TISCIA

Vol. IX

INDEX

SZEGED, 1974

TISCIA

Vol. IX

DISSERTATIONES BIOLOGICAE A COLLEGIO EXPLORATORUM
FLUMINIS TISCIAE EDITAE

EDITIONEM CURAT

GY. BODROGKÖZY

ADJUVANTIBUS

L. GALLÉ, I. KISS, M. MARIÁN, L. MÓCZÁR

REDIGIT

IMRE HORVÁTH

1974

Felelős kiadó: Dr. Horváth Imre
Készült: 350 pld. — Terjedelem: 14,7 A/5
74-3348 — Szegedi Nyomda

PROF. PÉTER BERETZK

1894—1973

PÉTER BERETZK was born in Szeged on 23 October 1894, and for the greater part of his 79 years lived in this town and devoted himself to its service. He was an obstetrician and gynaecologist, who participated enthusiastically in every cultural movement in his town, and whose name is known to practically every inhabitant of Szeged through his frequently appearing and gladly read articles in the newspapers.

He began his university studies in the Faculty of Medicine at Kolozsvár, and continued them in Budapest, where he also obtained his diploma. His first position was in a hospital, but he then entered the medical service of the Hungarian National Railways, where he worked for 43 years. He reached the grade of chief physician, and was awarded several honours.

From the 1930's on he spent virtually all his free time in the open. In the early years he traversed the South Hungarian Plain as a hunter. His attention turned to the hunting area of Lake Fehértó near Szeged, then still in a wild and primitive condition. Together with his hunting companions, he built a small house here, the "hunters' house", the predecessor of the present Fehértó research house. He was a passionate hunter. From week to week he roved over the region of the lake and collected the special birds; he mounted the bulk of these himself, and very beautifully too.

Under the influence of the noted ornithologist, MIKLÓS VASVÁRI, he himself developed into an expert ornithologist. His interest turned increasingly to the study of the regions of occurrence of the individual species and to the research of the phenomena of bird migration. In cooperation with the Hungarian Ornithological Institute, over a number of decades he ringed many thousands of birds, thereby making a significant contribution to the elucidation of the migration routes of bird species breeding in Hungary.

His real area of investigation, however, was the life and environmental relations of birds (acquiring of food, nest building, breeding, training of young, etc.). The results of his observations enriched the Hungarian ornithological literature with many new data. In his papers, some of which he wrote together with his ornithological friend DR. ANDRÁS KEVE, he rectified many oecological and systematic data.

The main significance of his ornithological activity was that in the middle of the 1930's he gave a new impetus to Hungarian ornithological studies. At the beginning of the 1930's, after the appearance of the comprehensive avifaunistic work of JAKAB SCHENK, the view was developing among Hungarian ornithologists that little remained to be done in ornithological research in Hungary. As a result of the observations made by BERETZK with persistent methodicalness at Fehértó, and the publication of these results, this view changed. It turned out that many species previously considered rare in Hungary were in fact common; late-migrating bird species were generally not breeding species; in the case of certain species the migration began as early as July; etc. Accordingly, there really was much still to do in the research into bird migration. As a consequence of the results obtained by PÉTER BERETZK at Fehértó, systematic ornithological observations were begun in other sodic regions. It can be said that the ornithological research Hungarian sodic waters had commenced.

Although he dealt primarily with the avifauna of the sodic areas, he also studied the birds of the mountain regions and the rivers. For a time he took part in the Bakony research programme. Since its establishment he worked actively in the Tisza Research Working Group and was also a member of its executive committee.

As recognition of his scientific work, Szeged University appointed him as an honorary lecturer in 1948, and as a professor in 1964. He was awarded the degree of Candidate of Science in 1952. The value of his work was recognized by the awarding of a number of honours.

For 6 years he was president of the Szeged Division of the Hungarian Biological Society. In recognition of his merits the Society elected him an honorary member. He was a member of the Agra Zoological Academy, of the South-Finland Nature-Conservancy Association and of the Swiss section of the World Wildlife Fund.

As regards the popularization of science, he was not only an enthusiastic supporter and an effective activist, but also an organizer. For 10 years he was president of the Biological Section in the Csongrád county Organization of the Scientific Educational Association. It was on his initiative that the Ornithological an Nature-Conservancy Study Circle was esblished within this Association in Szeged, and he was honorary president and an active member of this circle until his death.

Some 300 of his popularizing papers and articles appeared in hunting journals, magazines and daily newspapers. With his writings and his colourful, interesting descriptions of his observations, and with several hundred lectures, he converted a large number of people to the study and protection of birds.

By his activity in nature-conservancy, the name of PÉTER BERETZK became well-known both in Hungary and abroad. He unearthed the secrets of the Fehértó, one of the classical regions from among the Hungarain sodic salt marshlands, and made it famous throughout Europe by the publication of his research results. By his efforts 280 holds (165 hectares) of the Old-Fehértó region (the nesting site of sodic marsh birds) was designated a reservation in 1933. In 1946 a national order increased the area of the reservation to 500 holds. In the course of time, however, with the increase in area of the highly-productive fish farm at Fehértó, and with the introduction of fresh water, there was a radical change in the landscape. The possibility for the sodic marsh birds to nest disappeared.

The main aim in the life of PÉTER BERETZK was research of the Fehértó. For four decades he tirelessly collected the animals of the lake (mainly its birds and butterflies). He set an example to every investigator of nature with his persistence and methodicalness, carrying out observations on the avifauna and making notes in both summer and winter. (His ornithological diary, containing many thousands of observational data, is of extraordinary value.) He loved this region, for which he was the scientific observer on behalf of the National Nature-Conservancy Office. He fought long for the achievement of the protection of Fehértó, and later for the preservation of the nature-conservancy status of the lake. In the final decade of his life the uncertainty as to the protection of the reservation was a bitter disappointment for him. For his outstanding activity in nature-conservancy the Government of the Hungarian People's Republic awarded him the gold medal of the Order of Labour.

He worked on the development of Hungarian ornithology not only with enthusiasm, but also with self-denial. He collected very many animals, but retained nothing for himself. Throughout his life he unselfishly supported the Hungarian Ornithological Institute, the Móra Ferenc Museum in Szeged, the József Attila University in Szeged, and the Natural Science Museum in Budapest with his collections. His greatest sacrifice, however, was to present his famous bird collection to the Móra Ferenc Museum. This collection, which consists of some 800 stuffed birds, is of inestimable scientific value, all the more so since, because of the changes in the environmental conditions at Fehértó, the earlier avifauna is today documented only by this bird collection. During the subsequent years he made further additions to this endowment, providing about 400 Fehértó butterflies.

PÉTER BERETZK's ornithological diary, his collected publications and some 2000 of his photographs from Fehértó were presented by his widow to the Móra Ferenc Museum. In this way this valuable collection of scientific data has become available to ornithological research workers in the future.

The memory of DR. PÉTER BERETZK will be reserved not only by his extremely valuable bird collection, his tremendous collection of scientific data and the memorial tablet unveiled in the Szeged Museum, but even more so by his results in the field of Hungarian ornithology in his long and active life, and be the resulting great respect and love.

In memoriam Prof. Péter Beretzk

I. HORVÁTH

Uncle Péter!

This is how I addressed you when you were alive, and this is how I address you now as, with heavy heart, I bid you farewell in the name of József Attila University, the Faculty of Science and the Specialist Biologist Comittee of the University, and the Tisza Research Committee and Tisza Research Working Group of the Hungarian Academy of Sciences. Throughout your entire life you were an enthusiastic advocate and supporter of nature-conservancy. Time has proved that your views of half a century ago in the interest of nature-conservancy were fundamentally correct and justified: this has now become a scientific activity on a global scale. You are to be thanked for the nature-conservancy area at Fehértó, of which from first to last you were the ardent, tireless researcher and defender. To your name is attached the initiation of synchronous bird studies in Hungary, and it was at Fehértó that the first such observation station was established. At the mention of Fehértó it is your name which immediately comes into the mind of every nature-loving person, not only in Hungary, but abroad as well.

Since your youth the Tisza was one of your loves, and for decades you travelled it and carried out research into it. You were one of the pioneers and founders of the collective research activity which is performed today by the Tisza Research Working Group with the support of the Hungarian Academy of Sciences under the guidance of the Tisza Research Committee. We shall all of us miss your deep knowledge, your comprehensive experience and your kindly, winning personality. There was never a discussion in the Tisza Research Committee where you did not fail to assist in the attainment of our common goal with your suggestions and your initiatives. With your very last activity too you drew our attention to an area along the Tisza which was worthy of protection.

Your scientific work was recognized by the Scientific Qualifications Committee in 1953 with the award of the degree of Candidate of Biological Science. Your activity was fully worthy of the many state awards too.

You were also a tireless and enthusiastic educator of the young, and this was recognized by our university too when they awarded you the title of university professor.

Uncle Péter!

The final words of farewell are staggering for the biologist too. It is in vain that we know that birth and death are both natural and unavoidable. With death the man as a personality is destroyed, but he continues to live on in his creations. And so will you live on amongst us in your creations and in your realized and propounded thoughts. We shall treasure the memory of your gentle, captivating personality with reverence!

From the publications of

DR. PÉTER BERETZK

Vorkommen vom *Limicola falcinellus falcinellus* PONT. bei Szeged. (Aquila, XLII—XLV, 1935—38, p. 696.)

Nisten von *Bubo* b. *bubo* L. in Szeged. (Aquila, XLII—XLV, 1935—38, p. 699)

Die Vogelwelt des Fehérsees bei Szeged. (Kócsag, IX—XI, 1936—38, p. 32—42.)

Ornithologische Beobachtungen in der Umgebung von Kőrösmező. (Fragm. Faun. Hung., 1940, III., p. 121—123.)

Dryobates syriacus balcanicus BRUTVOGEL in Szeged. (Aquila, XLVI—XLIX, 1939—42, p. 486.)

Horsten des Uhu in Szeged. (Aquila, XLVI—XLIX, 1939—42, p. 491.)

Nisten des *Tringa stagnatilis* am Weissen See zu Szeged. (Aquila, XLVI—XLIX, 1939—42, p. 495.)

Larus hyperboreus auf dem Weissen-See in Szeged. (Aquila, XLVI—XLIX, 1939—42, p. 500.)

Die Ausbreitung der Dohle in Szeged. (Aquila, XLVI—XLIX, 1939—42, p. 500—501.)

Kreitzschnäbel in Szeged. (Aquila, XLVI—XLIX, 1939—42, p. 501.) Sonderbarer Unfall bei Bläss-Kreitschnäbel in Szeged. (Aquila, XLVI—XLIX, 1939—42, p. 501.)

Sonderbarer Unfall bei Blässhühnern. (Aquila, XLVI—XLIX, 1939—42, p. 506.)

The avifauna of the Fehértó near Szeged, on the basis of 10 years' observations. (Aquila, L, 1943, p. 317—344.)

The avifauna of the Fehértó near the town Szeged. (Aquila, LI—LIV, 1944—47, p. 51—80.)

Wild goose albino. (Aquila, LI—LIV, 1944—47, p. 183.)

Lesser White-fronted Goose in great number on the Lake „Fehértó" near Szeged. (Aquila, LI—LIV, 1944—47, p. 183.)

Wall-creeper in the town Szeged and its environs. (Aquila, LI—LIV, 1944—47, p. 191.)

Bird reservation at Fehértó near Szeged. (Hidrológiai Közl., 1953, 33, p. 2—8.)

Winter movements of *Streptopelia* d. *decaocto* FRIV. (Aquila, LV—LVIII, 1948—51, p. 273—274.)

Micropus a. *apus* — Swift — breeding in Szeged. (Aquila, LV—LVIII, 1948—51, p. 286—287.)

Abundance of *Panurus biarmicus russicus* BREHM — Bearded titmouse — in the autumn of 1950. (Aquila, LV—LVIII, 1948—51, p. 295.)

Fatal accident of breeding *Acrocephalus* a. *arundinaceus* L. — Great Reed-Warbler. (Aquila, LV—LVIII, 1948—51, p. 300.)

Über das Vorkommen der Brachschwalbe *(Glareola pratincola)* in Ungarn und einigen Nachbarländern. (Larus, VI—VII, 1952—53, p. 192—205.)

Die Raubseeschwalbe *(Hydroprogne caspia* PALL.*)* in Ungarn. (Állattani Közl., 1954, XLIV, p. 135—147.)

Recent data on the birds of Lake Fehértó near Szeged. 1949—1953. (Aquila, LIX—LXII, 1952—55, p. 217—227.)

Nesting of the Southern Black-headed Gull at lake Fehértó near Szeged. (Aquila, LIX—LXII, 1952—55, p. 430—431.)

Birds rarely occurring at Lake Fehértó near Szeged. (Aquila, LIX—LXII, 1952—55, p. 433.)
The Swift's regular nesting at Szeged. (Aquila, LIX—LXII, 1952—55, p. 442—443.)
Contributions to bird-organism's ability for regeneration of tissues. (Aquila, LIX—LXII, 1952—55, p. 467—468.)
Epidemic disease of wild birds on lake Fehértó near Szeged. (Aquila, LIX—LXII, 1952—55, p. 468—469.)
Rare breedeing birds on the Fehértó near Szeged in 1955. (Állattani Közl., 1956, XLV, p. 184.)
Die Bedeutung des Fehértóer Naturschutzgebietes für die biologische Forschung. (Móra F. Múz., 1956. Évk., Szeged, p. 147—154.)
Data on the breeding of the Black-necked Grebe. (Aquila, LXIII—LXIV, 1956—57, p. 328—329.)
Regular nesting of the Mediterranean Black-headed Gull on the bird-reserve of Szeged-Fehértó. (Aquila, LXIII—LXIV, 1956—57, p. 340—341.)
Mortality of juveniles in disturbed gull-colonies. (Aquila, LXIII—LXIV, 1956—57, p. 341—342.)
Nesting of the Whiskered Tern on lake Fehértó near Szeged. (Aquila, LXIII—LXIV, 1956—57, p. 342.)
Destructions of Swallows in summer caused by bad weather and simultaneous appearing of Swifts. (Aquila, LXIII—LXIV, 1956—57, p. 347.)
Black-headed Wagtail on the Fehértó near Szeged. (Aquila, LXIII—LXIV, 1956—57, p. 353.)
Das Leben der Tisza. (Acta Biol. Szeged, 1957, 3, p. 81—108.)
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Zum Zuge des Sanderlings *(Crocethia alba)* in Ungarn. (Orn. Mitteil., 1957, 9, p. 208—210.)
Das Leben der Tisza. (Acta Biol. Szeged, 1958, IV. p. 203—235.)
Zum Zuge des Knutts *(Calidris canutus)* und Pfuhlschnepfe *(Limosa lapponica)* in Ungarn. (Orn. Mitteil., 1958, 10, p. 81—83.)
Economic importance of the Curlews and taxonomical position of the Hungarian Populations. (Aquila, LXV, 1958, p. 89—126.)
Regular Breeding of the Mediterranean Black-Headed Gull on the Reserve Fehértó, near Szeged. (Aquila, LXV, 1958, p. 343.)
Breeding of the Bee-Eater in the Clay-Walls on the Shores of the Rivers Tisza and Maros. (Aquila, LXV, 1958, p. 348.)
Observed cases of bird epidemics. (Aquila, LXV, 1958, p. 371—372.)
Bird movement on the Fehértó reservation near Szeged in 1958. (Term. Tud. Közl., 1958, XC, p. 494—496.)
Ornithological importance of Tisza research. (Jászkunság, 1958, 5, 4. sz., p. 145—147.)
Pigmy Cormorant on lake Fehértó near Szeged. (Aquila, LXVI, 1959, p. 304—305.)
Occurrence of the Long-tailed Duck in summer. (Aquila, LXVI, 1959, p. 307.)
Recent nesting of the Mediterranean Black-headed Gull. (Aquila, LXVI, 1959, p. 310.)
Le Mouvement des Oiseaux du Fehértó de Szeged en 1958. (Állattani Közl., 1960, XLVII, p. 29—33.)
Tasks and some results of synchronous Research of Water-Birds. (Állattani Közl., 1960, XLVII, p. 119—124.)
The Fehértó reservation near Szeged. (Földr. Közl., 1960, 84, 1. sz.)
The dead arm of the Tisza at Körtvélyes in spring. (Term. Tud. Közl., 1961, V, p. 163—195.)
Pallas's Sea Eagle on lake Fehértó near Szeged. (Aquila, LXVII—LXVIII, 1960—61, p. 243.)
Occurrence of a Flamingo near the river Tisza at Körtvélyes. (Aquila, LXVII—LXVIII, 1960—61, p. 243.)
Notes on the Food-Biology of Black-Tailed Godwit. (Aquila, LXVII—LXVIII, 1960—61, p. 248.)
Data on the nutrition of the Black-headed Gull. (Aquila, LXVII—LXVIII, 1960—61, p. 250.)
Jahreszeitliche Veränderung im Bestand der Rohrammer-Population in Ungarn. (Acta Zool., 1962, VIII, p. 251—271.)
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Bird movement in 1958 on the Fehértó reservation near Szeged. (Biol. Közl., 1962, X, p. 73—74.)
Effects of transformation of the Fehértó landscape on the nesting and migration of birds. (Biol. Közl., 1962, X, p. 79.)
Velvet Scoters on the Lake of Kunfehértó. (Aquila, LXIX—LXX, 1962—63, p. 258.)
Rare breeding-birds of the reeds. The birds of floating islands. (Aquila, LXIX—LXX, 1962—63, p. 259—260.)
The assertion of parental and self-preservational instincs observed in damaged nests of the penduline tit. (Aquila, LXIX—LXX, 1962—63, p. 271—272.)
Neue Beitrage zur Kenntnis der Tierwelt des Oberen Tisza-Tales. (Tiscia, 2, 1966, p. 67—81.)
Vom Zug des Steinwälzers, *Arenaria interpres,* in Ungarn. (Beitr. z. Vogelk., 9, p. 391—396.)
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Der Zug des Zwerg- und Temmincks Strandläufers in Ungarn. (Beitr. z. Vogelk., 1967, 12, p. 297—307.)

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Taxonomische Bemerkungen zum Problem der Grünling-Population des Karpatenbeckens. (Bonn. Zool. Beitr., 1969, 20, p. 50—59.)

Questions of taxonomy of the Greenfinches *(Carduelis chloris* L.*)* of Hungary. (Állattani Közl., 1969, LVI, p. 17—20.)

Die Schwarzkopfmöwe, *Larus* m. *melanocephalus* Temm., in Ungarn. (Lounais-Hämeen Luonto, No. 37, pp. 17.)

Zug des Sumpfläufers *(Limicola falcinellus* Pont.*)* in Ungarn. (Beitr. z. Vogelk., 1970, 15, p. 133—139.)

Ornithologische Nachrichten aus der Umgebung von Szeged. (Állattani Közl., 1971, LVIII, p. 164—165.)

Die Raubseeschwalbe, *Hydroprogne caspia* Pall in Ungarn. 1953—1969. (Zool. Abh. Mus. Tierk. Dresden, 1971, 30, p. 227—242.)

Der Berghänfling, *Carduelis flavirostris* L. in Ungarn. (Lounais-Hämeen Luonto. No. 42. pp. 19.)

M. MARIÁN

EFFECT OF THE TURBIDITY OF THE WATER ON THE DEVELOPMENT OF ALGAL ASSOCIATIONS IN THE TISZA

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(Received 10 February 1974)

Abstract

In every year maxima can be observed in summer and early autumn in the plankton algal populations in the Tisza and in the Eastern Main Canal.

The Eastern Main Canal is an irrigation canal built to the east of the Tisza in the eastern half of Hungary. Its water is led off from the river Tisza, dammed up at Tiszalök. The length of the canal is 98 km; its width is 40 m, and its depth 2.3—4.2 m. Its maximum flow rate is 60 m^3/s.

The population maximum is characterized by the dominance of the *Cyclotella* species, *Synedra actinastroides* and the *Chlorococcales* species. It was observed in the present studies that there is a definite correlation between the rapid multiplication of the plankton algae and the photoclimatic conditions of the water. If the Tisza is free from flooding for 2—3 weeks in the summer and early autumn, then the seston settles out of the slowly-flowing water, the transparency of the water increases, the photoclimate becomes more favourable, and the population maximum develops. At such time the number of algae can rise to 5—20 million per litre. The *Cyclotella* species, *Synedra actinastroides* and the *Chlorococcales* species can comprise 80—95% of the total population.

Introduction

The large-scale multiplication of algae can be observed increasingly more often in the surface waters in Hungary. Algal associations rich in numbers of species and individuals may develop not merely in standing waters, but also in slow running rivers (BEHNING 1929, UHERKOVICH 1968a, b, 1969, 1971, FELFÖLDY—TÓTH 1970). In every year in the Tisza it is possible to observe algal population maxima (UHERKOVICH 1971, KISS KEVE 1974a, b), characteristic water-quality states of the river.

At the time of the population maxima it is primarily the true plankton algae which multiply; their numbers often exceed one million individuals per litre.

The development of the *Cyclotella* population maximum to be observed in the Eastern Main Canal and in the Tisza at the end of winter and in early spring is decisively affected by the light conditions prevailing in the water (KISS KEVE 1974a, b). In the present work a study is made of whether a similar correlation can be observed in the case of the mass multiplication of the algae in summer and autumn.

Sampling and examination methods

As regards the water quality, the dammed-up section of the Tisza at Tiszalök was regarded as starting point. From here the changes in the qualitative and quantitative compositions of the algae were followed in the lake-like river section throughout the year, as were the changes in the composition of the algal association in the Eastern Main Canal, proceeding towards Balmazújváros.

Water samples were taken at Tiszalök, Tiszavasvári and Balmazújváros, in all cases from the surface and from the current line. In winter, if the water was frozen, the samples were taken through holes cut in the ice (Kiss Keve 1974b).

The samples from Tiszalök and Tiszavasvári were always taken on one day, one after the other. In the sampling at Balmazújváros an effort was made to ensure that the water samples should be taken from the water mass already examined in the upper canal section. Accordingly, taking into account the momentary water rates in the Tisza and the canal, water samples were taken at Balmazújváros 2—7 days after the sampling at Tiszalök and Tiszavasvári (Uherkovich 1968a). Water samples have been taken every week at these three sites since 1968.

Fig. 1. Map of the Eastern Main Canal.

Quality examinations were carried out on settled-out samples and on the simultaneously netted plankton samples. For the quantitative analyses, 100—250 ml (depending on its seston content) of the original, shaken water sample was filtered through a membrane with a pore diameter of 0.45 μ. The material remaining on the membrane was diluted to a few ml and fixed with formalin. The concentrated sample, the volume of which was known exactly, was examined in a Bürker chamber. Since 1971 the quantitative analyses have been performed by the method of Utermöhl (1958).

Development of maxima of plankton algal populations in the Tisza and the Eastern Main Canal

The development of a number of population maxima in the Tisza has been described by UHERKOVICH (1968a, b, 1969, 1971). His observations showed that the majority of these occurred in the section of the river below Tiszalök. Data on the occurrence of population maxima in the Eastern Main Canal have not so far been published. In every year since 1968 it has been possible at the three sampling sites to observe rich algal populations each representing a characteristic state of the water quality.

The population maxima observed in our investigations to date can be classified into three types (KISS KEVE 1974a, b):

1. A summer population maximum characterized by the dominance of *Cyclotella—Synedra actinastroides* (UHERKOVICH 1968a, KISS KEVE 1974a).
2. An autumn population maximum characterized by the dominance of *Cyclotella—Chlorococcales* (UHERKOVICH 1968a, KISS KEVE 1974a).
3. An early spring population maximum characterized by *Cyclotella* dominance.

An account of this latter type has already been reported (KISS KEVE 1974 b).

Population maximum characterized by *Cyclotella—Synedra actinastroides* dominance

This rich algal association, which can be observed in almost every year, is typical of the summer plankton of the Tisza and the Eastern Main Canal. It develops in general in July and August. If the river is flood-free for a few weeks, then the algae begin to multiply rapidly. Within 1—2 weeks their number may rise from a few hundred thousand to 5—20 million per litre. The *Cyclotella* species and *Synedra actinastroides* may then comprise 80—90% of the overall population (Tables 1—2).

In our investigations to date it has been found that the total number of individual organisms is less in the Balmazújváros section of the canal than in the Tisza. The decrease is primarily observed for the *Cyclotella* species and *Synedra actinastroides*.

As characteristic species, mention may be made of *Melosira granulata* var. *angustissima, Nitzschia acicularis, Actinastrum hantzschii, Ankistrodesmus acicularis, A. angustus, Crucigenia tetrapedia, Kirchneriella lunaris,* and *Scenedesmus* species. The species-richness of the Chlorococcales group is characteristic of the population maximum.

In the interest of the decrease in size of Table 2, quantitative data are presented for only three typical sampling series. Algal species found during the entire examination period (24 May — 11 August 1972), but omitted from the Table, are as follows: *Attheya zachariasi, Ceratoneis arcus, C. arcus* var. *amphioxys, Cymatopleura solea, Cymbella ventricosa, Melosira granulata* var. *angustissima* f. *spiralis, M. varians, Nitzschia sigmoidea, Rhoicosphenia curvata, Surirella ovata, Ankistrodesmus falcatus, Franceia tenuispina, Lagerheimia wratislaviensis, Pediastrum duplex, Scenedesmus denticulatus* var. *linearis* f. *granulatus, S. ecornis* var. *disciformis, S. intermedius* var. *acaudatus, S. intermedius* var. *balatonicus, S. lefevrii* var. *semiserratus, S. quadricauda* var. *maximus, S. spinosus, Anabaena spiroides, Merismopedia glauca, Phacus longicauda, Ophiocytium capitatum* and *Closterium acutum.*

Table 1. *Quantitative compositions of the phytoplankton of the Tisza and the Eastern Main Canal at Tiszalök (1), Tiszavasvári (2), and Balmazújváros (3) from August 1969*

August 1969	11th	11th	13th	19th	19th	22nd	26th	26th	29th
sampling points	1	2	3	1	2	3	1	2	3
Attheya zachariasi					20				
Cyclotella spp	185	120	60	2400	2500	910	250	50	270
Melosira granulata var. *angustissima*	12,5		15			20			
M. granulata var. angustissima f. *spiralis*		30							
Nitzschia acicularis	12,5		15	60	40		50	50	15
N. longissima var. *reversa*				20					
Synedra actinastroides	125	45	45	3460	3080	560			
S. acus	37,5								
S. ulna	12,5	15		200	300				
other Bacillariophyceae		45	60	60	20	30	175	50	45
total Bacillariophyceae	385	255	195	6200	5960	1520	475	150	330
Actinastrum hantzschii			15	400	40	40			15
Ankistrodesmus acicularis	62,5	15	15		40	20			
A. angustus	175	150	135	20	20	30		50	30
A. arcuatus	12,5	15			40	10		50	
A. longissimus var. *acicularis*		30							
Coelastrum microporum			30	40		20			
Crucigenia apiculata	12,5				20	20			
C. quadrata		15							
C. tetrapedia	50	15		80	80	120			
Dictyosphaerium pulchellum	12,5			20	20	40			
Didymocystis planctonica					40				
Franceia tenuispina				20					
Kirchneriella lunaris	25	30	15	40		10			45

K. obesa	25	45	45			20			
Lagerheimia citriformis					20				
Micractinium pusillum	12,5	60	30	40	40	50			
Oocystis borgei	12,5	30	30	60	40	30			15
Pediastrum boryanum		15							
P. tetras	12,5			20		10			
Scenedesmus acuminatus	12,5	45		80	100	70			15
S. acutus	12,5			80	160		25		15
S. denticulatus var. *linearis*	12,5								
S. ecornis					20				15
S. intermedius						10			
S. opoliensis				20				50	
S. quadricauda	12,5	15		240	60	40	50		30
S. spinosus			30	40	60				
S. spinosus var. *bicaudatus*	12,5			20					
other Scenedesmus spp	50	45		160	40	40	25		75
Tetraëdron minimum					60	10			
T. muticum	12,5								
Tetrastrum glabrum					20				
T. staurogeniaeforme						10			
other Chlorococcales	287,5	195	495	280	200	320	150	100	240
total Chlorococcales	825	720	840	1660	1120	920	250	250	495
Microcystis flos—aquae					40				15
other Cyanophyta			30	40				50	
Euglena spp	15			20					
Chlamydomonas spp	25		10	20		20			
Peridinium spp			10	20		30			
Dinobryon sertularia				20	20	10			
Centritractus belenophorus				20	40				
Staurastrum paradoxum					20	10			
total phytoplankton 1000 ind/l	1250	975	1085	8000	7200	2510	725	450	840

Table 2. *Quantitative compositions of the phytoplankton of the Tisza and the Eastern Main Canal at Tiszalök* (1), *Tiszavasvári* (2), *and Balmazújváros* (3) *from June to July 1972*

	June			June			July		
	7 th	7 th	9 th	21 st	21 st	23rd	5 th	5 th	7 th
Sampling points	1	2	3	1	2	3	1	2	3
Cyclotella spp	17700	15300	4000	362,5	212,5	450	875	1250	1550
Melosira granulata var. *angustissima*						12,5			
Nitzschia acicularis	900	550	325	50	37,5	225		200	25
Synedra actinastroides	25	25	75	1225	1200	1200	75	25	300
S. acus			75						
S. ulna					12,5			25	
other Bacillariophyceae		100	125	12,5	62,5	37,5	25	125	175
total Bacillariophyceae	18625	15975	4600	1650	1525	1925	975	1625	2050
Actinastrum hantzschii	75	75	325				600	575	1275
Ankistrodesmus acicularis	100	125	75		12,5		50	125	50
A. angustus	600	500	1025	287,5	237,5	400	225	275	500
A. arcuatus							25	25	50
A. longissimus var. *acicularis*	150	150	175				75	75	
Coelastrum microporum	25	50	100		12,5	37,5	50	75	225
C. sphaericum				12,5	12,5	12,5	75		25
Crucigenia apiculata								75	25
C. tetrapedia					12,5	12,5			25
Dictyosphaerium pulchellum	175	150	125			12,5	150	25	75
Didymocystis planctonica	25	25		25	25	37,5	50	50	125
D. tuberculata		25		12,5	37,5			25	25
Kirchneriella lunaris	25	50	50	37,5	137,5	300	25	25	50
K. obesa	25	25	25	37,5	62,5	87,5		25	125
Lagerheimia quadriseta			25						25
Micractinium pusillum			25						
Oocystis borgei	50			12,5	12,5	12,5	50	25	50
Pediastrum tetras						12,5			

Scenedesmus acuminatus	300	300	50				105	25	
S. acutus	100	50					50		
S. acutus f. *alternans*	100	25					50	25	
S. acutus f. *costulatus*	25		25				25		
S. ecornis								25	25
S. intermedius			25						
S. intermedius var. *bicaudatus*	100			12,5	12,5			25	25
S. opoliensis					12,5				25
S. protuberans								25	25
S. quadricauda	150	225	100	3	75	75	225	200	150
other *Scenedesmus* spp	75	100	25		50	50	75	175	175
Schroederia setigera		75							
Tetraëdron caudatum var. *incisum*		25				12,5			
T. incus		25	50			12,5			
T minimum			50						
T. muticum	25		75		12,5				25
Tetrastrum glabrum		25	50	12,5	12,5	50	75	25	25
T. staurogeniaeforme				12,5				25	
Treubaria triappendiculata	50	25	50	12,5	12,5				50
other Chlorococcales	325	400	275	112,5	150	225	600	475	725
total Chlorococcales	2500	2450	2725	650	900	1350	2575	2425	3900
Microcystis flos-aquae						12,5			
other *Cyanophyta*	75	75				37,5		25	25
Euglena spp				12,5	12,5		50		25
Strombomonas fluviatilis									25
Trachelomonas spp					12,5			25	
Centritractus belenophorus									25
Dinobryon divergens									25
D. sertularia			25						
Peridinium sp					12,5				
Chlamydomonas spp	150	50	25	37,5	12,5				
total phytoplankton 1000 ind/l	21350	18550	7375	2350	2475	3325	3600	4100	6075

Table 3. *Quantitative compositions of the phytoplankton of the Tisza and the Eastern Main Canal at Tiszalök* (1), *Tiszavasvári* (2), *and Balmazújváros* (3) *from August to October 1971*

	August			September			October		
	25 th	25 th	27 th	22 nd	22 nd	24 th	20 th	20 th	22 nd
Sampling points	1	2	3	1	2	3	1	2	3
Asterionella formosa							12,5		25
Cyclotella spp	6960	8500	1625	11100	8200	1440	1875	1900	650
Melosira granulata var. *angustissima*		12,5		50		10	12,5	12,5	50
Nitzschia acicularis	40	25	37,5	50	50	60	25	25	50
N. longissima var. *reversa*		12,5	25	25	25				
Synedra actinastroides	90	75	25		50	20			
S. acus	10					20			
S. ulna var. *oxyrhynchus*		25							
other Bacillariophyceae	10		87,5	75		10		12,5	
total Bacillariophyceae	7110	8650	1800	11300	8325	1550	1955	1950	775
Actinastrum hantzschii	30	12,5		25	50	30			50
Ankistrodesmus acicularis	40	12,5	37,5	50	25	60	37,5		150
A. angustus	90	75	50	250	125	620	100	112,5	525
A. arcuatus	10		25	25	50	20	12,5		75
A. longissimus var. *acicularis*	10	12,5	37,5		50	80	100	75	25
Chodatella balatonica							25		
Coelastrum microporum			37,5	50			12,5	25	
C. sphaericum			12,5						
Crucigenia apiculata	30	25	25		25	20		12,5	
C. fenestrata							12,5		
C. tetrapedia	40	50	75	250	100	110	37,5	50	75
Dictyosphaerium pulchellum	10	12,5	25	25			12,5	25	50
Didymocystis planctonica	10	37,5	87,5	25	25	10		25	50
D. tuberculata				25			12,5	12,5	25
Kirchneriella lunaris	120	75	62,5	50		40		12,5	
K. obesa	10	25	87,5	75	25	110	62,5	50	150
Oocystis borgei	10	25	50	25		30	12,5		25
Pediastrum duplex	10								
Scenedesmus acuminatus		12,5	12,5	150	75	20	37,5	25	50
S. acuminatus var. *bernardii*					25			12,5	
S. acutus					50	10	25	12,5	75

S. acutus f. *alternans*				25	25				
S. anomalus var. *acaudatus*	10	25							
S. armatus var. *boglariensis*	10								
S. denticulatus var. *linearis* f. *granulatus*		12,5							
S. ecornis						10			
S. ecornit var. *disciformis*						10			
S. intermedius		12,5		25	125			50	100
S. intermedius var. *balatonicus*					25				
S. intermedius var. *bicaudatus*	10		25						
S. opoliensis						10	12,5	37,5	25
S. protuberans		12,5		25					
S. quadricauda	70	50	75	75	125	20	137,5	87,5	325
S. quadricauda var. *maximus*									50
S. quadricauda var. *setosus*								12,5	
S. spinosus			12,5			10	12,5		
S. spinosus var. *bicaudatus*							12,5		
other Scenedesmus spp	110	112,5	100	25	100	80	125	37,5	275
Tetraëdron caudatum var. incisum						20			
Tetratsrum glabrum	10		25		50	10	225	150	575
T. punctatum			12,5						
T. staurogeniaeforme	10			25					
Treubaria triappendiculata		12,5		25					
other Chlorococcales	190	250	375	125	225	130	125	100	250
total Chlorococcales	840	875	1250	1375	1300	1460	1150	925	2925
Aphanisomenons flos-aquae				75	25	10			
Microcystis flos-aquae							12,5		
other *Cyanophyta*	30	12,5		25	50	20	12,5	25	75
Euglena spp	30	12,5	62,5						25
Strombomonas fluviatilis				25					
Trachelomonas spp	20	12,5	12,5		25	20	25	12,5	50
Peridinium spp		12,5	37,5						
Centritrctus belenophorus			12,5			10			
Dinobryon spp					25	60	25		25
Chlamydomonas spp	10		25	75	50	10	50	12,5	50
Closterium acutum	10				50				
total phytoplankton 1000 ind/1	8050	9575	3200	12875	9850	3140	3200	2925	3925

The *Cyclotella—Synedra actinastroides* population maximum generally lapses within a few weeks, and then in September, if the river is flood-free, a new rich algal association develops in the Tisza; this is characterized by the dominance of the *Cyclotella* and *Chlorococcales* species.

Population maximum characterized by *Cyclotella—Chlorococcales* dominance

In early autumn, if the end of the summer is not rainy, a species-rich algal association usually develops in the Tisza and the Eastern Main Canal. In addition to the *Cyclotella* species, a considerable number of organisms belonging to the *Chlorococcales* group are then found. Of these one may stress *Ankistrodesmus acicularis, A. angustus, Crucigenia tetrapedia, Tetrastrum glabrum* and *Scenedesmus* species. With high numbers of individuals, these are the main components of the phytoplankton population. On 29 September 1969, for instance, the number of

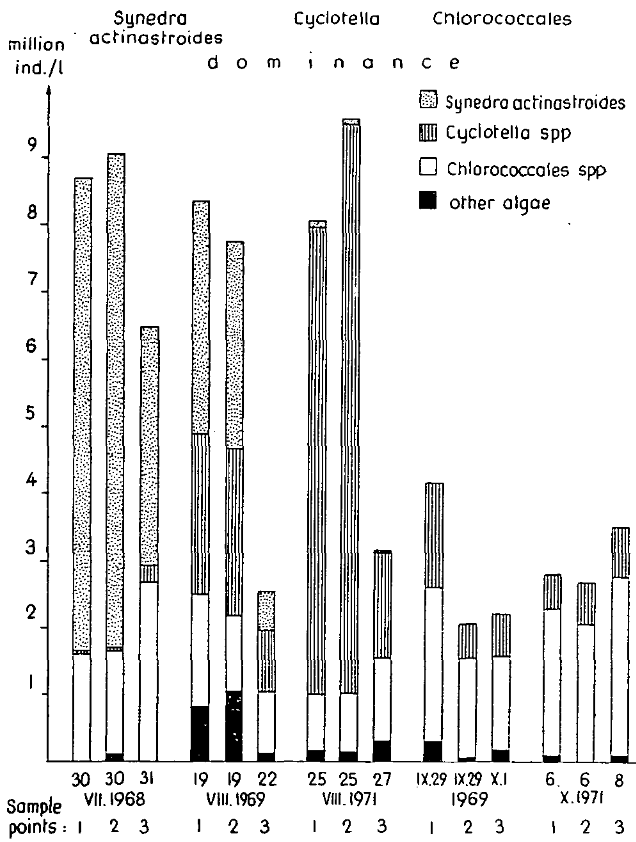

Fig. 2. Quantitative compositions of the phytoplankton of the Tisza and the Eastern Main Canal, based on one characteristic sample each from 1) Tiszalök, 2) Tiszavasvári and 3) Balmazújváros.

individuals from the *Scenedesmus* species reached 990 thousand per litre. They then comprised 23.8% of the total population.

The number of individuals is generally less in the canal than in the Tisza; this is primarily the result of the decrease in the number of individuals in the *Cyclotella* species. In some cases, however, (e.g. 23 September—22 October 1971) it was found that the number of phytoplankton organisms was higher at Balmazújváros. This increase was caused by the enhanced multiplication of the species of the *Chlorococcales* group (Table 3).

The size of Table 3 has been decreased by reporting the quantitative data for only three characteristic sampling series. The algal species found in the course of the full examination period (4 August—29 October 1971), but not reported in the Table, are as follows: *Diatoma vulgare, Gyrosigma scalproides, Melosira granulata, M. varians, Surirella robusta* var. *splendida, Coelastrum cambricum, Crucigenia quadrata, Desmatractum indutum, Franceia tenuispina, Lagerheimia marsonii, L. quadrisete, L. wratislaviensis, L. wratislaviensis* var. *trisetigera, Micractinium pusillum, Pandorina morum, Pediastrum boryanum, P. tetras* var. *tetraodon, Scenedesmus acutus* f. *costulatus, S. armatus, S. carinatus* f. *granulatus, S. gutwinskii* var. *bacsensis, Schroederia setigera, Tetraëdron minimum, T. muticum, Lyngbya limnetica, Merismopedia glauca, M. teniussima, Spirulina maior, Euglena acus, E. proxima, Phacus longicauda, Trachelomonas oblonga, Ceratium hirundinella, Dinobryon divergens, D. sertularia* and *D. sociale.*

Comparison of the *Cyclotella—Synedra actinastroides* and the *Cyclotella—Chlorococcales population* maxima leads to the conclusion that in many respects, they resemble one another. One decisive difference between them is that in the first type the number of *Synedra actinastroides* individuals reaches and exceeds 100,000 per litre, frequently being above one million per litre, whereas in the second type it does not. The former rich algal association develops at the height of the summer, at the earliest in the middle of June. After a few weeks have passed, the *Synedra actinastroides* disappear from the phytoplankton population, which is then characterized by the predominance of the *Cyclotella* and *Chlorococcales* species. This transition is shown in Fig. 2.

Ecological factors affecting the development of the population maximum

Factors of importance in the multiplication of the algae and in the development of the population maxima are the nutrients (Heron 1961, Lund 1964, 1965, Belcher—Swale—Heron 1966, Wang—Evans 1969, Ahlgren 1970, Holland—Beeton 1972), the temperature (Lund 1965, Wang—Evans 1969, Uherkovich 1971). and the light (Swale 1963, Lund 1965, 1967, Unerkovich 1970).

No exact measurements are available as to the nutrient contents of the Tisza and the Eastern Main Canal. It may be assumed that at the end of summer and in early autumn, when there is no flooding, the seston settles out from the slowly-flowing river, and in parallel with this an anaerobic bottom-zone develops and the release of nutrient is increased. Thus, the nutrients do not mean a minimum factor as regards the development of the population maximum. It is desired to clarify this assumption with further measurements.

In his publications on his investigations from the Tisza, Uherkovich (1968a, 1969, 1971) indicates on several occasions that the development of the population maximum, and its character, are affected by whether the river water is warmer or colder. In our examinations to date we have not found a relation between the occurrence of the summer and autumn population maxima and the change of the water temperature.

A third important ecological factor influencing the overmultiplication of the algae is the light (SWALE 1963, LUND 1965). Our own observations so far have revealed that the development of the population maxima is affected considerably by the light conditions. This is also pointed out in the papers of UHERKOVICH (1968a, 1971).

A slight digression must be made here to clarify what factors affect the photoclimate of the waters examined. It is well known that the water of the Tisza is strongly alluvial (UHERKOVICH 1971). At the time of flooding at Tiszalök, suspended-matter contents of even 600—800 mg/l have been measured (KISS KEVE—PINTÉR—MUNKÁCSY 1974). As a result of the shading effect of the large amount of seston, there is a rapid absorption of the light entering the water. Only the uppermost layer of the water is well provided with light, although this undergoes continuous exchange because of the turbulence of the river water. Our observations indicate that the photoclimates of the waters of the Tisza and the Eastern Main Canal are primarily determined by their seston contents. In rainy, overcast weather, if the amount of seston is small the light conditions may still be more favourable than in sunny weather combined with a high seston content.

In our investigations there was no possibility of carrying out on-the-spot,

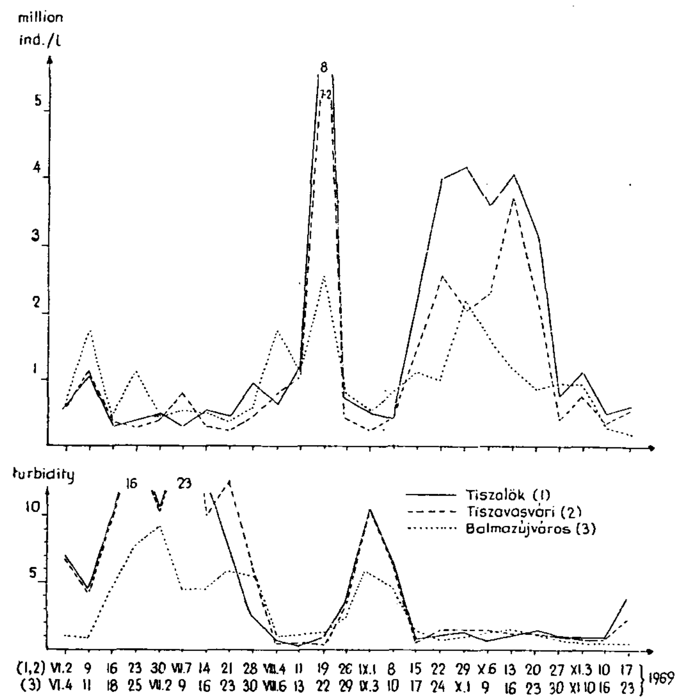

Fig. 3. Quantitative conditions of the phytoplankton of the Tisza and the Eastern Main Canal, and the change in the turbidity of the water between 2 June and 23 November 1969.

instrumental, underwater photomeasurements. Instead of this, photometric turbidity measurements were made at 442 mμ. The values of the turbidity were expressed in units of mg mastix/l. Since the turbidity of the water depends on the seston content, while the amount of seston also decisively affects the photoclimate of the water, in the knowledge of the turbidity it is possible to draw conclusions on the light conditions prevailing in the Tisza and the Eastern Main Canal. Of course, this can be done only to the extent of saying whether these are favourable or unfavourable for the multiplication of the algae.

From Figures 3—6 it can be stated that if the turbidity of the water of the river or the canal decreases (to be less than a turbidity value of ca. 3), i.e. if the photoclimate becomes favourable, then the rapid multiplication of the algae will begin and the population maxima will develop. With the increase of the turbidity, however, there is a parallel decrease in the number of algae, and the population maximum declines. At a turbidity of 3 the seston content of the water varies in the range 20—40 mg/l, while the Secchi transparency is 100—150 cm.

The dependence of the total number of algae on the turbidity was studied by carrying out correlation calculations (Theiss 1958). (The data of Figs. 3—6 were utilized. The data for the numbers of algae referring to the same turbidity values were averaged.) The result was:

Correlation index I=0.583

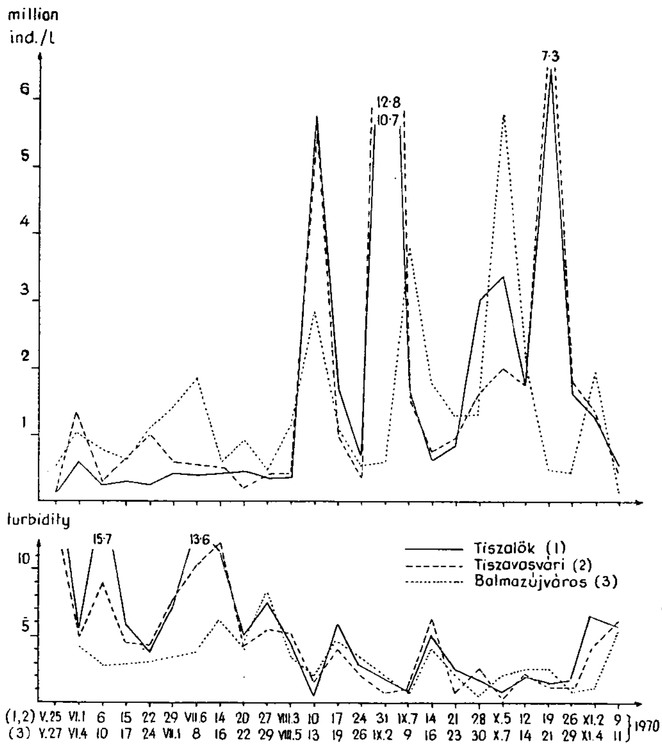

Fig. 4. Quantitative conditions of the phytoplankton of the Tisza and the Eastern Main Canal, and the change in the turbidity of the water between 25 May and 11 November 1970.

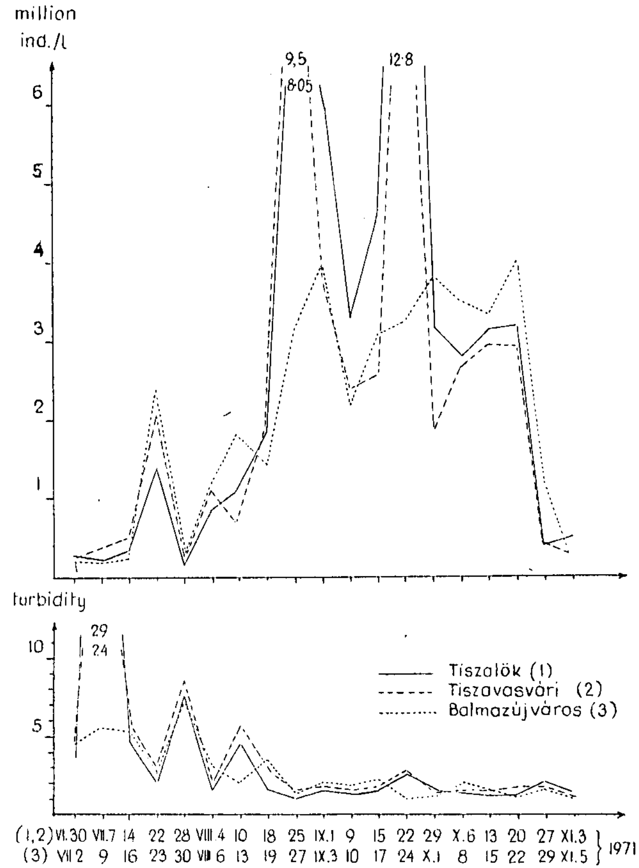

Fig. 5. Quantitative conditions of the phytoplankton of the Tisza and the Eastern Main Canal, and the change in the turbidity of the water between 30 June and 5 November 1971.

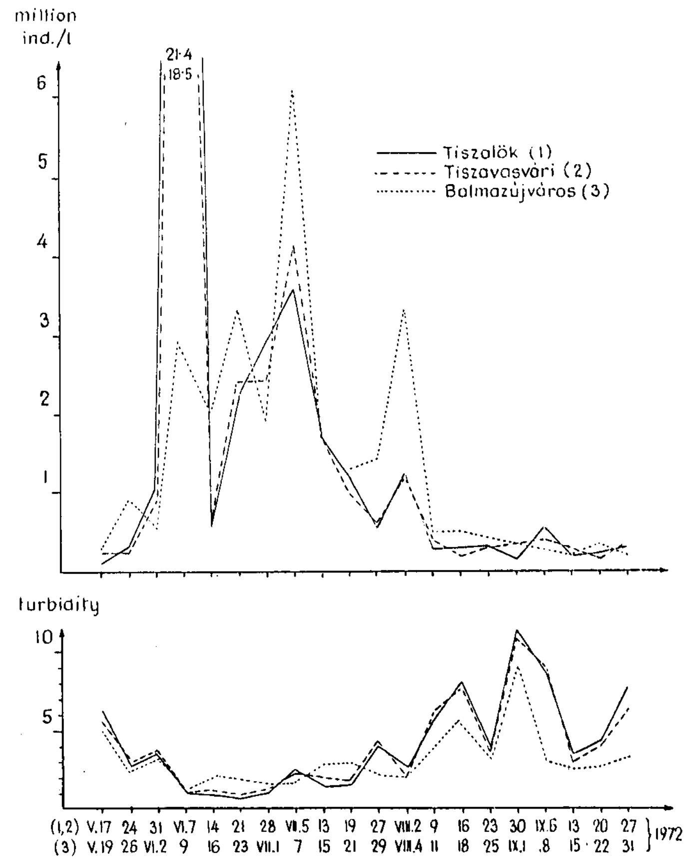

Fig. 6. Quantitative conditions of the phytoplankton of the Tisza and the Eastern Main Canal, and the change in the turbidity of the water between 17 May and 31 September 1972.

The correlation can be described by a hyperbolic function (see Fig. 7):

$$Y' = 317.3 + 3075.4 \cdot \frac{1}{X}$$

From a comparison of the turbidity values from Figures 3—7, it may be stated that plankton algal population maxima can develop in the Tisza and in the Eastern Main Canal if the turbidity of the water decreases below 3. At such time the light conditions are favourable for the overmultiplication of the algae.

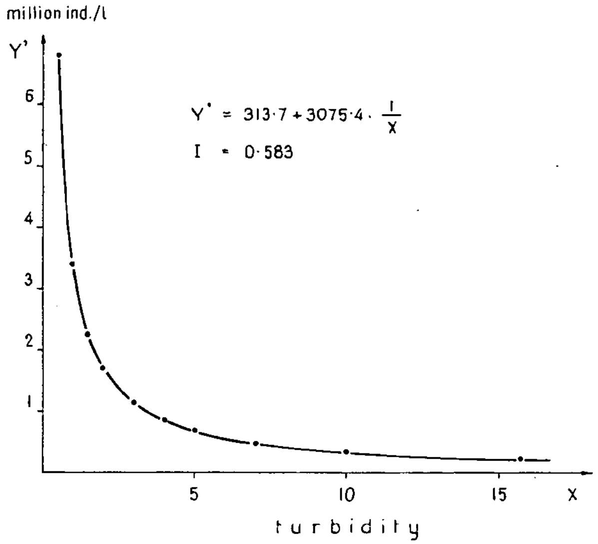

Fig. 7. Hyperbolic relation between the overall number of algae and the turbidity.

There may be significant differences between the total numbers of algae at the three sampling points at any time. The reason for this is in part that in summer and early autumn the rate of flow of the Tisza section dammed up at Tiszalök is small because of the low water-level, whereas the water flow in the canal may be rapid because of the intensive irrigation (UHERKOVICH 1964, 1966, 1971, KISS KEVE—PINTÉR—MUNKÁCSY 1974) and the increased turbulence is not favourable for the multiplication of the algae. The rich algal association of the Tisza becomes poorer in the Canal, and the numbers of algae decrease. It can be observed in Figures 3—6 that if a population maximum develops in the Tisza, then the turbidity there is less than in the Balmazújváros section of the Canal. Naturally, the reverse situation also occurs in several cases. It is beyond doubt, however, that, besides the flow conditions, the light and the turbidity, other unexamined ecological factors (such as the nutrient supply) also affect the development of the number of algae. Nevertheless, it can be seen from the results of the investigations that if the value of the turbidity is high and if the photoclimate of the water is unfavourable, then the population maxima can not develop in the Tisza and in the Eastern Main Canal.

Our observations lead to the conclusion that if the Tisza is flood-free for 2—3 weeks after May—June and its water becomes clearer, then the possibility exists for the population maxima of the plankton algae to develop in it.

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QUESTIONS OF THE UTILIZATION OF THE DEAD-ARMS OF THE TISZA FOR FISHING PURPOSES PROBLEMS CAUSED BY POLLUTION

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(Received 25 January 1974)

Abstract

One of the possibilities for the development of fishing is the more intensive inclusion of the dead-arms of the rivers into fish-production. Because of the mass destruction of the fish which can occur in the dead-arms of the Tisza, however, fish-breeding there is risky. Such a loss of the fish has already taken place in practically all of the dead-arms, without pollution of extraneous origin. The cause of the destruction of the fish as a result of natural biological processes is hydrogen sulphide, formed as a product of sulphate reduction. It is also known that cases of such an origin do not occur in the dead-arms of the Danube, and thus the mineral composition of the mud, or more exactly the presence of lime, plays an essential role in the occurence or not of the lethal effects.

The dead-arms are at the same time important water reservoirs in the irrigation system. Accordingly, it can be understood that a problem of increasing importance recently is the pollution of the previously comparatively pure waters of the dead-arms. The waters discharged into the dead-arms include thermal waters used for the heating of factories and green-houses, which contain significant amounts of ammonium ion (5—10 mg/l) and phenol (1.7—2.3 mg/l).

Examinations were made to decide the question of whether the thermal waters can exert a direct or indirect deleterious effect on the quality of the water in the dead-arm, and harm the fish population. It was found that the above substances are diluted so much by the large mass of water in the dead-arm that the fish population is not harmfully affected, and the water is suitable for irrigation purposes. In those dead-arms where the eutrophication is in an advanced state, the destruction of the fish may be brought about by hydrogen sulphide, formed in the mud as a result of natural processes and released periodically, mainly as a consequence of climatic factors.

Possibilities of developing the area

There are two possibilities for the regional development of Hungarian fishing which have not yet been utilized to their full extent:

1. The conversion into fish lakes of sodic areas which are useless as regards agriculture, or at best are used periodically as pastures.
2. The more intensive utilization of the dead-arms for fishing purposes.

Although the two possibilities can not be distinguished sharply from each other with regard to the hydrobiological questions of the development, and indeed involve completely identical problems too, the present work deals with the hydrobiological questions of the utilization of the dead-arms only (these are restricted to the dead-arms of the Tisza), with the difficulties involved, and with the possible solutions.

Dead-arms of the Tisza

The waters of the dead-arms in the Hungarian section of the river Tisza occupy an area of several thousand hectares. Merely in the county of Csongrád the dead-arms at Csongrád, Felgyő, Mártély, Atka, Körtvélyes, Nagyfa and Gyála account for more than 700 hectares. The area of the three large dead-arms in the vicinity of Tiszaföldvár in the county of Szolnok is even larger. The colonizing and harvesting of fish is carried out on only in some of these dead-arms, and even not systematically. The main reason for this is that it is not guaranteed that the costs of the colonizing and harvesting will be returned. The maintenance of the fish life in the dead-arms has not been certain in the past; it is sufficient here to recall the repeated mass deaths of the fish in 1958 at Atka (DONÁSZY 1959) and in the dead-arm at Gyála. The risk involved in fish-farming is still further increased nowadays by the greater degree of pollution of the waters. The periodic destruction of the fish population has the greatest effect not on the sporting and recreational angler, but on the fishing-cooperatives.

A basic problem towards ensuring the maintenance of the fish life is the elucidation of the causes of the destruction. The clarification of these processes is an indispensable precondition in the activities of defence and avoidance.

Material and method

In the course of the investigations, use was made of the methods of MAUCHA (1930) and of the procedures given in the Collection of Water-examination Methods published in Jena in 1971. The Woker curves were used for the determination of free ammonia.

The establishment of the thickness of the iron sulphide-containing mud layer is an important factor in the determination of the total amount of hydrogen sulphide expected to be liberated from the mud. A thick-walled glass tube, 3.5 cm in diamater, was employed for this purpose. The tube was pressed vertically into the mud and then withdrawn with the mud inside it. The thicknesses of the upper, oxidized mud layer and the lower, black, iron sulphide-containing mud layer were measured, and samples were taken for the determination of sulphide (VÁMOS 1971).

Thin-layer chromatography was used for the demonstration of the organic compounds in the thermal waters.

Phenolic compounds which can give an unpleasant taste to the fish meat, were detected by the following procedure, as a direct method. A piece of the flesh, about 7—8 cm long and 1 cm wide, is cut from the side of the fish, put into a test-tube and covered with water. The test-tube is then heated over a gas flame. The vapour emerging from the tube after the commencement of boiling is tested by smell at frequent intervals; if the meat is contaminated by phenolic compounds, the smell of phenol is clearly perceived after 3—4 minutes.

Pollution of the dead-arms

Urbanization and the development of industry and agriculture have led to a significant increase in the quantity of waste waters. In many cases the outlets of the sewers are not in the living Tisza, but (perhaps fortunately as regards the quality of the river water) in the dead-arms. In such cases of course this pollution of external origin can be responsible for the death of the fish. However, such losses have also been known to occur (and recur) in dead-arms into which no waste water is discharged. Accordingly, in these cases the poisoning material must be produced in the dead-arm itself. That is, the natural processes taking place in the mud and water of the dead-arms can give rise to products harmful to the fish population. The water courses flowing into the dead-arms can increase the eutrophication and enhance those processes which are of danger to the fish. Water courses able to enhance the eutrophic state are:

1. Thermal waters used to heat green-houses and industrial plants, the average oxygen consumption of which is 25—60 mg/l. They have a significant ammonium content of 10—14 mg/l, but their solid constituent contents are insignificant.

2. Water courses leading off industrial, town and agricultural waste waters: e.g. the Maty stream, which runs into the upper section of the dead-arm at Gyála. The pollution delivered by the Maty stream frequently includes material in the form of a fine industrial grease, which prevents the penetration of oxygen. This alone promotes the development of an anaerobic state.

3. The eutrophication can be increased considerably by nutrient materials such as nitrogen, phosphorus and potassium, washed in by rainfalls on the adjacent agricultural areas, and immediately utilized by the aquatic plants. The amounts of such nutrient materials are growing as a consequence of the more common use of artificial fertilizers.

Prior to a discussion of the increasing pollution, it is necessary to deal with the original water quality in the dead-arms. In this respect it is essential to understand the processes which can affect the quality of the water, and which determine it in those cases when no pollutants or nutrient material enhancing the eutrophication enter the dead-arm. The results of these investigations give the basis for a comparison of the effects caused by or attributed to the individual water courses in the event of the question of the responsibility of the water-pollution arising.

Original quality of the water of the dead-arms

The dead-arms came about on the regulation of the river, by the cutting-off of the larger bends and the construction of embankments. Two cases are possible for the connection of the river and the water in a dead-arm:

1. All contact between the river and the dead-arm ceased at the time of the regulation, but water from the river can enter the dead-arm on the occasion of flooding of the river. This can happen, for example, at Mártély and Körtvélyes.

2. When an appreciable amount of water, generally polluted, flows into the dead-arm from a sewer or stream, the surplus can only be passed on to the Tisza. The means of this depend on the level of water in the river. When the river water level is high, the transfer is accomplished by pump, but when it is low, the water is able to flow into the river by gravitation. Both forms of transfer are employed in the case of the Dead-Tisza at Gyála, which is mainly fed by water originating from Szeged, via the Maty stream.

After consideration of the utilization of the water and the most economical consumption of energy, the following practice has been adopted in the exchange of the water in the dead-arm at Gyála. During the winter, when the level of the Tisza is generally low, the water accumulated in the dead-arm is admitted into the river. At the time of the high-waters in spring, when the vast majority of the water, is the result of snow-melting, the dead-arm again fills up. This water, however, is excellently suited for irrigation purposes.

Today, therefore, the dead-arm can be regarded as a long standing-water, broken up by cross-dams, where exchange of the water is carried out annually. Culverts and sluices ensure the movement of water across these cross-dams. The transfer of the water is never perfect, however. The mud here is not aerated to the sam extendt as occurs every year, systematically, in the case of a well-built and well-ehandle fish-lake. In those parts where the bottom of the bed remains covered by water, or the mud is saturated with water, the oxidation processes which are of extreme importance from the point of the aquatic life, including that of the fish, and which can be ensured only by the penetration of air, do not take place. As a consequence, the standing-water character of the dead-arm becomes more pronounced than that of the fish-lakes, and is more similar to that of natural lakes. The changes occurring in the standing waters, which govern the fishing activity and the provision of the nutriment for the fish, are closely related with the nature of the mud and its organic and mineral composition. The principle holds here that the fish lives in the water, but feeds from the mud. The fact that the mineral composition of the sediment is an important controlling factor in the intensity and regulation of the biological processes is demonstrated most strikingly in the dead-arms of the Tisza and the Danube. The natural mass-destruction of the fish such as is observed in the case of the dead-arms of the Tisza is never found in the dead-arms of the Danube. We shall see that this is connected with the mineral composition of the bottom of the bed

Mineral composition of the sediment in the river and the biological processes

The Tisza has cut and changed its bed in its own deposit; the bed became finalized only az the time of the regulation. However, there is an essential difference between the qualitative compositions of the alluvia of the Tisza and the Danube. It is necessary to know here that the limy alluvium of the Danube approaches the Tisza near Szeged (at Kiskundorozsma). In contrast with the Danube, which descends from the Alps, the Tisza contains no, or only a very little lime in its deposit. The deposit of the Tisza is much richer in iron, and with time the amount of iron passing into solution by the action of the electrons produced by the bacterial respiration is still further increased during the subsequent soil-formation. The quantity of iron washed in from the neighbouring, agriculturally cultivated areas is higher than ever observed in the mud of the dead-arms and in the soils formed on the deposit of the Danube. This large amount of iron plays a substantial role in the binding of the hydrogen sulphide produced by the action of bacteria in the mud, and in the accumulation of sulphide in the form of iron sulphide. These features, the abundance of iron and the absence of lime, exert a controlling influence on the biological processes, on the transformations of the products of these, and thus on the effects of the compounds formed on the life of the environment.

The process in which the effects of the mineral components are expressed most markedly is the bacterial sulphur cycle proceeding in the mud and in the water layer, i.e. the microbiological and the following abiotic transformations of the sulphur compounds. This process is closely connected to the cyclic turnover of the other organogenic elements and is one of the main regulators of the quality of the water.

The bacteriological processes occurring in the mud at the bottom of the lake or deam-arm, and the mineral and organic matter composition of the mud, have previously not been sufficiently considered in the development of the quality of the water. Accordingly, the changes observed in the course of continuous water-examinations have not been explained. Nor has light been thrown on the causes of the mass death of the fish.

Depending on the quantity and quality of the organic matter in the mud of the dead-arms, and also on the temperature, the oxygen-consumption of the bacteria multiplying there can give rise to anaerobic conditions. The electrons produced by bacterial respiration reduce the manganese and iron oxides in the mud, and in consequence the amounts of manganese and iron which can be dissolved by the mud solution increase (Figure 1). Where there is much manganese *Trapa natans*

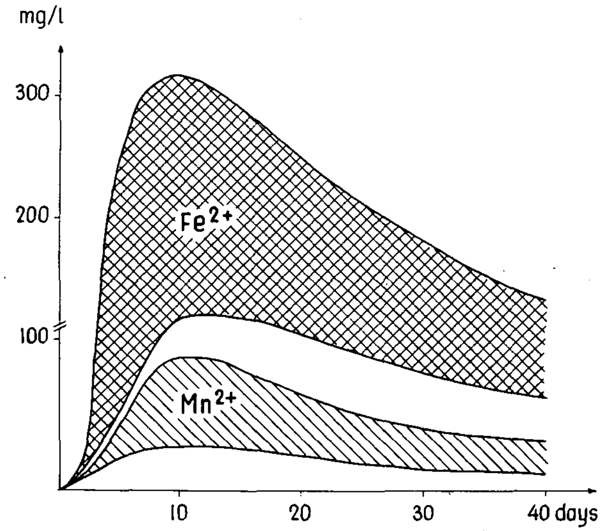

Fig. 1. Increase of the amounts of Fe^{2+} and $Mn^{2}{}_{+}$ in the mud of the dead-arms of the Tisza. Model experiment.

is extremely prolific; about half of the mineral content of the produce of this is manganese. In this environment, where the anaerobic decomposition mainly of plant residues proceeds at a redox potential of $Eh_0 \sim 0$ mV, the sulphate-reducing bacteria multiply, the oxygen demands of which are provided by the sulphate ions. The two products, sodium hydrocarbonate and hydrogen sulphide, are important factors from both pedological and limnological points of view as regards the further biological processes of the water. Thus:

1. On the decrease of the intensity of the decomposition of organic matter, and the accompanying decrease in the amount of carbon dioxide produced, the hydrocarbonate, which is converted to soda, increases the alkalinity of the water, i.e. the pH value. This circumstance indirectly promotes the formation of free ammonia which, as a respiration poison acting on the central nervous system, can lead to the death of the fish if it attains a concentration of 0.2 mg/l.

2. As a general cell, enzyme and nerve poison, the other product, hydrogen sulphide, can be harmful to the fish life both directly and indirectly. Via its poisoning action it reduces the fish population directly, while by destroying the living fish-food it can inhibit the growth of the fish.

Assessment of the changes in the waters of the dead-arms is facilitated by the fact that examination data obtained over several decades are available in this respect.

Perhaps the most valuable of the investigations relating to the earlier composition of the waters of the Tisza and the Körös are those of SCHICK (1934).

In 1955 the following results were obtained for the dead-arm at Gyála (which was cut of from the Tisza in the eighteen-nineties) and were compared with those for the water of the living Tisza. The results are worthy of attention, for at that time the industrial zone of Szeged beside the main road to Budapest did not exist, and thus the Maty stream delivered much less pollutant matter into the dead-arm. A proportion of the organogenic elements are washed into the dead-arm from the intensively cultivated gardens and agricultural land in the direct vicinity, by the action of the rainfall. As can be seen from the data of Table 1, there have been significant increases in the amounts of sodium, calcium, magnesium, hydrocarbonate and sulphate ions in the water of the dead-arm. Industrial contamination is not always necessary, therefore, for an increase in the amount of sulphate, as it can also appear as a consequence of a natural process. The more rapid increase in the quantity of sulphate ion to be found in the standing waters in Hungary today is rather a consequence of the industrial contamination. The presence of carbonate is a typical lacustrian hydrobiological phenomenon. All these changes are in the main the results of sulphate reduction. Unfortunately, the data relating to the mud from that period are not available.

The main factors involved in the changes taking place in the water of the dead-arm are the composition of the running water used to fill the dead-arm, the total organic matter content of the mud, and the temperature, which controls not only the evaporation but also the intensity of the decomposition of the organic matter.

Since the very small amounts of the products of nitrate and phosphate reduction are negligible in comparison with the products of sulphate reduction, from the point of view of fishing the quality of the water in the dead-arms is affected most by the above two products, soda and hydrogen sulphide.

The possibility of the destruction of the fish in the dead-arms of the Tisza due to the action of ammonia

In the evaluation of the qualitative effects, the first task is to assess the possibility of the danger of free ammonia.

When filled up at the time of the spring flood, the water of the dead-arm has a pH of 7.0—7.2. Depending on the decomposition of organic matter and on the intensity of the reduction processes, this value can rise to about 7.5—7.8 in the course of the summer. The data available indicate that in the nineteen-sixties the pH approached a value of 8.0 only in rare cases, while in the period 1955—1958 the pH remained successively below 7.8. Since the Woker curves show that at a pH of 7.8 and a temperature of 20 °C in summer 3% of the total NH_4 is converted to free ammonia, the water should contain 7 mg NH_4 per litre in order that the free ammonia might attain a toxic level. However, such conditions have not developed to date; in summer there has never been such a high water pH or such a high NH_4 ion content in the water of the dead-arms that the destruction of the fish has been attributed to the formation of free ammonia. The amount of NH_4 ion measured in the dead-arms in summer varied in the range 0.6—1.1 mg/l. This relatively low ammonium ion content can be explained by the nitrogen uptake of the algae and the high-order aquatic plants. The lowest ammonium ion concentrations, 0.3—0.4 mg/l, were measured in May—June, the periods of vegetative development of the aquatic plants. Since the destruction of the aquatic plants, the so-called reed-grass destruction, in the dead-arms does not attain the extent characteristic of certain fish lakes, the destruction of the fish in this indirect way is not a threat either.

The destruction of fish by the action of hydrogen sulphide in the dead-arms

Th other product of sulphate reduction, hydrogen sulphide, reacts with the iron ions in the mud solution and, as long as the solution contains iron, is immediately bound. The resulting iron sulphide colours the mud layer black (Figure 2). The

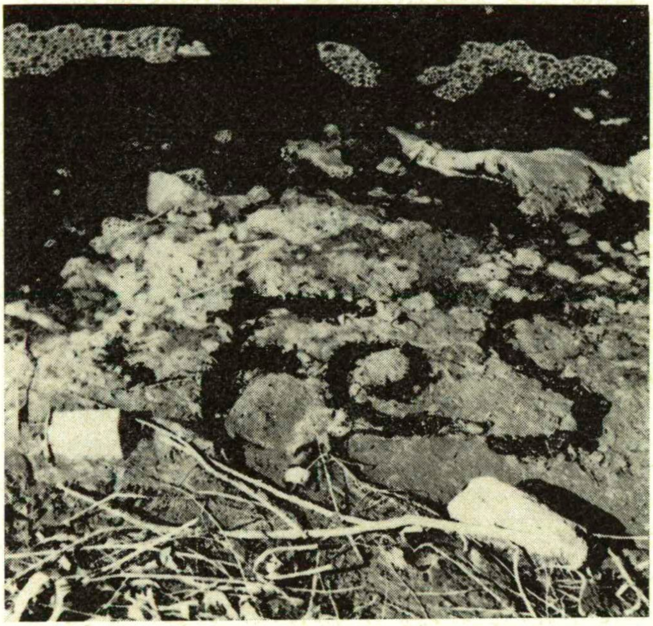

Fig. 2. The bank-side mud, black from iron sulphide, is covered by a thin, oxidized layer.

thickness of the black layer therefore indicates the accumulated iron sulphide, and from a knowledge of this the amount of hydrogen sulphide liable to be liberated can be estimated.

The sulphide content of the iron sulphide layer is on average 10—30 mg S^{2-}/100g. There are cases, which are particularly frequent in the dead-arms of the Körös, when it attains, and even exceeds 100 mg S^2/100 g. This usually occurs, however, only at the upper end of dead-arms into which waste water is introduced, or where organic refuse matter is used to fill up the dead-arm.

The hydrogen sulphide thus accumulates in the mud in the form of iron sulphide. In this form it is not harmful to living creatures, and the worms in the mud, including *Tubifex*, develop undisturbed. It only becomes dangerous when molecular hydrogen sulphide is released in large masses from the iron sulphide. In the case of the dead-arms, there are two main periods for this:

1. One of these is the summer, or more exactly the second half of August, when the first rapid cooling-down and air-pressure decrease occurs following a prolonged hot period of uniform air pressure. One typical example of this is the destruction of fish at Atka on 18—23 August 1958 (DONÁSZY 1959), but at the same time there was a similar occurrence in a section of the dead-arm at Felgyő. The rapid temperature and air-pressure decreases on 18 August 1958 also promoted the release of hydrogen sulphide and the resulting poisoning of the fish elsewhere, for instance in the fish lakes at Kelebia and in the lake at Palics.

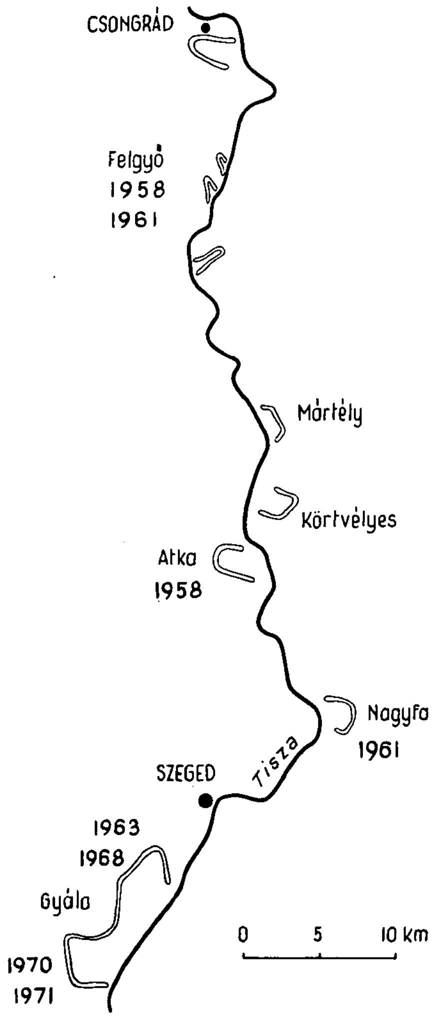

Fig. 3. Dead-arms of the Tisza in the county of Csongrád. The years are those involving destruction of the fish.

2. The other period is the beginning of winter, when the temperature suddenly falls from the comparatively high 6—10 °C to below the freezing point. The surface of the water freezes, and thus the hydrogen sulphide released from the mud can not escape into the atmosphere. Such a case was involved in the destruction of the fish in the lake at Grébics, the weather factors of which were described by VESZPRÉMI (1964).

In both cases, therefore, fish destruction can occur, the onset of this being closely connected with the weather conditions. It has been observed only in certain years, when the weather had been favourable for several years with regard to the accumulation of a considerable amount of iron sulphide, and similarly the conditions which arose permitted the release of a large mass of hydrogen sulphide at a high rate. The two main factors in the weather which play an important role in the formation, release and accumulation of hydrogen sulphide are the changes in air pressure and temperature (VÁMOS 1964).

On the basis of our experience to date, it can be concluded that the iron sulphide accumulates in the mud as the product of several years' bacterial sulphate-reduction. The reason is that on the cooling-down in autumn and winter not all of the sulphide is oxidized. The rate of the oxidation also depends on the proportions of the clayey constituents of the mud. The larger the quantity of clay, the more protracted the drying-out, and hence the slower the change in the anaerobic → aerobic conditions. An iron sulphide zone always remains in mud saturated with water. When continuously hot summers follow one after another, and there are no significant differences in temperature and air pressure, the thickness of the reduction layer increases, and with it the amount of sulphide in it. Under such conditions, and depending on the weather changes, the occurrence of the mass death of the fish is to be expected. It is understandable that it is now known when the destruction of the fish occurs en masse in almost every dead-arm of the Tisza. Similar phenomena also occur in the dead-arms of the Körös. One of the most extensive such poisonings of the fish by hydrogen sulphide took place in the dead-arm of the Körös at Endrőd in 1968. Figure 3 shows the dead-arms of the Tisza in the county of Csongrád, together with those years in which the mass death of the fish ensued in them.

The course of the destruction of the fish in the dead-arms

Study of the destruction of the fish by hydrogen sulphide is much more fruitful in the dead-arms than in the fish lakes. The beds of the dead-arms are about 100 m wide, and my be even 5—10 km long. Observations to date indicate that the destruction of the fish does not begin at the same time everywhere throughout the entire bed section, but generally commences at the upper end and proceeds in the direction of the earlier flow. As it spreads further it gives the impression of being caused by some infectious microbe. The destruction thus takes several days, that at Atka, for instance, lasting for 5 days. All five sections of the dead-arm at Gyála, which is split up by cross-dams, count as separate lake-units, and the destruction of the fish in these has taken place in different years and in different seasons. The penetration of the oxygen required for respiration, and the escape of hydrogen sulphide, are inhibited at the time of the death of the fish in summer by the oxygen consumption of the algal mass on the surface of the water (water-blooming), and in the winter by the ice cover. In winter, however, when the oxygen content of the water is high, the hydrogen sulphide is oxidized and the elemental sulphur is precipitated in a colloidal form resembling milk, which colours the bottom of the ice or the water a characteristic sulphur-yellow (Figure 4).

Fig. 4. The separation of sulphur colours the water a yellowish-green.

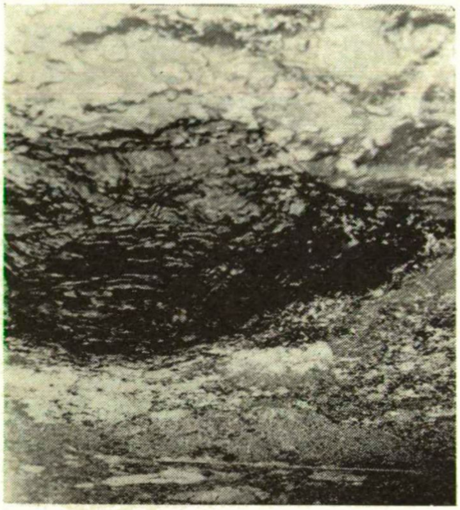

Fig. 5. The mud contains gases even in the middle of the bed.

The role of the air-pressure decrease

On the rapid decrease of the air pressure, the gases in the mud (CO_2, N_2, CH_4, H_2S) rise to the surface. The ascending gas bubbles carry up fine particles of mud with them (Figure 5) and the water becomes disturbed. As the fisherman then says "The bottom of the water is upset". The oxygen content of the water decreases. The fish float about under the surface and then begin to gasp for breath.

The accumulation of hydrogen sulphide in the water layer

Our observations so far indicate that the gaseous hydrogen sulphide can accumulate in the mud and enter the water layer in two ways:

1. Climatic effects lead to the rapid release of hydrogen sulphide from the iron sulphide formed as a result of sulphate reduction.

2. In iron-poor mud the hydrogen sulphide accumulates in the form of gas bubbles, and only on the fall of the air pressure or the artificial disturbance of the mud does it rise into the water layer and from there into the air, where its smell becomes apparent. This phenomenon is characteristic only of lakes with alkaline water and limy soil, e.g. at Kunfehértó.

In the dead-arms of the Tisza only the first process is known, i.e. the rapid release of the gas from iron sulphide. The cooling-down, which is a regular fore-runner of the release of hydrogen sulphide, is accompanied by the oxidation of the

Table 1. *Analysis of the waters of the river Tisza and the dead arm of Tisza at Gyála, from the time when there was no water-exchange*

	Dead-arm at Gyála	River Tisza	
	1954	1931	1954
		mg/l	
Ca^{2+}	51,49	37,0	28,5
Mg^{2+}	28,58	4,5	7,7
Na^{+}			
K^{+}	137,82	20,0	23,06
Fe^{2+}	0,26	2,5	0,33
Cl^{-}	41,20	17,5	7,20
SO_4^{2-}	146,28	17,0	25,15
CO_3^{-}	19,05	—	—
HCO_2^{-}	408,58	137	119,26
PO_4^{3-}	0,03	—	0,01
SiO_2	10,40	—	0,05
Total organic matters	10,96	—	3,59
Total salts	880,00	—	210,00
pH	7,6	—	7,2

surface iron sulphide to sulphuric acid, and it is this strong mineral acid which sets the gas free (Vámos 1964, Starkey 1966). The death of the fish always begins in the more shallow end of the dead-arm. This is understandable, for this is where the hydrogen sulphide is liberated first as a result of the earlier oxidation of the iron sulphide in the shallower water, while in addition the smaller volume of water present means that the hydrogen sulphide attains a lethal concentration more quickly.

For the assessment of the danger of hydrogen sulphide release, it is indispensable to determine the thickness of the mud layer containing iron sulphide. The thick-walled glass tube described in the Methods section is excellently suited for this. From the analysis of the samples it was established that the sulphide content below the redox level is always higher than in the deeper levels. The decrease, however, is not always gradual. An important factor in this may be the organic matter and total nitrogen content of the mud. This can be exemplified by the analyses of samples taken in two different places (Table 2).

Table 2. *Vertical decrease of the amount of S^{2-} in two mud samples*

Deepness cm	Dead-arm at Gyála	Dead-arm at Mártély
	S^{2-} mg/g	
0,5—1	7,8	3,5
1—3	6,6	2,8
3—5	4,9	2,4
5—8	2,7	0,7
8—11	2,1	0
11—13	0,4	0

The physiological effect of hydrogen sulphide

The amount of hydrogen sulphide which leads to the death of carp within a short time is about 0.4—4.0 mg/l. Unfortunately, there are no data referring to predatory fishes. The sequence of sensitivity is the following: bream, pike, pike perch, silurus, tench, carp, crucian, bull-nosed pout, loach. A number of factors affect the lethal concentration: the state of health, the pH of the water, its temperature, its oxygen and salt contents, the quantity of suspended colloids, etc. It is to be understood, therefore, that it is a difficult task to denote an exact lethat concentration of general validity. Hydrogen sulphide primarily paralyzes the respiratory centres. As a result, the gills of fish suffering from the effects of hydrogen sulphide are a lilac colour because of the accumulating carbon dioxide. If a fish which has recently sunk to the bottom is placed in fresh, oxygen-rich water, it regains consciousness and remains alive. The open gill-covers of unconscious fish sinking head-downwards to the bottom are often impaled (like an arrow) in the mud, and hamper the ascent of the decomposing fish to the surface.

If the hydrogen sulphide does not attain the lethal concentration, the carp reacts in a different way to the continuous poisoning effect. Before this is described it is necessary to know that in pure tap water the carp loses its appetite at an oxygen concentration below 4 mg/l. Under conditions of insufficient oxygen supply the toxic concentration of hydrogen sulphide is lower. Because of the inhibiting effect of hydrogen sulphide on the respiration, the fish may be observed gaping on the surface even when the oxygen content of the water would be enough for respiration.

It was also found that as a result of the continuous effect of sublethal concentrations of hydrogen sulphide the red blood cell count progressively decreases. A count of about 6—700,000, in place of the normal 2.1—2.3 million, is the minimum that the fish can still endure for a prolonged period. As a consequence of the considerable anaemia and blood-supply disturbances, the internal organs lose their colour completely.

It was established that at a hydrogen sulphide content above 2 mg/l the carp does not spawn. Since hydrogen sulphide has never been observed in the waters

Fig. 6. Mud particles containing iron sulphide adhere to the gas bubbles ascending from the disturbed mud.

of the dead-arms at the time of the spring spawning, the latter is not disturbed in any way.

The different fish species are not uniformly sensitive to hydrogen sulphide. It follows from this that, depending on the concentration of the poison, there can be various levels of destruction. For example, a case is known from the upper section of the dead-arm at Gyála when only the bream died, but all the other species survived. At the same place, but in a different year, however, not only large numbers of bream were destroyed, but also the predatory fish, among them the pike perch. In the case of apparently total destruction, the carcases of practically every type of fish can be seen on the surface of the water, mainly near the banks or washed in among the reeds (Figure 6).

In spite of appearances, however, not all of the fish are destroyed, for the hydrogen sulphide does not attain the lethal concentration in the whole of the dead-arm at the same time. The release of the poisonous gas is not instantaneous, and this is the reason why certain of the fish remain alive even when it appears that the destruction is complete in the dead-arm and that all the fish are dead. The growth of the fish which remain alive after hydrogen sulphide poisoning is faster than at other times, in contrast with cases of ammonia poisoning, after which the growth is always more drawn-out.

The effect of hydrogen sulphide on the taste of the fish meat

In several cases of the poisoning of fish by hydrogen sulphide, examinations were made to determine whether hydrogen sulphide can cause a perceptible change in the meat of the fish, detectable on its consumption. As it has no charge, hydrogen sulphide can penetrate the cell wall almost without hindrance. It diffuses in the tissues about 100 times more quickly than does oxygen. Our experience to date on the effects on the taste of the fish meat is as follows:

When the destruction occurs in winter, when the respiration is slow, the absorption of the hydrogen sulphide is more protracted. The fish can endure a given concentration of the poison for a longer time in winter than in summer. The cause of this is presumably that the amount of oxygen dissolved in the cold water is at least double (8—10 mg/l) that to be measured in the summer. At such time no unpleasant side-taste can be detected in the meat of the fish.

On the cooling-down in summer, on the other hand, it can happen that the fish stir up the mud of the fish-bed, and may then spend even several days in this hydrogen sulphide-containing slime until they are removed. The death of the fish can then easily occur, but even in the case of the fish remaining alive, the danger exists that the meat of the fish will absorb hydrogen sulphide and other compounds dissolved in the mud. This can give rise to the meat having a characteristic swampy taste, which in many cases is confused with the taste of phenol. Such a case occurred in the dead-arm at Gyála in December 1972, when the fish remained in hydrogen sulphide-containing water in the dead-arm about 3—4 weeks. This long period entailed such a large quantity of hydrogen sulphide penetrating and being accumulated in the meat of the fish, that its later consumption afforded no pleasure. During the first 14 days of the fishing the meat and its taste were of an excellent quality.

If a young fish undergoes the shock of hydrogen sulphide poisoning and successfully recovers, then later it does not succumb to a similar concentration of the poison.

The effect of thermal waters on the quality of the water in the dead-arms

Deep-borings carried out for various purposes in the vicinity of the Tisza have produced significant quantities of thermal waters varying considerably in composition. These are used in part as medicinal bathing waters, but also to heat houses, factories and green-houses. These waters are excellently well suited for this, as their temperature often exceeds 80 °C.

A still existing problem in connection with the utilization of thermal waters, however, is the leading-off and disposal of the "spent water" from the heating system. If these are admitted to a reservoir, such as a dead-arm, where there is a fish population, they may give rise to changes endangering the fish, or even kill them. In certain cases changes and unpleasant tastes in the meat of the fish have been attributed to the effects of thermal waters.

Sinces disputes have arisen between plant-producing cooperatives utilizing the thermal waters and the fishing cooperatives which make use of the dead-arms into which the thermal water is discharged, it appears necessary to clarify this question. For instance, the death of the fish in the dead-arm at Gyála in December 1972 was ascribed by the fishing cooperative there to the properties of the thermal water.

Examinations were therefore carried out to decide the question of whether the physical and chemical properties and the amount of the thermal water entering the dead-arm can lead to changes in the health of the fish and in the taste of the meat, or even bring about their death, and if so, then to what extent.

The results and experience emerging from these examinations can be classified into three groups:

1. The original properties of the "spent" thermal water, established from samples taken from the channel section prior to the outlet into the dead-arm.
2. The original properties of the water in the dead-arm or reservoir, and the periodic changes in these.
3. The physical, chemical and biological changes to be attributed to the thermal water in the water of the dead-arm, and which can be interrelated with the harmful effects on the fish.

The subject of a dispute is overall connected with the above changes. Our examinations to this end, and similarly our experience relating to the utilization of the dead-arms will be summarized below.

The examination of thermal waters

Although the already reported quality of the initial water of the reservoir is the most important factor as regards the fish life, analysis of the thermal water discharged into the dead-arm provides information not only on the components which are present in larger amounts, but also on the small quantities of organic compounds which give perhaps an unpleasant taste to the meat, and which are much more difficult to detect when diluted by the large mass of water into which they are discharged.

The data of an examination of the thermal water flowing into one dead-arm, the analyses of samples taken from the effluent tap at the end of the heating system, are given in Table 3. Although the water discharged from the heating system in

Table 3. *Exhange of the thermal water in the heating system*

Samples	pH	Ca^{2+} mg/l	Fe^{2+} mg/l	CO_2 mg/l	Total hardness G°	O_2 consumption mg/l	SO_4^{--} mg/l	S^{2-} mg/l	Alkalinity m-val/l	NH_4^+ mg/l
Original thermal water	8,0	7,00	0,06	36	1,2	64,0	76,7	0,36	49,2	13,2
At the wastepipe	8,3	3,45	0,26	18	0,48	60,3	29,6	1,7	48,0	9,7

many cases reaches the Dead-Tisza arm at Gyála only after passing through several kilometres of channels, the changes reported below are those which occurred in the first step, i.e. in the heating system itself.

Increase of the pH

The increase of the pH is partly a consequence of the decrease of the carbon dioxide pressure, but it is presumable that a more important role here is played by the sulphate reduction. The increase of the pH can be seen clearly in the case of 5 water samples taken from thermal water used to heat green-houses. The rise in the pH of the thermal water samples, taken from different sites, on standing for 30 days at room temperature, is shown in Table 4.

Table 4. *Increase of the pH of thermal water in contact with the air*

Number of sample	pH			
	0	6	18	29
	days			
I.	7,4	8,2	8,9	9,5
II.	7,5	8,4	9,0	9,6
III.	7,5	8,5	9,1	9,7
IV.	7,6	8,5	9,1	9,7
V.	7,4	8,4	8,8	9,4

The reason for the alkalinification to be observed in the Table is that the sodium hydrocarbonate is gradually converted to sodium carbonate, which undergoes dissociation to yield sodium hydroxide. Later, in the open system, where the carbon dioxide can escape moro easily, only the transformation of hydrocarbonate to carbonate is responsible for the rise in the pH value.

The decrease of ammonium ion observed in the pipe system is presumably a consequence of the nitrogen-consumption of the sulphate-reducing bacteria. The ammonium ion is the only source of nitrogen for these bacteria, for they are unable to utilize nitrate nitrogen, which in fact is a poison for them.

Decrease of the sulphate ion, and formation of hydrogen sulphide and sulphides

The most striking change within the closed system is the decrease in the amount of sulphate ion; the initial sulphate content, 60—80 mg SO_4^{2-}/l, is more than twice the sulphate concentration of the water discharged from the system. The cause of this is bacterial sulphate reduction. As a consequence of this, samples taken from those parts of the heating system where the water stagnates of flows only slowly contain 2.3—7.7 mg S^{2-}/l, mainly in the form of iron sulphide. The sulphate-reducing bacteria (Desulphomaculum nigrificans) multiplying here can endure temperatures in excess of 80 °C (POSTGATE 1966), and reduce sulphate in order to satisfy their oxygen requirements. A role may be played in the food-supply of the sulphate-reducing bacteria by the dissolved organic matter content of the water, which frequently exhibits an oxygen consumption of 50—60 mg/l, but an even more important role may be that of the polarized water molecules on the suıface of the metal. The sulphate-reducing bacteria are able to use the hydrogen atoms of this water as an energy source.

A chromatographic procedure revealed indole derivatives in the initial water, these being responsible for the unpleasant taste and smell of the water.

It can be concluded from the above results that the changes occurring in the heating system are not sufficiently large for exception to be taken to the original water from an ichthyophysiological aspect after its dilution by the great mass of water in the dead-arm.

Appropriate utilization

Independently of whether the thermal waters discharged into the dead-arm contain compounds harmful to the fish, possibilities arise for the utilization of the water by both plant producers and fishermen.

The gardeners begin the heating for the production of their early fruit and vegetables at the end of October and in November. By this time, however, the fishermen have generally completed their harvesting. One factor making this difficult is the high level of the river in autumn, for this prevents the discharge of the wa er in the dead-arm and, similarly as in fish lakes, this is the procedure employed in the fishing of the dead-arms, when possible. Fishing in the dead-arms must be performed earlier than in the fish lakes, for the bottom of a dead-arm is not very uniform. In addition, frost and an ice-cover involve many more difficulties than in the fish lakes.

In the lakes of the dead-arm at Gyála, the letting-out of the water is considerably promoted by the trench at the middle of the dead-arm, dug out parallel to the bank. This facilitates not only the lead-off of the water, but also the catching of the fish.

When the dead-arm at Gyála is filled up with the excellent water from the Tisza in spring, the thermal water is diluted by a minimum of 650—850 million litres of river water. After such a considerable dilution, the ammonium content of the thermal water (initially 6 mg/l) is no longer harmful, but it does improve the poor nitrogen-supply of the Tisza water. The daily amount of ammonium nitrogen contained in the thermal water discharged into the dead-arm section is 7—11 kg, which (calculating for an area of 30 hectares) corresponds to a weak fertilization. In spring the ammonium content of the water of the Tisza is at most 0.4—0.6 mg/l. The favourable nitrogen-supply is an important factor in the multiplication of the zooplankton serving as living fish-food. The unexpectedly large multiplication of the zooplankton in fish lakes filled with Tisza water and treated with ammonium sulphate (Szeged State Farm) led to the increase of the natural yield. A detailed study of this is in progress, but requires examinations over a number of years.

With regard to the pH and ammonium ion concentration in the period of feeding and development of the fish in the dead-arm at Gyála, our investigations indicate that these do not and can not attain levels toxic for fish. The death of fish due to ammonia poisoning has not been observed in the dead-arms. The same holds, but to a greater extent, for the phenolic derivatives descharged into the dead-arm with the effluent waste-water. The dilution of the phenol content of 1.7 mg/l means that it can never attain the lower limit of toxicity, 4—5 mg/l, and nor can it be the source of a perceptible change in the taste of the fish.

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STUDY OF THE INDICATOR ROLE OF PLANT POPULATIONS OF MARSH-MEADOWS ALONG THE TISZA IN THE WATER-HOUSEHOLD OF THE ENVIRONMENT IN THE DISTRICT OF KISKÖRE

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(Received 20 January 1974)

Abstract

The construction of the second series of locks on the Tisza will lead to the largest artificial water-reservoir in Hungary. With its tremendous water surface and water mass, this reservoir can be expected to exert an influence on the surroundirg plant populations via the rising of the subsoil water and the increase of the moisture content of the air. With the aim of the qualitative and quantitative measurement of the changes involved, a few years ago the hydrologists, climatologists, botanists and zoologists of the Tisza Research Working Group initiated a complex reesarch programme in the district of Kisköre and Tiszafüred (HORVÁTH et al. 1973).

Within the framework of this programme, in the past few years (1968—1973) we have carried out studies of the synecological state of this area in the period prior to the formation of the reservoir, this being planned as the basis of comparison for later investigations. In this respect we set out to establish the following:

a) what hygro-meso- and xerophil meadow associations occur on the two banks of this section of the Tisza outside the area of the reservoir;

b) what the species compositions of these plant populations are;

c) what changes take place in these plant populations as a result of precipitation.

In accordance with these aims, the zonal ordering brought about in the individual populations by the differences in height of the areas was studied, and for 5 years their regional variations were recorded.

Material and method

Our investigations began in the autumn of 1969. On both banks of the planned reservoir meadow associations were selected which included both dry pastures and various types of riverside marsh-meadows. As regards a dry pasture, a *Peucedano-Asteretum punctati* MÁTHÉ—SOÓ (1933) 1947 population was selected on the uncultivated Telekhát steppe at Cserőköz, about 1.5 km from the left embankment of the Tisza.

The site for study of the hygrophil marsh-meadow types *(Agrosti-Alopecuretum pratensis* SOÓ (1933) 1947*)* was in the Sarud pony-pasture, about 800 m from the embankment on the right bank opposite Cserőköz.

The site at Cserőköz is flat, but the Sarud pasture exhibits differences in level of 80—110 cm. In such meadows zones develop with different supplies of water. As a consequence of the various precipitation conditions (wet and dry periods) these differences become more enchanced. In these zones of varying ecological characteristics, different types of marsh-meadow associations develop.

From 1969 systematic phytocoenological and soil-moisture examinations were carried out at these two sites. Since the zonally ordered types of marsh-meadow in the Sarud area could be well distinguished from each other, their extents and the changes in these were recorded on a profile diagram (Fig. 1).

In the evaluation of these long investigations it is hoped to provide answers to the questions of what degree of change takes place in the extents of these zones as a result of the changes brought about in the wet and dry periods by the precipitation, and what close correlation can be established in the species composition of the individual populations.

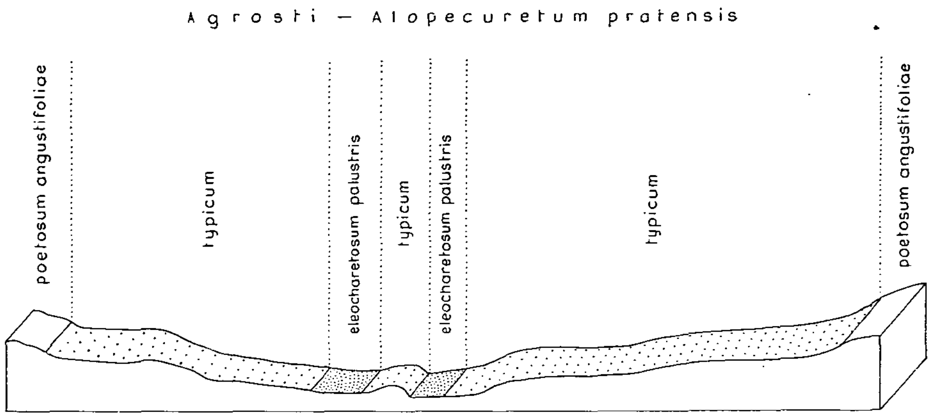

Fig. 1

The soil-moisture examinations were carried out at one spot in the dry lawn-type, and in 4 zones on the Sarud sample area, sampling being performed at 10 cm intervals to a depth of 60 cm. The water content of the soil was expressed in dm^3/l.

As regards the amount of precipitation, the data from the nearest large meteorological station (Szolnok) were taken into consideration.

From 1973 the dry-matter production too was systematically determined, by a mowing method, in three repetitions from 40×40 cm plots.

Comparative discussion of the results

Cserőköz

a) Wet period

The amount of precipitation in the last two months of 1969 resulted in the accumulation of the soil moisture. This state, which was favourable for the hygrophil species, was maintained in the first five months of 1970 and not only here, but on the whole of the Great Hungarian Plain, led to the saturation of the soil with water.

The experimental area at Cserőköz can be regarded as the *Peucedano-Asteretum punctati* (Máthé—Soó 1933) Soó 1947 *alopecuretosum pratensis* Soó 1957 dridrierer variant characteristic of sodic forest clearings. It is possible to find in them the characteristic species of the association: *Peucedanum officinale, Aster punctatus, Veronica orchidea.* Meadow solonetz soil, steppefying deep down, is indicated by the deeply-rooting *Limonium gmelini* and *Artemisia salina.* The sodic representatives of the ephemeral Papilionaceae are *Trifolium striatum* and *T. retusum.*

The differential species of the sub-association emerge from among the hygrophil species components: *Alopecurus pratensis, Lythrum virgatum, Trifolium hybridium, T. repens, Senecio jacobea,* etc.

Table 1. *Peucedano-Asteretum punctati*

	Percent coverage	
	wet period (August 1970)	dry period (June 1973)
Glyco-hygro-mesophil species:		
Alopecurus pratensis	20,0	10,0
Trifolium repens	14,0	5,0
Trifolium hybridum	0,5	.
Senacio jacobea	0,5	.
Centaurium minus	0,1	.
	36,6	15,0
Glyco-mesophil species:		
Daucus carota	0,1	0,5
Trifolium pratense	0,5	.
Eryngium planum	0,5	.
Mentha pulegium	0,2	.
	2,1	0,5
Glyco-meso-xerophil species:		
Inula britannica	1,0	0,5
Centaurea pannonica	1,0	1,0
Veronica orchidea	2,0	.
Trifolium campestre	0,1	0,1
Cichorium intybus	5,0	6,0
Agropyron repens	2,0	3,0
Galium mollugo	1,0	1,0
	14,2	11,6
Glyco-xerophil species:		
Festuca pseudovina+*Festuca sulcata*	6,0	25,0
Achillea collina	7,0	10,0
Potentilla argentea	0,5	0,5
Gypsophila muralis	0,5	0,5
Scorzonera cana	0,5	1,0
Plantago lanceolata	1,0	1,0
Trifolium arvense	0,5	.
	17,0	38,0
Halo-hygro-mesophil and mesophil species:		
Peucedanum palustre	6,0	5,0
Lotus tenuis	1,0	.
Trifolium striatum	0,5	3,0
Trifolium angulatum	.	2,0
	7,5	10,0
Halo-meso-xerophil and xerophil species:		
Aster punctatus	2,0	5,0
Limonium gmelini	0,5	2,0
Artemisia salina	2,0	2,0
	4,5	9,0

As regards the quantitative relations, the high dominance values of *Alopecurus pratensis* and *Trifolium repens* are the most striking, as a consequence of the favourable hydrographic effect (Table 1). The data of 10 recordings were used to calculate the participations of the species present, expressed quantitatively as percentage covers, according to the hygroecological classification. In the summer aspect of the vegetation period in 1970, a year with a particularly high precipitation, the glyco-hygro-mesophil species became predominant and overshadowed the glyco-xerophil species. The dominant species was *Alopecurus pratensis,* which represented more than half of the phytomass of the hygro-mesophil species. This was followed by the accompanying *Trifolium repens,* the total cover of these species being more than 36%.

In contrast, the participations of the glyco-meso-xerophil and the glyco-xerophil species were almost the same: total covers of 14% and 17%, respectively. These values were made up from relatively high numbers of species, even the participation of *Cichorium intybus*, which was dominant among the meso-xerophil species, not being more than 4%.

The result was similar for the xerophil species too. Appreciable declines and low values were exhibited by the two *Festuca* species present, *F. pseudovina* and F. *sulcata*. The participiation of *Achillea collina* was outstanding.

Since the soil possessed favourable physical and chemical properties, and contained sodium salts only in the lower layers, the total cover of the halophil species scarcely exceeded 10%. Of these, the halo-hygro-mesophil and mesophil association-character species, *Peucedanum palustre,* was the most significant. The *Limonium* and *Artemisia* species dominating on other sodic steppes were forced into the background here.

b) Dry period

The extremely dry year of 1970 was followed by a dry period. The most suitable year for study was 1973, when the amount of precipitation was about 70% of the many years' average. In the third year of the dry period the state of the ecological groups had developed as follows. The comparison of the two extreme ecological groups, the hygrophil and the xerophil species, gave exactly the opposite picture to that for 1970. The group of the hygro-mesophil species was decreased to about half of the earlier area. Certain species were so repressed that they were observed only as individual stems. The cover of *Alopecurus* too fell by 50%. An ever greater reduction was that of *Trifolium repens*, the cover of which was nearly 70% less than in the wet period. In contrast, as regards the xerophil species the coverages of the previously overshadoved two *Festuca* species increased by a factor of four. This was due in part to the bushing-out of the individual specimens, and to the revival of these hair-grass lawns following the repression of the foxtail grass and the white clover.

An increased participation was similarly shown by *Achillea collina*. The other xerophil species did not exhibit appreciable changes.

The coverages of the halophytons, and especially the meso-xerophil halophytons, increased during these three dry years; for example, that of *Aster punctatus* more than doubled. The hygro-mesophil and mesophil halophytes similarly achieved their spreading through the annual ephemeral *Trifolium* species.

Sarud pony-pasture

Three zones could be distinguished on the lower-lying sections of the *Agrosti-Alopecuretum* in the selected area. The deepest zone belongs in the *Eleocharis palustris* meadow-type, or its *Lythrum virgatum* sub-type. The middle zone was a typical variant of the Tisza-side *Agrosti-Alopecuretum*, or its *Senecio jacobea* sub-type. In the bank-side zone of this deeperlying flat area, which is about 300 m in diameter, where the rise is more significant, the dry types of this hay-meadow, *Poa angustifolia* and *Festuca pseudovina,* have developed alternately. The variation of the wet and dry periods could be observed not only in the species composition of the individual meadow types and in the participation proportions of the species components, but also in the change of the zone boundaries.

a) Wet period

In the course of the examinations in August, 1970 it was found that of these zones that of *Eleocharis palustris,* favouring the hygrophil conditions, was dominant. Even on the slightest rise the vegetation reacted sensitively to the change of the hygrographic conditions. The vegetation conditions of the middle zone developed on mounds 10—15 cm in height and 5—10 m in diameter.

The species composition of this low zone according to the hygroecological classification was the following:

Eleocharis palustris, forming the lower lawn layer the two-layer meadow, made up nearly half of the hygrophil species composnents. The upper lawn level was dominated in part by the hygrophil *Agrostis alba,* but its participation did not exceed 5%. *Lythrum salicaria* contributed with a further 5%, while as expected the meso-xerophil and xerophil species were completely absent. Of the mesophil species too, only *Mentha pulegium* occurred.

The picture changes, as regards both species compoition and coverage proportions, in the middle zone, where following the extensive decrease of the hygrophil species the hygro-mesophil species came into the foreground. In 1970, therefore, a complete ecological group-difference appeared between the two zones, in that *Alopecurus pratensis* occurred as 50% of the total coverage, whereas the other species each comprised less than 5%.

The upper zone, for which there was a difference in levels of about 80—110 cm compared to the deepest point, resulted in a further substantial change in that the meso-xerophil species assumed importance. *Poa angustifolia* appeared, and even became dominant. It was here, however, that the really hygro-mesophil nature and broader ecological adaptability of *Alopecurus pratensis* appeared, for as a result of the favourable precipitation conditions it exhibited a decrease of barely one-third in the upper zone, compared to the previous zone. Trifolium repens accompanied it, with a similarly significant participation of up to 5%. This gave rise to the situation that, although the examinations were carried out in a dry-type zone of the foxtail grass, the total participation proportion of the hygro-mesophil species exceeded that of the meso-xerophil species.

However, the picture changes if the values for the hygrophil and hygro-mesophil species and the proportions for the xerophil and meso-xerophil species are added together. The joint participation of the latter two ecological groups will then be the higher. This is due to the appearance of the xerophil species and the coverage of Festuce pseudovina and Achillea collina.

Table 2. *Agrosti-Alopecuretum*

	Percent, coverage							
	lower zone				middle zone		upper zone	
	eleocharetosum				Typicum		Poa angustifolia subass.	
	normale		Lythrum fac					
	70	73	70	73	70	73	70	73
Hygrophil species:								
Eleocharis palustris	25,0	10,0	8,0	2,0	.	.	.	.
Agrostis alba	10,0	5,0	2,0	5,0	.	.	.	.
Lythrum salicaria	5,0	1,0	5,0	.	3,0	.	.	.
Juncus compressus	3,0	.	.	.	.	.	.	.
Alisma plantago-aquatica	2‘0	.	.	.	.	.	.	.
Lythrum hissopifolia	0,5	.	0,5	.	0,2	.	.	.
Juncus atratus	2,0	.	0,5	.	.	.	.	.
Baldingera arundinacea	1,0	1,0	.	.	.	.	.	.
Typha latifolia	1,0	.	.	.	.	.	.	.
	48,5	17,0	16,0	7,0	3,2	—	—	—
Hygro-mesophil species:								
Alopecurus pratensis	5,0	30,0	25,0	40,0	50,0	35,0	30,0	10,0
Lythrum virgatum	.	6,0	.	8,0	2,0	5,0	1,0	.
Trifolium repens	.	.	.	1,0	.	1,0	5,0	1,0
Lysimachia nummularia	2,0	.	0,5	.	.	.	.	.
Senecio jacobea	0,5	.	.	1,0	2,0	.	.	.
Bidens tripartitus	.	.	.	0,5	0,2	.	.	.
Ranunculus sardous	.	.	.	.	.	.	0,2	.
	7,5	36,0	25,5	51,0	54,2	41,0	36,2	11,0
Mesophil species:								
Mentha pulegium	4,0	1,0	6,0	2,0	3,0	3,0	.	.
Lotus corniculatus	.	.	.	.	.	1,0	6,0	4,0
Daucus carota	.	.	.	.	.	1,0	2,0	1,0
Medicago lupulina	.	.	.	.	.	0,5	0,5	1,0
	4,0	1,0	6,0	2,0	3,0	5,5	8,5	6,0

Meso-xerophil species:								
Cichorium intybus	.	.	.	.	0,5	1,0	2,0	0,5
Poa angustifolia	.	2,0	.	.	.	15,0	20,0	35,0
Inula britannica	.	.	.	.	0,5	0,5	1,0	1,0
Lolium perenne	.	.	.	.	.	5,0	5,0	10,0
Convolvulus arvensis	.	.	.	.	.	.	0,5	1,0
Trifolium campestre	.	.	.	.	.	0,5	.	0,5
Lathyrus tuberosus	.	.	.	.	.	.	.	1,0
	—	2,0	—	—	1,0	22,0	28,5	44,0
Xerophil species:								
Festuca pseudovina	.	.	.	.	.	.	5,0	10,5
Achillea collina	.	.	.	.	.	.	6,0	8,0
Plantago lanceolata	.	.	.	.	.	.	2,0	3,0
Scorzonera cana	.	.	.	.	.	.	1,0	2,0
Gypsophila muralis	.	.	.	.	.	.	0,5	2,0
Potentilla argentea	.	.	.	.	.	.	0,5	1,0
Eryngium campestre	.	.	.	.	.	.	0,5	1,0
Carex praecox	.	.	.	.	.	.	0,1	0,5
	—	—	—	—	—	—	15,6	27,0

b) Dry period

For the evaluation of the changes, use was made of the results for 1973. The study of soil samples collected on 14 June 1973 revealed the effect of the lack of precipitation on the moisture content of the soil (Fig. 2).

The three dry years gave rise to a considerable change in the zone boundaries and in the extents of the zones. The Lythrum sub-type of the lower zone became

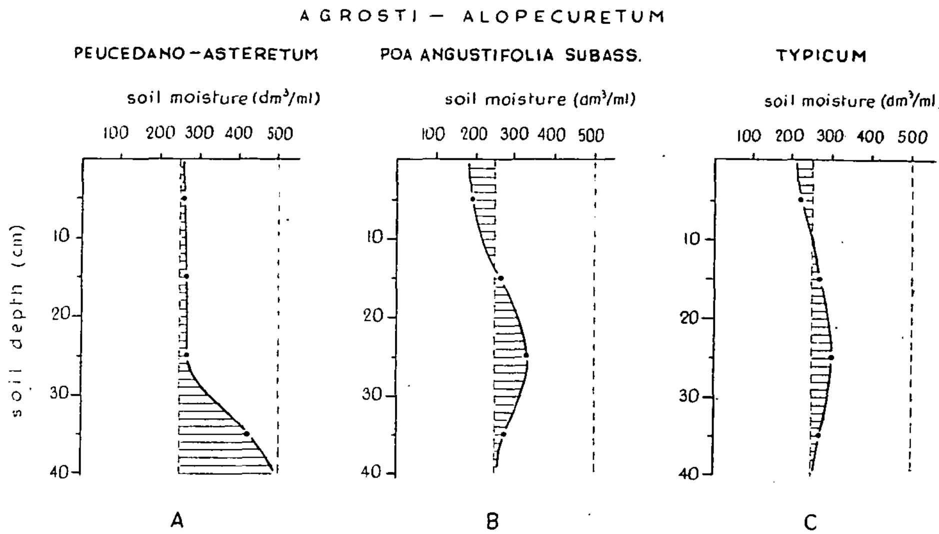

Fig. 2

in its entirely the typicum, but the higher stage of the Eleocharis type also developed as a typicum. In this way the extent of the lower zone was only 36 m, in contrast with the diameter of 150 m three years previously.

The coverages of the ecological groups and their species components resulted in appreciable changes. The Eleocharis population of the lower lawn level of the deepest lower zone exhibited a participation decrease of more than 70%, and the hygrophil Agrostis alba suffered a similar decline. At the same time, the participations of *Alopecurus pratensis* and Lythrum virgatum increased by a factor of eight. In the dry period, therefore, the hygro-mesophil species assumed a leading role in the lower zone, with a total coverage participation of 36%.

In the examination of the middle zone it turned out that the participation of *Alopecurus* decreased, in contrast to the increase in the lower zone. The participation of *Lythrum virgatum* too was nearly the same, and thus similar findings can be reached as in the case of the foxtail grass.

Poa angustifolia, on the other hand, which had earlier lain dormant in the middle zone, after the three years appeared with a participation of 15%. A contribution to this was due to the occurrence of Lolium perenne, which attained a participation of 5%.

It can be seen from all this that the succession showed very considerable changes during the three years (Table 2).

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EFFECT OF TOWN WASTE-WATER ON THE DEVELOPMENT OF CILIATA PLANKTON IN THE SZOLNOK SECTION OF THE TISZA

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Abstract

The results are reported of hydrobiological examinations carried out in 1958, 1962 and 1970 in the Szolnok section of the Tisza. The aim of the investigations was to establish how and to what extent the town waste-water effects the development of the Ciliata plankton in the river. The water of the Tisza arriving at Szolnok can be classified as first-quality. The Szolnok section of the river is polluted not only by the waste-water, but also by the by-products of various industrial works. Of these, the paper and cellulose, sugar and chemical factories have significant effects. Water samples were taken below the waste-water inlets. The inflow of the water of the river Zagyva results in a 50% concentration change in the Tisza. On average, the total dry matter content of the Tisza water is 200 mg/l more below the confluence than above it. As a consequence of the concentration change, the Ciliata plankton is almost completely destroyed below the mouth of the Zagyva. The development of the number of Ciliata plankton species and their frequencies are illustrated graphically. Those species which were found in the water samples on at least 2 occasions during the examination periods are tabulated. 7 of the 27 species are α-meso and polysaprobiotic species. The data from the investigations confirm that below the main sewer inlet from the town, and the waste-water inlets from the cellulose and sugar factories, the river assumes an α-meso and polysaprobiotic character. Because of the toxic effect of the industrial waste-waters, the numbers of species and individuals among the Ciliata plankton are generally low.

Collection sites and examination methods

It is clear from the literature that the study of the pollution of natural surface waters is being increasingly supplemented by biological examinations. The practical importance of these latter arises from the recognition of the fact that the polluted or unpolluted nature of natural surface waters is indicated by the biological state of the waters.

In the biological examination of surface waters the quantity and quality of the indicator organisms are taken as basis for the demonstration and depicting of the pollution (HUSMANN 1948—49, KNÖPP 1954, LIEBMANN 1964). The frequencies of organisms of the same saprobity are determined at each of the collection sites. In this way numerical values are obtained to express the degree of each saprobia. With the aid of the numerical values, the extent of pollution of the water is plotted graphically by various methods. The pollution of the Danube was studied by a similar method by MUHITS (1955).

The experience of the present author has convinced him that the members of the Ciliata plankton react sensitively to changes in their environment. Since the Szolnok section of the Tisza serves as a classic example for the examination of the effects of various town waste-waters, the aim of this investigation was chosen to be the establishment of how and to what extent the town waste-waters affect the development of the Ciliata plankton in the Szolnok section of the Tisza.

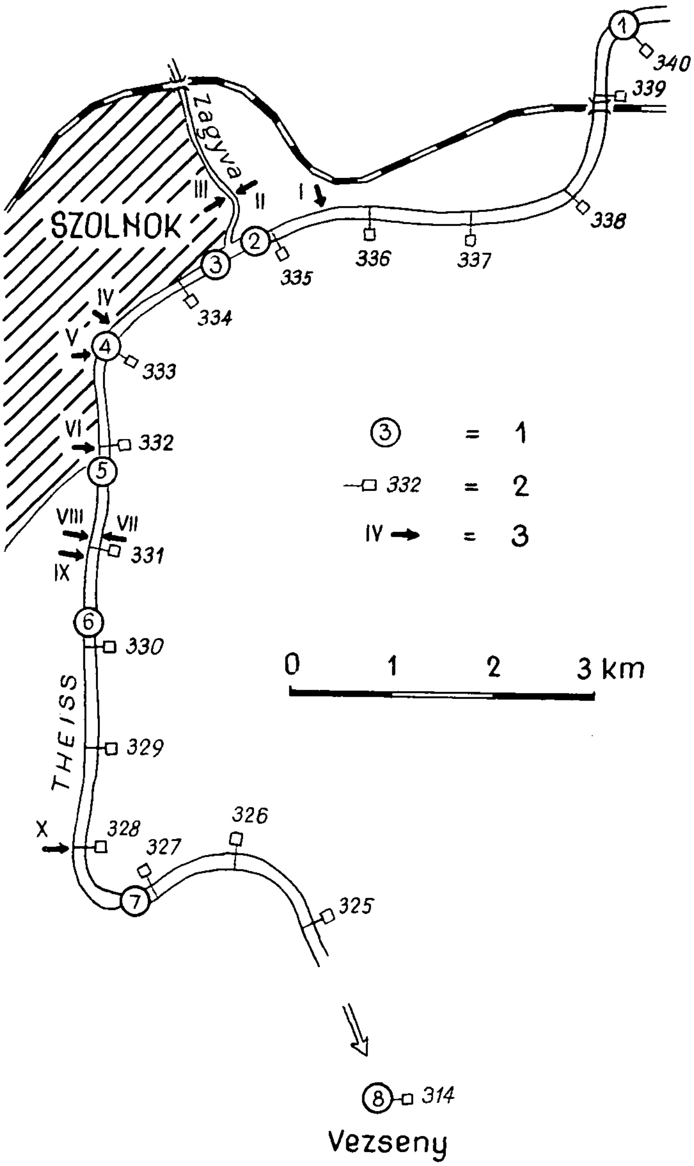

Fig. 1. Waste-water inlets into the Tisza at Szolnok
and the collection sites in the Szolnok section of the river.
1 = collection sites
2 = river km
3 = waste-water inlet sewer

In the interest of the study of the effect of the town waste-waters, the water samples were primarily taken below the waste-water inlets: at 334.5 river km, above the mouth of the Zagyva, at 334 river km, below the mouth of the Zagyva, at 333.5 river km, below the main town sewer inlet, at 332 river km, below the paper and cellulose factory waste-water inlet, at 331 river km, below the sugar factory waste-water inlet, and at 327 river km, below the chemical factory waste-water inlet. Water samples for control examinations were taken at 340 river km, 5 km above the town, and at 314 river km, 20 km below the town, at Vezseny. The town waste-water inlets and the collection sites are shown in Fig. 1. The water samples were mainly taken at distances of 5 and 10 m from the bank, for the Ciliata plankton tend to form associations close to the banks of the river. The plankton examinations were based on a total of 90 water samples: 36 were taken in 1958, 24 in 1962, and 30 in 1970. In every sampling a plankton net (no. 25) was used, and 100 litre water samples were filtered. For the study of the town pollution, water samples were mainly taken from the right bank. On the left bank, corresponding to the pollution collections were made above and below the mouth of the Zagyva and at 331 river km.

The individual species were determined on the basis of the book by KAHL (1935). The determinations involved the use of sublimate fixation, and the GELEI—HORVÁTH silvering, the PÁRDUCZ rapid staining, the BRESSLAU opal-blue and the FEULGEN nuclear staining microtechnique procedures. Vital observations were carried out to establish the nutrition of the Ciliata species. A BÜRKER chamber was used to examine the numbers of individuals in order to determine the frequencies of the individual species.

Considerable help is provided towards the biological study of the effects of town waste-waters by the data of water-chemical examinations. Unfortunately, water-chemical analyses relating to the industrial pollution from the individual factories have not yet been carried out. Chemical analytical data for the samples taken in 1962 above and below Szolnok and at Vezseny were provided by the Central Tisza Regional Water Board. Further, data were also available as published by the Water Division of the National Public Health Institute, relating to water-chemical analyses for the water above and below the mouth of the Zagyva and below the main town sewer inlet (PAPP 1961). The results of examinations carried out over the 10-year period are used to determine the minimum, average and maximum values.

Development of Ciliata plankton

The air temperature at the time of the examinations was 26—30 °C in 1958 and 1970, and 32 °C in 1962. On all occasions the weather was sunny. The water temperature was 18—22 °C in 1958, 23 °C in 1962, and 21 °C in 1970. The pH of the water was 7.4, 7.6 and 7.8. The height of the water was 166.

In the course of the examinations, only those species were taken into consideration which were present on at least 2 occasions in the examination periods. Species occurring on only 1 occasion and as only a few individuals were not taken into account. The species comprising the Ciliata plankton and the frequencies of the individual species are reported in Tables 1 and 2. The categories used to record the frequencies are as follows: 1 = 1—20 specimens (few); 2 = 20—50 individuals (appreciable); 3 = 50—100 individuals (many). The numbers of individuals refer to 100 litres of filtered water.

1. At 340 river km above the town the Ciliata plankton is very poor as regards the numbers of both species and individuals. Of the 4 Ciliata species observed, *Cinetochilum margaritaceum occurs* uniformly from the catharobe in waters of a polysaprobe nature. Chilodonella fluviatilis was found in clear-water sections of the Tisza (JÓSA 1962). A large degree of adaptation to the water saprobia conditions is also exhibited in the Hungarian section of the Tisza by *Cyclidium glaucoma* and *C. obliquum* (JÓSA 1962, 1963, 1964). In the bacterium-poor water, however, both species occur only in low numbers of individuals. The saprobia-endurance of the species and their low numbers of individuals point to unpolluted, clean water.

On the basis of the water-chemical examinations, the water of the Tisza arriving at Szolnok can be classified as of water-quality I above the town. The average number

Table 1. *Development of the Ciliata plankton in the Szolnok bed-section of the Tisza in 1958 and 1970*

	Water-sampling sites															
	340 r. km		Zagyva mouth above		Zagyva mouth below		333 r. km		332 r. km		330 r. km		327 r. km		314 r. km	
Trachelophyllum pusillum PERTHY – CLAP L.							2	2			1	1	–	2	–	2
Coleps hirtus NITZSCH			1	2	–	1	2	3			2	3	–	2	–	2
Chilodontopsis depressa PERTHY							–	2	2	–	2	2	1	–	2	–
Chilodontopsis vorax STOKES									3	2	2	–	2	2	2	3
Chilodonella capucina PENARD			2	3			–	2			2	2	2	2		
Chilodonella cucullulus O. F. MÜLLER			–	2			2	–	2	3						
Chilodonel'a fluviatilis STOKES	1	1														
Frontonia elliptica BEARDSLEY							–	2	3	2	1	–	–	1	2	2
Tetrahymena pyriformis EHRBG.							3	2			2	2				
Colpidium campylum STOKES			–	3			3	3	–	2	3	2	–	2	–	1
Colpidium colpoda STEIN			3	2			3	3	–	2	3	3	–	2	–	2
Cinetochilum margaritaceum PERTY	2	2	–	2			2	2	2	2	1	2	–	2	2	3
Lembus pusillus QUENNERSTEDT									–	2			2	–		
Cyclidium citrullus COHN			3	2			3	2			2	2				
Cyclidium glaucoma O. F. MÜLLER	2	1	3	3	2	–	3	2			2	2	–	2	2	2
Cycliùium obliquum KAHL	2	–					2	–	1	2	2	1	1	2	2	2
Cristigera setosa KAHL			–	2			2	3			2	3	2	3		
Halteria grandinella O. F. MÜLLER			2	2			–	2			2	2				
Blepharisma lateritium LEPSI							2	2								
Holosticha simplicis WANG – NIE			1	—	1	1									2	–
Stylonychia mytilus EHRBG.			–	2			2	3	3	2	2	2	–	2	1	2
Stylonychia pustulata EHRBG.			3	2			2	2	3	2	–	2				
Opisthotricha parallela ENG.			2	2							2	–				
Onychodromus grandis STEIN							2	2	3	2	–	1	–	2	2	2
Euplotes rotunda GELEI							2	1	–	2	–	1				
Aspidisca costata DUJARDIN			1	2			2	2	2	2	2	2			2	2
Vorticella convallaria LINNE – NOLAND			–	2			–	2					3	2	2	2
Number of species in 1958	4		10		2		17		10		18		7		11	
in 1970		3		15		2		20		13		18		14		13

of coli does not reach 10 per ml. A coli number below 10 in the case of surface waters means clean water. The mean value of the oxygen consumption is 4—6, and its maximum is 8—9 mg/l. The average value of BOI_5 (the biological oxygen-demand) is only 2 mg/l, while its maximum does not attain 4 mg/l either. The oxygen saturation in flowing waters classified as clean is 80—90%. In this section of the Tisza the average value of the oxygen saturation is 80% and its maximum is 100%. From a comparison of the data, it can be stated that the results of the water-chemical examinations confirm those of the biological examinations.

2. Directly above the mouth of the Zagyva up to 335 river km, the right bank of the Tisza is visibly polluted. In this section the Tisza flows through the town area. On the right bank 8000 m^3 of domestic waste-water flows daily into the Tisza from the Schefcsik settlement, together with waste-water from the Fishing Cooperative. On the left side the water of the Tisza is polluted from the town strand and the free strand. The number of Ciliata species in the water samples was 10 in 1958 and 14 in 1970. 70% of the species are bacteriophages. The appearance of a larger number of individuals of *Colpidium colpoda*, a poly and α-mesosaprobe indicator organism (KOLKWITZ 1950), demonstrates the richness of bacteria in the

Table 2. *Development of the Ciliata plankton in the Szolnok bed-section of the Tisza in 1962*

	Water-sampling sites							
	340 r. km	Zagyva mouth above	below	333 r. km	332 r. km	330 r. km	327 r. km	314 r. km
Lagynophrya halophila KAHL		2						
Coleps hirtus NITZSCH		2	1	2		2	1	
Chilodontopsis depressa PERTY			2			1		3
Chilodontopsis vorax STOKES						1	1	
Chilodonella capucina PENARD		2	1	1				
Colpidium campylum STOKES				2	2	1	1	
Colpidium colpoda STEIN				3		2		
Cinetochilum margaritaceum PERTY				3	2	2	2	
Loxocephalus ellipticus KAHL				2				2
Uronema elegans MAUPAS		2		2				
Lemboides rostrata KAHL				2	1			2
Cyclidium citrullus COHN		2		1				1
Cyclidium glaucoma O. F. MÜLLER		2	1				1	1
Cyclidium obliquum KAHL	1			2		1		
Cristigera setosa KAHL	1	2		2		2	2	
Halteria grandinella O. F. MÜLLER		2						
Stylonychia mytilus EHRBG.				2				1
Stylonychia pustulata EHRBG.		1			2	1		1
Euplotes rotunda GELEI					2			
Aspidisca costata DUJARDIN		2		1	1			
Number of species	2	10	4	13	6	9	6	7

water along the bank. Bacterial pollution is similarly indicated by the occurrence of Cyclidium citrullus, C. glaucoma and Stylonychia pustulata. The bulk of the species are α-mesosaprobe species. The populous species on the left bank (α-meso and polysaprobe) are *Claucoma scintillans, Colpidium campylum, C. colpoda* and Cyclidium citrullus.

It is clear from the data that the water of the Tisza directly above the mouth of the Zagyva exhibits bacterial and organic pollution.

3. As a result of the pollution above the mouth of the Zagyva and the contaminating effect to be expected from the tributary, it was assumed that rich and populous Ciliata plankton would be found below the mouth of the Zagyva. In fact, however, the examinations led to just the opposite result. In each of the 3 years only a few individuals from 1—2 species were found in samples taken below the confluence and 200 m downstream from the bridge.

Examinations below the mouth showed the average value of the coli number to be 30—40, while its maximum value exceeded 100 per ml. On the basis of the number of coli it would be justified to expect a more extensive spreading of the bacteriphage Ciliata species in this section of the river. Since Ciliata plankton fairly rich in bacteriophage species arrive in this bacterium-rich section of the river below the confluence, the disappearance of the Ciliata plankton in this region of the river is particularly striking. The explanation for the disappearance of the population is the chemical state of the tributary.

The data from examinations carried out below the mouth of the Zagyva are as follows: average oxygen-consumption 4 mg/l, maximum oxygen-consumption 12 mg/l, average BOI_5 value 6 mg/l. This means a water quality of grade II. Compared to the section above the mouth, the sulphate contamination is 100 mg/l higher, at 170 mg/l. The average and maximum values of the total dissolved solid constituent contents of the Tisza water above the mouth of the Zagyva are 100—200 and 200—400 mg/l, respectively, and below the mouth 200—300 and 300—600 mg/l, respectively. The total dissolved solid constituent content of the Tisza water below the mouth of the Zagyva is thus 200 mg/l on average more than above the mouth. This means that the osmotic value of the water of the main river changes essentially after the confluence with the tributary. The concentration change of as high as 50% can result in the destruction of the Ciliata plankton. The ciliated unicellular animals are very sensitive to the osmotic conditions and to fluctuations in the salt concentration of the water.

In the collection periods the water of the Zagyva was dirty, and a dark oil-green in colour. The water-bloom was caused by *Microcystis* and *Anabaena* species. Only a few individuals of 2—3 Ciliata species were found in water samples taken from the Zagyva.

4. The main sewer from the town discharges into the river at 333.7 km, in the vicinity of the Áron Gábor ship-yard. A Ciliata population consisting of 17—20 species was found in samples taken from the detritus-rich water at 333 river km (Table 1). One third of the Ciliata taxons occurring are α-meso and polysaprobe species. Only the bacteriophage species multiplied in the Ciliata plankton. The higher number of *Colpidium colpoda* individuals, a poly and α-mesosaprobe indicator organism, similarly shows that the water of the Tisza became of an α-mesosaprobe nature in this section.

The average number of coli was 40, and its maximum value was 200 individuals per litre. The sulphate contamination was reduced to 70 mg/l. The total dissolved solid constituent content of the river water was the same as the value below the mouth. The average BOI_5 value was 4, and its maximum was 8 mg/l. This means a water quality of grade III. The average value of the oxygen consumption was 4, and its maximum value was 14—15 mg/l. The values of the coli number, the oxygen consumption and the biochemical oxygen demand indicate the state of pollution of the river. The main sewer of the town delivers daily a total of 20,000 m^3 of waste-water into the river.

5. At 332.1 river km the waste-water from the Szolnok Paper and Cellulose Works enters the river, again in a daily quantity of 20,000 m^3. 100 m lover, 500 m^3 of effluent enters the river daily from the sewer of the abattoir. There is no purification plant in either of these works. Below the waste-water inlet from the cellulose factory the surface of the Tisza is covered by a yellowish, dirty, frothy scum. The number of Ciliata species in the water samples here is reduced to 10—12. The individuals of *Chilodontopsis depressa, Ch. vorax, Frontonia elliptica* and *Chilodonella cucullulus* fed here mainly on silicious algae. As a consequence of the pollution from the cellulose factory, therefore, a change occurs in the feeding conditions of the Ciliata plankton and, as a result, in the composition of the species too. The individuals of *Stylonychia mytilus*, otherwise a detritus and bacterium-eating species, were observed in these examinations to be feeding on diatoms too. Of the 10 Ciliata species found in the water samples, therefore, exactly half were species feeding on diatoms. Bacteriophage species were *Cinetochilum margaritaceum*, *Cyclidium obliquum* and *Aspidisca costata*. There was one predatory species: Onychodromus grandis. One species consumed detritus. The effect of the industrial pollution can be seen in the fact that, as a result of the frothy scum, the Ciliata plankton is relatively rich in the middle of the river too.

6. At 331.2 river km the waste-water from the hospital is discharged into the

river (500 m³ per day). Opposite the hospital waste-water inlet is that from the Tisza-liget holiday-camp. At 331 river km 25,000 m³ waste-water enters the river daily from the sugar factory. A comparatively high number of Ciliata plankton species were found in water samples taken at 330 river km. The dirty, frothy scum on the surface of the river forms huge patches and islands, 2—3 cm in thickness. These scum-islands are not dispersed even after floating for long distances downstream. 60% of the Ciliata plankton are bacteriophages, and 4 species consume detritus. 5 of the species are α-meso and polysaprobe species. Of these, *Colpidium campylum* and *Colpidium colpoda* occurred in appreciable numbers of individuals in the water samples. The number of individuals in the species is less than in the population arriving from upstream. The species composition of the Ciliata plankton is indicative of α-mesosaprobe water. Compared to the degree of saprobia of the water, the density of the individuals in the species is relatively low, i.e. they are rare. The low Ciliata plankton population indicates chemical pollution which has a harmful effect on Ciliata plankton, and may even be toxic.

7. At 328 river km the effluent from the chemical works is discharged into the Tisza. This comprises 40,000 m³ daily. Water samples were taken at 327 river km. The data from the examinations in 1958 and 1962 show that below the inlet from the chemical factory the Ciliata plankton in the river is diminished considerably as regards the numbers of both species and individuals. The Ciliata population is decreased to 7 species, 2 of which consume diatoms. *Vorticella convallaria* occurred in appreciable numbers only among the detritus. The diminishing of the Ciliata plankton was obviously caused by the sulphurous acid contamination. Richer Ciliata populations were found in the water samples taken in 1970. The plankton then consisted of 14 species, the bulk of these containing appreciable numbers of individuals. The cause of the change is that a neutralizing plant was installed to control the effluent from the chemical works in 1963.

8. 11—13 Ciliata species can be found in water samples taken at 314 river km below the town. The majority of these are β-mesosaprobe species. The self-purification of the river water is confirmed by the values of the oxygen saturation and BOI_5. At Vezseny these are 84—95% and 2.23—3.52 mg/l, respectively.

The salt concentration of the water of the Tisza at Vezseny is variable: the total dry-matter content fluctuates between 293 and 562 mg/l. The effects of the pollution from the cellulose and sugar factories can still observed in water samples taken at Vezseny.

Saprobiological analysis of the Ciliata plankton

The development of the number of Ciliata plankton species is depicted graphically in Fig. 2. If the development of the numbers of these species is compared with examinations of the plankton algae made in the Szolnok bed-section of the Tisza in 1960 and 1961 (UHERKOVICH 1962), it can be concluded that the microphytoplankton and the microzooplankton react in different ways to the effects of pollutants. The unpolluted river water provides ecological conditions favourable for the spreading of the plankton algae. Whereas the algal vegetation is rich in the pure river water, the reason for the very low Ciliata plankton population is to be found just in the purity of the river water. The bulk of the Ciliata species living in the Tisza are bacteriophages. It is natural, therefore, that the Ciliata species will appear and spread at those sites in the river where, because of the organic pollution, the

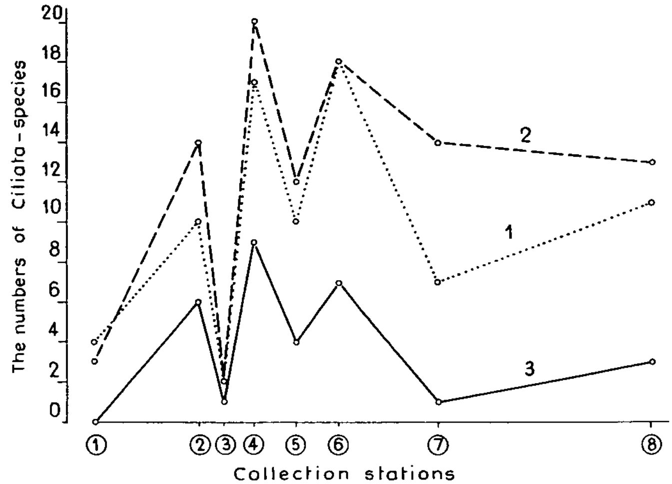

Fig. 2. Development of the numbers of Ciliata plankton species.
1 = results of study in 1958
2 = results of study in 1970
3 = α-meso and polysaprobe species

bacterial flora becomes rich and populous. The results of plankton examinations show that on the action of the town waste-waters the number of Ciliata plankton species is always higher, if other harmful effects do not influence the water of the river, than in unpolluted sections of the river. On the other hand, the town waste-water causes a significant decrease in the number of plankton algae taxons. From a comparison of the taxon numbers the conclusion may be drawn that, in contrast with a decrease in the number of plankton algae individuals, the number of Ciliata plankton species indicates the bacterial pollution of the river water in a positive manner. The increases in the curve depicting the number of species in Fig. 2 show that the number of Ciliata plankton species rises on the effect of the pollution from the town (at 335, 333 and 330 river km).

The development of the relations concerning the number of Ciliata plankton individuals, given in terms of the frequencies, is illustrated graphically in Figures 3 and 4. If the densities of the individuals of the species in each population are compared

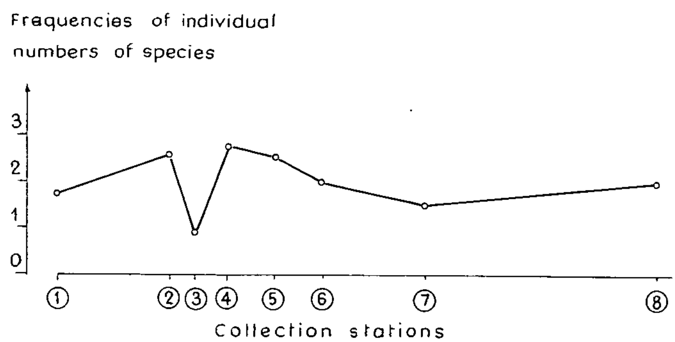

Fig. 3. Frequencies of Ciliata plankton species.

to the degree of saprobity of the biotope concerned, then it becomes clear that the number of individuals in the species is relatively low. The data of a number of foreign authors (BICK, WILBERT, etc.) and the investigations in the Danube by MAGDA BERECZKY indicate that with the increase of the temperature of the water there is a parallel tendency to decrease in the numbers of both the species and the individuals. A contribution towards the reduction of the species is also made by deleterious pollution of the river water. The comparatively low numbers of individuals in the species living in the Ciliata coenoses of the polluted bank sections draw attention to the fact that the chemical effects of the industrial pollutants can be toxic as regards the life in the water of the river.

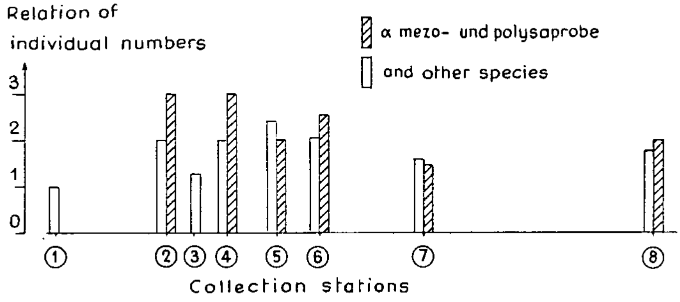

Fig. 4. Comparative graph showing frequencies of α-meso and polysaprobe, and other species at the collection sites.

According to water-chemical examinations, the water of the Tisza above Szolnok, below the main sewer of the town, and below the cellulose factory can be classified as of grades I, II and III, respectively. On the basis of the indicator organisms of the plankton algae associations, UHERKOVICH classifies the bank-side water below the cellulose, sugar and chemical works as of an α-mesosaprobe nature.

In order to be able to demonstrate the degree to which the town effluents affect the saprobe character of the bank-side water, saprobiological analysis of the members of the plankton is necessary. In the characterization of the saprobiological degree of the Ciliata species the findings of KOLKWITZ (1950) were given preference.

Of the Ciliata species, Colpidium colpoda is a species classified as an indicator organism (KOLKWITZ 1950). As a poly and α-mesosaprobe indicator organism, *Colpidium colpoda* appears and multiplies only in the polluted bank-side waters. Such areas are to be found in the Szolnok reaches of the Tisza in the section above the mouth of the Zagyva, and the sections below the inlets from the main sewer of the town and from the sugar factory. As a polysaprobe organism, Tetrahymena pyriformis similarly indicates the degree of pollution of the water. Based on the data of SLADECEK (1973) and other authors, this can also be regarded as an isosaprobe species. As a consequence of the pollution from the town, the following poly and α-mesosaprobe Ciliata species also appear among the Ciliata plankton of the Tisza: *Chilodonella cucullulus, Colpidium camylum, Cyclidium citrullus* and *Stylonychia pustulata.* The appearances of the α-meso and polysaprobe Ciliata species indicate that on the action of the waste-water from the main sewer of the town, the effluent of the sugar factory, and the contamination above the mouth of the Zagyva, the right and left banks of the Tisza become of an α-mesosaprobe character.

From an analysis of the species compositions of the individual Ciliata populations it can be stated that in these bank-side waters which have assumed an α-mesosaprobe character large numbers of β-mesosaprobe species also appear in addition to the α-meso and polysaprobe species. The author's saprobiological examinations in the Szeged reaches of the Tisza similarly confirmed that as a result of the waste-water from the sewers of the inner town and at Boszorkány Island the β-mesosaprobe Ciliata species too appeared en masse in the water which had become of α-meso and even polysaprobe nature (Jósa 1963).

Cinetochilum margaritaceum, Cyclidium glaucoma, Cyclidium obliquum and *Aspidisca costata* can be found at most of the collection sites. These are widespread species in the bed-section at Szolnok. They never multiply en masse, however, in parts of the bed-section with different saprobities. The widespread species are in general eurisaprobe species, such as *Cinetochilum margaritaceum*, for example. According to the investigations of Liebmann (1964), *Aspidisca costata* appears where the degree of β-mesosaprobity of the water undergoes a transition to the α-mesosaprobe grade.

The microfauna of the water of the Tisza at Szolnok was also studied by Gál (1963) in June 1962. In that period he did not find Ciliata species in the plankton above Szolnok, while its frequency below the town was practically insignificant.

Comparison of the Ciliata plankton with the Ciliata fauna of other biotopes

In addition to the Ciliata plankton, a study was also made of the Ciliata fauna living in algal coatings on bank-side stones, jetties and boats and in decaying matter floating in the river Tisza in its reaches at Szolnok. Only a few data are reported from this study, in the interest of comparison.

In an algal coating sample taken from the jetty of the boat-station at 333 river km, there was a Ciliata fauna rich in both species and numbers of individuals. The species-composition of this population was as follows: *Trachelophyllum pusillum* Perty-Clap. L., *Coleps hirtus* Nitzsch, *Hemiophrys fusidens* Kahl, *Loxophyllum helus* Stokes, *Lionotus fasciola* Ehrbg.—Wrzeseniowski, *Chilodontopsis vorax* Stokes, *Chilodonella cucullulus* O. F. Müller, *Paramecium caudatum* Ehrbg., *Glaucoma scintillans* Ehrbg., *Tetrahymena pyriformis* Ehrbg., *Colpidium campylum* Stokes, *Colpidium colpoda* Stein, *Cinetochilum margaritaceum* Perty, *Uronema marinum* Dujardin, *Cyclidium glaucoma* O. F. Müller, *Cyclidium obliquum* Kahl, *Cristigera setosa* Kahl, *Metopus fuscus* Kahl, *Metopus mucicula* Kahl, *Halteria grandinella* O. F. Müller, *Onychodromus grandis* Stein, *Euplotes charon* Müller and *Vorticella convallaria* Linné—Noland.

In scrapings taken from the surfaces of decaying matter and pieces of bark washed to the bank at 307 river km the Ciliata populations were very rich both in species and in numbers of individuals. The species occurring en masse were: *Paramecium caudatum* Ehrbg., *Colpidium campylum* Stokes, *Tetrahymena pyriformis* Ehrbg., *Glaucoma scintillans* Ehrbg., *Cyclidium glaucoma* O. F. Müller,. *Cyclidium obliquum* Kahl, *Lembus subulatus* Kent, *Metopus fastigatus* Kahl Species occurring in appreciable numbers of individuals were: *Trachelophyllum pusillum* Perthy—Clap. L., *Uronema marinum* Dujardin, *Stentor coeruleus* Ehrbg., *Oxytricha* sp. and *Euplotes charon* Müller.

In a sample taken from the muddy bank-side water rich in detritus at 340 river km, besides the many *Amoeba Cinetochilum margaritaceum* PERTY and *Cyclidium obliquum* KAHL were found with many individuals, and *Glaucoma scintillans* EHRBG., *Tetrahymena pyriformis* EHRBG., *Cristigera setosa* KAHL, *Metotopus fuscus* KAHL and *Euplotes patella* MÜLLER with appreciable numbers of individuals.

It is clear from a taxonomic analysis of the Ciliata fauna of the different biotopes that the Ciliata fauna living in the bank-side mud, in the algal coatings and on the decaying matter is richer than the Ciliata plankton. The Ciliata species find favourable feeding conditions in the bank-side mud of the unpolluted river-water at 340 river km, and in the water of a sapropel nature, and accordingly they multiply there. The β- and α-mesosaprobe species multiply en masse in the algal coatings at the inlet of the main sewer of the town. Rich and populous Ciliata populations can be found on the decaying matter washed to the bank below the effluent inlet from the chemical works. Here too the species include more poly and α-mesosaprobe Ciliata species. Populous Ciliata coenoses rich in numbers of species can similarly be found in the algal coatings on the sides of boats. Examinations of the various biotopes confirm that the main habitats of the Ciliata fauna in the Tisza consist of decaying matter, and the coatings on bank-side stones, jetties and boats. The population densities of these biotopes also show that these biotopes provide protection to the Ciliata plankton against the harmful action of pollutants.

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DATA ON THE HORIZONTAL AND VERTICAL DISTRIBUTIONS OF THE ZOOBENTHOS OF THE TISZA

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(Received 30 February 1974)

Abstract

From layer zoobenthic examinations at bank-side sites in the lower reaches of the Tisza it can be established that the bottom fauna is richest at a water depth of 1—2 m, and in the uppermost 10 cm layers of the clayey bottom. The decrease of the number of individuals among the fauna (at a water depth of 2—3 m) can probably be explained by the more unfavourable conditions developing in the current line. The decrease of the number of individuals is accompanied by the accumulation of the zoobenthic organisms in the uppermost bottom layers. In the deeper layers of the bottom, those Oligochaeta species predominate which live in the bottom of the deeper water, farther from the bank *(Tubifex tubifex, Psammoryctes moravicus)*.

Introduction

In both time and space the zoobenthic fauna is characterized by a constant quantitative and qualitative change. The concrete measurement of this population dynamics and the elucidation of the relations of cause and effect are promoted by the investigation of the vertical and horizontal distributions of the zoobenthos.

The Tisza, Hungary's second largest river, is from many respects a fairly extreme river. The variation of its water level, and consequently the play of its water, is the greatest. The transport of mud in its water is on a yearly average the most considerable in this river. Its mean mud content at Szeged is 560 g/m^3, compared with 130 g/m^3 in the Danube at Baja, while the highest mud contents are 3500 g/m^3 at Szeged, and 900 g/m^3 in the Danube at Baja. The high degree of alluvial transport, particularly in the event of flooding and high water level, is especially characteristic for the lower reaches of the Tisza (NAGY 1971). Naturally, the deposition of alluvium too is more extensive here, where the fall of the water level is only 4 cm/km. The rate of flow of the water at Szeged is 0.5—1.1 m/sec. In the Tisza the water generally falls in the months of August and September, and at the time of collection the water level was continuously negative, at -78 cm.

Naturally, the quantitative and qualitative distributions of the zoobenthic fauna of the rivers are influenced both directly and indirectly, to a large extent, by the hydrographic conditions.

Material and method

The collections were made on the left bank of the Tisza at 166.5 river km, on 6 September 1973; 6 sampling sites were involved, at 1 m intervals, in each of 2 parallel bands separated by a distance of 2 m, from the bank towards the river bed. The width of the river bed at this point was 250 m. The depths of the water near the bank were 0.35 and 0.60 m, and at the points farther from the bank 3 and 3.50 m. In the area examined the bottom was clayey, and the bank line was fairly steep. It was a typical argillorheophil biotope. (KORN 1963, SHADIN 1940, WACHS 1968).

The bottom samples were taken with a tube excavator, 16 cm in diameter (CSOKNYA—FERENCZ 1972), separated in 10 cm thick layers, and washed through a metal sieve with 0.28×0.28 mm apertures. After selection the material was fixed in 4% formalin and then determined.

The aim of this examination was to elucidate the quantitative and qualitative distributions of the mesozoobenthic organisms, and the changes of these distributions as functions of the depths of the water and the bottom.

Results

On the basis of our preliminary cross-sectional examinations it can be stated that there is a decrease of the zoobenthic fauna of the Tisza in the middle of the bed compared with the bank-side.

The present examinations indicate that the highest concentration of the benthic organisms live at a depth of 1—2 m, between the current-line and the bank-side. The most thinly-populated area is the shallower, bank-side part. This latter can probably be explained by the greatest exposure to the effects of fluctuation of the water level. The bottom fauna in the river visibly demands a certain depth of water, and thereby "insures itself" against the change of the water level, and accordingly it prefers to live at greater depths. After the decrease of the number of individuals inwards from the more densely populated sites at a depth of 1—2 m (the cause of which might be explicable by the negative effect of the current-line passing across this zone), their D value again rises, approaching the maximum value at a water depth of 3—4 m.

The maximum D value in the Oligochaeta distribution coincides with that for the overall data, but their number of individuals exhibits a strong decrease with the increase of the water depth.

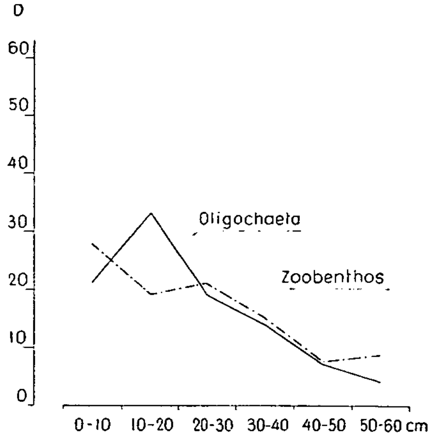

Fig. 1. Vertical distribution of zoobenthos

The highest concentration of zoobenthic organisms is to be found in the uppermost 10 cm layer of the bottom, and downwards from this there is a gradual decrease in the number of individuals. On the other hand, the Oligochaeta species predominate in the 10—20 cm layer of the bottom, and progressively decrease below this (Fig. 1).

If the mutual interrelations of the horizontal and vertical distributions are considered (Fig. 2), it can be established that in the sites farther from the bank

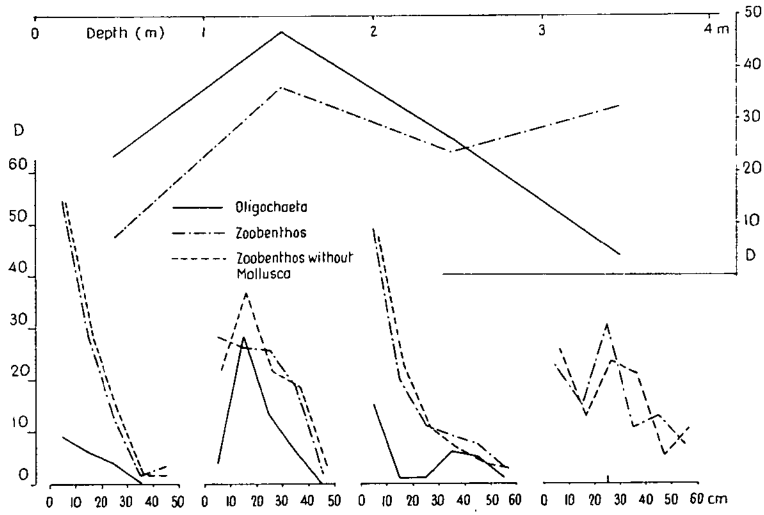

Fig. 2. Vertical and horizontal distributions of zoobenthos

and where the water is deeper the animals also penetrate down to greater depths in the bottom (50—60 cm). Their vertical distribution is more uniform, and there is a maximum concentration at a depth of 20—30 cm and in the bottom. In the shallower sites close to the bank the majority of the zoobenthic organisms live in the uppermost 10 cm layer of the bottom.

In the biotope examined the Oligochaeta comprised only a very small proportion (12%) of the total zoobenthic organisms (this is not characteristic of the Szeged reaches of the Tisza in general). More than half of the species belong to the *Limnodrilus* genus, as established earlier too (FERENCZ 1968).

As regards the vertical distribution of the Oligochaeta species (Fig. 3, a), the *Branchiura sowerbyi* live in the greatest number of individuals in the uppermost 10 cm layer of the bottom. This may be a consequence of the morphophysiological feature of this species that external gills are present at the end of the body. Although their living-tubes approach a length of 30 cm (the length of the individuals may be 10—15 cm), the gilled end of the animal's body protrudes from this. The data of our examinations to date indicate that this species favours a clayey-muddy bottom. Certain literature data suggest that it reacts sensitively to a deficiency of oxygen and to changes in temperature (LISKOVÀ 1964).

In the mud layer at a depth of 10—20 cm the Limnodrilus species predominate: *Limnodrilus hoffmeisteri, L. udekemianus, L. claparedeanus.* All three species, and particularly the first, ar common in the Tisza. In this biotope *L. udekemianus* was present in a relatively low number of individuals; this tends to multiply to the greatest extent in waters rich in detritus and containing much organic debris.

It is interesting to observe the almost parallel quantitative increases of the *Tubifex* and *Psammoryctes* species in the deeper bottom layers, and finally their absolute predominance at a bottom depth of 40—50 cm. *Tubifex tubifex* and *Psammoryctes moravicus* generally avoid the stronger water currents. The proportion

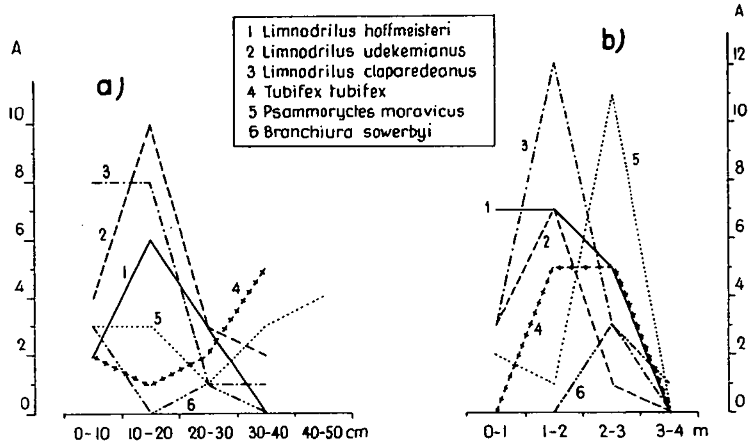

Fig. 3, a. Vertical distribution of Oligochaeta species
Fig. 3, b. Horizontal distribution of Oligochaeta species

of combined occurrence of the *Tubifex* and *Limnodrilus* species, and their relation to each other, are also influenced by the size of the granules of the bottom: in a bottom with finer granules (e.g. clayey) the *Limnodrilus* populations tend to predominate.

With regard to the horizontal distribution of the Oligochaeta species (Fig. 3,b), *Limnodrilus hoffmeisteri* appears to be the only species which lives in the highest number of individuals in the shallower bottom near to the bank, and decreases progressively towards the river bed. *Limnodrilus claparedeanus* and *L. udekemianus*

Table. *Overall abundance (A) values in the vertical distributions of the taxonomic groups of the zoobenthos*

	a	b	c	d	e	f	g	h	i	j
0—10 cm	37	29	—	8	56	—	89	56	28	1
10—20 cm	36	7	1	1	33	2	49	39	40	1
20—30 cm	28	9	—	—	13	—	73	29	19	1
30—40 cm	33	1	—	—	3	—	45	17	12	—
40—50 cm	18	2	—	—	—	—	1	16	5	—
50—60 cm	8	—	—	—	—	—	1	6	1	—

Explanation of symbols:

a = *Palingenia longicauda* larva
b = Chironomida larva
c = Ceratopogonida larva
d = Trichoptera larva
e = Amphipoda
f = Astacus sp. (juv.)
g = Gastropoda
h = Lamellibranchiata
i = Oligochaeta
j = Polychaeta

reach their maxima at a water depth of 1—2 m. *Tubifex tubifex* and *Psammoryctes moravicus* not only inhabit mainly the deeper layers of the bottom, but also favour the deeper water levels. *Branchiura sowerbyi* seems to be a species preferring deeper water: it finds conditions favourable for the satisfaction of its oxygen-demands in the surface layers of the bottom at a depth of 2—3 m in the current line.

It emerges from the overall A data in the Table that the *Palingenia* larvae in the main penetrate down to the deepest layers examined (50—60 cm) in the river--water deposit. As regards the Mollusca species, with regard to the fact that the data relating to the empty shells do not indicate conclusively that the animals reaches these places alive, besides the vertical distribution of the total zoobenthos in Fig. 2, a separate indication has been given of the quantitative data for the other taxonomic groups, with the exclusion of the Mollusca.

Of the other taxons, it is interesting to note the occurrence of *Hypania invalida* (Polychaeta), even though only in isolated examples, at a depth of 30 cm in the bottom.

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DATA ON THE DISTRIBUTION OF MAYFLY LARVAE (EPHEMEROPTERA)

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(Received 28 February 1974)

Abstract

The horizontal and vertical distributions of mayfly larvae in a special biotope are reported, and reference is made to the effects of the abiotic and biotic factors on the density.

Introduction

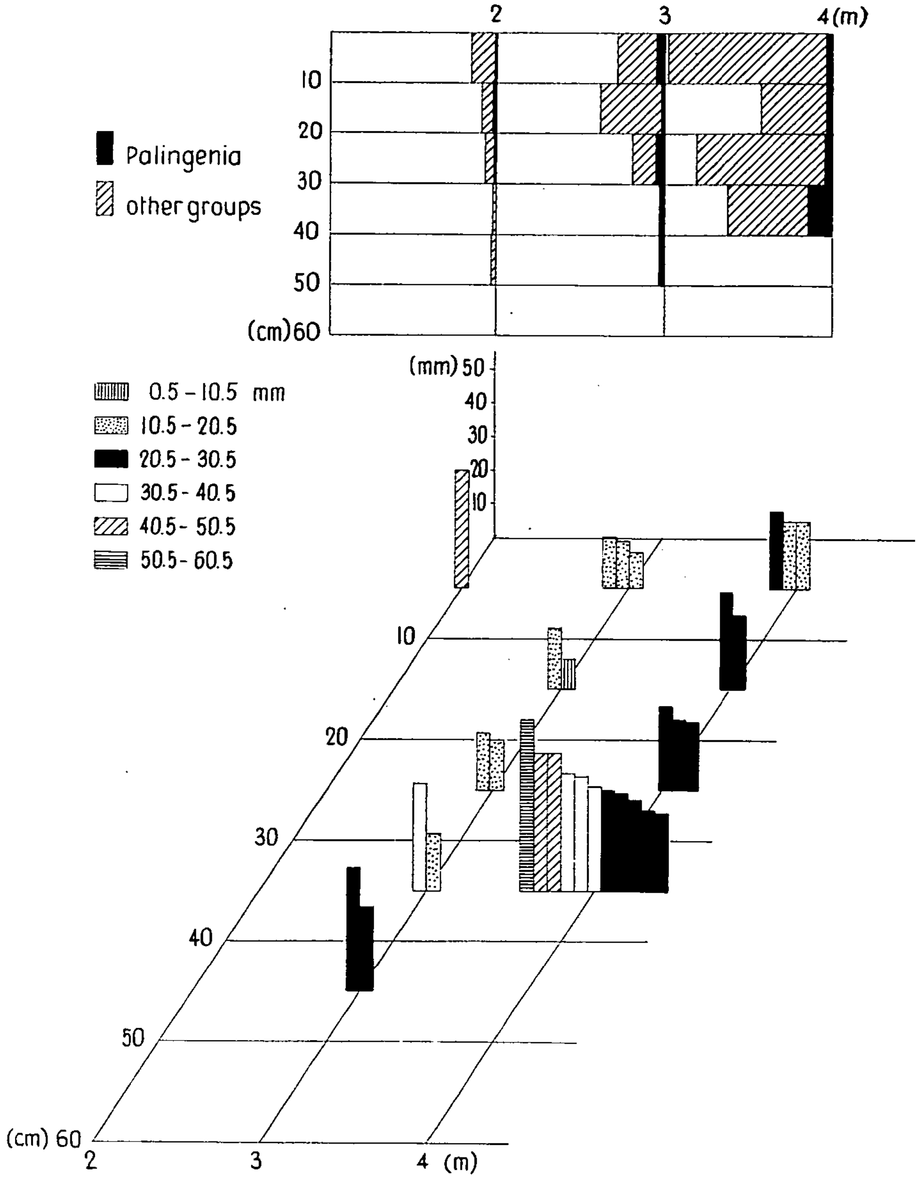
In recent years many new data have been provided by the zoobenthic study of the Hungarian section of the river Tisza (Beretzk et al. 1958, Csoknya et al. 1972, Ferenz 1968, 1969); these data are the results partly of faunistic, and partly of zoocoenological observations.

In the course of our researches on parts of this river with a definite bottom type (areas termed by us Palingenic biotope), the more important taxonomic groups were reported (Csoknya et al. 1972), and data were presented on the distribution ratios of mayfly larvae and other groups. Subsequently, the study of the relative density of the larvae and the variations in the movements of larvae of different ages was designated the primary task of our researches.

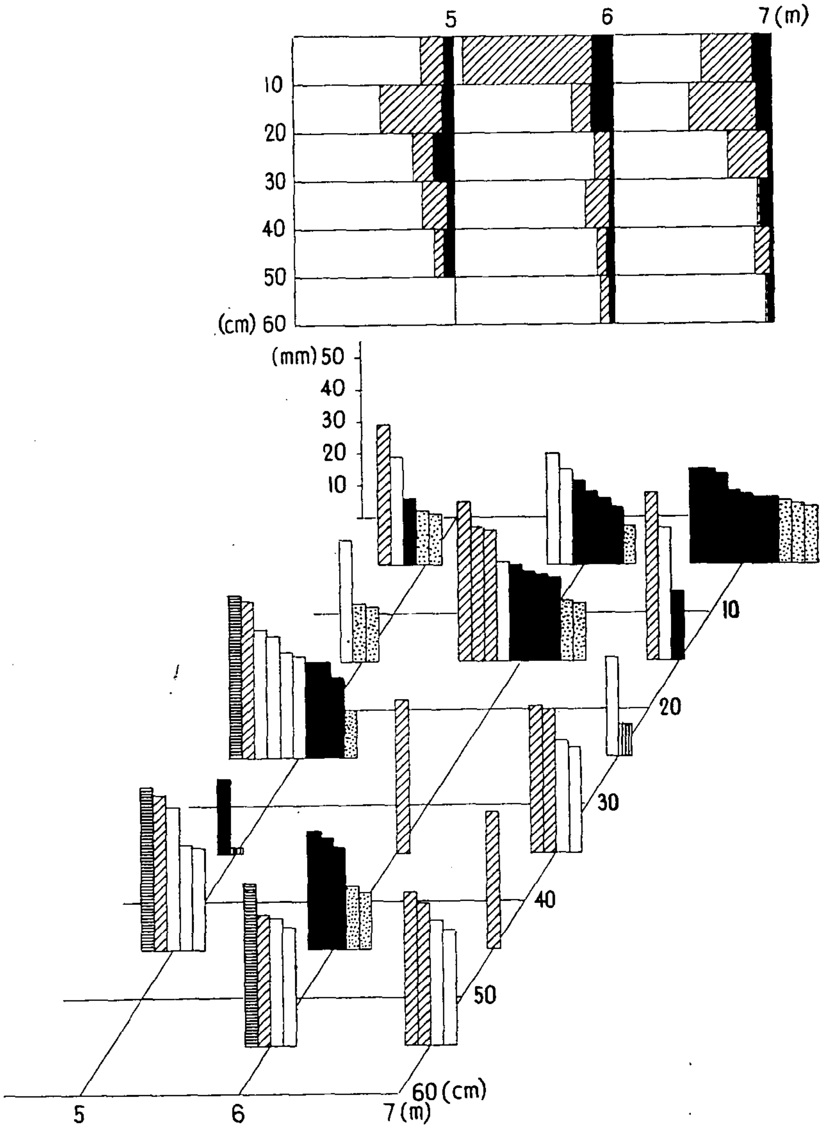
The aim of our preliminary study was to provide data on the horizontal and vertical distributions of these larvae by examining first a region where there had been no significant fluctuation of level of the water (rise or fall) for a long time, and the collection was performed well after the swarming of the last year's larvae.

Material and method

Our investigations were made on 6 October 1973 at 166.5 river km in the Tisza. The sampling apparatus was an iron cylinder 16 cm in diameter, which removed 12,000 cm^3 of mud on each occasion. The samples taken from the cylinder were divided up at 10 cm intervals, and then washed through a sieve with apertures 0.51 mm in diameter. The animals were separated according to taxonomic groups and fixed in 10% formalin. To obtain information on the horizontal distribution of the larvae too, samples were taken at one-metre intervals towards the river bed and were processed as above.



Histogram 1, a: Horizontal and vertical distributions of mayfly larvae and overall taxonomic groups.
(0.5 mm = 1 individual per 4000 cm^2;
m = distance in metres from the bank;
cm = mud depth in centimeters; mm = length of animals in millimetres)



Graph 1, b: Horizontal and vertical distributions of mayfly larvae of different sizes.

Results and discussion

As regards their more important taxonomic groups (Ephemeroptera, Oligochaeta, Polychaeta, Mollusca, Diptera, Trichoptera, Amphipoda), samples taken from the Palingenic biotope with characteristic bottom exhibit considerable agreement with the data observed in collections from similar biotopes at other sites in the Tisza and the Maros (CSOKNYA et al. 1972, FERENCZ et al. 1973). In the present case the Ephemeropterae were represented by the larvae of a single species, *Palingenia longicauda.*

The horizontal and vertical distributions of the sum of the larvae and other taxonomic groups are shown in the histogram 1, a, from which it emerges that the most uniform distribution of the zoobenthos is found 5 m from the bank towards the river bed, in the entire depth of the mud samples (60 cm). Up to 5 m from the bank the fauna is the richest in the 0—40 cm layers, while beyond 6 m it is richest in the uppermost 0—20 cm layers. This distribution (abundance values) holds not only for the overall fauna, but for the mayfly larvae too.

The dominance values are frequently given in the literature as percentage values referred to the biomass (SUKOP 1973). We did not carry out measurements of such a nature, but with regard to the tremendous extent of the larvae compared to other species it can be maintained that they do display such a dominance.

Besides the data referring to the numbers of the mayfly larvae in the samples, one may also examine their distribution according to development (the standard of development is taken as the length of the larvae). This distribution is shown in graph 1, b. It can be seen from the graph that in the region lying closer to the bank (3 m) the young larvae (0.5—20.5 mm) are distributed fairly uniformly in the mud samples. Between 3 and 7 m from the bank, however, they occur in the uppermost 20 cm layers. The largest larvae (40.5—60.5 mm) are more frequent 4—7 m from the bank, and predominantly in the lower mud layers (30—50 cm). Intermediate larvae (20.5—40.5 mm) exhibit uniform distribution in the examined region.

It is known that the movement of the benthic fauna in the mud, and hence their density too, are decisively affected by the abiotic factors (FERENCZ et al. 1973, LEHMKUHL et al. 1972, RADFORD et al. 1971, WAYNE—MINSHAL et al. 1969, ZELINKA 1969), the most important of them being the variation of the water level. With the change of this, the effects of the other abiotic factors (pollution, oxygen-supply, etc.) become more enhanced. This is particularly the case for mayfly larvae (CSOKNYA et al. 1972, FERENCZ et al. 1973). From the data of the present investigation it appears to be evident that the larvae in various stages of development found the most favourable abiotic factors at various depths of the benthos 5 m from the bank (water column height 2.2 m).

In addition to the abiotic factors, the biotic factors too naturally have a significant effect on the distribution of the larvae. The life-cycle must be mentioned above all here; this decreases the number of individuals considerably at the time of swarming (LANDA 1968). In the case of the mayfly larvae, the effect of predatory fish can not be neglected either (SUKOP 1973). The establishment of the efficiency of these latter factors will form a later task.

We consider the data of this paper as the basis for a comparative investigation in which a joint examination will be made of the effects of abiotic and biotic factors on the distribution of mayfly larvae.

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COMPARATIVE STUDY OF THE WATER-BUG (HYDROCORISAE) POPULATIONS OF A DEAD-ARM OF THE TISZA AND SOME SODIC WATERS

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(Received 15 February 1974)

Abstract

The paper deals with the material collected over two years (1970—71) from a dead-arm of the Tisza and from some sodic waters. The Hydrocorita fauna of the collection sites is reported, and the individual developments of the most commonly occurring species are discussed in relation to the changes in the environmental factors in the annual period. The Hydrocorita species occurring in fresh waters and in sodic waters are compared.

Material and method

Collections were carried out monthly from May 1970 to October 1971. The collection sites were the dead-arm of the Tisza at Mihálytelek; Lake Rókus; and Lake Fehér. All of these are in the area of Szeged. The samples were taken from the sediment (one sample at each collecting site) with a mud-scoop measuring 20×20×4 cm, i.e. with a volume of 4 dm³, and from the surface water layers (from among the vegetation and from the open water) with a water-net. These latter samples were obtained by filtering the water from 50 castings. The samples were taken from 5 different areas along the entire length of the dead-arm:

a) From shallow bank-side zones:

1. from svampy parts
   (Phragmites communis TRIN.*)*
2. from water suurounded in a semicircle by reeds
   (Ceratophyllum demersum L., *Lemna minor* L., *Potamogeton* sp., *Myriophyllum* sp.*)*
3. from submerged bank-side zones
   (Phragmites communis TRIN., *Typha angustifolia* L., *Carex* sp., *Polygonum amphibium* L., *Lysimachia nummularia* L.*)*
4. from vegetation-free shallow bank-side water.

b) From a boat, from greater water depths
(Myriophyllum sp., *Potamogeton* sp.*)*

For Lakes Fehér and Rókus, collections were made on one occasion each in spring, summer and autumn, exclusively from bank-side zones. The vegetation unvaryingly gave:

Phragmites communis TRIN., *Carex* sp., *Ceratophyllum demersum* L., *Potamogeton* sp., *Lemna minor* L.

The samples were taken from three different sites:

a) vegetation rich bank-side zones
b) water covered exclusively by reeds
c) vegetation-free shallow bank-side water.

On all occasions recordings were made of the exact collecting site, the temperature of the water, the water-depth, the pH, the weather conditions, and the time of day. The collected samples were washed in a fine cloth with 200 μm apertures, and preserved in 6% formalin.

Collecting sites

Dead-Tisza at Mihálytelek

The Dead-Tisza at Szeged is 9—11 km long, and lies in a semicircle to the south of the town. It is divided up into several parts, and from these collections were made in the Dead-Tisza at Mihálytelek, to the left of and parallel with the road leading to the frontier. The side nearer the road has a steep, clayley bank, while the opposite side is characterized by a gentle slope from the cultivated land down to the water surface. It has no connection with the Tisza, there is no sewage inlet, and it is richly stocked with fish.

The collections were made up to at most 4 m in from the bank. In this zone the water was 10—80 cm deep, and the mud was a characteristic black colour.

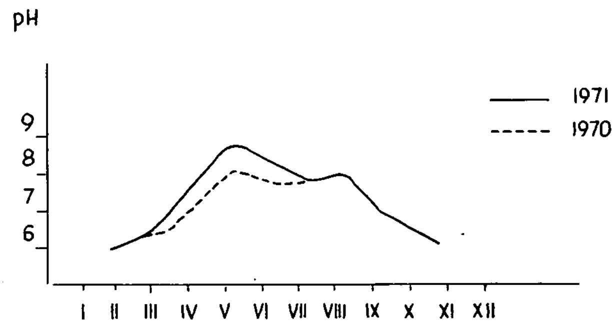

Fig. 1. Variations of the pH values in 1970—71.

The water contained sodium and magnesium carbonates and bicarbonates. Ions indicative of pollution could not be detected at all, or only in very small amounts: S^{2-} n.d.; NH_4^+ 0—3.0 mg/l; NO_2^- 0.02—0.2 mg/l. Oxygen consumption: 40—55 mg/l; dissolved oxygen content: 9—15 mg/l; percentage oxygen saturation: 100—130 %. These data refer to the period from May to September 1971. The course of the pH during the period of the investigations is shown in Fig. 1.

Sodic waters (Lake Rókus, Lake Fehér)

In parallel with the collections from the dead-arm of the Tisza, comparative examinations were also carried out of the Hydrocorita fauna in some sodic waters. The climatic conditions which predominate in these waters are completely different from those in the Dead-Tisza. They have shallow waters; there is an appreciable fluctuation of the water level; their average depth does not exceed 100 cm; and the sediment is extremely rich in decomposing organic matter.

Of the salts dissolved in the water the sodium salts (carbonate and bicarbonate) predominate. The course of the pH is extreme; in the event of a high water level (e.g. from May till August 1970) it was at most 8—8.5, while for a low water level in the same period it even attained a value of 10.

The organic-matter production of the small water mass is considerable in the early spring, summer and autumn months. The intensive processes of decomposition of the organic matter at the time indicated may easily swing over from the oxidative aerobic stage to a reductive anaerobic stage; the effect of this on the life in the lake may be accompanied by serious consequences (BERCZIK 1962, VÁMOS—ZSOLT—RYBIÁNSZKI 1963).

Discussion of the material collected

The species detected were the following:

Mesovelia furicata MULS & REY
Naucoris cimicoides L.
Plea Leachi MCGREG. & KIRK
Cymatia coleoptrata FABR.
Cymatia Rogenhoferi FIEB
Sigara lateralis LEACH
Sigara striata L.
Sigara falleni FIEB
Corixa affinis LEACH
Hesperocorixa Linnei FIEB
Micronecta meridionalis COSTA
Notonecta glauca L.
Gerris sp. (Geocorisae subordo)
Nepa cinerea L.
Ranatra linearis L.
Hydrometra gracilenta HORV.

From a comparison of the present results with those obtained by CSONGOR (1958) in a study of the dead-arms in the reaches of the Tisza between Szolnok and Csongrád, it can be established that there is a considerable degree of similarity in the dominant species:

Naucoris cimicoides L.
Plea Leachi MCGREG. & KIRK
Sigara lateralis LEACH (less so)

while the frequencies of

Micronecta meridionalis COSTA
Notonecta glauca L.
Gerris sp.

as found in the material collected from the Dead-Tisza at Mihálytelek are much lower.

The material from Lakes Rókus and Fehér contains mainly the Corixidae species:

Sigara lateralis LEACH
Sigara striata L.
Sigara falleni FIEB
Corixa affinis LEACH
Hesperocorixa Linnei FIEB
Cymatia Rogenhoferi FIEB
Micronecta meridionalis COSTA

The other species occurred only in extremely low numbers of individuals, but in 1970 the extreme climatic condition characteristic of these sodic areas were changed as a consequence of the unusually high water level, and the following non--dominant species were also collected in high numbers of individuals:

Naucoris cimicoides L.
Notonecta glauca L.
Ranatra linearis L.

Comparison of the fauna from the sodic waters with that from the Dead-Tisza at Mihálytelek shows that the Corixidae species predominate in the sodic waters, while other species, which are predominant in the dead-arm of the Tisza, are very much rarer. It is striking, however, that *Sigara lateralis* is predominant in both types.

In the course of the collections during the two years, the times of appearance of the larvae and imagos of the individual species were recorded, as were the times of their mass-occurrence and their recession. The results are summarized in groups as shown in Fig. 2—4.

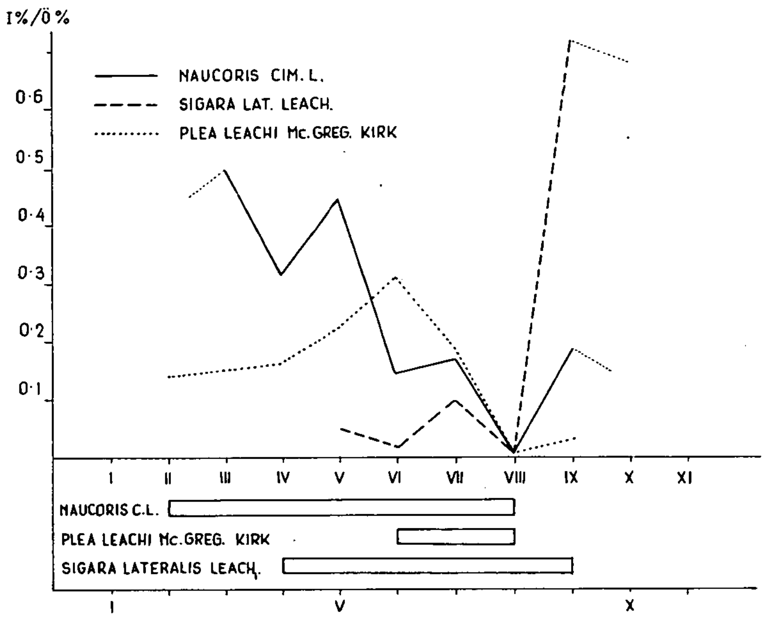

Fig. 2. Developmental rhythms of *Naucoris cimicoides,* L., *Sigara lateralis* LEACH and *Plea Leachi* McGREG. & KIRK, as a function of the quotient of the imago % and the total bug %, supplemented with the collection cycle of the larvae of the species (1970—71).

In spring it is primarily the predatory species less sensitive to the fluctuations in temperature of the water which appear (*Naucoris cimicoides* L., *Notonecta glauca* L., *Gerris* sp., *Sigara striata* (phytophagous) L.). The breeding of these species takes place in the early spring months (e.g. *Notonecta* gl., *Gerris* sp., *Sigara* str.), or lasts from early spring until the middle of summer (e.g. *Naucoris* cim.). At oviposition the females of these species seek out the vegetation-rich sites. The

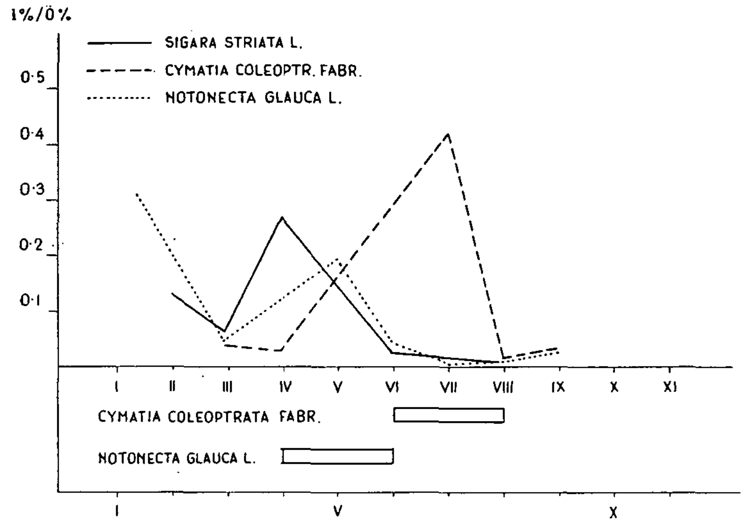

Fig. 3. Developmental rhythms of *Sigara striata* L., *Notonecta glauca* L. and *Cymatia coleoptrata* FABR. as a function of the quotient of the imago % and the total bug %, supplemented with the collection cycle of the larvae of these species (1970—71).

ova are laid into the stems and leaves of the plants *(Naucoris cim., Notonecta gl.)* or on the surfaces of the stems and leaves *(Sigara str., Gerris* sp.).

Different behaviour is exhibited by the similarly predatory *Nepa cinerea* L. and *Ranatra linearis* L., the developmental conditions too of which differ. The

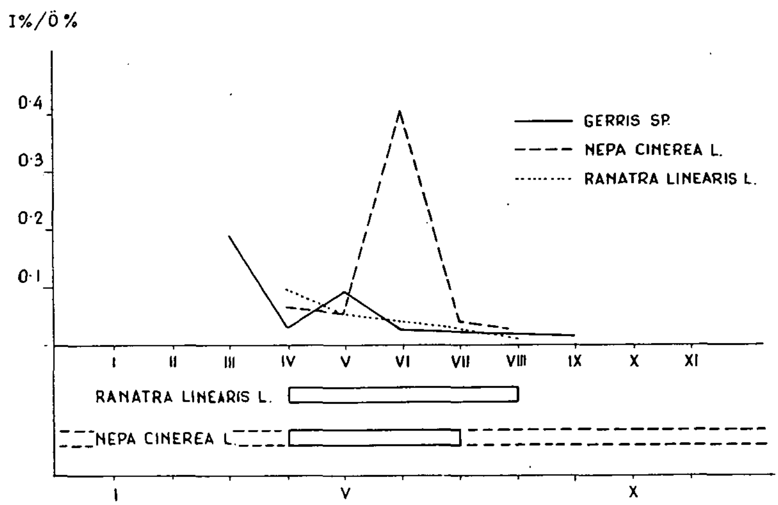

Fig. 4. Developmental rhythms of *Gerris* sp., *Nepa cinerea* L. and *Ranatra linearis* L. as a function of the quotient of the imago % and the total bug %, supplemented with the collection cycle of the larvae of these species (1970—71)

breeding period of *Nepa cinerea* L. lasts from September until July of the following year, but its ova are deposited only from early spring until the middle of summer, similarly to *Ranatra linearis*. In displaying this long breeding period, *Nepa cinerea* L. is unique among the water-bugs. The larval stage of *Nepa cinerea* L. is long, and the undeveloped larvae hibernate. For *Ranatra linearis* the breeding period is shorter (May—July), and specimens hibernating in the larval stage were not found.

By the end of May and in June the water gradually becomes warmer, its temperature becomes nearly constant, and the production of organic matter is accelerated. The conditions emerge for the development of water-bugs requiring more steady water temperature, which are primarily phytophagous (e.g. *Sigara lateralis* LEACH, *Cymatia coleoptrata* FABR., *Plea Leachi* MCGREG. & KIRK (only partially phytophagous)).

It was striking that larvae and imagos of practically every species were collected in general 4—5 weeks earlier than would be expected from the literature data. It may be assumed that the favourable climatic conditions necessary for their development were already given earlier.

In subsequent investigations it is necessary to learn the connection between the environment and developmental stages of this group of animals, and also their nutritional biology. Research must be made into the complex effects of the biotic and abiotic factors controlling the limits of their extents, which may presumably be completely different from species to species.

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QUANTITATIVE AND QUALITATIVE STUDY OF CHIRONOMIDA LARVAE ON THE SECTION OF THE TISZA BETWEEN TISZAFÜRED AND KISKÖRE

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Abstract

With the construction of the second series of locks on the Tisza, a lake will develop on a section of the river about 45 km long above the dam. The changes arising in this section compared to the previous state will influence the organisms living here.

In order to record the initial state and the changes, the author began in 1970 a quantitative and qualitative study of the mud-inhabiting Chironomida species in the section of the river Tisza between Tiszafüred and Kisköre, and in the dead-arm of the Tisza beside the strand at Tiszafüred.

20 samples each were taken from the Tisza at Kisköre and at Tiszaörvény, and 10 samples each from the Kistisza and from the dead-arm at Tiszafüred.

The processing of the material revealed that of the total of 60 samples only 22 contained larvae. In all, 46 larvae individuals were found in the samples, these belonging to 11 species. The bottom fauna of the dead-arm is very poor. The single dominant species in the Tisza is *Polypedilum nubeculosum* MEIG., which provided 30% of all the larvae. In spite of the fact that for the whole of 1971 the river was in its bed, the species characteristic of standing water comprised 67% of the total larva population in the section of the river examined.

Introduction

In order to be able to follow the changes in the life of the water-basin forming in this section of the river after the construction of the dam at Kisköre, it is necessary to obtain the present faunistic and floristic picture. Within the Tisza Research Working Group, several specialist groups have been formed to study this area.

The author undertook to discover the situation relating to the Chironomidae by quantitative and qualitative surveys of the zoobenthos. Such a study of the Chironomidae is considered of importance in this section of the Tisza, not only because changes will take place there within a few years and there will be not possibility later for the investigations, but also because, in contrast with the Danube, studies of the Chironomida population of the Tisza have not yet been carried out in Hungary. The study of the Chironomida fauna of the Tisza was begun in 1970, and the accomplishment of this is the main aim up to the commencement of the dam.

The data reported are thus the first data from work already begun, but planned to last for several years.

Material and method

Mud samples were taken on both the right and left banks of the Tisza, about 300 m north of the 405 river km mark, in the vicinity of Kisköre, and from the Kistisza along the right bank at lock-keeper's house no. 404. Further samples were taken from the Tisza, about 200 m north of the 428 river km, mark, on both banks at the Tiszaörvény ferry and also from the dead-arm at Tiszafüred. Sampling was performed on 18—19 June 1971. The samples were taken 4—5 m from the edge of the water-covered bed. 10 samples were collected from each sampling site, at 10 m intervals from one another. This means that data were obtained for 100 m stretches, on the basis of the principle of chance.

The reason why samples were taken 4—6 m in towards the middle of the river or dead-arm from the edge of the water-covered bed, was that in this way the sampling sites would not be such that they had not been covered by water weeks or months before and thus not inhabited by fauna.

On the day prior to the first sampling the Tisza began to flood, and the water level rose 40 cm.

The mud samples were taken with a semi-automatic mud-scoop. In form this was a regular cylinder; its diameter was 84 mm and its height 425 mm. The cross-sectional area was thus 55.4 cm^2.

The sampling yielded the following numbers of samples: from the Tisza at Kisköre: 20; from the Tisza at Tiszaörvény: 20 (i.e. a total of 40 samples from the Tisza); from the Kistisza: 10; and from the dead-arm at Tiszafüred: 10. Thus, a total of 60 samples were collected on the two days. After the completion of each day's collecting, these were washed through a sieve-series. The animals thereby collected were preserved in 10% formalin. The separation of the individual taxonomic groups was performed in Attila József University, Szeged.

The Chironomida species collected and determined from this area are listed in Table 1, together with the numbers of individuals.

Results and conclusions

It is striking that there were no Chironomida larvae in a significant proportion of the samples. For purposes of clarity the empty samples too have been given in the Table.

It is also clear that in comparison with the number of samples the total number of larvae is also very small: only 46. These are distributed among 11 species. Some species are found to be represented by only a single larva.

The single dominant species in the Tisza was *Polypedilum nubeculosum* MEIG. This gave 30% of the total larva population, although in the Kistisza a *Trissocladius* sp. attained 36.5%.

Because of their immaturity, they can be determined only according to genus.

The samples indicate that the larva population in the dead-arm is poorer than those in the Tisza and Kistisza. One cause of this is undoubtedly the deep mud in the dead-arm, for the oxidation processes take place only on the surface of this. The surface to a depth of 2—3 cm is brown, but at greater depths it is the steel-blue characteristic of the formation of hydrogen sulphide. It is well-known (BERCZIK 1962) that the larvae flee from the hydrogen sulphide into the higher, hydrogen sulphide-free layers; if this is impossible, they die.

There are two common species in the Tisza and the Kistisza: *Trichocladius distylus* K. and *Polypedilum nubeculosum* MEIG. Although these are species typically characteristic of standing waters, nevertheless their larvae were not found in the dead-arm. The dead-arm is characterized (though by only a single specimen) by *Chironomus halophilus* K. The same can not be said either for the species found in the Tisza, or for the majority of those found in the Kistisza. Of these latter species, in effect only three are exclusively standing-water ones:

the *Thienemanniola* species have so far been found only in springs, brooks and rivers;

some species of the *Trissocladius* genus are also known from standing waters.

The species found here, however, will without doubt be some running-water species.

The *Pseudochironomus* species live in slow-running waters and are predatory.

According to both the foreign (THIENEMANN 1944, 1945, ALBU 1966) and the Hungarian (BERCZIK 1966) literature, the other species are characteristic of standing water.

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ODONATA FAUNA OF THE AREA OF THE SECOND SERIES OF LOCKS ON THE TISZA

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(Received 20 February 1974)

Abstract

Since 1966 the author has been carrying out entomological researches in the inundation area of the Tisza between Tiszabábolna and Kisköre. Up till 1973, besides the Dipterae primarily the Odonata fauna was collected. The present paper ettempts to provide a picture of the fauna of this area by means of processing and evaluating 3800 dragonfly specimens collected during the 8 years. The 41 species detected represent 68% of the Hungarian fauna. However, if the species from the hilly and mountain districts are disregarded, then this value changes to about 86%.

Introduction

The Odanata fauna in Hungary can be said to be comparatively well explored, but nevertheless, from an odonatological aspect, some white spots can still be found, primarily on the Great Hungarian Plain. This is very clearly shown by maps illustrating the extents of Hungarian dragonfly species (STEINMANN 1959). The present paper reports the results of investigations in such a less well-studied area, the area of the second series of locks in a small part of the central reaches of the Tisza.

Very little work has been done on the Odonata fauna of the Tisza valley. Only scattered data are to be found in a few publications (ZILAHI-S 1961, STEINMANN 1962, TÓTH 1972). To the best knowledge of the author, there is only one work dealing exclusively woth the fauna of this area (TÓTH 1966). This latter reports data from the areas of Vásárosnamény, Tokaj, Tiszapalkonya, Oszlár, Tiszatarján and Szeged.

Examination of the literature data available revealed data only from Tiszafüred (13 species) and Tiszaderzs (1 species!). Accordingly, in the period from 1966 to 1973 the Odonata material collected provides almost entirely new data on the dragonfly fauna from this area. The region examined, from Kisköre to Tiszabábolna, but predominantly between Kisköre and Tiszafüred, is not a large one relatively, but it contains a very large number of aquatic biotopes, and therefore its Odonata fauna is richer than the average.

The number of Odonata species detected in Hungary is exactly 60. Of these, 10—12 live exclusively in hilly and mountain districts. If this is taken into consideration, then it can be stated that the 41 species discovered so far in this area roughly represent the entire fauna of the second series of locks on the Tisza.

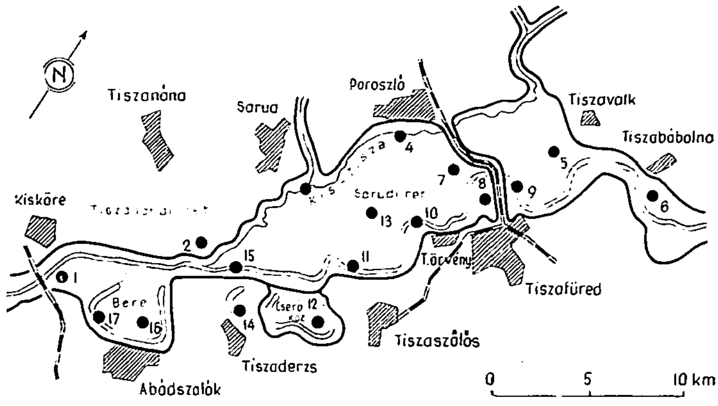

Fig. 1. Area of second series of locks on the Tisza, showing the more important collecting sites.

The blacks circles on the sketch map of the area indicate the more important collecting sites. The majority of these areas 1—2 km in diameter. Further detail would perhaps not be justified, since the majority of the dragonflies are fairly mobile. It would also be fairly difficult to denominate the individual points more precisely. Since the sketch map does not give the names of all of the collecting sites, these are listed separately here:

1. Tisza inundation area at Kisköre
2. Meadow at Tiszanána
3. Kis-Tisza at Sarud
4. Kis-Tisza at Poroszló
5. Tisza inundation area at Tiszavalk
6. Tisza inundation area at Tiszabábolna
7. Tisza inundation area at Tiszafüred
8. Dead-Tisza at Tiszafüred
9. Tisza at Tiszafüred
10. Tisza inundation area at Tiszaörvény
11. Tisza at Tiszaszőlős
12. Cserőköz
13. Meadow at Sarud
14. Dead-arm ("Canal") at Tiszaderzs
15. Tisza at Tiszaderzs
16. Bere
17. Dead-Tisza at Abádszalók

The limited extent of this publication does not permit a detailed account of the faunistic data relating to the large amount of material. The collection times, divided up into 10-day periods, are shown simply in one Table. From this a good picture can be obtained for some the species as regards the times of swarming too.

Dominance relations

Very little research has been carried out into the quantitative dominance relations involving the Odonatae in Hungary. Only a few part-results have been obtained in this field.

In the course of the collections, 3800 Odonata specimens were caught and determined. The total number of samples is distributed very unevenly among the individual species. Accordingly, it appeared advisable to deal with the dominance relations. The data refer overall to the entire collecting season. Examination of the individual months would clearly show a different picture. Ischnura elegans elegans Van der Linden, for example, which comprises 30% of the material, is no longer the predominant species in the autumn months, although it can still be caught in lower numbers in September.

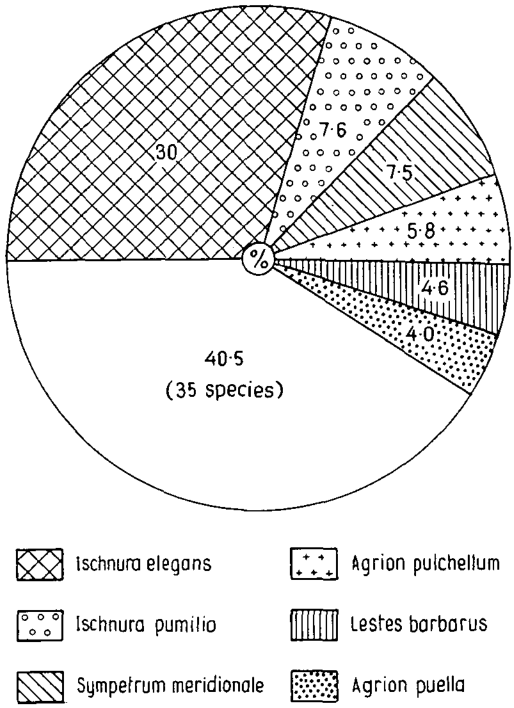

Fig. 2. Dominance relations of most frequent species.

The 6 species each comprising more than 3% of the material are depicted on the circular diagram of Fig. 2. The residual 40.5% is distributed among the other 35 species. The proportions of 15 of these are above 1%. The rarest species, making up only 0.1% of the material, are *Anax imperator imperator* LEACH, *Anax parthenope parthenope* SELYS, and *Lencorrhinia pectoralis* CHARP. Of course, this does not mean that these are necessarily the most rarely occurring species in this area. It must be remembered that these animals are excellent fliers, and extremely difficult to catch.

In recent years the Odonata fauna of the Dead-Tisza at Oszlár was also processed (TÓTH 1972), and thus there is a possibility for the comparison of the faunas of the area of the second lock-series on the Tisza and the Dead-Tisza at Oszlár. Taking into consideration that this area is substantially smaller, but possesses similar features (Dead-Tisza, at Oszlár, sand-pits, Hejő, brook, living Tisza), the similarity is considerable. Nevertheless, there are some differences, mainly as regards the dominance relations, for which it is difficult to find a satisfactory answer. This

Table 1. *Some of the more important data relating to the Odonata*

No.	Species	Months V. 10-day period 2.	V. 3.	VI. 1.	VI. 2.	VI. 3.	VII. 1.	VII. 2.	VII. 3.
1.	*Platycnemis p. pennipes* PALLAS	■	○	□	■	□	□		□
2.	*Agrion (Coenagrion) ornatum* SELYS	□		□	□	□		□	
3.	*Agrion (Coenagrion) p. puella* LINNÉ	□	■	□			○	□	□
4.	*Agrion (C) p. pulchellum* VAN DER L.		○		□	□	□	□	□
5.	*Pyrrhosoma nymphula* SULZER				□				
6.	*Erythromma viridulum* CHARPENTIER				□	□	□		
7.	*Ischnura e. elegans* VAN DER LINDEN	○	■	□	□	□	■		□
8.	*Ischnura pumilio* CHARPENTIER	○	■	□	□	□			□
9.	*Enallagma c. cyathigerum* CHARPENTIER		□	□			■	□	□
10.	*Sympecna fusca* VAN DER LINDEN	□	■	□	□	□	□		□
11.	*Lestes barbarus* FABRICIUS	○			□	□	■	□	□
12.	*Lestes dryas* KIRBY					□	□	□	
13.	*Lestes macrostigma* EVERSMANN				□	□			□
14.	*Lestes sponsa sponsa* HANSEMANN		○			□	□	□	
15.	*Lestes virens vestalis* RAMBUR							□	□
16.	*Lestes v. viridis* VAN DER LINDEN								
17.	*Calopteryx (Agrion) s. splendens* HARR.	○	○	□	□		□	□	□
18.	*Gomphus v. vulgatissimus* LINNÉ		○		□	□			
19.	*Gomphus flavipes* CHARPENTIER		○	■	□			□	
20.	*Brachytron hafniense* MÜLLER		□	□	□				□
21.	*Aeschna affinis* VAN DER LINDEN		○		□	□		□	
22.	*Aeschna mixta* LATREILLE		○						
23.	*Anaciaeschna i. isosceles* MÜLLER		□	□	□				
24.	*Anax imperator imperator* LEACH						□	□	
25.	*Anax parthenope parthenope* SELYS	○		□					
26.	*Cordulia aenea aenea* LINNÉ	□	□				□		
27.	*Somatochlora flavomaculata* VAN DER L.		□	□	□			□	
28.	*Libellula depressa* LINNÉ	○	□	□		□	■	□	
29.	*Libellula fulva fulva* MÜLLER	○	□		□	□			
30.	*Libellula q. quadrimaculata* LINNÉ	■	□		■	□	□	□	
31.	*Orthetrum b. brunneum* FONSCOLOMBE			□	■				
32.	*Orthetrum c. cancellatum* LINNÉ					□	□	□	
33.	*Orthetrum c. coerulescens* FABIRCIUS		○	□	■		□	□	
34.	*Crocothemis e. erythraea* BRULLÉ								
35.	*Sympetrum depressiusculum* SELYS							□	□
36.	*Sympetrum f. flaveolum* LINNÉ		○	○			□	□	□
37.	*Sympetrum meridionale* SELYS	○	○					□	□
38.	*Sympetrum s. sanquineum* MÜLLER		○					□	
39.	*Sympetrum s. striolatum* CHARPENTIER								
40.	*Sympetrum vulgatum vulgatum* LINNÉ		○					□	□
41.	*Leucorrhinia pectoralis* CHARPENTIER				□				

Explanation of symbols
□ = imago
○ = larva
■ = imago + larva
ÉT = Bank of Living Tisza
HK = Dead-arms, sand-pits
KT = Kis-Tisza
KV = Smaller water courses, ditches
RL = Meadow, pasture
L = Grove-wood

species collected in the area of the second series of locks on the Tisza

Months								Proportion, %	Conditions of occurrence in more important biotopes
VIII.			IX.			X.			
of month									
1.	2.	3.	1.	2.	3.	1.	2.		
	□	□	□					2,9	HK KT KV L
								0,6	HK KT KV RL L
□				□				4,0	HK KV RL
□		□						5,8	HK KT KV RL L
								0,2	KV
	□							0,9	HK L
□	□	□	□		○	○		30,0	ÉT HK KT KV RL L
□				□		○		7,6	ÉT HK KT KV RL L
			□			○		2,7	HK KT KV RL
□	□	□	□	□	□	□	□	2,0	ÉT HK KT KV RL L
			□	□	□			4,6	ÉT HK KT KV RL L
□	□							0,9	HK KT RL L
								0,2	HK RL
	□	□						1,3	ÉT HK KT KV RL L
		□						2,0	ÉT HK KT KV RL L
	□	□						0,2	HK KV
	□	□						2,9	ÉT HK KT KV RL L
								0,6	ÉT HK KV
								0,7	ÉT
								1,0	HK KT KV
		□						1,2	ÉT HK KT L
	□	■	□					0,5	HK L
								0,6	HK KT
								0,1	HK
								0,1	HK
								0,5	ÉT HK KT KV L
								0,6	HK
								2,3	ÉT HK KT KV RL L
								0,6	HK KT KV
								1,3	ÉT HK KT KV L
	□	□						0,8	ÉT HK RL
□								1,0	ÉT HK KT KV RL L
								1,3	ÉT HK KT KV RL L
		□	□	□				0,5	HK RL L
			□	□		□		1,2	ÉT HK L
	□	□	□	□	□		0	2,5	ÉT HK KT KV RL L
□	□	□	□	□	■			7,5	ÉT HK KT KV RL L
□	□	□	□			□		2,9	ÉT HK KT KV RL L
	□	□	□		□	□		1,7	HK KT KV L
□		□		□				1,6	ÉT HK KT KV RL L
								0,1	HK

would require a systematic and intensive examinations of the group of problems. 39 species were found in the Dead-Tisza area at Oszlár. (Unfortunately, for technical reasons the *Calopteryx splendens splendens* HARRIS data were omitted from the listing in the above paper, but they do appear in the quantitative evaluation.)

Second lock-series on Tisza	%	Dead-Tisza at Oszlár	%
Ischnura elegans	30	*Agrion pulchellum*	16.2
Ischnura pumilio	7.6	*Ischnura elegans*	12.5
Sympetrum meridionale	7.5	*Agrion puella*	7.6
Agrion pulchellum	5.8	*Sympecna fusca*	7.2
Lestes barbarus	4.6	*Platycnemis pennipes*	6.1
Agrion puella	4	*Calopteryx splendens*	5.8

Note: The larvae do not appear in the numerical data reffering to the Dead-Tisza at Oszlár, but this does not affect the dominance relations essentially.

It is interesting that Agrion p. pulchellum Van der Linden, which occurs in first place in the data for the Dead-Tisza at Oszlár, is only in fourth place for the area of the second lock-series on the Tisza. To a certain extent this may perhaps be explained in that the larva of this species favours slow-running brooks and streams (although it also develops in high numbers in standing waters too). The Odonata fauna from the Dead-Tisza at Oszlár are subject to the strong influence of the richly vegetated Hejő brook, which runs slowly past only a few metres away. Of course, this is only an assumption, and there may well be some other explanation.

The percentage frequency data for all of the species are given in Table 1.

Detailed account of the species

A list is given below of the species detected in the area of the second series of locks on the Tisza, taking into account the most recently accepted taxonomic classification. A brief reference is made to the Hungarian extents of the species and to the conditions of their occurrence in the examined area, and the more important habitats are indicated.

1. *Platycnemis pennipes pennipes* PALLAS: frequent throughout the country, and common in places. Also frequent in this area of the Tisza, while its larvae were found too from slowly running water (ditches emptying into the Kis-Tisza at Sarud): Abádszalók, Dead-Tisza, Cserőköz, Kis-Tisza, Tiszafüred, Tiszavalk.

2. *Agrion (Coenagrion) ornatum* SELYS: Predominantly found in hilly and mountain districts in Hungary. It is sporadic in this area of the Tisza, and is generally only found individually: Sarud, Kis-Tisza, Poroszló, Kis-Tisza, Tiszafüred.

3. *Agrion (Coenagrion) puella puella* LINNÉ: Frequent throughout the country, and in this area of the Tisza too. It can mainly be collected along the dead-arms and the sand-pits: Cserőköz, Kisköre, Tiszaderzs, Tiszafüred, Dead-Tisza.

4. *Agrion (Coenagrion) pulchellum pulchellum* VAN DER LINDEN: Common throughout the country along slow-running brooks, brooklets and standing waters, and found in every habitat in this area of the Tisza.

5. *Pyrrhosoma nymphula* SULZER: Known in only relatively few places in Hungary, mainly in hilly districts. 10—15 years ago it was considered very rare, but in intensive research it was found not only in many places in the hilly districts, but also on the plains. In spite of this, it can still not be said to be frequent, although in some habitats it can be collected in large numbers. Its occurrence in this area of the Tisza is an interesting datum with regard to the extent of this species. 5 specimens were found in small water-courses emptying into the Kis-Tisza near Sarud.

6. *Erythromma viridulum* CHARPENTIER: Frequent in Hungary, being found mainly along swamps and bogs, and smaller lakes. It is found in low numbers in this area of the Tisza, primarily beside sand-pits: Cserőköz, Kisköre, Tiszabábolna.

7. *Ischnura elegans elegans* VAN DER LINDEN: Common throughout Hungary. Found in the highest proportion (30%) in almost every habitat in this area of the Tisza. It was also detected by STEINMANN (1962) at Tiszafüred. Its orange-coloured female too can be found in appreciable numbers in the area.

8. *Ischnura pumilio* CHARPENTIER: Common throughout the country along slow-running brooklets, brooks and standing waters. Frequent in this area of the Tisza, and in places (e.g. the Dead-Tisza at Tiszafüred) can be caught in masses. Its larvae too were located in large numbers in the Dead-Tisza at Tiszafüred. STEINMANN (1962) too detected it at Tiszafüred. Its orange-coloured females are also frequent.

9. *Enallagma cyathigerum cyathigerum* CHARPENTIER: Frequent throughout the country, and in this area of the Tisza too: Bere, Cserőköz, Poroszló, Kis-Tisza, meadow at Sarud, Tiszabábolna, Tiszafüred, Tiszavalk. Also detected by SPEINMANN (1962) at Tiszafüred.

10. *Sympecna fusca* VAN DER LINDEN: Frequent throughout the country, and common in places. It is the only Hungarian dragonfly species hibernating in the imago form, and thus it can be collected from early spring until late autumn. Frequent in this area of the Tisza too. It can regularly be found in dry biotopes too, relatively far from the water: Bere, Cserőköz, Kisköre, meadow at Sarud, Tiszaderzs, Tiszafüred, Tiszaörvény, Tiszavalk. It is also reported by STEINMANN (1962) from Tiszafüred.

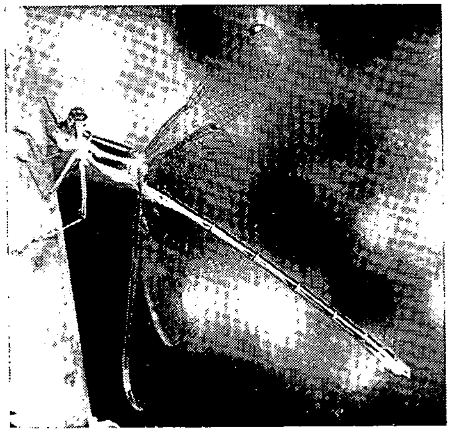

Fig. 3. *Lsstes barbarus* FABR.

Fig. 4. Characteristic Odonata biotope (dead-arm detail) in the Tisza inundation area on the outskirts of Abádszalók

11. *Lestes barbarus* FABRICIUS: Common everywhere in Hungary. Many larvae were found in dead-arms and sand-pits in this area of the Tisza. The imagos were often observed en masse on the sunny edges of woods, and in places with bushy, clumpy high-stalked vegetation: Bere, Cserőköz, meadow at Sarud, Tiszafüred, Tiszaörvény, Tiszavalk.

12. *Lestes dryas* KIRBY: Frequent throughout the country along standing waters and marshy meadows. It can be canght sporadically in this area of the Tisza: Cserőköz, meadow at Sarud, Tiszafüred, Dead-Tisza. It is also reported by STEINMANN (1962) from Tiszafüred.

13. *Lestes macrostigma* EVERSMANN: Can be found in Hungary, mainly on the Great Hungarian Plain, in places in large numbers. It can be collected rarely in this area of the Tisza, but its larvae were not found here: Tiszafüred, Tiszavalk.

14. *Lestes sponsa sponsa* HANSEMANN: Frequent in Hungary, mainly along standing waters and marshes in flat country. It occurs throughout this entire area, and appears frequent mainly in the Dead-Tisza area at Tiszafüred.

15. *Lestes virens vestalis* RAMBUR: Occurs throughout the country along standing waters and marshy meadows. It is frequent mainly in flat country, and appears in masses in places. It can be found throughout this entire area of the Tisza, and is frequent mainly at Cserőköz. This is the only species which, apart Tiszafüred, is mentioned in the literature from Tiszaderzs (STEINMANN 1962).

16 . *Lestes viridis viridis* VAN DER LINDEN: Occurs throughout the country along standing waters, and is frequent in individual places. Not frequent in this area of the Tisza, and its larvae were not found: Cserőköz, Tiszafüred, Dead-Tisza.

17. *Calopteryx (Agrion) splendens splendens* HARRIS: Common in Hungary along slow-running brooks and ditches, mainly in flat country. Frequent in every habitat in this area of the Tisza, primarily along the Kis-Tisza and the channels and ditches connected to it, but it can also be found continuously along the living Tisza too.

18. *Gomphus vulgatissimus vulgatissimus* LINNÉ: Frequent in Hungary, mainly in hilly and mountain districts, and common in places. Occurs sporadically in this entire area of the Tisza, and is more frequent at Cserőköz and along the living Tisza.

19. *Gomphus flavipes* CHARPENTIER: Can be found sporadically along the slow-running parts and dead-arms of the larger rivers in Hungary. According to investigations to date in the Tisza valley it appears more frequent than the national average. Its larvae too were found (Oszlár, Tiszafüred). Its imagos too were caught along the Tisza: Kisköre, Tiszafüred, Tiszavalk.

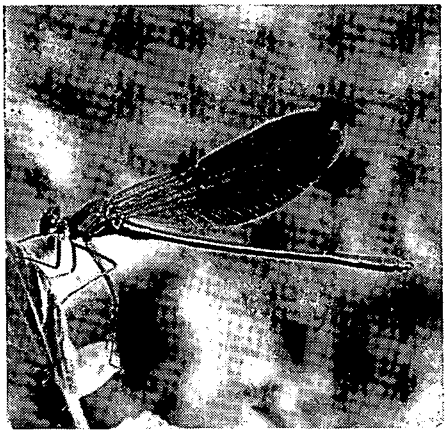

Fig. 5. *Calopteryx splendens splendens* HARR.

Fig. 6. *Aeschna affinis* VAN DER LINDEN.

20. *Brachytron hafniense* MÜLLER: Frequent throughout Hungary. Occurs sporadically in this area of the Tisza: Abádszalók, Dead-Tisza, Cserőköz, Poroszló, Kis-Tisza, meadow at Sarud, Tiszaszőlős.

21. *Aeschna affinis* VAN DER LINDEN: Frequent throughout the country along standing waters. Occurs in this entire area of the Tisza. It swarmed in particularly large numbers on 16 October 1966 in the vicinity of sand-pits along the left-hand embankment in the inundation area of the Tisza near Kisköre. This datum is of interest, as previously this phenomenon was known only in the last third of August (STEINMANN 1959), and it thus provides new information on the time of swarming of this species.

22. *Aeschna mixta* LATREILLE: Common throughout the country. Can be collected sporadically in this area of the Tisza: Cserőköz, meadow at Sarud, Tiszafüred.

23. *Anaciaeschna isosceles isosceles* MÜLLER: Frequent mainly in flat country. It is not rare in this area of the Tisza either, and can be collected mainly along the Kis-Tisza: Cserőköz, Kis-Tisza, Tiszavalk.

24. *Anax imperator imperator* LEACH: Frequent in Hungary everywhere, but mainly along larger lakes. In this area of the Tisza only 3 specimens were collected (Tiszafüred, Dead-Tisza). However, it was observed sporadically in other habitats too; it is very difficult to catch.

25. *Anax parthenope parthenope* SELYS: Occurs around larger open-water lakes mainly in flat country, but in general it is not frequent in Hungary. It is rare in this area of the Tisza: Tiszafüred, Dead-Tisza.

26. *Cordulia aenea aenea* LINNÉ: Occurs throughout the country beside reed-bordered lakes, and is fairly common. It can be collected sporadically in this entire area of the Tisza.

27. *Somatochlora flavomaculata* VAN DER LINDEN: Occurs everywhere along standing waters in Hungary, but it is not frequent. Nor is it rare in this area of the Tisza: Abádszalók, Dead-Tisza, Cserőköz, Tiszafüred, Dead-Tisza.

28. *Libellula depressa* LINNÉ: Common everywhere in Hungary. Occurs in this entire area of the Tisza, and can be collected in large numbers mainly along the Kis-Tisza.

29. *Libellula fulva fulva* MÜLLER: Occurs everywhere in Hungary, and is a sporadically frequent species. It can also be caught sporadically in this area of the Tisza: Cserőköz, Kisköre, Poroszlo, Kis-Tisza, Tiszafüred, Dead-Tisza.

30. *Libellula quadrimaculata quadrimaculata* LINNÉ: Frequent everywhere in Hungary, and common in places. Frequent in this entire area of the Tisza. Pasticularly many specimens were observed in sand-pits along the railway near Tiszafüred.

31. *Orthetrum brunneum brunneum* FONSCOLOMBE: Generally widespread in Hungary, and a frequent species. Appears frequent primarily along the Dead-Tisza at Abádszalók in this area of the Tisza, and its larvae were also found here. Other habitats: Cserőköz, meadow at Sarud, Tiszafüred, Tisza bank.

32, *Orthetrum cancellatum cancellatum* LINNÉ: Frequent throughout the country, and common in places. Occurred too in every habitat of this area of the Tisza. However, its larvae could not be found.

33. *Orthetrum coerulescens coerulescens* FABRICIUS: Common throughout Hungary along standing or slow-running waters. Occurred everywhere in this area of the Tisza too, and appears frequent primarily along the Kis-Tisza.

34. *Crocothemis erythraea erythraea* BRULLÉ: Frequent in Hungary, mainly in flat districts. It can be caught sporadically in this area of the Tisza: Cserőköz, meadov at Sarud, Tiszabábolna, Tiszafüred, Tisza inundation area. It is also reported by STEINMANN (1962) from Tiszafüred.

35. *Sympetrum depressiusculum* SELYS: Occurs sporadically throughout the whole of Hungary. It can also be caught sporadically in this area of the Tisza too: Abádszalók, Dead-Tisza, Cserőköz, Tiszabábolna, meadow at Tiszanána, Tisza-örvény. It has also been reported from Tiszafüred (STEINMANN 1962).

36. *Sympetrum flaveolum flaveolum* LINNÉ: Frequent throughout the country along standing waters. It is common in every habitat in this area of the Tisza.

37. *Sympetrum meridionale* SELYS: This is the most frequent Sympetrum species in Hungary, and in this area of the Tisza too. It occurs in every habitat. Steinmann (1962) also reports it from Tiszafüred.

38. *Sympetrum sanquineum sanquineum* MÜLLER: Common throughout Hungary. It can also be found in every habitat in this area of the Tisza. It is noted from Tiszafüred in the literature (STEINMANN 1962).

39. *Sympetrum striolatum striolatum* CHARPENTIER: Common in most districts of Hungary. Also frequent in this area of the Tisza: Bere, Cserőköz, Kisköre, meadow at Sarud, Tiszafüred, Dead-Tisza, Tiszanána, Tiszaszőlős. It is also reported in the literature from Tiszafüred (STEINMANN 1962).

40. *Sympetrum vulgatum vulgatum* LINNÉ: Frequent everywhere in Hungary, and common in certain regions. It is also frequent in this area of the Tisza: Cserőköz, Kisköre, Poroszló, Kis-Tisza, meadow at Sarud, Tiszabábolna, Tiszafüred, Tiszavalk. STEINMANN (1962) also mentions it from Tiszafüred.

41. *Leucorhinia pectoralis* CHARPENTIER: Occurs in flat districts in Hungary, and primarily on the Hungarian Plain, but not frequent. Only 3 specimens were found in this area of the Tisza: Tiszafüred, Dead-Tisza, Tiszaörvény.

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MOLLUSCA COMMUNITIES IN THE TISZA BED IN THE REGION OF SZEGED

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(Received 25 April 1973)

Abstract

Benthos samples from six collection sites were processed. 42% of the samples were living Mollusca. The number of Mollusca species found was 10. The bulk of the species were shells. The number of individuals of the Mollusca comprised about 30% of the invertebrates belonging to the different taxonomic categories. The number of Mollusca individuals was greatest in those parts of the water near the bank, at a depth of 1—5 m, where there was a neutral or moderately eroding bed-side (along the current-line). The character-species everywhere was *Lithoglyphus naticoides*. In comparison with the collection site above the town, which is free from contamination, in the town section of the river the proportion of Mollusca increases and that of species belonging to other taxonomic categories decreases. In the town section of the Tisza the number of empty shells was several times larger than the number of living specimens.

It can be stated that via the quantitative changes in the Mollusca it is possible to measure the cultural effects on the river, and also to characterize the changes taking place in the river water.

Introduction

The material for this study consisted of benthos samples collected by DR. MAGDOLNA FERENCZ from the 173—178 river km section of the Tisza in the region of Szeged, between 1963 and 1971.

As so many benthos samples were involved, it was possible to investigate the dispositions of the Mollusca in the river bed and their quantitative and qualitative relations, with regard to the contamination entering the river from the town. Site and means of collecting; method of processing.

The benthos samples were obtained from a water-depth of 1—7 m, from both banks and from the middle of the bed of the river Tisza. In all cases the mud-excavator extracted bottom samples 20×40 cm in area from the individual sites.

Collections were generally repeated three times annually, from six sites (Fig. 1): the Ship-repair yard (1), the vicinity of the Kőrössy Fischermen's Inn (2), the winter harbour (3), 300 m below the waste-water outlet of the Salami Factory (4), below the site of the old railway bridge (5), and in the Maros, 300 m above its mouth into the Tisza (6).

In this section waste-water from the town or factories enters the river at six points: above the Kőrössy Inn (1), below the Salami Factory (2), above the railway bridge (3) (at the river km values indicated in Fig. 1); of these inlets the three above the railway bridge lead the waste-water into the middle of the river, while in the other cases it enters from the bank.

51 of the 119 samples available (42%) contained living Mollusca. Besides the benthos sampling, separate collections were also made, as controls, on the stones on the banks of the Tisza and the Maros. Data prepared by the Szeged Water Board and relating to the cross-sections of the bed were utilized. In the evaluation of the material, attention was also paid to the positions of the town waste-water inlets in the vicinity of the collection sites, and to the water-quality examinations performed by the Water Board.

The list of Mollusca species found was compared with the data already published on the Tisza Mollusca (HORVÁTH 1943, 1955). The quantitative distribution of the Mollusca species was compared with the quantitative relations of the other taxonomic categories observed in the samples (Annelida: Oligochaeta, Hirudinoidea, Arthropoda: Ephemeroptera, Diptera (Chironomidae).

The similarities and differences between the Mollusca from the individual collection sites were established by species-identity and dominance-identity calculations, using the Ramsay—Pócs formula (PÓCS 1966). The calculations were checked with a chi^2 significance test. The total numbers of individuals found in each individual collection site were employed in the analysis.

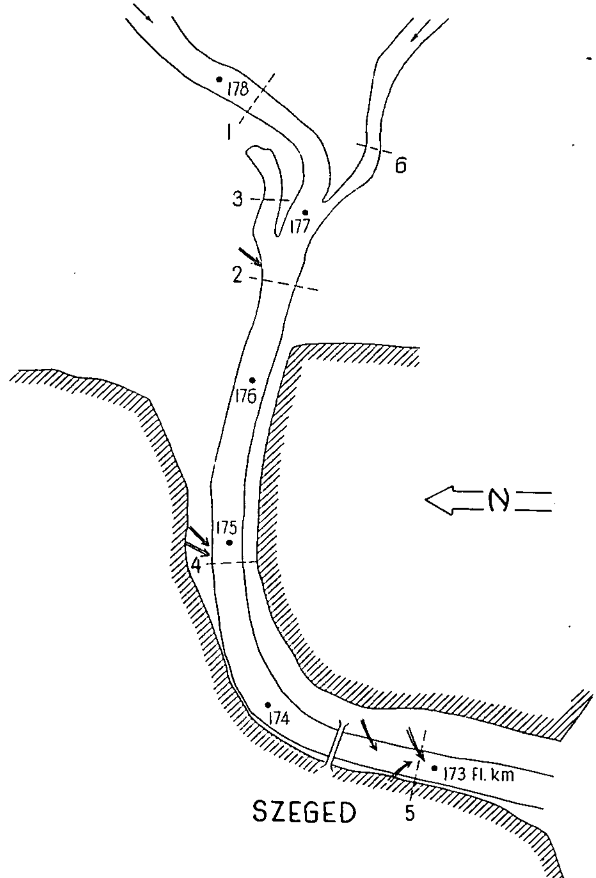

Fig. 1

Table 1. *Occurence of Mollusca species at the collection sites*

Species	Collection sites					
	1	2	3	4	5	6
Theodoxus transversalis (C. PFEIFFER)	–	+	–	–	+	+
Lithoglyphus naticoides (C. PFEIFFER	+	+	+	+	+	+
Sphaerium rivicola (LAMARCK)	+	–	–	–	–	–
Unio pictorum balatonicum KÜSTER	+	–	–	–	–	–
Unio crassus bosnensis MÖLLENDORF	+	–	–	–	–	–
Unio tumidus zellebori ZELLEBOR	+	–	–	–	–	–
Pisidium amnicum (O. F. MÜLLER)	+	+	–	+	–	–
Pisidium subtruncatum MALM	+	–	–	–	–	–
Pisidium nitidum JENYNS	+	+	–	–	–	–
Dreissena polymorpha (PALLAS)	+	+	–	+	+	–

The author's thanks are due to DR. MAGDOLNA FERENCZ for providing the samples, and to Dr. J. G. J. KUIPER, a *Pisidium* specialist, for the revision of the dwarf Mollusca.

Species found and their ecology

In addition to 6908 Annelida, Ephemeroptera and Diptera, the 51 bottom-samples yielded 1969 Mollusca, which can be classified in ten species (see Tables). The total number of Mollusca individuals comprises 29% of the invertebrates belonging to the different taxonomic categories. This proportion agrees with that found by ZAGUBIZENKO and LUBYANOV (1971) in reservoirs and rivers on the plains in the Ukraine.

The species found are very widespread in the rivers of Europe. An exception is *Theodoxus transversalis,* which lives only in the catchment area of the Danube (BROHMER—EHRMANN—ULMER 1960).

Compared to the publications of HORVÁTH (1943, 1955), two new *Pisidium* species were found: *Pisidium subtruncatum* and *Pisidium nitidum.* Whereas only their empty shells had previously been found, the present work revealed living specimens of *Sphaerium rivicola* and *Pisidium amnicum.* However, *Pseudanodonta complanata* (ROSSM.), which figures in the publications of HORVÁTH, was not found, and nor were the standing-water species which he collected from the bank-side waters. Further, it can be stated that the Mollusca fauna of the Tisza is poorer than that of the Danube (DUDICH 1948).

Table 2. *Quantitative distribution of the different taxonomic categories*

Category	Collection sites					
	1	2	3	4	5	6
Annelida	2126	879	207	267	699	199
Mollusca	775	112	168	156	666	92
Ephemeroptera	127	132	1	4	53	139
Diptera	278	504	5	96	484	705
Proportion of Mollusca to the other categories	23	6	43	29	35	8

As a result of the control collections, the bank-side stones yielded 20 individuals of *Theodoxus fluviatilis* from the Maros, complementing the earlier finds in the Tisza (HORVÁTH 1955). The possibility of the occurrence of this species in the water-system of the Danube has been strongly denied by SOÓS (1965). Very many *Lithoglyphus naticoides,* some *Theodoxus transversalis* and some *Radix peregra ovata* (DRAP.) were found in the company of the *Theodoxus fluviatilis* among the bank-side stones.

Because of the steepness of the banks, the *Unio* species are found only in small numbers.

The Mollusca observed are without exception eaters of alga and detritus. For this reason their settlement is favoured by a bottom rich in organic detritus, in contrast with sand poor in organic matter. The settlement of the Mollusca is not favoured by varying bed-conditions, or by building-up or strongly eroding bed-sections, as at the collection site in the Maros. From this respect, the Szeged section of the Tisza is favourable, for it is a stagnating bed-section. A mosaic-like settlement results here from the soil-conditions and the entering waste-waters.

On the basis of the benthos samples it can be established that the numbers on Mollusca individuals in samples from near the bank, at water-depths of 1—5 m, are higher than those in samples from the middle of the bed. As regards the two sides of the Szeged section of the Tisza, the bulk of the Mollusca were found on the right bank, where the current-line of the river runs. The settlement on the left bank may be inhibited by the accumulation of phenol originating from the Maros. However, the laboratories of the Water Board have no reliable methods for the determination of phenol accumulated in the mud.

Mollusca communities, and conclusions drawn from their changes

The structure of the Mollusca communities is typified in that there is only one character-species: *Lithoglyphus naticoides.* At all six collection sites Mollusca species are dominant, such as *Dreissena polymorpha* and *Pisidium amnicum.* At the Ship-repair yard these are accompanied by *Unio crassus.* The communities are different variants of the *Lithoglyphus naticoides* synusium type.

Characteristic decreases can be observed in the number of species and the total number of individuals at the collection sites between the two end-points of the benthos examinations. Characteristic changes also occur in the proportions of Mollusca and other invertebrates living in the bed. Since there were no significant differences in the position of the current line and in the quality of the bottom between the two end-points of the examinations, the reason for the decreases in the numbers of total individuals and species may primarily be the town waste-water flowing into the river.

As regards the collection sites, the Tisza section at the Ship-repair yard is the richest in Mollusca. Here 666 individuals from 10 species were found. There is no waste-water inlet into the Tisza in the vicinity of this collection site. The fewest Mollusca were obtained from the water of the winter harbour, where 168 individuals of only one species, *Lithoglyphus naticoides*, were found. Below the Kőrössy Inn 112 individuals of 5 species were found, below the Salami Factory 156 individuals of three species, and from the Tisza section below the railway bridge site 666 individuals of three species. The high number of individuals at the last-named collection site can be attributed to the fact that the right bank is free from contamination.

Characteristic values similar to the number of species and the total number of individuals are also exhibited by the proportions of the Mollusca in comparison to the other taxonomic categories. The proportion of Mollusca compared to the Annelida, Ephemeroptera and Diptera categories is relatively low, 23%, above the Ship-repair yard, which is free from town waste-water. It is very low below the Kőrössy Inn (6%) and at the collection site in the Maros (8%), where a strong effect is exerted by the Maros water rich in industrial contamination. At the other collection sites this proportion increases with the number of waste-water inlets. Thus, below the two inlets of the Salami Factory it is 29%, and after the additional three inlets at the railway bridge 35%. The proportion of the Mollusca is highest (43%) in the standing water of the winter harbour, which is rich in oil contamination.

The fact that the contamination gives rise to changes in the numbers and proportions of the Mollusca species and individuals is also shown in that there is a parallel extensive decrease in the numbers of individuals in the other invertebrate taxonomic categories taken as the basis for comparison. At the Ship-repair yard the total number of individuals of the invertebrates mentioned above is 3306, at the Kőrössy Inn 1627, at the winter harbour 381, at the Salami Factory 523, at the railway bridge 1902, and at the collection site in the Maros 1135.

Discussion

The numbers show that the increase in the proportion of the Mollusca after the waste-water inlets must be interpreted in that the number of individuals of a majority of the species found in the Tisza decreases to zero, while at the same time the number of individuals in some species increases. Of the invertegrates, the detritus-eating Mollusca with the greatest limits of endurance remain. These are *Lithoglyphus naticoides, Dreissena polymorpha* and *Pisidium amnicum*. What has been said draws attention to the role of the Mollusca in the self-cleaning of the river. The species remaining in spite of the pollution are small, and do not include the large *Unio* species.

It is well known from the investigations by BERINKEY (1966), KNEDITS (1903), UNGER (1918) and ZIEMIANKOVSKY—CRISTEA (1961) that the Mollusca are important food for fish of value in Hungary, mainly the predatory and omnivorous fish.

On the basis of the investigations, the poorness in fish of the Szeged section of the Tisza can be correlated with the decrease in the numbers of individuals of the Mollusca and other invertebrates.

Evidence of this is provided by the number of individuals per square metre, calculated from the samples richest in individuals. The number of individuals per square metre is 937 at the Ship-repair yard, 412 at the Kőrössy Inn, 275 at the Salami Factory, and 662 at the railway bridge. As comparative data, it may be mentioned that densities of 1300 and 6600 Mollusca per sq. metre were found in the Siret in the Ukraine (flow-rate 1.5—2 m/sec) and in the lower reaches of the Danube, respectively (ZAGUBIZENKO—LUBYANOV 1971, ZIEMIANKOVSKY—CRISTEA 1961).

In the course of the author's investigations to date, the change in the quantitative relations of the Mollusca has been used to characterize the land-biotopes. From the evaluation of the benthos samples it may be stated in conclusion that the changes taking place in the river water may be characterized with the aid of the quantitatice changes in the Mollusca living in the river bed. Via the quantitative changes in the Mollusca, it is possible to measure the cultural effects on the river.

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SPREADING AND HABITS OF HIPPOLAIS PALLIDA ELAEICA (LIND.) ALONG THE TISZA

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(Received 20 May 1973)

Abstract

The main data relating to the spreading in Hungary of the olivaceous warbler *(Hippolais pallida)* are reviewed, and are supplemented by the results of the author's Hippolais studies in 1972. It is found that the olivaceous warbler can be observed everywhere in the suitable habitats between Szeged and Tiszakürt. Its most favoured habitat is *Salicetum triandrae* plant associations on the edge of the water along the Tisza and on the inundation area of the Hungarian reaches of the Danube. Data are also reported on its habits, ethology and breeding biology in the populations on the Hungarian inundation areas.

Introduction

Of Europe's five *Hippolais* species, two occur in Hungary: the icterine warbler *(Hippolais icterina)* has long been a member of the Hungarian fauna, while the olivaceous warbler *(Hippolais pallida)* is a recently established immigrant. This latter belongs among those species spreading to the north from the Balkan peninsula. As regards the extent of its spreading, it can be considered to be in third place, behind *Streptopelia decaocto* and *Dendrocopos syriacus*. The processes of areal spreading of these three species were probably induced simultaneously by similar external and internal effects, but because of the breeding nature of the olivaceous warbler and its lower extra-territorial activity it may have progressed more slowly; thus, even today it has reached only the central parts of the Hungarian Plain. The spreading of the olivaceous warbler is similar to that of the other two species for it is also continuous. It gradually advances in the inundation-area vegetation of the larger rivers. Further, the olivaceous warbler too is in part a culture-following species, since a smaller proportion of its population establishes itself in town parks and gardens (in Szeged, Makó, Orosháza, etc.).

Let us consider briefly the data relating to its occurrence in Hungary. The first Hungarian datum was a suspected observation from Transdanubia: WARGA (1955) considered that he had seen it at the Kisbalaton in 1943, but his description appears to be indicative of the marsh warbler.

It was not known on the Hungarian reaches of the Danube until 1972, although without doubt it had established itself earlier there too, for it had been observed as long ago as 1954 by RUCNER (1962) in the Danube—Dráva angle in Yugoslavia. The first singing pair in Hungary were observed on 12 June 1972, opposite the Buvat forestry section on the bank of the Danube at Érsekcsanád. Further to the south, a nest containing two eggs and belonging to a different pair was found on the same day on Koppány island by TIBOR JASZENOVICS, who observed an additional two singing birds on 5 July 1972 at Dunaföldvár.

The real scene of its spreading is the Tisza and its surroundings. As early as 7 June 1947 P. BERETZK and A. KEVE considered that they had heard its song in the Móra park on the bank of the Tisza in Szeged (GYÖRY—SCHMIDT 1962). The probability of their observation increased later, for the Móra park has since become one of the most constant habitats of the olivaceous warbler in Szeged. From year to year, one or two pairs settle there. In 1956 the first conclusive specimen was collected at Hódmezővásárhely (PÉCZELY 1962), and in 1958 it was again observed at Hódmezővásárhely by PÉCZELY (1962) and at Orosháza by MURVAY (1962). In 1959 GYÖRY and SCHMIDT found it breeding and collected a confirmatory specimen in Szeged, and also observed it at Makó and Sasér, while STERBETZ observed it nearly at the height of Szentes (GYÖRY—SCHMIDT 1962). CSIZMAZIA (1965) found it breeding in a Szeged garden. Its breeding in Orosháza in 1960 was confirmed by MURVAY (1964). It was observed in Csongrád by PÉCZELY (1962) and at Tőserdő by SCHÄFER (1964), while in 1962 it was found by CSIZMAZIA at Vezseny and then at Szajol. Up to the present this is the most northerly occurrence reported in Hungary. It is characteristic of its constancy in the Móra park in Szeged that it was observed there on 11 June 1963 by G. CREUTZ (1966) and his colleagues, while a strongly singing olivaceous warbler was seen on 20 June 1967 by A. KEVE in the company of G. ZINK (Radolfzell) (written communication by A. KEVE).

The advance of the olivaceous warbler can also be detected in the neighbouring countries. PASCOVSCHI and NADRA (1958) surveyed its population in that area of Roumania to the south of the Maros. It is also spreading on the Adriatic coast towards Istria, (RUENER 1967), and reached Austria in 1967 (DUDA—LEISLER 1967).

On the suggestion of M. MARIÁN, the author began to study the spreading and ecology of this species in 1968. In that year 7—8 pairs bred on a 700 m section of the Tisza bank at Tápé. Because of the reorganization of this area, the population decreased to 4—5 pairs in 1969. In these two years it also bred in Ady Square and in the Móra park in Szeged (BANKOVICS—MOLNÁR 1970). The high flood-level in 1970 forced the bush-inhabiting birds from the inundation area, and unfortunately there are no data on the olivaceous warbler for that year. In 1971 the presence of 3 pairs was established at about 223 river km on the outskirts of Csanytelek.

From 1972, the time when the author began to cooperate in the Tisza Research Programme, his research into the olivaceous warbler became more intensive. In order to correlate the scattered data described above, and to establish the present northernmost limit of their extent, it was considered necessary to carry out a continuous research trip, setting out from Szeged and preceeding to the north, to estimate the olivaceous warbler population and to perform ecological and breeding-biological examinations along the route. The results of this research trip are reported below.

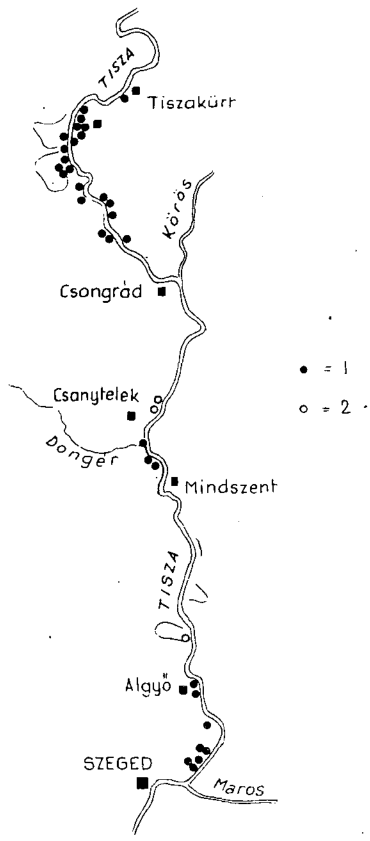
Material and method

In the course of this work the authoı travelled on foot and by motor-cycle mainly on the right bank along a 98 km inundation-area section from Szeged to Tiszakürt, and also an 8 km section between Szolnok and Szajol. The observations were made at the end of May and in June, when the olivaceous warbler sings most intensively. As will be returned to later, the exact observation and the population survey is then most certain, for it is based on the loud and characteristic song.

Throughout the journey, the sites of occurrence of the individual pairs were recorded both topographically (on the basis of the river km) and according to the habitat. The nests found were measured, and nidobiological observations were carried out at nests containing young.

Sites of occurrence of olivaceous warbler in 1972

Olivaceous warblers in greater or smaller numbers were observed everywhere in the suitable habitats throughout the 98 km section from Szeged to Tiszakürt, between the 175 and 273 river km points. In all 32 pairs were definitely established, but it is beyond doubt that here are far more than this on the two banks (Map 1). Although there were suitable habitats in that section too, this species was not observed on the 8 km section between Szolnok and Szajol (333—341 river km).



Map 1. Sites of observation of *Hippolais pallida elaeica* (LIND.) along the Tisza in 1972.
(1 = 1972, 2 = 1947 – 1971)

The 32 pairs observed between Szeged and Tiszakürt in 1972 occupied the following vegetation types:

1. The most favoured habitat of the olivaceous warbler is the 2—6 m high *Salicetum triandrae* association, generally on the flat bank at the direct edge of

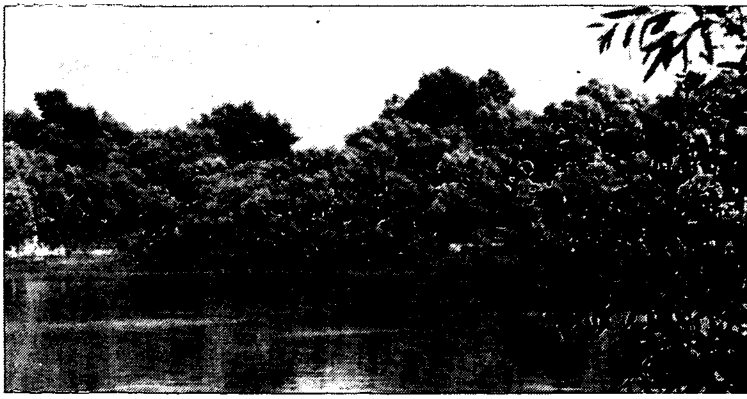


Fig. 1. The main habitat of the olivaceous warbler is *Salicetum triandrae* associations. (Photo by A. BANKOVICS.)

the river (Fig. 1). The main tree species here is *Salix triandra* L., which usually grows from seeds. In this plant association 25 pairs occurred, 78.1 % of the observed numbers.

2. Two pairs (6.2%) occurred in *Salix alba* L. and *Salix fragilis* L., with *Rubus caesius* L. as base vegetation, sometimes 200—250 m from the living water.

3. One pair (3.1 %) lived in the dense *Amorpha fruticosa* L. developing generally on a high bank in the direct vicinity of the river.

4. One pair (3.1 %) was found in young (10—15-year old) *Salix alba* L. with, a base vegetation of *Amorpha fruticosa* L., 200 m from the river.

5. One pair (3.1 %) occurred in an old *Populus canescens* (AIT.) SM. grove. below which there was a dense new growth of *Fraxinus pennsylvanica* MARSCH, 250 m from the water.

6. Two pairs were observed in willows interlaced with reeds close to the river (6.2%). (This is also the habitat of the marsh warbler *(Acrocephalus palustris)*, which can easily be confused with the olivaceous warbler.)

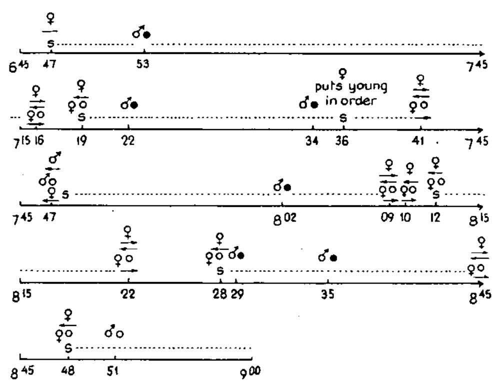
It emerges from the analysis, therefore, that the true habitat of the olivaceous warbler is the *Salicetum triandrae* plant association on the inundation area, but that in addition it also settles in smaller numbers in other types of vegetation.

Behavioural, ethological and nidobiological observations

1st song and other sounds

From the spring arrival of the olivaceous warbler, the middle day of which can be taken as 18 May, it sings intensively. Its song is particularly strong up to the time of nest-building (at the beginning of June), or until the hatching of the young (at the middle of June). After the hatching of the young, the pairs sing more rarely, as they are busily occupied in seeking out food and in feeding their young. Of course, there are always one or two delayed hatchings or even unsuccessful ones, and thus singing olivaceous warblers can be encountered throughout the whole of June and even in the first half of July. Under suitable weather conditions at the beginning of the hatching period, this species sings all day long as it searches for food in the fine, sunny weather. At times it sits for various periods of time on a lower dry branch of the willow-foliage, or on a side branch, and sings its song there, remaining in one place. At other times it lurks among the branches, and sings its song while moving. It did not prove possible to detect the time of commencement of its dawn song. At 3.20 a.m. on 4 June it was already singing strongly together with the other birds. Like the other Sylvidae species, it leaves off singing in the late evening. In this respect, observations could be carried out on the same two birds under similar weather conditions, in bright, dry weather, on 29 May and 3 June (Table 1).

Table 1



Explanation of symbols

♂● ♂ brings food, ♀ feeds young
♂○ ♂ brings food, ♂ feeds young
♀○ ♀ brings food, ♀ foods young
← bird arriving at nest, → bird leaving nest
s sits down on nest, ········ continuously sits on nest

According to the two series of data, on these two days the birds last sang at 19.58 and 20.00, i.e. 28 and 25 minutes, respectively, after sunset. (To characterize the light conditions: this period coincides with the appearance of Venus in the sky.) On both occasions the two birds, which spent the night 25 m apart in the foliage of *Salix triandra* L., sang their final song at the same time, almost as a farewell to each other.

Although the sounds of this species have already been studied by modern ornithomusicological methods (Jilka 1967), it is not unnecessary to record their various sounds in syllabic form. The song of the olivaceous warbler is much more uniform than that of the icterine warbler. Two types of songs can be distinguished:

1. Its more frequently heard typical song, which is reminiscent of the chirping of the sedge warbler *(Acrocephalus schoenobaenus)* (Győry—Schmidt 1962). This is heard extremely strongly, particularly in bright weather, at the beginning of the courting period. It can be described as: "chiri-chiri-chiri-chee-chew-chi" or "chroee-chrree-chraa-chraa-chaa-chi-chi". Each stanza lasts for about 12 seconds, and its continuous song consists of repetitions of these stanzas.

2. Its other song is a quieter, more melodious song, more pleasant for the human ear. It can be described as follows: "tyewp-tyewp-tyewp-tsiew-tsiew-tsiew", succeeded in a mellow twittering, in another variation, by "pi-pi-pi-pi-pi-tew-tew-tew-tew-tew-chivi-chivi-chivi-tsi-tsi-tsi-trewi-trewi-trewi", with at intervals between soft twitterings. This is probably its imitative song, and can be heard only rarely. Such a song was noted at Csanytelek by the author and T. JASZENOVICS on 28 May 1972, and again at Tápé on 29 May.

On the approach of man or some other danger, it begins an alarm chirping. This is similar, but much stronger than the corresponding sounds of the *Sylvia* species. On the increasing of the danger, its chirping accelerates and becomes continuous, and is then reminiscent of the similar sound of the red-backed shrike *(Lanius collurio)*. Its chirping is often transformed into song. Its state of excitement is sometimes expressed by *Lanius*-like "chraa-chraa-chraa" sounds. If man approaches the nest, it begins to chirp, but it soon rather leaves the vicinity or becomes quiet. When frightened at other times it emits "tsri-tsri-tsri" sounds too. On hearing the alarm call of a group of *Parus maior* L. passing overhead, one singing specimen of olivaceous warbler also began to give the alarm. In a strong state of excitement or during prolonged singing and chirping, it ruffles up its head feathers.

Feeding ethological data

In the research into its feeding, examinations of the stomach content have not yet been made in Hungary. Field-observations indicate that it catches mainly hairless caterpillars, Diptera imagos, etc. It searches for these primarily in the foliage of *Salix triandra* L., and more rarely among the tops of *Salix alba* L. and *Salix fragilis* L. It rapidly hops from branch to branch among the foliage, and moves nimbly along the horizontal branches, in the meantime snatching up insects with its beak. If the prey is spotted a little above the bird, then it remains on the branch but stretches up to catch it. If it cannot reach it in this way, it jumps up for it. If it is at a distance of 25—30 cm, then in the same manner as the *Phylloscopus* it hangs in one place, catches the insect while "hovering", and then realights on a lower branch. When it catches larger caterpillars, it beats these against a baranch before it eats them. After feeding it frequently wipes its beak on the branches.

For resting and preening, it generally conceals itself on a dry branch under the foliage of *Salicetum triandrae*. In this way it is well covered from above, while it can spot danger approaching from below well in time.

Nidoecological and breeding biological data

Some pairs commence nest building only two weeks after their arrival, but other pairs leave this work until later. In 1968 the author found a ready, but still empty nest as early as 30 May, but at Tiszaug in 1972 pairs singing in the *Salicetum triandrae* had still not begun to build their nests on 13 June. It should be noted that on the preceding day, 12 June, two egg-containing nests were found beside the Danube.

The most common site chosen for nesting along the Tisza is the 2—6 m high *Salicetum triandrae* band stretching beside the edge of the river. If these trees reach a height of 8—10 m, then their lower parts do not provide sufficient denseness, and the birds leave them. For example, at TápE in 1968 7—8 pairs used such a band for nesting, but in 1972 they had left them completely and resettled in younger and lower trees. In another area they retained the taller trees as feeding sites, but in 1972 built their nests in the directly adjacent, low and dense *Amorpha fruticosa* L., whereas four years previously these had been in the *Salicetum triandrae.* More rarely they nest in the shrub level of *Salix alba* L. and *Salix fragilis* L.

They build their nests most frequently on the pencil-thin branches and twigs of *Salix triandra* L., on a triple or quadruple branching; more rarely they build them in the same way in *Amorpha fruticosa* L., sometimes in places where *Rubus caesius* L. increases the denseness, and in this case they use the thorny shoots of the letter as supports for the nests. In contrast with this, TRISCHLER (1943) found the first nests in the Carpathian basin (in the village of Katy on one of the islands in the Danube) on *Crataegus.*

Table 2 gives the dimensions of 15 nests from the banks of the Tisza and 1 from the Danube, together with the heights from the ground.

Table 2. *Dimensions of nests of Hippolais pallida elaeica* (LIND.) *(all values in cm)*

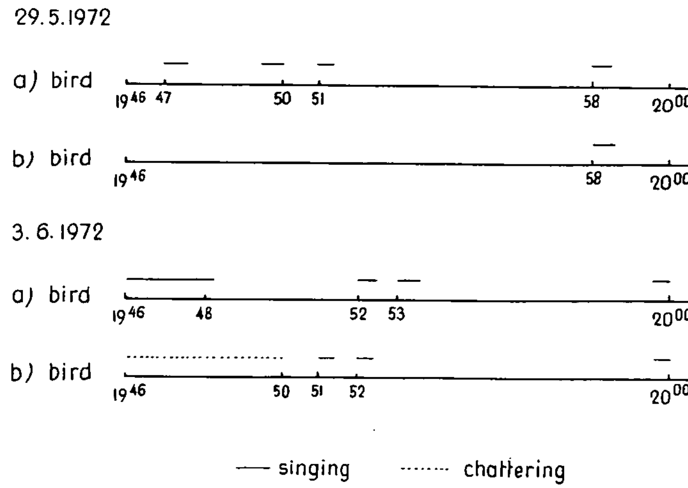
No.	Height from ground	Nest		Interior	
		Height	Diameter	Depth	Diameter
1	150	7.5	8	5	4.5
2	115	14	8.5	4	4.5
3	130	7	8.5	4	5
4	95	8	7.5	4	4
5	110	8.5	8.5	4	5
6	165	7.5	8.5	4	5.5
7	170	8	9	4.4	4.5
8	105	7.5	7.5	4	4.5
9	75	8	8	4	4
10	110	—	—	—	—
11	95	9	8	4	4
12	125	8	8.5	4	5
13	100	—	—	—	—
14	107	9	9	3.8	5
15	270	7	9.4	4.3	5.3
16	430	8.2	8	4.8	5
Ave.	147	8.4	8.3	4.2	4.7

It is clear form the data in the Table that the heights and overall diameters of the nests are fairly variable, whereas the depths and diameters of the interiors are relatively constant. This is understandable as these latter values are directly related to the body-sizes of the birds.

It is interesting to note nest no. 16, which was built almost at the end of one of the small branches of a 4.5—5 m high *Salix triandra* L. The lining material was carried into this nest on 1 July 1972. In connection with the building of nests at such a late date, the question arises of whether these are needed for supplementary hatchings, or for second hatchings. Since the hatching failure-rate is fairly high, it is probably a matter of supplementary hatchings in these cases. It is worth mentioning that, with the exception of this latter example, the height from the ground of the nests of the populations in the inundation areas exhibits much less variation than that for the town populations, which nest both in low bushes and in the tops of trees.

The material of the nests consists of dry plant fibres, between which is incorporated much white, cotton-like matter from the willow. This makes the nests compact-

Table 3



walled, and white in colour, and thus they can readily be distinguished from the nests of the Sylvia species. As lining too, they employ almost exclusively willow-cotton, but feathers and down not at all.

Generally in the first third of June, the nests contains most often 4, and more rarely 3 eggs. Nest-parasitism by the cuckoo *(Cuculus canorus)* is frequent (GYŐRY—SCHMIDT 1962, CSIZMAZIA 1965, BANKOVICS—MOLNÁR 1970).

Fig. 2. Olivaceous warbler nest with 4—5-day old young. (Photo by A. BANKOVICS.)

On 1 July 1972 the author succeeded in observing the course of the feeding in a nest containing four young at Tiszaug (Table 3). It is probable that the young were 4—5 days old. The nest was at a height of 2.70 m in a *Salix triandra* L. (Fig. 2).

The data of Table 3 show that the parents fed the young on 18 occasions between 6.45 and 9 a.m. The feeding was carried out in three ways:

1. Because of the cool, windy weather, the female generally remained sitting on the young. At times, however, she flew off the nest; on these occasions she caught something in the close vicinity (2—3 m) and returned with it to the nest to feed the young. She was always absent for only a short time. Feeding in this way was performed 10 times.

2. The male most often (7 times) fed the young only indirectly. He first transferred the insects he had brought to the female, who was then standing in the nest. The female next bent down to feed the young. The male sought the food over a greater area (ca. 25 m), but he never flew from the Salicetum triandrae belt.

3. On one occasion, when the male did not find the female on the nest, he himself fed the young.

During the midday hours the female did not sit on the nest either, and the two parents took it in turns to bring the food and feed their young.

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ORNITHOLOGICAL OBSERVATIONS IN SOME BIOTOPES OF THE UPPER-TISZA INUNDATION AREA

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(Received 10 January 1973)

Abstract

A study was made of the avifauna of the Tisza inundation area from Tokaj to Záhony in 1971—1972. The paper analyzes ornithological problems of the pastures, orchards, arable land, swamps and flood-defence embankments. The woods have been dealt with specialy in a separate publication. The inundation area forms a mosaic complex, where the individual biotopes alternate, and with involved feeding relations. It can be said in general that the nesting avifauna of the habitats examined is poor as regards both species and individual numbers. The biological energy produced is not utilized appropriately, and this raises the possibility of rational bird-settlement, which at the same time would also increase the biological protection of the area.

Introduction

The considerable surface transformation due to human activity in the past 100 years includes the regulation of the river Tisza. The once vast rushy swamps, the barely penetrable woods and the neglected river-beds now belong in the memories of the past. The river and its flood waters now flow between embankments, and man has created biotopes with new aspects in the place of the old wild world. These anthropogenic areas can today be found not only outside the embankments, but also inside them. The aim of the present paper is to study, analyze and explain their avifauna. In the course of this it is desired to deal with the avifauna of orchards, pastures, arable land, swamps and embankments, and the related observations. The woods of the inundation area have already been treated separately in an earlier paper. It will be seen that these areas are species-poor biotopes, as a direct result of their anthropogenic origin. Their investigation is important, however, as they are parts of the large mosaic-complex of the Tisza inundation area, and as their energy leads to their being feeding areas for many species. They are thus incorporated as organic parts in the food gradient which has developed on the inundation area. Accordingly, our picture of the whole of the inundation area, and of the biological role and value of the ornis living there, will be complete only when the investigation of the woods has been supplemented by the investigation of these biotopes too.

Region examined and method

Observations were made on the inundation area from Tokaj to Záhony in 1971 and 1972. This is a section covering about 86 river km. With regard to the great physiognomic variety of the biotopes, the methods of observation and data collection had to be applied accordingly. In the orchards, 1 hectare characteristic of the area was designated, and in this the species and individuals were counted. In the open pastures the square was much larger, at ca. 25 hectares. Just because of the openness, there are far fewer birds here, and the feeding individuals flee from a large distance.

An unit area was not marked out in the swamps, and coenological recordings were not performed. This will be returned to later. Here all the observed species were recorded without reference to unit area. A similar procedure was employed on the arable land, where such a recording could not be made because of the great poorness in birds.

On the flood-defence embankments, however, the well-applicable band-recording method was used. It must be noted here that (as will be treated in more details later) the quantitative and qualitative relations of the band-recording, and this probably holds for other recordings too, depended decisively on the period of the day in which they were made.

The numbers of species and individuals per unit area was established on the basis of the nests, singing males young-feeding parents and visible individuals observed on traversing the areas several times. Thus, the number of nesting pairs at each observation site could be determined with approximative accuracy. The analyses were based primarily on the nesting pairs, for these are in the greatest harmony with the area and for just this reason are in the closest biological connection with the ecosystem there. In order to obtain the average characteristic of the biotope, observations were made at each habitat type at many points of the inundation area. The fauna lists reported in the paper are the results of the summation and averaging of these observations. However, it must be noted that these are all open biotopes, and only feeding areas for many species, and therefore it is extremely important that the quantitative and qualitative relations of these species should also be taken into account. Special reference is made to this in each case. Because of their complexity, it is now desired to analyze the ecological conditions of the individual biotopes in parallel with the analysis of the avifauna.

Avifauna of the pastures

Pastures of various sizes are found along the entire length of the inundation area from Tokaj to Záhony. They are generally flat or gently undulating, with filled-in river-valleys and swamp vestiges. The vegetation is the lawn-association typical of the inundation area, with *Alopecuretum pratensis* grass-meadows on their higher parts, and *Agrostetum albae* marsch-meadows on the lower, wetter parts. They are in the main tree- and bush-tree, and old *Populus nigra* residual trees are found only in a few places. The biotope is used by man as pasture, and in merely a small number of sites was the mowing of the grass observed, and in very low amounts. The molestation of the area is thus constant, but is of such a nature as is readily endured by the birds, and indeed certain species even require it. It was observed that there were practically no, or only a very few birds in the pastures where the grass was high (40—50 cm). They were associated mainly where the grass-cover had been eaten short. There may be two reasons for this. One is that the careful bird can in this way keep a watchful eye on the environment, which offers little protection, and can flee in time. The other is that the food can more easily be collected in the short grass.

The recordings revealed 31 bird species on this biotope. Of these, only 8 species (23.6%) were nesting, the other 23 species (76.4%) merely visiting the area to feed. The distribution of the species is given in Table 1, where the non-nesting species are denoted by +.

The bulk of the breeding species and pairs on unit area (25 ha) exhibit relatively high constancy: degree III—V. This confirms that they are in perfect harmony with the area. For this reason too, the number of pairs here is higher: 2—3/25 ha.

Table 1. *Bird species observed on the pastures and their constancy relations, referred to an area of 25 ha*

No.	Species	Nesting pairs per 25 ha	Constancy degree
1	*Ardea cinerea* L.	+	II
2	*Egretta garzetta* L.	+	I
3	*Ciconia ciconia* L.	1	I
4	*Ciconia nigra* L.	+	I
5	*Anas platyrhynchos* L.	+	I
6	*Accipiter gentilis* L.	+	I
7	*Buteo buteo* L.	+	I
8	*Falco subbuteo* L.	+	I
9	*Falco vespertinus* L.	+	I
10	*Falco tinnunculus* L.	+	III
11	*Perdix perdix* L.	1	III
12	*Coturnix coturnix* L.	1	III
13	*Phasianus colchicus* L.	+	I
14	*Vanellus vanellus* L.	3	III
15	*Asio otus* L.	+	I
16	*Merops apiaster* L.	+	I
17	*Coracias garrulus* L.	+	I
18	*Alauda arvensis* L.	2	V
19	*Hirundo rustica* L.	+	II
20	*Riparia riparia* L.	+	II
21	*Corvus cornix* L.	+	V
22	*Corvus frugilegus* L.	+	V
23	*Coloeus monedula* L.	+	I
24	*Pica pica* L.	+	II
25	*Saxicola torquata* L.	1	I
26	*Motacilla alba* L.	+	II
27	*Motacilla flava* L.	+	I
28	*Sturnus vulgaris* L.	+	III
29	*Carduelis carduelis* L.	+	I
30	*Emberiza calandra* L.	1	II
31	*Emberiza citrinella* L.	+	I

Taking the averages of the individual recording areas as basis, it was found that in general there are 3.1 species per unit area, represented by 5.3 pairs. This means on average a biomass of 2026 g; behind this there is a very large spread, depending on the disturbance to the area, and over what extent. On the long, narrow pastures, for example, far fewer species were found. If the species arriving to feed are also included, then these values increase of course. The number of observed species becomes 8.5, and the value of the biomass 45262 g. There is similarly a large spread here. This is mainly due to the fact that the crows do not seek out every pasture, but only those close to habitations.

As a result of its special nature, the biotope is favourable for those species nesting at ground level. 7 of the nesting species (87.1%) and 10 of the pairs (91%) breed their young on the ground. There was only one species, *Ciconia alba,* which represented the species nesting at tree-foliage level; this nested on a very large poplar in one of the pastures. The terricolous species therefore enjoyed absolute dominance.

The distribution of the species according to feeding is very interesting. Here too a separate study was made of the nesting species and those arriving only to feed. The relevant data are given in Table 2.

The nesting species could be allocated to three categories. The most significant of these were the insectivore and herbivore species; the only carnivore species was

Table 2. *Distribution of the species on the basis of the food consumed*

Feeding form	Nesting species			Feeding species	
	no.	%	wt. % g/25 ha	no.	%
Carnivorous	1	12.5	73.4	8	34.8
Insectivorous	4	50.0	15.5	8	34.8
Herbivorous	3	37.5	11.1	4	17.4
Mixed-feeding	—	—	—	3	13.0

Ciconia alba L. It can also be seen from Table 2, and the earlier biomass data too are indicative of this, that a very important role is played in the turnover of the biological matter in the pastures by the species arriving only to feed. By this means food passes out of the area, is incorporated into the communities of other biotopes, and is converted into new living matter and biological energy. This phenomenon makes the ecosystem of the pastures open, and underlines the assumption that the birds primarily treat these areas as feeding grounds. The areas demand a considerable degree of adaptation to the special conditions on the part of the nesting species, and as we have seen few of the species are capable of this. This is perhaps the reason why no species was observed, either among the nesters or among the feeders, which occurred in every pasture area. Thus, the value of the species-identity was obtained as zero. In contrast, the value of the life-form-identity (feeding-form-identity) turned out to be 25%.

Avifauna of the orchards

Orchards are found throughout this inundation area of the Tisza. They occur in patches of various sizes on the right bank from Tiszakarád on, and on the left bank from Gávavencsellő on. It might be said that they comprise the most significant branch of agriculture in the inundation area. They occupy a much larger territory than the arable land. From Szabolcsveresmart to Záhony 70% of the left bank inundation area is covered by apple orchards. It must be noted at once that, regardless of whether older or younger orchards are considered, the apple is predominant. In comparison, other fruit, such as the plum, although it can be found, is present in negligible amounts. From an ornithological point of view, the orchards can come into consideration only when there is already a developed foliage on the trees. In the experience of the author, however, this can be expected only in the old, decaying orchards. As a consequence of the systematic pruning, spraying, curing and cultivation, primarily the settlement of cavity-living species can be reckoned with, and this requires old orchards. Nevertheless, because of the constant disturbance, only a very sparse bird population is established. The species arriving to feed are more significant here too. They comprised 13 of the observed 17 species (76.4%). Only 4 nesting species (23.6%) were found. The distribution of these species is given in Table 3.

On the basis of the averages averaga for the individual observation sites, 1 ha generally contains 1.9 nesting species, represented by 3.3 pairs. The biomass of the nesting species attained a previously never observed low level, 252 g, while with the feeding species, as seen for the pastures too, the values rise. The number of species per hectare is then 4.0, and the value of the biomass is 3500 g. This tremen

Table 3. *Bird species observed on orchards and their constancy relations, referred to an area of 1 hectare*

No.	Species	Nesting pairs per ha	Constancy degree
1	*Perdix perdix* L.	+	II
2	*Phasianus colchicus* L,	+	I
3	*Streptopelia turtur* L.	+	I
4	*Upupa epops* L.	+	I
5	*Picus viridis* L.	+	I
6	*Dendrocopus malor* L.	1	III
7	*Corvus cornix* L.	+	II
8	*Corvus frugilegus* L.	+	I
9	*Coloeus monedula* L.	+	I
10	*Pica pica* L.	+	II
11	*Garrulus glandarius* L.	+	I
12	*Parus maior* L.	1	II
13	*Sylvia curruca* L.	+	I
14	*Sturnus vulgaris* L.	2	III
15	*Passer montanus* L.	2	V
16	*Chloris chloris* L.	+	I
17	*Emberiza citrinella* L.	+	I

dous difference arises from the fact that the relatively heavy pheasants, partridges and crows also gladly seek out this biotope.

It is worth noting how much better the constancy relations of the nesting species are than those of the feeding species. This may arise from the fact that the area is suitable for the former, and satisfies their demand perfectly. The latter group is only an occasional guest; it is not a standard member of the avifauna.

It was pointed out earlier that the limitations to the nesting conditions explain the poorness in species observed here. The breeding species all nest at tree-trunk level, that is they are cavity-dwellers. Only this defends the birds from the interference by large-scale treatment of the fruit-trees. If this sequence of thought is continued, it automatically emerges that by the use of artificial nesting cavities it would be possible to settle useful, insect-destroying birds in such orchards. Unfortunately, however, examples of this were not observed anywhere.

How valuable this would be can be seen from the fact that the bulk of the nesting species (75%) are insectivores, and 25% are mixed-feeders. Indeed, even on the examination of the weight dominance the balance lies in favour of the insectivores. They comprise 80% of the biomass, and only 20% is due to the mixed-feeders.

In the group of birds arriving only to feed, herbivores are present in addition to the previous two categories. The distribution of the groups is even, the insectivores comprising 31%, the herbivores 31%, and the mixed-feeders 38%.

Similarly to the previous one, therefore, this habitat is open, for the food is removed from the area by the guest birds. This fact proves that the food reserve (the production) is greater than its utilization. Accordingly, the flow of material to other biotopes is possible, and for this reason bird settlement would be necessary.

In an interesting way this habitat possesses a more uniform nesting community, if it can be termed a community at all. While the value of the species-identity on the pastures was zero, here it is 25%. The life-form (feeding-form) identity attained 50%.

The orchards thus possess a specialized, mainly insectivorous fauna of low biomass, the characteristics and biological value of which could be successfully increased by bird settlement.

Avifauna of arable land

Strictly speaking, by arable land is understood the plough-land. This is without exception flat, and can be found throughout the entire length of the inundation area. Plant production is continued on this land, but predominantly those crops which require only a short growing time. The frequent spring floods mean that it is often possible to work on these areas only later, at the end of April and in May. Accordingly, the commonest crops are maize, fodder plants and potatoes. As a consequence, the areas are uncovered in spring and autumn. At such time they do not provide hiding places, nesting sites or food for the birds. Further, in the course of the summer the continuous treatment of the plants means such a strong disturbing effect that this land is not suitable for the terricolous nesters. This biotope provides no possibilities for other nesting species.

Here too an attempt was made to make coenological recordings in a similar way as at the other habitats, but the results were so poor that the author contented himself with simply noting the observations, without reference to any unit area.

It is possible that if this biotope had been concentrated on, a nesting species too would have been found, but previous visits to this area had not revealed a single bird which could conclusively, or even with high probability, be shown to have hatched on the ploughland. The customary analyses are thus not possible here.

Based on experience, therefore, this habitat can be regarded only as a feeding ground. Altogether 4 species were observed; these were hunting for insects and collecting food on the ploughland. These species were: *Phasianus colchicus* L., *Corvus cornix* L., *Corvus frugilegus* L. and *Pica pica* L. In addition to the low number of species, there were also only few individuals. On each occasion a maximum of 1—3 specimens per species was seen. On the above basis it appears justified to conclude that the avifauna of the inundation area does not play a significant role in the biological protection of the ploughlands in this area. For just this reason the food material produced here is not appropriately utilized. The thought may arise, therefore, of the artifical breeding of game birds, which might make this biologically fairly inactive area more mobile. Pheasants raised here would be able to find shelter during the winter in the coverts of the inundation area.

Avifauna of the swamps

The extensive inundation area investigated is relatively poor in swamps. The bend cut off in the regulation of the river generally turned into swamps or became filled in. The few swamps which remained are in the main not favourable for birds, as the vegetation-free, bare banks and water-surfaces do not provide possibilities for nesting. Another continual disturbing factor is the constant fishing activity of man.

However, the area does include some swamps suitable for the settlement of birds. Nevertheless, their low number and small extents mean that their avifauna is not sufficient to influence the overall picture of the ornis of the inundation area to any degree. The swamps are typified not by the hydrophilic, but by the mesophilic and xeriphilic species. Accordingly, and also in part because of the difficulties of recording, recordings relating to a unit of area were not made in the case of the swamps either; instead, data-collecting observations were made on several occasions at 3 swamps suitable for the settlement of birds. The results obtained are reported in Table 4.

Table 4. *Bird species observed in the swamps*

No.	Species	Timár I swamp nesting	Timár I swamp feeding	Timár II swamp nesting	Timár II swamp feeding	Marótzug swamp nesting	Marótzug swamp feeding
1	*Ardea cinerea* L.	+					+
2	*Egretta garzetta* L.						+
3	*Ciconia ciconia* L.				+		
4	*Ixobrychus minutus* L.	+					
5	*Anas platyrhynchos* L.	+			+	+	
6	*Anas querquedula* L.	+				+	
7	*Aythya nyroca* GÜLD.					+	
8	*Circus pygargus* GM.	+			+		
9	*Fulica atra* L.	+		+		+	
10	*Vanellus vanellus* L.		+	+			+
11	*Tringa totanus* L.		+				
12	*Gallinago gallinago* L.		+				
13	*Philomachus pugnax* L.		+				
14	*Chlidonias niger* L.		+				
15	*Hirundo rustica* L.		+		+		
16	*Acrocephalus arundinaceus* L.	+					
17	*Acrocephalus scirpaceus* L.	+					

These swamps can in general be regarded as closed ecological units. They form a self-providing and self-maintaining ecosystem, in which a significant migration of nutrient matter (as in the preceding biotopes) is inconceivable. As a consequence of their hydrophilic natures, the species living here adhere to their habitat, with regard to both nesting and feeding. This is the reason why food and bioenergy are taken to other biotopes by only a few species: *Ardea cinerea* L., *Egretta garzetta* L. and *Hirundo rustica* L.

The richness of the fauna depends on the size of the swamp, on its vegetation, and on the extent of the disturbance. Since the nesting community is strongly independent of the ecosystems of the other biotopes of the inundation area, and there is little connection via the transport of biological material, a detailed analysis is considered unnecessary.

Ornithological role of the flood-defence embankments

These form one of the most characteristic biotopes of anthropogenic origin in the inundation area. From an ornithological point of view they must be considered primarily as feeding areas, but in this respect they are very important. It emerged that certain species preferably seek out the embankments for the purpose of feeding. Similarly, they use the telephone poles and wires which are to be found everywhere on the embankments as look-out sites. This ecological combination is in all respects of human origin, and has been excellently adapted by several species to their advantage. The grass-covers of the embankments provide a very good habitat for numerous small mammals (e.g. *Microtus arvalis*), ants and other insects. These are significant as food, and attract the birds to these sites. Certain species indeed specialize on the embankments, and can almost definitely be found there at certain times of the day.

This observation stimulated the author to count the individuals of the characteristic species by proceeding along the embankment by motor-cycle. In the course of this work, however, it turned out that a recording made in the early morning revealed quite different qualitative and quantitative relations than one prepared in the middle of the day. On all occasions, therefore, it was necessary to take into consideration the times when birds were active. For example, *Upupa epops* L., *Picus viridis* L. and *Pica pica* L. appeared in much larger numbers in the early morning recordings than in those made at around noon. On the other hand, *Lanius collurio* L. was then completely absent. It may be a matter here of the thermophilia and psychrophilia of the birds and the food. The essence is, however, that an approximately correct result is obtained if the activity period of the given species is known, and the recording is made accordingly. In this way it was found that on one section of the embankment the recording had to be made between 7 and 9 a.m., and on another between midday and 2 p.m. The survey of the birds then feeding on the embankment thus approximates to the realistic value in all respects.

Of course, the counting did not extend to all of the species on each occasion, but only to the most characteristic ones. Of these, only *Sturnus vulgaris* L. was omitted; this occurred in such large groups that it was not possible to count them from a moving motor-cycle. The results obtained are illustrated in Table 5.

Table 5. *Results of band-recordings on the flood-defence embankments*

No.	Species	1*	2	3	4	5	6
1	*Falco vespertinus* L.		1	1			
2	*Falco tinnunculus* L.	6	12	9		18	1
3	*Perdix perdix* L.					24	13
4	*Phasianus colchicus* L.					5	2
5	*Cuculus canorus* L.				11		
6	*Coracias garrulus* L.	12	12	8	1		
7	*Upupa epops* L.	4	14	3	9	17	1
8	*Picus viridis* L.		13	1		15	5
9	*Corvus cornix* L.					42	14
10	*Coloeus monedula* L.						30
11	*Pica pica* L.	11	32	10		65	26
12	*Lanius miror* GM.		32	33			
13	*Lanius collurio* L.			37			
14	*Motacilla alba* L.					6	2

* The data relating to the recordings are as follows:
1. From Zemplénagárd to Tiszabercel ferry, 46 km, 14 June 1972.
2. From Tiszabercel to Komoró, morning, 41 km, 15 June 1972.
3. From Komoró to Tiszabercel, noon, 41 km, 15 June 1972.
4. From Vencsellő to Veremszeg swamp, 19 km, 10 April 1971.
5. From Tiszabercel to Záhony, 57 km, 9 April 1971.
6. From Tiszabercel ferry to Révleányvár, 38 km, 11 April 1972.

It can be seen from this Table that reasonably large numbers were found, and these in fact do not mean all of the birds! There can not be many problems with the utilization of the production of the embankments, and with their biological protection. As proof of this, it is possible to consider two recordings, made in the early morning and at midday, which thus provided the most useful data. These are recordings 2 and 3. Here the numbers of individuals of the observed species were calculated for a 10 km section of the embankment (see Table 6).

This means an active biomass of about 4132 g. If it is now considered that of this 3445 g relates to the insectivorous birds, which consume a very large mass

Table 6. *Number of individual birds on 10 km section of embankment between Tiszabercel and Komoró*

No.	Species	Individuals/10 km
1	*Falco vespertinus* L.	0.2
2	*Falco tinnunculus* L.	2.9
3	*Coracias garrulus* L.	2.9
4	*Upupa epops* L.	3.4
5	*Picus viridis* L.	3.2
6	*Pica pica* L.	7.8
7	*Lanius minor* GM.	8.1
8	*Lanius collurio* L.	9.0

because of their rapid digestion and of the indigestible chitin, then it can be understood why it was stated earlier that there can not be many problems here with the biological equilibrium.

The recordings to date have been few in number and of an informatory type, but even so they draw attention to the fact that it would be worth while to make similar recordings, extending if possible to all species, in order to obtain a satisfactory picture of the turnover of biological material in these areas.

Species observed on the river Tisza

The entire region with its characteristic ecology owes its existence to the Tisza. By means of its flood-waters and its surface-forming activity, the river has given rise to a number of biotopes suitable for the settlement of birds. At the same time, however, the river itself serves only as a source of food for merely a few birds. An attempt was also made here to carry out a regular recording, but the appearance of the avifauna was so irregular and so seasonable that this was not possible. The only choice was to record occasional observations. The river-water involves biological conditions quite unlike those dealt with so far, and it has such a strong selecting effect that only a very few bird species develop a direct connection with it. *Anas platyrhynchos* L. pairs were observed in a number of places, and on one occasion *Anas querquedula* L. was encountered. Throughout the summer individual specimens of *Actitis hypoleucos* L. were observed on several occasions, hunting for insects on the bank of the Tisza along the whole of this section. Similarly, individual specimens of *Larus ridibundus* L. and *Chlidonias niger* L. were observed as they flew above the water collecting their food. A more massive bird-movement on the water was not seen anywhere.

The individual biotopes were examined independently, and isolated from their environments, but only so that their essence could more readily be apprehended. At the same time, however, these are parts of the inundation area, a large ecosystem built up from mosaics, influenced by an almost inextricable network of close and loose connections. The aim of this investigation was to continue the work begun earlier, in order to get nearer to the ornithological problems of this biologically and economically extremely valuable area, in a search for the ways and means to enhance the forest and biological protection and the production. The work is not completed, and further observations, recordings and analyses are necessary. These will be continued next year.

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

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(Received 17 February 1974)

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

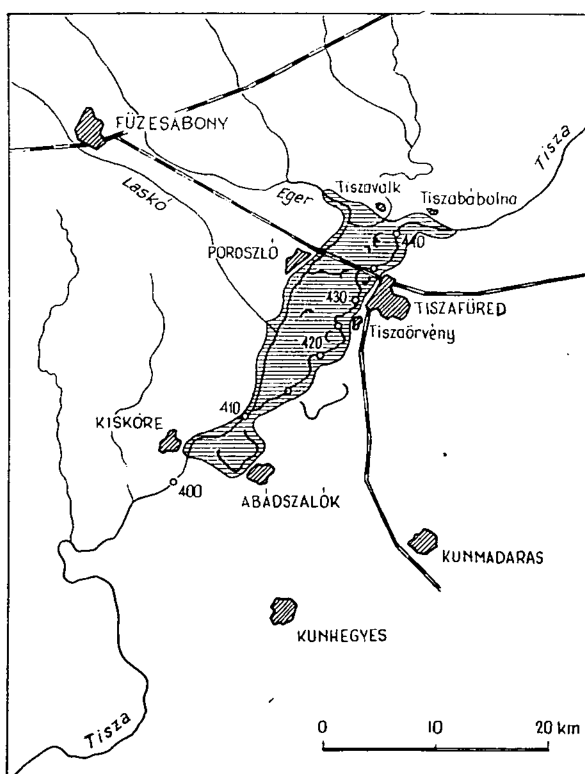

Fig. 1

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 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 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.

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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QUANTITATIVE AND QUALITATIVE CHARACTERIZATION OF THE AVIFAUNA OF THE MAROS-SIDE (1965—1967)

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(Received 15 February 1974)

Abstract

During the examinations the occurrence of 119 species was observed on this area. In both years 13 species were observed to nest on the area.

The greatest numbers of species and individuals occur in aspects III and III' (autumn). During the spring migration (in aspects I and I') the numbers of species and individuals are low, and indeed in the first year of the examination they did not even attain the values from the winter period.

In aspects II mainly those species coming to nest, feed and drink are found on the area.

The lowest number of species is observed in aspect IV, because of the hard winter in the second year of the study. The snow was knee-high and the Maros was frozen along the entire section, and this did not provide the means for many species to stay on the area. The higher numbers of species and individuals in the same aspect of the first year of the examination can be explained by the mild winter. A complete absence of birds from the area was not observed in either year, not even in the winter period.

A qualitative analysis of the bird population led to the following findings: the insect-eating species are dominant in the first three aspects in both years of the study. The number of seed-eating species is lowest in aspect I, but their number gradually increases, and they are dominant in aspect IV. The number of predatory bird species is generally low, but it rises perceptibly in aspect IV.

Because of the distance of the woods, there is very little change in the number of omnivorous species during the aspects.

The number of aquatic bird species varies mainly with their components. There is a fairly significant decrease in aspects III—IV.

The importance of the area is confirmed by the number of species arriving to nest, to feed, to drink and for refuge, and by the number of migrating species.

Introduction

The ornithological literature of the Roumanian Socialist Republic does not contain a large number of treatments of the coenological aspects. Mention must be made here of the works of KOHL, KORODI GÁL, KÓNYA and VESPREMEANU. At the present time quantitative and qualitative examinations are of very great importance. Civilization and the cultivated regions are consuming an ever larger area from free nature, thereby decreasing the living space of the fauna and upsetting the natural biological equilibrium. It is well known that by this means not only the fauna, but also the human community suffers.

"It is primarily the biotopes on agriculturally worked areas which are today undergoing substantial transformations, and thus the study of these is particularly urgent" (EGON SCHMIDT).

Different biotopes can be characterized from various aspects. In the quantitative and qualitative evaluation of the bird species in the biotope, an approximately accurate picture is obtained of the biological state of the area. This tells us the extent of the population of the biotope, and whether the fauna is developing or stagnating. The presence of the different bird species gives an indication of the numbers of weeds, harmful insects and rodents on the area.

In the course of the present investigations these considerations were taken into account, in an effort to provide as realistic a picture as possible of the area. For their help during the observations and in the treatment of the material, the author wishes to express his thanks to István Kohl, Dr. János Korodi Gál, Egon Schmidt, László Antal, Attila Gombos, Attila Kelemen and Zoltán Szombath.

Area examined. Method

The area examined was a 2700 m long section of the river Maros above the town of Marosvásárhely; the geographical location of this area is 24° 35′ N, 46° 33′ W, and its height above sea-level is 308 m. In this section the Maros runs for 2/3 of the distance between high banks, while 1/3 of the distance is bordered by stones, or reeds and various aquatic plants; on one reach of about 500 m, a more or less continuous strip of bushes can be found (the average width of this is 3 m, and its height is 4—5 m). On one 300 m section the strip containing the bushes separates the cultivated areas from that part of the Maros-side used as a sand-pit pasture, and serving at times as an inundation area of the Maros. Sand-pits and stony parts can also be found to a small extent between the bank-side cultivated areas. Two old poplars, each about 30 m high, stand on this section of the Maros; these served as an alighting place for some of the bird species. The strip of bushes is accompanied on the side nearer the river by a ditch in which water is to be found throughout the entire year. As a result of this, the vegetation of the bush-strip is strikingly dense, and accordingly the observation of the species here and the

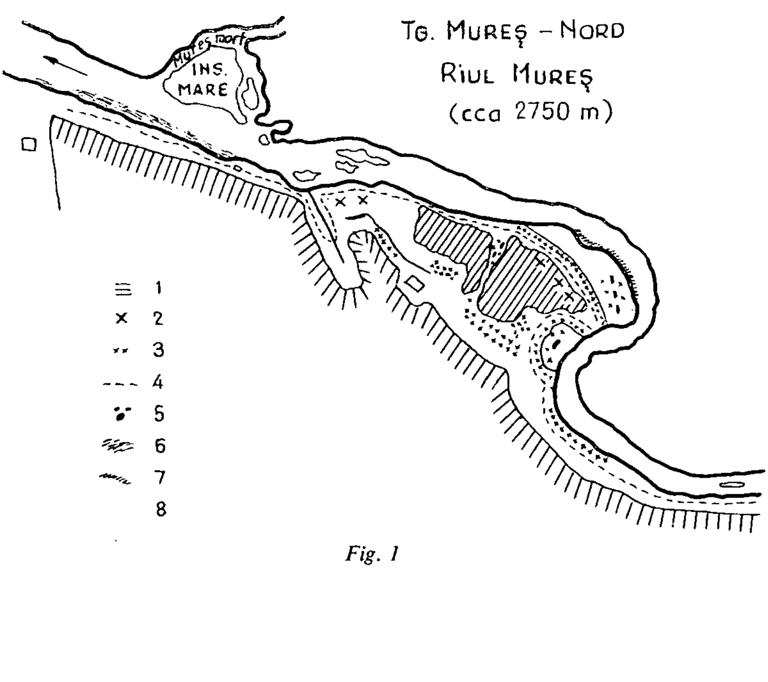

Fig. 1

finding of their nests was made quite difficult. The water in the ditch primarily provided a nearby source of drinking water for the small birds of the area, but it also meant a possibility for feeding for some of the aquatic bird species.

The anthropogenic biomes bordering the area in general consist of maize and soya-bean crops. These fields provided rich feeding possibilities for *Motacilla flava, Motacilla alba, Phylloscopus collybita, Acrocephalus palustris, Sylvia communis, Sylvia corruca, Anthus pratensis* and *Saxicola rubetra.* Naturally, the area was also richly stocked with small rodents, *Cricetus cricetus* and *Microtus arvalis,* the numbers of which were particularly high in the second year. The Maros and its bank-line, in some places rich in stones, aquatic plants and mud, provided optimum possibilities for feeding and hiding for the species occurring here. The number of bird species in the area was strongly influenced by the proximity of the town, and by the human settlements in the neighbourhood of the area. Their importance is highest in winter, when the food reserves of the area are very poor.

Of the plants observed in the area, the following are worthy of mention: *Populus robusta, Salix* sp. bushes, *Alnus glutinosa, Crataegus monogyma, Prunus spinosa, Cornus sanguinea, Morus nigra, Ligistrum vulgare, Viburnum opulus, Rubus tomentosus, Rosa canina, Sambucus nigra*; of the soft-stemmed plants: *Poligonum* sp., *Hipericum perforatum, Lavatera thuringiaca, Althaea officinalis, Simphitum officinalis, Verbascum* sp., *Dipsacus laciniatus, Melliotus officinalis, Carduus* sp., *Cirsium* sp., and various wild Gramineae and Leguminosae. Of these, mainly the berry-producers *Sambucus nigra, Ligistrum vulgare, Morus nigra* and *Cornus sanguina*, and the soft-stemmed weeds *Cirsium* sp., *Carduus* sp., *Dipsacus laciniatus* and *Cichorium inthibus* were of great importance in the nutrition of the birds.

The mammals occurring on the area were: *Microtus arvalis, Cricetus cricetus, Mustela nivalis, Lepus europeus, Mustela putorius, Vulpes vulpes, Lutra lutra, Talpa*

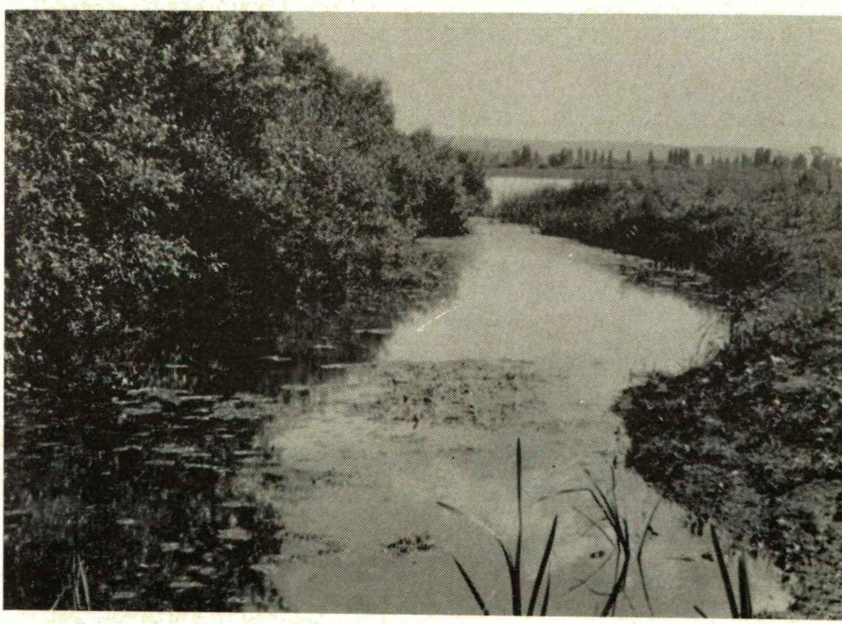

Fig. 2

Table 1

Species	I.			II.			III.		
	T_1	F_1	Q_1	T_2	F_2	Q_2	T_3	F_3	Q_3
Gavia arctica									
Podiceps ruficollis							4	10,0	0,09
Podiceps cristatus							4	15,3	0,09
Podiceps griseigena	1	5,0	0,04						
Ardea cinerea	5	15,0	0,19	2	9,0	0,04	1	7,6	0,02
Ardea purpurea	6	25,0	0,21	5	22,7	0,10			
Egretta garzetta	1	5,0	0,04						
Ixobrychus minutus	5	20,0	0,19	10	31,8	0,20	2	15,3	0,04
Ciconia ciconia	3	15,0	0,10	17	45,4	0,35			
Anser albifrons									
Anas platyrhynchos				1	4,5	0,02	9	23,0	0,2
Anas querquedula	300	30,0	11,7						
Aythya nyroca	51	10,0	1,9	8	18,1	0,17			
Bucephala clangula									
Milvus migrans	2	10,0	0,08	3	13,6	0,06			
Accipitër gentilis									
Accipiter nisus				1	4,5	0,02	2	15,3	0,04
Buteo buteo	1	5,0	0,04				13	46,1	0,3
Buteo lagopus							1	7,6	0,02
Pandion haliaetus	3	15,0	0,10				1	7,6	0,02
Falco subbuteo	1	5,0	0,04	4	18,1	0,08	8	46,1	0,19
Falco columbarius									
Falco tinnunculus	1	5,0	0,04	1	4,5	0,02	9	53,8	0,2
Perdix perdix							20	7,6	0,47
Coturnix coturnix	2	10,0	0,08	3	13,6	0,06			
Crex crex	2	10,0	0,08						
Porzana porzana									
Gallinula chloropus				4	4,5	0,08	3	15,3	0,07
Squatarola squatarola									
Charadrius hiaticula									
Charadrius dubius	56	90,0	2,1	79	100	1,7	1	7,6	0,02
Tringa erythropus									
Tringa totanus	27	25,0	1,0						
Tringa nebularia				12	13,6	0,25	6	23,0	0,14
Tringa ochropus	10	30,0	0,39	5	13,6	0,10	1	7,6	0,02
Tringa glareola	9	10,0	0,35	6	4,5	0,12			
Actitis hypoleucos	114	75,0	4,4	58	90,9	1,2	1	7,6	0,02
Gallinago sp.							3	15,3	0,07
Galidris minuta	23	15,0	0,89	2	4,5	0,04	1	7,6	0,02
Galidris temmincki				1	4,5	0,02			
Galidris alpina									
Philomachus pugnax	65	40,0	2,5						
Larus ridibundus									
Larus minutus	4	10,0	0,18	3	4,5	0,06	4	7,6	0,09
Chlidonias leucoptera.	10	10,0	0,39						
Chlidonias niger	135	45,0	5,2	5	13,6	0,10			
Sterna hirundo	2	10,0	0,08						
Streptopelia turtur	96	70,0	3,7	310	95,4	6,6	13	30,7	0,3
Streptopelia decaocto				12	13,6	0,25	30	61,5	0,7
Cuculus canorus	10	45,0	0,39	3	13,6	0,06			
Asio flammeus									
Alcedo atthis							1	7,6	0,02
Upupa epops	4	15,0	0,18	14	22,7	0,29	4	7,6	0,09
Jynx torquilla	1	5,0	0,04						
Picus viridis							1	7,6	0,02
Dendrocopos maior	1	5,0	0,04	2	9,0	0,04	2	7,6	0,04

IV.			I′			II′			III′			IV′		
T_4	F_4	Q_4	T'_1	F'_1	Q'_1	T'_2	F'_2	Q'_2	T'_3	F'_3	Q'_3	T'_4	F'_4	Q'_4
									1	11,1	0,04			
						1	7,1	0,03				4	20,0	0,4
2	10,0	0,1	2	20,0	0,2				1	11,1	0,04			
			2	20,0	0,2	4	14,2	0,15						
						4	14,2	0,15	1	11,1	0,04			
			1	20,0	0,1									
			4	20,0	0,5	16	64,2	0,59						
						30	85,7	1,1	20	11,1	0,9			
1	10,0	0,06										1	10,0	0,1
9	20,0	0,5							1	11,1	0,04	13	20,0	1,3
			18	40,0	2,3	23	21,4	0,85						
			2	20,0	0,2				3	11,1	0,10			
1	10,0	0,06										2	20,0	0,2
			2	20,0	0,2	10	42,8	0,37						
1	10,0	0,06	1	20,0	0,1	1	7,1	0,03	2	22,2	0,09			
2	20,0	0,1							5	55,5	0,21	5	40,0	0,5
10	70,0	0,6				8	42,8	0,29	21	77,7	1,0	36	100,0	3,7
16	70,0	0,9										18	80,0	1,8
									1	11,1	0,04			
			1	20,0	0,1	9	50,0	0,3	8	77,7	0,32			
1	10,0	0,6												
6	50,0	0,37				6	21,4	0,2	8	77,7	0,32	6	50,0	0,6
128	30,0	7,6				5	14,2	0,18				35	30,0	3,6
						1	7,1	0,03						
						1	7,1	0,03						
						11	35,7	0,4	2	22,2	0,09			
									6	33,3	0,3			
									8	44,4	0,32			
			17	80,0	2,2	28	42,8	1,0						
						2	14,2	0,07	1	11,1	0,04			
			1	20,0	0,1	19	14,2	0,69						
						14	35,7	0,50	3	22,2	0,12			
1	10,0	0,06	2	40,0	0,2	7	28,5	0,16	2	11,1	0,09			
			10	40,0	1,3	2	14,2	0,07						
			19	80,0	2,5	53	92,8	1,9	10	66,6	0,42			
						1	7,1	0,03	1	11,1	0,04			
						2	7,1	0,07						
									6	22,2	0,3			
			2	20,0	0,2									
						12	14,2	0,44	1	11,1	0,04			
						1	7,1	0,03						
			18	60,0	2,3	2	7,1	0,07						
			245	60,0	32,4	80	42,8	2,9	2	11,1	0,09			
			9	40,0	1,1	80	100	2,9	48	66,6	2,3			
12	40,0	0,7	4	40,0	0,5	8	21,4	0,29	21	77,7	1,0	11	50,0	1,1
			4	60,0	0,5	8	35,7	0,29	1	11,1	0,04			
												1	10,0	0,1
									2	22,2	0,09			
			2	20,0	0,2	9	50,0	0,3						
						2	14,2	0,07	1	11,1	0,04			
1	10,0	0,06							2	20,0	0,2			

europaea and *Erinaceus europaeus roumanicus*. In both years the numbers of *Microtus arvalis* and *Cricetus cricetus* were very high, and correspondingly there were many predatory birds too.

The observations were in the main carried out by the band-method (65 observations in the first year of the investigation, and 38 in the second year). A great amount of care was taken to avoid the recording of not accurately defined species. To a certain extent, however, this modifies the bird-capacity of the area. Those species flying over the area were recorded only if certain aquatic or predatory bird species were involved, which, according to the observations, sought out this area for feeding, rest or refuge. On the occasion of the population recording, a small number of specimens were collected on the area for confirmatory purposes (*Motacilla flava, Motacilla flava feldeggi,* etc.). For reasons beyond the author's control, ringing could not be performed.

The methods applied by KORODI GÁL and SCHMIDT were followed in the characterization of the birds in the area.

Constant-dominant species: Present in all four aspects in the course of the year. Breeding species. $F>80\%$ and in at least two aspects $Q>4\%$.

Aspect-characterizing dominant species: In the aspect $F>80\%$, $Q>4\%$.

Aspect-characterizing species: $F>80\%$, Q is not characteristic.

Concomitant species: which occur in certain aspects or throughout the entire year, but whose characteristics do not attain the above categories.

Accessory species: Recorded only rarely, and on isolated occasions.

Constant-dominant species

In the first year's study, *Galerida cristata* and *Passer montanus* can be classified in this category. 4—5 pairs of *Galerida cristata* nested in the sand-pit parts among the anthropogenic biomes and on the pasture periodically serving as the inundation area of the Maros. In both years 3 pairs successfully nested on the sand-pit parts, while the gravel-production and floodings on the inundation pasture meant that 1—2 pairs did not succeed in breeding.

Their feeding territory is confined almost exclusively only to the bank-line. On occasions they could be observed on the cultivated areas during ploughing, and on hot summer days. Their food consisted mainly of insects, but in summer too they seek out horse droppings, which contain partially digested seeds. At the same time, this is an excellent habitat for worms and insects. In late autumn and winter the stable manure brought out to the agricultural areas, and the seeds of the various weeds, provided feeding possibilities.

Appreciable numbers of *Passer montanus* sought out the bushes of the area for refuge, and the cultivated areas and the pasture for feeding purposes. They caused a small amount of harm to the cultivated areas, mainly because of incorrect agrotechnical methods. They performed a considerable role in the repression of the *Melolontha vulgaris* invasion in the first year. Unsuccessful attempts were made to nest in the two poplars.

Aspect-characterizing dominant species

Motacilla alba (I—III, I′—III′): nested in three and two pairs, respectively. Their breeding was unsuccessful on the high bank, but on the sand-pit area two pairs successfully bred in each year. Their food was collected around the sand-pits and from the cultivated areas on the Maros bank. The fairly large number of specimens visiting to seek food from the surrounding areas can be attributed to individuals.

Riparia riparia (II—II′): in the first year 10 pairs, and in the second year 6 pairs attempted unsuccessfully to nest, but they were successful on the opposite high bank-side. They generally acquired their food above the Maros and the pastures.

Pica pica (IV′): a species occurring constantly on the area. Their successive attempts to nest were thwarted by hunters. Their food consists mainly of insects, mice and to a lesser extent corn-seed.

Hirundo rustica (II—I′—II′): appeared on this area to search for food and to rest. In aspects I and III they could frequently be observed on the branches of bushes, and at night among the reeds. The largest number of specimens occurred in the second aspect, feeding their flying young on the bushes in the area.

Delichon urbica (II′): occurred less systematically than the former. It appeared on this area exclusively to feed. It nested in the town.

Streptopelia turtur (II): specimens visited the Maros-side from the more distant woods, in order to drink and feed. As can be seen from the Table, they occur in the highest numbers in aspect II. They visit the ditch to drink, and sit for hours on the branches of the bushes.

Passer domesticus (II—II′—III′): visited this area to feed and drink, and for refuge. They feed primarily on the cultivated areas, and in spring and the beginning of summer mainly destroy insects harmful to cultivated plants.

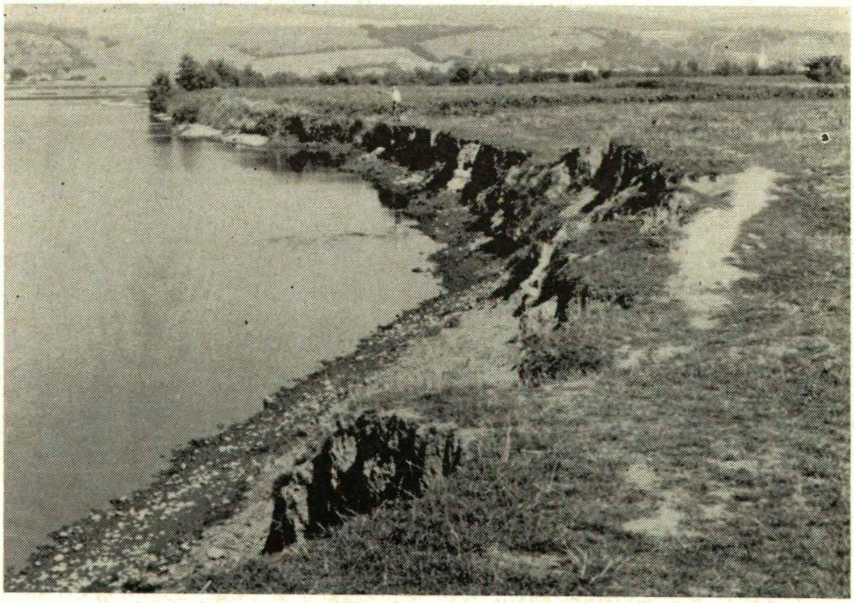

Fig. 3

Carduelis carduelis (II′—IV′): they seek mainly the plants *Carduus* sp. and *Dipsacus laciniatus*. In the second aspects they already visit the area with their young. In spring and early summer they come to the Maros-side to drink.

Sturnus vulgaris (I—III′): similarly to *Streptopelia turtur*, they visit the ditch beside the strip of bushes for drinking purposes. They were also observed to a lower extent feeding on the pasture.

Corvus cornix (IV—IV′): occurs in the largest numbers in the winter aspects, but appears in a well-demonstrable number of specimens in all aspects. Besides hunting for mice and insects, it fishes on the Maros-side, and also presumably raids the nests of *Charadrius dubius* .

Parus maior (IV): appears in greater numbers in general at the end of aspect II. For feeding it mainly visits the bushes and reeds.

Anthus pratensis (IV): comes to this area for migration and feeding.

Pyrrhula pyrrhula (IV′): a late-autumn and winter species. Its remaining on the area in the course of the second year can be attributed to the rich privet and weed growth.

Emberiza schoeniclus (IV′): generally appears at the end November. It mainly inhabits the bushy and reedy spots, but it is also predisposed to visit the weeds of the cultivated areas.

Buteo buteo (IV′): in the fourth aspect of the second year of observation it stands so close to this category that its discussion can be regarded as acceptable. In the other periods it generally appears in very low numbers. Because of the rodent invasion in the second year, however, it remained in the area in fairly large numbers. Exclusively only *Microtus arvalis, Cricetus cricetus* and *Mustela nivalis* remains were found in the *Buteo buteo* pellets examined.

Aspect-characterizing species

This section presents a discussion of those species which did not come into any of the above categories. The majority of the species nesting in this area belong in this category.

Charadrius dubius (I—II—I′): one of the characteristic birds of the Maros-side. It remains on this area from April until the second half of September. Two pairs nested in each year. In May or June the contents of the nests were destroyed because of the flooding. Successful nesting was observed only in the control period (14—17 July 1967).

Actitis hypoleucos (II—I′—II′): its phenology is similar to that of *Charadrius dubius*. In the first year it was established that two pairs successfully nested. The birds found their food on the Maros bank and on the pasture.

Acrocephalus arundinaceus (I—II): presumably one pair nested. In the second year, besides its own young it also reared a young *Cuculus canorus*. The family was observed on several occasions in the maize, and feeding the young in the bushes.

Acrocephalus palustris (II′): occurred in larger numbers along the bush-strip. Presumably 2—3 and 6 pairs, respectively, nested. No nests were found, but at the end of June and the beginning of July parents feeding their flying young were often observed. It fed primarily on the cultivated areas.

Sylvia communis (I—II—III): 4 and 2 pairs, respectively, nested in the bushes. Their nests were found only in the first year. They visit the cultivated areas diligently. They readily eat the berries of Sambucus nigra.

Sylvia curruca (I—II—III—I′—II′—III′): occurs in smaller numbers than the preceding species. Based on the singing males, 3 pairs are assumed to have nested in each year. A nest was found in the first year. In addition to three of its own eggs, the nest also contained an egg of *Cuculus canorus*. Its feeding area is predominantly the strip of bushes. It visits *Sanbucus nigra* intensively.

Luscinia luscinia (I′—II′): this seeks out the densest places. Its nests were not found. It is assumed that two pairs bred. It feeds exclusively on the bushy part. It readily consumes the berries of *Sambucus nigra* and *Cornus sanguinea*.

Lanius collurio (II′): the specimens observed in the first year visited this area from the neighbouring areas. Their nesting was observed at the beginning of August in the second year. In the control year 3 pairs nested. Their feeding grounds are primarily the pasture and the sand-pits.

Chloris chloris (III′): this area was sought out as a place for drinking and for refuge, in aspects I—II. It arrived in the third and fourth aspects to feed. One pair was observed nesting at the end of July in the second year.

Ciconia ciconia (II′): the visiting specimens arrived from the populations of the nearby villages. They collected their food on the Maros-side and on the pasture.

Buteo lagopus (IV′): in the second year its numbers were comparatively high because of the *Microtus arvalis* and *Cricetus cricetus* invasion. Pellet and stomach-content examinations gave the same results as in the case of *Buteo buteo*.

Falco subbuteo (III′): one pair regularly visited the area. Their food consisted mainly of locusts.

Falco tinnunculus (III′): occurs irregularly in the course of the whole year. It feeds mainly on insects and mice.

Streptopelia decaocto (III′): occurs in low numbers in almost every aspect. It visits the area mainly to drink.

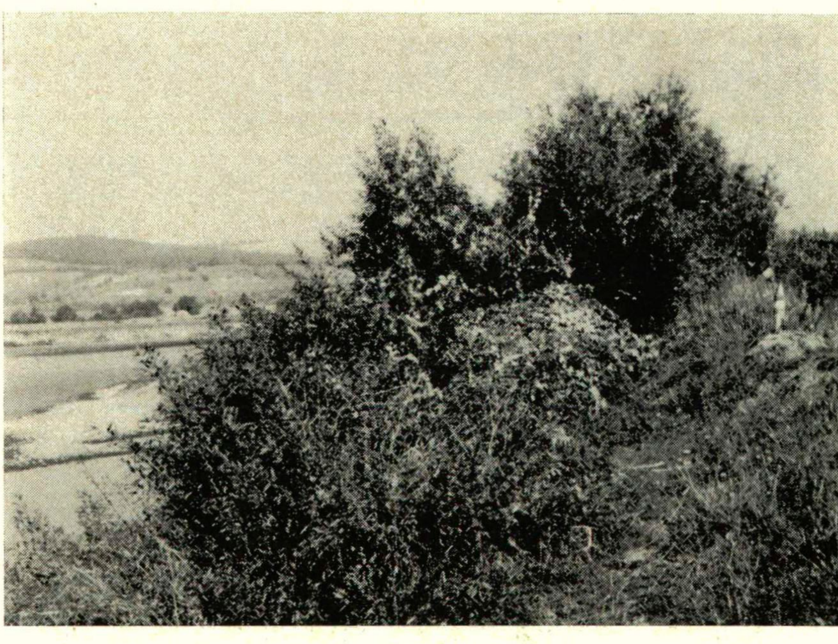

Fig. 4

Emberiza citrinella (IV): visits the area in the winter aspects. Its occurrence can be explained by the closeness of human settlements.

Phylloscopus collybita (III′): can mainly be observed on the autumn migration. Its feeding grounds are the maize and bushy areas. It is presumable that *Phylloscopus trochilus* specimens also occur among its population. It was observed only in the control period on the spring migration.

Concomitant species

Only the more important species in this category will be discussed. Since there are essentially two biotopes in the area examined, the species will be classified according to habitats.

Maros and bank-line: The following species were observed in this biotope: *Podiceps cristatus, Podiceps fluviatilis, Ardea cinerea, Ardea purpurea, Anas platyrhynchos, Anas querquedula, Aythya nyroca, Gallinula chloropus, Totanus totanus, Tringa ochropus, Tringa nebularia, Tringa glareola, Calidris minuta, Larus minutus, Chlidonias leucoptera, Chlidonias nigra.*

These species in part seek out this area at the time of migration, and in part come here to feed and rest at other periods of the year.

Bush-strip, pasture and cultivated areas: These provided food and refuge for the following species: *Accipiter gentilis, Accipiter nisus, Perdix perdix, Cuculus canorus, Upupa epops, Dendrocopus maior, Alauda arvensis, Oriolus oriolus, Corvus corax, Parus coeruleus, Turdus pilaris, Turdus merula, Turdus philomelos, Oenanthe oenanthe, Phoenicurus phoenicurus, Erithacus rubecula, Acrocephalus schoenobaenus, Lanius excubitor, Carduelis spinus, Carduelis cannabina, Fringilla coelebs, Embriza calandra, Fringilla montifringilla.* With only a few exceptions, these species sought out this area mainly in the migration and winter periods.

In the breeding season, two "species" visited the area more or less regularly: *Motacilla flava,* which was first observed in 1964 in the vicinity of Marosásárhely, and *Motacilla flava feldeggi,* first found on 7 May 1966. *Motacilla flava* is very widespread on the Maros-side. *Motacilla flava feldeggi* was observed in the environs of the town during the breeding period: 3 pairs in 1966, and only one pair in 1967.

Accessory species

The occurrence of some rarer species is reported below.

Pandion haliaetus: a rare species, even on a national scale. Observed on 5 occasions during the examination period.

Falco columbarius: observed on one occasion.

Squatarola squatarola: two specimens observed on each of three successive days. One specimen was collected. According to the literature, this is the fifth recorded occurrence in Transylvania.

Charadrius hiaticula: two specimens observed. Its occurrence was more frequent in the control period.

Calidris temmincki: observed in the company of two *Calidris alpina.*

Eremophila alpestris: observed once on this section of the Maros, and on 17 occasions below the town.

Remiz pendulinus: its occurrence is extremely rare. It was now observed for the first time in the past 10 years.

In the course of the observations in the control period, the following species were included in this category.

Turdus iliacus: 6 specimens found on 16 April 1967.

Larus canus: one specimen observed on 9 September 1967.

Limicola falcinellus: collected by ATTILA GOMBOS on this area on 31 August 1967.

Calidris ferruginea: 2 specimens observed and photographed on 11 September 1967.

Pluvialis apricaria: observed by ATTILA GOMBOS in April 1967.

TISCIANA HUNGARICA SERIES 1970—1972

Compiled by
M. MARIÁN

A list is given below of those publications of members of the Tisza Research Work Group which appeared between 1970 and 1972, and which were included by the Tisza Research Committee in the Tisciana Hungarica series.

1970

1. BÁBA, K. — 1970: Ökologische Beobachtungen bezüglich der Schneckenarten im Tisza-Tal. Die Besiedlung des Inundationraums. — Móra Ferenc Múzeum Évkönyve 93—100.
2. MEGYERI, J. (1970): Mesozooplankton of the Tisza, I. Rotatoria. — A Szegedi Tanárképző Főiskola Tudományos Közleményei 115—130.

1971

3. ANDÓ, M. — 1970—71: Natural geographic conditions of the Tisza-reaches (power basin) at Kisköre. — Tiscia (Szeged) *6*, 131.
4. BÁBA, K. — 1970—71: Malacocoenoses of backwaters of the Upper Tisza with various vegetations. — Tiscia (Szeged) *6*, 89—94.
5. GAUSZ, J. — 1970—71: Ecological and coenological investigations of Orthoptera in the environs of Poroszló. — Tiscia (Szeged) *6*, 57—66.
6. GÁL, D. — 1970—71: Die Rhizopodenfauna der ungarischen Strecke der Theiss und des Mündüngsteiles ihrer Nebenflüsse. — Tiscia (Szeged) *6*, 31—40.
7. HARKA, Á.—TÓTH, L. (1971): Fish-basket trap examinations in the region of the second lock-series on the Tisza. — Halászat *17*, (64), 114—115.
8. LEGÁNY, A. — 1970—71: Data to the ornithological conditions of the inundation area Tiszafüred—Kisköre. — Tiscia (Szeged) *6*, 41—55.
9. MEGYERI, J. (1971): Mesozooplankton of the Tisza. II. Entomostraca. — A Szegedi Tanárképző Főiskola Tudományos Közleményei 99—110.
10. SZÉPFALUSI, J. — 1970—71: Water-chemical investigations in the Csongrád—Szeged reaches of the Tisza. — Tiscia (Szeged) *6*, 1—18.
11. UHERKOVICH, G. — 1971: Über das Phytoseston der eutrophierten Theis (Tisza). II. Zur Frage der Indikatoralgen für den eutrophierten Flusszustand. — Tiscia (Szeged) *6*, 19—24.
12. VÁMOS, R.—TASNÁDI, R. (1971): Investigations to prevent mass death of fish in dead-arms of the Tisza. — Halászat *17*, 100—101.

1972

13. CSIZMAZIA, GY. (1972): Data on the biocorrosion of mammals on the flood-defence embankments in the environment of Szeged at the time of the flood in 1970. — In: Az Alsó-Tisza vidéki nagy árvízvédekezés, 1970. Budapest, 161—162.
14. HARKA, Á. (1972): Composition of the fish population of the living Tisza. — Halászat, *18*, 22—24.

RESEARCH INTO THE LIFE OF THE TISZA
CONFERENCE ON TISZA RESEARCH IN 1973

Compiled by
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In recent years it has become customary to hold a Tisza Research Conference, and such a conference was again held in 1973. This took place on 28 April, in the Assembly Hall of the Club-house of the Academy Committee in Szeged, with a total of 12 lectures. The topics varied from regional ecological problems of the Tisza valley to research into micro- and macrovegetation, and from the zooplankton to an account of the mammalian fauna of this valley.

Below are given brief summaries of the individual lectures and the contributed comments. (Those lectures which have since been published are indicated only by their titles.)

After the chairman's address by Dr. IMRE HORVÁTH, the lecture series began with a topic from the field of natural geography.

1. M. ANDÓ:

Regional ecological conditions of the Region-Conservation District at Mártély—Körtvélyes

The Mártély—Sasér area consists of homologous ecological facies closely connected to each other genetically, and of a group of these. In a regional sense the area forms part of the South Tisza valley, where only a small proportion of the homologous facies groups have remained in their natural state, the natural ecotope ghoup; here too in the bulk there are many close-lying economic ecotopes affected by anthropogenic activity. In the examination of the regions consisting of the various ecotypes in the course of the research into the regional areal elements it is also necessary to explain and investigate the natural and social-historical aspects, for in a geographical environment transformed to a considerable extent by the social-economic activity the natural factors similarly act to a changed extent and at a different rate.

Since this area has been increasingly under the effects of human activity since the turn of the century, the results of anthropogenic activity frequently fuse units differing ecologically from one another, possibly into a uniform areal type. (For example, the flood-free meadows transformed to plough-land have merged already ecologically with the cultivated steppe-meadows.)

One such ecological type is provided by the economically cultivated areas (ploughland) on the flood-land. The plough-land occupies about 10% of the area of the district, and lies mainly on the backs of the riverside dunes on the higher parts of the flood-land. Nowadays these areas to a considerable extent already possess an excellent soil structure. The character of the soil is developing from the meadow irrigation to the open country soil type.

Prior to the flood-water regulation these parts were not covered by flood-water. They have been inundated only since the construction of the embankment systems. In the course of the surface development here a complex of ecotypes differing sharply from the aquatic environment can be observed in the case of the soil and the individual surface substrates.

The effects of human activity are less significant on the areas of the flood-area grassy surfaces (meadows, pastures). The flood-area meadows occur sporadically. A larger unified area is observed in the region of Körtvélyes and on the widened flood-land lying to the south of this. In certain places the grassy surfaces are utilized for pasturing and for hay-making, but complex pasture and meadow farming does not take place on them at all. As a consequence the interactions of the natural processes now taking place proceed relatively naturally in the stock types of the individual grass vegetations.

As regards the open-country (meadow and flood-area pastures) ecotypes it can be noted that the mutual correlations of the natural geographical factors are sharply reflected in the individual qualitative and quantitative features. For example, the micro-relief of the terrain and the related hydrological conditions stand out significantly in the composition of the vegetation.

Since the flood-plain of the Tisza is involved, one might think that the water is not a problem here. It can be proved, however, that the flood-area is one of those areal groups where there is at times plenty of water, but at other times only a little, i.e. as regards the water-household it can be classified as very extreme. To outline briefly the hydrogeographic conditions (one of the most decisive factors here) on the area of the flood-land, it may be stated that the state of the layer-water below the flood-plain surface varies in parallel with the water-level in the living river. Since the water-level of the Tisza is low, particularly in the vegetation period, it follows that the soil-water too lies deep down below the level of the terrain. The soil-water level of the flood-plain is not raised either by the soil-water flowing in from the area of the Hungarian Plain, since the flood-land environment lying outside the embankment systems is 2—3 metres lower on average than the flood-area level. Consequently, the soil-water flowing into the valley of the Tisza runs off to a considerable extent by flowing down from the surface via the drainage channels, and passes directly into the living river. As a result of the water-sealing effect of the deposit of the flood-area surface, the precipitation falling on the surface flows off predominantly on the surface. This quantity of water does not reach the level of the soil-water either, so that the local precipitation does not mean a replacement either for the soil-water reserve of the flood-plain. In contrast, it frequently occurs that surface waters form on the occasions of heavier precipitations in the low spots of the flood-plain; these evaporate rapidly in the summer period, and hence the water-vapour content of the air of the flood-plain increases. Particularly on the flood-area meadows it is possible to find surface water which are relatively well-protected from the wind among the woods of the flood-plain. Favourable moisture conditions develop on such type of meadow and open-country ecotopes, as observed on meadows outside the flood-area. Where the meadows are not protected from the wind there is a difference of 10—15% in the humidity content in the flood-plain too.

In the flood-plain perhaps one of the most significant natural and anthropogenic ecotope groups is the flood-area wood population. On the Mártély—Sasér flood-plain this ecotype exhibits a considerable heterogeneity in the non-distribution of the species (from the plane tree to the willow). The appreciable effect of the anthropogenic factor is reflected by the colony types, which can not always be brought into correlation with the relief of the terrain and with the other natural features.

However, on this area there are also small woods remaining, where the state before the flood-water is reflected, i.e. as a consequence of the current natural factors characteristic forms are developing, which differ from the anthropogenic ecotopes. Such, for instance, are the wood populations to be found on the deeper parts lying between oxbow-lakes, or the oxbow lakes themselves on partially filling marsh-land.

Since 75% of the surface of the area is covered by woods, the work already carried out as regards the terrain investigations has been concentrated on the study of the woodland ecotopes. During the past 20 years a terrain investigation has been performed in a cross-section of the Tisza flood-plain at Algyő, Sasér, Ludvár and Körtvélyes.

The natural and artificial wood population of the flood-plain serves to decrease the force and rate of the flood-wave. Consequently, the possibilities of the danger of flooding in Szeged and its district are reduced. This is of particular importance when the flood-wave of the Tisza coincides with that of the Maros. In order to avoid this situation completely, anthropogenic intervention has been performed to produce woods on the flood-plain.

In the flood-area wooded environment developed since the turn of the century numerous residual ecotypes are encountered, where the natural geographical processes are being considerably enhanced and the anthropogenic effects are decreasing. Such areas are the standing-water surfaces of the oxbow-lakes, and the areas of the partially filled oxbox-lake marshes.

Contributions to the discussion:

B. Szőkefalvi-Nagy: The scientific work is an aid to raising the level of tourism, and is an effective supporter of conservation of the biosphere (pollution, biological equilibrium, etc.).

I. Kiss: Attention is drawn to the connection between flood-defence work and sodification: the dangers of breaks in embankments and inundation by water because of embankments constructed from sodic soil.

Gy. Bodrogközy: The regional ecological examinations provide a good basis for other biological researches. The maps prepared are considered of particular value. However, a survey of the soil-geographical development is required.

M. Marián: The preparation of the maps should be continued. The occurrence of Trochosa singoriensis at Mártély had become understandable; this species could maintain itself only on a dry island before the regulation too. In connection with the drying-out of the flood-area grove-woods, the destructive activity of man was suggested.

The lecturer's reply: He wished to give a soil-ecological picture, with special regard to the perspective anthropogenic effects.

2. T. Kiss Keve:

Conditions of the development of plankton algae population maxima in the Eastern Main Canal and the Tisza

In the Eastern Main Canal, where a water-purification plant is being built, a particular worry at the time of the plankton algae population maxima is the ensuring of drinking-water of good quality. The algae may give rise to taste and smell problems, and may make filtration difficult. Accordingly, it is important to examine those factors which affect the rapid multiplication of the phytoplankton.

The development of a population maximum characterized by a dominance of *Cyclotella* has been observed at the beginning of the year in every year since 1969 in the Eastern Main Canal. The main constituents of the algal association were *Cyclotella kützingiana* and *Cyclotella meneghiniana.*

The spring silicaceous-algae maximum has been described by very many authors, primarily from lakes. In their view a significant factor in the development of the diatom maxima is that during the winter the phosphorus, nitrate and silicate accumulate in the water; the amounts of these decrease in parallel with the rapid multiplication of the algae. Other essential factors are considered to be increasing water temperature and the light.

There are no exact data with regard to the phosphorus, nitrogen and silicate contents of the Eastern Main Canal; it is assumed merely that they must be present in concentrations favourable for a *Cyclotella* maximum.

The role of temperature in the canal has not been clarified completely. In some cases the temperature of the water increased in parallel with a rapid multiplication of the algae (in 1969 from 6 to 9.5 °C; in 1970 from 3 to 8 °C; in the period 15—29 March 1971 the water-temperature rose from 2.7 to 9.8 °C, while the number of algae increased from 50—100 thousand to 1000—8000 thousand individuals per litre). At other times, however, the temperature fell when the maximum was developing.

In the case of the Eastern Main Canal it was observed that an important role is played in the development of the plankton algae population maximum by the light conditions prevailing in the water. *Cyclotella* maxima develop only when the suspended-matter content is low, the turbity of the water is low (a turbidity less than 3 mg mastix per litre), and the translucence is high.

Contribution to the discussion:

M. ANDÓ: How was the translucence of the water measured?
The lecturer's reply: A selenium-cell luxmeter was employed.

3. G. UHERKOVICH:

The occurrence of *Biddulphia levis* EHRBG. in the Tisza

(Because of the absence of the author, the lecture was read by Dr. M. MARIÁN.)

The *Biddulphia* (GRAY 1831) silicaceous alga family contains about 100 species. The majority of these are marine organisms, and some of them also pass over into brackish water. There are also two species in the family which at times pass over from brackish water into fresh water, but these occurrences can not be regarded as typical fresh-water occurrences.

One of these *Biddulphia* species which has also been observed in a few cases in "fresh water" is *Biddulphia levis* EHRBG. This organism has been found in the Tisza too. The author has found it on threads of the characteristic red alga of the Tisza, *Thorea ramosissima* BORY, colonized directly below the water-line on floating objects at Szeged.

A closer ecological analysis of the habitat revealed the following: The water of the Maros has an NaCl content far in excess of the fresh-water average (expressed as Cl ion, it is generally 150—230 mg/l). As a result of this high content in the Maros, the NaCl content of the Tisza too rises below the mouth of the Maros, and at Szeged has a value of 90—120 mg/l (expressed as Cl ion). The high NaCl content compared with other fresh waters is one of the reasons for the occurrence of *Biddulphia* here. Nevertheless, in itself the NaCl concentration would not be enough to explain the occurrence of *Biddulphia.*

As regards the oxygen and other dissolved substances, it has long been shown that the lower concentrations of certain substances in river water is sufficient to satisfy the special demands of living species, for fresh doses of these substances can be taken up continuously from the river water flowing past the body surface. Thus, the river water may represent physiologically higher concentrations of certain substances than standing water containing the same concentrations. In the present case too the not insignificant NaCl content corresponds to a physiologically higher concentration. Further, the presence of the halophyton *Nitzschia filiformis* (W. SMITH) HUST. of the other silicaceous algae, living adhering on the assimilation hairs of the Szeged Thorea ramosissima, indicates that this biotope with its characteristic ecology is to be regarded physiologically as a limiting case in a certain respect of the fresh-water biotopes.

Contribution to the lecture:

I. KISS: The speaker gave an account of and praised the book of Gábor Uherkovich: The phytoseston of the Tisza. This book summarizes the results of 10 years' alga research. It is a work striving for completeness, and lays claim to international interest too. The results of examinations along the length-profile of the Tisza are compared with the data for other Central European rivers.

4. L. GALLÉ:

Plant ecological and teratological observations on the flood-areas of the Tisza

A certain correlation can be established between the floodings, the artificial irrigations and the occurrence of the teratological phenomena. Most plants do not benefit from a prolonged period of inundation, and those organs which developed in the dry are not developed further. Primarily the leaves are destroyed. As a consequence of the inundation, however, it is possible to observe the teratologic change not only of the leaves, but also of the flowers, which tend to turn green (chlorantia). In this phenomenon the petals may be transformed to upper leaves or broad leaves, but every part of the flower may appear in the form of green leaf structures.

The chlorantia can be well observed in *Ranunculus sceleratus, Limosella aquatica, Bidnes tripartitus, Potentilla supina, Juncus bufonius* and *Cyperus fuscus,* and in *Senecio vulgaris* may sometimes attain nearly 50%.

In flooding areas other abnormalities too can occur: e.g. twin-leaves and ascidia in *Euphorbia* and *E. virgata*; many scapus-fasciato in the *Taraxacum* family; twin-leaves in *Xanthium strumarium* and *Salix alba*×*triandra* hybrid; twin-flowers in *Malva silvestris* and double, imparripinate leaves in *Fraxinus pennsylvanica.*

As the inducing factors, mention may be made of the qualitative and quantitative changes in the nutriments as a result of the inundation; the changes in the physiological state of the plants; and secondary virus infections.

Contribution to the discussion:

I. HORVÁTH: In the case of the teratologic changes, does the function play a primary or a secondary role, and is it a matter of nutriment enrichment?

The lecturer's reply: The abnormalities are caused by chromosome aberrations and polyploidy but the effects of the nutritional factors are beyond doubt. The fact of the inundation is considered to be a strongly-acting factor.

5. GY. BODROGKÖZY and I. HORVÁTH:

Production examinations on the hayfields of the Mártély—Körtvélyes Region-Conservation District

Contributions to the discussion:

M. ANDÓ: Does the plant production vary in time (compared to the 1950 data)?

I. KISS: Attention is drawn to the fact that examination of the root mass is of importance as regards production biology (N equilibrium).

The lecturer's reply: The interaction of the relief conditions and the vegetation is beyond doubt. There was not an extensive change during the past 20 years, but a new survey would be necessary to record the certain shifts.

6. M. MARIÁN:

The present state of the zoological research in the Region-Conservation District at Mártély—Körtvélyes

A survey is given of the results and problems of the zoologists of the Tisza-Research Working Committee who are carrying out research in this region. The basic aim is the ecological faunistic elucidation of the district, in the interest of the future zoological reconstruction. These examinations will be followed by production-biological, ethological and other researches.

At present 13 specialists are studying 16 systematic groups or zoocoenoses (Zooplankton, Benthos, Collembola, Ephemeroptera, Odonata, Plecoptera, Orthoptera, Formicoidea, Rhynchota, Lepidoptera, Oribatiformes, Pisces, Amphibia, Reptilia, Aves, Mammalia).

From a comparison of the supply of specialists in the Working Committee and the number of taxonomic units and zoocoenoses investigated with the corresponding data for other research communities, it is found that Szeged is in a much better position than the Hungarian Danube Research Station or the Sodic Working Community of the SZAB, but from such an aspect the situation is not so good as in the Bakony Research Working Community, where more specialists carry out research in more directions.

90% of the work of the researches is restricted to Körtvélyes island. Investigations must be extended to the Barc meadow, to Kutyafenék and to Mártély island.

How much progress has been made by the ecological and faunistic research? From the reports given it has turned out that the working group can give a fauna list on 8 systematic groups, and similarly 8 investigators can characterize the zoospecies of their special fields from a zoogeographical point of view.

For the time being some interesting contradictions appear in the results: some investigators emphasize that hill-living species are not found; in contrast, others stress that the fauna of the area examined exhibits many related features to those of the Upper Tisza fauna. It turns out from all this that many investigations will be required before the Working Community can make a satisfactory proposal with regard to the fauna reconstruction.

To summarize, it is stated that, with the exception of one or two systematic groups, the study of the essential taxonomic units has begun well. It is proposed that the present year is an exceptional one, when the spring flood-water did not cover the flood-plain, and should be well utilized for research. In this "dry" year a significant proportion of the fauna will regenerate well. Thus, the examination results can be usefully compared in the future with the results of the normal "flood-water years".

Contributions to the discussion:

D. GÁL: As supplementation it is reported that Dr. LÁSZLÓ MÓCZÁR too is making collections.

M. FERENCZ: The question of the necessity of water-chemical examinations is raised, this being closely connected with water-pollution problems.

K. KISS: In addition to water-chemical examinations, investigations of the phytoplankton too are considered necessary.

S. TÓTH: A complex entomological collection is considered useful. Attention is drawn to the fact that Coleoptera trapping would be necessary.

L. GALLÉ: Seasonal entomological collection is considered important, all the more so since new data can be expected in this field (see Á. UHERKOVICH who described a new butterfly subspecies from this area).

I. DOSZTÁL: Offers his help in the carrying-out of water-chemical examinations.

I. HORVÁTH: Similar surveys are seen to be very useful, all the more so since in this way the tasks of the future can be laid down.

The lecturer's reply: The water-chemical examinations have not been solved for the moment (perspective: assistance from water-conservancy and Dosztál). The participation of specialists in the entomological collections is considered useful.

7. D. GÁL:

Zooplankton of the Dead-Tisza at Körtvélyes in 1972

From February until November 1972 zooplankton collections were made monthly from 3 points of the Dead-Tisza at Körtvélyes. From February until May the total zooplankton amount increases steadily (from 8900 to 64,200 individuals per 10 litres). In May it attains the maximum, and then decreases continuously to nearly half (37,800 individuals per 10 litres). In October the total number of individuals increases somewhat (51,100 per 10 litres), and then again decreases in November.

With the exception of April, the Rotatoria species always dominate as regards both the number of species in the zooplankton and the number of individuals. The Protozoa are generally low, while the Entomostraca family appears with moderate numbers of species and individuals.

The species characteristic of the dead-arm, and occurring most frequently, in the highest numbers of individuals, are as follows:

Protozoa: *Arcella discoides* EHRENBERG, *Difflugia globulosa* DUJARDIN, *Centropyxis aculeata* EHRENBERG, *Centropyxis constricta* DEFLANDRE, *Codonella cratera* LEIDY, *Vorticella campanula* EHRENBERG, *Stylonychia mytilus* EHRENBERG.

Rotatoria: *Polyarthra vulgaris* CARLIN, *Keratella cochlearis* GOSSE, *Brachionus angularis* GOSSE, *Lecane luna* MÜLLER.

Entomostraca: *Moina rectirostris* LEYDI, *Bosmina longirostris*-typica MÜLLER, *Chydorus sphaericus* MÜLLER, *Megacyclops viridis* JURINE.

In the course of the year the saprobiological quality of the water also changed substantially. From February until May the oligosaprobe and beta mesosaprobe species dominate (o—b: 43.5%, b: 38.9%), while the beta—alpha-mesosaprobe species are present to a much lower extent (13.9%). In the summer months the quality of the water progressively worsens, and the numbers of individuals and species characteristic of beta—alpha-mesosaprobe water increase. The quality of the water in the dead-arm is worst in August, when the total number of individuals of the oligo—beta-mesosaprobe species decreases (32.7%), and in their place appear the beta—alpha-mesosaprobe species, in higher numbers of individuals (27.8%).

Contributions to the discussion:

GY. CSIZMAZIA: It is asked whether the Mártély or the Körtvélyes dead-arm is the more polluted.

GY. BODROGKÖZY: It is asked whether the effects of poisoning materials could be demonstrated, whether there is a correlation between the higher-order aquatic plants and the zooplankton, and whether special dead-arm species should be recommended as protected.

M. ANDÓ: It is considered interesting to explain the distribution of the zooplankton by air-motion. It would be worth determining the pollution at the time the water of the rice-fields is run off.

The lecturer's reply: The water of the Mártély dead-arm is shifted towards alpha-mesosaprobe. The effects of poisonous substances were not examined, though it is considered conceivable, particularly in the case of the Rotatoria. An undoubted connection was found between the higher-order plants and the zooplankton. At present not a single species can be recommended for protection.

8. S. TÓTH:

Dipterological researches in the region of the series of locks, Tisza II

Contributions to the discussion:

M. MARIÁN: Proposes the clarification of possible Culicida research now under way in this area.

L. GALLÉ: Asks whether there is a danger of malaria today along the Tisza.

The lecturer's reply: The discovery of Culicida examinations in the region of Kisköre is difficult; apart from those of FERENC MIHÁLYI, only sporadic data appear to be available. The lecturer does not know of malarial diseases, but *Anopheles maculipennis* does live along the Tisza too, and frequently in masses.

9. A. BANKOVICS:

The spreading of the olivaceous warbler along the Tisza

Contributions to the discussion:

P. BERETZK: The olivaceous warbler was first found at Szeged, and since then appears annually. In its spreading it follows the line of the Tisza.

M. MARIÁN: The lecturer's investigations are followed with interest abroad too. It is asked what occupies this species if it can be found in both gardens and flood-area.

GY. CSIZMAZIA: The explosion-like spreading of the olivaceous warbler (1958—61) has stopped. What is the cause of this? The questioner attributes it to the selecting action of the cuckoo.

M. ANDÓ: The extent of spreading of the olivaceous warbler can probably be explained by its climatic sensitivity.

The lecturer's reply: The true habitat of the olivaceous warbler is the flood-area wood, though it does also occur in towns. The cause of the high number of individuals around Szeged may indeed well be climatological. Its climatic sensitivity is undisputed. When driven from the flood-area at the time of flooding, in its need it also makes use of other habitats too.

10. A. LEGÁNY:

The study of bird associations on the Upper Tisza

As a consequence of human activity transforming nature, it is increasingly more urgent to take the natural environment into consideration. An assessment must be made of what dangers threaten the present living world, and how it is possible to ensure the biological conservation and equilibrium of the environment.

With this aim the lecturer has carried out ornithological observations in the area of the Tisza from Tokaj to Záhony, and prepared coenological recordings by the square and band method. The most productive biotope and nesting association were sought for.

In the course of the investigations a separate analysis was made of the individual biotopes (sand-pit wood, willow-poplar grove-wood, willow wood, acacias, mixed wood, poplars, orchards, pastures, ploughland, oxbow lakes, flood-defence embankments and the flowing Tisza). It was found that the most productive habitats as regards the nesting species are the woods. Of these, special mention must be made of the sand-pit woods (5185 g/ha) and the mixed woods (6505 g/ha). The numbers of species and nesting pairs also attained the maximum here. The poorness in species and low production of the poplars planted in place of the indigenous flood-area woods were marked; this should be stopped by means of mixed colonization and with artificial nesting sites. The wood biotopes at the leafy crown and trunk levels are the most favourable for the breeding species, and mainly for the insectivores.

The pastures and orchards primarily come into consideration as feeding areas. The numbers of species and individuals nesting were low, but the mass of those arriving merely to feed was more significant.

In the case of the ploughland and the flood-defence embankments (with the exception of the piles of wattle mats on the embankments), nesting species were not observed. These biotopes were important as sources of food. The mainly unusable ploughland areas might be made more mobile with half-wild pheasant breeding.

The low number of oxbow lakes with the insignificant quantity of ornifauna do not play an important role in the movement of material in the flood-area. They form an ecological unit fairly independent of the neighbouring biotopes.

The ornithological role of the river Tisza too is seen to be that of a resting area rather. This is so particularly at the time of migration. The consumption of food by the low number of species occurring (almost individualized) was not appreciable

Contributions to the discussion:

M. MARIÁN: The lecturer has carried out modern research on a little-studied and interesting area, and has also made useful proposals for the protection of the avifauna. It is asked to what extent the equilibrium of the avifauna is affected by the telephone poles there. In his view the hydro-meso-xerophil avifauna determination is questionable.

P. BERETZK: Because of the disappearance of certain species it would be interesting to take into account the effects of pesticides too.

K. BÁBA: It is asked whether chemical insecticides are used in the Upper Tisza area.

L. GALLÉ: It is asked what the enemies of the birds are on the cut pastures.

The lecturer's reply: The biological protection of the embankments is closely correlated with the telephone poles and wires. Chemical herbicides have not been observed on the flood-plain, but they have in the apple orchards; thus, a change is to be expected in the fauna. On the mown meadows where the avifauna is richer, the birds find food more easily, though their enemies, the fox and man, can also approach them more easily.

11. Gy. Csizmazia:

The mammalian fauna of the Region-Conservation District at Mártély—Körtvélyes

Contributions to the discussion:

M. Andó: The Upper and Lower Tisza districts are similar microclimatologically. It is proposed that steps be taken against the elimination of the big game in the area of Körtvélyes.
Gy. Bodrogközy: The lecturer is asked to collect the nature-conservance proposals and to submit them to the County Nature-Conservance Committee.
P. Beretzk: It is proposed that the otter should be declared a protected animal.
A. Bankovics: The recolonizing of the deer is not recommended before the regional reconstruction.
The lecturer's reply: In his view the differences in the Lower and Middle Tisza are caused by the microclimate.

Dr. Imre Horváth thanked the lectures and contributors, and made special mention of the fundamentally important lectures of Dr. Mihály Andó and Dr. Miklós Marián.

Announcements:

1. New members of the Working Group: Dr. Sándor Újhelyi and István Dosztál. For the time being Mária Tóth has left the Group.
2. A base-house is being constructed at Körtvélyes for purposes of accommodation and storage. A meteorological station is also planned at this site.
3. Tiscia will appear in two numbers this year. It is requested that articles be submitted in June—July.