab1 100	F4 0.69	W2
22	<i>Anas platyrhynchos</i>	295	73.75	17.08	19.39	54.35	128.1	5.83	Ab4 100	F4 5.83	W4
23	<i>Aythya ferina</i>	199	49.75	17.13	-4.79	54.54	104.29	3.93	Ab3 100	F4 3.93	W3
24	<i>Aythya nyroca</i>	127	31.75	15.06	-16.18	47.93	79.68	2.51	Ab3 100	F4 2.51	W3
25	<i>Circus aeruginosus</i>	3	1	0	1	0	1	0.05	Ab1 75	F3 0.04	W1
26	<i>Falco tinnunculus</i>	2	1	0	1	0	1	0.03	Ab1 50	F2 0.01	W1
27	<i>Rallus aquaticus</i>	4	1	0.4	-0.29	1.29	2.29	0.07	Ab1 75	F3 0.05	W1
28	<i>Gallinula chloropus</i>	94	23.5	7.57	-0.61	24.11	47.61	1.85	Ab2 100	F4 1.85	W3
29	<i>Fulica atra</i>	441	110.25	12.45	70.59	39.65	149.9	8.72	Ab4 100	F4 8.72	W4
30	<i>Vanellus vanellus</i>	1	0.25	0.25	-0.54	0.79	1.04	0.01	Ab1 25	F1 0.004	W1
31	<i>Larus ridibundus</i>	120	30	8.83	1.89	28.1	58.1	2.37	Ab3 100	F4 2.37	W3
32	<i>Larus cachinnans</i>	64	16	5.75	-2.32	18.32	34.32	1.26	Ab2 100	F4 1.26	W3
33	<i>Chlidonias hybridus</i>	242	60.5	9.04	36.72	28.77	94.27	4.78	Ab3 100	F4 4.78	W3
34	<i>Chlidonias niger</i>	3	0.75	0.75	-1.63	2.38	3.13	0.05	Ab1 25	F1 0.01	W1
35	<i>Chlidonias leucopterus</i>	23	5.75	2.28	-1.52	7.27	13.02	0.45	Ab1 75	F3 0.34	W2
36	<i>Sterna hirundo</i>	20	5	1.47	0.31	4.68	9.68	0.39	Ab1 100	F4 0.39	W2
37	<i>Cuculus canorus</i>	13	3.25	1.18	-0.5	3.75	7	0.25	Ab1 75	F3 0.19	W2
38	<i>Alcedo atthis</i>	8	2	0	2	0	2	0.15	Ab1 100	F4 0.15	W2
39	<i>Merops apiaster</i>	46	11.5	9.03	-17.24	28.74	40.24	0.9	Ab1 50	F2 0.45	W2
40	<i>Upupa epops</i>	2	0.5	0.28	-0.41	0.91	1.41	0.03	Ab1 50	F2 0.01	W1
41	<i>Dendrocopos major</i>	2	0.5	0.28	-0.41	0.91	1.41	0.03	Ab1 50	F2 0.01	W1
42	<i>Hirundo rustica</i>	142	35.5	11.21	-0.18	35.68	71.18	2.8	Ab3 100	F4 2.8	W3
43	<i>Motacilla alba</i>	4	1	0.57	-0.83	1.83	2.83	0.07	Ab1 50	F2 0.03	W1
44	<i>Troglodytes troglodytes</i>	1	0.25	0.25	-0.54	0.79	1.04	0.01	Ab1 25	F1 0.004	W1
45	<i>Erithacus rubecula</i>	11	2.75	0.94	-1.26	3.01	5.76	0.21	Ab1 75	F3 0.16	W2
46	<i>Luscinia megarhynchos</i>	2	0.5	0.5	-1.09	1.59	2.09	0.03	Ab1 25	F1 0.009	W1
47	<i>Phoenicurus phoenicurus</i>	17	4.25	2.46	-3.58	7.83	12.08	0.33	Ab1 50	F2 0.16	W2
48	<i>Acrocephalus schoenobaenus</i>	33	8.25	4.97	-7.57	15.82	24.07	0.65	Ab1 50	F2 0.32	W2
49	<i>Acrocephalus scirpaceus</i>	47	11.75	6.78	-9.84	21.59	33.34	0.92	Ab1 75	F3 0.69	W2
50	<i>Acrocephalus arundinaceus</i>	132	33	14.73	-13.88	46.88	79.88	2.61	Ab3 75	F3 1.95	W3
51	<i>Sylvia curruca</i>	19	4.75	1.7	-0.66	5.41	10.16	0.37	Ab1 75	F3 0.28	W2
52	<i>Sylvia communis</i>	36	9	3.1	-0.89	9.89	18.89	0.71	Ab1 75	F3 0.53	W2
53	<i>Sylvia atricapilla</i>	9	2.25	1.31	-1.93	4.18	6.43	0.17	Ab1 50	F2 0.08	W1
54	<i>Cyanistes caeruleus</i>	31	7.75	2.83	-1.28	9.03	16.78	0.61	Ab1 75	F3 0.45	W2
55	<i>Parus major</i>	58	14.5	5.54	-3.14	17.64	32.14	1.14	Ab2 75	F3 0.86	W2
56	<i>Sitta europaea</i>	2	0.5	0.28	-0.41	0.91	1.41	0.03	Ab1 50	F2 0.01	W1
57	<i>Lanius collurio</i>	16	4	2.12	-2.75	6.75	10.75	0.31	Ab1 75	F3 0.23	W2
58	<i>Pica pica</i>	8	2	0.81	-0.59	2.59	4.59	0.15	Ab1 75	F3 0.11	W2
59	<i>Corvus corone cornix</i>	96	24	4.37	10.06	13.93	37.93	1.89	Ab2 100	F4 1.89	W3
60	<i>Sturnus vulgaris</i>	242	60.5	20.85	-5.86	66.36	126.86	4.78	Ab3 100	F4 4.78	W3
61	<i>Passer domesticus</i>	280	70	31.83	-31.31	101.31	171.31	5.53	Ab4 75	F3 4.15	W3
62	<i>Passer montanus</i>	53	13.25	8.97	-15.31	28.56	41.81	1.04	Ab1 50	F2 0.52	W2
63	<i>Fringilla coelebs</i>	41	10.25	5.8	-8.23	18.48	28.73	0.81	Ab1 75	F3 0.6	W2
64	<i>Carduelis carduelis</i>	9	2.25	0.85	-0.46	2.71	4.96	0.17	Ab1 75	F3 0.13	W2
65	<i>Emberiza schoeniclus</i>	61	15.25	9.34	-14.5	29.75	45	1.2	Ab2 75	F3 0.9	W2

Note: T - total number of individuals observed; M - mean; SE - standard error;  $\sigma$  95% - confidence level with lower (-) and higher (+) values; Ab% - abundance; F% - frequency; W% - index of ecological significance (Dzuba index).

- considering the abundance aspect (Ab), most species belong to the subprecedent species group (Ab1, 70%) and only one species, the Great Cormorant (*Phalacrocorax carbo*), is eudominant (Ab5, 2%). Recedent and dominant species hold similar values (Ab2, 8%, respectively, Ab4, 6%), whilst the subdominant are more numerous (Ab3, 14%);
- as regards frequency (F) the most abundant are euconstant and constant species (F4, 37%, respectively, F3, 32%), followed by accessory species (F2, 20%) and those that are accidental (F1, 11%);
- ecological significance (W), bears a classification similar to that employed in the aspect of abundance, though with distinct division criteria. The most numerous are recedent species (W2, 49%), followed by subprecedent ones (W1, 24%), subdominant (W3, 20%), dominant (W4, 5%) and eudominat (W5, 2%). As in the case of abundance and ecological significance, the only eudominant species is the Great Cormorant (*Phalacrocorax carbo*).

From the aquatic species, the most well-represented are those that recorded higher numbers. Therefore, the Great Crested Grebe (*Podiceps cristatus*), Great Cormorant (*Phalacrocorax carbo*), Ggreat White Pelican (*Pelecanus onocrotalus*), Mute Swan (*Cygnus olor*), Mallard (*Anas platyrhynchos*), Common Ppochaard (*Aythya ferina*), Ferruginous Duck (*Aythya nyroca*), Eurasian Coot (*Fulica atra*), Black-Headed Gull (*Larus ridibundus*), Whispered Tern (*Chlidonias hybridus*) Great Reed Warbler (*Acrocephalus arundinaceus*), are species included in the subdominant-dominant categories in terms of abundance and ecological significance, as well as constant-euconstant regarding frequency.

Following this research, it is required to account for certain recommendations and consider some projects and further research throughout a period of 2-3 years so as to determine: a detailed analysis of intra- and interspecific relationships of the biocenoses; spatial distribution of water bird populations, which is not fortuitous, but in fact in tight connection with the existing environment conditions; an inventory of the environment and anthropic factors which influence the dynamics of the aquatic species in the area; monitoring species either in small groups or as unique species; identifying some possible new vegetal aseemblages and/or phytotaxa; a rational assessment of vegetal resources in accordance with the medicinal, fodder and ornamental importance.

## Conclusions

This research can be deemed a premiere because there was an integrated approach of floristic, phytocoenologic and ornithological research. From the total of analysed plant species (87 taxa), a number of 67 taxa (77%) vegetate within the area and on the premises of Rotundu Lake (zone with RAMSAR integrated protection). Phytotaxa with special status at domestic and international level (*Stratiotes aloides*, *Trapa natans*, *Utricularia vulgaris*, *Nymphaea candida*, *Wolffia arrhiza*, *Salvinia natans*) are in good conservation condition. Palustre and aquatic vegetation highlights 23 vegetal assemblages, five habitats of national interest and three community habitats displaying a floristic composition and a well-represented coenotic structure complying with data from the specialty literature.

There were recorded bird species holding a special protection status on domestic and European level, being included in the annexes of more directives and conventions: the Birds Directive (Council of European Parliament 2010), Berne Convention (Council of Europe 1979), Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals 2012). For these species there are worth concerted efforts so as to preserve their environment conditions unaltered, pristine with the aim of further maintaining the bird populations in the

area. The low numbers of some species such as the Pigmy Cormorant (*Microcarbo pygmaeus*), Little Egret (*Egretta garzetta*), Great Egret (*Ardea alba*), Purple Heron (*Ardea purpurea*), Glossy Ibis (*Plegadis falcinellus*) or Eurasian Spoonbill (*Platalea leucorodia*) may raise a question mark as regards their presence within the research zone.

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### References

- [1] R.L. Naylor, R.J. Goldberg, J.H. Primavera, N. Kautsky, M.C.M. Beveridge, J. Clay, C. Folke, J. Lubchenco, H. Mooney, M. Troell, *Effect of aquaculture on world fish supplies*, **Nature**, **405**(6790), 2000, pp. 1017-1024. DOI: 10.1038/35016500.
- [2] A. Sarbu, **The Danube Delta-aquatic and Palustre Plants**, Ceres Publishing House Bucuresti, 2015, p.302.
- [3] G. Andone, H. Almasan, D. Radu, E. Chiriac, G. Scarlatescu, *Research on ichthyophaga birds from the Danube Delta*, **Studies and Research ICSP**, **27**(1), 1969, pp.133-183.
- [4] M. Marinov, D. Hulea, *The dynamics of the mixed colonies of cormorants and herons from the Danube Delta, between 1959-1995*, **Scientific Anals of Danube Delta Institute, Tulcea**, 1996, pp. 211-226.
- [5] C. Tudorancea, M.M. Tudorancea (eds.) **Danube Delta. Genesis and Biodiversity**, Backhuys Publishers, Leiden, 2006, pp. 367-398.
- [6] A. Papadopol, *Considérations sur l'écologie des oiseaux du secteur Murighiol-Tulcea-Babadag-Lunca (Jurilovca) dans le contexte de la dynamique de l'avifaune du complexe lagunaire de Razelm-Sinoe (Dobrogea, Roumanie)*, **Travaux Museum d'Histoire National Grigore Antipa**, **23**, 1981, pp. 259-282.
- [7] M. Paspaleva, J.B. Kiss, M. Talpeanu, *Oiseaux coloniaux dans le Delta du Danube*, **Travaux Museum d'Histoire National Grigore Antipa**, **26**, 1985, pp. 289 - 304.
- [8] M. Platteeuw, J.B. Kiss, N. Sadoul, M.Y. Zhmud, *Colonial waterbirds and their habitat use in the Danube Delta, as an example of a large-scale natural wetland*, **Riza Raport**, 2004.
- [9] D. Radu, **The birds from The Danube Delta**, Academic Publishing RSR, București, 1979.
- [10] I. Catuneanu, A. Johnson, M. Talpeanu, *Researches ornithologiques dans la Dobrogea (1965-1966)*, **Travaux Museum d'Histoire National Grigore Antipa**, București, **2**, 1967, pp. 419-435.
- [11] P.M. Vitousek, H.A. Mooney, J. Lubchenco, J.M. Melillo, Human domination of Earth's ecosystems, **Science**, **277**(5325), 1997, pp. 494-499. DOI: 10.1126/science.277.5325.494
- [12] W. Lutz, W. Sanderson, S. Scherbov, *The end of world population growth*, **Nature**, **412**(6846), 2001, pp. 543-545.

- [13] N. Stefan, T. Chifu, J. Hanganu, M. Coroi, *Phytocenologic researches on aquatic and swamp plants from Somova Pond (Tulcea county)*, **Publisihing of Botanical Garden Iasi**, **5**, 1995, pp. 133-140.
- [14] H. Andren, Effects of habitat fragmentation on birds and mammals in landscapes with different proportions of suitable habitat - A review, **OIKOS**, 71(3), 1994, pp.355-366.
- [15] T.G. Tutin, V.H. Heiwood (ed.), *Flora Europaea*, Cambridge University Press, 1-5, 1964-1980.
- [16] T.G. Tutin (ed.), *Flora Europaea*, vol. 1, Cambridge University Press, II, 1, 1993.
- [17] T. Savulescu, **Flora of the Socialist Republic of Romania**, Publishing House Academiei Republicii Socialiste Romania, I-XIII, 1952-1976.
- [18] A. Beldie, **Romanian Flora-an Ilustrative Establishment of the Vascular Plants**, Publishing House Academiei Republicii Socialiste Romania, I-II, Bucuresti, 1979.
- [19] V. Ciocarlan, **An Illustration of the Flora from Romania–Pteridophyta et Spermatophyta**, (second edition), Ceres Bucuresti Publishing, 2000, p. 1138.
- [20] J. Braun-Blanquet, *Pflanzensoziologie*, 3, Aufl., Springer, Wien, 1964, p. 865.
- [21] K. Kostrakiewicz-Gieralt, C.C. Palici, A. Stachurska-Swakon, V. Nedeff, I. Sandu, *The causes of disappearance of sword lily *Gladiolus imbricatus* L. from natural stands-synthesis of current state of knowledge*, **International Journal of Conservation Science**, **9** (4), 2018, pp. 821-834.
- [22] V. Sanda, **Romanian Phytocenosis- Syntaxonomy, Structure, Dynamics and Evolution**, Ars Docendi Publishing, Bucuresti, 2008, p. 570.
- [23] R. Popa, I.C. Moga, M. Rissdorfer, M.L.G. Ilis, G. Petrescu, N. Craciun, M.G. Matache, C.I. Covaliu, G. Stoian, *Duckweed utilization for fresh water conservation (management) in recirculated aquaculture systems*, **International Journal of Conservation Science**, **8**(4), 2017, pp. 715-722.
- [24] W. Lutz, W. Sanderson, S. Scherbov, *The end of world population growth*, **Nature**, **412** (6846), 2001, pp. 543-545.
- [25] \* \* \*, **Birdlife International/European Bird Census Council, European Bird Populations: Estimates and Trends**, Cambridge, UK: Birdlife International (Birdlife Conservation Series No. 10), 2000
- [26] \* \* \*, **Birds in the European Union: A Status Assessment**, Wageningen, The Netherlands: BirdLife International, 2004.
- [27] \* \* \*, **European Birds of Conservation Concern: Populations, Trends and National Responsibilities**, Cambridge, UK: BirdLife International, 2017.
- [28] \* \* \*, **IUCN Red List Categories and Criteria**, Version 3.1. Second edition, Gland, IUCN, Switzerland and Cambridge, UK, 2012
- [29] \* \* \*, **Guidelines for Application of IUCN Red List Criteria at Regional and National Levels**, Version 4.0. Gland, IUCN, Switzerland and Cambridge, UK, 2012.
- [30] J.H. Karyamsetty, *Floral diversity, phenology, and pollination mechanism of true viviparous and crypto-viviparous mangroves of Godavari and Krishna Delta of Andhra Pradesh, India*, **International Journal of Conservation Science**, **8**(4), 2017, pp. 723-730.
- [31] D.M. Alongi, *Present state and future of the world's mangrove forests*, **Environmental Conservation**, **29**(3), 2002, pp. 331-349.
- [32] M. Oltean, G. Negrean, A. Popescu, N. Roman, G. Dihoru, V. Sanda, S. Mihailescu, **The Red List of Superior Plants from Romania**, Academia Romana Publishing, Biology Institute, 1994, p.52.

- [33] G. Dihoru, G. Negrean, **The Red Book of Vascular Plants from Romania**, Publishing House “Academia Romana”, Bucuresti, 2009, p. 630.
- [34] K. Kostrakiewicz-Gieralt, *The effect of vegetation character on abundance and structure of subpopulations of rare herb species *Gentiana pneumonanthe* L.*, **Polish Journal of Ecology**, **61**(1), 2013, pp. 35-43
- [35] V. Sanda, G. Serbanescu, I. Zavoianu, *Research on aquatic and palustre vegetation from the Danube Delta*, **Hidrobiology**, **11**, 1970, pp. 217-226.
- [36] A. Van Hoeck, N. Horemans, P. Monsieurs, H.X. Cao, H. Vandenhove, R. Blust, *The first draft genome of the aquatic model plant *Lemna minor* opens the route for future stress physiology research and biotechnological applications*, **Biotechnology for Biofuels**, **8**, 2015, Article Number: 188, DOI: 10.1186/s13068-015-0381-1.
- [37] C. Staniloiu, C. Florescu, *Considerations for Optimization of Biological Treatment Process for Small Wastewater Treatment Plant*, **Revista de Chimie**, **65**(4) 2014, pp. 502-505.
- [38] D. Kumar, S.R. Asolekar, *Significance of natural treatment systems to enhance reuse of treated effluent: A critical assessment*, **Ecological Engineering**, **94**, 2016, pp. 225-237.
- [39] Md. Nuruzzaman, A. Al-Mamun, Md N. Bin Salleh, *Challenges in the Rehabilitation of the Pusu River*, **International Journal of Conservation Science**, **8**(1), 2017, pp. 121-130.
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