

On the origin of certain amphiboreal
gadoid and clupeoid fishes in the light of
the species composition of their parasites

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The Origin of Certain Amphiboreal
Cods and Herrings as Related to
the Composition of their Parasites

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A taxonomical study and a detailed analysis /1335*
of the geographical distribution of cods have made it
possible to establish more clearly (Svetovidov, 1940, 1944,
and 1948) than in the broadest previous studies (Günther,
1880, p. 269; Shmidt, 1904, p. 402) that the cod family, as
distinguished from other groups of fish and aquatic creatures,
is represented by a larger numbers of species and genera
in the northern Atlantic Ocean than in the northern Pacific.
This became fully evident after the isolation, from the
Gadidae family, of the special family Moridae, which is
much more widely distributed and is also represented by a
large number of genera and species in the northern Pacific

* Numbers in the right margin indicate the corresponding
pages in the original

Ocean. It has been established, too, that there exists a clear genetic dependency of Pacific Ocean cod upon Atlantic cod, which have a large number of endemic genera lacking among Pacific Ocean genera. A sole exception to this general rule has been the monotypic genus Theragra, represented (by Th. chalcogramma) only in the northern Pacific Ocean and not present in the Atlantic. A representative of this genus (Th. finmarchica) was, however, found not long ago in the North Atlantic Ocean as well (Koefoed, 1956; Svetovidov, 1959). All this indicates that Pacific Ocean cod have originated from Atlantic cod, an opinion which has been variously expressed by other authors (Scheuring, 1930, p. 197; Zenkevich, 1933, p. 21; Shmit, 1936, p. 175).

On the basis of the contemporary distribution of cod, their biological characteristics, in particular their preference for cold (especially during the reproductive period), their fossil location and age, and the geological history of the seas which once covered the areas where fossil remains have been found, it has been assumed that when the climate became cold in the Upper Tertiary period

and earlier, cod moved into the seas covering what is now Central Europe and the Caucasus, where the most numerous cod fossil remains have been found, from seas situated further north, from the Polar Basin and ^{from} the adjacent Scandian, and other basins (for more details, see Svetovidov, 1948).

Further study of cod fossil remains, however, has revealed that the evolution of the most ancient representatives of the family - the fossil genus Palaeogadus (= Nemopteryx) and related transitional intermediate fossil forms of the modern genus Merluccius (N. inferus) - took place in the seas which once covered the Caucasus, the Carpathians, and Central Europe (Danil'chenko, 1947, 1951, and 1960). Here there took place the development of the fossil genus Palaeomolva, resembling Palaeogadus, but with several characteristics relating it to the modern genus Molva (Danil'chenko, 1947a). These facts indicate that the emergence of the oldest family representatives originating the subfamilies Lotinae and Merlucciinae of the modern cod, took place in the seas which preceded the modern Mediterranean

Sea and Atlantic Ocean. Thus, in 1956, I recognized the Atlantic origin of the cod. Nonetheless, proven cod fossils of the subfamily Gadinae from the Caucasus and the Carpathians are known from no earlier epoch than the Upper Myocene, i.e. when the climate of the seas covering these areas resembled that of today. These few remains of small Gadinae (Bogachev, 1933 and 1938; see also Svetovidov, 1948, where other species are enumerated and references to other writers are given) resemble most the modern genera Trisopterus and Odontogadus, now found in the Mediterranean. Fossil remains of the large, cold-seeking species of Gadinae, which inhabit the colder regions of the northern Atlantic, are unknown; it may be assumed that their development took place in more northern seas.

Nonetheless, despite the Atlantic origin of the majority of cod that are basically boreal in their distribution and biological characteristics, there exist several species (Arctogadus, Boreogadus, Eleginus, and, possibly,

Microgadus), and certain subspecies of Gadus morhua (G. morhua ogac and G. morhua macrocephalus) whose biological characteristics and (in most cases) distribution indicate their Arctic origin.

I later expressed similar views (Svetovidov, 1944, 1949, 1949a, and 1956) on the origin of herring, which predominate in the North Atlantic, as compared with the Pacific, to an even greater extent than cod. The herring family in its entirety, as compared with cod, has a much greater tendency to seek warmth; it consequently has a more southerly distribution and is found less in Arctic waters. Among herring there is not a single genus or species related by distribution or origin to the Arctic seas. Only the forms of the subspecies Clupea harengus pallasii, which has a low vertebral count, can, by their biological characteristics and distribution, be considered Arctic. Most of the above mentioned genera and species (Eleginus, Microgadus, Theraga, Gadus Morhua and Clupea harengus) are amphiboreal in distribution: they are found

in the northern Atlantic and Pacific Oceans and adjacent seas and do not exist in the Arctic.

A.P. Andriyashev (1957), while not opposing my opinion on the Atlantic origin of herring and cod, disagrees as to the Arctic origin of low vertebral count herring (Clupea harengus pallasii and its forms), both species of navaga (Eleginus navaga and E. gracilis) and Microgadus (N. tomcod and M. proximus); one of his working hypotheses is that these fish are characterized by a dual migration - from the Atlantic to the Pacific and back. He claims that the Atlantic ancestors of these fish, when they penetrated to the North Pacific, originated the low vertebral count form of herring (pallasii) on the one hand, and, on the other, the entire group Eleginus -Microgadus, which, off the coast of North America, formed the genus Microgadus, and, in the Far East seas, Eleginus. Later, from the North Pacific, the low vertebral count form of herring (pallasii) and Eleginus spread out along the Siberian

coast to the west, while Microgadus went around North America to the east; Eleginus and Microgadus formed separate species which (especially E. Navaga) in certain morphological features were more highly organized than Pacific Ocean varieties. A.P. Andriyashev's basic objection to the Arctic origin of these fish is that, in his opinion, it is difficult to assume that the main biological characteristics of low vertebral count herring and navaga should have developed and survived under Arctic ocean conditions, while E. navaga should, in certain essential morphological characteristics, have been more highly organized than the Far Eastern E. gracilis. He considers that these biological characteristics developed under conditions prevailing in the North Pacific and adjacent seas and that the more complex arrangement of morphological characteristics that he observed in E. navaga was developed after its return migration to the Arctic seas. /1337

I have examined in detail (Svetovidov, 1959a) this point of view and the ideas and evidence advanced in support of it. In analyzing the main morphological and biological features of the above mentioned fish, together with the functional and adoptive significance of these features, I have come to the conclusion that they were developed under Arctic ocean conditions. All of these fish, which had settled widely in the temperate waters of the North Pacific ~~far~~^{to} the south and which had there originated separate forms and species, kept their biological characteristics and merely adapted to their new environment.

A.P. Andryashev (1957, p. 124) believes that the parasitological data obtained by B.E. Bykovskij and Yu. I. Polyanskij (1953), S.S. Shul'man, and P.E. Shul'man, — Al'bova (1953) are of considerable interest. In his opinion, this information supports his own view. We shall examine these data.

Actually, B.E. Bykhovskij and Yu. I. Polyanskij (1953), in analyzing their own data on the distribution of the monogenetic trematoda Gyrodactylus gerdi and G. arcuatus, as well as their subspecies and related species, conclude that the navaga came to the White Sea and the eastern Barents Sea from the east, i.e. from the Pacific.

The White Sea navaga (E. Navaga) is a host for G. gerdi, a subspecies of which (G. gerdi orientalis) feeds on the saffron cod or Far Eastern navaga (E. gracilis). Also, on the gills of the White Sea navaga is found G. arcuatus elegini, which is absent on the saffron cod. The ^{basic} form of G. arcuatus elegini is parasitic on sticklebacks (Gasterosteus aculeatus and Pungitius pungitius). In addition, G. rarus is found on both these species and on Pungitius Platygaster, while G. bychowskyi is parasitic on G. aculeatus. The latter two species, like their hosts, are extremely widely distributed: they are found on sticklebacks in salt and fresh water both in Europe and the Far East. A basic form of G. arcuatus is parasitic on both sticklebacks in salt and fresh water in Europe, while some subspecies (G. arcuatus elegini), as indicated above, live on the White Sea navaga (G. arcuatus proximus) and on the coalfish (Boreogadus saida) in the Barents Sea; G. arcuatus, however, is not found on coalfish in the Kara Sea. In Far Eastern waters this species is not known on either stickleback or saffron cod. This information was the basis for the conclusion by the above writers that G. gerdi ^{developed on Eleginus} ~~migrated with the cod~~ in the Pacific Ocean Basin and that when Eleginus moved west, G. gerdi migrated with it to

the White Sea where, for a second time, G. arcuatus passed from stickleback to it (i.e. to Eleginus).

The conclusion of B.E. Bykhovskij and Yu. I. Polyanskij regarding the Pacific Ocean origin of the navaga is, in the opinion of S.S. Shul'man and P.E. Shul'man - Al'bova (1953), also confirmed by the distribution of certain other parasites, although it should be noted that these data do not contradict the navaga's Atlantic origin. Thus, the species of slimy sporozoan Sphaerospora orientalis which the latter two writers have described (1953, pp. 17, 180) has been found on both White Sea and Far East navaga. In addition, they disclosed (1953, pp.30, 180) on both species of Eleginus the infusorian Trichodina elegini, a similar species of which (T. sphaeroides) is parasitic on Sphaeroides pardalis, found off the coast of Japan and in Peter the Great Bay. /1338

The similarity of these two species of infusorians may be considered in two ways. First, as S.S. Shul'man and P.E. Shul'man - Al'bova assume, this infusorian was able,

along with S. pardalis, to pass to Eleginus and, isolated on a similar species, to enter the White Sea with its host. Another explanation, however, is just as valid: this infusorian penetrated the North Pacific along with Eleginus and here originated a similar species on S. pardalis. The fact that S. orientalis has been found on both species of Eleginus serves equally to confirm either point of view. The discovery of S. orientalis on both navaga and low vertebral count herring - White Sea (Clupea harengus pallasi n. maris - albi) and Pacific Ocean (C. harengus pallasi) - and its absence on high vertebral count Atlantic herring (C. harengus harengus) is also no evidence of a purely Pacific origin for navaga. More will be said on this later. The presence of S. orientalis on White Sea and Pacific Ocean herring and the discovery of another species of slimy sporozoan (Ceratomyza orientalis) on both these herring and on the Far Eastern sardine (Sardinops sagax melanosticta) and the absence of these parasites on other herring of the

Barents Sea and the North Atlantic confirms, in the opinion of S.S. Shul'man and P.E. Shul'man - Al'bova, the Pacific ocean origin of White Sea herring as well.

It should be added that B.E. Bykhovskij and Yu. I Polyanskiĭ (1953), proceeding from the distribution of G. Marinus, confirm the Atlantic origin of cod. The hosts of the typical form of this parasite species are the Atlantic cod (G. morhua morhua), the Pacific Ocean cod (G. morhua macrocephalus) and the walleye pollock (Th. chalcogramma), while a special subspecies (G. marinus aeglefini) is peculiar to the haddock (Melanogrammus aeglefinus). An older Atlantic origin for both G. marinus and the cod, in their opinion, is indicated by the presence in the Atlantic Ocean on both cod and haddock of various subspecies of this parasite, while in the Pacific Ocean on both the cod and the walleye pollock the same subspecies is found as on the Atlantic cod. The formation and settlement of G. marinus, as illustrated by Bykhovskij and Polyanskiĭ (1953, figs 22 and 23), could have taken place in two ways. According to the first hypothesis, G. marinus was carried from the Atlantic to the Pacific by the Atlantic cod (G. morhua morhua), where it passed to the walleye pollock. According to the second hypothesis, which ~~ix~~ its authors consider less likely, G. marinus became isolated much earlier than the genus Theragra became isolated in the Pacific Ocean, and both the cod and the walleye pollock received it from a common ancestor - an ancient fish of the

Order Gadiformes. "From the Atlantic¹" cod G. marinus passed to ~~Italics mine - A.S.~~ the haddock, where it formed a special subspecies. In Post-Glacial times, the cod populations brought G. marinus into the Pacific Ocean together with its hosts. In the Pacific Ocean at this time, the walleye pollock existed together with its population of G. marinus" (Bykhovskij and Polyanskij, 1953).

It is still not clear, however, from the foregoing why G. marinus was passed from the ancient Anacanthini only to the cod and the walleye pollock and then passed from the cod to the haddock, forming a special subspecies on the latter. If these hypotheses are adhered to, it may readily be assumed that from the ancient Anacanthini G. marinus must have passed directly not only to the cod and the walleye pollock, but also to the haddock and, possibly, to other cods, on which it is not now found. The fact that the walleye pollock is also found in the North Atlantic (accompanied by) Th. finmarchica simplifies these hypotheses and makes it clearer how the Pacific Ocean species of Theragra became isolated. The lack of information regarding the presence of G. marinus on ~~the~~ Th. finumarchica makes it impossible to decide, on the basis

¹
Italics mine - A.S.

of parasitological data, whether the genus Theragra is of Atlantic or Pacific origin. Unfortunately, neither B.E. /1339 Bykhovskij nor Yu. I. Polyanskiĭ considered my views on the Atlantic origin of Pacific ocean cod. They stressed, in their hypotheses outlined above, that the Pacific Ocean cod received G. marinus from the Atlantic cod. My research (Svetovidov, 1948, pp 48 and 164) indicates that the Pacific Ocean cod differs essentially from the Atlantic cod and that in its basic morphological and biological characteristics it is more similar to the Greenland cod (G. morhua ogac), with which it has a common origin; consequently G. marinus could not have passed to it (the Pacific Ocean cod) from the Atlantic cod: the Pacific Ocean cod could have obtained G. marinus only from an ancestral form which it had in common with the Greenland cod. The parasites of the Greenland cod, however, have not been studied, and it is not known, any more than for the Atlantic walleye, whether G. marinus exists on it at all, nor, if it does, whether it is a typical form or a special subspecies. In other words, there is simply insufficient material for a decision on this question.

The absence of G. marinus is also characteristic (Shul'man and Shul'man-Albova, 1953, pp. 38, 180) of White Sea coastal cod (G. morhua maris-albi) and of the so-called White Sea winter cod (G. morhua morhua n. hiemalis), which, as these writers show, is believed to have come to the White Sea from the Barents Sea (see also Sevetovidov, 1948, p. 172). The absence of G. marinus on both these fish, in the opinion of S. S. Shul'man and P.E. Shul'man - Al'bova, justifies their assertion that neither fish moves beyond the White Sea. This is actually true for the White Sea coastal cod. There is, however, another explanation for the absence of this parasitic worm on the White Sea winter cod. It is a known fact (Polyanskij, 1955, p. 129) that young (~~it~~) G. morhua morhua are not infested with G. marinus; it may be assumed, therefore, that the White Sea winter cod moves from the Barents into the White Sea at an age at which it is free from this parasite.

A.N. Sevetovidov's views (1944, 1948, 1949, 1949a, 1952, 1956, and 1959a) on the Arctic origin of herring and cod and their migration to the Pacific Ocean should be set forth briefly prior to any discussion of the foregoing and any subsequent parasitological data. This is all the more necessary in that Bykhovskij and Polyanskij, even while ~~xxx~~ corroborating

Svetovidov's opinions, apparently misunderstood them, as in the case of G. marinus and the cod, and arrived at unfounded conclusions.

The monotypical genera Clupea and Gadus are divided first into two subspecies with several forms in each, and secondly into two groups of subspecies, low vertebral count (C. harengus pallasii, C. harengus pallasii n. maris-albi and C. harengus pallasii n. suworowi), ^{and} high vertebral count herring (C. harengus harengus, which in turn is divided into several races^M including C. harengus harengus n. membras), and broad-headed (G. morhua macrocephalus and G. morhua ogac) and narrow-headed cod (G. morhua morhua, G. morhua callarias, G. morhua kildinensis, and G. morhua maris-albi), which are essentially different both morphologically and biologically. High vertebral count herring, in particular C. harengus harengus, and the narrow-headed cod, particularly G. morhua morhua, occupy a broad and similar area

^M Translator's note: Race is defined as "an hereditarily distinct form, not separated geographically from the ~~the~~ type species".

in the North Atlantic Ocean and adjacent seas. The low vertebral count herring (C. harengus pallasii n. maris-alba and C. harengus pallasii n. suworowi) and the broad-headed cod (G. morhua ogac) are much less widely distributed in the Arctic seas and adjacent areas of the Atlantic Ocean; the former is found east of the C. harengus harengus area in the White and Kara Seas, while the latter dwells northwest of the G. morhua morhua area in Hudson Bay and Davis/1340 Strait. The conditions under which were formed the biological characteristics of low vertebral count herring and broad-headed cod on the one hand and those of high vertebral count herring and narrow-headed cod on the other, have differed considerably. The former developed in the Arctic seas and the latter in the North Atlantic. Only the low vertebral count herring and the broad-headed cod were, because of their marked preference for cold, able to penetrate to the North Pacific Ocean, where they separated into special forms (the typical forms C. harengus pallasii and G. morhua macrocephalus) and occupied a broad common area.

E. navaga, in seas adjacent to the north-eastern Atlantic Ocean, occupies the same area as both forms of low vertebral count herring (C. harengus pallasii n. maris-albi and harengus pallasii n. suworowi). The community of their ^{present}/~~contemporary~~ areas of distribution and the similarity of several main biological features of navaga and both forms of low vertebral count herring are grounds for assuming that these characteristics were developed in ancestral forms of these fish when they occupied a common area under similar conditions. This apparently explains why Sphaerospora orientalis is found on both navaga and low vertebral count herring, although each belongs to a different family.

Neither this parasite species, nor Ceratomyxa orientalis, both of which are found on low vertebral count White Sea and Pacific Ocean herring, exist on high vertebral count herring, particularly C. harengus harengus, not only because their contemporary areas of distribution are isolated, although there is some overlapping and both herring groups are biologically distinct. The lack of both parasites on high vertebral count herring probably has resulted from the fact that high and low vertebral count herring, with all their characteristics, developed under various conditions in areas

of distribution which were no less isolated than those of their ancestral forms.

The ancestral form of the navaga, when it penetrated into the North Pacific, became isolated into an independent species (E. gracilis) and spread widely southwards in the western half of the ocean, occupying the same area along the coast of Asia as the herring (C. harengus pallasii). The eastern area of C. harengus pallasii coincides, as indicated above, with the area of Microgadus proximus. When the navaga resettled in the North Pacific, it brought with it the mucous sporozoan S. Orientalis, and the infusorian T. Elegini, as well as the multigenetic trematode G. gerdi, which here became isolated on the Far Eastern navaga into a special subspecies (E. gerdi orientalis), while T. elegini, as noted above, passed to Sphaeroides pardalis, forming a species similar to T. sphaeroides.

Thus, the distribution of all these parasite species does not contradict the Atlantic or, more likely Arctic, origin of the navaga. The only reason forcing B.E. Bykhovskij and Yu. I. Polyanskij to come to an opposite conclusion - that the navaga was of Pacific origin - was the ~~lack~~ absence of S. arcuatus elegini on the Far Eastern navaga. It should be noted that the material for the article by B.E. Bykhovskij

and Yu. I. Polyanskiy on the Pacific Ocean species of Gyrodactylus was gathered in Southern Sakhalin and the South Kurile shoal , i.e. from the southern part of the navaga's Far Eastern area of distribution. Subsequently, E.V. Zhukov (1960), when studying the parasites of Far Eastern navaga from the coast of the Chukotsk Peninsula out of Providenie Bay, i.e. from the northern part of the navaga's distribution area, discovered, among other parasitic species existing on navaga, G. arcuatus ^{el}gerini. On the basis of this, E.V. Zhukov (1960, p. 328) concludes that both this parasite and its host-the navaga-are of Atlantic origin. Consequently, the sole argument against the Arctic origin of the navaga is not only invalid, but, on the contrary, in the light of new information, actually indicates such an origin for it. It should be added that E.V. Zhukov (1960, p. 311) /1341 found, on the gills of a ~~far~~ Far Eastern navaga from Providenie Bay, a typical form of G. gerdi, (and not G. gerdi orientalis, as described by B. E. Bykhovskiy in 1948) from the same host originating in the most southerly part of the Sea of Okhotsk (Aniva Gulf).

As was noted earlier, the navaga, cod, walleye pollock, and herring, having entered the North Pacific and spread far south, retained their main biological characteristics, merely adapting to a new environment. The Far Eastern navaga, in Far Eastern seas under different conditions, retained all the characteristics which were developed in the Arctic seas; it is found and, in particular, reproduces only in areas where these conditions prevail (for details see Sevetovidov, 1959 a). Even in the southern regions of its distribution area, it found suitable conditions for the most important period of its life - that of reproduction - while its parasite, G. arcuatus elegini, did not find suitable conditions for some important part of its life cycle. E.V. Zhukov (1960, p. 330) also noted the preference for cold on the part of the GYRODACTYLIDAE family. This preference is the reason why the species does not occur on Far Eastern navaga from South Sakhalin and from the South Kurile Shoal. In the navaga's most northerly area of distribution - off the coast ~~shores~~ of the Chukotsk Peninsula - conditions are approximately the same as those in the seas populated by European navaga; hence in this area the

navaga has retained not only G. arcuatus elegini, but also the typical form S. gerdi, which, in the southern part of the Far Eastern navaga's area of distribution, has originated a subspecies, G. gerdi orientalis. Here it should once more be noted that S. arcuatus is absent on sticklebacks in both salt and fresh water in the Far East, being found only in the European part of the U.S.S.R.

Consequently, all known data on the distribution of the above mentioned parasites affirm rather than contradict the Arctic origin of the navaga. The observations expressed above on the distribution of Sphaerespora orientalis on both species of navaga and on White Sea and Pacific Ocean low vertebral count herring, the presence on the latter of Ceratomyxa orientalis and the absence of both parasites on high vertebral count herring of the Atlantic Ocean also proves that low vertebral count herring are indeed not of Pacific but of Arctic origin. When the herring penetrated into the Pacific Ocean, C. orientalis passed from it to the Far Eastern sardine (Sardinops sagax melanosticta) similar to the way in which T. elegini passed to Sphaeroides pardalis; on the above sardine this parasite was represented by

the same species and form. It must once more be stressed that the distribution of S. orientalis on both species of navaga and on low vertebral count herring, together with the common distribution areas and similar important biological characteristics of these fish, indicate the joint development of their ancestral forms. As noted above, there is not at the present time sufficient knowledge of either the distribution or the possible hosts of G. marinus to come to any conclusions as to the relationship of this parasite to cod and walleye pollock. Hence research on the Greenland cod and the Atlantic walleye pollock is necessary.

In conclusion it should be said that although parasites provide valuable clues to certain problems of the distribution, origin, and past settlements of fish, they nonetheless play a subsidiary role to the extent that conclusions based on their study agree with those based on data required and obtained directly from the study of the fish themselves; this latter information is, of course, conclusive. A basic requirement for using parasitological data is that it be considered in sufficient entirety and that all possible hosts be taken into account.

The specificity of parasites is, ~~xxxx~~ in turn, important in investigating the philogenetic relations of several

groups of parasitic invertebrates. This may have been most clearly demonstrated by B.E. Bykhovskij (1957) in his example of monogenetic trematodes.

In summing up his analysis of monogenetic trematodes of various groups and their hosts (1957, p. 320) he came to the conclusion that "in analyzing the phylogenetic relations of individual groups of Mono genoidea, aside from evaluating their own interrelations, one must verify the nature^{of} the origin of individual fauna". In other words, he believes that the natural mutual relations of the Monogenoidea are the main thing to consider and that their adaptation to hosts serves only as a reference point in investigating individual fauna. If B.E. Bykhovskij were to use paleontological data indirectly in studying monogenetic trematodes, this reference point would be of even less significance.

Therefore, from all that has been said, it is fully evident that neither the origin nor the settlement history of fish, much less, their taxonomic relationships, can be based solely on the makeup of their parasites. In this connection, we should examine certain far-reaching conclusions by L. Szidat

(1955,1961) on the origin of the settlement and the taxonomic relationships of certain codfish, which he made only on the grounds of their parasitic makeup without considering their congeneric relationships from the standpoint of morphological and paleontological data. Thus, on the basis of the difference noted between the parasites Merluccius hubbsi, from off the Atlantic coast of South America, and the North Atlantic parasite species of the genus Merluccius and their indentity or near kinship to Pacific Ocean parasites, he assumes that this species should be considered as a migrant from the Pacific Ocean. In his opinion, it is probable that M. Hubbsi, together with M. Gayi (off the Pacific coast of South America) originate from M. Productus, from the North Pacific. Since the parasites from the Pacific group which have been examined are more primitive than those from the Atlantic group, Szidat believes that there is good reason to view Merluccius as originating ~~from~~ⁱⁿ the North Pacific. He writes that approximately in the Oligocene epoch, that part of the Tetis Sea was settled which covered what is now the Caucasus, while in the Miocene and Pliocene the same processewent on in the middle North Atlantic.

It is still not clear how Merluccius, moving from west to east out of the North Pacific, could populate first the eastern regions (the Tetis Sea) and then the more westerly regions - the middle North Atlantic. On the attached maps (I and II) showing the distribution of Merluccius in the Tertiary period and the routes and times of its migration to the Atlantic Ocean, its appearance in the North Atlantic is given as being in the Pliocene and, in more southern areas, in the Pleistocene.

The evolution of the genus Merluccius which, in seas covering the modern Caucasus, Carpathians and Central Europe in Middle Oligocene times, became isolated from one of the branches of the most ancient fossil representative of the cod family - the Oligocene genus Paleogadus - has been studied in detail, as mentioned above, by P.G. Danil'chenko (1947 and 1960); this information does not confirm Szidat's opinion, which is based only on parasites.

On the grounds of having discovered typical North Pacific parasites on Micromesistius australis (off the coast of South America), Szidat concludes that this species, too, is of Pacific origin and frames an even less likely hypothesis

that it is a direct descendant of Boreogadus saida of the Bering Sea. At the same time, in his opinion, the North Atlantic species of this genus (M. poutassou) originated from the north Atlantic genus Pollachius. B. saida is a typically Arctic species and, in the Bering Sea, is restricted to the most northerly areas, while the genus Micromesistius is entirely absent from the Pacific Ocean. It is not clear how M. Australis could ~~/1343~~ have originated, as Szidat writes, directly from B. saida. It is also puzzling how two species of one and the same genus, having identical characteristic skull structures, could have originated from the two genera Boreogadus and Pollachius, which generally have little in common. Only Urophycis Brasilien-^{/1343}sis (off the coast of South America) is acknowledged to be related to other Atlantic species of the genus and to be of Atlantic origin. It cannot be agreed, however, that morphologically this species is either the closest or identical to Phycis chesteri, since there are no grounds for such an assumption. Ph. chesteri is essentially different morphologically, and especially in the peculiarities of skull construction, from species of Urophycis found off the Atlantic coast of America. It differs in the

same way from U. brasiliensis and should be classed with another genus (Phycis), most species of which are found off the coast of Europe (Svetovidov, 1948).

We shall not consider other pronouncements by Szidat concerning the relationships of the above mentioned and other species of Gadiformes. We shall only stress once more that the above examples point to the limited value of parasites in determining the relationships of fish species.

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