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Studies on Unionidae populations from the Crapina- Jijila complex of pools (Danube zone liable to inundation)

by

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INTRODUCTION

Unionidae populations play an important role in the circulation of matter and energy, representing in certain waters, more than 90% of the benthonic fauna (ÖKLAND, 1963; MANN, 1964; NEGUS, 1966). In the Crapina-Jijila complex of pools of the Danube zone liable to inundation, the dominant species of Unionidae are: *Unio pictorum*, *Unio tumidus* and *Anodonta piscinalis*.

In Romania Unionidae, particularly those belonging to the genus *Unio*, are exploited for the button industry and used as fodder in poultry farms. Only here and there cases are known that mussel flesh is consumed by man.

In the Danube delta and in pools of the zone liable to inundation, mussels constitute an important source of food for pigs, which are left throughout the year to feed on the banks of the pools.

The investigations of BURLACU et al. (1968) showed that mussel meal administered to poultry in certain rations, has a much higher energy value than any other fodder used so far.

Brăila pool, together with the Crapina-Jijila complex of pools, constituted one of the most intensively exploited pools of the productive sectors (Fig. 1). According to data furnished by the Brăila State piscicultural enterprise during 1963—1967, the following quantities of valves of the species *U. pictorum* and *U. tumidus*, were produced from the pools around the Brăila locality (the Crapina-Jijila complex included):

Year	1963	1964	1965	1966	1967
Quantities in tons	789	663,2	101,1	242,4	238,5

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We mention, moreover, the fact that the Unionidae can serve as valuable indicators of accumulations of radioactive substances in different aquatic basins (RAVERA & VIDO, 1961; RAVERA, 1966).

Thus it follows that a rational exploitation of these molluscs is imperative, so as not to exhaust the aquatic basins of this natural resource, valuable both to man and to the economy of the pools. It has been the aim of the present study to investigate the populations of Unionidae from the viewpoint of population dynamics and elucidate their role as structural and functional units in the ecosystem.

From the structural point of view, problems of species composition, migration, age-structure, sex-ratio, reproduction and individuality will be dealt with. From the functional point of view the flow of energy through the population will be quantitatively ascertained. Concepts and methods elaborated by the following authors were used throughout this study: SCHMALHAUSEN (1946, 1958), DICE (1955), ODUM (1959), ZAVADSKI (1961), MAYR (1963), MACFADYEN (1963), BOTNARIUC (1964, 1967b), STUGREN (1965).

MATERIAL AND METHODS

The studies on the Unionidae populations of the Crapina-Jijila complex of pools were begun in October 1962. Observations were continued until 1967. In 1965 the Jijila pool was dammed up.

Collecting was carried out with a dredge built on the model of the one used by mussel collectors, fixed on a pole, to which a wire net was fixed with meshes of about 3—4 mm, thus avoiding selective collecting of individuals (TUDORANCEA, 1969).

In order to assess quantitatively the material collected with this dredge, starting and finishing points of dredging were marked with two poles and the distance between them measured.

Dredgings performed with this dredge were carried out each time in almost all of the 15 collecting zones (5 zones in the Jijila pool and 10 zones in the Crapina pool). Dredging zones always comprised the three kinds of substrate, described by BOTNARIUC & BELDESCU (1961a): silty bottom, hard bottom and silty bottom with vegetation.

Samples used to determine the dynamics of density, abundance and frequency of Unionidae, were taken as follows: Jijila pool: December 1962, on a surface of 38,05 sq.m., June 1963, on a surface of 114,88 sq.m., May 1964 on a surface of 41,31 sq.m., May 1965 on a surface of 77,60 sq.m., and April 1967 on a surface of 42,90 sq.m.; Crapina pool: October 1966 on a surface of 144 sq.m. and September 1967 on a surface of 80,10 sq.m.

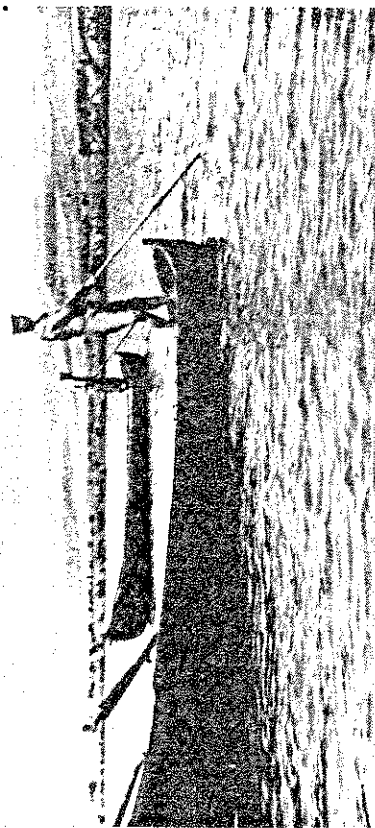


Fig. 1. Mussel collectors at work (Jijila, 1962).

In the above pools, molluscs are of yet another interest, connected with their role in pool morphology (BOTNARIUC et al., 1964). The huge quantities of shells, left over after the death of the animals, crumbled to pieces and carried by waves, constitute a basic material in the construction of bank ridges and pool shores. On the agglomerations of small pieces of shells, on which alluvial deposits settle, reed and rush clusters begin to grow, and in the long run change the configuration of pools, modifying the morphology and structure of the bottom and the banks, and affect the evolution of biological processes in them (Fig. 2).

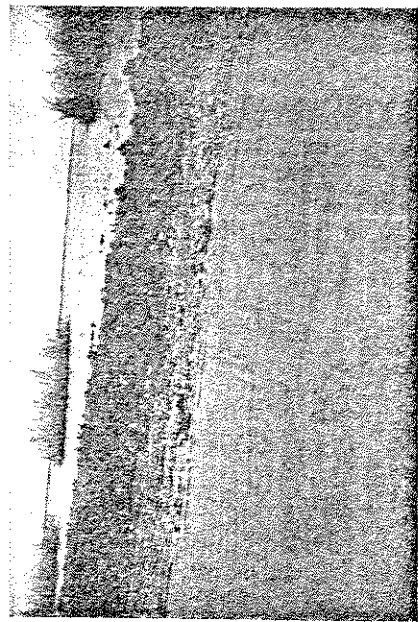


Fig. 2. Reed and rush clusters fixed on mounds made up of rests of molluscs and alluvial deposits (Crapina, 1966).

Beside these quantitative dredgings, qualitative samples were taken on the 1st and 15th of each month over a period of two years (1963, 1964) in Jijila pool, and once a month in Crapina pool in 1966 and 1967. This material, together with that collected quantitatively, was used to determine the growth of individuals, in establishing the structure by ages, sizes and sexes of the respective populations, and in obtaining certain data concerning reproduction biology.

The material employed for determining individual growth, and for establishing the age structure, was worked out in the laboratory, where the age, length, height, thickness and weight (with and without valves) of each individual were determined.

Age was determined by means of the growth striae, as indicated by several authors (SEBESTYEN, 1942; COMFORT, 1957; ÖKLAND, 1963; WILBUR & OAVEN, 1964; NEGUS, 1966). For a greater exactitude in age determination, we corroborated the result of the striae method with that of frequency curves of sizes (BOTNARIUC & TUDORANCEA, 1967).

Observations concerning the reproduction and gestation periods and on the sex-ratio were carried out on the material collected bi-monthly in 1963 and 1964 in the Jijila pool, and monthly in the Crapina pool in 1966 and 1967. Gestant females could be discovered by carefully opening the valves without killing the animal and observing the external branchiae filled with eggs or glochidia. Sex determination of individuals not in gestation calls for observation under the microscope.

For a determination the energy flow characteristic of each population separately, we used LINDEMAN's trophic model (1942), subsequently developed by other ecologists (ODUM, 1959; MACFADYEN, 1963). According to this model the quantity of energy assimilated by a population (A) is equal to the sum of the quantity of energy included in the population as weight increase (net production — P_n) and the quantity of energy spent in respiratory processes of the individuals (respiration-R).

We determined net production by the method based on the age structure, density, annual growth and weight increase of individuals (TUDORANCEA & FLORESCU, 1968a, 1968b, 1969). The energy value of valveless organic mass was established with a calorimetric bomb, after a quantity of moist substance had been previously dried at the temperature of 105°C.

Experiments concerning respiration intensity were performed in the period March 1966 — February 1967, on a total of 2,624 individuals: 1,122 *Unio tumidus*, 730 *U. pictorum* and 722 *Anodonta piscinalis*. Respiration was determined monthly most of the year in

natural conditions, using the WINKLER method, adapted to the field (BASLAVSKAIA & TRUBETKOVA, 1964). Batches of mussels of each species were used each time, the batches comprising individuals of about equal age and size. Each experiment lasted as long as the oxygen concentration of the water did not fall below 30% of the initial value. In summer an experiment generally lasted 1-2 hours, and in winter 3—4 hours. The molluscs employed were brought into the laboratory where they were measured and weighed, after having previously been drained of the water of the palaeal cavity with filter-paper.

The quantity of energy released by respiration was computed using IVLEV's mean oxaloric coefficient, equal to 3,38 cal/mg.O₂ (IVLEV, 1934).

The chemical composition of silt was determined in the Laboratory of Chemistry of the Bucharest Piscicultural Research Institute.

THE CRAPINA-JIJILA COMPLEX OF POOLS AND THE ABIOTIC FACTORS INFLUENCING THE LIFE OF THE ORGANISMS

The Crapina-Jijila complex of pools is integrated into the zone liable to inundation of the Danube, whose investigation was initiated by GR. ANTIPA (1910). On the one hand he showed broadly the origin of these waters and on the other hand, mechanism of the piscicultural productivity.

Continuing and extending the investigation initiated by ANTIPA, PROF. N. BOTNARIUC and a body of research workers, studied the Crapina-Jijila complex of pools for over 10 years, revealing a series of laws which govern the evolution of aquatic ecosystems of the Danube (BOTNARIUC & BELDESCU, 1961a; 1961b; BOTNARIUC, 1967a).

As the detailed description of this complex was already made by BOTNARIUC & BELDESCU (1961a), we shall only mention its characteristic traits, necessary for understanding the present problem.

The Crapina-Jijila complex is situated on the right bank of the Danube, in the north-western part of the Dobrudga (Fig. 3). The two main pools, Jijila and Crapina, have a different location and geomorphology, and communicate by the Lătimi streamlet. At present the Jijila pool is transformed into fish-ponds, retaining the connection with the Danube, but its connection with Crapina is interrupted. The Jijila pool, with a total surface at medium waters of 1390 ha, has its longitudinal axis in a N-S direction, while the Crapina pool, with a total surface at medium waters of 2480 ha, presents its long axis in a NW-SE direction. The shore line of the

Jijila pool is less sinuous than that of the Crapina pool, and thus the perimeter of the former is smaller (17,500 m) than that of the Crapina pool (49,000 m). The bottom of the Jijila pool has the shape of an elongated, shallow basin, having its deepest zone somewhere about the middle along its longer axis. The bottom of the Crapina pool presents a much more varied relief. A characteristic of this pool is the presence of several reed and rush clusters situated on some elevated parts of the bottom and made up mostly of rests of mollusc valves. Dredgings effected by BOTNARIUC & BELDESCU showed that the nature of the bottom is much more varied than in the Jijila pool.

The Crapina pool differs from the Jijila pool also as regards the adjacent system of streamlets and backwaters ('japsa'), which system is much more developed in the former than in the latter.

The different location and geomorphology of these two pools bring about a series of differences as regards the life progress in the two ecosystems. Of these we mention the following: Jijila pool is protected against the dominant north and north-eastern winds by the hills between Măcin and Bugeac on the east and north-east, while the Crapina pool is exposed to those winds. The Jijila pool (prior to its being dammed up) was in a more advanced degree of silting than the Crapina one. In the shallow Jijila pool wind and waves are able to stir up the water from the bottom, increasing the quantity of silt. This does not occur in the much deeper and more extensive Crapina pool, specially not after the damming up of the zone liable to inundation.

Owing to its more developed system of streamlets, Crapina pool offers much better shelter to the fauna of molluscs (BOTNARIUC et al., 1961c), than Jijila pool.

The different geomorphology of the two pools, ensures a very limited exchange of individuals between the respective animal populations, resulting in a certain degree of differentiation between the adjacent populations of the same species.

Besides these differences between these two pools, there is a series of similarities, originating from the fact that both pools are submitted to the periodic action of the Danube high floods, and causing similarities in the development of biota in the two ecosystems and in the rhythm of biological processes.

Of the abiotic factors of the complex, we shall only mention those acting on the benthonic fauna.

Wind

In the Crapina-Jijila complex, wind represents a factor with a

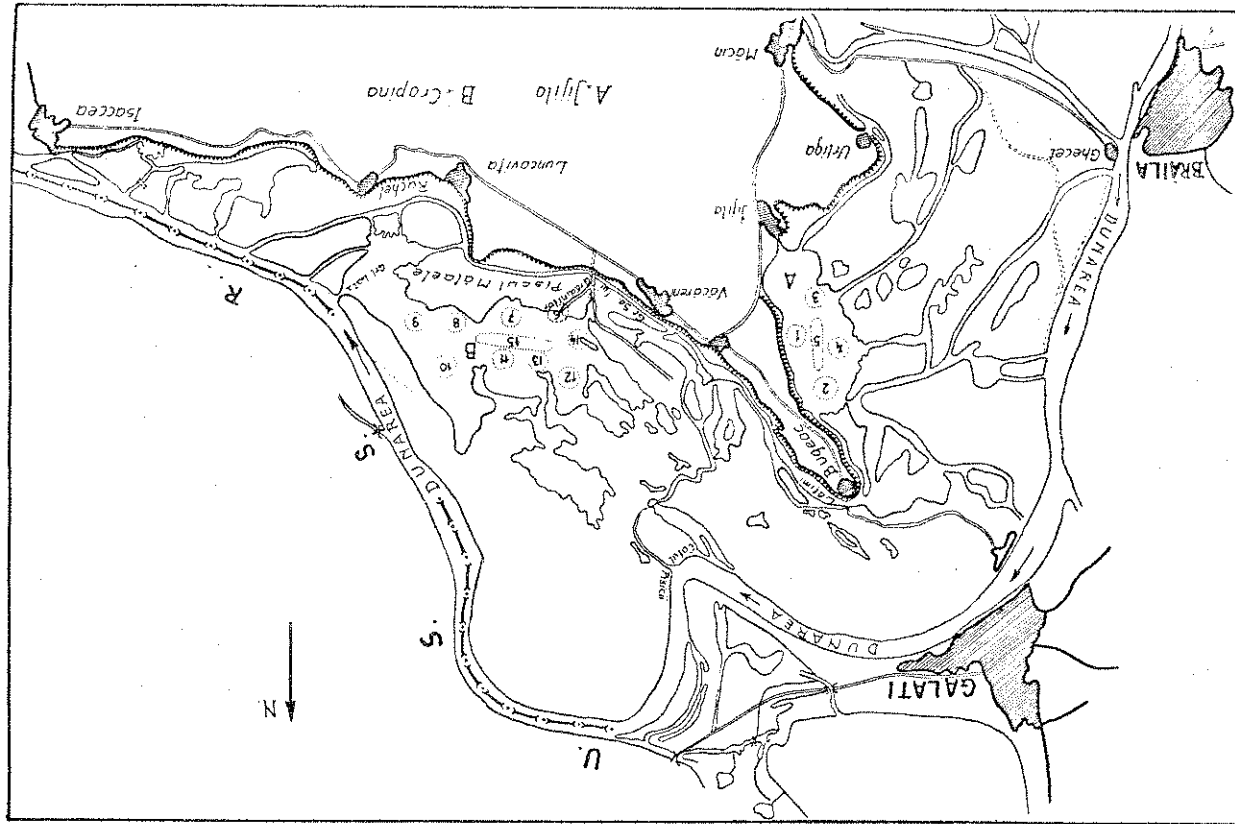


FIG. 3. Crapina-Jijila complex of pools.

multilateral and complex influence upon the physiography and the biology.

One first consequence of the action of wind is the stirring up of mud, leading to the diminution of transparency. This has repercussions upon the development of vegetation, and on life processes of other biota as well. Another consequence is the distribution and sedimentation of alluvial deposits. Places exposed to the wind have rather unstable bottoms, which fact hampers vegetation as well as benthonic fauna. Places better protected against wind and currents have siltier bottoms and a richer benthonic fauna.

In the investigated region, wind exerts a strong morphogenous action through the agency of waves.

Particularly in the Caprina pool, which is exposed to N and N-E winds, waves carry and break up important quantities of mollusc shells and valves, thus continually raising the bank ridges. Moreover, during certain periods of the year strong winds throw large quantities of molluscs and vegetable rests upon the shores, thus inducing important modifications in the age and size structure of the mollusc populations (BOTNARIUC & TUDORANCEA, 1967; TUDORANCEA, 1969).

Temperature

The region around the Crapina-Jijila pools is warm and relatively dry, so there is an intense water evaporation. As a consequence of the large surface and the shallowness of the pools, the water temperature follows the average air temperature closely (BOTNARIUC & BELDESCU, 1961a). Maximum water temperature is attained during July-August, while the minimum will be found during the winter period (December-February). The difference between the temperature at the water surface and at the bottom is relatively small: 3°-4°C in summer and 1°-2°C during winter.

Water transparency

When Danube high floods are large, early and of long duration, this determines a low water transparency in the pools, and submerged vegetation cannot develop. On the other hand the phytoplankton, zooplankton, microphytobenthos, benthonic fauna and ultimately the fish fauna will develop well. Such a phenomenon occurred in 1956, when a particular abundance of molluscs, especially *Viviparus*, *Fagotia*, and Unionidae bivalves, was recorded (BOTNARIUC et al., 1961c).

In years with limited high floods or with large high floods arriving late, high water transparency permits the development of submerged and floating vegetation. In that case phytoplankton, micro-

phytobenthos, zooplankton, benthic fauna and fish will develop poorly.

Chemical composition of silt

This complex of factors affects the formation, growth, and perhaps the shape of the valves of the molluscs. Although the influence of the various chemical factors upon the life of molluscs is not exactly known, an essential condition for the formation of thick, good quality valves must be the presence of mineral salts and especially of calcium in either water or mud.

Another factor which may affect the quality of valves is the pH of the water. Usually a low pH leads to the erosion of valves. In places where organic substance accumulates and does not mineralize normally, the quality of the valves is deteriorated by acids formed.

The results of chemical analysis of silt samples collected in 5 stations situated in the Crapina pool and from one station (station 1) of the Jijila pool are given (Table I).

It follows from this table that the water is slightly alkaline and relatively uniform. Nitrates occur in insufficient quantities. Phosphates are likewise found in small quantities. Chlorides are present in small quantities in all samples, indicating slightly saline soils. Sulphates are characteristic of fresh waters and show values reaching a maximum of 0.197% at the Popina mică station (zone 7), in July 1967. The carbonates ascertained point to a moderate content of carbonic ions, characterizing slightly carbonated soils. In all stations the quantity of CaCO₃ is smaller in winter than in summer.

The organic substance in the entire complex indicates a normal mineralization of the bottom deposits, most values oscillating between 3.48% and 5.17%. A beginning of silting is recorded in winter months at station 6, where the values of organic substances were 6.08 and 7.18%, at stations 9 and 7 (the greatest quantity of organic substance of the entire complex was recorded in July: 15.08%).

STRUCTURE AND DYNAMICS OF THE UNIONIDAE POPULATIONS OF THE CRAPINA-JIJILA COMPLEX OF POOLS

Spatial structure and its dynamics

From the qualitative points of view, there are no differences between the mollusc faunas of the two pools. The mollusc association of each is made up of the following species: *Unio pictorum* LINNÉ, *U. tumidus* PULLIUSON, *Anodonta piscinalis* NILSSON, *A. Cygnea* LINNÉ,

Collecting zone	Date of collection	pH	Nitrates NO ₃ mg %	Phosphates P mg %	Chlorides Cl g %	Sulphates SO ₄ g %	Organic substance g %	Carbonates CaCO ₃ g %
(Jijila)	29.XI.1966	7.30	0.45	0.58	0.016	0.041	5.48	9.48
	5.VI.1967	7.35	0.55	0.030	0.007	0.057	3.48	12.43
	17.VII.1967	7.40	0.60	0.050	0.019	0.076	4.75	13.87
	10.XI.1967	7.40	traces	0.050	0.006	0.050	7.18	0.12
	18.I.1968	7.45	traces	0.041	0.005	0.053	6.08	0.16
	5.VI.1967	7.35	traces	0.031	0.007	0.108	3.37	9.91
	17.VII.1967	7.30	0.45	0.021	0.013	0.197	15.08	3.37
	5.VI.1967	7.40	traces	0.021	0.006	0.080	3.73	10.77
	10.XI.1967	7.40	traces	0.073	0.013	0.028	6.79	0.09
	18.I.1968	7.40	1.55	0.041	0.005	0.053	6.08	0.16
	17.VII.1967	7.40	traces	traces	0.034	0.080	5.39	15.01
	5.VI.1967	7.35	traces	traces	0.007	0.104	5.71	22.92
	17.VII.1967	7.35	traces	0.018	0.010	0.118	4.59	23.64
	18.I.1968	7.45	0.77	0.115	0.005	0.043	5.51	0.18
	21.V.1967	7.45	traces	0.089	0.044	0.053	5.48	9.92

TABLE I
Chemical analysis of mud samples collected from the Crapina-Jijila complex

Pseudanodonta complanata (ZGL) ROSSMAESSLER, *Pisidium henlowianum* SHEPPARD, *Dreissena polymorpha* PALLAS, *Monodonta pontica* EICHWALD, *Theodoxus fluviatilis* LINNÉ, *T. danubialis* C. PFEIFFER, *Viciparus viviparus* LINNÉ, *Valvata piscinalis* O. T. MÜLLER, *V. pulchella* STUDER, *Lithoglyphus naticoides* C. PFEIFFER, *Bilhyia lentaculata* LINNÉ, *Fagotia acicularis* FÉRUSSAC, *F. esperi* FÉRUSSAC, *Linnæa stagnalis* LINNÉ, *Corctus corneus* LINNÉ, *Gyraulus albus* MÜLLER

The differences between the two associations pertain to the following aspects: density, biomass and numerical relationship between the different species.

By comparing the density of molluscs in Jijila in December 1962 (Table II) (average water depth was 0.80 m) with the density of molluscs in the Crapina pool in September 1967 during similar conditions of water depth (Table III), it is found that the species of Lamellibranchiates are better represented in the Crapina pool, both as number and a biomass. Thus in the Jijila pool, the density of the five species varied between 2.0 individuals/sq.m. (zone 4) and 6.8 ind./sq.m. (zone 2) with an average of 3.8 ind./sq.m., while in the Crapina pool the density varied between 1.8 ind./sq.m. (zone 10) and about 36 ind./sq.m. (zone 6), with an average of 12.3 specimens/sq.m.

It follows that the degree of silting is less intense in the Crapina pool, the rivulet system around it which creates good conditions for water circulation offers better conditions for the development of these animals.

As regards density and biomass, the species of *Unio* take first place followed by *Anodonta piscinalis* and *Pseudanodonta complanata*.

The quantitative distribution of Unionidae molluscs is modified in time and space by modifications of its habitat. One of the factors inducing modifications of the density and biomass of mussels in the same place is the stretch and depth of the water, determined by the Danube high floods and their withdrawal. In water with large stretch, mussels are more widely dispersed over the pool and as the water subsides mussels begin to withdraw as well. In fig. 4 the average density variations of each Unionidae population investigated in the Jijila pool in the period 1962—1967 is recorded in relation to the depth of the water in different years. In periods with shallow water, thus with less extensive surface, mussel density is greater, and vice versa. However, the low density of the three species in Jijila, in April 1967, when the water reached its minimal depth and surface extension as a consequence of its damming up in 1964/1965, is partially accounted for by the action of intense exploitation of molluscs after damming up, and partly by the intense degree of silting, favoured by damming up. Thus the pool became stagnant,

which led to an intense mortality of molluscs. In samples collected in April 1967, a high percentage of empty valves was found.

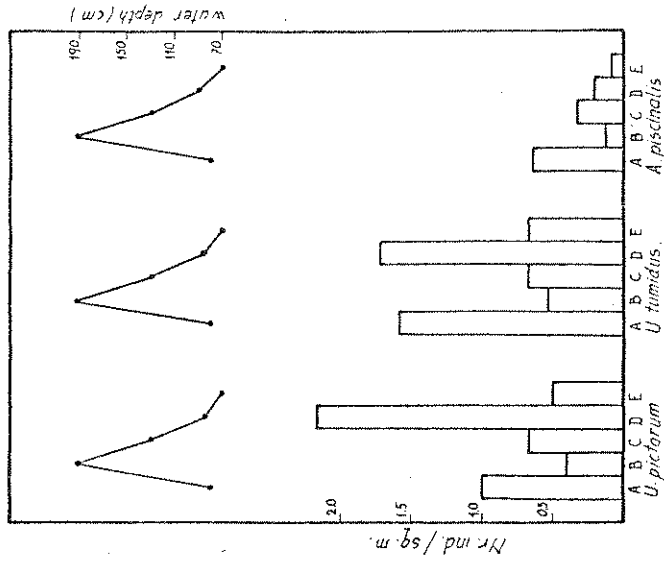


Fig. 4. Density dynamics of Unionidae populations of the Jijila pool in the period 1962—1967. A. December, 1962; B. June, 1963; C. May, 1964; D. May, 1965; E. April, 1967.

Other factors affecting the distribution of molluscs in these pools are: the nature of the bottom and the presence or absence of submerged vegetation. As detailed data concerning this problem are published in a previous paper (BOTNARIUC, NEGREA, TUDORANCEA, 1964), only the way in which these factors affect the spatial distribution of Unionidae will be briefly mentioned.

In places where the bottom surface is covered by a thick layer of bare mud, the richest fauna of molluscs is found. In this association, the Unionidae dominate, and among these the genus *Unio* dominates both numerically and in biomass. In places with silty bottom covered with vegetation (*Vallisneria* and *Ceratophyllum*), the association of molluscs has the same qualitative composition but in different quantitative relationships. Of the Unionidae, *A. piscinalis* becomes a dominant species, while the species of *Unio* take the second place. In places with sandy, well-aerated bottoms, the fauna

Col-lecting zone	Average depth (m)	Dredged surface (sq.m.)	<i>Unio picturum</i>	<i>Unio tumidus</i>	<i>Anodonta piscinalis</i>	<i>Pseudanodonta complanata</i>	<i>Monodacna pontica</i>	Total bivalves
6	0.40	4.50	nr./sq.m. 6.2	nr./sq.m. 19.3	nr./sq.m. 4.0	nr./sq.m. 38.0	nr./sq.m. 2.6	nr./sq.m. 35.9
7	0.80	18.00	nr./sq.m. 2.7	nr./sq.m. 13.5	nr./sq.m. 1.1	nr./sq.m. 4.9	nr./sq.m. 0.4	nr./sq.m. 6.5
8	1.20	14.40	nr./sq.m. 1.6	nr./sq.m. 31.9	nr./sq.m. 3.4	nr./sq.m. 0.2	nr./sq.m. 0.1	nr./sq.m. 7.2
10	1.00	5.40	nr./sq.m. 0.9	nr./sq.m. 19.8	nr./sq.m. 0.5	nr./sq.m. 0.0	nr./sq.m. 0.2	nr./sq.m. 1.8
11	1.20	8.10	nr./sq.m. 6.0	nr./sq.m. 77.7	nr./sq.m. 3.2	nr./sq.m. 9.4	nr./sq.m. 2.6	nr./sq.m. 207.7
12	1.50	4.50	nr./sq.m. 0.9	nr./sq.m. 4.7	nr./sq.m. 2.9	nr./sq.m. 9.3	nr./sq.m. 1.5	nr./sq.m. 32.3
15	1.50	25.20	nr./sq.m. 1.9	nr./sq.m. 13.5	nr./sq.m. 2.16	nr./sq.m. 5.1	nr./sq.m. 0.6	nr./sq.m. 77.5

Average values of the density and biomass (with values) of some bivalve populations of the Crapina pool, in September 1967

TABLE III

Col-lecting zone	Average depth (m)	Dredged surface (sq.m.)	<i>Unio picturum</i>	<i>Unio tumidus</i>	<i>Anodonta piscinalis</i>	<i>Pseudanodonta complanata</i>	<i>Monodacna pontica</i>	Total bivalves
1	0.75	6.15	nr./sq.m. 1.3	nr./sq.m. 30.9	nr./sq.m. 1.4	nr./sq.m. 2.9	nr./sq.m. 0.1	nr./sq.m. 3.3
2	1.00	10.25	nr./sq.m. 2.1	nr./sq.m. 40.4	nr./sq.m. 0.5	nr./sq.m. 13.5	nr./sq.m. 0.8	nr./sq.m. 68.9
3	0.85	10.65	nr./sq.m. 0.6	nr./sq.m. 26.4	nr./sq.m. 0.8	nr./sq.m. 16.8	nr./sq.m. 0.8	nr./sq.m. 133.0
4	0.70	11.00	nr./sq.m. 0.5	nr./sq.m. 10.4	nr./sq.m. 0.6	nr./sq.m. 16.5	nr./sq.m. 0.1	nr./sq.m. 35.8

Average values of the density and biomass (with values) of some bivalve populations of the Jijila pool, in December 1962

TABLE II

of molluscs is extremely poor. Among the 6 species present, the genus *Unio* dominates.

In the connecting rivulets of the complex with permanent water throughout the year and not overgrown by vegetation, the reversible current creates good aeration and molluscs develop in large quantities.

The species of genus *Unio* are most frequent, followed in order by *A. piscinalis* and *Pseudanodonta complanata* (Table IV). The decrease of Unionidae in 1967 in the Jijila pool, was caused by the intense exploitation of these molluscs and by the deterioration of the habitat.

TABLE IV
Frequency of Unionidae species in the Crapina-Jijila complex of pools

Species	Jijila		Crapina	
	1962	1967	1966	1967
<i>U. pictorum</i>	83%	87%	100%	100%
<i>U. tumidus</i>	100%	87%	100%	100%
<i>A. piscinalis</i>	91%	37%	100%	100%
<i>Ps. complanata</i>	66%	37%	73%	73%

From the point of view of abundance, a numerical dominance of the species of *Unio* is recorded in both pools (Fig. 5 and 6).

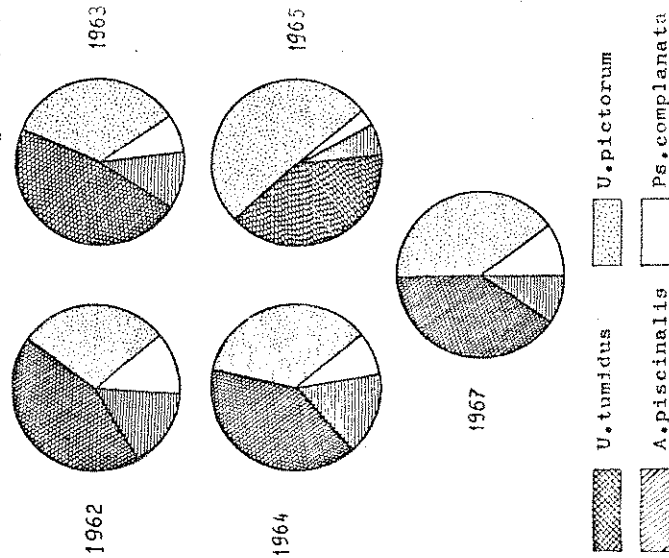


Fig. 5. Numerical abundance dynamics of Unionidae populations of the Jijila pool, in the period 1962-1967.

Examining the quantitative relationships between the species of Unionidae in the Jijila pool in the period 1962-1967 (Fig. 5), it is found that although modifications of the density, biomass and incidence of the respective species took place during this time, no significant modification took place in the quantitative relationships between the 4 species. Thus, in 1962, the species of the genus *Unio* represented about 73% of the Unionidae association and *A. piscinalis* with *Ps. complanata* the remaining 27%. In 1967, after numerous oscillations between the species which took place in the period after damming, the species of genus *Unio* represented 80% of the total of Unionidae, and *A. piscinalis* and *Ps. complanata* together, the remaining 20%.

The dynamics of numerical abundance of the species of Unionidae of the Crapina lake in 1966 and 1967 likewise presents insignificant variations between the species of genus *Unio* (Fig. 6).

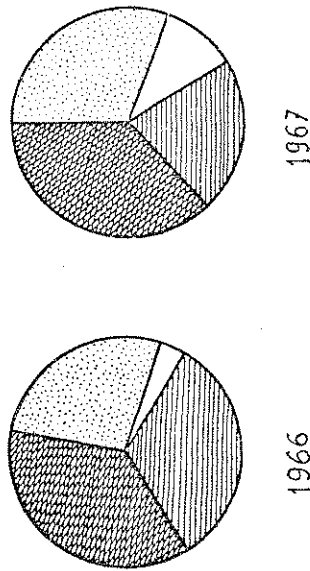


Fig. 6. Numerical abundance dynamics of Unionidae populations of the Crapina pool, in 1966 and 1967.

Migration

Shiftings of lamellibranchiate molluscs on the bottom of an aquatic basin, determined by water depth, temperature or pressure, were observed by several biologists (EVERMANN & CLARK, 1918; COKER et al., 1921; VAN CLEAVE, 1940; JADIN, 1952; MARKOVSKII, 1955), but the amplitude of such 'migrations' and its biological significance in river meadows liable to inundation were shown by BOTNARIUC et al., (1961c). These authors described two kinds of migrations of the species *Anodonta piscinalis* in the Crapina-Jijila complex: an autumn or reproduction migration, and a spring or feeding migration. The latter is carried out on tens of hectares around the pool, simultaneously with the overflows of Danube waters outside the pool (Fig. 7). On these grounds inundated by well heated water, a rich microbenthos develops, providing abundant food for bivalve molluscs.

TABLE V

Mortality of Unionidae molluscs on grounds liable to inundation after sudden subsidence of the water

Species	Nr./30 sq.m.	Age (years)
<i>A. piscinalis</i>	88	1—3
<i>A. piscinalis</i>	13	4
<i>U. pictorum</i>	4	4
<i>U. tumidus</i>	2	1
<i>Ps. complanata</i>	1	2

Such rapid subsidence of water from the inundated grounds does not occur every year, but when it does occur, the structure and dynamics of the Unionidae populations are severely affected by the marked mortality induced, particularly in certain age groups. As a rule, however, the water subsides gradually and most bivalve molluscs withdraw simultaneously.

Besides these active, spring and autumn shiftings, there is also a passive migration of Unionidae which takes place during the larval stage parasitizing on fish.

The passive migration of Unionidae has an important evolutionary significance, particularly for populations in the zone liable to inundation. In this zone, where different aquatic basins are connected with one another, and also with the Danube, fish can circulate all around, thus carrying the Unionidae larvae from one population to another. This circulation of genetic information between neighbouring populations in the zone liable to inundation of the Danube, does impede their differentiations, and adds to maintaining the integrity of the respective species.

Age structure

This structure represents a characteristic feature of each separate population, and is modified under the influence of various factors.

The age structure of the *Unio pictorum* population of the Jijila pool, differs from that of the Crapina population (Fig. 9). In the Jijila population this structure is characterized in 1962 by the numerical dominance of individuals of 6+, 7+ and 8+ years, and by a low percentage of juvenile individuals up to 3+ years and of those above 10+ years. In 1967, three years after damming up of the pool, the structure is characterized by the dominance of age classes from 5+ to 9+ years, and by the marked diminution tendency of classes of extreme ages. As a matter of fact, individuals of 1+ and 2+ years are lacking.

In the same year, the age structure of the *U. pictorum* population

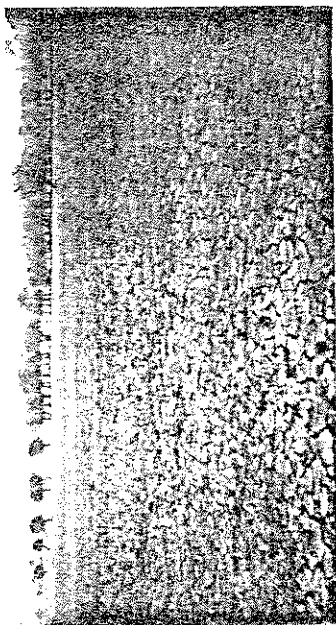


Fig. 7. Wide ground surfaces covered with water in years with great Danube high floods (Crapina, 1967).

At the end of August 1967 waters were subsiding rapidly from the inundated areas around the Crapina pool, and in the few days while this subsidence lasted, a real 'cemetery' of molluscs, especially Unionidae, remained on the dry grounds (Fig. 8). From a surface

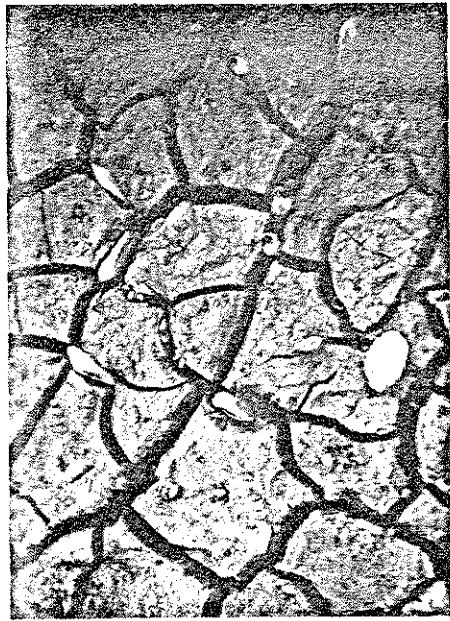


Fig. 8. Molluscs left on dry ground following the rapid withdrawal of waters (Crapina, August, 1967).

of 30 sq. m. we collected 108 individuals belonging to the four species of Unionidae. The greatest number of migrated individuals belonged to the species *A. piscinalis*, and of these most were juvenile specimens (Table V). The other individuals belonged to the other species of Unionidae, and were juvenile as forms well.

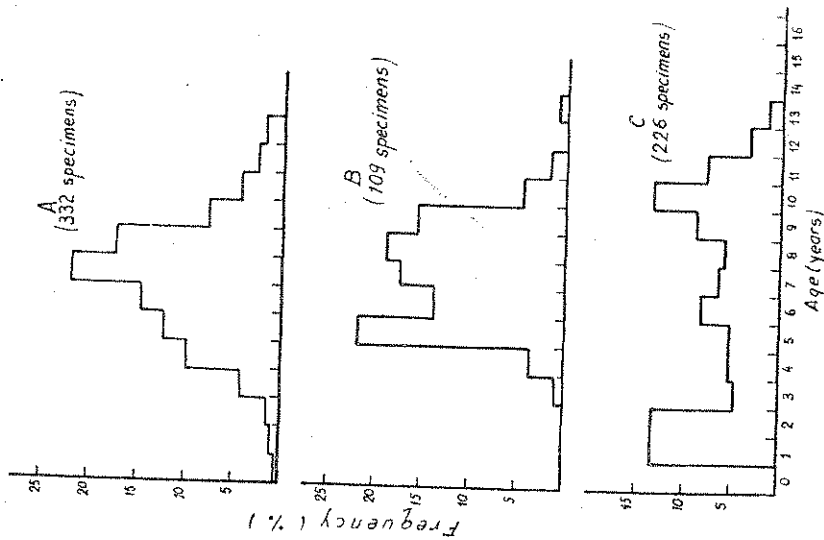


Fig. 9. Structure by ages of *U. pictorum* populations of the Jijila pool (a. December, 1962; b. April, 1967) and the Crapina pool (c. April, 1967).

of the Crapina pool is characterized by the numerical dominance of individuals of 1+ and 2+ years, and of those over 10+ years.

The size structure of the two *U. pictorum* populations differ as well. In December 1962 the *Anodonta piscinalis* population of the Jijila pool is characterized by a numerical dominance of individuals of 4 and 5 summers (49.1%), and by a very small percentage of juvenile individuals of one and two summers (6.9% and 9.6%). Due to the very small number of specimens collected in April 1967 in the same pool, we could not represent the age structure of this population in this period.

In September 1967, the *A. piscinalis* population in the Crapina pool, is characterized by the numerical dominance of individuals from the summer of the same year (18.79%) and of those of 4 summers (22.43%). Beginning with the 5th year, the percentage of individuals begins to decrease with age (Fig. 10).

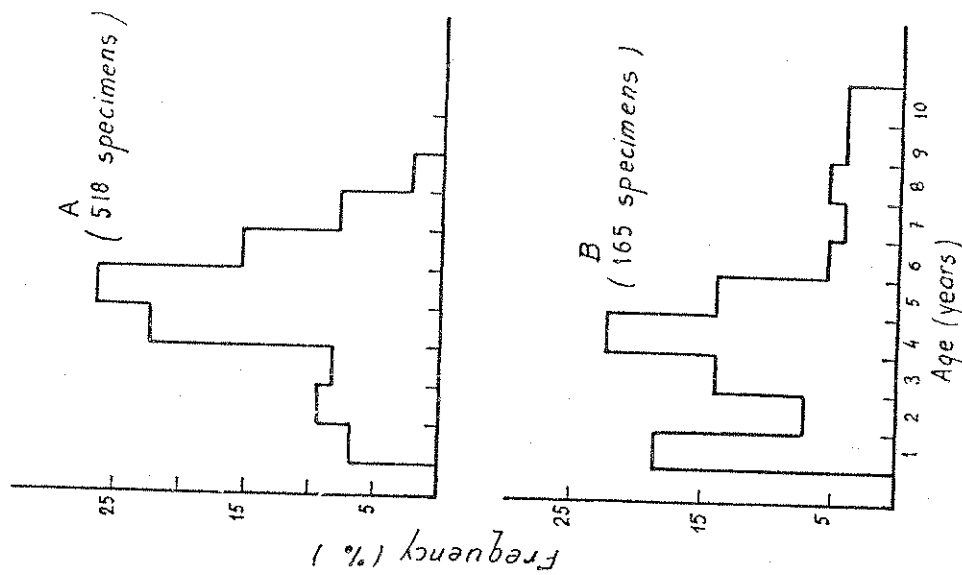


Fig. 10. Structure by ages of *A. piscinalis* populations of the Jijila (a. December, 1962) and Crapina pools (b. September, 1967).

The age structure of each separate population of *Unio tumidus* proved to be characteristic as well (TUDORANCEA, 1969).

The dynamics of the age structure depends on the relationship between birth and death rates, and is influenced by various environmental factors.

The birth rate of Unionidae molluscs in this habitat is mainly influenced by the Danube high floods. As was shown by BOTNARIUC et al. (1961c), years with great and long lasting high floods, e.g. 1956—1957, favour a good development of Unionidae, while years with small and short lasting high floods, offer poorer conditions. From our observations it follows that the absence of Danube high

floods in 1965 in the Jijila pool, owing to the damming one year before, interfered with breeding during the following year.

In the period April 15-July 18, 1965, of a total of 734 specimens belonging to the two species of *Unio* of the Jijila pool, none was found in gestation. This fact was confirmed by the absence of *Unio* juvenile individuals in the Jijila populations in the spring of 1967, those individuals which should have been born in the 1964—1965 period.

In the Crapina pool, which remained in connection with river system, this phenomenon was totally absent and overflowing the Danube waters brought about a rich development of Unionidae.

In the Unionidae mortality seems to be most intense in the larval stage. If glochidia do not succeed in clinging to some fish, they will die in a few days (BOTNARIUC & TUDORANCEA, 1967).

The action of mussel exploitation represents an important factor in the modification of the age and size structure of the Unionidae populations. Due to this action, the percentage of individuals of maximal ages and sizes diminished, as is evidenced by the situation in the Jijila pool, specially after the construction of the dam.

Sex-ratio

Taken as a whole the group of bivalve molluscs is characterized by unisexuality, because about 96% of the species of this class have separate sexes (COE, 1945 — after FRETTER & GRAHAM, 1964). This applies to the Unionidae as well (JADIN, 1952; PENNAK, 1953; GROSSU, 1962).

Investigations carried out of the Unionidae of the Crapina-Jijila complex showed that the relationship between the sexes is modified in different seasons of the year. In both species of *Unio*, the percentage of females exceeds that of males in the reproduction and gestation period (April-July) (Tables VI and VII). Beginning in July, thus concurrently with the end of the gestation period, the percentage of females begins to decrease in favour of males (37.3% in October 1966 in the *Unio tumidus* population, and 48.1% in October-November 1966 in the *U. pictorum* population). In the following year, beginning in March, the proportion of females begins to grow out again in each separate population, exceeding again the percentage of males in the reproduction period (April-July). It seems likely that in the sexual activity period a transformation of males into females takes place, while in the rest period a transformation of females back into males occurs, thus classifying these animals among the hermaphrodites.

The literature concerning the sex bivalve molluscs is fairly contradictory, some authors affirming their unisexuality (LEEWEENHOEK,

TABLE VI

Sex-ratio of the *U. tumidus* population of the Crapina pool

Period	Males (%)	Females (%)	Total number of individuals
May 1966	45.5	54.5	165
June 1966	45.7	54.3	162
July 1966	65.2	34.8	46
October 1966	62.7	37.3	75
March 1967	52.8	47.2	53
April-May 1967	47.6	52.4	128

TABLE VII

Sex-ratio of the *U. pictorum* population of the Crapina pool

Period	Males (%)	Females (%)	Total number of individuals
April-May 1966	45.0	55.0	60
June 1966	41.8	58.2	127
October-November 1966	51.9	48.1	52
May 1967	47.0	53.0	136
June-July 1967	53.5	46.5	252
September 1967	62.0	38.0	50

XVII century; BASTER, 1765; PREVOST, 1825; VON SIEBOLD, 1837; VAN BENEDEEN, 1844 — after LACAZE DUTHIERS, 1845; QUATREFAGES, 1849), others their hermaphroditism (MERY, 1701; POUPART, 1706; POLL, 1795 — after L. DUTHIERS, 1845; BLAINVILLE, 1828; PELSENER, 1895). In our opinion only a cytological analysis, more thorough than those made so far, combined with marking and recapturing experiments, permitting the observation of the reproduction process over a period of several years, would offer new data concerning the sex of Unionidae.

BIOLOGICAL HETEROGENEITY OF POPULATIONS

The pronounced variability of morphological characters of the Unionidae valves (colour, shape, size, a.s.o.) is well known. But the insufficiently profound study of the significance of this phenomenon, has led to the breaking up of species, and to the description of a number of morphological 'forms' of uncertain taxonomical status. According to HAAS (1940), BOURGUEINAR's school even wants to describe any individual differing in size or in other indices from the individuals already known, as a new species. KAESTNER (1955) mentions that forms belonging to two Central European species of

Anodonta, were initially classified into 88 species according to the morphology of their shells. HUNTER (1964) shows that although 458 species of Unionidae had been described in Switzerland and France, there were in fact less than 10 valid species of *Anodonta* and *Unio*.

In what follows we shall show a few aspects of the variability of the Unionidae populations of the Crapina-Jjilla complex, attempting to elucidate the biological significance of at least some of them.

Size, growth, colour

The maximum size of *Unio* and *Anodonta piscinalis* individuals of the pool complex studied, are generally included within the maximum limits established by other authors.

Thus, the maximum sizes of *U. tumidus* individuals were 92/40/29 mm, as against 90/40/35 mm quoted by JADIN (1952) and 110/50/35 mm quoted by GROSSU (1962).

The maximum sizes of *U. pictorum* individuals were 96/40/30 mm as compared with 90/40/28 mm of those quoted by JADIN and 102/42/30 mm of those quoted by GROSSU (1962).

The *A. piscinalis* specimens of the investigated pools attain a maximum size of 116/56/36 mm, as against 109/65/37 mm quoted by JADIN (1952) and 95/60/29 mm mentioned by GROSSU (1962).

The variability of the sizes of individuals of the same age was extremely large. This variability is all the more accentuated as individuals of the same size can belong to 3, 4 or even 5 different ages. At juvenile ages of 1—2 years, *A. piscinalis* and *U. tumidus* individuals, can exceed in length that of other individuals of the same age twice or three times (BOTNARIUC & TUDORANCEA, 1967; TUDORANCEA, 1969).

Growth in length in individuals of the three species (Fig. 11) proceeds continuously, being more intense in the first years of life, and becoming less pronounced afterwards without stopping altogether.

For all three species one of the causes of the slowing down of the growth rhythm after the first three years is attaining of sexual maturity. A great part of material and energy resources of the body of mussels is then used for the formation of glochidia and growth will have to slow down.

As was shown earlier (BOTNARIUC & TUDORANCEA, 1967; TUDORANCEA, 1969) it is possible that the active growth rhythm may have a selective role in the first three years of life, protecting the individuals with the most rapid growth against the negative action of certain environmental factors, such as predation by fish and dislocation by wind and waves. The first three year classes are specially vulnerable in this respect.

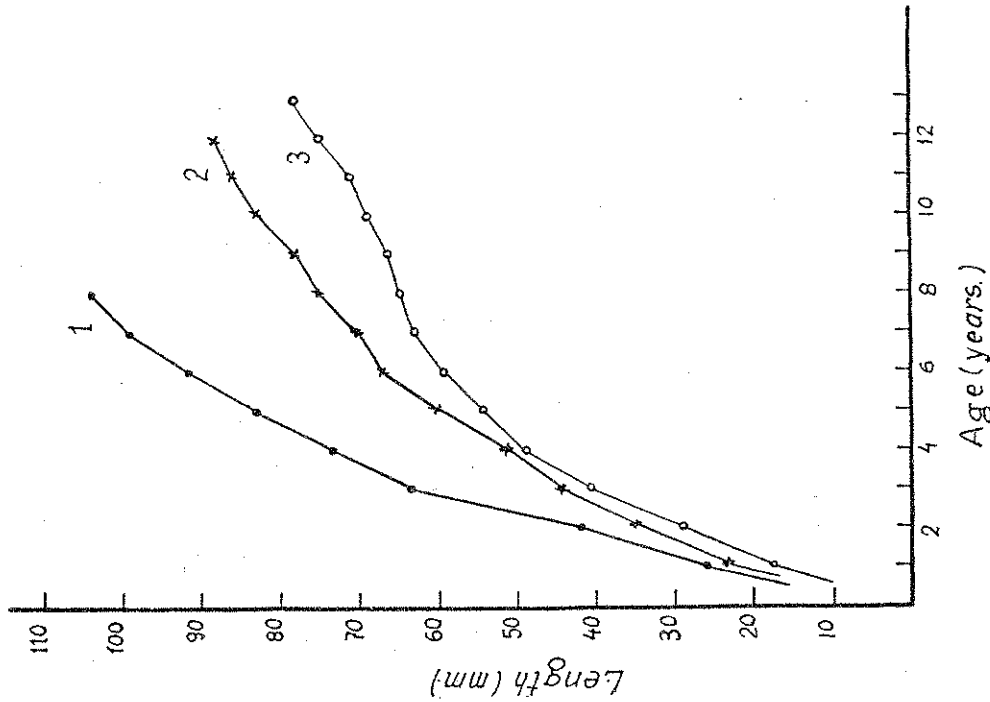


Fig. 11. Growth in length of individuals of the three species of Unionidae, derived from the Jjilla pool; 1. *U. pictorum*; 2. *U. tumidus*; 3. *A. piscinalis*.

The variability of the relationship between height and length ($\frac{H}{L}$) and relationship between thickness and length ($\frac{T}{L}$) was investigated. In the *A. piscinalis* population of the Jjilla pool, the average values of the $\frac{H}{L}$ relationship varies between 45.7% in individuals of maximum sizes and 52.8% in juvenile individuals. In the *U. pictorum* population of the same pool, the average values

of the $\frac{H}{L}$ relationship varies between 41.5% and 46.0%, while those of the $\frac{T}{L}$ relationship between 30.2% and 33.3%.

The average values of the $\frac{H}{L}$ relationship in the Jijila *U. tumidus* population vary between 43.8% and 52.1%, and those of the $\frac{T}{L}$ relationship between 32.3% and 41.2%.

For a comparison between the populations of the same species of *Unio* of the two pools, we computed the arithmetical mean (\bar{x}) of each relationship, the standard deviation (δ), the variability coefficient (CV) and the degree of significance of the difference between arithmetical means computed on the basis of the 'u' test (STEINBACH, 1961) (Table VIII).

TABLE VIII

Statistical indices concerning the variability of $\frac{H}{L}$ and $\frac{T}{L}$ relationships in *U. pictorum* and *U. tumidus* populations of the Crapina-Jijila complex of pools

Species	Relation-ship	Population	$\bar{x} \pm Sx$	δ	CV (%)	'u'
<i>Unio pictorum</i>	$\frac{H}{L}$ 100	Jijila	43.7 ± 0.1	2.3	5.35	1.66
		Crapina	43.9 ± 0.1	2.2	5.13	
	$\frac{T}{L}$ 100	Jijila	32.1 ± 0.1	2.1	6.82	2.66
		Crapina	31.7 ± 0.1	1.7	5.48	
<i>Unio tumidus</i>	$\frac{H}{L}$ 100	Jijila	50.0 ± 0.1	3.2	6.46	5.86
		Crapina	51.7 ± 0.2	3.4	6.64	
	$\frac{T}{L}$ 100	Jijila	36.3 ± 0.1	2.6	7.13	6.80
		Crapina	38.0 ± 0.2	2.9	7.62	

It follows from the data that: 1) in all four *Unio* populations, the variability coefficient (CV) is below 10%, indicating a small degree of variability; 2) the variability coefficient of the two relationships shows similar values in populations of the same species, proving a similar degree of heterogeneity; 3) differences between the average values of the same relationship characteristic of the two *U. tumidus* populations, are strongly significant (5.86 and 6.80).

This proves that natural selection acted differently on the two *U. tumidus* populations. In the Crapina pool, submitted to heavy water

agitation, and to much more powerful wind and waves action than in Jijila, selection induced the formation of somewhat more robust valves, more bulgy and higher in relation to body length, and thus better able to resist the action of these factors.

In each of the three Unionidae populations of the Crapina pool, we observed some groups of individuals which differed in colour and quality of valves. Thus, the valves of individuals derived from zone 6, were generally of smaller sizes than those of the rest of the pool. They showed a dark colour and growth rings could hardly be distinguished. The region around the ambone was eroded and the valves were extremely fragile. On the contrary, mussels taken out of the Gîrla Satului were larger, with light yellowish coloured, sturdy valves on whose surface growth rings were easily detectable.

Fig. 12 shows three groups of individuals, each belonging to the species *Unio pictorum* of the Crapina pool, beside a group of individuals from the Jijila pool, with well developed valves, of light yellowish colour and with distinct growth rings.

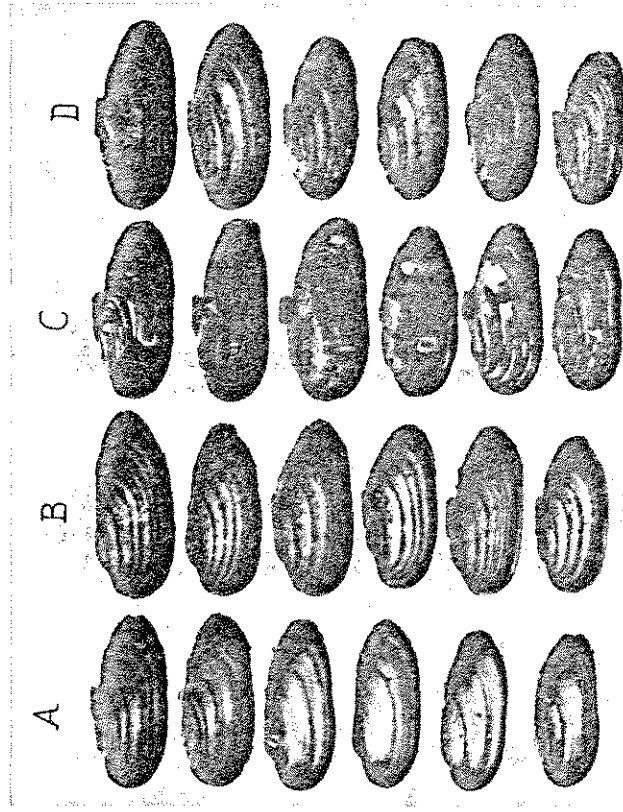


Fig. 12. Variability of valves in *U. pictorum* populations of the Crapina-Jijila complex of pools; A-valves from Jijila; B, C, D-valves from Crapina pool.

Further statistical studies might well shed some light on the problem concerning the existence of infrapopulation units in the *Unio* and *A. piscinalis* populations of the Crapina pool.

Reproduction and gestation period

The *Anodonta* species spread their reproductive cycle over a long period of time, from autumn until spring, the *Unio* species, on the other hand, reproduce only during spring.

The wide variability of the duration of some phases of the development cycle plays an adaptive role in the life of the respective populations.

The amplitude of the period of gestation and elimination of glochidia in *A. piscinalis* populations is comprised between medio September (water temperature around 20°C) until about the end of March (water temperature around 6°–7°C). During this interval individuals breed and enter into gestation at different periods, the gestation of an individual lasting about two months.

In the two species of *Unio* these processes take place between medio April (water temperature around 15.5°C) and the end of July (water temperature around 26°C). The duration of an individual's gestation is of about one month (TUDORANCEA, 1969) (Fig. 13).

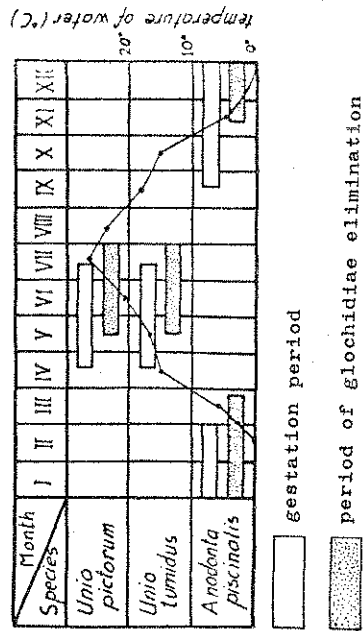


Fig. 13. Breeding cycle in Unionidae populations of the Crapina-Jijila complex of pools;

It thus follows that the variability of the period of entrance into gestation of the individuals of a population determines the variability of the period of elimination of larvae, the variability of the period of their fixation on the bodies of fishes, and their falling off. This may account to a great extent, for the dimensional variability within the same age, a problem previously dealt with.

A series of observations carried out in nature and in the laboratory, showed that although the reproductive cycle of Unionidae involved unfolds within wide temperature limits, thermic shocks, even within these limits, induce a mass elimination of larvae from mussels and simultaneously the destruction of the branchial tissue. As a rule,

elimination of larvae in the natural habitat will take place gradually and not suddenly, as temperature shocks are uncommon.

Observations on the variability of glochidia showed that in the branchiae of the same individual, all developmental stages can be met with, from egg to larva ready to be eliminated from the mother mussel. In *A. piscinalis* the variability of the size of glochidia in the same individual was established. Measuring 450 glochidia, belonging to 11 different individuals, it was found that the glochidia of one and the same individual differed in size between 100 to 125 μ .

Accepting the general principle that the amplitude of variability is the result of the action of natural selection, this phenomenon might play an adaptive role in their life.

The fact that in the branchiae of each individual the laying of eggs is very heterogeneous, determines a succession in the development and elimination of larvae. The successive elimination of larvae from the body is an advantage for the survival of the adults because, in the case of massive elimination, destruction of the branchial tissue might inflict severe harm. Moreover, the gradual deposition and elimination of the larvae offers an advantage by increasing the chance of the eliminated glochidia to reach the skin of a fish and thus continuing its development and maintaining the population. If glochidia would be released in mass, and at the same time by all individuals of the population, the chance of adhering to the body of a fish would diminish, the more so as glochidia cannot survive many days in the absence of hosts. Moreover, the massive release of glochidia from mother mussels would lead to a massive infestation of fishes, which would likewise be harmful.

LIMITS AND DEGREE OF DIFFERENTIATION OF POPULATIONS

As shown by SCHWARTZ (1960), distinct populations do exist if the territories occupied by the respective groupings differ in their conditions of existence, if the exchange of individuals between neighbouring groups is small or absent, and if biocenotic connections of ecosystems to which they belong differ as well.

The pools studied here, are interconnected and also connected to the river, so there is no complete spatial isolation between them. Given the proximity and relative isolation of the two pools, it seems at first sight that an intense exchange of individuals between the Unionidae of the two pools will take place. Consequently it may be assumed that each of the three analysed species is represented in the Crapina-Jijila complex by one single population each.

On the other hand, MAVR (1963) shows that if neighbouring

populations of one species are compared, they are usually found to differ by a number of characters.

In this sense, the investigations performed upon the Unionidae of the Crapina-Jijila complex, evidenced a series of differences between individuals of the same species. Of these, as shown above, the following are the most important: 1. the values of *U. tumidus* individuals present significant morphological differences; 2. the structure by ages and sizes is characteristic of each 'grouping' separately; 3. Unionidae groupings of the Crapina pool have a more marked morphological polymorphism than those of Jijila, due to a greater variety in the conditions of existence.

These facts prove that in the Crapina-Jijila complex, the species of *U. pictorum*, *U. tumidus* and *Anodonta piscinalis* are represented each by two distinct populations.

It follows that the genetic exchange between populations was not so intense as to render them uniform. This is corroborated by a series of ichthyological observations. BANARESCU (1969), making a comparative biometrical study on bream (*Abramis brama*) in the two pools, found that there are two distinct populations. The exchange of individuals could not ensure complete morphological and genetical uniformity. This means that those fish populations, with a limited genetic interchange only, likewise achieve a poor exchange of individuals between adjacent Unionidae populations.

This fact was proved for the bream, but it might not be true for other fish populations. It is known, for instance, that in the lower Danube region, carp (*Cyprinus carpio*) is a semi-migratory fish, changing its habitat between river beds, meadow pools and pools in the delta, according to the season (ANTONESCU, 1963). No doubt such fish will realize also their exchange of genetic information between the different Unionidae populations during their displacements.

The degree of differentiation between Unionidae populations is the result of the interaction between the adaptive radiation processes favoured by natural selection and the interpopulation genetic flow induced by the action of various fishes. Thus the respective species of Unionidae are represented in the different pools of the region studied here, by distinct populations, each representing a phenotypical, genetic and ecological unit.

THE ROLE OF UNIONIDAE POPULATIONS IN THE ECONOMY OF THE ECOSYSTEM

In an effort to determine the role of the three species in the

economy of the ecosystem, we computed net production (P_n), energy spent in respiratory processes (R) and energy assimilated by population (A).

The general scheme of the energy which flows through the three Unionidae populations of Crapina is represented in fig. 14 (more detailed data are published in previous papers).

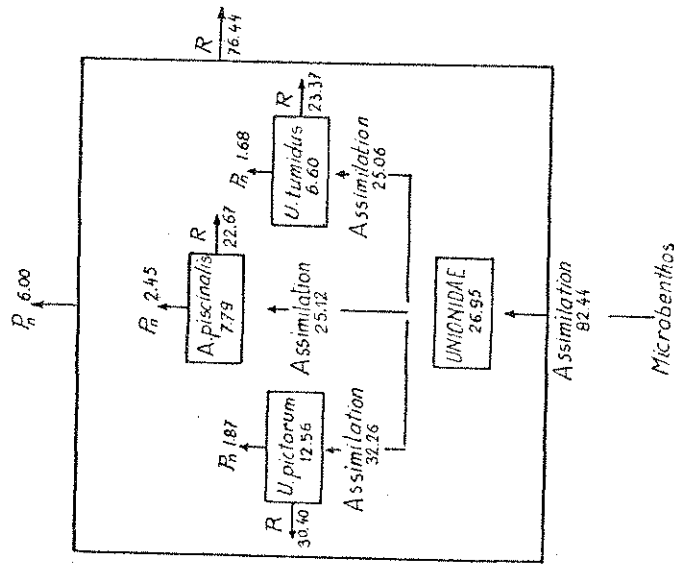


Fig. 14. Energy flow through the three Unionidae populations of the Crapina pool in the year 1966—1967. The data in the small framings represent biomass (valveless) expressed in Kcal/sq.m. The other data are expressed in Kcal/sq.m./year.

For the year 1966/1967 the net production values were: 1.86 Kcal/sq.m./year or 2.55 g/sq.m./year in the *U. pictorum* population; 1.68 Kcal/sq.m./year or 2.99 g/sq.m./year in the *U. tumidus* population and 2.44 Kcal/sq.m./year or 5.08 g/sq.m./year in *A. piscinalis* population.

The P/B (Production/Biomass) relationship established for the three Crapina populations is 1 : 4.49, which means that the efficiency of energy production is 22.27% of the existing biomass (valveless). Computing the P/B relationship for each separate population, it is found that the efficiency of organic substance accumulation and energy is high in *U. tumidus* and *A. piscinalis* populations (25% and 33%) and low in the *U. pictorum* population (15%).

Values obtained for Unionidae populations of Crapina show a much greater efficiency of energy accumulation than populations of the same species in the Thames river. Thus, NEGUS (1966) finds for the entire Unionidae association of the Thames a P/B relationship equal to 1.6 and for each population separately, the following values: 13.7% for *U. pictorum*, 12.5% for *U. tumidus* and of 20.4% for *A. anatina*.

Computing the average yearly respiratory values for each population separately and transforming them into energy values by means IVLEV's oxaloric coefficient, we obtained the following values of the energy spent by the respective individuals: 22.674 Kcal/sq.m./year for *A. piscinalis*, 23.377 Kcal/sq.m./year for *U. tumidus* and 30.400 Kcal/sq.m./year for *U. pictorum*.

Summing up the energy values spent (R) and those of net production, the energy values assimilated (A) by each population separately is obtained. Computations of the annual quantity of microbenthos consumed in the year 1966/1967, showed that 82.44 Kcal/sq.m./year was assimilated in the populations of Crapina, distributed as follows: 25.06 Kcal in the *U. tumidus* population, 32.26 Kcal in the *U. pictorum* population and 25.12 Kcal in the *A. piscinalis* population.

Computing Pn/A relationship for each population, we found the following values: 9.74% for *A. piscinalis*, 5.79% for *U. pictorum* and 6.71% for *U. tumidus*.

It follows from these data that the *Unio* and *A. piscinalis* populations of the Crapina-Jijila complex are of slight importance in the ecosystem economy, as they put at the disposal of the other trophic levels a small fraction of the total quantity of assimilated energy only (less than 10%). If it is further considered that the individuals of the Unionidae species are long-lived, and thus store and immobilize in their bodies, matter and energy which they will put back into the ecosystem energy circuit only after a long time, their trophodynamic role appears still smaller.

According to their capacity of mineralizing the organic substances they take in concurrently with water (the value of R/A relationship exceeding 90%), it can be asserted that the Unionidae play an important role in biological purification of the water.

SUMMARY

This work represents the study of the structure, dynamics and functioning of some Unionidae populations of the Crapina-Jijila complex of pools, integrated into the zone liable to inundation of the Danube.

Of the five species of Unionidae present in the Crapina-Jijila complex of pools, the populations of *Unio pictorum*, *Unio tumidus* and *Anodonta piscinalis* were investigated as these species dominate in the respective ecosystems both in number as well as in biomass.

The following conclusions were arrived at:

1. Density, biomass, incidence and abundance are greater in the Crapina populations than those of Jijila, owing to more favourable life conditions (smaller degree of silting, better water circulation, greater variety of the bottom, a.s.o.).

2. Spatial distribution is influenced by water level determined by the Danube high floods, nature of the bottom and presence or absence of vegetation.

3. Age structure constitutes a characteristic trait for each population separately at any moment, while the dynamics of this structure takes places under the action of some environmental factors. Danube high floods exert an important influence upon the Unionidae birth rate, favouring the breeding and development of molluscs in years when these high floods are great, yearly and of long duration. Wind, waves and the exploitation of molluscs are factors which exert a selective action.

4. The sex-ratio of the two *Unio* populations of Crapina fluctuates in the course of the year, and probably indicates consecutive hermaphroditism.

5. Observations confirm the amplitude of the active spring and autumn migration of the Unionidae in the area studied, showing at the same time the influence this phenomenon can exert in certain years upon the structure of the respective populations.

6. The growth in length in individuals of the three species is continuous, rather fast in the first three years and slowing down afterwards, as exual maturity is attained.

Individuals of the same age show a marked individual variability, induced, among other factors, by the variability of the breeding period.

7. Comparative biometrical investigation of *U. pictorum* and *U. tumidus* individuals of the two pools, showed significant morphological differences among *U. tumidus* populations. Thus, the relative values of H/L and T/L relationships are greater in individuals of the Crapina population than those of Jijila, due to different local conditions.

In Unionidae populations of Crapina a more accentuated polymorphism was evidenced, expressed by the existence of certain groups of individuals which differ in colour, size and quality of the valves.

8. A marked variability is presented by the different phases of

the breeding cycle of Unionidae, a phenomenon with adaptive value in the life of the respective populations.

9. Ecological investigations and comparative biométrical studies of individuals of the same species, showed that, in spite of the relative isolation between the pools, each of the three species is represented by two distinct populations.

10. The energy flow, established for the Crapina populations, shows a low efficiency of net production ($P_n/A < 10\%$). At the same time a high percentage of energy is spent in metabolic processes ($R/A > 90\%$).

This energy aspect shows that Unionidae molluscs play a small trophic role in the economy of the respective complex, but are important mineralizers of organic substances.

RÉSUMÉ

Le présent travail est une étude de la structure, de la dynamique et du fonctionnement de quelques populations appartenant aux espèces *U. pictorum*, *U. tumidus* et *Anodonta piscinalis*, du complexe d'étangs Crapina-Jijila (zone inondable du Danube).

Dans les étangs de la zone inondable du Danube, la distribution spatiale des Mollusques Unionidés est soumise à l'influence des crues du Danube, à celle du fond de l'étang et à la présence ou l'absence de la végétation.

La structure et la dynamique des populations d'Unionidés sont influencées par les facteurs suivants: les grandes crues du Danube, le vent, les vagues et l'exploitation des Mollusques.

Les observations concernant la dynamique saisonnière du rapport entre les sexes chez les populations d'*Unio* de l'étang de Crapina indiquent probablement un hermaphroditisme consécutif.

La croissance en longueur des individus appartenant aux espèces étudiées est continue, plus intense durant les premières trois années d'existence et moindre après qu'ils ont atteint la maturité sexuelle.

Les différents phases du cycle reproductif des Unionidés de ces étangs présentent une variabilité prononcée, phénomène d'une valeur adaptative particulière dans la vie de ces espèces.

Les recherches écologiques et l'étude biométrique comparative des individus de la même espèce montrent que malgré l'isolement relatif des deux étangs qui constituent le complexe en question, chacune des trois espèces qui constituent le complexe par deux populations distinctes.

Du point de vue énergétique, les populations d'Unionidés ont un

rôle trophique réduit dans l'économie des écosystèmes aquatiques de la zone inondable du Danube (production nette/assimilation $< 10\%$), mais elles ont par contre un rôle important dans la minéralisation des substances organiques de l'eau (respiration/assimilation $> 90\%$).

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