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ZOOGEOGRAPHICAL ANALYSIS OF THE PARASITE FAUNA OF FISHES IN AZERBAIJAN WATER BODIES

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Abstract. The parasite fauna of fishes of the Kura and Volga rivers and the Caspian Sea is analyzed and compared. A characteristic feature of the Kura river basin is the high percentage of parasites of southern origin among which the Ponto-Aralo-Caspian species prevail. There is also a relatively large number of Middle-Eastern species, but only few northern, cold-requiring species. The Volga river is characterized by a rich parasite fauna of fishes, consisting mostly of the northern species; less numerous are the southern forms, while the species of Middle East and the endemic species of mountain type are completely lacking. The parasite fauna of the Caspian Sea consists mainly of euryhaline fresh-water species; in addition to them there is a considerable proportion of marine and fresh-water parasites and some species of southern type, whereas the northern species are few in number.

The waters of Azerbaijan are of great interest from the zoogeographical view. They enter the Caspian circle, which is situated on the boundary of the Ponto-Aralo-Caspian province, including besides the Caspian also the Black Sea, and the Aral circle with Central Anatolian and Iran provinces of the Mediterranean Subregion. Two regions of the Caspian circle, namely the Volga and Kura-Iran regions, meet on the territory of the republic. With the exception of waters north of the Apsheron Peninsula, which forms a part of the Volga region, all other water systems belong to the Kura-Iran region. It may be assumed, therefore, that the waters of Azerbaijan, which are situated on the junction of three provinces, contain not only the species of the Ponto-Aralo-Caspian province, but also that of Middle East. Up to this time, several attempts have been made to prepare a zoogeographical analysis of the parasite fauna of individual water bodies of Azerbaijan (Mikailov 1957, Kandilov 1964, Abdullaeva 1971), but owing to the lack of material they could not be complete. The study of the parasitological material not only confirms the data obtained by ichthyological, hydrobiological and zoogeographical research, but may also supply many new and interesting findings contributing to the knowledge of origin of the fauna in the respective water (Dogel and Bykhovsky 1939, Dogel and Akhmerov 1966, Polyansky 1958, Shulman 1954, 1958 and others). This fact, as well as the complementary material available, enabled us to make a zoogeographical analysis of fish parasites of Azerbaijan, with regard to the fact that their localities are on the boundary of two regions of the Caspian circle. This analysis concerns the following areas: the Kura river basin, the Caspian Sea and the Volga river basin.

MATERIAL AND METHODS

The fishes of Azerbaijan have been reported to harbour about 300 species of parasites. Among them we distinguish several zoogeographical groups. Widely distributed palaearctic species, which occur in nearly all water systems of the European and Asian part of the U.S.S.R., are included in different zoogeographical provinces and subregions. They correspond approximately to the boreal-plain complex, according to Nikolsky (1947, 1955). The parasites of southern origin comprise the Ponto-Aralo-Caspian species occurring mostly in the water bodies connected with the basins of these seas; the Black Sea species occurring in the rivers of the Black Sea basin; the Caspian Sea species, characteristic for the rivers of this sea, and the species of Middle East. We named the last group conditionally, since these species were found only in the waters of the border with Iran and Central Anatolian provinces, which Berg (1940) earlier united in a province of Middle East. This group of parasites is likely to correspond to the Asian complex after Nikolsky.

The north and cold-requiring parasites include the circumpolar species with the following distribution: the Arctic species, characteristic principally for the northern waters of Eurasia, North-European species, occurring mostly in northern waters of Europe, and cold-requiring endemic species of Alpine type, occurring in mountain parts of waters.

Among these parasites is a large number of marine and salt-water species, which are encountered mainly in the Caspian Sea, especially in its southern part, and some of them have been introduced with their fish hosts into the Kura river.

Many species of parasites have not been ascribed to any of the above-mentioned groups, due to the lack of knowledge of their distribution (Table 1).

Table I. Zoogeographical groups of parasites in the Caspian Sea and the Volga and Kura rivers

Group of parasites	Volga		Caspian Sea		Kura	
	No. of species	%	No. of species	%	No. of species	%
Palaearctic species	94	40.0	35	26.0	59	29.0
Ponto-Aralo-Caspian species	73	31.4	44	33.0	55	27.5
Caspian species	5	2.2	5	3.6	4	1.4
Black Sea species	1	0.5	1	0.7	1	0.5
Middle East species	–	–	–	–	25	12.0
Circumpolar species	5	2.2	1	0.7	2	0.9
Arctic Ocean species	7	3.0	2	1.4	2	0.9
North-European species	1	0.5	–	–	1	0.5
Mountain endemic species	–	–	–	–	2	0.9
Marine species	5	2.2	22	16.0	5	2.4
Species from unknown area	43	18.0	25	18.6	52	24.0
Total number of southern species	(79)	(34%)	(50)	(37.3%)	(85)	(40%)
Total number of northern species	(13)	(15.5%)	(3)	(2.2%)	(7)	(3.3%)
Total	234	100	135	100	208	100

RESULTS

FISH PARASITES OF THE KURA RIVER

In the Kura river basin, the group of palaearctic species comprises the largest number of species (59). The second most numerous group is the Ponto-Aralo-Caspian with 55 species. One of its representatives known only from the Caspian Sea, namely *Capillaria tuberculata* (Linstow, 1914), has not been found in the Kura river basin. Most pro-

bably it is due to the absence of *Acipenser ruthenus*. Of interest was the finding of a Black Sea species, *Myxobolus pfeifferi* Thelohan, 1895, which has not been reported from any other large river (Volga, Ural) falling into the Caspian Sea. It may be assumed, therefore, that this species was introduced into the Kura river basin through upper reaches of rivers falling into the Black Sea.

Relatively numerous are also the Middle-Eastern species (25). It is of interest that none of them was found in the basins of the Volga and Ural rivers. As it might be expected, the number of parasites of northern origin was comparatively low. Two species may be considered circumpolar—*Metechinorhynchus salmonis* (Muller, 1870) and *Argulus coregoni* Thorell, 1864, and two of the Arctic Sea—*Cystidicoloides tenuissima* (Zeder, 1800) and *Ascarophis skrjabini* (Layman, 1933). The species *Proteocephalus neglectus* La Rue, 1911, although found in the northern regions, occurs in the Kura river basin only in the mountain parts (Lake Sevan), representing here a mountain relict. The same concerns also the above-mentioned circumpolar species *M. salmonis* and Arctic species *C. tenuissima* and *A. skrjabini*. Finally, two species, *Metechinorhynchus baeri* (Kostylew, 1928) and *M. sevani* (Dinnik, 1933), are endemic of the Alpine Lake Sevan, but their resemblance to the northern *M. truttae* shows a ceratin relation with the northern parasites. They may be considered endemic species of Alpine type. The total number of northern and cold-requiring parasites, with regard to the mountain relicts and endemic species in the Kura river basin, is not high, no more than 7 species.

Besides the typical fresh-water parasites, also the species of marine and salt-water origin occur in the lower reaches of the Kura river, namely *Nitzshia sturionis* (Abildgaard, 1794), *Eubothrium acipenserinum* Cholodkovsky, 1918, *Cucullanus sphaerocephalus* (Rudolphi, 1809), *Leptorhynchoides plagycephalus* (Westrumb, 1821) and *Pseudotracheliastes stellatus* (Mayor, 1824). For the Kura river basin is thus characteristic a high percentage of species of southern origin (40%), among which the Ponto-Aralo-Caspian species prevail. Relatively numerous are the species of Middle East, while the northern and cold-requiring species, among which the mountain relicts and endemic species are dominating, are only few in number.

FISH PARASITES OF THE VOLGA RIVER

As mentioned above, it is of interest to compare the parasite fauna of fishes from the Kura region of the Caspian circle with the Volga region and the Caspian Sea itself, where the fresh-water species prevail. We have therefore used the data of some papers on fish parasites of the Volga river and the Caspian Sea (Dogel and Bykhovsky 1939, Bogdanova and Nikolskaya 1965, Saidov 1956 and others).

As it may be seen from Table I, the fishes of the Volga river have more rich parasite fauna, which is associated with the rich hydrofauna as a whole. One of the important peculiarities of parasite fauna of the Volga river is the comparatively large number of northern species, which is due to the former junction of the upper reaches of the Kama river with the rivers of the Arctic Ocean basin (Pechora, Northern Dvina) and the connection of some waters of the Raltic Sea basin with the upper reaches of the Volga river in the past. At the same time, the Volga river differs also from the Caspian Sea and the Kura river in the relatively smaller number of southern forms, and, especially, the complete absence of Middle-Eastern parasites. The Volga river differs from the Kura river also in the absence of endemic species of mountain type. Some parasites, as *Proteocephalus neglectus, Cystidicoloides tenuissima, Ascarophis skrjabini* and *Metechinorhynchus salmonis*, occur in the Kura river basin as Alpine relicts only and in the Volga river basin they are plain species.

The Caspian Sea is an inland water body of marine origin, but the marine fauna decreased considerably during its long and complicated genesis. At the present time there are 22 species of parasites of marine and salt-water origin. Of them, *Sphaerospora caspiolosae* (Dogiel, 1939), *Nitzshia sturionis, Mazocraes alosae* Hermann, 1782, *Bothrimonus fallax* Lühe, 1900 and *Cucullanus sphaerocephalus* occur also in other seas and oceans, besides the Caspian and Black Seas. There are, evidently, the most ancient relicts of marine fauna, preserved from the time when the South-Russian seas were widely connected with one another and with the World Ocean. The species *Eubothrium acipenserinum, E. clupeonellae* Dogiel et Bychowsky, 1969, *Skrjabinopsolus semiarmata* (Molin, 1858), *Cyclozone acipenserina* Dogiel, 1932, *Leptorhynchoides plagycephalus* and *Pseudotracheliastes stellatus* occur only in the Caspian and Black Seas and are, apparently, of the Ponto-Caspian origin. They are the relicts of the salt-water species which remained from the Ancient Pontic basin. Also the species *Ceratomyxa caspia* (Dogiel, 1938), *Gyrodactylus proterorhini* Ergens, 1963 and *Proteocephalus gobiorum* Dogiel et Bychowsky, 1939 are likely to belong to this group.

Most probably also the species *Bunocotyle cingulata* Odhner, 1928 should be placed in the group of Pontic origin. This salt-water species occurs in the whole Caspian Sea and in the estuaries of the Black Sea and the Sea of Azov. It was found also in the Aral Sea. It is of interest that Odhner (1928) found it first in the Baltic Sea. This was the reason why *B. cingulata* was considered a species of northern origin introduced into the Caspian and Baltic Seas (Dogel and Bykhovsky 1939). If this view were correct, then it would be difficult to elucidate the presence of this species in the Black and Aral Seas. On the basis of the distribution of *B. cingulata* it may be assumed that this parasite is a salt-water relict of Ponto-Caspian origin, which penetrated in some way into the Baltic Sea where it is distributed in a small part. Obviously, the more eastern regions of the Baltic Sea are too freshen and the more western regions extremely salt for it. The species *Triaenophorus meridionalis* Kuperman, 1968 seems to have become a salt-water form of fresh-water origin. During the retreat of glaciers it adapted itself to parasitic life at the stage of plerocercoid in bullheads (Kuperman 1967). This species may be also considered a Caspian relict. In the Caspian Sea, there is also a small group of parasites of salt-water origin, which originated under conditions of the Caspian Sea and has not been reported from any other locality: *Dogielina inexpectata* Dogiel et Bychowsky, 1939, *Proteocephalus skorikowi* (Linstow, 1904) and probably also the digenetic trematode *Skrjabinopsolus minor* Bychowskaya-Pavlovskaya et Mikailov, 1969 described recently from the intestine of *Acipenser guldenstadti* (Bykhovskaya-Pavlovskaya and Mikailov 1969).

In the Caspian Sea, there is another group of marine parasites which is widely represented also in the northern seas and therefore there is no doubt about its penetration from the north. This group comprises the species *Eubothrium crassum* Bloch, 1779, *Corynosoma strumosum* (Rudolphi, 1802). *Porrocoecum reticulatum* (Linstow, 1899) and *Anisakis* sp. With the exception of the first species parasitizing *Stenodus leucichthys* and *Salmo salar caspius*, the other species parasitize mainly *Phoca caspica*. The occurrence of three species of northern parasites in the Caspian *Phoca caspica* supports undoubtedly the opinion on the northern origin of the seal itself. Even if admitting the hypothesis of some authors considering *Phoca caspica* the local form, the northern origin of this species is confirmed by the parastiological material. There is also a possibility that *Corynosoma strumosum* was introduced into the Caspian Sea from the north with the first intermediate host of this parasite, *Pontopore affinis* (Crustacea).

Other group of marine parasites occurring in the Caspian Sea was introduced here

with their hosts during acclimatization of fishes (Mikailov 1957, 1969). This group comprises the species *Haplosplanchnus pachysomus* (Eysenhardt, 1829), *Saccocoelim tensum* Looss, 1902, *Vlassenkotrema longicollum* (Wlassenko, 1931), *Cucullanellus minutus* (Rudolphi, 1819) and *Gyrodactylus proterorhini*.

A large part of fish parasites of the Caspian Sea belong to the euryhaline fresh-water species, which adapted themselves to the life in salt water. Although the number of fresh-water species is considerably lower than in the Volga and Kura rivers, they constitute the main part of the parasite fauna of fishes in the Caspian Sea. It should be noted that the number of fresh-water parasites adapted to the life in the Caspian Sea increases if the northern parts of the Caspian Sea are studied in detail, since this region was mostly freshen.

Thus a characteristic feature of the Caspian Sea, besides the impoverished fresh-water parasites, is the large proportion of marine and salt-water species, whereas the southern species and the northern forms are less numerous. In comparison with other sea basins, in the Caspian Sea the number of typical sea fauna decreased considerably and there are a certain number of salt-water endemic species and a marked prevalence of fresh-water species.

DISCUSSION

The marine parasites in the Caspian Sea have been so impoverished that this locality may be compared even with the fresh-water basins, especially the Volga and Kura rivers, which, undoubtedly, contributed to the formation of the fres-water fauna in the Caspian Sea.

The fish parasites of the river Kura, in comparison with those of the Volga river, have decreased in number, which is due primarily to the decrease of all hydrofauna. In addition to it, some fish species (*Esox lucius, Perca fluviatilis, Tinca tinca, Scardinius erythrophthalmus, Lota lota, Pungitius platygaster*) in the Kura river basin are close to the boundary of their area. These fish species are known to have occupied the Kura-Caspian basin in the recent geological past and therefore their distribution area does not extend farther than to littoral lowlands of the Kura and Araks rivers. Of the mentioned species only *Tinca tinca* and *Esox lucius* occur in the Kura river up to Yevlach, whereas the other species are distributed mainly in the South Caspian Sea and rarely get to the mouth of the Kura river. The *Lota lota* is a rarity for the South Caspian Sea and the Kura river (Derzhavin 1951, Abdurakhmanov 1962). According to Berg (1940), these northern fish species occupied the region of the South Caspian Sea at the late Pliocene epoch, at the time when the northern and middle parts of the Caspian Sea did not exist and the Volga river fell into the South-Caspian basin in the region of the delta of the Kura river, and both deltas lay close to one another. In these fishes, which live on the boundary of their distribution area, a total decrease in their parasite fauna occurred, as it was mentioned above. Therefore about 30 parasite species known to infect the mentioned fishes in the Volga river were absent from the Kura river. Besides that, in the Kura river the number of parasites of northern origin has been lowered in comparison with the Volga river (in all 7 species — 3.3%). Of them only *Pseudoechinorhynchus clavula* (Dujardin, 1845) and *Argulus coregoni* (Thorell, 1864) were found in the lower reaches of the Kura river, all others are the mountain relicts or endemic species. The impoverishment of fauna at the expense of many northern and widespread species resulted in higher proportion of southern elements. This prevalence of southern species is due to the fact that the Kura river contains a large number of Middle-East species (25), hitherto not known either from the Volga river basin or the Caspian Sea.

It may be concluded that the parasite fauna of fishes from the Kura river, as well as

from the whole Kura-Iran region, markedly differs not only from that of the Volga region, but also from that of the Caspian Sea. The comparative analysis of parasite fauna of fishes of the Caspian circle shows that the Caspian Sea occupies the intermedial position between the Volga river from one side and the Kura river from the other. The parasite fauna of fishes of the Caspian Sea differs from that of both rivers in the lower total number of parasites, particularly in the absence of many fresh-water fish species, characteristic for both mentioned rivers. Besides that, an analysis of parasite fauna of fishes of the Caspian Sea shows that it is even in its southern part markedly closer to that of the Volga river than that of the Kura river, although this river lies in immediate proximity. As mentioned above, the Middle-East species and the mountain endemic species are completely lacking in the Volga river and in the Caspian Sea. In the Caspian Sea, 34% of species were found to be common with the Volga river basin and 30% of species with the Kura river basin. This emphasizes to some extent the identity of parasite fauna of the Caspian Sea with that of the Volga river. Remarkable is also the fact that some northern parasites characteristic of the Volga river occur even in its upper reaches and are rather often found also in the Caspian Sea, even in its southern part, while the Asian species of the parasite fauna and the species of mountain origin occupy the upper region of the Kura river and have never been reported from the Caspian Sea. In this way, the formation of fresh-water parasite fauna of fishes from the Caspian Sea occurred at the expense of the parasite fauna from the Volga river. The conditions of the Caspian Sea, however, are not quite suitable for many fresh-water parasites and therefore a considerable impoverishment occurred.

The Kura river basin is situated between two provinces, Ponto-Aralo-Caspian from one side and Middle-East from the other side. Therefore the representatives of both provinces occur in it. It is natural that the number of Middle-East species increases in that parts of the Kura river basin which are nearer to the Iran and Central-Anatolian provinces. Considering the large proportions of Ponto-Aralo-Caspian species in the parasite fauna of fishes, it may be assumed that the Kura river belongs to the Ponto-Aralo-Caspian province (Berg 1940), which is confirmed by its parasite fauna. At the same time, the difference between the Kura and Volga parts of the Caspian circle, similarly as between the individual parts of the Kura river basin itself, is more marked among the fish parasites than among their hosts. The study of the parasite fauna of fishes of various parts of the river Kura may thus contribute to the knowledge of the genesis of the fauna in this river basin. It is of interest that the upper reaches of the Kura river are close to the Central-Anatolian province, whereas the upper reaches of its largest tributary Araks lie in immediate proximity of Iran province.

ЗООГЕОГРАФИЧЕСКИЙ АНАЛИЗ ПАРАЗИТОФАУНЫ РЫБ ВОДОЕМОВ АЗЕРБАЙДЖАНА

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Резюме. В данной работе дается сравнительный анализ паразитофауны рыб рек Куры и Волги и Каспийского моря. Для бассейна Куры характерен высокий процент видов южного происхождения, среди которых преобладают понто-арало-каспийские виды. Сравнительно велика примесь переднеазиатских элементов и очень незначительное количество северных или холодолюбивых видов. Для рыб Волги характерна более богатая фауна паразитов, со сравнительно большим числом северных элементов и относительно меньшим количеством южных форм и полным отсутствием переднеазиатских паразитов

и эндемиков горного типа. Для Каспийского моря характерна значительная часть эвригалинных пресноводных паразитов и большой удельный вес морских и солоноватоводных паразитов и, отчасти, южных паразитов, в то время как северных форм значительно меньше.

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