STUDY OF THE FISH POPULATION IN THE REGION OF THE SECOND SERIES OF LOCKS ON THE TISZA (1970—1973)

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Abstract

The first stage of the construction of the second series of locks on the Tisza (Tisza II) was completed in 1973, and the damming-up of the water of the river began. This will bring about profound changes in the natural environment, and consequently will also modify the composition of the fish population.

The present paper records the conditions prior to the damming-up. On the basis of the literature data the results of fishing, and the author's own observations, an account is given of, among others, the decrease of the frequency of some fish species, the multiplication of other species, and the appearance in the Tisza of plant-eating fish species colonized only in closed fish-farming lakes, and the frequencies of the more important species are recorded.

The recording of the state prior to the damming-up will be used as a basis for comparison in the establishment of the extents of the changes occurring later in the composition of the fish population.

Introduction

According to the National Water-management Plan, five series of locks will be created on the Hungarian section of the river Tisza, and of these that at Tiszalök has already been built.

It is well known that as a consequence of the damming significant changes took place in the fish population of the section of the river above Tiszalök (Tisza I). However, there is no exact way to establish these, for the previous situation had not been surveyed and recorded.

The second series of locks on the Tisza (Tisza II) is now under construction. This is perhaps the most significant of the operations transforming the face of Nature in Hungary today. The first step was the building of the dam at Kisköre; this has been in operation since April 1973, and at present maintains the water of the river section above it at a uniform (flooded) level. In the second and third steps, planned to be completed by the 1980's, a water-reservoir will be formed with an area of 127 km^2, a length of almost 30 km, and a width in places of more than 6 km. After the Balaton, this will be the largest connected water-surface in the country.

It is clear from the scale of the building work that the changes to be expected from the Tisza II programme will almost certainly be more considerable than those resulting at Tiszalök. This large-scale transformation now provides current actuality to the biological research of this area, one of the more important fields within this research being ichthyological examinations.

Natural conditions of the area

The main field of study in the Tisza II area was the survey of the state prior to the damming (as a starting state), in the period 1970—1973. The main emphasis was naturally afforded to the study of the fish population. However, the composition of the fish population is closely related to the features of the environment. In the course of the damming it is primarily the natural environment which changes, and in the main these are well reflected by the transformations in the fish population. Accordingly, it became necessary to extend the examinations to the natural conditions, and it appeared of indispensable importance to record these too.

Situation, surface and climate of the region

The region examined is the section of the Central Tisza between 403 and 444 river km, its main line being in the NE-SW direction (Fig. 1).

Its terminating settlements are Kisköre in the south-west, and Tiszabábolna in the north-east. The more important of the bank-side settlements are Tiszafüred on the left bank, and Poroszló on the right bank.

The predominant relief forms of the bank accompanying the river are talus from the Holocene and the dead-arms. The majority of the dead-arms are connected with the main branch of the river only at the time of more appreciable flooding. Anthropogenic formations are the flood-defence embankments, the water inlet

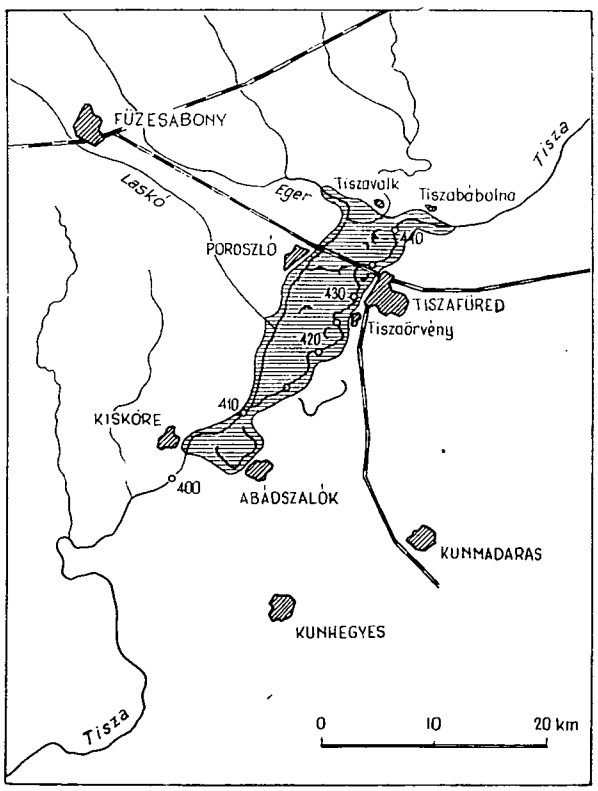

Fig. 1

channels, and the road and railway embankments traversing the inundation area (BULLA 1962).

The climate of the area is characterized by little cloud cover, abundant sunshine and comparatively low precipitation.

Characterization of the river section

This section of the Tisza has a central-section character, and even after the regulation its course remained strongly meandering. The amount of water delivered is extremely variable. The water level, which is of great importance with regard to fishing too, in general exhibits two maxima annually: the spring and the early-summer floods. At the time of flooding the mass of water delivered may be several times more than the average, and forms a practically complete cover on the comparatively large inundation area, the width of which exceeds 6 km in places. In parallel with the volume of water, the depth too is very variable. At times of low water the depth in the shallows hardly attains 1 m, whereas at times of flooding it exceeds 15 m in certain places.

The bed develops in accordance with the current of the water. Its characteristics are relatively extensive sands beds, with mud deposits at those parts where the current

Table 1. *Characteristic data of the water of the Tisza (KÖTIVIZIG)*

Site of sampling: 424 river km (Tiszaörvény)
Time of sampling: 1972, once monthly

Measured datum	Units	Minimum	Maximum	Average value
Water level	cm	−78	+170	+36
Water flow	m^3/sec	157	547	304
Water temp.	°C	0.0	23.5	12.7
Transparency	mm	75	160	108
Dissolved O_2	mg/l	7.1	12.0	10.1
O_2 saturation	%	73	97	85
pH	$-\log H^+$	7.0	7.7	7.47
Total hardness	German °	á.0	10.6	8.7
Ca ion	mval/l	1.9	2.9	2.2
Mg ion	mval/l	0.68	1.25	0.8
Na ion	mval/l	0.65	1.3	0.8
Cl ion	mval/l	0.6	1.05	0.8
SO_4 ion	mval/l	0.66	1.3	0.9
HCO_3 ion	mval/l	2.0	2.9	2.3
Dissolved matter	mg/l	213	294	250
Seston	mg/l	27	128	71

Quality of the water on 12 samplings:
on 8 occasions: pure
on 4 occasions: a little contaminated.

is slower. As a consequence of the defence work on the banks, there are comparatively few places where the bank is clayey and falls steeply. Heaps of stones and stone dams are frequently employed in the bed to direct the current-line of the river, and in several reaches the bank too is covered with stones.

Table I provides data on the quality of the river water. These data were obtained from the analyses of water samples taken monthly in 1972, i.e. a total of 12 samples.

Flora and fauna of the area

The vegetation on the banks running down to the water consist in the main of bushy willows. Behind these lie groves of willows and poplars, and the bigger stands are comprised of the American ash *(Fraxinus pennsylvanica* MARSCH.*)*. In the areas of the inundation area with a suitable situation, one can find cultivated land, meadows and smaller orchards. The treeless areas, however, are becoming increasingly larger, for the destruction of the woods is continuing at an ever higher rate in the preparatory operations for the reservoir.

As regards the fish population, the most important groups among the flora and the fauna of the river water are those which mean a direct source of food. These are primarily planktonic and benthic organisms.

Of the Rotatoria to be found in the mesozooplankton of the Tisza, species of the *Brachionus* and *Keratella* genera occur most generally. They are often present en masse, and thus provide a significant proportion of the biomass (MEGYERI 1970).

The majority of the Entomostraca species are of a tichoplanktonic nature. These species are generally scattered in occurrence and appear in low numbers of individuals. They enter the river from time to time from waters in connection with the Tisza, but because of their high adaptability they persist for long periods in the river. These species include representatives of the *Daphina, Moina* and *Bosmina* genera (MEGYERI 1972). Of the autochthonous species of a euplanktonic nature (which are primarily characteristic of the river), the following are significant according to MEGYERI (1972): *Eudiaptomus gracilis, Eucyclops serrulatus* and *Acanthocyclops vernalis*. These species are constant members of the zooplankton of the Tisza and are generally represented by high numbers of individuals.

The fauna of the benthos is primarily characterized by species belonging to the following taxonomic groups: Chironomus, Oligochaeta, Ceratopogonida, Ephemeroptera and Trichoptera. In addition to these groups with their relatively high numbers of individuals, other more important taxons are Mollusca, Odonata, Diptera, Coleoptera and Nematoda (FERENCZ 1968, BÁBA—FERENCZ 1971, SZÍTÓ 1973).

Fish population of the river section

With the formation of the water reservoir, the water will cover more than 100 km^2 of surface which was earlier inundated only at the time of extraordinarily high flooding (PICHLER 1971). This will result in a radical change in the flora and fauna of the present inundation area, but the fish population will also be modified be the slowing-down of the water, by the silting-up, by the eutrophication, and by other factors. The long-range task of the examinations is simply to record these changes, in order to facilitate continuous and planned intervention in the life of the water.

The main aims of the first stage of the investigations, up to 1973, were as follows:

1. To create a basis for comparison by recording the present state of the fish population; by comparison with the results of similar investigations in years to come, the changes brought about by the construction of the Tisza II system will become assessable.
2. To survey the changes which have taken place in the fish fauna in recent decades.

3. To prepare a forecast of the trends to be expected in the fish population, by taking into account the populations of species of importance as regards fishing, the ecological demands of the species, and the probable changes in the environment.

The exact establishment of the composition of the fish population is not possible in the case of a river section, for methods such as draining-off and fishing-out of all the fish are not applicable here. In the present case too, therefore, the aim was merely to collect as many data as possible referring to the fish population. In addition to the author's own observations, sources for these data were the literature relating to the fish population of the Tisza, and the cathing statistics of the fishing-cooperatives operating in the area.

Literature data relating to the fish population

No systematic surveys of the fish population of this section of the Tisza have yet been made, and thus the relevant data is not available in such form in the literature. Nevertheless, a number of authors have dealt with the fish and fishing of Hungary, and data referring to the Tisza too appear in these works.

PAP (1882) mentions 27 species in the Tisza; among these he distinguishes between permanent inhabitants and newcomers. In the latter class he includes the sturgeon varieties, as being of marine origin.

CZIRBUSZ (1884) mentions 30 species which are claimed to be common in the Tisza.

Of great importance is the work of HERMAN (1887), who used both his own observations and those of other authors (HECKEL, PETÉNYI, KÁROLI) to review the ichthyological results up to that time. He describes 32 fish species from the central section of the living Tisza, 31 of which can be accepted. The exception, *Acipenser schypa* GÜLDENSTADT, in not an independent species, but a species hybrid: *Acipenser nudiventris* × *Acipenser güldenstadti* (UNGER 1918, LOVASSY 1927). I tis interesting that two species, *Chondrostoma nasus* L. and *Leuciscus cephalus* L., now considered common in the Tisza, do not appear among these 31 species. It is certain, however, that these two species were members of the Tisza fauna then too, for (as emerges from the common fish-names) both were familiar to the fishermen of the Szeged district. It is probable that the two species were rarer at that time than they are now, and for this reason escaped the attention of the naturalists. This assumption is supported by the fact that one of these two species, *Leuciscus cephalus* L., does not figure in the Tisza fauna list compiled by VUTSKITS (1904), containing 39 fish species and still valid at present. Nor is its occurrence mentioned in the subsequent fauna catalogue (VUTSKITS 1918). In this latter work 40 species are described in the Tisza.

The fish fauna of Hungary is discussed by UNGER (1918) and LOVASSY (1927), primarily on the basis of the works of the above-mentioned authors, but they do point out the incorrect evaluation of a number of variants and hybrids previously considered as species.

HANKÓ (1931, 1945) lists 76 species in the waters of the Carpathian Basin, and 67 species in the Hungarian waters, but he presents few data on their extents in Hungary.

Based on the literature and his own observations, VÁSÁRHELYI mentions 60 Hungarian species. 56 of these were detected among the Tisza fauna, while 42 of

them are mentioned as occurring in the central section of the Tisza, including both the living and the dead waters. 36 species were successfully detected in the waters of this section of the river now examined.

In a study of 879 fish specimens collected from the living and dead arms of the Tisza, FERENCZ (1965) detected the presence of 28 species.

Reporting the occurrence of the Hungarian species in generality, without habitats, BERINKEY (1966) describes 67 definitely detected species, and mentions a further three, the occurrence of which is to be expected.

Some data referring directly to the Tisza II Water-reservoir area are those of TÓTH (1972), who analyzes the fish populations of the dead-arms in the vicinity of Tiszafüred and records the occurrence of 22 species.

As a consequence of the possibility of comparison, the latest fauna list for the Hungarian section of the Danube is worthy of special attention. According to this, 59 species occur in the Hungarian section of the Danube (TÓTH 1970).

Data from fishing statistics

Whereas the qualitative features of the compositions of the fish populations predominate in the literature, in the fishing statistics prominence is given to the quantitative aspects. The basis of the classification in the latter case is not systematic allocation, but the commercial value of the species. For example, many taxonomically very different species appear in the group "miscellaneous white fish", for the simple reason that they are all only of low value.

As regards the more valuable species, the fishing-cooperatives do make a distinction between the various species, but these distinctions should be treated with great care, for at times they are very imprecise and thus may be misleading.

Data for this survey were provided by the catching results of the May 1st Fishing-Cooperative at Poroszló. Table 2 contains the individual and overall data from this cooperative which relate to the living water.

With regard to the total catches reported in the Table, the results for 1970 stand out markedly. This is due to the fact that this total includes the fish caught during the flood period from March until June, when the dead-arms too were counted as living water because of the extremely high flooding. The low total catches

Table 2. *Data relating to the fish catches from the living Tisza by the May 1 st Fishing-Cooperative at Poroszló*

Species (group)	1968	1969	1970	1971	1972
	kg				
Miscellaneous white fish	3 906	7 585	37 880	2430	2012
Silurus glanis L.	2 170	964	2316	1140	1686
Cyprinus carpio L.	854	1 814	3065	695	405
Barbus barbus L.	1 061	901	428	166	214
Lucioperca lucioperca L.	1 031	600	730	747	492
Acipenser ruthenus L.	105	221	29	112	68
Esox lucius L.	1 889	2 191	17 604	496	150
Amiurus nebulosus LE SUEUR	2 342	2 022	10 423	144	70
Other	33	163	695	20	115
Total	14 391	16 461	73 170	5950	5212

for 1971 and 1972 do not indicate a decrease of the fish population of the Tisza; they are simply a reflection of the fact that in these years there was a reduction of the intensity of fishing in the river. In this period a higher proportion of the fishermen from the cooperative worked on the dead-arms, which had been replenished on the occasion of the high flood, by this means utilizing the favourable post-effects of the flooding.

Taking into consideration the inaccuracy of the figures, particularly for the period from 1968 until 1970, the following conclusions may be drawn from the fishing data:

The majority of the catch consists of the group of miscellaneous white fish; earlier observations indicate that in this section of the river this group comprises mainly *Blicca bjoerkna* L. and *Abramis* CUVIER species, in addition to many other species of lower frequency (HARKA—TÓTH 1970). Significant proportions are also observed for *Silurus glanis* L., *Lucioperca lucioperca* L. and *Barbus barbus* L.

The inaccuracies are observed primarily in the case of the species which are to be found in both living waters and dead-arms. Thus, the data relating to the catches of *Cyprinus carpio* L., *Esox lucius* L. and *Amiurus nebulosus* LE SUEUR must be accepted with reserve, the values in the Table certainly being exaggerated. *Acipenser ruthenus* L. is worthy of mention, for in spite of the fact that significant numbers were not caught, it is nevertheless a characteristic species in this section of the river.

Although the literature and the fishing statistics do provide many data, in themselves these are not sufficient basis for the assessment of the fish population. A newer, supplementary study therefore appeared necessary.

Newer observations

The essence of investigations relating to the composition of the fish population is the systematic and mass collection of fish, and also the determination of the collected material. Because of their economic importance, however, the catching of fish is regulated by laws, which had to be observed in the course of this work. Thus, in the collections it was possible only to strive for the best possible utilization of the opportunities given by the cooperative exercising the fishing rights, and there was no possibility of planning the place, time or means of these in advance.

Place, time and methods of collections

Collections were made on the 30-km section of the Tisza between 410 and 440 river km, in the period 9 August 1970 to 4 September 1973. The whole of this section of the Tisza lies in the area of the planned reservoir.

The most important means of collecting were the fish traps, these being used on 367 occasions. The number of traps varied between 10 and 50 on each occasion. Variously baited hooks were used less often: on 217 occasions; and smaller nets in only 4 cases. The catching was always carried out with the participation of the fishermen, to whom thanks are due for their ready help.

Examination material

In the 4 years of the study a total of 9564 fish specimens were caught. The collections were distributed as follows:

in 1970: 556 specimens, all caught by trap;
in 1971: 3852 specimens, 3041 of these caught by trap, 529 by hook, and 282 by net;
in 1972: 3072 specimens, 2953 of these caught by trap, and 119 by hook;
in 1973: 2084 specimens, 1658 of these caught by trap, and 426 by hook.

The distribution of the individual species according to means of collection is shown in Table 3.

The determination of the majority of the specimens collected was performed on site according to BERINKEY (1966) and WOYNÁROVICH (1969), but in part on the basis of VÁSÁRHELYI (1956) in the case of the Cyprinidae, with the aid of the pharyngeal teeth and bones. Species hybrids too were observed during the determination. These are not given separately among the data, however, but were added

Table 3. *Distribution of fish according to means of catching*

Species	Trap	Hook	Net	Total
Acipenser ruthenus L.	20	37	97	154
Esox lucius L.	248	1	—	249
Rutilus rutilus L.	59	—	—	59
Leuciscus cephalus L.	41	7	—	48
Leuciscus idus L.	46	44	3	93
Scardinius erythrophthalmus L.	1	—	—	1
Aspius aspius L.	6	30	3	39
Chondrostoma nasus L.	78	6	—	84
Gobio gobio L.	—	1	—	1
Barbus barbus L.	292	51	2	345
Alburnus alburnus L.	—	1	—	1
Blicca bjoerkna L.	3411	38	67	3516
Abramis brama L.	601	39	13	653
Abramis sapa PALLAS	919	14	48	981
Abramis ballerus L.	1017	20	19	1056
Vimba vimba L.	3	—	1	4
Pelecus cultratus L.	41	156	1	198
Carassius carassius L.	20	—	—	20
Carassius auratus gibelio BLOCH	304	—	3	307
Cyprinus carpio L.	163	50	5	218
Ctenopharyngodon idella VAL.	2	—	—	2
Hypophthalamichthys nobilis RICH.	1	—	—	1
Hypophthalamichthys molitrix VAL.	1	—	—	1
Silurus glanis L.	236	392	15	643
Amiurus nebulosus LE SUEUR	84	40	—	124
Anguilla anguilla L.	—	3	—	3
Lota lota L.	86	4	3	93
Lucioperca lucioperca L.	426	57	2	485
Lucioperca volgensis GMELIN	—	2	—	2
Perca fluviatilis L.	24	—	—	24
Aspro zingel L.	55	18	—	73
Aspro streber Siebold	—	9	—	9
Acerina cernua L.	—	9	—	9
Acerina schraetzer L.	15	41	—	56
	8	13	—	21
Total	8208	1074	282	9564

to the specimens of that species to which they showed the greatest resemblance. The totals for the samples collected include data for those specimens which were returned to the water because they were caught in a forbidden period, or as a consequence of size-limit regulations.

The weights of the specimens caught were established after their separation according to species. A single-pan balance with sliding weights was used, which could weigh between 0 and 10 kg. The larger specimens were weighed on a platform scale.

Results

Since the examination was performed in only a short section of the river, and in addition lasted for only a brief period and was made with selective means, there is no possibility for the compilation of a fauna list. In part as a result of these same reasons, the data reported do not give an accurate picture of the quantitative distribution of the fish population. The data given below, therefore, simply serve to supplement earlier knowledge relating to the fish population of the Tisza, and to provide a starting basis for later studies of the effects of the dam construction on the fish population.

Data relating to the species composition of the fish population

The 9564 specimens caught represent 34 species, and are distributed systematically as follows:

Order: **Acipenseriformes**

Family: *Acipenseridae*

1. *Acipenser ruthenus* L.

Order: **Clupeiformes**

Family: *Esociade*

2. *Esox lucius* L.

Order: **Cypriniformes**

Family: *Cyprinidae*

3. *Rutilus rutilus* L.
4. *Leuciscus cephalus* L.
5. *Leuciscus idus* L.
6. *Scardinius erythrophthalmus* L.
7. *Aspius aspius* L.
8. *Chondrostoma nasus* L.
9. *Gobio gobio* L.
10. *Barbus barbus* L.
11. *Alburnus alburnus* L.
12. *Blicca bjoerkna* L.
13. *Abramis brama* L.
14. *Abramis sapa* L.
15. *Abramis ballerus* L.
16. *Vimba vimba* L.
17. *Pelecus cultratus* L.
18. *Carassius carassius* L.
19. *Carassius auratus gibelio* BLOCH

20. *Cyprinus carpio* L.
21. *Ctenopharyngodon idella* VALENCIENNES
22. *Hypophthalamichthys nobilis* RICHARDSON
23. *Hypophthalamichthys molitrix* VALENCIENNES

Family: *Siluridae*

24. *Silurus glanis* L.

Family: *Amiuridae*

25. *Amiurus nebulosus* LE SUEUR

Order: **Anguilliformes**

Family: *Anguillidae*

26. *Anguilla anguilla* L.

Order: **Perciformes**

Family: *Percidae*

27. *Lucioperca lucioperca* L.
28. *Lucioperca volgensis* GMELIN
29. *Perca fluviatilis* L.
30. *Aspro zingel* L.
31. *Aspro streber* L.
32. *Acerina cernua* L.
33. *Acerina schraetzer* L.

Order: **Gadiformes**

Family: *Gadidae*

34. *Lota lota* L.

30 of these 34 species correspond with those reported by VÁSÁRHELYI (1960, 1961), but it did not prove possible to detect the presence of 12 species in this section of the river. These are:

1. *Acipenser stellatus* PALLAS
2. *Hucho hucho* L.
3. *Umbra krameri* WALBAUM
4. *Tinca tinca* L.
5. *Barbus meridionalis Petényii* HECKEL
6. *Chalcalburnus chalcoides mento* AGASSIZ
7. *Alburnoides bipunctatus* BLOCH
8. *Rhodeus sericeus amarus* BLOCH
9. *Cobitis taenia* L.
10. *Misgurnus fossilis* L.
11. *Micropterus salmoides* LACEPÉDE
12. *Lepomis gibbosus* L.

There are several reasons for this apparently significant difference:

1. Apart from his own observations, VÁSÁRHELYI also made use of the earlier data from the literature, and accordingly included species such as *Acipenser stellatus* PALLAS and *Hucho hucho* L. However, the specimens of these species were already extremely rare 50 years ago (UNGER 1922), and as a consequence of their further decline they are today practically only of historical significance. In this section of the river, therefore, they can not be regarded as permanent members of the fish population.

2. Among the 42 species reported by VÁSÁRHELYI there are some species the occurrence of which in living water can only be attributed to chance (e.g. *Tinca tinca* L., *Lepomis gibbosus* L., etc.). These species can indeed be found in the dead-arms of the district, sometimes en masse (TÓTH 1972), but they are similarly not constant members of the living-water fauna.

3. Micropterus salmoides Lacepéde, which was introduced merely in small quantities and can thus be considered rare in all Hungarian waters (BERINKEY 1966), also appears among the data of VÁSÁRHELYI, although only a single specimen could be identified, from gastric contents (VÁSÁRHELYI 1960).

It is a fact, however, that even when these are discounted a difference remains; this can primarily be ascribed to the selectivity of the collecting means. Although supplemantary collections were made too with small hooks, whereby a few small-bodied species could be added to the species-list *(Alburnus alburnus* L., *Gobio gobio* L.*)*, nevertheless there could have remained other species whose presence passed undetected. Great benefit in this field might result from the application of electrical fishing techniques.

The examinations yielded four species which do not figure in the earlier literature relating to this section of the river:

1. *Carassius auratus gibelio* BLOCH

This was introduced from Bulgaria into the fish lake at Szarvas in 1954. Escaping from there, it multiplied first in the dead-arms along the Körös and the Tisza (PÁSKÁNDY 1968), but in the past decade it has also spread to the currently-examined section of the Tisza. According to TÓTH (1972), it is rare in the neighbouring dead-arms, but it occurs regularly in the river-water catches. In spite of its special, gynogenetic means of multiplying, it must be regarded as a constant, established member of the fish fauna of the Tisza.

2. *Ctenopharyngodon idella* VALENCIENNES

The establishment in Hungary of this fish species, of Chinese origin, began in 1963 (ANTALFI—TÖLG 1968), but its introduction was permitted only in closed fish lakes. It is not possible to tell whether the few specimens caught in this section of the river from year to year are the result of systematic escapes from the fish lakes, or whether they arise from the theoretically possible natural multiplication in the river periodically, or even whether both possibilities exist. Whatever the explanation, the fact remains that this species is now a rare, but constant member of the fish population in this section of the river. Similar findings have been reported by TÓTH (1970) with regard to the Hungarian section of the Danube.

3. *Hypophthalamichthys nobilis* RICHARDSON

This arrived in Hungary by chance in 1963 with a delivery of young plant-eating fish (BERINKEY 1966), but its breeding is now being dealt with at the fish lakes. Its relatively high demands as regards the water temperature make its natural multiplication improbable, and thus any specimens caught in the river are almost certainly escapees from the fish lakes.

4. *Hypophthalamichthys molitrix* VALENCIENNES

The Hungarian breeding of this species similarly began with its import in 1963. Its natural multiplication is improbable, and here too, therefore, its finding is probably due to chance.* The single specimen observed merely indicates the possibility of its presence.

Besides the species listed above, the occurrence of a further two species can be reckoned with in the future. These two species are *Pseudorasbora parva* SCHLEGEL and *Neogobius fluviatilis* PALLAS. The former has already been observed in several places in Hungarian waters (MOLNÁR 1967, WIESINGER 1971, SZIKLAI 1972, BIRÓ 1972), and on the basis of its excellent adaptability, lack of demands and multiplication it can be expected that it will soon appear in the Tisza too. The latter species has so far been detected in the Balaton (BIRÓ 1972), but earlier experience in connection with the spreading of other species indicates thet the spreading of this species too is probable. It is likely that more systematic examinations would already reveal a number of habitats.

Data relating to the quantitative distribution of the species

To a certain extent, a listing of the species living there may be suitable for the characterization of a river section, but it is more appropriate if only the most typical fish species are indicated. This conception is expressed in the generally accepted characterization of river sections according to the level-regional nature. Level-regions, however, are not suitable for the demonstration of finer differences, and at the same time they may also be sources of errors, as they can afford the opportunity for misunderstandings. Thus, even when the level-regional nature persists, it can come about that the earlier characteristic species are repressed as a result of external effects such as the pollution of the water. At the level-region of *Barbus barbus* L. and *Acipenser ruthenus* L. in the Danube, for instance, the latter species is now becoming rare (RIBIÁNSZKY—WOYNÁROVICH 1962, TÓTH 1972).

A more exact picture can be obtained if the previous considerations are supplemented with a quantitative examination of the fish population. However, the fish population of a river section could only be surveyed accurately if every individual of each of the species occurring there could be taken into account. Even then the data would be valid only for the given instant, and would give a picture equivalent merely to a snapshot of this system, which is varying constantly and dynamically in both time and space as regards both its individuals and its entirety.

It is natural, therefore, that this examination can not undertake to establish the quantitative distribution of the fish population, although its data may promote the development of a picture somewhat closer to reality, and thereby permit a more shaded characterization of the river section.

The distribution according to species of the 9564 species determined during the investigation is given in Table 4, which also contains the results relating to the individual years.

Since the collections in the different years of the examination were made with different intensities and different means, it would not be realistic to draw conclusions

* More recent observations (SZŰCS 1973) permit the conclusion that the plant-eating species can adapt to Hungarian conditions and multiply in the wild state too.

on the changes in the individual species by comparing the data for the different periods. In the case of some species, however, and primarily for those the catches of which were not connected with a fixed season and which can be readily caught with traps, there is also a possibility of this, for the majority of the collections were made with traps in all three years.

Blicca bjoerkna L. appears with high values in each of the four years, and with its constant nature proved the most frequent species. Although there was some modification in their proportions, the three species of the genus *Abramis Cuvier* were similarly frequent throughout. Also of significance were *Lucioperca lucioperca* L., *Barbus barbus* L., and *Esox lucius* L., although the catches of these exhibited annual variations in relation to the total catch. Although the data for *Carassius auratius gibelio* BLOCH were not outstanding, the number of specimens caught annually confirms that this is nowadays a common species in the Tisza and that its population may be tending to increase.

The striking decrease in the catches of *Amiurus nebulosus* LE SUEUR is worthy of attention. In the first year of the examination it comprised 5.9% of the individuals

Table 4. *Distribution of fish according to species*

Species	1970	1971	1972	1973	Total no.	Total %
Acipenser ruthenus L.	—	133	5	16	154	1.61
Esox lucius L.	15	168	58	8	249	2.60
Rutilus rutilus L.	—	34	14	11	59	0.62
Leuciscus cephalus L.	9	32	6	1	48	0.50
Leuciscus idus L.	—	55	23	15	93	0.97
Scardinius erythrophthalmus L.	1	—	—	—	1	0.01
Aspius aspius L.	1	34	2	2	39	0.41
Chondrostoma nasus L.	1	39	20	24	84	0.88
Gobio gobio L.	—	1	—	—	1	0.01
Barbus barbus L.	21	183	85	56	345	3.61
Alburnus alburnus L.	—	1	—	—	1	0.01
Blicca bjoerkna L.	242	1086	1491	697	3516	36.77
Abramis brama L.	31	301	187	134	653	6.83
Abramis sapa PALLAS	70	374	250	287	981	10.26
Abramis ballerus L.	29	337	436	254	1056	11.04
Vimba vimba L.	—	1	2	1	4	0.04
Pelecus cultratus L.	3	58	26	111	198	2.07
Carassius carassius L.	19	—	1	—	20	0.21
Carassius auratus gibelio BLOCH	12	59	78	158	307	3.21
Cyprinus carpio L.	20	84	51	63	218	2.28
Ctenopharyngodon idella VAL.	—	2	—	—	2	0.02
Hypophthalamichthys nobilis RICH.	—	—	1	—	1	0.01
Hypophthalamichthys molitrix VAL.	—	—	—	1	1	0.01
Silurus glanis L.	9	412	128	94	643	6.73
Amiurus nebulosus LE SUEUR	30	60	3	31	124	1.30
Anguilla anguilla L.	—	1	—	2	3	0.03
Lota lota L.	—	8	69	16	93	0.97
Lucioperca lucioperca L.	33	240	117	95	485	5.07
Lucioperca volgensis GMELIN	—	2	—	—	2	0.02
Perca fluviatilis L.	3	13	7	1	24	0.25
Aspro zingel L.	2	60	8	3	73	0.76
Aspro streber SIEBOLD	—	9	—	—	9	0.09
Acerina cernua L.	5	51	—	—	56	0.58
Acerina schraetzer L.	—	14	4	3	21	0.21
Total	556	3852	3072	2084	9564	100.00

caught, only 1.5% in the second year, and merely 0.09% in 1972. This considerable decrease can not be regarded as chance, and nor can it be justified by the variations in the collection conditions, for the same phenomenon emerges from fishing statistics and has also been observed by fishermen and anglers in the area. The probable explanation is the fish disease which could be observed in the majority of the specimens caught in 1971. Its most characteristic symptoms were the epithelial necroses to be observed around the lips and on the belly-side, and on other regions of the body too, together with peeling-off of the epithelial layer in patches. According to animal health experts, this was either a previously unknown disease, or a concealed form of ichthyophthiriasis (verbal communication from GY. HÁMORI). The disease was also observed in a number of *Silurus glanis* L. specimens. It appears that the population has already passed through the worst, for a larger quantity of young specimens were caught in 1973, and in these the earlier symptoms could not be observed.

Comparison would not be realistic in the case of the other species. Accordingly, in the following only the overall data are evaluated; the percentage values are designed to give a clearer picture.

Even among the overall data, the high proportion of *Blicca bjoerkna* L. stands out. This species provides more than one third of the number of individuals caught. This is followed by *Abramis ballerus* L., with a proportion of about 11%, and then *Abramis sapa* PALLAS and *Abramis brama* L., with values of about 7—10%. These four species together comprise more than 60% of the collected material. The order of frequency of the noble fish is as follows: *Silurus glanis* L., *Lucioperca lucioperca* L., *Barbus barbus* L. and *Esox lucius* L. It might appear from the data that the frequency of *Silurus glanis* L. (6.73%) is roughly the same as that of *Abramis brama* L. (6.83%). This does probably not reflect the actual situation, however, but is a consequence of the fact that the fishing cooperative specialized strongly in the catching of *Silurus glanis* L. This is achieved in part by the choice of the hook size, in part by the selection of the bait, and in part by the use of a special method whereby almost exclusively only this species is caught. This ancient method (which involves beating the surface of the water with a cup) resulted in about 10% of the catch. In spite of this, the *Silurus glanis* L. population in this section of the river presents a favourable picture.

Fishing statistics for the past decade show that *Acipenser ruthenus* L. is showing a tendency to decrease (PAPP 1970), but it is clear from the data that it does not yet count as a rare species in this section of the river. Further species of importance are *Carassius auratus gibelio* BLOCH, *Cyprinus carpio* L., *Pelecus cultratus* L. and *Amiurus nebulosus* LE SUEUR. In connection with *Cyprinus carpio* L., however, it must be noted that the Table also contains the data for 41 specimens which were netted from among specimens introduced on the occasion of fish-marking at Tiszafüred on 11 April 1972 (HARKA 1972b). Even with these, the catch of *Cyprinus carpio* L. was less than that of *Carassius auratus gibelio* BLOCH. Also worthy of mention is *Lota lota* L., the proportion of which would be significant if fishing were carried out systematically in the late autumn and early spring. These are the periods when this winter-spawning fish can primarily be caught.

As regards the examination material, special attention should be paid to the results for 1972. These contain the data for all of the fish specimens caught by the fishermen in the Tiszaörvény section from 19 February until 9 November. The 3072 specimens collected in that year were the result of catches on 196 days. It must be noted, however, that two-three days frequently passed between examination

of the traps. In such cases the specimens caught in the three days were also regarded as the catch for one day.

The species-distribution of the specimens caught in 1972 is in agreement with the experience for the other years. Only for a few species is there a more significant difference, and this can be accounted for by the conditions of the collections. For instance, the low catch of *Acipenser ruthenus* L. is explained by the fact that netting was not performed were caught by net or with sport-angling equipment, as can be seen in Table 3. The other major difference is in the catch of *Lota lota* L. The reason for this lies in the fact that, in contrast with other years, in 1972 systematic fishing was already being carried on in February and March, and the majority of the specimens (64 from 69) were caught in these two months. The differences for the other species are not appreciable enough to warrant further special comment.

The agreement between the results for the years of the investigation permits a number of conclusions to be drawn from the data with regard to the composition of the fish population in this section.

The data showing the percentage distribution of the collected specimens can not be related directly to the fish population. For example, the fact that certain specimens were not caught at all, or if so then in only low numbers, does not necessarily mean that the species is absent from the river, or that its population is significant. Other factors may be involved, such as unsuitable means of collecting, a hidden way of life, etc. There can be no doubt, however, that if a species is caught in large numbers of specimens from year to year, then this species comprises a significant part of the fish population.

Since the objective difficulties of the examination mean that it can not be expressed as a percentage, the characterization of the proportions of the individual populations in the overall fish population is at present an unsolved problem. When it is not avoidable, a number of authors (CZIRBUSZ, HERMAN, VUTSKITS, VÁSÁRHELYI and others) use common expressions such as "a frequent species, common everywhere", "a rare species", etc., but these expressions are not uniformly interpreted. In an effort towards unambiguousness and greater accuracy, in the present study the author has introduced the use of four concepts, defining these as follows:

1. Species occurring en masse: which can be collected in major amounts practically at any time during the fishing period (from early spring till late autumn), and which give at least 25% of the number of fish specimens collected.
2. Frequent species: which occur systematically in the collections, and the proportion of which attain 10%.
3. Common species: which occur frequently in at least certain periods during the collections, or perhaps in smaller numbers but for a longer time. Their proportion in the collected material exceeds 0.1%.
4. Rare species: which can be caught in only a few specimens during systematic collections for one or possibly more years, and the proportions of which remain below 0.1%.

In the optimum case, the word collection is to be understood as a method whereby all species can be caught with equal probability. However, the methods applied in practice are more or less selective, and in their combination too, therefore, a significant degree of subjectivity must be reckoned with, for in the judgement of the effectiveness of the methods it is necessary to rely on estimations (this was the case in the present study, too). For just this reason, the following list includes

only those species for which the similarity of the various observations means that the uncertainty factor is lower.

En masse species:

Blicca bjoerkna L.

Frequent species:

Abramis sapa PALLAS
Abramis ballerus L.

Common species:

Abramis brama L.
Silurus glanis L.
Lucioperca lucioperca L.
Barbus barbus L.
Carassius auratus gibelio BLOCH
Esox lucius L.
Cyprinus carpio L.
Pelecus cultratus L.
Chondrostoma nasus L.
Acipenser ruthenus L.
Aspro zingel L.
Amiurus nebulosus LE SUEUR
Rutilus rutilus L.
Leuciscus cephalus L.
Perca fluviatilis L.

Rare species:

Vimba vimba L.
Anguilla anguilla L.
Ctenopharyngodon idella VALENCIENNES
Hypophthalamichthys nobilis RICHARDSON
Hypophthalamichthys molitrix VALENCIENNES
Carassius carassius L.

This latter species must be considered as rare, despite the fact that it appeared in fairly high numbers in the collections, for with one exception every specimen was caught after the high flood in 1970, when there was a possibility for the fish populations of the living water and the dead-arms to mix.

Lota lota L., *Aspius aspius* L., *Acerina cernua* L., *Acerina schraetzer* L. and *Aspro streber* SIEBOLD do not figure among the common species, for frequent species too may appear among them, but the collection equipment was not suitable to demonstrate these. In the case of the other species which were omitted from the above list, there was no way to make even an approximate conclusion.

The literature sources contain very few references to the populations of the species in the Tisza. Only VÁSÁRHELYI (1960) mentions the frequency for the majority of the species. Of these, only those which gave results different from those of the present investigation will be dealt with below.

VÁSÁRHELYI found *Acipenser ruthenus* L. to be a frequent species, whereas in the present work it turned out merely to be common. One of the explanations is probably that, since VÁSÁRHELYI's observations began about 50 years ago, there has been a decrease in the population of this species.

According to VÁSÁRHELYI, *Abramis ballerus* L. can be found everywhere, but not in such large numbers as *Abramis brama* L. In this section of the river the situation is the reverse.

VÁSÁRHELYI reports *Leuciscus cephalus* L. as frequent, *Scardinius erythropthalmus* L. as most frequent, *Chondrostoma nasus* L. as en masse, and *Perca fluviatilis* L. as frequent. In the present investigation *Leuciscus* was found to be common, *Scardinius erythrophthalmus* to be rare (frequent in the dead-arms). *Chondrostoma nasus*L. to be common, and *Perca fluviatilis* L. to be common.

It should be noted that VÁSÁRHELYI does not mention whether the frequency refers to the river water or to the subsidiary waters in the various cases; further, the expressions "common" and "frequent" at times appear to be used in the same sense in his work.

Data referring to fish production

For the results of this examinations to be referred to the fish production, the possibility of readjustment of the values had to be created. The means of this,

Table 5. *Distribution of 1972 catch according to ber of individuals and weight of species*

Species	Individuals		Weight	
	no.	%	kg	%
Acipenser ruthenus L.	5	0.16	1.10	0.13
Esox lucius L.	58	1.89	1.20	4.08
Rutilus rutilus L.	14	0.45	1.20	0.14
Leuciscus cephalus L.	6	0.20	2.30	0.29
Leuciscus idus L.	23	0.75	8.70	1.13
Aspius aspius L.	2	0.06	2.40	0.30
Chondrostoma nasus L.	20	0.65	4.90	0.63
Barbus barbus L.	85	2.76	42.15	5.52
Blicca bjoerkna L.	1491	48.56	198.70	26.13
Abramis brama L.	187	6.09	57.50	7.55
Abramis sapa PALLAS	250	8.14	28.10	3.68
Abramis ballerus L.	436	14.20	55.40	7.26
Vimba vimba L.	2	0.60	0.35	0.03
Pelecus cultratus L.	26	0.84	4.65	0.60
Carassius carassius L.	1	0.03	0.10	0.01
Carassus auratus gibelio BLOCH	78	2.54	8.10	1.05
Cyprinus carpio L.	51	1.66	38.95	5.10
Hypophthalamichthys nobilis RICH.	1	0.03	2.00	0.25
Silurus glanis L.	128	4.17	185.00	24.33
Amiurus nebulosus LE SUEUR	3	0.10	0.40	0.04
Lota lota L.	69	2.24	26.80	3.01
Lucioperca lucioperca L.	117	3.81	60.50	7.95
Perca fluviatilis L.	7	0.22	0.75	0.08
Aspro zingel L.	8	0.26	1.45	0.18
Acerina schraetzer L.	4	0.13	0.30	0.03
Total	3072	100.00	763.00	100.00

with approximative accuracy, is provided by the comparison of the number of specimens caught from the individual species and their total weights (Table 5.) Merely to highlight the data relating to the more important species, the following relations can be seen from the Table:

As regards both the number of individual speciemens and the weight, *Blicca bjoerkna* is in first place, but whereas it comprises nearly half of the total number of individuals, it makes up only about one quarter of the total weight. The proportion of the *Abramis Cuvier* genus similarly represents only half as much in the total weight as it does in the number of individuals. An exception to this is *Abramis brama* L., which is the largest-growing of these species, and accordingly makes a larger contribution to the weight.

A large difference is exhibited by *Silurus glanis* L., the largest fish in Hungarian waters. It comprises barely more than 4% of the number of individuals caught, but its weight proportion is about six times this. *Lucioperca lucioperca* L., *Barbus barbus* L. and *Esox lucius* L. are similarly among the larger fish species, and thus their weight proportions are about twice as high as those for the numbers of individuals.

If the relations of the weight and number of individuals are taken into consideration, the possibility arises for the comparison of the results of the present examination with the data from fishing statistics (Table 1).

The comparison reveals that the present results agree comaratively well with the fishing results for the last two years. The only significant difference is observed in the case of the data for the catches of *Cyprinus carpio* L. The reason for this may be that the fishermen more willingly give the name of "Tisza" fish to those specimens caught in the subsidiary waters too, the river fish being more sought after by the consumers as they are considered more valuable. The same reason probably explains the more significant proportions of *Esox lucius* L. and *Amiurus nebulosus* LE SUEUR in the reports for the earlier years.

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