

# Chapter 15

## Internet-based information resources on aquatic alien species relevant to the Ponto-Caspian Region

VADIM E. PANOV

*Zoological Institute, Russian Academy of Sciences,*

*199034 St. Petersburg, Russia*

*e-mail: gaas@zin.ru*

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Open information systems are considered to be essential elements of dissemination of information on invasive alien species, and are powerful management tools. A review of available online information resources, relevant for the Ponto-Caspian Region, has revealed that they are not sufficient to serve the region. Development of the regional, Ponto-Caspian online information system on aquatic alien species is urgently needed, in view of the accelerating rates of introductions of harmful alien species in the region, severe impacts of these species on the environment, and associated economic losses. Such an information system should be developed using already available information technologies, in order to ensure its effective incorporation in a global invasive species information network.

### 1. Introduction

The development of open databases and information systems on invasive alien species\* is essential for effective international cooperation in data and expertise sharing, and provides support for management and control efforts. The international legal regime requires governments and other relevant organizations to support the creation and maintenance of such information resources (Decision VI/23 2002). These resources may provide comprehensive information for the management of invasive alien species, as well as for scientific and educational purposes.

The following definitions are used: (i) “alien species” refers to a species, subspecies or lower taxon, introduced outside its natural past or present distribution. Introduction includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce; (ii) “invasive alien species” means an alien species whose introduction and/or spread threaten biological diversity (iii) “introduction” refers to the

movement by human agency, indirect or direct, of an alien species outside of its natural range (past or present) (Decision VI/23 2002).

There is an urgent need for open information on aquatic alien species in the Ponto-Caspian area. This region is particularly heavily affected by species invasions: the list of exotic species includes 59 names for the Black Sea, and 39 for the Caspian Sea (Zaitsev & Öztürk 2001). In the early 1980s, the Atlantic ctenophore *Mnemiopsis leidyi* was introduced with ballast water into the Black Sea, and by the late 1990s it had spread to the Mediterranean and Caspian Seas. The invasion of *Mnemiopsis* resulted in a drastic decline in the anchovy fishery in the Ponto-Caspian region with huge economic losses, estimated in hundreds of million of US dollars per year. Currently, the unique biodiversity of the Caspian Sea is also under serious risk, with numerous species facing extinction (Caspian Environment Programme 2002).

On the other hand, the Ponto-Caspian region is serving as an important donor area of harmful aquatic organisms to other parts of Europe and worldwide. During the last two decades, several invasive species have been introduced to the Baltic Sea with the ballast water of ships, including the Ponto-Caspian cladoceran *Cercopagis pengoi* which is considered harmful in the Baltic (Leppäkoski et al. 2002a; this volume). The biodiversity of inland running and stagnant waters of Europe and the Great Lakes of North America too is seriously endangered by the introduction of alien species of Ponto-Caspian origin (Ketelaars, this volume). Some of the most harmful of those include the Ponto-Caspian zebra mussel *Dreissena polymorpha*, a number of amphipod and mysid species, and the fishhook waterflea *Cercopagis pengoi* (Leppäkoski et al. 2002b).

The present paper provides a brief overview of existing internet-based information resources regarding alien species in the Ponto-Caspian region and invasive alien species of Ponto-Caspian origin, and discusses the perspectives of their further use and development.

## 2. Regional and international online databases and information systems

### 2.1. CASPIAN SEA BIODIVERSITY DATABASE

A demonstration version of the Caspian Sea Biodiversity Database (CSBD) has been developed during 2001-2002 in the framework of the UNDP Caspian Environment Programme (CEP), and posted on the CEP web-site since June 2002. The CSBD exists in English and Russian language versions, and currently includes entries on 36 aquatic species, both native (30 species) and alien (6 species) in the Caspian Sea ecosystem (Caspian Sea Biodiversity Database 2002). Alien species in the CSBD are represented by three unintentionally introduced zooplankton organisms: the mediterranean diatom alga *Rhizosolenia calcar-avis*, the Atlantic copepod *Acartia tonsa*, the Atlantic ctenophore *Mnemiopsis leidyi*, and three intentionally introduced organisms: the Atlantic-Mediterranean clam *Abra ovata*, and the two fish species, *Liza aurata* (Atlantic-Mediterranean), and *Liza saliens* (Mediterranean). The CSBD also includes entries on two native species, considered as invasive outside of the Ponto-Caspian Region, viz. the cladoceran *Cercopagis pengoi* (fishhook waterflea) and the fish *Neogobius melanostomus*

(round goby). Entries in the database include information on the species' taxonomy, their distribution and biology, and bibliographic references. All entries are illustrated by figures of the organisms involved (Fig. 1). Entries on *Cercopagis* and *Mnemiopsis* include Internet-links to entries on these species in the *Regional Biological Invasions Center Information System* (see section 2.5).

**Figure 1.** Main page of the Caspian Sea Biodiversity Database with inserted entries of selected invasive species (source: Caspian Sea Biodiversity Database 2002)

The figure displays the main page of the Caspian Sea Biodiversity Database, featuring several overlapping screenshots of the website interface. The top section shows the header with the 'CASPIAN ENVIRONMENT PROGRAMME' logo and the text 'Caspian Environment Programme' and 'Каспийская Экологическая Программа'. Below the header, there are navigation buttons: 'Previous species', 'Next species', 'Species gallery', 'Information', and 'New window'. The main content area is divided into sections for different species. One section is titled 'Caspian Sea Biodiversity Database' and includes a search bar and a list of species under 'Fishes': *Abramis brama orientalis*, *Acipenser gueldenstaedtii*, and *Acipenser nudiiventris*. Another section is titled 'Caspian Sea Biodiversity Database' and includes a search bar and a list of species under 'Zooplankton': *Acartia tonsa*, *Cercopagis pengoi*, *Eurytemora grimmeri*, *Mnemiopsis leidyi*, and *Zoobenthos*. A third section is titled 'Caspian Sea Biodiversity Database' and includes a search bar and a list of species under 'Zooplankton': *Acartia tonsa*, *Cercopagis pengoi*, *Eurytemora grimmeri*, *Mnemiopsis leidyi*, *Zoobenthos*, *Abra (Syndesmya) ovata*, *Caspiastacus pachypus*, *Dreissena (Pontodreissena) rostrata*, *Gammarus (Chaetogammarus) p*, *Hypanis angusticostata*, and *Pontastacus eichwaldi*. The main content area also features detailed entries for selected invasive species, including 'Neogobius melanostomus (Pallas, 1814)' with a photograph of the fish and its taxonomy (Type: Chordata, Class: Osteichthyes), 'Cercopagis pengoi Ostroumov, 1892' with a drawing of the water penny larva, and 'Mnemiopsis leidyi (A. Agassiz, 1965)' with a drawing of the comb jelly and its taxonomy (Phylum: Ctenophora, Class: Tentaculata, Order: Lobata, Family: Mnemiidae) and common names (Russian: Mnemiopsis, English: comb-jelly Mnemiopsis).

## 2.2. CIESM ATLAS OF EXOTIC SPECIES

The International Commission for the Scientific Exploration of the Mediterranean Sea (CIESM) Atlas of Exotic Species includes detailed descriptions of 125 alien species of

mollusks, 55 species of alien crustaceans, and 91 species of alien fish that have invaded the Mediterranean Sea. The list of alien species includes five species, known as invasive in the Ponto-Caspian region: the Pacific gastropod *Rapana venosa*, the North Atlantic clam *Mya arenaria*, the West Atlantic crabs *Rhythropanopeus harrisi* and *Callinectes sapidus*, the Chinese mitten crab *Eriocheir sinensis*; and two more species, intentionally introduced in the region: the Japanese oyster *Crassostrea gigas*, and the Far-East Asian fish *Mugil soiuy*. Individual species pages include illustrations, diagnostic features, biological information, literature references and a distribution map (CIESM 2001).

### 2.3. BALTIC SEA ALIEN SPECIES DATABASE

An Internet Database on aquatic alien species in the Baltic Sea area was developed as an initiative of the Baltic Marine Biologists' Working Group on Non-indigenous Estuarine and Marine Organisms in 1997; in 2000, a new concept of the online Database appeared with support received from the Baltic Marine Environment Protection Commission (HELCOM). At present, the database represents an interactive, user-friendly tool, which includes several information-retrieving options.

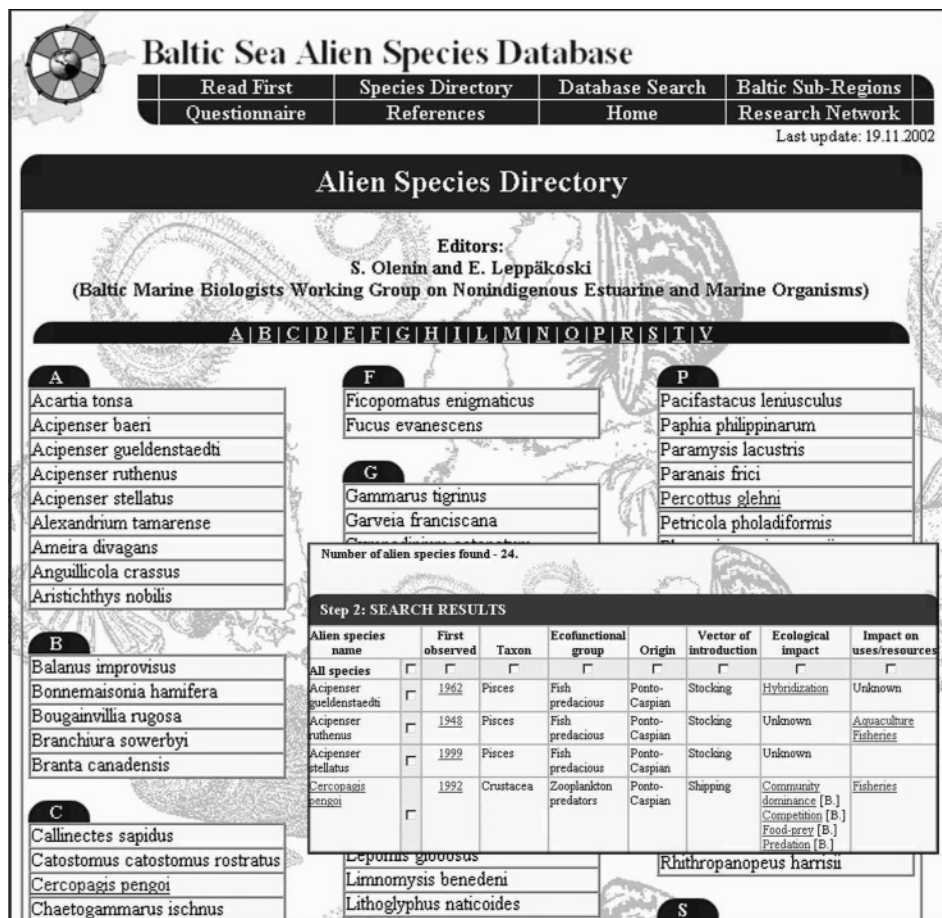
The database species-directory contains individual species entries. An entry includes the complete taxonomy of a species and available comments, complementing and specifying the database features (year of introduction, ecological impact, etc.). Currently, the directory includes 24 alien species of Ponto-Caspian origin (Fig. 2), and several invasive alien species from other regions, common to the Baltic, Black and Caspian Seas (e.g. the Atlantic barnacle *Balanus improvisus* and the crab *Rhythropanopeus harrisi*). The Database Search tool offers a direct way to retrieve information according to a number of major features. It allows the retrieval of data by a single feature (i.e. by "Taxon") or by combined features (i.e. "Taxon" and "Origin" and "Ecological impact"), including multiple selections of items within any feature.

A list of species, retrieved according to the selected criteria, is linked to relevant individual entries on species and references (Baltic Sea Alien Species Database 2002, Olenin et al. 2002), which include individual entries on such invasive Ponto-Caspian species as the fishhook waterflea *Cercopagis pengoi* and the round goby *Neogobius melanostomus*. Some species-specific entries are hosted by the Regional Biological Invasions Center Information System (see section 2.5). The entry for the zebra mussel, *Dreissena polymorpha*, is an example.

### 2.4. GLOBAL INVASIVE SPECIES DATABASE

The *Global Invasive Species Database* was developed by the IUCN/SSC Invasive Species Specialist Group (ISSG) as part of the global initiative on invasive species, led by the Global Invasive Species Programme (GISP 1999). It provides global information on invasive alien species to agencies, resource managers, decision-makers, and interested individuals. The database focuses on invasive species that threaten biodiversity and covers all taxonomic groups from micro-organisms to animals and plants. Species information is supplied by expert contributors from around the world and includes the species' biology, ecology, native and alien range, bibliographic references, contacts, links and images.

Figure 2. Alien Species Directory of the Baltic Sea Alien Species Database with inserted results of the query on Ponto-Caspian species (source: Baltic Sea Alien Species Database 2002)



**Baltic Sea Alien Species Database**

Read First | Species Directory | Database Search | Baltic Sub-Regions  
 Questionnaire | References | Home | Research Network

Last update: 19.11.2002

### Alien Species Directory

Editors:  
S. Olenin and E. Leppäkoski  
(Baltic Marine Biologists Working Group on Nonindigenous Estuarine and Marine Organisms)

A | B | C | D | E | F | G | H | I | L | M | N | O | P | R | S | T | V

**A**

- Acartia tonsa
- Acipenser baeri
- Acipenser gueldenstaedti
- Acipenser ruthenus
- Acipenser stellatus
- Alexandrium tamarense
- Armeira divagans
- Anguillcola crassus
- Aristichthys nobilis

**B**

- Balanus improvisus
- Bonnemaisonia hamifera
- Bougainvillea rugosa
- Branchiura sowerbyi
- Branta canadensis

**C**

- Callinectes sapidus
- Catostomus catostomus rostratus
- Cercopagis pengoi
- Chaetogammarus ischnus

**F**

- Ficopomatus enigmaticus
- Fucus evanescens

**G**

- Gammarus tigrinus
- Garveia franciscana

**P**

- Pacifastacus leniusculus
- Paphia philippinarum
- Paramysis lacustris
- Paranis frici
- Percottus glehni
- Petricola pholadiformis

Number of alien species found - 24.

Step 2: SEARCH RESULTS

Alien species name	First observed	Taxon	Ecofunctional group	Origin	Vector of introduction	Ecological impact	Impact on uses/resources
All species	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Acipenser gueldenstaedti	<input type="checkbox"/> 1962	Pisces	Fish-predacious	Ponto-Caspian	Stocking	Hybridization	Unknown
Acipenser ruthenus	<input type="checkbox"/> 1948	Pisces	Fish-predacious	Ponto-Caspian	Stocking	Unknown	Aquaculture Fisheries
Acipenser stellatus	<input type="checkbox"/> 1999	Pisces	Fish-predacious	Ponto-Caspian	Stocking	Unknown	
Cercopagis pengoi	<input type="checkbox"/> 1992	Crustacea	Zooplankton-predators	Ponto-Caspian	Shipping	Community dominance [B.] Competition [B.] Food-prey [B.] Predation [B.]	Fisheries
Lepomis gibbosus							
Limnomysis benedeni							
Lithoglyphus naticoides							
Rhithropanopeus harrisi							

**S**

Currently it includes entries for the 100 “World’s Worst Invasive Alien Species”, which involve both aquatic invasive species of Ponto-Caspian origin (the fishhook waterflea *Cercopagis pengoi* and zebra mussel *Dreissena polymorpha*) and harmful aquatic species that invaded the Ponto-Caspian region (the Atlantic ctenophore *Mnemiopsis leidyi* and the Chinese mitten crab *Eriocheir cinensis*) (Fig. 3). These information sources are linked to the Baltic Sea Alien Species Database, the Caspian Sea Biodiversity Database and the Regional Biological Invasions Center Information System (see section 2.5) (ISSG Global Invasive Species Database).

Figure 3. Main page of the Global Invasive Species Database with inserted entries of selected invasive species of interest (source: ISSG Global Invasive Species Database)

The image shows a screenshot of the Global Invasive Species Database (ISSG) website. The main header reads "GLOBAL INVASIVE SPECIES DATABASE" with a "100 OF THE WORST" badge. A search bar and navigation menu are on the left. The main content area displays three species entries, each with a "100 OF THE WORST" badge:

- Dreissena polymorpha** (aquatic invertebrate)
- Cercopagis pengoi** (aquatic invertebrate)
- Mnemiopsis leidyi** (aquatic invertebrate)

The **Mnemiopsis leidyi** entry is expanded, showing tabs for Ecology, Distribution, Habitat Matches, References and Links, and Contacts. It lists 6 references found for this species:

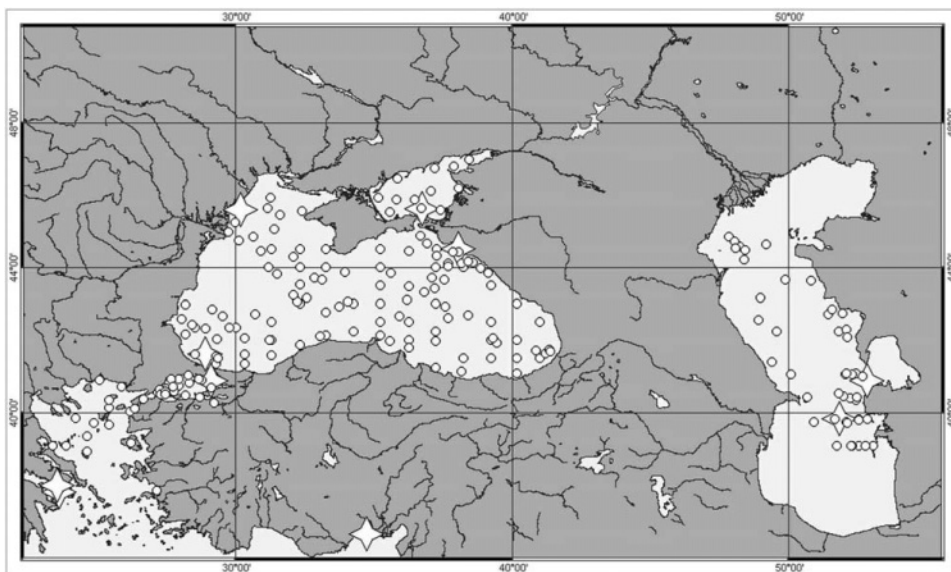
1. *Mnemiopsis leidyi* in the Caspian Sea. GFF International Waters Portfolio. **Summary:** Details about an April 2001 workshop convened to combat the threat of a comb jellyfish invasion of the Caspian Sea.
2. Dumont, H. J. 2000. Endemism in the Ponto-Caspian fauna, with special emphasis on the Oryzochopoda (Crustacea). *Advances in Ecological Research* 31.
3. Ivanov, V., Kamakin, A., Ushitzhev, V., Shiganova, T., Zhukova, O., Aladin, N., Wilson, S., Harbison, R. and Dumont, H. 2000. Invasion of the Caspian Sea by the comb jellyfish *Mnemiopsis leidyi* (Ctenophora). *Biological Invasions* 2.
4. Kremer, P. 1979. Predation by the ctenophore *Mnemiopsis leidyi* in Narragansett Bay, Rhode Island. *Estuaries* 2.
5. Sorokin, Y. 2001. *The Black Sea*. Backhuys Publishers.
6. Group on Aquatic Alien Species - *Mnemiopsis leidyi*.

## 2.5. REGIONAL BIOLOGICAL INVASIONS CENTER INFORMATION SYSTEM

The *Regional Biological Invasions Center Information System (RBIC)*, hosted by the Zoological Institute of the Russian Academy of Sciences in St. Petersburg, is a new product of the Group on Aquatic Alien Species (GAAS) web-site, which initially was opened in 1999, and at that time already included first versions of entries on two Ponto-Caspian invasive species, *Dreissena polymorpha* and *Cercopagis pengoi* (Panov 1999). Beginning with 2001, the GAAS web-site became a part of RBIC. Currently RBIC is serving as the regional clearinghouse on invasive alien species (both aquatic and terrestrial), and as a web portal, providing access to the Internet-based information resources on invasive species research and management in Europe and worldwide (Regional Biological Invasions Center 2001a). The development of the Geographic Information System "INVADER" as an international database on the Internet is one of RBIC's priorities. Currently, a demonstration version of GIS "INVADER", with comprehensive geo-referenced information on the distribution of the Ponto-Caspian invasive cladoceran *Cercopagis pengoi* in Europe and North America, is available online (Regional Biological Invasions Center 2001b).







An example of a GIS “INVADER” - generated map of distribution of the Atlantic ctenophore *Mnemiopsis leidyi* in the Ponto-Caspian Region is provided in Fig. 4.

**Figure 4.** Example of the GIS “INVADER”-generated map: distribution of *Mnemiopsis leidyi* in the Ponto-Caspian Region (asterisks indicate sites of 1st records in the ecosystems) (source: RBIC - Regional Biological Invasions Center - 2001b)



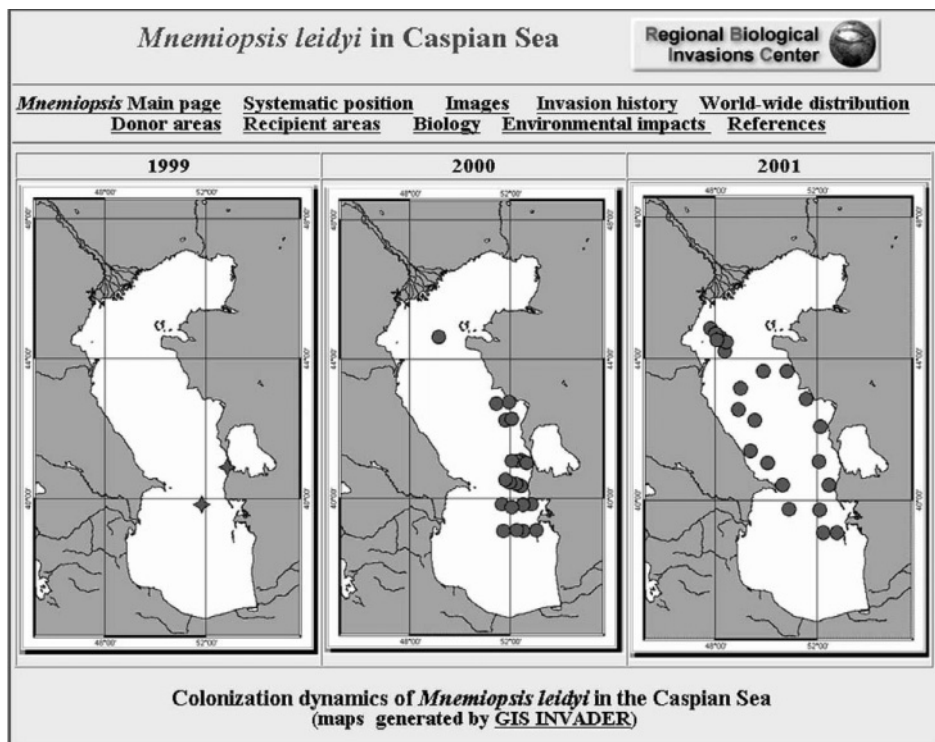
On-line geo-referenced distribution maps of selected invasive species, including *Mnemiopsis leidyi*, *Dreissena polymorpha* and *Cercopagis pengoi*, along with detailed descriptions of their taxonomy, invasion histories, biology, and environmental impacts are available at the RBIC Illustrated Database of the Aquatic Invasive Species of Europe, interlinked with the Baltic Sea Alien Species Database, the Global Invasive Species Database and the Caspian Sea Biodiversity Database (Fig. 5) (Regional Biological Invasions Center 2001c). The entry on *Mnemiopsis leidyi* provides an example of a comprehensive and user-friendly online information system on the invasive species, linked to other Internet-based sources of information (Shiganova & Panov 2002). The entry on *Mnemiopsis* in the RBIC Illustrated Database is already serving as an open information system on *Mnemiopsis* for the Ponto-Caspian Region, and is updated on a regular basis (Fig. 6).

Figure 5. Main page of the Illustrated Database of the Aquatic Invasive Species of Europe (source: Regional Biological Invasions Center 2001c)

Aquatic Invasive Species of Europe			Group on Aquatic Alien Species (GAAS) 	
Species	Image	Systematic position	Donor areas	Recipient areas
<u>Mnemiopsis leidyi</u>		Ctenophora: Lobata: Bolinopsidae	<u>Atlantic coastal waters of North America</u>  <u>Black Sea</u>	<u>Black Sea, 1982</u> <u>Azov Sea, 1988</u>  <u>Aegean Sea, 1990</u> <u>Marmara Sea, 1992</u> <u>Mediterranean Sea, 1993</u>  <u>Caspian Sea, 1999</u>
<u>Cercopagis pengoi</u>		Crustacea: Onychopoda: Cercopagidae	<u>Ponto-Caspian Basin</u>  <u>Baltic Sea</u>	<u>Baltic Sea, 1992</u>  <u>North American Great Lakes, 1998</u>
<u>Bythotrephes longimanus</u>		Crustacea: Onychopoda: Cercopagidae	<u>St. Petersburg Harbour</u>  <u>Unknown European source</u>	<u>North American Great Lakes, 1982</u> <u>The Netherlands, 1987</u> <u>Belgium, 1991</u>
<u>Gmelinoides fasciatus</u>		Crustacea: Amphipoda: Gammaridae	<u>Lake Baikal Basin (Siberia)</u>  <u>Lake Ladoga</u>	<u>Volga River Basin, 1962</u> <u>Lake Ladoga Basin, 1971</u> <u>Lake Peipsi, 1972</u> <u>Neva Estuary (Baltic Sea), 1996</u>
<u>Dreissena polymorpha</u>		Mollusca: Bivalvia: Dreissenidae	<u>Ponto-Caspian Region</u>  <u>Unknown European source</u>	<u>Baltic Sea Basin, 1803 - 1940'</u> <u>Eastern Gulf of Finland, since 1980's</u> <u>Great Lakes (N. America), since 1986</u>

The RBIC portal is also supporting the web pages of some international working groups and networks, including the developing European Research Network on Aquatic Invasive Species, the Caspian Environment Program Regional Invasive Species Advisory Group, and the SIL Working Group on Aquatic Invasive Species (Regional Biological Invasions Center 2001d), and serves as a regional information hub for the developing global invasive species information network (for more information on the global network, see the online Report of the Joint Convention on Biological Diversity/Global Invasive Species Programme Informal Meeting on Formats, Protocols and Standards for Improved Exchange of Biodiversity-related Information 2002, and Report of the Workshop on Development of Nordic/Baltic Invasive Species Information Network 2002).

Figure 6. Example of web page from the entry on *Mnemiopsis leidyi* in the Illustrated Database of the Regional Biological Invasions Center (source: Shiganova & Panov 2002)



## 2.6. OTHER REGIONAL AND INTERNATIONAL INFORMATION RESOURCES

Other principal online informational resources on aquatic alien species, relevant to the Ponto-Caspian Region, include three regional and two international information systems: the Directory of Non-native Marine Species in British Waters, the *Caulerpa taxifolia* Database, the United States Geological Survey Non-indigenous Aquatic Species (USGS NAS) Information Resource, the Food and Agriculture Organization of the United Nations (FAO) Database on Introductions of Aquatic Species (DIAS), and the Global Information System on Fishes (FishBase). Additional information about databases on aquatic alien species can be found in a recent review by S. Gollasch (2002).

The directory of Non-native Marine Species in British Waters includes entries on six species, considered as alien for the Ponto-Caspian Region: the New Zealand mud snail *Potamopyrgus antipodarum*, the Japanese oyster *Crassostrea gigas*, the North Atlantic clam *Mya arenaria*, the West Atlantic crab *Rhythropanopeus harrisii* and the Chinese

mitten crab *Eriocheir sinensis*. The species-specific entries include data on species taxonomy, dates of introduction, origin, method of introduction, rates of spread, brief description of distribution, effects on the environment and control methods.

The *Caulerpa taxifolia* Database is located at the Université de Nice-Sophia Antipolis (France), and provides distributional maps, information on environmental impacts and images of this Pacific invasive macroalga, which potentially poses the threat of invading the Ponto-Caspian Region (primarily the Black Sea coastal ecosystems).

The USGS NAS Information Resource is located at the Florida Caribbean Science Center (USA), and has been established as a central repository for accurate and spatially referenced biogeographic accounts of nonindigenous aquatic species. Provided are scientific reports, online/realtime queries, spatial data sets, regional contact lists, and general information. It includes comprehensive entries on some Ponto-Caspian species, including the round goby *Neogobius melanostomus* and the tubenose goby *Proterorhinus marmoratus*, the zebra mussel *Dreissena polymorpha* and the fishhook waterflea *Cercopagis pengoi*. It also includes information on invasive species, alien to the Ponto-Caspian Region, such as the New Zealand mud snail *Potamopyrgus antipodarum* and the Chinese mitten crab *Eriocheir sinensis*, and provides links to other online sources of information on aquatic invasive species in North America and Europe, including those located at the Regional Biological Invasions Center information system.

The *FAO database on introductions of aquatic species* currently contains about 3,150 records of introductions of freshwater and marine fishes, and other taxa, and can be accessed through a Search Form. The database includes records of species introduced or transferred from one country to another. Coverage of accidental introductions of organisms (e.g., through ship ballast waters) is not complete and records on this topic have been entered only when important impacts on fisheries or on the environment have been caused (*Mnemiopsis* introduction to the Black Sea, for instance).

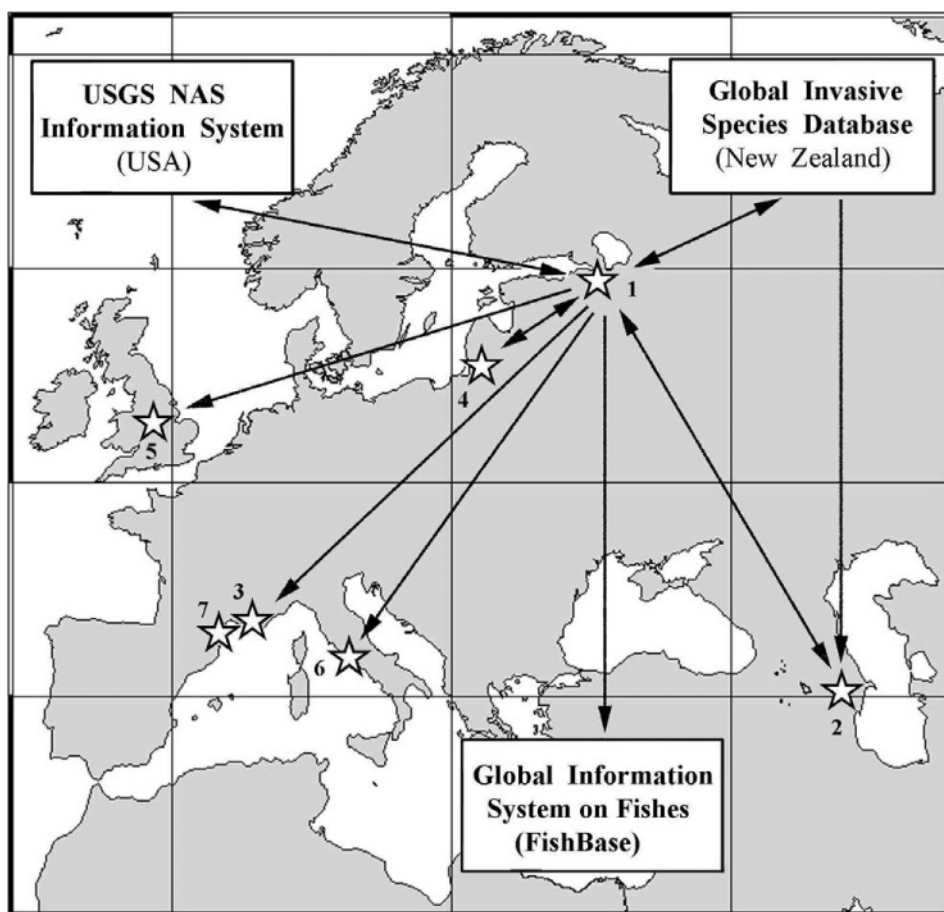
The *Global Information System on Fishes (FishBase)* is one of the most comprehensive online informational resources on freshwater and marine fishes. FishBase was developed at the International Center for Living Aquatic Resources Management (ICLARM) in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and with support from the European Commission. FishBase is a relational database, which contains practically all fish species known to science (more than 25,000 species), and includes information on invasive Ponto-Caspian species and on fish species alien to the Ponto-Caspian Region.

### **3. Development of an information system on aquatic invasive species for the Ponto-Caspian Region**

At present, open information on aquatic invasive species alien to the Ponto-Caspian Region (or introduced from the Ponto-Caspian Region), is located in the online regional and international databases and information systems, briefly described above. These open information sources are already linked, within the World Wide Web, with the Regional Biological Invasions Center serving as a regional web portal, and providing links to these sources (Fig. 7). However, at present available online information is not sufficient

for management purposes, such as the prevention of introductions, control or eradication of invasive alien species established in the Ponto-Caspian Region. Probably, only in the case of the invasive ctenophore *Mnemiopsis*, available information in the interlinked Global Invasive Species Database, Caspian Sea Biodiversity Database and Regional Biological Invasions Center Information System (Fig. 7) is sufficient for the elaboration of adequate control measures in the Ponto-Caspian, as well as for undertaking preventive management measures in those regions which are recipients of these harmful species (the Baltic Sea, for instance).

**Figure 7.** Present links between available regional and international online information resources on aquatic alien species, relevant to the Ponto-Caspian Region (1 - Regional Biological Invasions Center Information System, 2 - Caspian Sea Biodiversity Database, 3 - CIESM Atlas of Exotic Species, 4 - Baltic Sea Alien Species Database, 5 - Directory of Non-native Marine Species in British Waters, 6 - FAO Database on Introductions of Aquatic Species, 7 - *Caulerpa taxifolia* Database)



The development of the regional online information system on aquatic alien species (all alien species in novel ecosystems should be considered as potentially invasive) as a principal management tool should be considered as one of the regional priorities. Considering the significance of the Ponto-Caspian Region as an important donor area of invasive species for the Baltic Sea region and worldwide, such a regional information system should be a part of the developing global invasive species information network. Integration of the Ponto-Caspian regional information system on aquatic alien (invasive) species in the global network of relevant databases will ensure its effective service as an early warning system for other regions and as a tool for risk assessment of harmful species introductions from the Ponto-Caspian to the potential recipient regions.

The regional Ponto-Caspian information system on aquatic alien organisms should be build on the basis of the information technologies developed for the adjacent Baltic Sea Region, in order to ensure inter-operability. For this reason, the online Baltic Sea Alien Species Database could be used as a prototype database, and the regional directory of alien species should be linked to the detailed species-specific entries, including those already available at the existing information hubs (Global Invasive Species Database, Regional Biological Invasions Center and other). A timely incorporation of geo-referenced data from alien species monitoring in the regional Ponto-Caspian information system should also be ensured, and, for this purpose, GIS applications like one described in section 2.5. should be considered.

## References

- Baltic Sea Alien Species Database, 2002. Olenin S., E. Leppäkoski & D. Daunys D (eds), Alien Species Directory. <http://www.ku.lt/nemo/mainnemo.htm>
- Caspian Environment Programme, 2002. *Mnemiopsis leidyi* in the Caspian Sea. <http://caspienenvironment.org/mnemiopsis>
- Caspian Sea Biodiversity Database, 2002. V. N. Belyaeva (ed) <http://www.caspianenvironment.org/biodb/eng/main.htm>
- Caulerpa taxifolia* Database <http://www.caulerpa.org>
- CIESM Atlas of Exotic Species in the Mediterranean Sea (2001). <http://www.ciesm.org/atlas>
- Decision VI/23 COP6 of the Convention on Biological Diversity (2002) <http://www.biodiv.org/decisions>
- Directory of Non-native Marine Species in British Waters. Eno NC, Clark RA & Sanderson WG (eds). <http://www.jncc.gov.uk/marine/dns>
- FAO Database on Introductions of Aquatic Species (DIAS) (1998). <http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/index.htm>
- GISP, 1999. Global Invasive Species Programme. <http://jasper.stanford.edu/gisp>
- Global Information System on Fishes (FishBase). <http://www.fishbase.org/home.htm>
- Gollasch, S, 2002. Databases on aquatic alien species: North and Mediterranean Seas and non-European Initiatives. In: Leppäkoski E, Gollasch S & Olenin S (eds) 2002. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Kluwer Academic Publishers, Dordrecht, pp 520-524
- ISSG Global Invasive Species Database. <http://www.issg.org/database>
- Leppäkoski, E., S. Gollasch, P.Gruszka, H. Ojaveer, S. Olenin & V. Panov, 2002a. The Baltic—a sea of invaders. Can. J. Fish. Aquat. Sci. 59: 1175-1188

- Leppäkoski, E., S. Gollasch & S. Olenin (eds), 2002b. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Kluwer Academic Publishers, Dordrecht, 583 pp
- Olenin, S., E. Leppäkoski & D. Daunys, 2002. Internet database on aliens species in the Baltic Sea. In E. Leppäkoski, S. Gollasch & S. Olenin (eds) 2002. Invasive Aquatic Species of Europe. Distribution, Impacts and Management. Kluwer Academic Publishers, Dordrecht, pp. 525-528
- Panov, V. E., 1999. GAAS: Group on Aquatic Alien Species at the Zoological Institute in St.Petersburg, Russia. *Biological Invasions* 1: 99-100
- Regional Biological Invasions Center, 2001a. V. Panov, M. Dianov & A. Lobanov (eds) <http://www.zin.ru/projects/invasions>
- Regional Biological Invasions Center, 2001b. V. Panov, M. Dianov & A. Lobanov A (eds), Interactive Geographical Information System for Documentation and Mapping of Alien Species Distribution. <http://www.zin.ru/projects/invasions/gaas/invader/invader.htm>
- Regional Biological Invasions Center, 2001c. V. Panov, M. Dianov & A. Lobanov (eds) Aquatic Invasive Species of Europe. [http://www.zin.ru/projects/invasions/gaas/aa\\_idb.htm](http://www.zin.ru/projects/invasions/gaas/aa_idb.htm)
- Regional Biological Invasions Center, 2001d. V. Panov, M. Dianov & A. Lobanov (eds), International Networking. [http://www.zin.ru/projects/invasions/gaas/aa\\_netw.htm](http://www.zin.ru/projects/invasions/gaas/aa_netw.htm)
- Report of the Joint Convention on Biological Diversity/Global Invasive Species Programme Informal Meeting on Formats, Protocols and Standards for Improved Exchange of Biodiversity-related Information (2002). <http://www.biodiv.org/doc/meetings/cop/cop-06/information/cop-06-inf-18-en.doc>
- Report of the Workshop on the Development of a Nordic/Baltic Invasive Species Informational Network (2002). [http://www.us-reo.dk/IS\\_Database.htm](http://www.us-reo.dk/IS_Database.htm)
- Shiganova, T. A. & V. E. Panov, 2002. *Mnemiopsis leidyi* A. Agassiz, 1865. Entry to the Illustrated Database, Regional Biological Invasions Center Information System. <http://www.zin.ru/projects/invasions/gaas/mnelei.htm>
- United States Geological Survey Nonindigenous Aquatic Species (USGS NAS) Information Resource. <http://nas.er.usgs.gov>
- Zaitsev Y. & B. Öztürk (eds), 2001. Exotic species in the Aegean, Marmara, Black, Azov and Caspian Seas. Published by Turkish Marine Research Foundation, Istanbul, Turkey, 267 pp