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Research Article

Trends of aquatic alien species invasions in Ukraine

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Abstract

This review is a first attempt to summarize data on the records and distribution of 240 alien species in fresh water, brackish water and marine water areas of Ukraine, from unicellular algae up to fish. A checklist of alien species with their taxonomy, synonymy and with a complete bibliography of their first records is presented. Analysis of the main trends of alien species introduction, present ecological status, origin and pathways is considered.

Key words: alien species, ballast water, Black Sea, distribution, invasion, Sea of Azov

Introduction

The range of organisms of different taxonomic groups varies with time, which can be attributed to general processes of phylogenesis, to changes in the contours of land and sea, forest and deserts, to elevation and isolation of mountains, to changes in water bodies and water flows. These historical activities may be enhanced or slackened under global climate changes. Continental drift, the elevation and lowering of large areas of the Earth, the origin and transformation of oceans, inner lake-seas have led to the formation on the Earth, in the Paleocene and Neocene periods of isolated water bodies with distinct flora and fauna. As a result of active geological processes and global climate changes (especially in the glacial age) a natural shift and transformation of fauna occurred. However, with the origin of man and with the progress of civilization including extensive travel, the introduction of plants and animals to new areas increased over the ages.

From the beginning of the 19th century, due to rising technical progress, the influence of man on nature has increased in geometrical progression, gradually becoming comparable in dimensions to climate impact.

In the past, even when aquatic 'stepping stones' existed across continents, very often negative environmental factors created natural obstacles hindering the spread of different species of aquatic bacteria, fungi, plants and animals. For example water salinity serves as a barrier impeding the entry of hydrobionts from the Mediterranean to the Black Sea and Sea of Azov. However, aquatic habitats with salinities of 5-26‰ similar to the Black Sea and therefore suitable for brackish organisms are widely distributed on the Earth (Vinogradov 1986). Thus as these areas are geographically isolated, spread by man can lead to successful colonization of new comers. So the Black Sea

has high risk in naturalization of exotic species in comparison with other areas of world ocean.

Once the natural obstacle can be overcome, species can spread over a new territory and expand its range. Often this occurs with the help of intentional or accidental human introductions. As an example of accidental introduction (simultaneously with intentional introduction of valuable species) data can be obtained that of the 36 species brought to the Black Sea from the USA, only 4-6 have been applied in fisheries and in angling and 10 for aquarium fishes. The rest, which penetrated into natural water bodies, are to some degree dangerous for aboriginal fauna (Zaitsev and Ozturk, 2001). The most common way of accidental introduction of new species is via ocean-going ships that transfer organisms through natural barriers. According to the International Marine Organisation (IMO) 80% of world cargoes are transported by shipping. Annually, about 85 000 ships carry 3-10 billion tons of ballast water in which more than 3,000 species of algae, invertebrates and fish have been recorded (IMO Bulletin 1998).

The dispersal of species is accompanied by a simultaneous decrease in native species diversity in the entire biosphere and in separate locations unifying the genetic fund of the planet. The successful invasive species inevitably leads to heavy competition squeezing out weaker often native species, resulting in a decline of biological diversity (Convention on Biological Diversity: June 5, 1992, Rio de Janeiro, Brasil).

The Black Sea – as a brackish water basin, semi-isolated from the Mediterranean Sea has been closely studied for biological invasions. Not only has a high biodiversity of alien species been established – more than 140 – but also their substantial impact on the marine ecosystem (Gomoiu et al. 2002; Alexandrov 2004) is evident. The invasion of the comb jelly *Mnemiopsis leidyi* Agassiz, 1865 was characterized as an ecological disaster (GESAMP 1997). The risk of entry of alien organisms into the Black Sea has been promoted by the dredging of shipping channels. These include the Danube-Main-Rhine Canal, connecting the Black and North Seas in 1836, and the Volga-Don Canal connecting it with the Caspian Sea in 1952.

An important factor simplifying the naturalization of alien species in the Black Sea is the instability of its ecosystem. Wide scale eutrophication, observed first in the northwestern sea in the early 1970s, spread almost all over the coastal shelf especially close to river estuaries and large cities. These changes in the trophic status of the sea led to a decline in biological diversity (losses of immunity due to a reduction in the number of predators) the freeing of ecological niches and their occupation by highly productive alien species (Alexandrov and Zaitsev 1998).

Of all the lacustrine states in the Black Sea basin, Ukraine, due to its physical-geographic position and economic development, has all the conditions necessary for becoming the main testing area for control the introduction of aquatic alien species.

The aim of this paper is to illustrate, with the help of data from the literature, the chronology of biological invasions of freshwater, brackish and marine species in Ukraine ranging from unicellular algae to fish, with synonyms included.

Methodology

All species of aliens can be divided into two groups:

1) *Distant aliens* – species which never previously inhabited the Black Sea–Azov basin, In other words these have a different origin, and were introduced into the water bodies of Ukraine unintentionally or intentionally with human help.
2) *Neighbouring aliens* – inhabitants of the Black Sea – Azov basin, or adjacent areas expanding by chance within Ukranian waters or with spread accelerated by human activities (this is mostly freshwater species).

Alien species have subsequently been grouped into four categories namely casual, invasive, established and cryptogenic (questionable).

- *Casual*: In this paper alien is used in the sense of CIESM: Alien species are identified as having been recorded only once (no more than twice for fishes) in the scientific literature: they are presumed to be not established in a river basin. http://www.ciesm.org/online/atlas/index.htm
- *Invasive*: These are the introduced species that, having overcome biotic and abiotic barriers, can propagate away from their area of initial introduction through the production of fertile offspring without any reference to

impact (Richardson et al. 2000). In many definitions the term invasive is also considered as established species which are agents of change and threaten native biological diversity (IUCN 2002) or as species that threaten the diversity or abundance of native species, the ecological stability of infested ecosystems, economic activities dependent on these ecosystems and/or human health (EPA 2001). It is in this last meaning that the term IAS (Invasive Alien Species is used here).

- *Established* (synonym: *naturalized*): These include an introduced or feral population of a species. Species established in the wild with free-living, self-maintaining and self-perpetuating populations unsupported by and independent of humans (European Commission 2004).
- *Cryptogenic* species are species with no definite evidence of their native or introduced status according to Carlton (1996). Species whose probable introduction has occurred prior to 1800, i.e. has not been witnessed, have also been included in our compiled list. Often these species are excluded from lists of aliens or included among the established ones. In this review we considered it best to separate them.

Physical and Geographical Features

Among the Black Sea countries Ukraine has the longest shoreline – 4,431 km making up 36.7% of the total (Shujskiy 1989).

Ukraine has the greatest shelf area as opposed to its territorial waters (to 200m isobaths), equal to 55,750 km^2 or 57% of the total Black Sea shelf (Zaitsev 1992).

The dense indentations of the shore line and the high number of water body types (lagoons, bays, embayments, limans, lakes) provide various habitats for aquatic organisms. These aquatic habitats are of varying salinity (0.2-300 ‰), depth (0.8-36.0 m), substrate and vegetation (Zaitsev and Alexandrov 1998). Ukraine has 17 large limans with a total area of 1952 km^2, 8 bays –1770 km^2, 19 coastal wetlands – 6350 km^2 (Conservation. 2003). A liman is the former mouth of a river now covered with sea water. This definition is very close to a estuary, but as a tide-less sea, the Black Sea does not have estuaries.

The largest rivers of the Black Sea (Danube, Dnieper, Dniester) make up more than 50% of the total river runoff into the Black Sea (Nikolaenko and Reshetnikov 1991), and their catchments create a zone of maximum biological productivity in most of the shelf of Ukraine. In total, Ukraine has about 73,000 rivers. The highest number are present in the western mountainous area including the Dniester and Danube basins. The density of the river network there is 1–1.5 km/km^2. In the Crimea, rivers are relatively rare, with many areas lacking natural water flow. The density of the Crimean river networks is 0.22 km/km^2.

The continental waters of the Ukraine pertain to two of the largest zoogeographical areas, i.e. Palearctic and Ponto-Caspian brackish areas (Starobogatov 1970). The Palearctic includes North Eurasia and Northwest Africa. Within the boundaries of Ukraine, there are two zoogeographic provinces: the Baltic and Danube-Don. The former includes the rivers of the Visla basin and Shatskie lakes. The Ponto-Caspian area includes the Caspian Sea, limans and the lower reaches of the rivers of the Black and Azov Seas. According to some data a number of relict lakes in Macedonia, Greece, Italy, Iran, Iraq, Central and Western Turkey, i.e. Eastern Mediterranean coast and Asia Minor (Wilke et al. 2007) should be included.

The Crimean peninsula could be included in the Ponto-Caspian area. Up until the 20th century it lacked the relict Ponto-Caspian fauna as zoogeographically it is not a peninsula, but an island and its isolation from the lower basins of the Dnieper and Don occurred before the introduction of Ponto-Caspian fauna. The Crimea can actually be considered to be a faunal isolate of the European-Siberian subarea of Palearctic. However, the Crimean hydrofauna contains a number of Asian elements. The Crimea itself was never considered in large zoogeographical classifications (Figure 1).

Results and Discussion

On the base of collected information 169 species of distant aliens and 71 neighbouring aliens have been registered in aquatic areas of the Ukraine (Annex). Check-list of aquatic alien species of Ukraine have been compiled according to available data published before May 2007. For this reason some recent data are not included in the results of our investigations. For example,

Figure 1. Ukrainian part of the Black Sea.

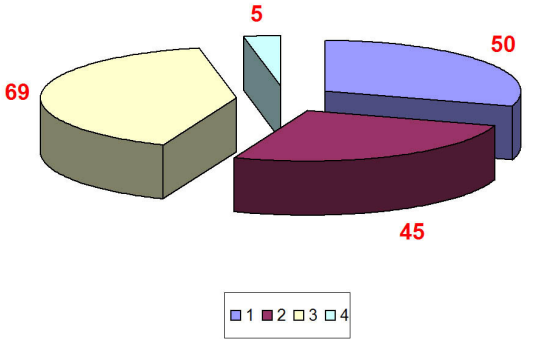

Figure 2. Ratio between main categories of distant alien species: 1 - Established (naturalized), 2 – Invasive, 3 – Casual, 4 – Cryptogenic. Total number of distant alien species is 169.

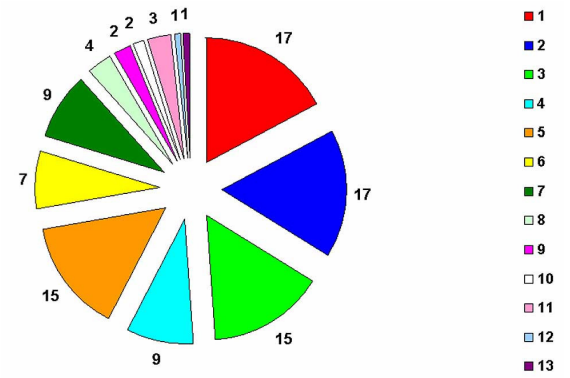

Figure 3. Main sources of alien species introduction into Ukrainian waters: 1 – Ponto-Caspian, 2 – Atlantic, 3 – SE Asia, 4 – N America, 5 – Other, 6 – Indo-Pacific, 7 – Europe, 8 – Atlantic, 9 – Indo-pacific, 10 – Atlantic Pacific, 11 – Pacific, 12 – Holarctic.

this includes information about distant (mystery blenny *Parablennius incognitus* Bath, 1968, golden goby *Gobius xanthocephalus* Heymer and Zander, 1992; *Syngnathus acus* Linnaeus, 1758; chameleon goby *Tridentiger trigonocephalus* Gill, 1859) and neighbouring (bleak *Alburnus alburnus* Linnaeus, 1758; carp *C. carpio*; pike *Esox lucius* Linnaeus, 1758; goby *Gobius ophiocephalus* var. Ninni 1938; black goby *G. niger jozo* Linnaeus, 1758; ruffe *Gymnocephalus cernuus* Linnaeus, 1758; chub *Leuciscus cephalus* Smitt, 1895; sand goby *Neogobius fluviatilis fluviatilis* Pallas, 1814; racer goby *N. gymnotrachelus* Kessler, 1857; round goby *N. melanostomus* Pallas 1811; European perch *Perca fluviatilis* Linnaeus, 1758; tubenose goby *Proterorhinus marmoratus* Pallas, 1814; rodeus *Rhodeus sericeus amarus* Berg, 1949; roach *Rutilus rutilus* Linnaeus, 1758) alien species in coastal and inland water of Crimea that have been firstly registered during 2002-2006 (Boltachev et al. 2007).

Analysis of distant species registration

In relation to salinity many of the encountered species are brackish organisms encountered both in the sea and in freshwater bodies. However, 59% of the registered species were attributed to the coastal ecosystem of the Black and Azov seas, 29% to brackish and 16% to freshwater areas. Most of the distant alien species (23 species of fish) were registered in the period from the beginning of 1950 to 1975 due to wide scale introduction of valuable varieties of fish in the water bodies of Ukraine and neighboring countries (Russian, Moldova, Belarus). Of the number of aliens observed in that period, 44% relate to introductions. However, of the above mentioned 23 fish species brought to Ukraine, only 4 species became naturalized. These were able to reproduce in new conditions without the help of man. These species include spotted silver carp *A. nobilis*, silver carp *H. molitrix* and grass carp *C. idella* among the freshwater hydrobionts and haarder *L. haematocheila* in the marine species (see Annex).

The process of successful introduction is linked with a number of biological, physical and chemical factors which at present cannot be accurately forecasted. Of the total number of registered species of distant aliens, only 30% (or 50 species) were naturalized, and today are part of the food web of Ukranian aquatic ecosystems able to support their populations. Almost half of

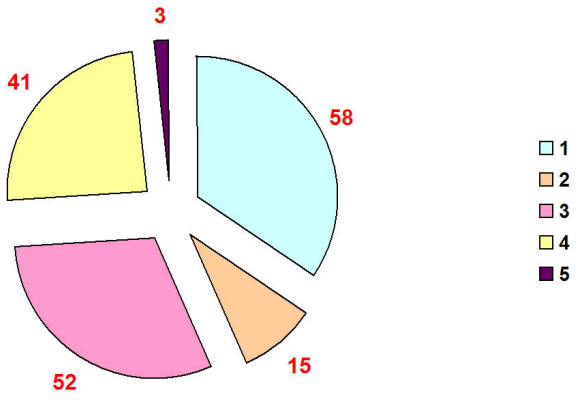

Figure 4. Ratio of life forms of distant alien species (biological composition of distant alien species of Ukrainian aquatic ecosystems): 1 – Plankton, 2 – Fouling, 3 – Benthos, 4 – Nekton, 5 – Parasites.

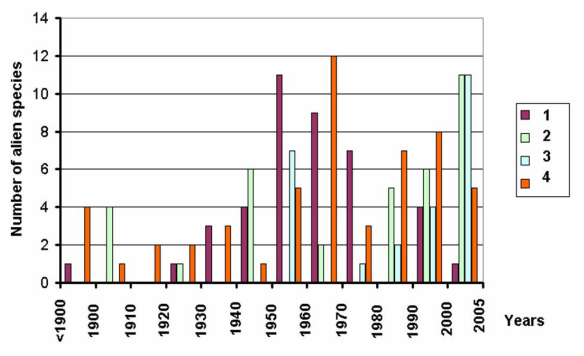

Figure 5. Biological structure of distant alien species introduced into Ukrainian aquatic ecosystems: 1 – fish, 2 - phytoplankton, 3 – zooplankton, 4 – zoobenthos.

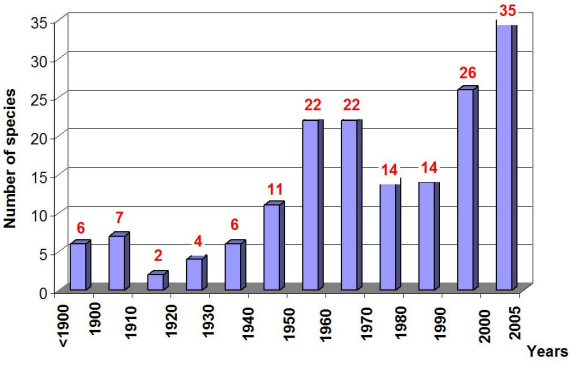

Figure 6. Long-term changes in distant alien species introduction .

the species (41% or 69 species) were discovered no more than twice and in small amounts, and that is why they are placed in the casual category (Figure 2).

In total, most of the registered number recorded in Ukranian water bodies are distant aliens (Figure 3), with the majority of the species being either planktonic or fouling organisms (Figure 4).

This confirms the key role of shipping in transferring aliens. Usually, benthic animals entered Ukranian water bodies as result of ships' hull fouling. The maximum number of recorded aliens occurred before the early 1970s (Figure 5). It is possible to explain the subsequent decline due to the widespread introduction of hull antifouling coatings. For example, in the 1970s, the overwhelming majority of ships' hulls were coated with tributyltin (TBT), which protected the hulls from fouling for 18 to 24 months. Since then the number of cases of recorded planktonic organisms invasions has risen, due to ballast water exchange in tanker fleets (see Figure 5). The total tonnage of tankers in the 1980s made up 42% of the world total and determined their priority in cargo turnover (Marine encyclopedic reference. 1986).

Since 1973, subsequent to the adoption of MARPOL -73/78, a measure to prevent pollution from ships, conditions for survival of hydrobionts in ballast tanks were much better due to isolation from oil products. This was another reason why the probability of transferring planktonic hydrobionts to new ecosystems has increased.

When characterizing the long-term dynamics of alien introduction records into Ukranian water bodies, two maxima have been noted (Figure 6).

One of them, in the 1960-1970s, is connected with the introduction of fish in freshwater bodies and also with the establishment of new marine ports, increasing the risk of the introduction of aliens into the Black Sea. The second maximum has been recorded since the beginning of the new millenium and can be explained by two factors. On one hand, it can be explained by a large increase in ballast water transportation especially by the oil tanker fleet. On the other hand, there also has been a rise in scientific interest into the problems of biological pollution in the world's oceans resulting in a more comprehensive study of its biological structure. This can be illustrated by the increasing number of publications in the electronic abstract version of ASFA. In the past

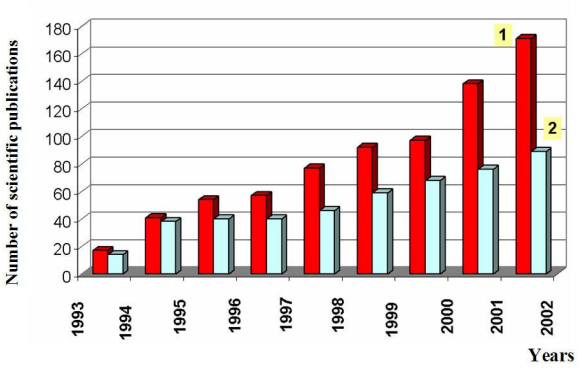

Figure 7. Dynamics of scientific publications on invasive species. Source: Cambridge Scientific Abstract; key words 1 – "invasions", 2 – "alien species".

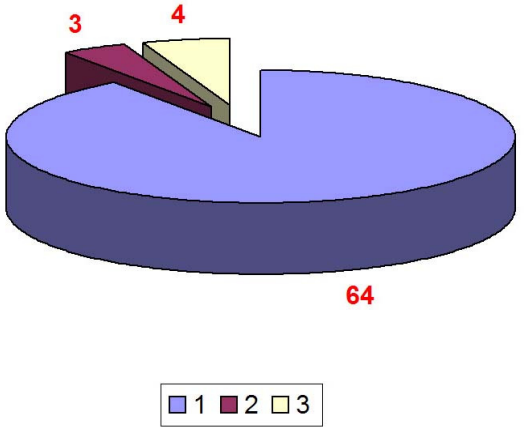

Figure 8. Ratio between main categories of neighbouring alien species: 1 - Established (naturalized), 2 – Invasive, 3 – Casual. Total number of nearby alien species is 71.

decade the number of publications on alien species and invasion has increased by 6-7 times (Figure 7).

Due to more intense biological studies in Ukraine the list of alien species was extended adding marine fungi – 7 species, infusorians – 6, parasites – 3 and unarmored Dynophyta – 11 species (see Annex). Due to the study of new previously un-studied systematic groups, 3% (or 5 species) of the aliens discovered were placed in the category "Cryptogenic" (see Figure 2)

The greatest numbers of distant species of freshwater hydrobionts were introduced and dispersed in the Ponto-Caspian basins. A small part moved up the Dnieper to the mid Dnieper – Danube province. Another fraction was introduced into northwestern Ukraine (Baltic province) and the Crimea. The Annex illustrates some species introduced into the upper Dnieper cascade from North Europe. These species are characteristic of the Baltic province. If the Ukrainian water bodies of the Baltic basin were closely studied, they would have most likely have been found there. Probably, these species entered the Dnieper basin through a system of channels connecting it with the Baltic. In this case, if borders are not taken into consideration, then the introduction is similar to that in Annex 2 (nearby aliens).

Separate attention is necessary to focus on aquarium species. Subsequent introductions to waterbodies may occur unintentionally when emptying aquariums. One of the famous examples is killer algae *Caulerpa taxifolia* (M. Vahl) C. Agardh, 1817 that penetrated into Mediterranean coastal ecosystems from the aquarium of Monaco Oceanographic Institute.

Most of the cultivated species in aquaria are of tropical or subtropical origin. As a rule, they survive in natural conditions of the area under study, being sensitive to lower temperatures. However, in the warm season they are encountered close to populated areas. Examples are aquarium fish like guppies and platies encountered episodically in the Dnieper Basin (Novitskij 2005), and piranha discovered in the summer, 2006, in Lake Kasyanka (Dnieper Basin) near Dnepropetrovsk. At present this invasion is being studied by specialists from Dnepropetrovsk National University (R. Novitskij, personal communication).

However, some of the aquarium species are able to form long-term populations in artificial water bodies (in cooling ponds) – *Ampullaria* sp., *Biomphalaria glabrata* Say, 1818, *Melanoides tuberculata* Müller, 1774; or even in the natural biotopes of most southern regions of Ukraine – *Craspedacusta sowerbyi* Lankester 1880, *Ferrissia fragilis* Tryon, 1863), *Physella heterostropha* (Say, 1817) (Protasov et al. 1981, Son 2007a).

It is evident that most of the aquarium species of the populations formed in open water bodies are functional species (bloodfluke planorb *B. glabrata*, pewter physa *Ph. heterostropha*) and not cultivated decorative species which clean the aquarium of "aquarium weeds" entering from

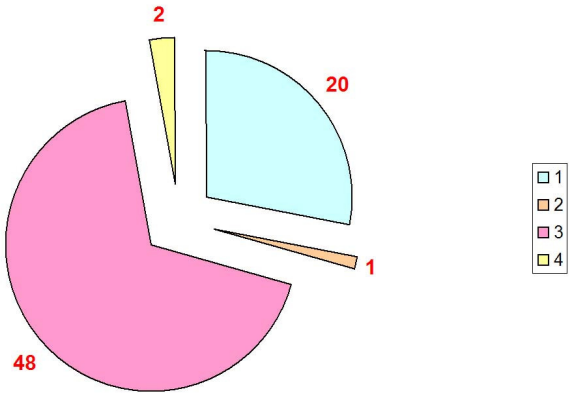

Figure 9. Ratio of life forms of neighbouring alien species in Ukrainian aquatic ecosystems: 1 – Plankton, 2 – Fouling, 3 – Benthos, 4 – Nekton.

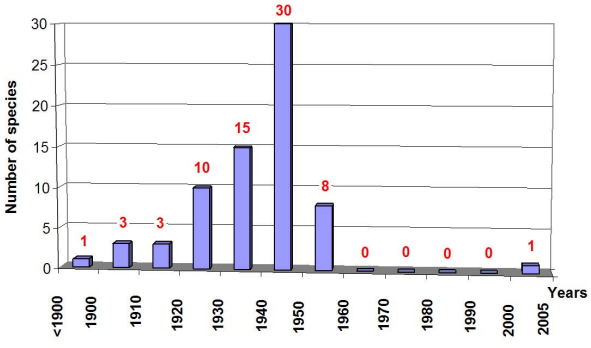

Figure 10. Long-term changes of neighbouring alien species introduction into Ukrainian aquatic ecosystems.

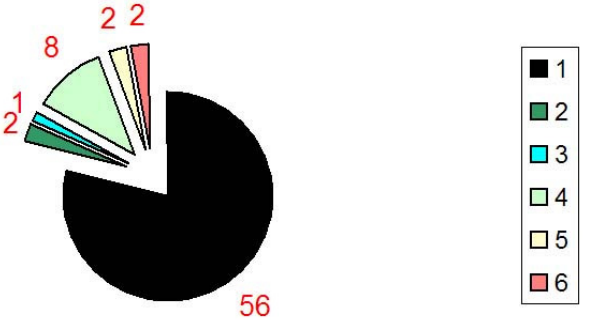

Figure 11. Main donor areas for neighbouring alien species introduction into the Ukrainian part of the Black Sea: 1- Ponto-Caspian relics, 2 – Black Sea, 3 - Mediterranean Sea, 4 - European water bodies, 5 – Holarctic, 6 – Cosmopolitan.

one aquarium to another with sediments or plants (red-rimmed melania *M. tuberculata*, freshwater jellyfish *C. sowerbyi* Lankester 1880, freshwater limpet *F. fragilis*. All of these species have very a high fertility rate. The aquarium species of gastropods have asexual reproduction (Son 2007a). These specific ecological properties facilitate successful introductions.

Analysis of neighbouring alien records

The main feature of neighbouring species, which differentiate them from distant species is the high percentage of naturalized species present – 90% (Figure 8), and also the fact that most of the species records (68%) pertain to benthic organisms (Figure 9). The chronology of introducing species shows that their penetration into the water bodies of the Ukraine was linked with the wide scale melioration in 1950s, due to the withdrawal of runoff from the largest rivers of the Black Sea basins for agriculture purposes.

The subsequent introduction of hydrobionts in the late 1950s was not comparable in scale with the previous one (Figure 10). The dominant neighbouring species originated as Ponto-Caspian relicts, which due to the artificial integration of river systems have widespread in the Black – Azov sea basin (Figure 11).

When considering neighbouring aliens, cases of species introduction from adjacent biogeographically areas, such as the Ponto-Caspian into the European - Siberian area through the Dnieper reservoir cascade and inner waters of Crimea, should be of first priority. It is quite clear that first of all many freshwater, brackish Ponto-Caspian relicts were introduced, which were lacking previously from the European – Siberian sub-area. Hydrobionts were able to overcome the zoogeographical border along the Dneiper river bed after the removal of the barrier between Dnipropetrovsk and Zaporozhie following construction of a dam in Kichkas and after activating river shipping, dredging channels, setting up a reservoirs and after intentional introductions. This led to further distribution in the European-Siberian sub area: mid Dnieper (from it to the Don, then into the Volga) and upper Dnieper (from it the Baltic basin, then to West Europe and Britain).

It is known that separate species of hydrobionts with local areas in Europe as the cladocerans *Cercopagis pengoi* (Ostroumov, 1891), *Limno-cletodes behning* (Borutzky, 1926), *Para-leptastacus spinicaudata* (T. Scott

et A. Scott, 1895), and the amphipods *Rivulogammarus kischineffensis* (Schell.), *Synurella ambulans* (Müller, 1846) (see Annex) appeared in the Dnieper cascade also at the time of introduction of Ponto-Caspian fauna. These species, which have very wide natural habitat, are made up of several interrupted localities. This is characteristic to Ukraine as in the lower Dniester and Danube where there are many separate relict localities of species, the main ranges of which are in South or West Europe. Possibly, these species were introduced into the Dnieper water reservoir simultaneous with the mass introduc-tion of Ponto-Caspian species as food resource for fish.

Besides being spread along the Dnieper, they penetrated to the Crimea. After the opening of the North-Crimean canal and as a result of introduction of food invertebrates in some water reservoirs in the peninsula, some species with a wide range of dispersal as crustaceans *Daphnia cucullata* Sars, 1862, *Leptodora kindtii* Focke, 1844, *Mesocyclops leucarti* Claus, 1857 and molluscs: river snail *Viviparus viviparus* Linnaeus, 1758; European fingernailclam *Sphaerium corneum* Linnaeus, 1758, *S. rivicola* Lamarck, 1818 were able to enter with representatives of the Ponto-Caspian fauna. Despite this there are some species, with a main range located in the European-Siberian sub area, which also entered the Crimea as Ponto-Caspian fauna, at the southern border of their distribution. The situation differs for three molluscs species *Fagotia danubialis* Bourguignat, 1884; gravel snail *Lithoglyphus naticoides* Pfeiffer, 1828 and freshwater nerite *Th. fluviatilis*. Their dispersal was first noted only in the Crimea but they, together with other species similar to the representatives of Ponto-Caspian fauna, have actively spread in Europe (see Annex). Often they are confused with Ponto-Caspian as most of the areas (lower Dnieper, South Bug, Dniester and Danube) coincide. However, in contrast to representatives of the Ponto-Caspian fauna, they have not been formed in the Sea of the Sarmat, but in rivers and are absolutely freshwater in nature. *L. natcoides* inhabits an isolated part of the area in the Baltic, while *F. danubialis* is found in the eastern tributaries of Pripyat. As for *Th. fluviatilis*, it pertains to a special zoogeographical group of the most ancient representatives of Ponto-Caspian fauna. It was formed like the zebra mussel *D. polymorpha* in the Eastern Mediterranean basins, but then migrated to the northwestern Black Sea from which many new species emerged - classical Ponto-Caspian. In origin it is like the zebra mussel as it is traditionally classified as a Ponto-Caspian species. However, in Annex this species is noted as European as in the summary table, its affinity as a species is not related to the zoogeographical group, but to its natural range.

The classification of the molluscs in the European species category is attributed to the time of paleoinvasion *Th. fluviatilis* has kept to its localities in the Baltic, as well as in Spain. At present, it is actively spreading in Europe. In the Ukraine it has been inhabiting limans and rivers (in contrast to classical representatives of the Ponto-Caspian fauna it is native in upper stretches of the large rivers) and also in several marine bays (Odessa, Egorlitsky, Tendrovsky) earlier forming the avandelta of the Dnieper (Son 2005). However, the marine part of its range does not border with the Chernaya River estuary. Evidently, it has been introduced to the Crimea like other species during faunal introductions from the lower Dnieper to mountainous water reservoirs.

Economic prerequisites in biological invasions

The presence of an indented coastline, deep water bays and limans promoted the establishment of a maximum amount of sea ports following intensive agricultural and industrial development in the Ukraine (see Figure 1), the largest of which are Odessa, Yuzhny, Ilyichovsk. In 2004 their annual turnover was more than a half of the sum total of 19 marine ports of Ukraine and amount to >60 mln. t (M t). By the way it is necessary to stress on the fact that main volum of shipping transportation in the Black Sea comes through Ukraine. For example at the same period (2004) cargo traffic of two main ports of Russian Federation (Novorossisk and Tuapse) was 89.8 M t, largest Black Sea ports in Constanza (Romania) – 50.43 M t, in Georgian ports (Poti, Supsa and Batumi) – 20.55 M t, in Bulgarian ports (Varna and Burgas) – 13.35 M t. Black Sea ports of Turkey (Istanbul, Darince, Zonguldag and Samsun) develop very quickly (Tokman 2005).

In the past 5 years (2001-2006) the total turnover of Ukrainian ports has increased 1.6 fold. Simultaneously, the volume of ballast water exchange increased; this is determined by the numbers of export-import operations. For

example, in the port of Odessa in 2001, it increased 17% in comparison to the previous period, while in the port of Ilyichovsk it dropped by 54%. It has been estimated that in 2001 alone, more than 11 M t of ballast waters were discharged in ten of the largest ports of Ukraine (Savusin 2002).

Another pathway for the introduction of alien species are the estuarine ports Ust-Dunaisk (near the Danube), Belgorod-Dnestrovsk (near the Dniester), the ports of Nikolaev and Kherson (near the Dneipro-Bug Liman). Although their cargo turnover is less than those mentioned previously, there is a greater risk of transferring alien species from a more dense marine environment to a less dense freshwater when ballast waters are discharged. This is evident in the high number of acclimatised species discovered in the Danube delta (Alexandrov 2004). It should be noted that most of the above mentioned ports, e.g. Ust-Dunaisk, Belgorod-Dnestrovskiy, Ilyichovsk and Yuzhny have been established in the past 50 years during the period 1958-1980. This should be taken into conside-ration when analyzing the chronology of invasions.

The Northern Crimean canal has become a powerful man-made source of biological invasions for the freshwater water hydrobionts of the Crimea.

The first Dneiper water came to the Crimean Peninsula in 1963. Having filled up 8 water reservoirs it is supplied to the cities of Kerch, Feodosiya, Simferopol and Sevastopol with maximum consumption of 300 m^3/sec.

The source of many biological invasions is the intentional introduction by man of valuable fish species for consumption. In addition to spreading naturalized fish e.g. haarder *Liza haematocheila* Temmnick and Schlegel, 1845 (=*Mugil soiuy* Basil and Europeski, 1855) and silver carp *Hypophthalmichthys molitrix* Valenciennes, 1844 which took place in the Black Sea basin, it allowed the simultaneous entry of other undesirable organisms. For example, some parasites, free-living algae, invertebrates and even fish as stone moroko *Pseudorasbora parva* Temminck and Schlegel, 1846 penetrated into the Black Sea. Fish introductions were carried out mostly in freshwater bodies. The existing network of rivers and streams in Ukraine is closely tied with those in the neighboring Moldova Republic and the Russian Federation, which should be taken into considerations in terms of fish breeding. During the Russian Empire, work for the introduction of species was conducted 150 years ago under the guidance of the Russian Society for Acclimatization founded in 1857. Before the disintegration of the USSR almost 250 introductions of 35 fish and 13 invertebrate species were performed annually. Before 2000 almost 100 introductions of 16 fish and 2 invertebrate species have been carried out in Russia (Stroganov and Zadoenko 2000). As an example, the river nerite *Theodoxus fluviatilis* Linnaeus, 1758, belongs to a special zoogeographical group of the most ancient Ponto-Caspian fauna representatives. Similar to zebra mussel *Dreissena polymorpha* Pallas, 1771 they evolved in the basins of the Eastern Mediterranean, but migrated to the Ponto-Caspian area producing many new classical Ponto-Caspian species (Gelembiuk et al. 2006). Introductions of fish from the Russian Federation were also carried out. In Moldova, the introduction of fish was carried out in three stages. In the first stage in 1950-1961 there were organized introductions of Lake Chud whitefish *Coregonus lavaretus maraenoides* Poljakow 1874, European carp *Cyprinus carpio* Linnaeus 1758, zander (European pike-perch) *Stizostedion lucioperca* Linnaeus 1758, eastern bream *Abramis brama* Linnaeus 1758, roach *Rutilus rutilus heckeli* Nordmann 1840 and various sturgeons (Acipenseridae). In the second stage, 1961-1974, fishes were introduced from Chinese water bodies: silver carp *H. molitrix*, spotted silver carp *Aristichthys nobilis* Richardson 1846, grass carp *Ctenopharyngodon idella* Valenciennes 1844. In the third stage, 1974-1990, valuable varieties of fish from the freshwater bodies of the USA: smallmouth buffalo *Ictiobus bubalus* Rafinesque 1818, bigmouth (common) buffalo *Ictiobus cyprinellus* Valenciennes 1844, black buffalo *Ictiobus niger* Rafinesque 1818, channel catfish *Ictalurus punctatus* Rafinesque 1818, paddlefish (spadefish) *Polyodon spathula* Walbaum 1792 were introduced (Lobchenko 1999).

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Species	Year of first record and recipient region			Origin / donor area	Vector	Pathway	Impact or potential impact / invasive-ness	References
	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Fungi, ANAMORPHIC								
Cirrenalia basiminuta (Kaghu-Kumar and Zainal, 1988)	2001	-	-	Indo-Pacific	Unintentional	Ships	Unknown	Kopytina 2002
Cumulospora marina (Schmidt, 1985) = *Vesicularia marina* (Schmidt, 1974); *Basramyces marinus* (Abdullah, Abdulkadder and Goos, 1989)	2001	-	-	Indo-Pacific	Unintentional	Ships	Unknown	Kopytina 2006
Cumulospora varia (Chatmata and Somrithipol, 2004)	2004	-	-	SE Asia	Unintentional	Ships	Unknown	Kopytina 2006
Fungi, ASCOMYCOTA								
Lulworthia uniseptata (Nakagiri, 1984)	2001	-	-	SE Asia	Unintentional	Ships	Unknown	Kopytina 2002
Savoryella lignicola (Jones and Eaton, 1969)	2001	-	-	Cosmo-politan	Unintentional	Ships	Unknown	Kopytina 2004
Zopfiella latipes (Malloch and Cain, 1971)	2001	-	-	Indo-Pacific	Unintentional	Ships	Unknown	Zaitsev et al. 2004, Kopytina 2006
Gloniella clavatispora (Steinke and Hyde, 1997)	2002	-	-	Indo-Pacific	Unintentional	Ships	Unknown	Kopytina 2004
Microalgae, BACILLARIOPHYTA								
Toxonidea insignis (Donkin, 1858)	1902	-	-	N Atlantic	Unintentional	Ships	Unknown	Merezhkowsky 1902-1903
Cocconeis britannica (Naegeli, 1849)	1902	-	-	N Atlantic	Unintentional	Ships	Unknown	Merezhkowsky 1902-1903
Pinnularia trevelyana ((Donkin) Rabenh., 1861)	1902	-	-	N Atlantic	Unintentional	Ships	Unknown	Merezhkowsky 1902-1903
Bacteriastrum hyalinum (Lauder, 1864)	1907	-	-	Atlantic	Unintentional	Ships	Unknown	Reingardt 1909
Pseudosolenia calcar-avis (Sundström, 1986)	1924	-	-	Atlantic, Indo-Pacific	Unintentional	Ships	Unknown	Usachev 1928
Asterionellopsis glacialis (Round,1990)	1967	-	-	Atlantic	Unintentional	Ships	Unknown	Senicheva 1971
Navicula finmarchica (Cleve and Grunow, 1880)	1970	-	-	N Atlantic, Pacific	Unintentional	Ships	Unknown	Bodeanu 1970
Achnanthes pseudogroenlandica (Hendey, 1964)	1984	-	-	Atlantic	Unintentional	Ships	Unknown	Guslyakov and Gerasemiuk 1984, Nevrova 2003
Undatella quadrata ((Brebisson) Paddock and Sims, 1980)	1985	-	-	N Atlantic	Unintentional	Ships	Unknown	Roschin et al. 1992
Nitzschia sigmoidea (Nitzsch, 1817), (Smith, 1853)	1986	-	-	N Atlantic	Unintentional	Ships	Unknown	Roschin et al. 1992

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Thalassiosira nordenskioeldii (Cleve, 1873)	1986 2000	-	-	N Atlantic	Unintentional	Ships	Unknown	Shadrin 2000, Terenko and Terenko 2000
Sceletonema subsalsum (Bethge, 1928)	1993	-	-	N Atlantic	Unintentional	Ships	Unknown	Bodeanu 1993
Lioloma pacificum (Hasle, 1996)	1999	-	-	Indo-Pacific	Unintentional	Ships	Unknown	Terenko and Terenko 2000
Chaetoceros diversus var. papilionis (Senicheva, 2002)	1999	-	-	Pacific	Unintentional	Ships	Unknown	Senicheva 2002
Chaetoceros tortissimus (Gran, 1900)	2001	-	-	N Atlantic	Unintentional	Ships	Unknown	Senicheva 2002
Microalgae, CHLOROPHYTA								
Hillea fusiformis (Schiller, 1925)	1948	-	-	Mediter-ranean	Unintentional	Ships	Unknown	Morozova-Vodyanitskaya 1948
Pterosperma cristatum (Schiller, 1925)	1948	-	-	Mediter-ranean, Pacific	Unintentional	Ships	Unknown	Morozova-Vodyanitskaya 1948
Pterosperma joergenseni (Schiller, 1925)	1948	-	-	Mediter-ranean	Unintentional	Ships	Unknown	Morozova-Vodyanitskaya 1948
Poropila dubia (Schiller, 1925)	1948	-	-	Mediter-ranean	Unintentional	Ships	Unknown	Morozova-Vodyanitskaya 1948
Pyramimonas longi-cauda (Van Meel, 1984)	2001	-	-	Pacific	Unintentional	Ships	Unknown	Zaitsev et al. 2004
Microalgae, CHRYSOPHYTA								
Octactis octonaria (Hovasse, 1946)	1948	-	-	Mediter-ranean	Unintentional	Ships	Unknown	Morozova-Vodyanitskaya 1948
Apedinella spinifera (Throndsen, 1971)	1999	-	-	Atlantic Mediter-ranean Pacific	Unintentional	Ships	Unknown	Terenko and Terenko 2000, Bryantzeva 2005
Microalgae, DYNOPHYTA								
Prorocentrum minimum (Schiller, 1933)	1948	-	-	Cosmo-politan	Unintentional	Ships	Unknown	Morozova-Vodyanitskaya 1948
Pronoctiluca pelagica (Fabre-Domergue, 1889)	1983	-	-	Atlantic, Mediter-ranean	Unintentional	Ships	Unknown	Senichkina 1983
Gymnodinium radiatum (Kofoid and Swezy, 1921)	1998	-	-	Pacific	Unintentional	Ships	Unknown	Krakhmalnyi 2001
Gymnodinium uberrimum (Kofoid and Swezy 1921)	1999	-	-	Europe	Unintentional	Ships	Unknown	Terenko and Terenko 2000

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Alexandrium acatenella ((Whed. and Kof.) Balech, 1985)	2001	-	-	Pacific	Unintentional	Ships	Unknown	Zaitsev et al. 2004
Alexandrium affine (Balech, 1985)	2001	-	-	SE Asia	Unintentional	Ships	Unknown	Zaitsev et al. 2004
Spatulodinium pseudonoctiluca (Cachon and Cachon, 1967)	2001	-	-	N America, Atlantic, Mediter-ranean	Unintentional	Ships	Unknown	Terenko 2003
Gyrodinium impudicum (Fraga and Bravo, 1995)	2001	-	-	Atlantic, Mediterran ean, Pacific	Unintentional	Ships	Unknown	Terenko 2003
Alexandrium tamarense (Balech, 1995)	2001	-	-	Cosmopolit an	Unintentional	Ships	Unknown	Zaitsev et al. 2004
Cochlodinium polykrikoides (Margelef, 1961)	2001	-	-	N America Indo-Pacific	Unintentional	Ships	Unknown	Terenko 2003
Alexandrium pseudogonyaulax (Horiguchi ex Yuki and Fukuyo, 1992)	2002	-	-	SE Asia	Unintentional	Ships	Unknown	Terenko 2003
Gymnodinium aureolum (Hansen, 2000)	2002	-	-	N America	Unintentional	Ships	Unknown	Terenko 2003
Gyrodinium instriatum (Freudental and Lee 1963)	2003	-	-	Atlantic Pacific	Unintentional	Ships	Unknown	Terenko and Terenko 2005
Macroalgae, PHAEOPHYTA								
Desmarestia viridis (Lamouroux, 1813)	1992	-	-	Atlantic	Unintentional	Ships	Unknown	Minicheva and Eryomenko 1993
Macroalgae, FUCOPHYCEAE								
Ectocarpus caspicus (Henckel, 1909)	1980	-	-	Caspian	Unintentional	Ships	Unknown	Maslov et al. 1998
Higher plants, POLYPHODIOPHYTA								
Azolla filiculoides (Lamarck, 1783)	-	1970s	1970s	N America	Unknown	Ornamental trade	Unknown	Dubyna and Protopopova 1980
Azolla caroliniana (Willdenow, 1810)	-	1970s	1970s	N America	Unknown	Ornamental trade	Unknown	Dubyna and Protopopova 1980
Higher plants, MAGNOLIOPHYTA								
Elodea canadensis (Michaux, 1791)	-	1890s	-	N America	Unknown	Ornamental trade	Competi-tion, habitat modi-fication	Stemninskij 1909
Ciliata, OLIGOTRICHA								
Eutintinnus lusus-undae (Entz, 1885)	2001	-	-	Indo-Pacific Mediter-ranean	Unintentional	Ships	Unknown	Gavrilova 2001
Eutintinnus tubulosus (Kofoid and Campbell, 1939)	2001	-	-	Atlantic, Indo-pacific	Unintentional	Ships	Unknown	Gavrilova 2005

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Eutintinnus apertus (Kofoid and Campbell, 1929)	2002	-	-	Pacific	Unintentional	Ships	Unknown	Gavrilova 2005
Eutintinnus hastae (Taniguchi and Hada, 1981)	2002	-	-	Pacific	Unintentional	Ships	Unknown	Gavrilova 2005
Salpingella sp. (*rotundata*?) (Kofoid and Campbell, 1929)	2002	-	-	Pacific	Unintentional	Ships	Unknown	Gavrilova 2005
Favella brevis (Jörgensen, 1924)	2002	-	-	Mediterran ean	Unintentional	Ships	Unknown	Gavrilova 2005
Coelenterata, HYDROZOA								
Craspedacusta sowerbii (Lankester, 1880)	-	1950s	-	S America	Unintentional	Ornamental trade	Unknown	Protasov et al. 1981
Cordylophora caspia (Pallas, 1771)*	-	1950s	-	Ponto-Caspian	Unintentional	Ships	Fouling	Zhuravel 1965
Blackfordia virginica (Mayer, 1910)	1960s	-	-	N America	Unintentional	Ships	Unknown	Zaitsev et al. 2004
Bougainvillia muscus (Van Beneden, 1844)	1960	-	-	Atlantic	Unintentional	Ships	Unknown	Simkina 1960
Tiaropsis multicirrata (Sars, 1835)	1990	-	-	N Atlantic	Unintentional	Ships	Unknown	Shadrin 1999
Eudendrium vaginatum (Allman, 1863)	1990	-	-	N Atlantic	Unintentional	Ships	Unknown	Shadrin 1999
Eudendrium capillare (Allman, 1856)	1990	-	-	N Atlantic	Unintentional	Ships	Unknown	Shadrin 1999
Cordylophora inkermanica (Marfenin, 1983)*	2002	-	-	BS	Unintentional	Ships	Fouling	Marfenin 1983, Koshelev 2003
Ctenophora, CTENOPHORA								
Mnemiopsis leidyi (Agassiz, 1865)	1982	-	-	Atlantic	Unintentional	Ships	Predation	Pereladov 1988, Zaitsev et al. 1988, Volovik et al. 1993
Beroe ovata (Bruguière, 1789)	1997	-	-	Atlantic (Mediter-ranean)	Unintentional	Ships	Predation	Konsulov and Kamburska 1998, Zaitsev 1998, Romanova et al. 1999
Plathelminthes, MONOGENOIDEA								
Ligophorus kaohsianghsieni (Gussev, 1962)	1994	-	-	SE Asia	Unintentional	Acclimati-zation of fish	parasite	Dmitrieva 1996
Gyrodactylus mugili (Zhukov, 1970)	1995	-	-	SE Asia	Unintentional	Acclimati-zation of fish	parasite	Maltsev 1997
Gyrodactylus zhukovi (Ling, 1962)	1995	-	-	SE Asia	Unintentional	Acclimati-zation of fish	parasite	Maltsev 1997

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Species	Year of first record and recipient region			Origin / donor area	Vector	Pathway	Impact or potential impact / invasiveness	References
	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Annelida, POLYCHAETA								
Hypania invalida (Grube, 1860)*	-	1950s	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1974
Hypaniola kowalewskii (Grimm, 1877)*	-	1956	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1974
Hesionides arenarius (Friedrich, 1937)	1960s	-	-	Atlantic, Mediterranean, Pacific	Unintentional	Ships	Unknown	Vorobyova 1977
Ancistrosyllis tentaculata (Treadwell, 1941)	1960s	-	-	Atlantic	Unintentional	Ships	Unknown	Shadrin 1999
Ficopomatus enigmaticus (Fauvel, 1923) = *Mercierella enigmatica* (Fauvel, 1923)	1961	-	-	SE Asia	Unintentional	Ships	Fouling	Zaitsev et al. 2004
Polydora cornuta (Bosk, 1802) first identified as *Polydora ciliata* (Johnston, 1838)	1962	-	-	Cosmopolitan	Unintentional	Ships	Fouling	Radashevsky and Pankova 2006
Manayunkia caspica (Annenkova, 1929)*	-	1963	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Glycera capitata (Oersted, 1843)	1970s	-	-	Atlantic, Pacific	Unintentional	Ships	Unknown	Mordukhay-Boltovskoy 1972, Kiseleva 2004
Nephthys ciliata (Muller, 1776)	After 1975	-	-	Atlantic, Pacific	Unintentional	Ships	Unknown	Mordukhay-Boltovskoy 1972
Magelona mirabilis (Johnston, 1845) = *M. papillicornis* (Muller 1858)	1997	-	-	Mediterranean N Atlantic	Unintentional	Ships	Unknown	Murina Skulyari 2000
Annelida, OLIGOCHAETA								
Tubificoides benedii (Udekem, 1855)	1916	-	-	N America	Unintentional	Ships	Fouling	Zagorovskiy and Rubinshtein 1916
Limnodrillus newaensis (Michaelsen, 1902) = Tubifex newaensis (Brinkhurst, 1963)*	-	1955	-	Ponto-Caspian	Unintentional	Ships	Unknown	Zhuravel 1974
Psammoryctes deserticola (Grimm, 1876) = *Ilyodrilus raduli* (Jaroschenko, 1948); *Tubifex deserticola* (Ostroumov, 1897)*	-	1989	-	Ponto-Caspian	Unintentional	Canals	Unknown	Grigorovich et al. 2002
Annelida, HIRUDINEA								
Cystobranchus fasciatus (Kollar, 1842)*	-	1974	-	Ponto-Caspian	Unintentional	Ships	Parasite	Pligin and Yemelyanova 1989

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Crustacea, CONCHOSTRACA								
Eocyzicus orientalis (Daday, 1914)	-	1981	-	Asia	Unintentional	Unknown	Habitat mo-dification	Dobrynina 2001
Crustacea, CLADOCERA								
Bosmina coregoni (Muller, 1867)	-	1950s	-	North Europe	Unintention al	Ships	Unknown	Alimov and Bogutskaya 2004
Bosmina crassicornis (Lillieborg, 1887)	-	1950s	-	North Europe	Unintention al	Canals	Unknown	Shcherbak 1989
Bosmina kessleri (Uljanin, 1875)	-	1950s	-	North Europe	Unintention al	Canals	Unknown	Alimov and Bogutskaya 2004
Eubosmina longispina (Leydig, 1860)	-	1950s	-	North Europe	Unintention al	Canals	Unknown	Shcherbak 1989
Daphnia cucullata (Sars, 1862)*	-	1955	-	Holarctic	Intentional	Acclimatization of forage fauna for fish	Unknown	Melnikov 1961
Leptodora kindtii (Focke, 1844)*	-	1955	-	Holarctic	Intentional	Acclimatization of forage fauna for fish	Predation	Melnikov 1961
Cercopagis pengoi (Ostroumov, 1891) = *C. tenera* (Sars, 1897)*	-	1959	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Predation	Gusynskaya and Zhdanova 1978
Cornigerius maeoticus maeoticus (Pengo, 1879) = *Evadne cornigera* (Sars, 1902)*	-	1959	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Mordukhai-Boltovskoi and Galinskii 1974
Podonevadne trigona (Sars, 1897)*	-	1960s	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1969
Cornigerius bicornis (Zernov, 1901)*	-	1966	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Basilevich 1972
Cornigerius lacustris (Spandl, 1923)*	-	1970s	-	Ponto-Caspian	Unknown	Unknown	Unknown	Basilevich 1972
Crustacea, COPEPODA								
Eudiaptomus gracilis (Sars, 1862)	-	1950s	-	North Europe	Unintentional	Canals	Unknown	Grigorovich et al. 2002
Eudiaptomus graciloides (Sars, 1886)	-	1955	-	North Europe	Unintentional	Canals	Unknown	Tseeb 1964
Mesocyclops leucarti (Claus, 1857)*	-	1955	-	Cosmopo-litan	Intentional	Acclimati-zation of forage fauna for fish	Unknown	Melnikov 1961
Heterocope appendi-culata (Sars, 1863)	-	1957	-	North Europe	Unintentional	Canals	Unknown	Gusynskaya and Zhdanova 1978
Calanipeda aquae-dulcis (Kritschagin, 1873) = *Popella guernei* (Richard, 1888)*	-	1960s	-	Ponto-Caspian	Unintentional	Acclimati-zation of forage fauna for fish	Unknown	Karpevich 1975
Heterocope caspia (Sars, 1897)*	-	1962	-	Ponto-Caspian	Unintentional	Canals	Unknown	Zhuravel 1969

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Acartia tonsa (Dana, 1849) = *Acanthacartia tonsa* (Dana, 1849)	1976	-	-	Indo-Pacific Atlantic	Unintentional	Ships	Competi-tion	Belmonte et al. 1994, Gubanova 1997
Rhincalanus sp.	1997	-	-	unknown	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003
Clausocalanus arcuicornis (Dana 1849)	2001	-	-	Atlantic Indo-Pacific	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003
Scolecetrix sp.	2001	-	-	unknown	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003
Crustacea, CYCLOPOIDA								
Oncaea minuta (Giesbrecht, 1892)	1997	-	-	Indo-Pacific	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003
Oithona plumifera (Baird,1843)	2001	-	-	Atlantic Indo-Pacific	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003
Oithona setigera (Dana, 1852)	2001	-	-	Atlantic Indo-Pacific	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003
Oithona brevicornis (Giesbrecht, 1891)	2001	-	-	Atlantic Indo-Pacific	Unintentional	Ships	Unknown	Zagorodnyaya 2002
Crustacea, HARPACTICOIDA								
Robertgurneya rostrata (Gurney, 1927)	1964	-	-	Atlantic, Pacific	Unintentional	Ships	Unknown	Kolesnikova 2003
Paramphiascella vararensis (Scott, 1903)	1964	-	-	Atlantic, Pacific	Unintentional	Ships	Unknown	Kolesnikova 2003
Idyella pallidula (Sars, 1905)	1964	-	-	Atlantic, Pacific	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003
Proameira simplex (Norman and Scott, 1905)	1964	-	-	Atlantic, Mediter-ranean, Pacific	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003
Ectinosoma abrau (Kritschagin, 1873)*	-	1970s	-	Ponto-Caspian	Unintentional	Unknown	Unknown	Monchenko 1995
Limnocletodes behning (Borutzky, 1926)*	-	1970s	-	Mediter-ranean	Unintentional	Unknown	Unknown	Monchenko 1995
Nitocra incerta (Richard, 1893)*	-	1970s	-	Ponto-Caspian	Unintentional	Unknown	Unknown	Monchenko 1995
Paraleptastacus spinicaudata (T. Scott et A. Scott, 1895)*	-	1970s	-	Europe	Unintentional	Unknown	Unknown	Monchenko 1995
*Schizopera bobrutzkyi**	-	1970s	-	Ponto-Caspian	Unintentional	Unknown	Unknown	Monchenko 1995
Onychocampus mohammed (Blanch and Richard, 1891)	-	1970s	-	Atlantic	Unintentional	Unknown	Unknown	Monchenko 1995
Amphiascus tenuiremis (Brady and Robertson, 1880)	1996	-	-	Atlantic, Pacific	Unintentional	Ships	Unknown	Zagorodnyaya and Kolesnikova 2003

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Crustacea, CIRRIPEDIA								
Balanus improvisus (Darwin, 1854)	1844	-	-	Atlantic	Unintentional	Ships	Fouling, habitat modifi-cation	Buchinsky 1885
Balanus eburneus (Gould, 1841)	1892	-	-	Atlantic	Unintentional	Ships	Fouling, habitat modifi-cation	Ostroumov 1892
Balanus amphitrite (Darvin, 1854)	1905	-	-	Atlantic	Unintentional	Ships	Fouling, habitat modification	Mavrodiadi 1908
Crustacea, MYSIDACEA								
Paramysis lacustris (Czerniawsky, 1882)*	-	1949	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1950
Limnomysis benedeni (Czerniavsky, 1882)*	-	1949	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1950
*Paramysis intermedia** (Czerniawsky, 1882)	-	1955	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1961
Hemimysis anomala (Sars, 1907)*	-	1955	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1961
Mesomysis kowalevskii (Grimm,1877)*	-	1955	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1961
Paramysis baeri (Martynov, 1924)*	-	1956	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1974
Katamysis warpachowskyi (Sars, 1893)*	-	1960s	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Ioffe 1968
Crustacea, CUMACEA								
Stenocuma cercaroides (Sars, 1894) = *Pseudo-cuma cercaroides**	-	1945	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1965
Pterocuma pectinata (Sowinsky, 1893)*	-	1956	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Kruglova 1961
Pterocuma rostrata (Sars, 1894)*	-	1965	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1965
Crustacea, ISOPODA								
Jaera sarsi (Valkanov, 1936)*	-	1960s	-	Ponto-Caspian	Unintentional	Canals	Unknown	Lyakhov and Mordukhai-Boltovskoi 1973
Crustacea, AMPHIPODA								
Corophium curvispinum (Sars, 1895) = *C. devium* (Wundsch, 1912); *C. curvispinum devium* (Bening, 1914); *C. curvispinum* (Sowinskyi prn. *devium* Martynov, 1924)*	-	1890s	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Dediu 1980

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Pontogammarus robustoides (Sars, 1894)*	-	1950	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Obesogammarus obesus (Sars, 1894) = *Pontogammarus obesus**	-	1950	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Turcogammarus aralensis (Uljanin, 1875) = *Pontogammarus aralensis**	-	1950s	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Chaetogammarus warpachowskyi (Sars, 1894)*	-	1953	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Dikerogammarus vilosus (Sowinsky, 1894)*	-	1955	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Grigorovich et al. 2002
Chaetogammarus ischnus (Stebbing, 1898) = *Gammarus tenellus* (Sars, 1896); *G. sowinskyi* (Bening, 1914)*	-	1955	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Tseeb and Olivari 1958
Dikerogammarus haemobaphes (Eichwald, 1841)*	-	1955	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Obessogammarus crassus (Sars, 1894)*	-	1955	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1961
Pontogammarus maeoticus (Sowinsky, 1894)*	-	1955	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1961
Lanceogammarus andrussovi (Sars, 1896) = Iphiginella andrussowi*	-	1956	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Tseeb and Olivari 1958
Amathilina cristata (Sars, 1894)*	-	1956	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Corophium robustum (Sars, 1895) = *C. bidentatum* (Sars, 1895)*	-	1956	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Gusynskaya and Zhdanova 1978
Corophium chelicorne (Sars, 1895)*	-	1956	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Corophium nobile (Sars, 1895)*	-	1956	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Zhuravel 1965
Gmelina costata (Sars, 1863)*	-	1965	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Dediu 1980
Gmelina pusilla (Sars, 1863)*	-	1965	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competition	Dediu 1980

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Corophium mucronatum (Sars, 1895)*	-	1969	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competi-tion	Zhuravel 1965
Corophium maeoticum (Sowinskyi, 1898)*	-	1969	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competi-tion	Dediu 1980
Stenogammarus carausui (Derzhavin and Pjatakova, 1962)*	-	1977	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competi-tion	Shcherbak 1989
Shablogammarus subnudus (Sars, 1896) = *Pontogammarus subnudus**	-	1981	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competi-tion	Pligin and Yemelyanova 1989
Kuzmelina kusnetzowi (Sars, 1894) = *Gmelina kusnezowi**	-	1982	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Competi-tion	Shcherbak 1989
Echinogammarus trichiatus (Martynov, 1932)*	-	1998	-	Ponto-Caspian	Intentional	Acclimati-zation of forage fauna for fish	Competi-tion	Grigorovich et al. 2002
Synurella ambulans (Müller, 1846)*	-	2000	-	Europe	Uninten-tional	Unknown	Unknown	Novitskij 2005
Rivulogammarus kischineffensis (Schell.)*	-	2002	-	Europe	Uninten-tional	Unknown	Unknown	Novitskij 2005
Crustacea, DECAPODA								
Rhithropanopeus harrisii (Gould, 1841)	1948	-	1937	N America	Unintentional	Ships	Competi-tion, predation	Gadzhiev 1963, Makarov 2004
Pandalus kessleri (Czerniavsky, 1878)	-	-	1959	Pacific, SE Asia	Intentional	Aquaculture	Unknown	Makarov 2004
Astacus leptodactilus (Eschscholtz, 1832) = *A. leptodactilus* (Rathke, 1837)*	-	1963	-	Ponto-Caspian	Intentional	Aquaculture	Unknown	Yanushevich 1966
Callinectes sapidus (Rathbun, 1896)	1970s	-	-	N America	Unintentional	Ships	Unknown	Zaitsev and Ozturk 2001
Marsupenaeus japonicus (Bate, 1888)	-	1977	-	Indo-Pacific	Intentional	Aquaculture	Unknown	Suprunovich and Makarov 1990, Zaitsev and Mamaev 1997
Macrobrachium rosenbergii (De Man, 1879)	1990-1992	1980s	-	Indo-Pacific	Intentional	Aquaculture	Unknown	Turanov and Turanova 2003, Makarov 2004
Eriocheir sinensis (Milne-Edwards, 1853)	1998	2002	-	SE Asia	Unintentional	Ships	Habitat modifi-cation	Zaitsev 1998, Novitskij 2005

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Mollusca, GASTROPODA								
Ferrissia fragilis (Tryon, 1863) = *Ferrissia clessiniana* (Jickeli, 1882), *Ancylus lacustris brevis* Puzanov 1925	-	1919	-	N America	Unintentional	Ornamental trade	Unknown	Son 2007, 2007b
Viviparus viviparus (Linnaeus, 1758)*	-	1949	-	Cosmopolitan	Intentional	Acclimatization of forage fauna for fish	Unknown	Tseeb 1965
Potamopyrgus jenkinsi (Smith, 1889)	-	2005	1951	Australia	Unintentional	Unknown	Habitat modification	Grossu 1951, Markovskij 1954, Son 2006
Rapana venosa (Valenciennes, 1846) = *Rapana thomasiana thomasiana* (Crosse,1861)	1954	-	-	SE Asia	Unintentional	Ships	Predation	Chukhchin 1961
Theodoxus fluviatilis (Linnaeus, 1758)*		1955	-	Europe	Unintentional	Unknown	Unknown	Zhuravel 1961
Lithoglyphus naticoides (Pfeiffer, 1828)*	-	1955	-	Europe	Unintentional	Unknown	Unknown	Zhuravel 1974
Aporrhais pespelecani (Linne, 1758)	1987	-	-	Mediterranean	Unintentional	Ships	Unknown	Anistratenko 1998
Corambe obscura (Verrill, 1870)	1989	-	-	Atlantic	Unintentional	Ships	Predation	Sinegub 1994, Roginskaya and Grintsov 1990
Ampullaria sp.	-	1999	-	Africa	Unknown	Ornamental trade	Unknown	Son 2007a
Neptunea arthritica (Bernardi, 1857) first identified as *Purpura pacifica*)	2000	-	-	Pacific IO	Unintentional	Ships	Unknown	Mironov et al. 2002, Shadrin et al. 2002
Fagotia danubialis (Pfeiffer, 1828)*	-	2000	-	Europe	Unintentional	Unknown	Unknown	Mironov et al. 2002
Melanoides tuberculata (Müller, 1774)	-	2000	-	Africa, SE Asia	Unknown	Ornamental trade	Unknown	Grigorovich et al. 2002
Biomphalaria glabrata (Say, 1818)	-	2000	-	Africa	Unknown	Ornamental trade	Unknown	Son 2007a
Ercolania viridis (Costa, 1866) = *E. funerea* (Costa, 1867)	2001	-	-	Atlantic	Unintentional	Ships	Predation	Zaitsev et al. 2004
Physella heterostropha (Say, 1817)	-	2004	2004	N America	Unknown	Ornamental trade	Unknown	Son 2006, 2007a
Mollusca, BIVALVIA								
Teredo navalis (Linne, 1758)	750-500 BC	-	-	Atlantic, Pacific	Unintentional	Ships	Habitat modification	Gomoiu et al. 1996
Crassostrea gigas (Thunberg, 1793)	1900s	-	-	SE Asia	Intentional	Aquaculture	Unknown	Zolotarev 1996

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Dreissena bugensis (Andrusov, 1897)*	-	1941	-	Ponto-Caspian	Unintentional	Canals	Habitat modification	Zhuravel 1967
Hypanis colorata (Eichwald, 1829) = *Monadacna colorata**	-	1948	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1950
Sphaerium corneum (Linnaeus, 1758)*	-	1955	-	Europe	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1961
Sphaerium rivicola (Lamarck, 1818)*	-	1955	-	Europe	Intentional	Acclimatization of forage fauna for fish	Unknown	Zhuravel 1961
Hypanis pontica (Eichwald, 1838); = *Monodacna pontica**	-	1961	-	Ponto-Caspian	Intentional	Acclimatization of forage fauna for fish	Unknown	Pligin and Yemelyanova 1989
Mya arenaria (Linne, 1758)	1966	-	-	N America	Unintentional	Ships	Competition	Beshevly and Kalyagin 1967
Anadara inaequivalvis (Bruguière, 1789)	1987	-	-	Indo-Pacific	Unintentional	Ships	Unknown	Zaika et al. 1992, Zolotarev and Zolotarev 1987, Zolotarev 1996
Corbicula fluminea (Müller, 1774)	-	1995	2000	SE Asia	Unintentional	Canals	Competition	Lyashenko et al. 2005, Son 2006, 2007a
Sinanodonta woodiana (Lea, 1834) = *Anodonta woodiana*	-	1999	2002	SE Asia	Unintentional	Parasite carrier	Habitat modification	Yurishinets and Korniyushin 2001, Son 2006
Mytilopsis leucophaeata (Conrad, 1831) = *Congeria leucophaeta*	-	-	2000	N America	Unintentional	Ships	Unknown	Therriault et al. 2004
Corbicula fluminalis (Müller, 1774)	-	2003	2000	SE Asia	Unintentional	Canals	Competition	Voloshkevich and Son 2002, Son 2007a
Mytilus edulis (Linnaeus, 1758)	2001	-	-	Atlantic	Unintentional	Ships	Fouling, hybridisation	Zaitsev et al. 2004
Mytilus trossulus (Gould, 1850)	2001	-	-	Pacific	Unintentional	Ships	Fouling, hybridisation	Zaitsev et al. 2004
Hypanis glabra (Ostroumoff, 1905) = *Adacna glabra* (Ostroumoff, 1905)	-	-	2004	Caspian	Unintentional	Ships	Competition	Nabozhenko 2004, Son 2007a
Tentaculata, ENTOPROCTA								
Urnatella gracilis (Leidy, 1851) = *U. dniestriensis* (Zambriborsch, 1958)	-	1954	1954	N America	Unintentional	Ships	Unknown	Bacescu 1954, Zambriborsch 1958

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
PISCES								
Carassius auratus gibelio (Bloch, 1782)	-	1900s	-	SE Asia	Intentional	Aquaculture	Unknown	Salekhova et al. 1987, Boltachev et al 2006
Micropterus salmoides (Lacepede, 1802)	-	end of XIX	-	N America	Intentional	Aquaculture	Unknown	Zhukinskyi 1959
Ictalurus nebulosus (Le Sueur, 1819)	-	1935	-	N America	Intentional	Aquaculture	Competi-tion	Zhukinskyi 1959
Ictalurus punctatus (Rafinesque, 1818)	-	1935	-	N America	Intentional	Aquaculture	Competi-tion	Grinjevskiy et al. 2001
Oncorhynchus mykiss (Walbaum, 1792) = *Salmo gairdneri iridea* (Gibbons, 1855); *Salmo irideus* (Gibbons 1885)	1965	1938	-	N America	Intentional	Aquaculture	Competi-tion, predation	Zhukinskyi 1959 Karpevich and Bokova 1963, Zaitsev and Mamaev 1997
Perccottus glehni (Dybowsky, 1877)	-	1948	-	SE Asia	Intentional	Aquarium trade	predation	Anisimova and Lavrovskiy 1983, Romanenko et al. 2003
Syngnathus abaster nigrolineatus (Eichwald, 1831)*	-	1956	-	Black Sea	Unntentional	Canals	Unknown	Suchoivan and Vjatchanina 1989
Rutilus frisii kutum (Kamensky, 1899)*	-	1959	-	Ponto-Caspian	Intentional	Canals	Unknown	Vovk 1963
Lepomis gibbosus (Linnaeus, 1758) = *Perca gibbosa* (Linne); *Eupomotis gibbosus* (Jordan and Evermann); *L. macrochirus* (Rafinesgue, 1815)	-	2002	1949	N America	Intentional	Aquaculture	Competi-tion, predation	Svetovidov 1964, Boltachev et al. 2003
Gambusia holbrooki (Girard, 1859)	-	1950s	-	N America	Intentional	Aquaculture	Predation	Zaitsev and Mamaev 1997, Delamure 1964 Boltachev 2006
Channa argus argus (Cantor, 1842)	-	1950s	-	SE Asia	Intentional	Aquaculture	Unknown	Zhukinskyi 1959
Coregonus albula ladogensis (Pravdin and Berg, 1948) = *Coregonus albula* (Linnaeus, 1758); *Coregonus ladogae* (Pravdin, Golubev and Belyaeva, 1938)	-	1950s	-	Holarctic	Intentional	Aquaculture	Predation	Zhukinskyi 1959 Karpevich and Bokova 1963, Prokopov 2003
Tribolodon brandtii (Dybowski, 1872)	1950s	-	-	Pacific	Unintentional	Ships	Unknown	Diripasko et al. 2001

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Aristichthys nobilis (Richardson, 1845)	-	1953	-	SE Asia	Intentional	Aquaculture	Unknown	Vovk 1963
Hypophthalmichthys molitrix (Valenciennes, 1844)	2001	1953	-	SE Asia	Intentional	Aquaculture	Unknown	Vovk 1963, Vovk 1976, Diripasko et al. 2001
Coregonus nasus (Pallas, 1776)	-	1954	-	Holarctic	Intentional	Aquaculture	Predation	Zhukinskyi 1959, Karpevich and Bokova 1963
Coregonus peled (Gmelin, 1788)	-	1954	-	Holarctic	Intentional	Aquaculture	Predation	Zhukinskyi 1959, Karpevich and Bokova 1963, Prokopov 2003
Ctenopharyngodon idella (Valenciennes, 1844)	2001	1954	-	SE Asia	Intentional	Aquaculture	Unknown	Vovk 1963, Vovk 1976, Diripasko et al. 2001
Coregonus autumnalis migratorius (Georgi, 1775)	-	1957	-	Holarctic	Intentional	Aquaculture	Predation	Zhukinskyi 1959, Karpevich and Bokova 1963
Rutilus frisii kutum (Kamensky, 1899)	-	1959	-	Ponto-Caspian	Intentional	Aquaculture	Unknown	Vovk 1963
Coregonus lavaretus ladoga (Poljakow and Berg, 1916) = *Coregonus lavaretus* (Linnauus, 1758)	-	1960s	-	Holarctic	Intentional	Aquaculture	Predation	Zhukinskyi 1959, Karpevich and Bokova 1963, Prokopov 2003
Lateolabrax japonicus (Cuvier, 1828) = *Labrax japonicus* (Cuvier, 1828)	1960-1970s	-	-	Pacific,SE Asia	Intentional	Aquaculture	Unknown	Zaitsev and Ozturk 2001,
Plecoglossus altivelis altivelis (Temminck and Schlegel, 1846)	1960-1970s	-	-	Pacific,SE Asia	Intentional	Aquaculture	Unknown	Zaitsev and Ozturk 2001
Salmo ischchan aestivalis (Fortunatov, 1926)	-	1960	-	Sevan Lake	Intentional	Aquaculture	Unknown	Karpevich and Bokova 1963, Prokopov 2003
Salmo ischchan gegorkuni (Kessler, 1877)	-	1960	-	Sevan Lake	Intentional	Aquaculture	Unknown	Karpevich and Bokova 1963, Prokopov 2003
Mylopharyngodon piceus (Richardson, 1846)	-	1961	-	SE Asia	Intentional	Aquaculture	Unknown	Grinjevskyi et al. 2001
Oncorhynchus gorbuscha (Walbaum, 1792)	1961	-	-	Pacific,SE Asia	Intentional	Aquaculture	Competi-tion, predation	Zaitsev and Ozturk 2001, Alimov and Bogutskaya 2004

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	Sea and inland saline waters	Fresh waters	Inland brackish waters or waters with salinity variation					
Pseudorasbora parva (Temminck and Schlegel, 1846)	1990s	1980s	1961	SE Asia	Unintentional	Unknown	Competi-tion	Dediu 1989
Oreochromis mossambicus (Ortega and Vari, 1856)	-	1961; 1996	-	Africa	Intentional	Aquaculture	Predation	Grinjevskiy et al. 2001, Novitskij 2005
Coregonus lavaretus maracnoedes, (Poljakow, 1874)	-	1965	-	Holarctic	Intentional	Aquaculture	Predation	Prokopov 2003
Morone saxatilis (Walbaum, 1792) = *Roccus saxatilis*	-	-	1965	N America	Intentional	Aquaculture	Unknown	Kozlov and Abramovich 1980
Oreochromis aureus (Steingachner, 1864)	-	1970s	-	Africa	Intentional	Aquaculture	Predation	Ivoilov 1986
Oreochromis niloticus (Linnaeus, 1758)	-	1970s	-	Africa	Intentional	Aquaculture	Predation	Ivoilov 1986
Tilapia zillii (Gervais, 1848)	-	1970s	-	Africa	Intentional	Aquaculture	Predation	Ivoilov 1986
Liza haematocheila (Temmnick and Schlegel, 1845) = *Mugil so-iuy* (Basil and Europeski, 1855)	-	1996	1972	SE Asia	Intentional	Aquaculture	Unknown	Zuev and Boltachev 1998, Parin 2003
Ictiobus bubalus (Rafinesgue, 1819)	-	1975	-	N America	Intentional	Aquaculture	Unknown	Grinjevskiy et al. 2001
Ictiobus cyprinellus (Valenciennes, 1844)	-	1975	-	N America	Intentional	Aquaculture	Unknown	Tretyak 1996
Ictiobus niger (Rafinesgue, 1820)	-	1975	-	N America	Intentional	Aquaculture	Unknown	Grinjevskiy et al. 2001
Sparus aurata (Linnaeus, 1758)	1987	2004	-	Atlantic, Mediter-ranean	Unintentional	Ships	Unknown	Boltachev and Yurachno 2002, Tkachenco 2005
Micromesistius poutassou (Risso, 1827)	1999	-	-	N Atlantic, Mediter-ranean	Unintentional	Ships	Unknown	Boltachev et al. 1999
Chelon labrosus (Risso, 1826)	1999	-	-	N Atlantic, Mediter-ranean	Unintentional	Ships	Unknown	Boltachev and Yurachno 2002
Sardinella aurita (Valenciennes, 1847)	1999	-	-	Atlantic Pacific	Unintentional	Ships	Unknown	Boltachev et al. 2000
Sarpa salpa (Linnaeus, 1758)	1999	-	-	Atlantic	Unintentional	Ships	Unknown	Boltachev and Yurachno 2002
Sphyraena obtusata Cuvier, 1829 = *Sphyraena chrysotaenia* non (Klunzinger, 1884)	1999	-	-	Pacific IO	Unintentional	Ships	Unknown	Boltachev and Yurachno 2002
Heniochus acuminatus (Linnaeus, 1758)	2003	-	-	Indo-Pacific	Unintentional	Ships	Unknown	Boltachev and Astakhov 2004

*Neighbouring alien species. (Species that not mark with star are distant aliens).