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5. Fish Community from Lower Danube River Arms

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Abstract: In the summer-autumn of 2019 (in all 6 months) fish fauna was investigated in different sites of Lower Danube River of its arms: Unique/United Danube in front of first split at Chilia Point (Ceatal), Sf. Gheorghe arm, Sulina arm, Chilia arm and few nearby networking canals. In study period was assessed the ecological status of fish fauna and fish community inside of ichthyocenoses, as abundance (dominance), biomass and frequency, even anthropogenic impact. In all sampling sites it were recorded 58 fish species included *Ameiurus melas, A. punctatus* (this meaning new records of two exotic species silurids observed and posed by fishermen first time in Danube Delta Biosphere Reserve - DDBR), but with few species less than past when was recorded 66 species (at the beginning of third millennium) and much more in 20 century. From 68 total number of fish species, 14 populate Anexes of Habitate Directive (*Alosa immaculata, A. tanaica*, *Leuciscus aspius, Romanogobio kessleri, R. vladykovi, Rhodeus amarus, Zingel zingel, Z. streber, Misgurnus fossilis, Cobitis elongatoides* and 4 sturgeon species). In 2019 fish fauna was dominated in abundance by *Alburnus alburnus, Blicca bjoerkna* and *Carassius gibelio*, but in biomass by *Blicca bjoerkna*, *Scardinius erythrophthalmus, Cyprinus carpio, Carassius gibelio* and *Silurus glanis* with differences between sampling methods. Main anthropogenic pressures consists legal and illegal overfishing and pollution.
Keywords: fish community, ecological status, arms of Lower Danube River

INTRODUCTION

Danube Delta Biosphere Reserve (DDBR) has 580,000 ha (5800 km²) of which Danube river has 11500 ha (115 km²) representing almost 2% from DDBR, with maximum depth in Danube delta of 45 m (Gâștescu & Știucă, 2008). Chilia, Sulina and Sfantu Gheorghe arms are major paths which through the river transport water and solid flow across the delta (10 % fueling lakes-complexes) towards the Black Sea. Before branching at "Ceatal" Chilia, multiannual mean Danube flow is estimated at 6515 m³/s (Driga 2004). Chilia arm water flow has decreased in last century, instead Tulcea with that two ramifications Sfântu Gheorghe and Sulina arm increased water flow, due to its continuous correction and dredging, nowaway the rapport of water flow Chilia: Tulcea being at almost 50:50% (Driga 2004, Gâștescu & Știucă, 2008).
Danube River is water and fish supplier for all Danube delta lakes, with lakes depends hydrologically by the river. The fish dominating catches from the different lakes varied from eurytopic/"grey fish" species to limnophilous/"black fish" species. This range corresponds with differences in lake-morphometry, substrate type, hydrological distance from the river and presence of aquatic vegetation (Oostemberg et. al. 2000, Năvodaru et. al. 2002, 2005). Richness species of Danube delta lakes is related with richness fish species from running water of Danube because mostly species are semi-migratory between lakes and river, potamodromous species (once with floods enter in lakes but recede in river with lower water level).
The aim of this study is to describe ecological status of river fish fauna from Danube delta arms, based on fish survey from 2019 and information from fisheries and scientific publications literature.
Inventory and monitoring of wild species, including fish species, as well as ecosystem services especially those of supply based on the sustainable use of natural resources in the context of biodiversity conservation in the DDBR has become one of the strategic activities for DDNI after 1989, for the continuous improvement of the existing database. This paper describes the sampling effort to

obtain field data and enrich the database with new data about the Danube and its arms in 2019. Present paper actualize fish fauna status from Lower Danube River in its arms or nearby to them.

MATERIAL AND METHODS

Study area and sampling period

Study area represents sectors from Danube, Chilia branch, Tulcea branch, Sfântu Gheorghe branch, Sulina branch, Sulina basin, meanders, dead arm (Old Danube from big M), and connections canals (Canal 36).

Ichthyofauna was sampled (June-August) in summer and autumn (Septermber-November) 2019 for mostly sites and some observations in 2020 and 2021 were done for dead arms of Danube, meanders and network natural and artificial channels. These observations supplemented with information of the discharges mouths of the Danube or from the Danube arms in various sectors enrich data base, but the most important sampling data on fish fauna remaining the year 2019.

Fish sampling

The sampling methods for Danube and its arms included captures in CPUE (Catch Per Unit Effort) are:

- Electric fishing with SAMUS 725 MP Electrofisher, multiple sampling points during 10 minutes per site, CPUE standardised at individuals or grams per 1 hour (act for shoreline or riverbank to the first threshold of the river).
- Net fishing: passive (stationary in low current 12 hours per night, CPUE standardization at 100 m² gillnets/night) and active (drifting with CPUE standardization at 100 m² gillnet/toana and 1km drift) gillnets fishing. Both passive and active gillnets fishing are composed by commercial gillnets or multi meshes gillnet fishing with Nordic gillnets (30 m length x 1.8 m high each gillnet). The Nordic gillnets have 12 randomly joined panels, 2.5 m length each panel, with multiples meshes: 6, 6, 8, 10, 12, 16, 20, 24, 30, 35, 45, 55 mm (Nyberg & Degerman, 1988, Năvodaru, 2008, DIN EN 147**, CEN/TC 230*. The Nordic gillnets fishing used was made of single thread of nylon for more catch efficiency (Năvodaru & Năstase, 2018). This net fishing in Danube arms and adjacent are completed in waterbody acting in pelagic water.
- The bottom dredge-track fishing for 200 meters length per site, iron D shape frame and bottom chain with bag nets with 7 mm knot to knot mesh size, towed by the 150 hp engine ship. CPUE standardisation meaning individuals or grams per toana.
- Planktonic and benthic nets fillets for fry or larvae capture (standardization to filtered volume individuals/m³ filtered).
- Directly observed species at angling and some traditional fishing tools (cluck, hand cast net, hand line, hooks, others) just for fish species determination, without others standardization.

Others observations include survey of dead fish individuals or parts of individuals found by us, direct contact with fish captured from authorized commercial and recreative fishermen or questionnaires at first's point of fish receive.

For biometric measurements, a ichthyometer with an accuracy of 1 mm / 50 cm was used for fish lengths, and for weights, an electronic scale with an accuracy of 1 g / 5 kg was used.

The points (sites) chosen to be sampled were different for each sector of the Danube, generally on opposite banks (geographical coordinates being dotted with GPS) where can done electric fishing and for gillnets fishing with commercial and Northern gillnets were chosen quiet zones or well-anchored gear should not be taken by the current, especially near to the shores at the thresholds where fishing activity is intense for migration from one area to another, covering a wide range of habitats and covering an area allows an assessment as close as possible to reality. Fishing with dredge-track D shape was carried out in areas known to be conducive to trawling, but even so the bottom of the Danube is unpredictable, surprising, but especially the existence of countless invisible mobile dangers have often led to hanging, deregulation or damage to the tool.

The physico-chemical parameters were found in the field with the help of the electronic multiparameter Hach (HQd Field Case), but also of the Secchi disk (depth, transparency) and the electronic thermometer (water and air temperature).

Taxonomy and Ecological indices

The fish species was identified after Antipa 1909, Bănărescu (1964, 2004), and taxonomic name after revision by Kottelat 1997, Kottelat & Freyhof 2007, Nelson 2006 and Froese & Pauly 2021

www.fishbase.org 2021) completing the species lists with the finds of fish species from the DDBR area after Năvodaru & Năstase 2011; Năstase et al. 2017, 2019a.
The frequency of occurrence (F) or constancy (C) was calculated as proportion of samples containing a species and used to characterize species distribution according to Botnariuc & Vădineanu 1982, Schwerdtfeger 1975 quoted by Schindrilariu et al. 2002, Ureche 2008: Fi = bi/a•100 (%), where, Fi = frequency of occurrence of specie i, bi = the number of samples in which species i was observed and a = total number of samples.
The relative abundance or dominance (D) was calculated as proportion of species to the total catch according to Mühlenberg (1993): Di = ni/N ·100 (%), where, Di = dominance of species i, ni = individuals of the species i, and N = total number of individuals.
Five classes of frequency, 6 for abundance/dominance and 5 classes of ecological significance were used for data interpretation (**Table 1**)

Table 1 Frequency (constancy), dominance and ecological significance classification (Botnariuc & Vădineanu 1982, Gomoiu & Skolka 2001, Muhlenberg 1993, Odum 1975, Sârbu & Benedek 2004, Schwerdtfeger 1975, Șindrilariu et al. 2002, Ureche 2008)

Dominance (D)			Constancy (C)		Ecological significance (W)	
Class		%	Class	%	Class	%
					Accidental-adventitious*	W1A< 0.001
sporadic	D1	<1 (2^0)	very rare	C1=0-10	accidental	W1< 0.1
subrecedent	D2	1 (2^0) - <2	rare	C2=10.1-25	accessory	W2=0.1-1
recedent	D3	2 (2^1) - <4	widespread	C3=25.1-45	associate	W3=1-5
subdominant	D4	4 (2^2) - <8	frequent	C4=45.1-70	complementary	W4=5-10
dominant	D5	8 (2^3) – 16	very frequent	C5=70.1-100	characteristic	W5=10-20
eudominant	D6	>16 (2^4)			main, leading	W6>20

* Accidental-adventitious (accented) (W1A less values than 0.001) is a proposal for Danube delta for accented degree of accidental fish species (used in Năstase phD thesis in Năstase 2009); Accidental class from literature (W1 higher value than 0.001, between 0.001-0.1) is more towards to accessory transitional values, appearing often accidental by-catch due to some multiple imperfection causes like bad time for river sampling for some species, malfunction gear at a time, or bad natural condition for a moment, etc. However, ecological significance indicator should be viewed critically as warp reality, sometimes values semnificativelly differs for same periods/conditions.

The biodiversity (Hs) was calculated according to the Shannon-Wiener formula (Gomoiu & Skolka, 2001; Sârbu & Benedek, 2004). The equitability Evenness (Gomoiu & Skolka, 2001; Sârbu & Benedek, 2004, Ureche, 2008) means the quantum of unequal distribution of different effective species proportion as an ideal community, where every species has the same number of individuals. The value of equitability Evenness index is included between a range of 0 and 1.
The general scheme for characterizing the ecological status according to Moss et al., 2003 for Danube and its arms from DDBR as it appears in **tab 2**.

Tabel 2 The general scheme for characterizing the ecological status according to Moss et al., 2003 used for DDBR ecosystems
Pi = native piscivores present
Abex = introduced aggressive species absent
Altd = either native piscivores absent or aggressive introduced species present

Ecotype no.	Temperature of warmest month (°C)	Area (km²)	Catchment geologiy	Conductivity (µS/cm²)	Ecological status	Fish community	Fish biomass (g/m²)	Pisc/zoopl (ratio by biomass)
17	>10<25	<100	Peat	101-800	High	Pi + Abex	5 to 20	> 1
					Good	Pi + Abex	5 to 20	> 1
					Moderate	Pi or Abex	> 20	0.5-1
					Poor	Altd	> 20	< 0.5
					Bad	Altd	< 5	< 0.5

To strengthen the ecological status from the point of view of fish of the Ecoframe method (Moss et.al 2003) we add for comparison other 2 methods: one with 4 parameters that were established with the

limits of the ecological status classes based on expert judgment (Năstase et. al., 2019a) and a method with a complex indicator included 15 parameters - IBI (Biological Integrity Indicator).
According to the WFD (Water Framework Directive) were used as new parameters, relative abundances and biomass (in CPUE), but also biodiversity indicators that include species richness, these 4 parameters some of the most important parameters for assessing the status ecological in an aquatic environment for ichthyofauna. All the parameters used were given the classes / limits of the state classes, and the final result of the condition is guided by the "one bad all bad" principle (if a single parameter has small values highlighting a weak, poorly represented ichthyocenosis, all other indicators, regardless their values, indicate poor status of ichthyocenosis) (Năstase 2016 unpublished data tested in 2014 for E-eye BSB project*****, Năstase et. al, 2019a) (**tabel 3**).

Tabel 3 The limits of the ecological status classes for fish used according to the "one bad all bad" principle in the "expert judgment" assessment per CPUE (CPUE=Catch per unit effort for individuals, BPUE=catch per unit effort for biomass, H=Shannon-Wiener species diversity, E=Evenness equitability) (n=individuals, g=grams)

Status	**Colors**	**Class**	**CPUE (n)**	**BPUE (g)**	**H**	**E**
Bad	Red	I	<25	<500	<1	<0.2
Poor	Orange	II	25-100	500-2000	1 - 1.4	0.2-0.4
Moderate	Yellow	III	100-200	2000-5000	1.4 - 1.8	0.4-0.6
Good	Green	IV	200-500	5000-10000	1.8 - 2.2	0.6-0.8
High	Blue	V	>500	>10000	>2.2	>0.8

The Biological Integrity Index (IBI) will be use, which will be adapted for lakes and rivers (Nastase 2016 unpublished data) by replacing parameter 3 ("total number of salmonids" with "total number of percids"). The justification for this replacement is because salmonids are missing from the DDBR (the exception is the species *Salmo labrax* which is very rare in the waters of the Danube, migrating from the Black Sea), while percids are the next family in terms of number of species and individuals after cyprinids. At the same time, parameters 12 and 13 were increased by the limit values adjusted to the values of river and deltaic waters specific to some eutrophic waters (Năstase 2016 unpublished data tested in 2014 for E-eye BSB project*****) (**table 4**), being included in the Integrity Assessment Class (**table 5**).

Table 4 Criteria of fish determining IBI (biological integrity index) (Ureche, 2008 after Battes, 1991, Karr, 1986 and Miller, 1985), adapted for big rivers and lakes by Năstase in ****2017

PARAMETERS CATEGORIES	PARAMETER	EVALUATION INTEGRITY CLASS 5	3	1
Composition and abundance of species	1. Total number of fish species (from initial)	> 90% (abund.)	50-90 % constant	<50% (rare)
	2. Total number of cyprinids	> 45%	20-45%	<20%
	3. Total number of percids	> 5%	1-5%	<1%
	4. Others fish species	> 20%	5-20%	<5%
	5. Total number of native fish species	> 68%	35-67%	<34%
	6. Total number of non-native species	<1%	1-10%	>10%
	7. Total number of disappearing fish species	<1%	1-10%	>10%
Composition of the food fish populations	8. Proportion of zoobentofagous species	> 45%	20-45%	<20%
	9. Proportion of carnivore species	> 5%	1-5%	<1%
	10. Proportion of carnivore and planctonofagous	<20%	20-45%	>45%
	11. Proportion herbivorous and detritivores	<25%	25-50%	>50%
Stock and general state of fish populations	12. Numerical Stock (ex./100 m²) (ex./100 m linear / collectors)	> 100 ex (>20 ex)	10-100 (5-20)	<10 (<5)
	13. Gravimetrical Stock (g/100 m²) (g/100 m linear / collectors)	> 1000 g (>5000 g)	100-1000 (500-5000)	<10 (<5)
	14. Proportion of hybrid individuals	0%	0-1 %	> 1%
	15. Proportion of ill individuals	0%	0-1 %	> 1%

Table 5 Framing levels of the evaluation integrity degree in fish ecosystems (Ureche 2008 after Battes, 1991, Karr 1986 and Miller, 1985)

No.	APRECIATION	SCORE Small rivers (Miller A, 1985)	Medium and big rivers and reservoirs Karr J. R. & Co., 1986	Battes K. W., 1991	EVALUATION INTEGRITY CLASS
1	Excellent	37-40	57-60	70-75	I
2	Excellent-good	34-36	53-56	66-69	II
3	Good	30-33	48-52	59-65	III
4	Moderate-good	28-29	45-47	55-58	IV
5	Moderate	23-27	39-44	47-54	V
6	Poor-Moderate	21-22	36-38	43-46	VI
7	Poor	16-20	28-35	35-42	VII
8	Poor-Very low	12-15.	24-27	20-34	VIII
9	Very low	<12	<23	<20	IX

RESULTS

Fishing effort and Total captures

In the summer (June) and autumn (September-November) of 2019, the ichthyofauna from the Danube and its arms were studied. 186 stations/sites were sampled, of which in electric fishing (cumulative fishing effort of more than 8 hours) there were 37 stations/sites, at single-thread nylon Nordic gillnets fishing (cumulative fishing effort of 1080 m net / night) 36 were sampled sites, at commercial gillnets fishing 67 sites was samplet (cumulative fishing effort of 2010 m net / night) and in the bottom dredge-track fishing 44 sectors / stations were sampled (**table 6**). A total of 4018 specimens were caught from the Danube in 2019, weighing over 417 Kg, including the amount of crayfish caught (**table 6**).

Tabel 6 Fishing effort and total catch (specimens and grams) made in 2019 in the Danube and its arms (Symbols used: No. = number of gears used, L = length, min. = Minutes, m = meters, ex. = specimens, g = grams)

Arms	Nordic gillnets Nylon	Nordic gillnets L (m)	Electric (min.)	Commercial gillnets No.	Commercial gillnets L (m)	bottom dredge-track fishing toana	Others fishing tools	Total catches ex.	Total catches g
United Danube	1	30	20	2	60	0	2	102	23084.5
Tulcea arm	0	0	0	0	0	3	1	31	7346
Chilia arm	12	360	110	21	630	24	4	1127	76091.2
Sf Ghe. arm	10	300	130	22	660	9	3	994	114463.1
Sulina arm	9	270	110	18	540	7	3	1491	154395
Canal 36	4	120	0	6	180	1	2	249	41050
Crayfish								24	641
TOTAL	36	1080	370	67	2010	44		**4018**	**417070.8**

Environmental factors

The environmental factors of the Danube and its arms were highlighted to observe their influence on fish species. The geographical coordinates of samples were between 44.92952° - 45.420572° North latitude and 28.625952° - 29.68991° East longitude.

The analyzed physical parameters were performed in the summer season (June) and autumn (September-November). In 2019 when the air temperature was 15-30°C, the water temperature average value 20.3°C (between 14.4-27.7° C); the depth (D) was on average 167 cm being between 30 cm and 1000 cm, and the transparency (T) between 5 cm and 80 cm, and their D/T ratio generally showed an average subunit ratio of 0.5 The soil is mostly alluvial sandy, but in some places like Sulina branch appears stone rock.

To the waterbank, the vegetation is dominated by a strip of reed and from place to places with willows and their roots, except on Sulina arm where is missing because of stone bank helpful for navigation; also for all Danube arms floating vegetation is missing and submerged plants are rare.
Conductivity was on average 498 µS / cm (between 373 - 1451 µS / cm) higher at the mouths of the river, oxygen on average 8.5 mg / L (between 6.58-10.45 mg / L) with a saturation in average of 92.1% and pH on average 8.37 (between 8-8.74).

Richness species

From 68 fish species observed in Danube River arms, most are native and 8 exotic non-native species (like *Ictalurus melas* and *I. punctatus* first record in DDBR in present paper based on verified fishermen fotos (**Photo 2**), also *Perccottus glenii, Hypophthalmichthys nobilis, Hypophthalmichthys molitrix, Ctenopharingodon idella* (**Photo 1**)*, Lepomis gibbosus* and *Pseudorasbora parva*). While almost half of the species are migratory, reophilous or reofilous-stagnofilous occurred accidentally in lakes being found only in rivers and more than ¼ are stagnofilous-reophilous and another ¼ species are stagnophilous but sometimes can reach near the Danube arms and adjacent channels, neighboring or present even into the arms fairway, but in area away from current, with some aquatic vegetation (**Table 7**).
With regard to adult food, most species are benthophagous (about 1/3 of the species), almost ¼ are omnivores and ¼ piscivorous (ichthyophagous), the remaining species with different diet. Tolerance to environmental degradation shows that most are tolerant of habitat degradation (more than ½ of the species), 1/3 species are sensitive to habitat degradation, the remaining 1/7 species are intermediate (**Table 7**).

Table 7 Richness fish species in Lower Danube River arms and adjacent from DDBR (1= present species, Origin: n=native, e=exotic or non-native; Preference for water current: eury=eurytopic, migr.=migratory, reo=reophilous, stag=stagnophilous or limnophilous; Salinity: fresh=freshwater, euri=euryhaline; Adult food: omni=omnivorous, ihti=piscivorous, bent=benthophagous, fito=fitoplaktonophagous, erb=herbivore, zoo=zoophagous, zoopl=zooplanktonophagous, plank=planktonophagous, periphiton=periphitonophagous, molusco=molluscophagous; tolerance to habitat degradation: tole=tolerant, into=intolerant, inter=intermediary)

No.	Class/Order/Family/Species	Literature*	Year 2019	Origin	Preference for water current	Salinity	Food of adult	Tolerance to degradation	Actual Status in DDBR based on expert judgment
	Class Cephalospidomorphi								
	Ord. Petromyzoniformes								
	Fam. Petromyzonidae								
1	*Eudontomyzon mariae*	1		n	reo	fresh	bent	into	Accidental
	Class Actinopterygii								
	Ord. Acipenseriformes								
	Fam. Acipenseridae								
2	*Acipenser ruthenus*	1	1	n	reo	fresh	bent	into	Decreasing
3	*Acipenser stellatus*	1	1	n	migr	euri	bent+ihti	tole	Decreasing
4	Acipenser gueldenstaedtii	1		n	migr	euri	bent+ihti	tole	Decreasing
5	*Huso huso*	1	1	n	migr	euri	ihti	tole	Decreasing
	Ord. Clupeiformes								
	Fam. Clupeidae								
6	*Alosa tanaica*	1	1	n	migr	euri	zoo	tole	Common
7	*Alosa immaculata*	1	1	n	migr	euri	Ihti	tole	Decreasing
8	*Clupeonella cultriventris*	1	1	n	migr	euri	zoopl	tole	Common
	Ord. Salmoniformes								
	Fam. Salmonidae								
9	*Salmo labrax*	1	1	n	migr	euri	ihti	into	Very rare
	Ord. Esociformes								
	Fam. Esocidae								
10	*Esox lucius*	1	1	n	stag	fresh	ihti	into	Common
	Fam. Umbridae								
11	*Umbra krameri*	1		n	stag	fresh	zoopl	into	lacustrine
	Ord. Cypriniformes								
	Fam. Cyprinidae								
12	*Abramis brama*	1	1	n	stag-reo	euri	bent	tole	Common
13	*Ballerus sapa*	1	1	n	reo	fresh	bent	into	Common
14	*Blicca bjoerkna*	1	1	n	stag-reo	fresh	omni	tole	Common

15	*Alburnus alburnus*	1	1	n	reo-stag	fresh	Plank	tole	Common
16	*Leuciscus (Aspius) aspius*	1	1	n	reo-stag	fresh	ihti	into	Common
17	*Hypophthalmichthys nobilis*	1	1	e	stag-reo	fresh	zoopl	tole	Common
18	*Hypophthalmichthys molitrix*	1	1	e	stag-reo	fresh	fito	tole	Common
19	*Ctenopharingodon idella*	1	1	e	stag-reo	fresh	erbi	tole	Rare
20	*Cyprinus carpio*	1	1	n	stag-reo	fresh	omni	tole	Common
21	*Carassius gibelio*	1	1	n	eury	fresh	omni	tole	Common
22	*Carassius carassius*	1		n	stag	fresh	bent	inter	lacustrine
23	*Chondrostoma nasus*	1	1	n	reo	fresh	periphiton	into	Rare
24	*Barbus barbus*	1	1	n	reo	fresh	bent	inter	Rare
25	*Romanoobio vladykovi*	1	1	n	reo	fresh	bent	tole	Common
26	*Romanogobio kessleri*	1	1	n	reo	fresh	bent	tole	Very rare
27	*Leucaspius delineatus*	1	1	n	stag	fresh	Plank	into	lacustrine
28	*Leuciscus idus*	1	1	n	reo-stag	fresh	omni	into	Common
29	*Pelecus cultratus*	1	1	n	reo-stag	euri	omni	tole	Common
30	*Petroleuciscus borysthenicus*	1	1	n	stag	fresh	omni	inter	lacustrine
31	*Pseudorasbora parva*	1	1	e	stag-reo	fresh	omni	tole	Common
32	*Rhodeus amarus*	1	1	n	stag-reo	fresh	erbi	into	lacustrine
33	*Rutilus rutilus*	1	1	n	eury	fresh	omni	tole	Common
34	*Scardinius erythrophthalmus*	1	1	n	stag	fresh	omni	into	Common
35	*Tinca tinca*	1	1	n	stag	fresh	omni	inter	Common
36	*Vimba vimba*	1	1	n	reo-stag	euri	bent	inter	Common
37	*Squalius cephalus*	1		n	reo	fresh	ihti	into	Accidental
	Fam. Cobitidae								
38	*Cobitis elongatoides*	1	1	n	eury	fresh	bent	inter	Common
39	*Sabanejewia bulgarica*	1	1	n	reo	fresh	bent	inter	Common
40	*Misgurnus fossilis*	1	1	n	stag	fresh	omni	tole	lacustrine
	Ord. Siluriformes								
	Fam. Siluridae								
41	*Silurus glanis*	1	1	n	stag-reo	fresh	ihti	into	Common
	Fam. Ictaluridae								
42	*Ictalurus melas*		1	e	reo	fresh	ihti	tole	First record
43	*Ictalurus punctatus*		1	e	reo	fresh	ihti	tole	First record
	Ord. Anguilliformes								
	Fam Anguillidae								
44	*Anguilla anguilla*	1		n	migr	euri	Ihti+zoo	tole	Very rare
	Ord. Gadiformes								
	Fam. Lotidae								
45	*Lota lota*	1		n	reo	fresh	ihti	into	Accidental
	Ord. Gasterosteiformes								
	Fam. Gasterosteidae								
46	*Pungitius platygaster*	1	1	n	stag	fresh	bent	inter	lacustrine
47	*Gasterosteus aculeatus*	1	1	n	stag	fresh	bent	into	lacustrine
	Ord. Syngnathiformes								
	Fam. Syngnathidae								
48	*Syngnathus abaster*	1	1	n	stag-reo	euri	zoopl	tole	Common
	Ord. Perciformes								
	Fam. Percidae								
49	*Perca fluviatilis*	1	1	n	stag-reo	fresh	ihti	tole	Common
50	*Sander lucioperca*	1	1	n	stag-reo	euri	ihti	into	Common
51	*Sander volgensis*	1	1	n	reo-stag	euri	ihti+zoo	tole	Accidental
52	*Gymnocephalus baloni*	1	1	n	reo	fresh	bent	into	Common
53	*Gymnocephalus cernuus*	1	1	n	stag	fresh	bent	tole	lacustrine
54	*Gymnocephalus schraetser*	1	1	n	reo	fresh	bent	into	Rare
55	*Zingel streber*	1	1	n	reo	fresh	bent	into	Very rare
56	*Zingel zingel*	1	1	n	reo	fresh	bent	into	Rare
	Fam. Gobiidae								
57	*Babka gymnotrachelus*	1	1	n	stag	euri	bent	tole	Common
58	*Benthophilus stellatus (nudus)*	1	1	n	stag-reo	euri	bent	tole	Common
59	*Benthophiloides brauneri*	1		n	stag-reo	euri	bent	into	Extinct?
60	*Knipowitschia caucasica*	1		n	stag	euri	bent	tole	lacustrine
61	*Neogobius fluviatilis*	1	1	n	stag-reo	euri	bent	tole	Common
62	*Neogobius melanostomus*	1	1	n	stag-reo	euri	molusco	tole	Common
63	*Ponticola eurycephalus*	1	1	n	stag-reo	euri	ihti-bent	into	Common
64	*Ponticola kessleri*	1	1	n	stag-reo	euri	ihti	into	Common
65	*Proterorhinus semilunaris*	1	1	n	stag	euri	bent	tole	Common
	Fam. Centrarchidae								
66	*Lepomis gibbosus*	1	1	e	stag	fresh	Ihti	tole	Common
	Fam. Odontobutidae								
67	*Perccottus glenii*	1	1	e	stag	fresh	ihti	tole	Increasing
	Ord. Atheriniformes								
	Fam- Atherinidae								
68	*Atherina boyeri*	1	1	n	migr	euri	bent	tole	Rare
		66	59	8e 60n					

*Literature (Oțel et al. 1992, 1993, 2004, Stăncioiu & Cristea 1992, Vasilieva 2007, Năstase et al. 2015)

Following the sampling of the Danube and its arms in June-November 2019, captured 58 (included 1 rase of carp species) and one species of crustacean, plus 2 non-native first record species based on fishermen fotos belonging Ictaluridae family and others caught fish species belonging to 15 families (**Table 7 and 8**), of which more than 1/2 species have commercial value, most are native species and 8 are exotic species, including *Perccottus glenii* (Amur sleeper) first reported in Romania found in the Suceava River in 2001 (Nalbant et al., 2004), than in the Danube Delta in 2007 (Năstase A., 2007), and after more than 10 years has acclimatized and invaded DDBRs waters (Năstase et al., 2019b) (**table 7**), with significant impact on other fish species. However, the Danube and its arms are only ways of transition to the lake environment, the favorite place of *Perccottus glenii*, so its abundance in running water is small.
The vast majority (more than ½) of the species are characteristic of flowing waters - rheophiles, but a lot of species are limnophilous that populate the quiet areas of the Danube, but especially its old arms, most are freshwater and tolerant to environmental degradation. The presence of some species from Habitate Directive Annexes is gratifying. Most fish species were caught in United Danube, Chilia and Sfântu Gheorghe arms (more than 40 species), and the fewest in channel 36 (18) **(Tabel 8).**

Tabel 8 Richness species from Lower Danube for each arms in 2019 (Simbols: 1=presents of species, bold species=present in annexes of Habitate Directive)

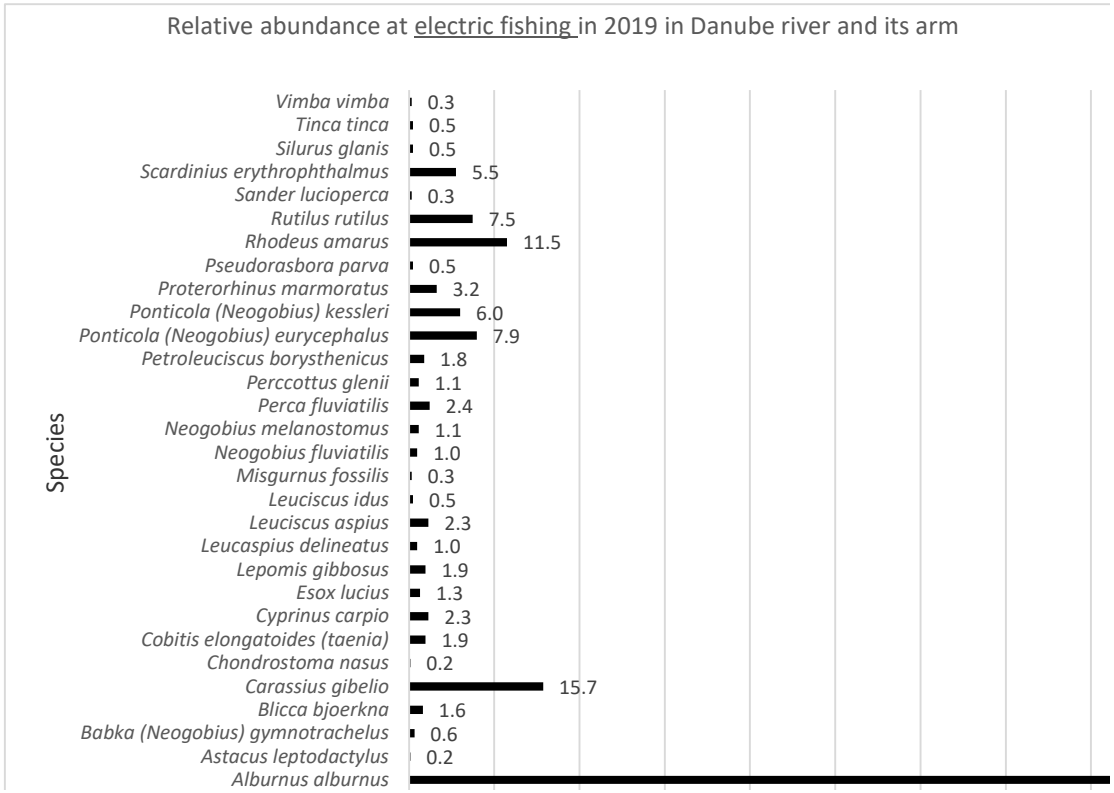
Family	Species	Common name	Chilia arm	Sfântu Gheorghe arm	Sulina arm	Tulcea arm	Canal 36	United Danube 10 miles upstream from Chilia Split (Ceatal)
Cy	*Abramis brama*	Common bream	1	1	1	1		1
Ac	***Acipenser ruthenus***	**Sterlet**	**1**			**1**		**1**
Ac	***Acipenser stellatus***	**Starry styurgeon**						**1**
Ac	***Huso huso***	**Beluga**						**1**
Cy	*Alburnus alburnus*	Bleak	1	1	1	1	1	1
Cl	***Alosa immaculata***	**Pontic shad**	**1**	**1**	**1**	**1**		**1**
Cl	***Alosa tanaica***	**Azov shad**	**1**	**1**	**1**	**1**	**1**	**1**
At	*Atherina boyeri*	Big-scale sand smelt	1		1			
Go	*Babka (Neogobius) gymnotrachelus*	Racer goby	1	1	1			
Cy	*Ballerus sapa*	White-eyed bream	1	1	1	1		1
Cy	*Barbus barbus*	Barbel	1	1		1		1
Go	*Bentophilus stellatus (nudus)*	Stellate tadpole-goby	1	1	1	1		1
Cy	*Blicca bjoerkna*	Silver bream	1	1	1	1	1	1
Cy	*Carassius gibelio*	Giebel (Prussian) carp	1	1	1	1	1	1
Cy	*Chondrostoma nasus*	Sneep			1	1		1
Cl	*Clupeonella cultriventris*	Blach Sea shad	1	1	1			
Co	***Cobitis elongatoides (taenia)***	**Spine-loach**	**1**		**1**			
Cy	*Ctenopharyngodon idella*	Grass carp	1				1	1
Cy	*Cyprinus carpio*	Carp	1	1	1	1	1	1
Cy	*Cyprinus carpio rasa Aischgrund*	Aischgrund carp			1			
Es	*Esox lucius*	Common pike	1	1	1	1	1	1
Pe	***Gymnocephalus baloni***	**Danube ruffe**	**1**	**1**	**1**	**1**	**1**	**1**
Pe	*Gymnocephalus cernuus*	Ruffe			1		1	1
Pe	***Gymnocephalus schraetzer***	**Schraetzer**				**1**		**1**
Cy	*Hypophthalmichthys molitrix*	Silver carp	1	1	1	1		1
Cy	*Hypophthalmichthys nobilis*	Bighead carp	1	1		1		1
Ce	*Lepomis gibbosus*	Pumpkinseed	1	1	1			

Cy	*Leucaspius delineatus*	Belica		1	1			1
Cy	***Leuciscus aspius***	**Asp**	**1**	**1**	**1**	**1**	**1**	**1**
Cy	*Leuciscus idus*	Ide		1		1		1
Co	***Misgurnus fossilis***	**Weatherfish**	**1**					
Go	*Neogobius fluviatilis*	Monkey goby	1	1		1		1
Go	*Neogobius melanostomus*	Round goby	1	1	1	1		1
Cy	***Pelecus cultratus***	**Ziege**		**1**	**1**	**1**		**1**
Pe	*Perca fluviatilis*	Perch	1	1	1	1	1	1
Od	*Perccottus glenii*	Amur sleeper			1			
Cy	*Petroleuciscus borysthenicus*	Dnieper chub	1	1	1		1	
Go	*Ponticola (Neogobius) eurycephalus*	Ginger goby	1	1	1	1		
Go	*Ponticola (Neogobius) kessleri*	Bighead goby	1	1	1	1		1
Go	*Proterorhinus marmoratus*	Tube-nose goby	1	1	1			1
Cy	*Pseudorasbora parva*	Stone moroko	1					
Ga	*Pungitius platygaster*	Southen ninespine		1				
Ga	*Gasterosteus aculeatus*	Three-spined stickleback			1			
Cy	***Rhodeus amarus***	**Bitterling**	**1**	**1**	**1**		**1**	
Cy	***Romanogobio (albipinnatus)***	**White-finned gudgeon**	**1**	**1**		**1**	**1**	**1**
Cy	***Romanogobio kessleri***	**Kesslers gudgeon**		**1**				**1**
Cy	*Rutilus rutilus*	Roach	1	1	1	1	1	1
Co	***Sabanejewia (aurata) bulgarica***	**Goldside loach**		**1**				**1**
Sa	*Salmo labrax*	Black Sea salmon			1	1		1
Pe	*Sander lucioperca*	Pike-perch, Zander	1	1	1	1	1	1
Pe	*Sander volgensis*	Volga pike-perch				1		1
Cy	*Scardinius erythrophthalmus*	Rudd	1	1	1	1	1	1
Si	*Silurus glanis*	Wels catfish	1	1	1	1	1	1
Sy	*Syngnathus abaster*	Black-striped pipefish		1				
Cy	*Tinca tinca*	Tench			1			
Cy	*Vimba vimba*	Vimba bream	1	1	1	1		1
Pe	***Zingel streber***	**Danube streber**	**1**	**1**		**1**		**1**
Pe	***Zingel zingel***	**Zingel**	**1**	**1**		**1**		**1**
15	**58**		**40**	**41**	**39**	**35**	**18**	**42**

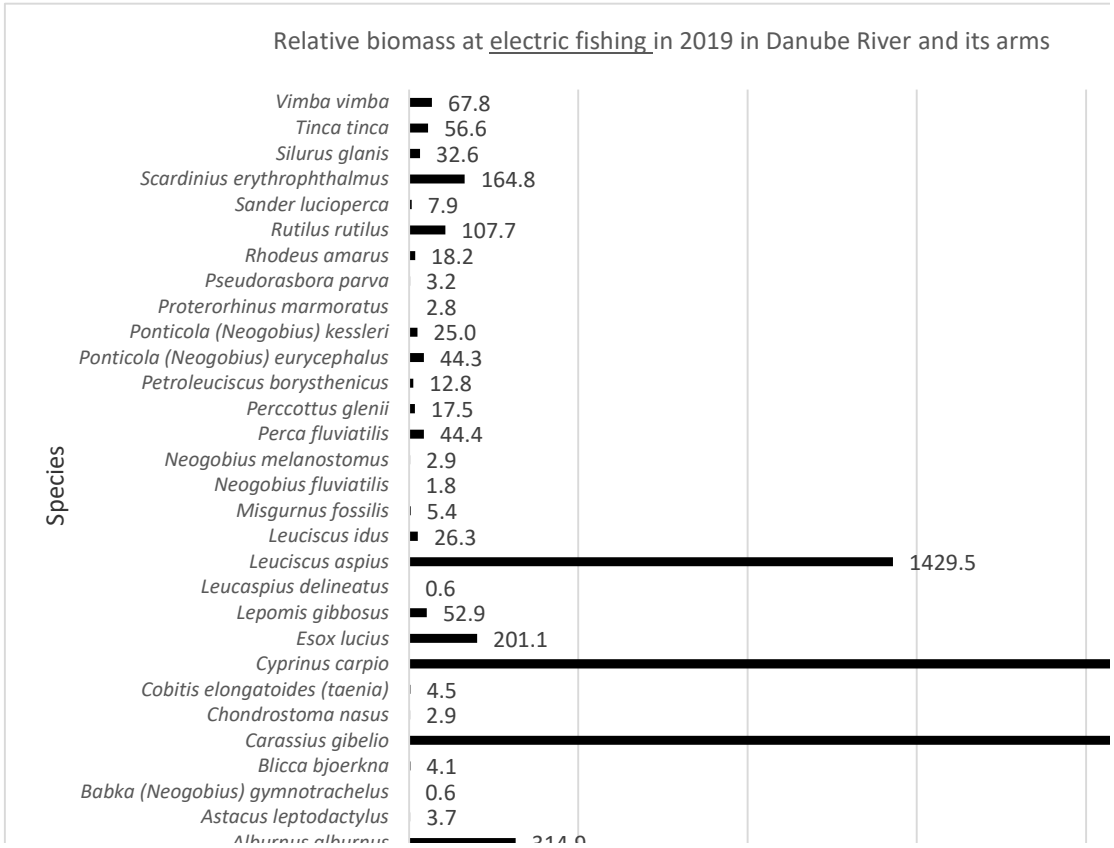
Relative abundance și biomass

Both relative abundance and biomass (per CPUE) at electric fishing are unbalancedly distributed, with some species very abundant or dominant and more others almost missing (**fig.1**).

In 2019, the electric fishing carried out in the Danube shores (waterbanks) in DDBR shows the abundance of small and medium-sized species such as *Alburnus alburnus* (bleak), *Carassius gibelio* (giebel carp), *Rhodeus amarus* (bitterling), *Rutilus rutilus* (roach), *Scardinius erythrophthalmus* (rudd) and some species of gobiids (**Fig. 1a up**). Biomass at this sampling method is far dominated by carp (*Cyprinus carpio*), giebel crucian (*C. gibelio*) and asp (*Leuciscus aspius*) species (**Fig. 1b down**).



a

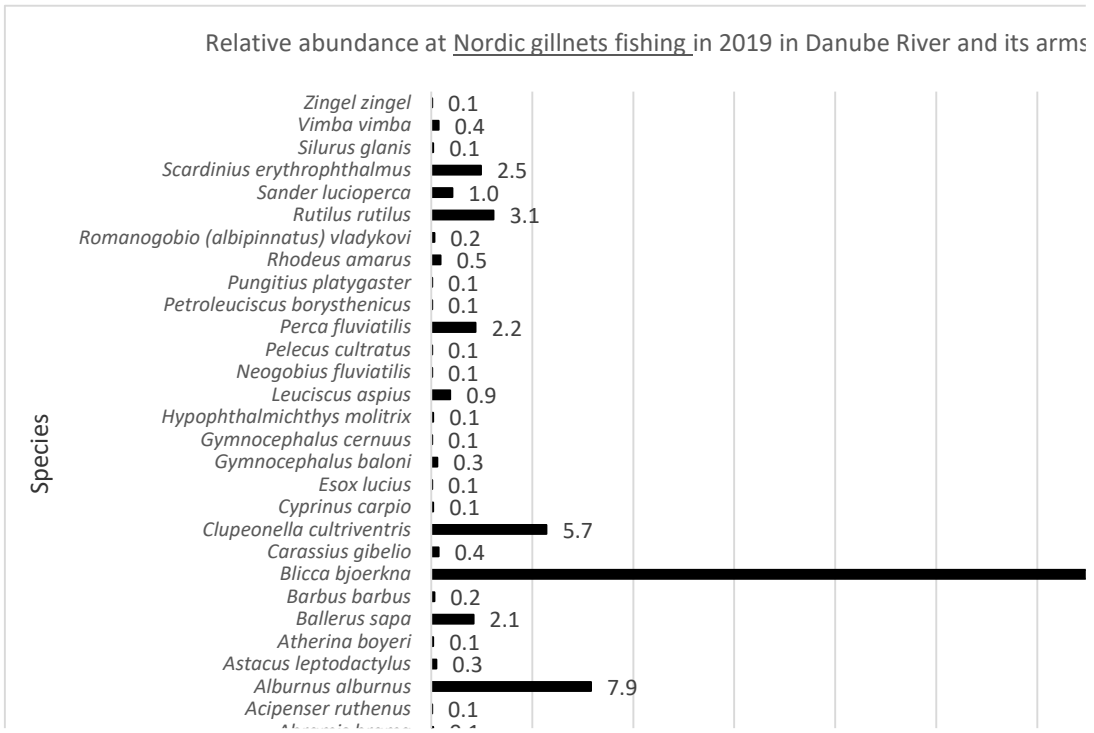


b

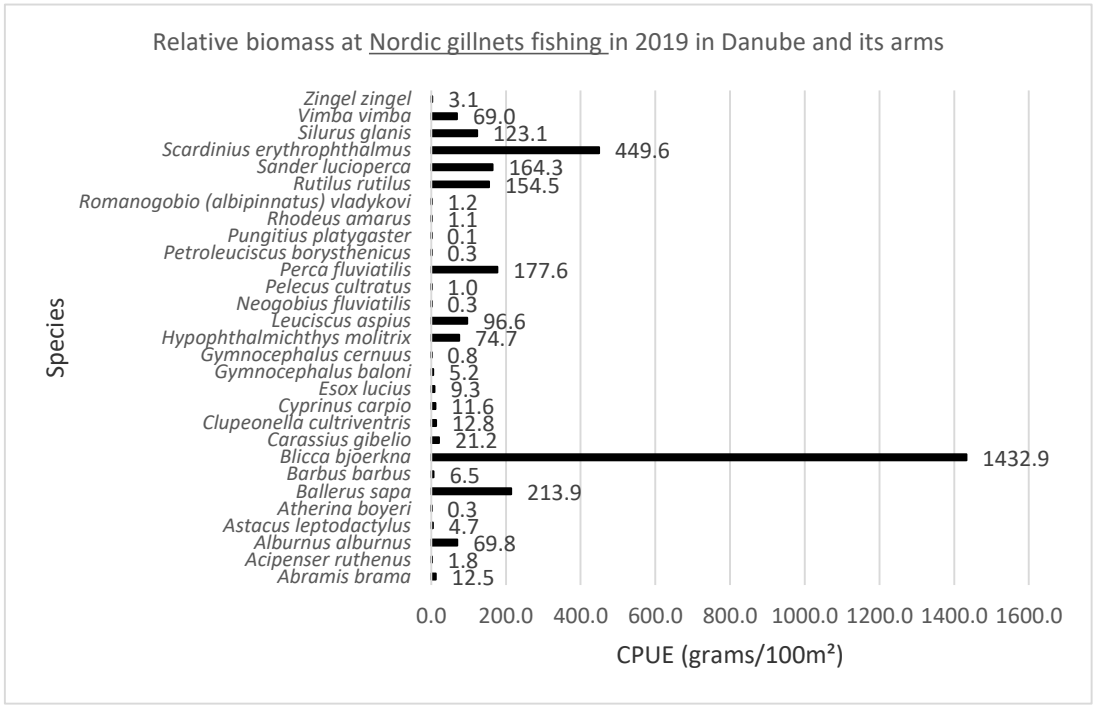
Figura 1 Relative abundance (a - up figure) and biomass (b - down figure) in CPUE to electric fishing in the studied area in 2019, carried out on Danube river shoreline

The relative abundance per CPUE of Nordic gillnet fishing in the Danube and its arms in 2019 clearly shows a massive dominance of some species, such as silver bream (*Blicca bjoerkna*) and bleak (*A. alburnus*), followed by *Clupeonella cultriventris, Rutilus rutilus, Scardinius erythrophthalmus,* but with

very low values are the majority species (**Fig. 2a up**). The biomass relative to Northern gillnets is dominated by the species *Blicca bjoerkna,* followed at a great distance by *Scardinius erythrophthalmus, Ballerus sapa*, *Perca fluviatilis* (perch), *Sander lucioperca* (pikeperch) and *Rutilus rutilus* (**Fig. 2b down**).



a



b

Figura 2 Relative abundance (a - up figures) and biomass (b - down figures) in CPUE to Nordic gillnets fishing in the studied area in 2019, carried out on Danube river pelagic water

The relative abundance per CPUE of Commercial gillnet fishing in the Danube and its arms in 2019 shows dominance of silver bream (*Blicca bjoerkna*), *S. erythrophthalmus* and *C. gibelio* (**Fig. 3a up**). The relative biomass to commercial nets is dominated by the species like *Blicca bjoerkna,* followed by *S. erythrophthalmus, C. gibelio, C. carpio* and *Leuciscus aspius* (**Fig. 3b down**).

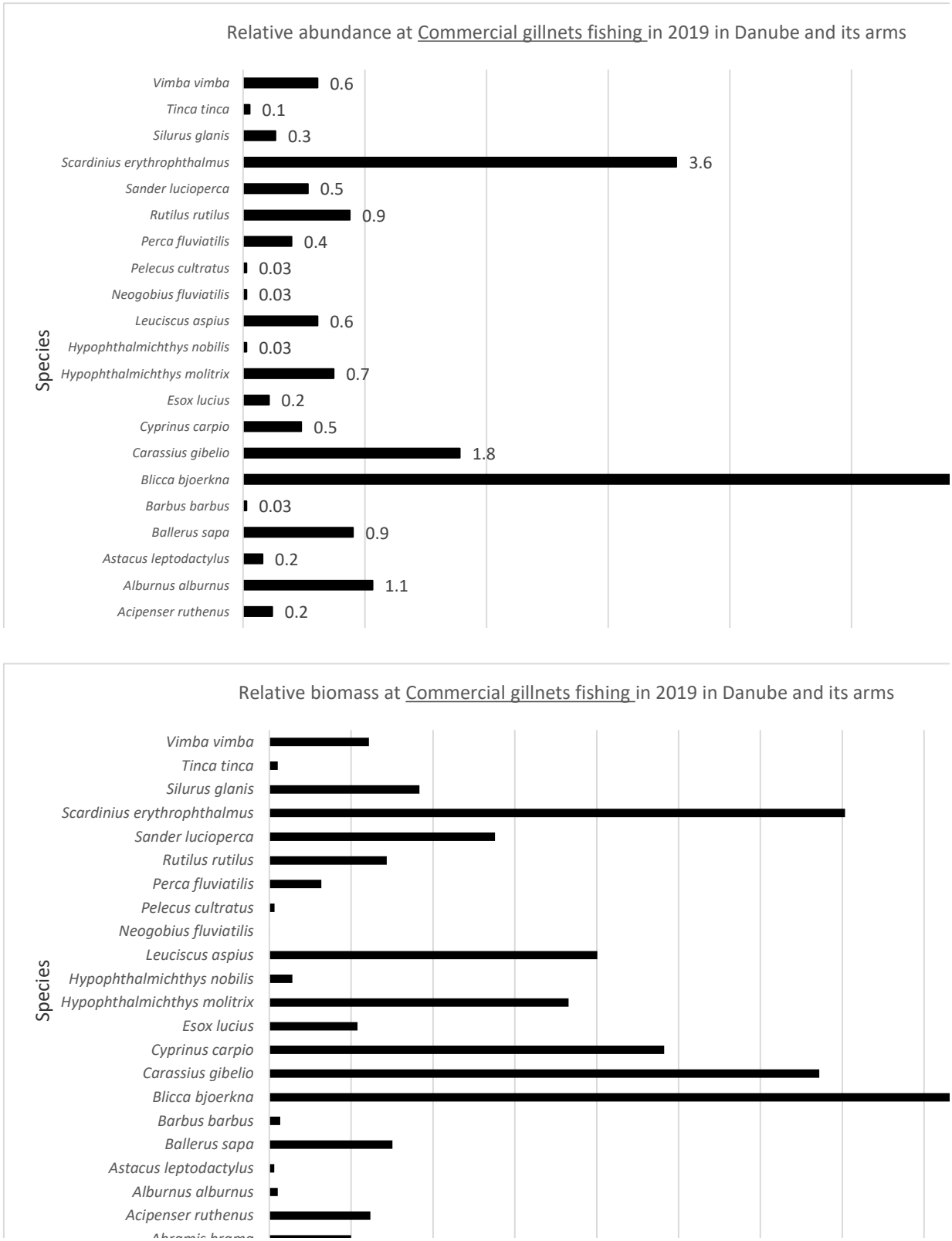
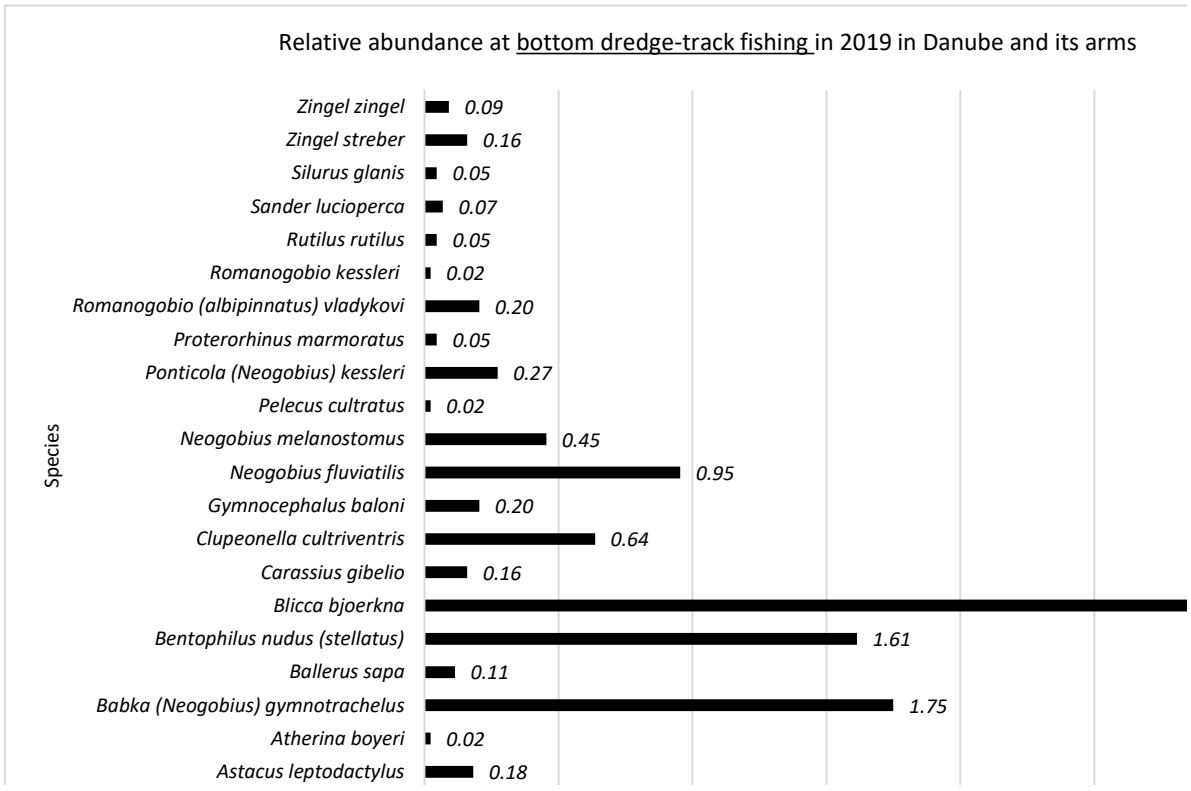


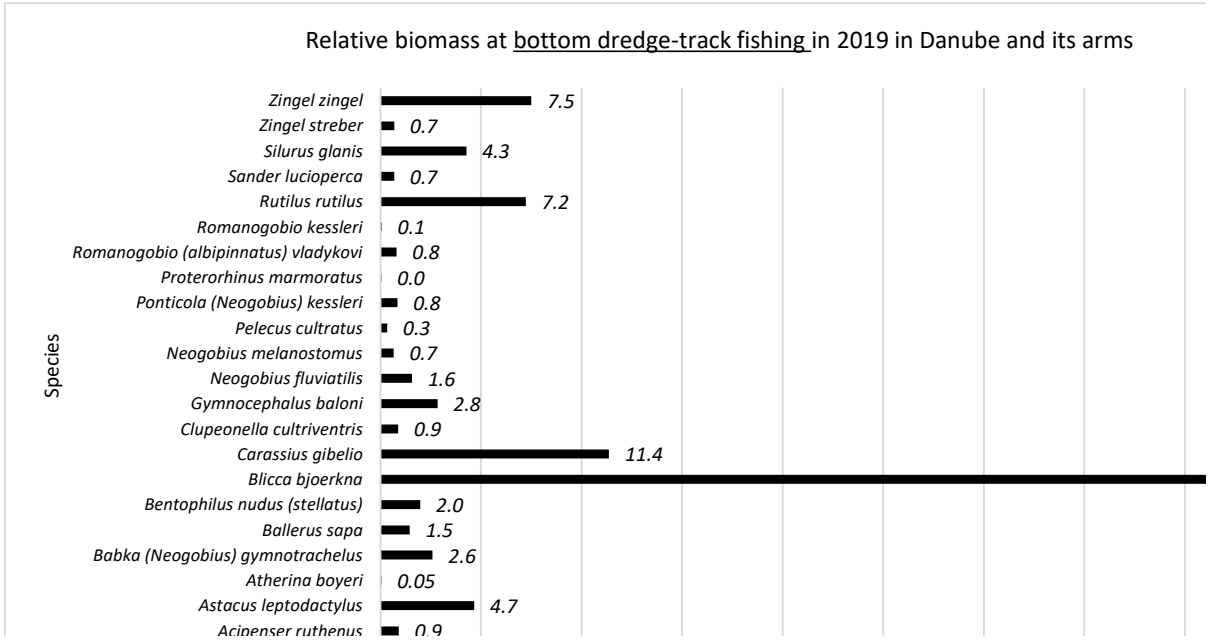
Figura 3 Relative abundance (a - up figure) and biomass (b - down figure) in CPUE to Commercial gillnets fishing in the studied area in 2019, carried out on Danube river pelagic water

The relative abundance per CPUE in bottom dredge-track fishing (trawling on the Danube bottom in the benthic zone) in 2019 shows the dominance of small species such as *Blicca bjoerkna, Babka gymnotrachelus* and *Bentophilus stellatus (nudus)* followed by *Neogobius fluviatilis, Neogobius melanostomus* and *Clupeonella cultriventris* (**Fig. 4a up**). The relative biomass to Danube bottom

fishing is dominated by the species *Blicca bjoerkna*, followed at a great distance by *Carassius gibelio, Zingel zingel* and *Rutilus rutilus* (**Fig. 4b down**).



a



b

Figura 4 Relative abundance (a - up figure) and relative biomass (b - down figure) in CPUE to bottom dredge-track fishing (trawling on the Danube bottom) in 2019, carried out on benthic water

Synecological and synthetic parameters

In 2019 in the Danube and its arms it is observed that the main, eudominant, euconstant species are *Blicca bjoerkna* (silver bream), *Alburnus alburnus* (bleak) and *Alosa immaculata* (Pontic shad) last one in spring migration time, and characteristic, dominant and euconstant species are *Rutilus rutilus*

(roach) and *Scardinius erythrophthalmus* (rudd). However, most species are accidental, sporadic or very rarely caught in the Danube and its arms, with differences between sampling methods (**Table 5**).

Table 5 Ecological parameters from the Danube and its arms in 2019: Ecological significance of fish species from Danube River and delta arms (Other tools of fishing species which could not be standardize, was just observed P = present)

Unelte	Nordic gillnets (Waterbody close to shore)			Commercial gillnets (Waterbody)			Electric fishing (Nearby shore)			Bottom dredge-track fishing			Others tools of fishing
SPECIA	D class	C class	W class	D class	C class	W class	D class	C class	W class	D class	C class	W class	
A. brama	D1	C1	W1	D3	C2	W2	D1	C1	W1				P
A. ruthenus	D1	C1	W1	D2	C1	W1				D1	C1	W1	
A. stellatus													P
H. huso													P
A. alburnus	D5	C4	W4	D1	C1	W1	D6	C5	W6				P
Alosa immaculata				D6*	C5*	W6*							P
A. tanaica				D2	C2	W2							P
A. leptodactylus	D1	C1	W1				D1	C1	W1	D2	C2	W2	P
A. boyeri	D1	C1	W1							D1	C1	W1	
B. gymnotrachelus							D1	C1	W1	D6	C2	W3	P
B. sapa	D3	C3	W3	D4	C2	W2				D2	C1	W2	P
B. barbus	D1	C1	W1	D1	C1	W1							P
B. nudus										D5	C2	W3	P
B. bjoerkna	D6	C5	W6	D6	C4	W5	D2	C2	W2	D6	C3	W5	P
C. gibelio	D1	C2	W1	D5	C3	W3	D5	C4	W4	D2	C1	W1	P
C. nasus							D1	C1	W1				
C. cultriventris	D5	C3	W3							D4	C1	W2	P
C. elongatoides							D2	C1	W1				
C. idella													P
C. carpio	D1	C1	W1	D3	C2	W2	D2	C2	W2				P
C. c. Aischgrund													P
E. lucius	D1	C1	W1	D2	C1	W2	D1	C2	W2				P
G. baloni	D1	C1	W1							D2	C2	W2	P
G. cernuus	D1	C1	W1										P
G. schraetzer													P
H. molitrix	D1	C1	W1	D3	C2	W2							P
H. nobilis				D1	C1	W1							P
L. gibbosus							D2	C2	W2				
L. delineatus							D1	C2	W1				
L. aspius	D2	C3	W2	D3	C3	W2	D2	C2	W2				P
L. idus							D1	C1	W1				P
M. fossilis							D1	C1	W1				
N. fluviatilis	D1	C1	W1	D1	C1	W1	D1	C2	W1	D5	C2	W3	P
N. melanostomus							D1	C1	W1	D4	C1	W2	P
P. cultratus	D1	C1	W1	D1	C1	W1				D1	C1	W1	
P. fluviatilis	D3	C3	W2	D3	C1	W2	D2	C3	W2				P
P. glenii							D1	C2	W2				
P. borysthenicus	D1	C1	W1				D2	C2	W2				
P. eurycephalus							D4	C3	W3				

P. kessleri							D3	C3	W3	D3	C2	W2	
P. marmoratus							D2	C2	W2	D1	C1	W1	
P. parva							D1	C1	W1				P
P. platygaster	D1	C1	W1										
R. amarus	D1	C2	W2				D4	C2	W3				
R. vladykovi	D1	C1	W1							D3	C2	W2	
R. kessleri										D1	C1	W1	
R. rutilus	D4	C4	W3	D4	C2	W2	D4	C3	W3	D1	C1	W1	P
S. bulgarica													P
S. labrax													P
S. lucioperca	D2	C3	W2	D3	C3	W2	D1	C1	W1	D1	C1	W1	P
S. volgensis													P
S. erythrophthalmus	D3	C3	W3	D6	C2	W3	D3	C3	W3				P
S. glanis	D1	C1	W1	D2	C2	W2	D1	C1	W1	D1	C1	W1	P
S. abaster													P
T. tinca				D1	C1	W1	D1	C1	W1				
V. vimba	D1	C2	W1	D3	C1	W2	D1	C1	W1				P
Z. streber										D2	C1	W2	P
Z. zingel	D1	C1	W1							D2	C1	W1	P

**Alosa immaculata* eudominant only in spring time in its migration, after that only scattered individuals

Piscivorous fish species have a percentage of 86% in biomass, while zooplanktivorous fish species (which includes even juvenile individuals of piscivorous fish species) have a percentage of 16% in biomass, and overall the ratio of the two being much higher (**Table 6**).

Table 6 Ecological status of the Danube and its arms by the variable Ratio of piscivorous and zooplanktivorous fish species, according to ECOFRAME version 8 (Moss et. Al. 2003)

CPUE piscivorous/zooplanktivorous	Biomass (CPUE)	%	Raport	Ecological status
CPUE piscivorous (Nordic gillnets)	**553**	86	86 / 16	
CPUE zooplktivorous (Nordic gillnets)	**88**	16	5,3	Very Good

According to the Ecoframe scheme (Moss et. Al. 2003), which is currently the main valid scheme for calculating the ecological status and the only one in published form that refers to the Fish parameter according to the Water Framework Directive (others variables must be added after verification and validation), according to this scheme in autumn 2019 the ecological status of the Danube and its arms is a Moderate-Good (**Table 7**).

Table 7 Ecological status of the Danube and its arms according to the Fish parameter, according to ECOFRAME version 8 (Moss et. Al. 2003)

Ecological status	Fish community	Fish biomass (g/m²) CPUE	Piscivorous/zooplanktivorous (ratio after biomass)	Fish community	Fish biomass (g/m²) CPUE	Piscivorous/zooplanktivorous (ratio after biomass)
Very Good	Pi + Abex	5 to 20	> 1			5,3 V. Good
Good	Pi + Abex	5 to 20	> 1			
Moderate	Pi or Abex	> 20	0.5-1	Pi or Abex Moderate	31,2 Moderate	
Bad	Altd	> 20	< 0.5			
Very Bad	Altd	< 5	< 0.5			

Fish diversity and IBI indexes

Regarding the biodiversity indices, it is observed that for the studied area during June-November 2019, the biodiversity indices are balanced both on the shore and in depth waters, with values of the Shanon-Wiener indices (H) between 1.6 and 2.3 almost. Therefore ichthyocenosis is stable close to average indicating a stable ecosystem with equity values (E) above 0.5 (**Table 8**).

Tabel 8 Biodiversity indices in 2019 in the Danube and its arms

	Electric	Nordic gillnets	Commercial gillnets	Bottom dredge-track fishing
H	**1.962**	**1.693**	**2.291**	**2.188**
Hmax	**3.611**	**3.367**	**3.091**	**3.091**
E	**0.543**	**0.503**	**0.741**	**0.708**

Other possible variables to be added to the Ecoframe scheme could be indices of abundance, biomass and biodiversity (Shannon-Wiener and Evernness), which also include species richness. Their value in the autumn of 2019 in the Danube and its arms are slightly above medium (**Table 9**). The ecological status according to the parameters of abundance (CPUE), biomass (NPUE) and biodiversity indices for electric fishing (Ele) and Nordic gillnet fishing (SN) in the Danube and its arms in autumn 2019 is Moderate (**Table 9**).

Tabel 9 The ecological status of the Danube and its arms according to the Pisces parameter (for the 4 indicators used), according to the principle "One bad all bad" Năstase et al. 2016, 2019 (CPUE = Capture per Unit of Effort in Abundance, BPUE = Capture per Unit of Effort in Biomass, H = Shannon-Wiener ichthyodiversity, E = ichthyological equity Evenness) for electric fishing (Ele) and Nordic gillnet fishing (SN)

	CPUE	BPUE	H	E	Total (one bad all bad)
SN values	**64.5**	**3120.0**	**1.693**	**0.503**	
Ecological status	**Poor**	**Moderate**	**Moderate**	**Moderate**	**Poor-Moderate**
Ele values	**175.46**	**7374**	**1.962**	**0.543**	
Ecological status	**Moderate**	**Good**	**Good**	**Moderate**	**Moderate-Good**

Another scheme that could complete the Ecoframe scheme is the use of the IBI indicator, whose value for the Danube and its arms in autumn 2019 is 57, which represents a Moderate-Good appreciation for the studied fish ecosystem (**Table 10**).

Table 3.3.6.6 Score and ecological status of the Danube and its arms according to the IBI Indicator

ECOLOGICAL PARAMETER	SCORE Lower Danube
1. Total number of fish species (from initial)	5
2. Total number of cyprinids	5
3. Total number of percids	5
4. Others fish species	5
5. Total number of native fish species	5
6. Total number of non-native species	1
7. Total number of disappearing fish species	3
8. Proportion of zoobentofagous species	3
9. Proportion of carnivore species	5
10. Proportion of carnivore and planctonofagous	5
11. Proportion herbivorous and detritivores	3
12. Numerical Stock (ex./100 m²) (ex./100 m linear / collectors)	3
13. Gravimetrical Stock (g/100 m²) (g/100 m linear / collectors)	5
14. Proportion of hybrid individuals	1
15. Proportion of ill individuals	3
	57
	MODERATE-GOOD

Discussion

Danube River brings in Danube Delta Biosphere Reserve (DDBR) large amounts of water and solids, being the main water way but more important the main reservoir of fish resources, thats why existence of poaching with uncontrolled and unauthorized electrical fishing is the most dangerous and exterminator qualitative and quantitative for fish species from main fish reservoir of the area, moreover overfishing and poaching being translate in decreasing the dimensions of the specimens exist from last century using underdimensionated and unconform nets forbiden by Autorities.
In Lower Danube (from Iron Gates to DDBR) was described 77 fish species, 10 have unknown status due to their rarity, 1 exotic escaped fish culture species (probably more) found in natural environment (Năstase et al., 2017) and 68 fish species present in Danube delta arms. From 68 fish species, most are native and 8 exotic non-native species (*Ictalurus melas* and *I. punctatus* first record in DDBR in

present paper based on verified fishermen fotos, also *Perccottus glenii, Hypophthalmichthys nobilis, Hypophthalmichthys molitrix, Ctenopharingodon idella, Lepomis gibbosus* and *Pseudorasbora parva*).

While almost half of the species are migratory, reophilous or reofilous-stagnofilous occurred accidentally in lakes being found only in rivers and more than ¼ are stagnofilous-reophilous, other ¼ species are stagnophilous but sometimes can reach near the Danube arms and adjacent channels, neighboring or even into the arms fairway, but in area away from current, with some aquatic vegetation. Regarding to adult food, most species are benthophagous (about 1/3 of the species), almost ¼ are omnivorous and ¼ piscivorous (ichthyophagous), the remaining species with other foods preferences. Tolerance to environmental degradation shows that most are tolerant of habitat degradation (more than ½ of the species), 1/3 species are sensitive to habitat degradation, the remaining 1/7 species are intermediate. The presence of some species from Habitate Directive Annexes is gratifying.

Most fish species were caught in United Danube and arms of Chilia and Sfântu Gheorghe (more than 40 species), and the fewest in channel 36 (18)**.**
In 2019 in the Danube and its arms it is observed that the main, eudominant, euconstant species are *Blicca bjoerkna* (silver bream) and *Alburnus alburnus* (bleak), and characteristic, dominant and euconstant species are *Rutilus rutilus* (roach) and *Scardinius erythrophthalmus* (rudd). However, most species are accidental, sporadic or very rarely caught in the Danube and its arms, with differences between sampling methods.

In the studied period of 2019, the ecological status of the ichthyofauna in the Danube and its arms is one of a kind Moderate-Good for all indicators used, with some minor differences.
Due to the rapid regenerative force of the fish, the ecological status is a seemingly positive one in 2019, probably it may have had a much higher status in the past, but we must not forget that a fish losses fisheries does not collapse suddenly but within 20 years of reduction (Alan et al., 2005), so to keep positive our conservation status of fisheries and ichthyological diversity, we must act quickly with concrete measures in the interest of protecting fish species, especially in the most vulnerable populations such as sensitive species, noting that mostly exotic, invasive species (like *Perccottus glenii, Ictalurus melas, I. punctatus*, even exotic carp silver carp and bighead carp) have acclimatized to the DDBR area and will have a significant impact on native sensitive species.

The Danube River is a large water body with 5-20 meters medium water depth, maximum 45 m in DDBR near Tulcea city, where is running important commercial fisheries. In this large river lives large fish species (maximum recorded fish was a beluga sturgeon approaches 1 ton weight and 8 meters length after Antipa 1909, Bănărescu 1964, Otel 2007, but actual body size of captured individuals not exceed 3 m and 300 kg (sturgeons and cat fish), reducing of fish individual size in catches is obviously effect of legal and ilegal overfishing, more aggressive in last century because of increasing eficience of fishing tools used (like more eficient relon nets fishing, electric fishing, nylon nets fishing).

Sturgeons and shads, captured only in migration period, have decreasing trend of population-herds, but the latest measures of recovery hoping to improved their situation, but follow-up more ample studies for more accurate data are needed. Extreme depletion of sturgeons (two species from 6 are not found since 1960) was caused by many, primarily anthropogenic factors which affected the Danube River and the Black Sea continental shell during recent last decades. Measures necessary for saving anadromous sturgeon species in the lower Danube are recommended (Bacalbașa 1997). More studies to evaluate the health of the stock using YOY (young-of-the-year) estimation (Paraschiv et. al. 2006) are needed (but not only YOY estimation requirement) especially after finished 15 protection years since 2006 and also continuing implementation of some beneficial measures for sturgeon species protection like hatchery programme, perspective to re-opening adjoining longitudinal migration route at Iron Gate dam and more others measures (Suciu et. al. 2008, 2013).

In Danube river silver carp and bighead carp individuals was captured by us or observed to the fishermen, individuals from different generations (age 0+, 1+, 2+ and more) and this confirm that species are acclimated in DDBR and have natural breeding in the area (confirming Staraș, Oțel, 1999 ipothese) as a results of increased eutrophication more accentuate after 1980.
Gobies species are increasing as against before 1991-1992 period (Oțel et. al. 1992) when were rare in Danube, especially *Neogobius melanostomus* increased number because of explosion of shell *Dreissena* species in Danube River, main food sources of this goby.

The mouths of the Danube, especially on the Chilia arm downstream of the Bâstroe arm confluence towards to the sea is silted and had reduced water curent, hence the massive abundance of stagnant water fish species, limnophilous species such as *Petroleuciscus borysthnicus, Misgurnus fossilis, Cobitis elongatoides,* also limnophilous fish species are present in Old Danube of big M of Sulina arm and meandres from Sf. Gheorghe arm, but less or missing in the main navigable route Sulina arm.

CONCLUSIONS

In 2019, the ichthyofauna of the Danube and its arms were studied, from which 186 sites/stations were sampled, capturing a total of 4018 fish specimens, weighing over 417 Kg, including the amount of crayfish caught. Following the sampling in 2019, 58 fish species and one crustacean species were caught, belonging to 15 families, plus a new family for DDBR - Ictaluridae family with 2 species *Ictalurus melas* and *I. punctatus* with the first record in this vast territory based on certain photos from fishermen. Relative abundance (per CPUE) is dominated by small and medium-sized species such as *Blicca bjoerkna*, *Alburnus alburnus,* follows by some species of gobiids, *Rutilus rutilus*, *Scardinius erythrophthalmus, Carassius gibelio* and *Alosa immaculata* in spring migration time, but most species have very low values of abundance, with differences between the sampling methods used. The relative biomass (per CPUE) in the Danube in 2019 shows a massive dominance of the species *Blicca bjoerkna*, followed by *Carassius gibelio*, *Cyprinus carpio* (carp), *Leuciscus aspius* (asp) and *Ballerus sapa*, but most species have very low biomass values, with differences between the sampling methods used.

In 2019 in the Danube and its arms it is observed that the main, eudominant, euconstant species are *Blicca bjoerkna* and *Alburnus alburnus*, followed by characteristic, dominant and euconstant species like *Rutilus rutilus, Scardinius erythrophthalmus* and *Carassius gibelio*, but most species are accidental, sporadic or very rarely caught in the Danube and its arms, including the species *Perccottus glenii* which is only passing into lakes. In the studied period of 2019, the ecological status of the ichthyofauna in the Danube and its arms is one of a kind Moderate-Good for all indicators used, with some exceptions.

Summary in Romanian language
În anul 2019 s-a studiat ihtiofauna din Dunăre și brațele sale de unde s-au eșantionat 186 staţii, dintre care la pescuitul electric (cumulând un efort de pescuit de peste 8 ore) au fost 37 staţii, la pescuitul cu setci nordice (cumulând un efort de pescuit de 1080 m setcă/noapte) au fost eșantionate 36 situri, la pescuitul cu ave comerciale au fost eșantionate 67 situri cumulând un efort de 2010 m ave/noapte, iar la pescuitul cu trandadaia s-au eșantionat 44 sectoare/stații, plus s-au utilizat și alte unelte de pescuit (ave, fileu bentonic, prostovol, vintir, cârlige, minciog). În total din Dunăre în 2019 s-au capturat 4018 exemplare de peşti cântărind peste 417 Kg, incluzând și cantitatea de raci capturată. În urma eşantionării în 2019 s-au capturat 58 de specii de peşti și o specie de crustacei, aparținând la 15 familii, plus o familie nouă pentru RBDD – familia Ictaluridae cu 2 specii *Ictalurus melas* și *I. punctatus* cu prima semnalare în acest vast teritoriu bazat pe fotografii certe de la pescari. Abundența relativă (per CPUE) este dominantă de speciile de dimensiuni mici şi medii precum *Blicca bjoerkna* (batca), *Alburnus alburnus* (oblete), unele specii de guvizi, *Rutilus rutilus* (babușca), *Scardinius erythrophthalmus* (roșioara), *Carassius gibelio* (caras) și *Alosa immaculata* (scrumbia de Dunăre) ultima doar în timpul migrației de primăvară, dar majoritatea speciilor au valori foarte mici ale abundenței, cu diferențe între metodele de eșantionare utilizate. Biomasa relativă (per CPUE) din Dunăre în 2019 arată o dominanță masivă a speciei *Blicca bjoerkna,* urmată de *Carassius gibelio* (caras), *Cyprinus carpio* (crap), *Leuciscus aspius* (avat) și *Ballerus sapa* (cosac cu bot turtit), dar majoritatea speciilor au valori foarte mici ale biomasei, cu diferențe între metodele de eșantionare utilizate.
În 2019 în Dunăre și brațele sale se observă că speciile principale, eudominante, euconstante sunt *Blicca bjoerkna* (batca) și *Alburnus alburnus* (oblete), iar specii caracteristice, dominante și euconstante sunt *Rutilus rutilus* (babușca), *Scardinius erythrophthalmus* (roșioara) și *Carassius gibelio* (caras), iar majoritatea speciilor sunt însă accidentale, sporadice sau foarte rar capturate în Dunăre și brațele sale, inclusiv specia *Perccottus glenii* care este doar în trecere spre lacuri. În perioada studiată din 2019 starea ecologică a ihtiofaunei din Dunăre și brațele sale este una per ansamblu Moderată-Bine pentru toți indicatorii utilizați, cu unele excepții.

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Photo 1 Carp, silver carp, bighead carp, grass carp and giebel carp (juvenile age 0+) in the stagnant small water bodies near waterfront of the Danube, grown large enough to be food for *Perccottus glenii*, but without chance in front of other ichthyophagous predators

Photo 2 *Ictalurus melas* (left) captured by fishermen near Isaccea locality and *I. punctatus* (right) on Chilia arm, both species first record in Danube Delta Biosphere Reserve in 2019