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REPORT OF THE

WORKING GROUP ON INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

Barcelona, Spain

21–23 March 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 OPENING OF THE MEETING AND INTRODUCTION

The 2001 meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was held at the Laboratori Botanica of the Facultat de Farmacia at the Universitat de Barcelona, Spain from 21 March to 23 March 2001.

Dr Antonio Diez, Vice President of the Facultad de Farmacia at the Universitat de Barcelona welcomed the Working Group. The objectives of the 2001 meeting were reviewed; the agenda for the meeting was considered and approved. The agenda is attached as Annex 1.

This meeting, the 23rd of the WGITMO, was chaired by Dr S. Gollasch. Dorothee Kieser (Canada) was appointed as Rapporteur. There were sixteen participants representing ICES Member Countries including countries bordering the Baltic Sea and invited guests from Italy and Georgia as well as one observer from Georgia. The list of participants is given in Annex 2.

2 TERMS OF REFERENCE

According to the recommendations of the 2000 meeting of the WGITMO, the following Terms of References were agreed by the ICES Council (ICES C.Res. 2000/2:ACME08):

a) develop an information brochure on the current issues surrounding exotic species invasions, and the impending potential threat of future invasions, to be distributed to ICES Member Countries and to be offered on the ICES website; these materials could also be distributed in the form of species-specific information bulletins, sheets, or posters, focusing on widespread and still spreading exotic species (such as *Hemigrapsus, Undaria*, and *Sargassum*) or on exotic species which are less well known to the public (such as the snails *Rapana thomasiana* and *Ocinebrellus inornatus*, and the American lobster); this effort would include a special advisory report on *Rapana* as discussed and approved by ICES in 1999;

b) carry out a review of previous National Reports (since 1992) to determine whether the recorded incidents of introduced species, in terms of both their geographical spread and their abundance, have been increasing in recent years and assess the consequences and significance of these introductions;

c) review and report on the status of databases on introduced species that have been developed on a regional basis, such as the databases developed by BMB, CIESM, and any others that are in the process of development, in order to improve communication and the dissemination of information within and between ICES Member Countries and to inform other groups such as HELCOM where up-to-date information on introduced species can be found;

d) develop a standardised reporting format for the collection of data on non-indigenous species, as a matter of high priority;

e) finalize the "Directory of Dispersal Vectors of Exotic Species" to be published in the *ICES Cooperative Research Report* series;

f) review the ICES Code of Practice on the Introductions and Transfers of Marine Organisms, with a view to updating its applicability in the light of issues associated with importation and transfers of species intended for such purposes as the aquarium trade, the bait industry, or for immediate consumption, that can result in the release in the wild of such species and any accompanying organisms, including pests, parasites, and disease agents;

g) report on the current status of fish, shellfish, algal, and other introductions in and between Member Countries, through:

    i) the submission of the National Reports, to include new information on genetically modified organisms and the use of any biocontrol agents,

    ii) continuing to review the status of selected current invasions, including:

        a the status of the invasion of the snail *Rapana* in Atlantic America, France, and the Mediterranean, with a focus on producing an "Alert Sheet" to be distributed to ICES Member Countries,

        b the continued spread of the kelp *Undaria* in France, Italy, Spain, Belgium, UK, the Netherlands, and other Member Countries,

        c the spread of the crabs *Hemigrapsus sanguineus* and *Hemigrapsus penicillatus*,

        d the status of the zebra mussel *Dreissena polymorpha* in Ireland and other countries, e the status of the water flea *Cercopagis pengo*i, especially any further spread in the Baltic Sea and the Great Lakes, and

f the snail *Ocinebrellus inornatus* in France.

iii) continuing to review the potential risks from world-wide trade in live aquatic organisms for the food trade, for the aquarium and ornamental trade, and as live bait for recreational fishing,

iv) discussing the preparation of a new *ICES Cooperative Research Report* entitled "Status of Introductions, 1992–2001" to summarise the new species introduced both intentionally and unintentionally in the past decade,

v) revise the structure of the National Reports so as to include the full range of vectors involved in the introduction and transfer of marine organisms and the possible inclusion of updated summaries of the introduced and transferred species in Member Countries,

vi) based on the above, provide information on the consequences of key introductions and evaluate their significance.

WGITMO will report by 27 April 2001 for the attention of ACME and the Mariculture and Marine Habitat Committees.

3 REVIEW OF THE 2000 WGITMO REPORT

There were no addenda/errata to the 2000 WGITMO report.

4 NEW PUBLICATIONS, WEBSITES

4.1 European Platform for Biodiversity Research Strategy

Dr D. Minchin reported on the meeting "European Platform for Biodiversity Research Strategy" held in Montpellier from 4–6 December 2000:

During the French Presidency of the European Union, the third meeting of this group concentrated on the theme "Biology of Invasions: strategic issues for European biodiversity research". Speakers addressed various issues, there being only one aquatic presentation presented by Dr Dan Minchin (Ireland).

Delegates attending agreed on several statements that covered past impacts and the potential threat of further invasions to biodiversity, which included economic and ecological impacts and difficulties for management. Distributions of invasive species enhanced by trade and the potential expansions of the EU were seen to provide new opportunities with the current free trade policy. The meeting urged a better understanding of invasive processes and the adoption of a precautionary approach to prevent the spread of introduced species.

The key issues under discussion were:

1) Develop methods and techniques to recognise and characterise organisms that may be invasive and ecosystems that may be particularly vulnerable to invasion; and develop predictions of invasive behaviour and ecosystem vulnerability to invasion.

2) Improve monitoring methodology to detect potentially problematic invasive organisms early to track invasions and to evaluate their ecological and socio-economic impacts, and, where appropriate, to control them.

   It was under this heading that research topics for high priority relating to marine organisms were placed:

   . <u>Section 2.2</u>: Develop methods to detect and manage [ALL] taxa in the major pathways such as trade, transport, tourism, travel, with emphasis on shipping and airlines.

   . <u>Section 2.3</u>: Develop detection and control measures to manage non-indigenous taxa transported in ballast water tanks and hulls of ships and vessels.

3) Develop multidisciplinary scientific support for appropriate policy on prevention, management for control, and legislation, public awareness and information.

4) Section 3.1: Provide scientific advice and methods to help strengthen international legal frameworks and implement legislation and develop guidelines to minimise invasions within EU Member States and between EU and other countries.

5) Section 3.3: Develop methods to improve awareness of invasive taxa within the general public and for the major sectors, including horticulture, agriculture, forestry, agroforestry, aquaculture, pet, aquaria and aid trade.

In addition:

4) Develop methods to predict and prevent invasive behaviour of GMOs released into the environment.

It was clear from this meeting that there was a poor understanding of the impacts of invasive species in the aquatic environment. Many of the issues researched by those attending would appear to have far less impact than aquatic invasive species. The invitation to include a marine biologist at this meeting seemed to be very much an afterthought. It is quite clear that more advertisement on the impact of aquatic invasive species is needed to ensure that adequate research funding will be provided to this area. An EU Biodiversity Science Group has been set up at: EUBiodiversityScience@egroups.co.uk and website:

http://www.egroups.co.uk/mygroups

4.2 ICES Annual Science Conference: Theme Session on Marine Biological Invasions: Retrospectives for the 20th Century – perspectives for the 21st Century

Dr D. Minchin and Dr H. Ojaveer summarised the Theme Session on Marine Biological Invasions: Retrospectives for the 20th Century – perspectives for the 21st Century, held in Bruges, Belgium on 30 September 2000, which was co-convened by Prof. James T. Carlton and Dr Dan Minchin. Fourteen papers and one poster were presented. The Theme Session will not have a special proceedings.

It was clear from the papers and discussions that marine bioinvasions were one of the main components that result in harmful change to aquatic ecosystems. The presence of invasive species is not normally known until some years later and many species remain cryptogenic. Monitoring of areas vulnerable to the invasion of exotics would greatly aid in the interpretation of future species movements. There have been many examples of invasions of exotic species from a wide range of taxa that have led to economic, environmental, and ecological changes to communities. Many vectors are presently operating to spread exotic species in either primary or secondary modes of spread. A number of vectors may be operating at the same time to redistribute species; their identity needs to be revealed for appropriate management. National and international frameworks for exotic species management should take account of the ways in which exotic species are transmitted and develop contingency measures for their impoundment, eradication or control. Up-to-date information on the movements of unwanted species is also seen as a tool to assist management.

It is essential that exotic species management be conducted through international cooperation because most of the vectors involve international trade. In addition, all researchers working on assessments should do so in the full knowledge of the scientific community. There is also a need for greater communication between industry, science, and management in the coming years. It was noted that appropriate taxonomic expertise is at historical ebb and has not been supported because of the changes in work practice. Understanding the role of vectors and understanding the scale of new invasions does, and will continue to, depend on this discipline. There was also found to be a lack of common understanding about the impact of aquatic invasive species and education and information dissemination to the public, industry and managers. The development of websites and media coverage is seen as important contributions. The impacts of harmful species need to be quantified so as to provide reliable information.

Papers during this Theme Session covered case history studies of introductions of *Caulerpa taxifolia* to the Mediterranean, *Homarus americanus* to the Oslo Fjord in Norway, *Marenzelleria* c.f. *wireni* to the Dutch Wadden Sea, and *Cercopagis pengoi* to the Vistula Lagoon in the Baltic Sea. Two papers related to ballast water, one on treatment and the other on ballast monitoring in France. Port surveys in Australia were reported and conceptual approaches for the management of species were discussed. One paper predicted likely problem areas for the shellfish industry that included releases of imports carried by aircraft. The expansion of Red Sea species in the Eastern Mediterranean and the importance of marinas as exotic species refuges and the dynamics of fouling populations were discussed.

The following recommendations (summarised) were made:

- ***Vector surveys*** ICES Member Countries should have in place permanent vector surveys that capture the spatial and temporal scales of species flow to understand invasion potential and the efficacy of management and regulatory regimes. ICES should continue to work with the EU and Directives on fish health in relation to stock and product movements that include aquaculture. **These efforts should include not only pathogens and disease agents, but other pest species as well**.
- ***International Cooperative Network of Vector Management*** ICES Member Countries should cooperate in the establishment of an international cooperative network for vector management.
- ***National and International Regulatory Framework*** ICES Member Countries should place the highest priority on the updating, broadening, and strengthening of regulatory frameworks for the prevention, control, and management of invasives.
- ***Assessing Invasion Impact*** ICES and ICES Member Countries should emphasise the need for quantitative experimental research on the impacts of invasions, relative to short-term and long-term patterns so as to understand the role of exotic species in impacting the economy and the environment.
- ***The fundamental Importance of Supporting Taxonomy and Systematics*** ICES and ICES Member Countries can play a critical role in revitalising taxonomy and systematics. All biological disciplines rely on the level of sophistication of taxonomic expertise. This void, unless it is filled, will lead to problems in the coming years.

4.3 Global Invasive Species Programme (GISP)

Dr G. Ruiz reported on the progress of the GISP, which holds regular meetings and has an active website (see Annex 7). GISP was initiated in 1996. At the European level, a scientific group was nominated to develop a “platform for a research strategy in biodiversity”. A first meeting was organised under the French Presidency in Montpellier, 4–6 December 2000 on “Biological Invasions”. Research priorities were specified within the three tasks: 1) to develop methods to assess potential invasive species and sensitive ecosystems so as to develop a modelling and predictive approach; 2) to improve the monitoring networks for early detection and risk assessment, including social and economic side effects; 3) to sustain a multidisciplinary scientific programme to facilitate decision-making to prevent, control, manage and inform decision makers and increase public awareness on these issues (see Section 4.1, above).

4.4 NEOBIOTA (German Group of Experts)

Dr S. Gollasch summarised the activities of the newly formed German group of experts relevant to species invasions, entitled “NEOBIOTA”. This new research consortium on biological invasions was recently founded to work on theoretical and applied aspects of such invasions. It also aims to educate the public and consult with policy makers. The group plans to compile and distribute a newsletter on a regular basis (see German National Report, below, for details).

5 DEVELOPMENT OF INFORMATION BROCHURES (TOR A)

Information brochures on selected non-indigenous species in ICES Member Countries should be developed for inclusion on the ICES WGITMO website (to be established by ICES, see further below) and for distribution to Member Countries. If acceptable to ACME, the following information will be prepared by WGITMO for each of the species of concern (e.g., *Hemigrapsus sanguineus, H. penicillatus, Undaria pinnatifida, Sargassum muticum, Rapana thomasiana* and *Ocinebrellus inornatus*):

1) Background information on exotic species invasions to be addressed for the general public and legislators including references to activities in (a) the International Maritime Organization (IMO), especially the Marine Environment Protection Committee, Ballast Water Working Group and the GloBallast Programme, (b) the International Chamber of Shipping (ICS), (c) ICES, and (d) the ICES/IOC/IMO Study Group on Ballast Water and Other Ship Vectors (SGBOSV);
2) Distribution map;
3) Species-specific follow-up material to be addressed to the scientists:
    a. Use striking examples (severely impacting “pest” species). Details on selected species previously introduced into ICES Member Countries,
    b. Information may be taken from documents prepared according to TOR d),

c. Provide details on contact person, authority and refer to ICES;

4) Colour illustration (photo or scientific drawing);

5) Impacts and threats (ecological, economical and human health, i.e., why are we concerned);

6) Information on likely vectors (how will it get there?);

7) Contact agency (to be added by member country);

8) Information for public response ("what can I do?");

9) Reference to WGITMO and other bodies working in this field (to be mentioned as footnote providing contact details).

In addition, WGITMO suggests that a general poster be developed on invasion biology and invasive species. Suggested titles: "What can I do", "Do not release them into the wild", "Save our seas" or "Do not destroy our natural heritage".

A model for such information for the general public could be the CITES material seen in airports and other areas frequented by travellers.

It was further recommended to develop **additional** material to be distributed targeting the following user groups:

- fishermen;
- aquaculture and ornamental trade;
- public aquariums;
- marinas;
- divers (give details on "What can be done", Mechanical eradication possible?;
- importer;
- scientists (see TOR d);
- policy/decision makers (Environmental Protection Agencies).

WGITMO suggests including this information material on the WGITMO homepage (to be developed).

6 SUMMARY OF NATIONAL REPORTS 1992–2001 (TOR B, TOR G iv)

WGITMO agreed that a summary of National Reports 1992–2001 could serve as a starting point for an *ICES Cooperative Research Report* (CRR). If ACME wishes a more comprehensive report to be issued, additional time will need to be allotted for completion of the report. Further, it was agreed that each country would designate a "volunteer" to collect and present relevant information to WGITMO meetings. For countries that have not submitted reports, Dr I. Wallentinus agreed to collect information on deliberate and accidental introductions of plants, while Dr S. Gollasch volunteered to collect the information for finfish and invertebrates.

WGITMO recommends including information from Mediterranean Countries and other invited guests and observers into the planned CRR. Further, the CRR will benefit from the knowledge of the SGBOSV and close cooperation between both groups is therefore recommended.

The following time schedule is suggested:

2001: ACME approves the proposed format for CRR (see below)

2002: Designate representatives from ICES Member Countries to collect national information

2003: Coordinate preparation of the report

If acceptable to ACME, the following information will be extracted from the National Reports submitted by Member Countries and used as the format for the CRR (see above):

Example of proposed table for availability of National Reports from Member Countries and invited guests (1992–2001) to document the geographical range covered by the WGITMO over time.

	1992	**1993**	**1994**	**…**
Belgium				
Canada	X	X	X	
Finland	X	X	X	
…				

1) Specific topics addressed by country

These sections will help in estimating if there are trends. If there are increases in the number of species introduced or the number of animals shipped between countries, patterns of introductions may become apparent. WGITMO proposes the following topics:

a) Deliberate Introductions:

Plants
Finfish
Invertebrates

b) Accidental Introductions:

All species detected and/or established (including occasional findings)
First record of detection
Potential impact of each species
Spread of introduced species

c) Bibliography

d) Meetings

WGITMO suggests that the CRR include case studies of selected species (e.g., *Rapana thomasiana, Cercopagis pengoi, Caulerpa taxifolia, Hemigrapsus sanguineus and H. penicillatus*) across all countries. The case studies would include information on:

Impacts
Economic impact
Biological impact

Dispersal
This section would include information on trade in live aquatic organisms for the food trade, aquarium and ornamental trade as well as live bait transportation (TOR g-iii)

Through natural life history (pelagic stages, etc.)
Human mediated

Type of habitat
Marine
Brackish, etc.

7 DATABASES ON INTRODUCED SPECIES (TOR C)

During the meeting, WGITMO members listed many databases on introduced and transferred species which are available or are in the process of development (see Annex 7). Many databases are specific to geographical regions. These databases are valuable sources of information to scientists and other groups (e.g., HELCOM) in ICES Member Countries as well as around the world.

The availability of information on websites is increasing exponentially. Information for the assessment of risks from ballast water introductions is only one example of the value of these regional databases.

8 REPORTING FORMAT FOR THE COLLECTION OF DATA ON NON-INDIGENOUS SPECIES (TOR D)

WGITMO agreed on a reporting format for the collection of data on non-native species or unexpected occurrences of species. Reports should include details on the species, biogeography and range expansion, method of introduction, relative abundance and distribution in invaded region, life history, impact, possible benefit, control measures and management options, mitigation in invaded country, further likely areas of colonisation, similar species in the area of invasion, reference material and references (see Annex 8).

9 DIRECTORY OF DISPERSAL VECTORS OF EXOTIC SPECIES TO BE PUBLISHED AS A COOPERATIVE RESEARCH REPORT (TOR E)

The Directory of Dispersal Vectors of Exotic Species was restructured and improved. It includes the following headings: (a) vessels (on the hull, hull-associated structures and ship equipment, in the hull, inside the vessel), (b) living trade and transfers, (c) aquaculture, (d) aquarium and garden pond trade, (e) releases, (f) commercial, recreational and community activities, (g) research and education, (h) biocontrol, (i) release of genetically modified organisms (GMOs), and (j) man-made waterways (see Annex 9).

WGITMO recommends that the relevant CRR on dispersal vectors should not only include this list, but that examples of species invasions should be included according to dispersal vectors providing a clear picture of the dimension of species transportation. It is suggested that the material for the CRR on dispersal vectors be compiled until the WGITMO meeting in 2003 or earlier.

10 REVISION OF THE ICES WGITMO CODE OF PRACTICE (TOR F)

WGITMO recommends an update of the current version of the Code of Practice on the Introduction and Transfers of Marine Organisms (prepared in 1994, published in 1995) to take advantage of recent developments regarding intentional species introductions. Especially the section on genetically modified organisms needs to be edited. Further, it was noted that species being intentionally introduced as a control agent for previously introduced unwanted organisms (biocontrol) were not covered in the current version of the Code of Practice, but need to be added as relevant activities develop (e.g., to control the alga *Caulerpa taxifolia* in the Mediterranean Sea and the ctenophore *Mnemiopsis leydii* in the Black Sea).

It was further suggested to prepare the new version of the Code of Practice merged with the manual of procedures (as outlined in the 1996 WGITMO report) to be published together as a stand-alone document and, in addition, to include the updated Code of Practice as an Annex to the CRR on the Summary of WGITMO National Reports (TOR b).

11 NATIONAL REPORTS (TOR G)

National reports were received from the following countries: Belgium, Canada, Estonia, Finland, France, Germany, Ireland, Netherlands, Norway, Spain, Sweden, United Kingdom (England and Wales), and the United States of America. These are attached as Annex 3. Further national reports were received from Georgia and Italy (Annex 4).

TOR g i) National reports were presented and are attached as Annex 3.

TOR g ii) a) *Rapana* "Alert Sheet". This item was postponed until the next meeting when an expert on the subject will be invited. Items b) – f) were covered by National Reports and specific presentations (see Section 12, Status of Invasions, and abstracts attached in Annex 3).

TOR g iii) Review potential risks from worldwide trade of live aquatic organisms including food trade, aquarium and ornamental trade, and live bait trade. This is partly covered by the National Reports attached and will be addressed through future itemised inclusions in National Reports (see National Report for Ireland and Annex 6: Proposed update of reporting format for National Reports).

TOR g iv) ICES CRR Status of Introductions 1992–2001. See Section 6, Summary of National Reports 1992–2001, above.

TOR g v) Revision of National Report structure. WGITMO proposes that the listing of possible vectors (TOR e) be included in the preparation of National Reports (see Annex 6, Proposed update of reporting format for National Reports).

TOR g vi) Consequences of key introductions. WGITMO proposes that possible impacts of introduced species be included in the preparation of National Reports. All species mentioned under TOR a and g ii) continue to spread in ICES Member Countries. Details on current and potential impacts are given in the relevant sections of the National Reports (see Annexes 3 and 4).

11.1 Highlights of the National Reports

National Reports contain details of new laws and regulations, deliberate releases, accidental introductions and transfers, live imports, live exports, planned introductions, and meetings. References cited in the National Reports, and elsewhere in the report, are compiled in the Bibliography (Annex 10).

11.1.1 Belgium

New laws prohibit the intentional introduction of non-indigenous species and genetically modified organisms into Belgian waters. Even the unintentional introduction of non-indigenous species can lead to penalties. This activity is regulated by Royal Decree.

A considerable number of non-native invertebrates have become established and are spreading in Belgian waters. The report lists several barnacles (*Balanus amphitrite, Megabalanus coccopoma*, *M. tintinnabulum, Balanus reticulatus* and *B. variegatus,* and *Elminius modestus)*, *Haliplanella lineata, Nemopsis bachei, Eriocheir sinensis, Rhithropanopeus harrisii, Crassostrea gigas, Crepidula fornicata, Corbula gibba, Ensis directus, Petricola pholadiformis, Mytilopsis leucophaeata* (=*Congeria cochleata*), *Caprella mutica, Ficopomatus enigmaticus, Hemimysis anomala, Callinectes sapidus, Tricellaria inopinata* and several bryozoans *(Bugula stolonifera, Bugula simplex,* and *Bugula neritina).* While there has been monitoring for *Hemigrapsus*, there have been no reports to date.

Several species of algae are also continuing to spread: *Undaria pinnatifida, Sargassum muticum, Codium fragile tomentoides, Antihamnionella spirographidis*.

Belgium expressed concerns about the import and export of a wide variety of marine and freshwater species for aquaculture, aquariums, human consumption and research. Much of this transfer appears uncontrolled. Oysters (*Crassostrea gigas*), imported from a number of countries, have formed dense populations in several harbours and are present offshore on buoys.

As reported by several other European countries, the North American lobster (*Homarus americanus*) is becoming a concern because of the potential genetic impact on the native species.

11.1.2 Canada

Canada is nearing completion of its National Code on Introductions and Transfers. This policy is based on a scientific risk assessment for the species to be transferred and its receiving habitat and will address all transfers and introductions into fish habitat and fish rearing facilities. Other transfers such as live food fish, aquarium species, and live fish for bait will not be covered by this code.

On the west coast, green crabs have not as yet become established, but on the east coast the crabs have made a significant jump into an oyster-producing area on Prince Edward Island (PEI). This transfer may have occurred with the movement of oyster seed. Another crab, *Dyspanopeus sayi*, was found to have travelled with oyster seed to the Magdalen Islands.

Juvenile Atlantic salmon, a species exotic to British Columbia that was introduced for aquaculture in the 1980s, have now been found on several occasions in streams on Vancouver Island. The majority is thought to have been escapes from local hatcheries, but it is likely that a number of fish originated from wild production.

Styela clava and *Codium fragile tomentoides*, both non-indigenous species, are found to have a negative impact on the shellfish industry in PEI. A toxic microalga, *Cochlodinium polykrikoides*, likely introduced through ballast water to Canada's Pacific coast has killed significant numbers of farmed salmon.

In freshwater lakes in Ontario, several non-native aquatic plants (*Cabomba caroliniana, Nymoides peltatum* and *Hydrochris morsus-ranae*) have become established. They probably originated in the aquarium or pond trade. In British Columbia, Koi, an ornamental carp variety, has been detected in local streams.

11.1.3 Estonia

The member from Estonia reported that there is now a government officer in the Ministry of Environment to deal with the issue of non-indigenous species.

Several of the non-indigenous species have been studied in detail to assess their impact on local ecosystems. The distribution of *Cercopagis pengoi* in the Baltic Sea has increased remarkably and has led to changes in the diet of several species such as herring and smelt. This probably influences fish stock structure. The species is also likely to have an economic impact through bio-fouling of fishing gear. *Dreissena polymorpha*, the zebra mussel, has an important role as a regulating, linking organism between the pelagic and benthic systems. The polychaete, *Marenzelleria viridis*, has the potential to reduce the growth of the native amphipod, *Monoporeia affinis*. It is also found to reduce the survival of the native polychaete, *Nereis discolor*. The bivalve, *Macoma balthica*, can cause significant losses in *M. viridis*. Hence, this introduced polychaete should only prevail where it can escape *M. balthica*.

11.1.4 Finland

Outbreaks of viral haemorrhagic septicaemia occurred on four Finnish farms in two regions. This has led to restrictions on the movement of fish into affected areas and out of those areas. The virus occurs in herring and may have migrated to the farms via these wild stocks.

There were deliberate releases of salmon (*Salmo salar*), sea trout (*S. trutta*) and whitefish (*Coregonus lavaretus*), and elvers (*Anguilla*) into the Baltic area.

A Russian sturgeon (*Acipenser gueldenstaedti*) was reported from the southwestern coast of Finland (Rymättylä) and a similar fish was found in the eastern Gulf of Finland in 2000. Four observations of starry sturgeon (*Acipenser stellatus*) have been made in Finnish coastal waters since the first one in 1999.

11.1.5 France

France reported that the EU Directive 91/67 is under consideration.

New accidental introductions/transfers included an Australian bivalve, *Bractechlamys vexillum*, a Pacific cirriped, *Megabalanus* sp. and *Acanthaster planci*. All of these were found in the marine sanctuary of Port-Cross. There also was an accidental release of Siberian sturgeon, *Acipenser baeri*, which escaped owing to the destruction of the farm due to the severe hurricane in 1999. There is a concern that specimens which were not recaptured might interbreed with the endangered, local species *A. sturio*.

Updates were given on previously introduced species: The snail, *Rapana venosa*, remains in Quiberon Bay (south Brittany) where since 1997, eleven individuals (adults) have been observed. The habitat seems to be around low tide (−5 m) and in sandy bottoms. No juveniles or signs of reproduction have been found. On the contrary, the muricid, *Ocinebrellus inortatus*, showed a significant spatial extension along the south Atlantic coast. *O. inornatus* affect the shellfish rearing beds. The population of the crab, *Hemigrapsus penicillatus*, is limited by the presence of a strong population of *Pachygrapsus marmoratus. Caulerpa taxifolia* continues to extend its colonisation and can go down to below 100 m. The destruction or control trials remain inconclusive.

11.1.6 Germany

No new accidental introductions were reported. Germany reported on the status of the following, previously introduced non-indigenous species: *Crassostrea gigas, Anguillicola* sp., *Dreissena polymorpha, Eriocheir sinensis,* and *Teredo navalis*. The temporary storage of *C. gigas* in Ireland led to the introduction of *Sargassum muticum, Ascophyllum nodosum, Styela clava,* and *Aplidium nordmannii*. Culture of the Pacific oyster has resulted in the increasing settlement of the species in the Wadden Sea, especially on adjacent mussel beds. The invasion of the Elbe and Weser Rivers by the zebra mussel is thought to have led to improvements in water quality, however the mussel growth has also been very costly for companies whose cooling water supply was affected by mussel growth. The mitten crab is sufficiently abundant that there is harvesting of juvenile crabs for live shipments to China for restocking. In addition, 10 tonnes of crabs are shipped annually to China for consumption.

In the ornamental trade, some CITES listed species are becoming increasingly popular (e.g., *Tridacna* sp.). However, because they are also cultured in Germany, the amount of illegal trade is difficult to ascertain.

Experimental work to study behavioural interactions between the native green crab, *Carcinus maenas*, and the Asian crab, *Hemigrapsus penicillatus*, showed that both species have similar habitat preferences, and can tolerate high temperatures and salinity variations. Dominance appears to be related to size, indicating that juvenile green crab will be impacted by adult *Hemigrapsus*.

NEOBIOTA, a new research consortium on biological invasions, was recently founded to work together on theoretical and applied aspects of such invasions. It also aims to educate the public and consult with policy makers.

In addition, Germany undertook a number of initiatives on ballast water both within the European Union and with other countries (Brazil, Canada).

11.1.7 Ireland

Several exotic invertebrates are cultured in Ireland: *Haliotis tuberculata, Haliotis discus hannai, Tapes philippinarum,* and *Crassostrea gigas*. All of them are grown from seed produced in Ireland. Because of the risk of importing unwanted biota with the shipment of half-grown oysters, growers have been advised that samples of imported seed would be monitored.

A number of invertebrates and parasites, that were accidentally introduced to Ireland previously, continue to spread or be introduced to new areas. Examples are *Anguillicola crassus, Mytilicola orientalis, Dreissena polymorpha, Calyptraea chinensis* and *Ficopomatus enigmatica.*

11.1.8 The Netherlands

The Pacific oyster, *Crassostrea gigas*, is well established and expanding in the Dutch Wadden Sea.

Several blue crabs, *Callinectes sapidus*, including egg-carrying females, were caught by fishermen in several places in the Westerschelde.

After being found in other North Sea countries, the Pacific crab, *Hemigrapsus penicillatus*, was predicted to colonise Dutch and Belgian coastal waters. The first crabs were found in early 2000 in the tidal area of the Oosterschelde at Sas van Goes. Several additional specimens were found throughout the year, one large enough to indicate that it might have been present in 1999. Despite intensive monitoring, the crabs were not found at other locations. *Hemigrapsus sanguineus* was also detected for the first time in the Netherlands in the Oosterschelde.

Similar to other North Sea and Baltic countries, the Netherlands is concerned about the escape and possible interaction of the American lobster, *Homarus americanus*, with its local species, *Homarus gammarus*.

The Japanese kelp, *Undaria pinnatifida*, is rapidly colonising some areas of the Oosterschelde since its introduction in 1999. It has also been moved, possibly with oysters, to the salt water lake Grevelingen. Because it is very slippery, the alga makes standard oyster and mussel harvesting more difficult.

11.1.9 Norway

The red king crab, *Paralithodes camtschatica*, originally introduced by Russia into the Barents Sea, is expanding its range, possibly aided by fishermen. Following its initial detection in 1999, the American lobster, *Homarus americanus*, has been found at several collecting stations in southern Norway. Circumstantial evidence indicates that the lobsters were released. All specimens were collected close to cities with airports.

Caprella mutica was found near Stavanger. It appears that the species may have been introduced into several places.

The red alga, *Dasysiphonia* sp., seems to be spreading rapidly or it may have several routes and locations of introduction.

11.1.10 Spain

Three pathogenic protozoan species pathogenic to shellfish, *Marteilia refringens, Bonamia ostreae*, and *Perkinsus atlanticus*, have been introduced to Spain, likely with the transfer of Pacific oyster or clam seed from France and Portugal. In addition, a number of Mediterranean species of invertebrates: *Gibbula albida, G. adansoni*, and *Cyclope neritea* and the North American species, *Crepidula fornicata*, were transferred to the Spanish coast with oyster seed from European countries.

Fundulus heteroclitus, the North American mummichog, was introduced to southwestern Spain and is expanding its range toward Portugal.

The PSP agent, *Alexandrium taylori*, has been detected on the Catalonian coast. *Caulerpa racemosa* has established populations in Palma de Mallorca Bay and has been reported from the Port of Ibiza. A number of filamentous red algae are becoming established. The likely vector for transfers are pleasure boats. The most important species are *Arcothamnion preisii, Antithamnion amphigeneum, Lophocladia lallemanii* and *Womersleyella setacea*. Several of these species are having negative effects on local benthic communities.

11.1.11 Sweden

New regulations have been promulgated by the National Board of Fisheries regarding the farming, release, and transfer of fish. Except for a few commonly cultured species (e.g., rainbow trout), non-native species are not permitted for culture.

To date there have been no reports of *Neogobius melanostomus* in Swedish waters, even though they are common in the Bay of Gdansk. A non-indigenous sturgeon (*Acipenser stellatus*) was caught in southeast Sweden.

Marenzelleria viridis is still increasing in the northern part of the Bothnian Sea. It is occasionally found in the southern Baltic, but there are no reports from the Swedish west coast. *Cercopagis pengoi* has been found in Himmerfjarden.

Some phytoplankton species: *Alexandrium angustitabulatum, Discroerisma psilonereiella,* and *Gyrodinium corallinum* have now been recorded. These could be new or previously overlooked introductions. While *Chattonella* cf. *verruculosa* was detected in Swedish waters, it did not form blooms.

No change was noted in the distribution of *Sargassum muticum*. While no *Dasysiphonia* has been found in Swedish waters, it is reported to be spreading south from Norway.

11.1.12 United Kingdom: England and Wales

No UK representative was present at the meeting.

There was natural recruitment of Manila clams (*Tapes philippinarum*) in Poole Harbour and a commercial fishery is being studied.

The Chinese mitten crab (*Eriocheir sinensis*) is reported to have spread northwards.

Members from other ICES countries reported that *Ensis directus* is spreading and that *Sargassum* is spreading from Strangford Loch. Also, Britain exports glass eels to many countries worldwide.

11.1.13 United States of America

Only a verbal report was received from the USA.

Several States (e.g., California, Washington State) now have ballast water legislation beyond the national regulations. In other States, new regulations are pending.

Little information is available on deliberate releases. Sterile (3N) *Crassostrea ariakensis* are being tried experimentally in Chesapeake Bay.

While approximately 500 marine non-native species are recognised in USA waters, some of the highlights on the Pacific Coast are: 1) *Carcinus maenas* has been found in Washington State (Grey's Harbour, Willapa Bay). However, populations appear to be decreasing. 2) *Eriocheir* appears generally restricted to San Francisco Bay, where their abundance is less than expected. Two specimens have been found at the mouth of the Columbia River. There, a monitoring programme and management plans have been put into place. 3) The tunicate, *Botrylloides* sp., is becoming abundant in Alaska, including Prince William Sound. 4) *Nuttallia obsurata*, the varnish clam, appears to be spreading to Washington, Oregon and, likely, California. 5) An eradication programme for the two known patches of *Littorina saxatilis* in San Francisco Bay is being discussed. As well, there is an eradication programme for *Caulerpa* in San Diego. On the Atlantic Coast, the most important issues are: 1) *Rapana venosa* appears to be established in Virginia (Chesapeake Bay). Multiple age groups have been found. 2) The haplosporidian (*H. nelsoni*) is found in *Ostrea virginica*. New information suggests that the actual introduction occurred several decades ago.

On the Gulf Coast, oil rigs transferred from other areas are considered a vector for new biota.

11.2 Highlights of National Reports from invited guests: Georgia and Italy (non-ICES Member Countries)

Georgia

Georgia reported that its seaports are increasingly threatened by shipping issues. Ballast water, household waste from ships, sewage, bilge water and sludge concerns are being addressed through the Waste Management Sector of the Georgian National Environmental Action Plan. Monitoring of ballast water is conducted according to IMO recommendation A.868(20) and Georgian Water Law. In Batumi Port, vessels arriving with dirty (or clean) ballast without segregated tanks must transfer the water to the port's treatment plant. Georgia aims to establish a data management system to control ballast water, train personnel in water analysis and establish laboratories, develop surveys including mapping of biotopes in different areas of the Black Sea, and develop a decision support system for waste and ballast water management.

Italy

The complete report from Italy is attached as Annex 4.

Aquaculture operations in Italy grow several introduced species: *Paralicthys olivaceus*, *Sciaenops ocellatus,* and *Pagrus major. P. major* is currently bred in several land-based farms. This species is also used to produce hybrids with other sparids. Penaid shrimp are reared in ponds. On one occasion, such shrimp were found in open habitat.

Several finfish species (*Seriola carpenteri, Pisodonophis semicinctus,* and *Chaunax suttkusi*) were found to have migrated from the Atlantic to the Mediterranean. Another new species is *Stephanolepis* cf. *dispros*. The marlin, *Makaira indica*, has been recorded again.

The status of several invertebrate species, their increase/decrease in certain areas and their spread to new locations is available in the report. *Rapana venosa* is now present in the Venice lagoon, but to date no negative impacts on cultured molluscs have been reported.

Italy has monitored phytoplankton composition since the nineteenth century. Hence, it can be demonstrated that the arrival of several species of *Alexandrium* is a recent occurrence.

A considerable number of non-indigenous algae are recognised and spreading in Italian waters, and are being studied. For instance, studies on two species of *Caulerpa* which could be in competition with native algae have been conducted. Introductions of non-native algae most commonly appear to occur near fish markets and sites of shellfish production.

Research on the introduced *Botrylloides violaceus* shows that it can outcompete the native species, *Botrylloides leachi*, because of its ability to withstand lower temperatures.

Two fish pathogens, *Photobacterium damsela* and a finfish Nodavirus, have been introduced with aquaculture products in the last decade. Both appear to be spreading.

12 STATUS OF INVASIONS (TOR G, CONTINUED)

12.1 Colonisation History, Status and Impacts of *Cercopagis pengoi* in the Baltic Sea and North American Great Lakes

Abstract submitted by H. Ojaveer

Cercopagis pengoi was first discovered in the Gulf of Riga and the Gulf of Finland in 1992 (first found along the southern coast of the Gulf of Finland in the port area of Muuga Bay; Ojaveer *et al*., 2000). By the mid-1990s, the species colonised large areas in the Gulf of Finland and Gulf of Riga becoming common species in local zooplankton communities (Avinsky, 1997; Krylov and Panov, 1998; Krylov *et al*., 1999; Uitto *et al*., 1999; Gorokhova *et al*., 2000; Ojaveer *et al*., 2000). In 1997, the species was reported from the Stockholm archipelago and the Baltic Proper (the Gotland Basin; Gorokhova *et al*., 2000). In the exceptionally warm year 1999, the species was spreading further north (Gulf of Bothnia) and south (Gulf of Gdansk; Uitto *et al*., 1999; Zmudzinski, 1999; Naumenko and Polunina, 2000; K.-E. Storberg, pers. comm.). New secondary introduction areas were reported in the Baltic Sea in 2000.

Cercopagis pengoi invaded Lake Ontario in 1998 (MacIsaac *et al*., 1999). Recent investigations show that the Baltic Sea was the likely source (Cristescu *et al*., 2001). In North America, *C. pengoi* invaded also Lake Michigan and at least six lakes in the Finger Lakes region of New York state during 1999, and one additional lake in the region during 2000 (MacIsaac, 2001).

By 1999, the species had colonised the whole Lake Ontario with higher population densities in the open part than in near-shore areas, where it constituted up to 74 % of the zooplankton biomass. As a comparison, in the Baltic Sea, this ratio was 25 % (Ojaveer *et al*., 1998). Higher maximal abundances were also observed in Lake Ontario than in the Baltic Sea (2500 and 1800 ind m^{-3}; Uitto *et al*., 1999; Ojaveer *et al*., 2001).

It has been shown very recently that the two morphologically distinct forms of *Cercopagis* in the Great Lakes are genetically identical and represent hatching egg and parthenogenetic generations of one species—*C. pengoi* (Makarewicz, submitted). Similar forms have also been found in the Baltic Sea (Simm and Ojaveer, 1999).

In the Gulf of Riga, concomitant to the invasion of *C. pengoi*, population abundance of the small-sized cladoceran, *Bosmina coregoni maritime*, dropped significantly. Although the long-term mean (1994–1998) share of *C. pengoi* in the diet of most abundant planktivorous fish (herring, smelt and sticklebacks) was below 10 %, the species constituted up to 100 % of the species in fish stomachs in some shallow coastal ecosystems during the warm season. Invasion of *C. pengoi* obviously complicates energy flow to higher trophic levels, but probably increases the overall stability of the Baltic ecosystem. As this euryhaline species originates from warmer climate conditions, the global warming should favour increase in population abundance of the species and facilitate, thus, further shifts in functioning of the Baltic Sea ecosystem (Ojaveer *et al*., 2000). Through clogging of fishing gear, *C. pengoi* has a direct negative impact on commercial fishermen (Panov *et al*., 1999; S. Olenin, pers. comm.).

In 1998, there were clear differences in zooplankton community composition of Lake Ontario between sites in the eastern basin at which *Cercopagis* was found and sites in the western basin where it was not found. The share of *Bosmina longirostris* was remarkably higher at sites where *C. pengoi* was not present and the dominant daphnid in the lake, *Daphnia retrocurva*, showed the opposite relationship with *Cercopagis* (Barbiero *et al*., 2000).

12.2 Update on the Red King Crab and the American Lobster in Norway

Abstract submitted by A. Jelmert

The red king crab, *Paralithodes camtchatica*, is reported to have spread further westward beyond the Varanger penninsula. Single specimens have been observed as far south as Tromsø, but these are likely secondary releases, rather than migrating specimens. There appears to be a tendency for the westernly distributed specimen to be in poorer physiological condition, with indications of starvation (J.Sundet, Norw. Fishery Univ. Tromsø) This may indicate that the migrating species has been forced to move due to intraspecific or interspecific competition, or that the interspecific competition for food resources is more severe in the western range of its distribution.

Some specimens have shown unusual colour characteristics, and it has been speculated that it is another species: the blue king crab, *Paralithodes platypus*. Material for genetic analysis is now being collected.

In 1999, two lobsters showing aberrant morphological characters from the native *Hommarus hommarus* were delivered to the aquarium of Drøbak. Both were shown by morphological and genetic analyses to be specimens of the American lobster (*Homarus americanus*).

A public awareness campaign directed through the fishermen's organisations, and a network between Norwegian aquariums for collecting suspected specimens, has been launched. During the year 2000, 24 specimens were collected, of which eight specimens were considered confirmed as *H. americanus*.

The reports of suspected *H. americanus* have been limited, but the ones found have occurred as clusters around larger cities with airports.

The laws and by-laws for preventing such introductions should in theory be effective against such introductions, but have evidently not been enforced. Additional genetic analyses for mapping of genetic make-up and a project on mating success will be undertaken in 2001. (Sources: G.v.d. Meeren, I.M.R., pers. comm, and Draft ICES report CM 2000/U: 20).

12.3 Problems with Live Imports of Seafood – the American Lobster, an Example

Abstract submitted by E. Sparrevik

There is an increasing worldwide interest in the sale and distribution of live marine fish, crustaceans, and molluscs for human consumption. This trading also increases the risks of accidental introductions of marine species into new habitats.

In Sweden the demand for live European lobsters (*Homarus gammarus*) is exceeding the supply so there is an interest in the import of live American lobsters (*Homarus americanus*). The yearly import of live American lobsters to Sweden is about 150–200 tonnes.

Laboratory studies have shown that males of the American lobster can reproduce with females of the European lobster. The hybrids have high survival and growth rates. The female hybrids can also reproduce. So there is a potential risk that the hybrids may outcompete the European lobster. There is also a risk that the American lobster can transfer parasites and diseases to the European lobster.

The imported American lobsters are sometimes, although illegal, kept in cages on the Swedish west coast. There are severe risks that the lobsters accidentally can escape from the cages. During autumn 2000, there were observations (Swedish west coast) of lobsters that did not resemble the European lobster. A DNA-identification is now being performed to decide if the caught specimens are hybrids or American lobsters.

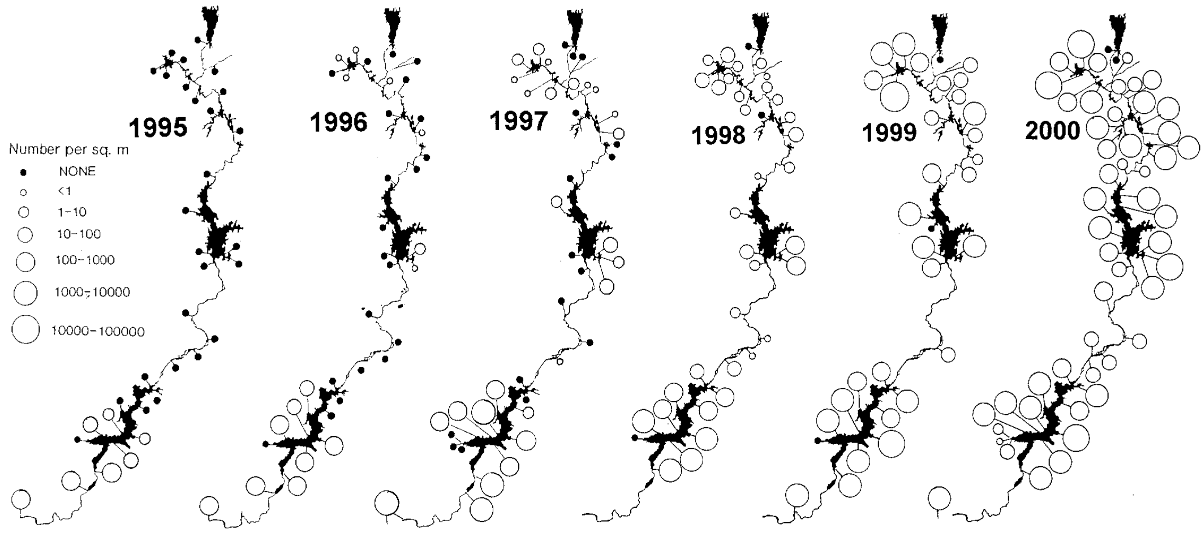
To reduce the spreading of the American lobster into European marine waters, it is important to give information to both consumers and producers about the risks of keeping lobsters alive. Stricter regulations of live imports of seafood could also be a way of reducing risks. A problem with stricter regulations is that they are often in conflict with the free trading of goods.

12.4 Zebra Mussels in Ireland during 1994–2000

Abstract submitted by D. Minchin

The zebra mussel arrived in Lough Derg on Ireland's largest river the Shannon during, or before, 1994, most probably on used boats from Britain or the Netherlands. The species, following its establishment, was almost certainly carried attached to the hull of boats moving up-river and via canals to other areas during 1996. It is presently established in the navigable waters of the Shannon, Boyle and Erne (in Northern Ireland) and attains its highest densities in lakes. As far as it is known, it has remained mainly confined to this region since 1997 when the first annual biological monitoring took place. Large increases of zebra mussel numbers were noted from 1998 on most navigable lakes; densities attained >120,000 individuals and 5 kg m^{-2} on rocks and stones (Figure 12.4.1). The species is present on the canal linking the Erne and Shannon navigations, mainly as large individuals. These probably dropped from boats in transit. However, it is now established in Lake Garadice on this waterway. In addition, a small population was found in Tullamore Harbour on the Grand Canal that links Dublin to the Shannon. Seasonal movements of fouled boats are known to carry zebra mussels through all linking canals, but populations on canals and rivers elsewhere are not known to have become established. Further transmission of the species by boats via the linked waterways is inevitable. The development of the Ulster Canal would almost certainly result in zebra mussels being spread to Lough Neagh. Overland transport of hull-infested boats to lakes, not presently colonised by zebra mussels, is a real risk and water sport enthusiasts have been kept aware of the need to be careful using information leaflets and media interviews.

Figure 12.4.1. Zebra Mussel densities on the Shannon-Boyle navigations (Ireland) from 1995 to 1997 (estimates) and 1998 to 2000 (based on data).



Zebra mussels have been found to be carried on broken *Phragmites* stems and *Cladophora* mats and on reed rafts following storms, some of these are carried downriver and become entangled in river banks. They also attach to submerged plants, reed beds and freshwater clams (*Anodonta* spp.). Clam populations have seriously declined and may be extinct within some infested lakes. The occurrence of zebra mussels in shallow areas where bathing occurs has resulted in an increase in foot lacerations with possible consequences of infection from a number of freshwater organisms that may include *Leptospira* that causes Weil's disease. Some water clearances in lakes have been attributed to the filtering ability of zebra mussels. There are few accounts of economic impacts on industry although some private water abstractors have had difficulties. Larger numbers of leisure craft are now removed from the water each winter for cleaning of hulls and for antifouling applications to reduce levels of hull fouling.

12.5 Exotic Cirripedia Balanomorpha from Buoys off the Belgian Coast

F. Kerckhof and A. Cattrijsse

Between November 1997 and November 1999, 52 buoys from the Belgian coastal waters were inspected for sessile fouling macrofauna. The position of the buoys varied between 0 km and 25 km offshore. The period these buoys had been out at sea varied between 4 and 24 months. Upon "landing" of each of these buoys, the sessile macrofauna was examined for the presence of non-indigenous cirriped species (Thoracica, Balanomorpha).

A total of eleven species was found, nine of which are exotic for the region. Six of these, *Balanus reticulatus*, *B. variegatus*, *B. trigonus*, *B. perforatus*, *Megabalanus coccopoma* and *M. tintinnabulum*, are new for the Belgian fauna. With the exception of *B. perforatus* and *M. tintinnabulum*, these are also new autochthonous records for the Southern Bight of the North Sea.

Other exotics include the species *B. improvisus*, *B. amphitrite* and *Elminius modestus* which were introduced earlier and now form an integral part of the regional fauna. *B. amphitrite* used to occur only in artificially warmed waters and in harbours. Our records show that this species is currently capable of surviving in open coastal waters.

The observation of gravid and two-year old individuals of *B. variegatus* and *M. coccopoma* indicate that at least these two new exotic species might establish self-sustaining populations in the area. Except for *B. perforatus*, which is probably a southern vagrant, all these cirripeds were most likely introduced with ballast water or originated from larvae released from the fouling community on ships. Recent climate changes and the beneficial habitat of the buoys favour the introduction of exotic cirripeds (see Annex 5 for more details).

13 RISK TO AQUACULTURE VENTURES BY SPECIES INVASIONS

13.1 Risk to Aquaculture Ventures – 1. Exotic Species

Abstract submitted by D. Minchin

Exotic species have been used to great benefit in aquaculture and have contributed to the economies of many countries. However, pests, parasites and diseases are moved by a wide range of vectors. These organisms may compromise aquaculture production and/or fisheries as well as the environment.

With the expansion of free trade there is increased worldwide movement of living organisms destined, for example, for direct consumption or used as aquarium species. Some of these consignments may become released to the wild. Perhaps the most important method is the unintended dispersal by shipping, either in ballast water or as hull fouling.

Rates of transmission have increased and some species carried will have serious implications in the forthcoming decades unless these issues are urgently tackled on an international basis. Failing to pursue such matters will inevitably result in serious economic and social consequences. Providing good advice on how to manage these species, once introduced, will inevitably result in considerable savings. Insurance organisations are strongly advised to take account of the appropriate scientific advice as this becomes available, in regard to the introduction of new species for culture. For example, introductions of new species for culture should not be covered for insurance unless clients conform to the advice provided by the ICES Code of Practice on the Introduction and Transfers of Marine Organisms.

13.2 Risk to Aquaculture Ventures – 2. Jellyfish

Abstract submitted by D. Minchin

Jellyfish is a collective term for a wide range of gelatinous zooplankton. All of these have stinging cells that vary in size and shape; those with longer stinging cells may penetrate further. These stings contain toxins that can vary greatly in their potency and may cause damage to outer fish surfaces. However, should tentacle fragments enter the fish's mouth cavity, serious damage to the gills can ensue. This can result in copious mucus production and suffocation. Most jellyfish are seasonal and may appear at any one locality either briefly or over long periods of time.

Several jellyfish species may be difficult to observe either because of their small size or because they are transparent and may remain unseen unless a special effort is made to search for them. Phantom fish kills may be attributable to jellyfish-induced mortalities. Some of these events can take place with sudden changes in water clarity, as has happened in northern Europe in recent years.

Future developments in fish farming will need to take account of jellyfish "blooms", particularly with the planned development of farm sites further offshore. Shellfish farming may also incur production problems with stings from some stages of jellyfish species. The impact of jellyfish on culture activities is generally poorly recognised and more research into this area is needed.

14 INTERNATIONAL LAWS AND REGULATIONS

14.1 Exotic species, Water Quality and the EU Framework Directive

Abstract submitted by D. Minchin

In the EU Water Framework Directive there is no reference to exotic species, yet invasive exotics have the ability to modify water quality to varying degrees. The Framework Directive principally addresses the anthropogenic effects on the environment from catchment sources to coastal waters and, where undesirable impacts on water quality are identified, requires that measures be introduced to rectify the situation.

In Ireland, the zebra mussel has implications for biodiversity, health, and water abstraction, including municipal water quality. As the species cannot be eliminated, measures to protect those areas beyond its current distribution rely on public cooperation. In estuarine and coastal ports, management of vectors in the transmission of exotic species requires urgent international cooperative research to identify measures to control further introductions principally via ballast water and hull fouling.

The recommendations presented by the International Maritime Organization are not adequate to manage ballast water and at best can only reduce the risk of primary inoculations. Secondary spread has little consideration. Regulatory action may inadvertently further the inoculation potential of exotic species in ports.

Following regulations on water discharges and the planned banning of TBT antifoulant coatings by 2008, port areas will become less toxic and perhaps more suitable for invasion. Methods of reducing exotic species establishment should take into account local port management because alteration of ship ballasting procedures may reduce the risk of transmission, including the risk of transport to other port regions. This assumes the more responsible approach of reducing the risk of transmission to other port regions.

To undertake a port profile would require the cooperation of relevant user groups including oceanographers and exotic species experts as well as a monitoring programme.

Exotic species will continue to be imported to Ireland by not only shipping but also, for example, by aquaculture, live food trade, the aquarium industry, and leisure activities. Future research should examine modes of introduction. By identifying high-risk vectors and knowing the unwanted species likely to be imported, practical advice to management can be provided to reduce the risk of their establishment. Unfortunately, several harmful aquatic species occur in northern Europe; and many of these have the potential to spread and either directly, or indirectly, modify water quality.

14.2 Reducing the Risk of Exotic Species Establishment and Transmissions in Port Regions

Abstract submitted by D. Minchin

The International Maritime Organization Guidelines provide a means for reducing the risk of importing unwanted species from becoming established. Unfortunately, these guidelines do not provide many measures for reducing the risk of secondary types of spread. The undertaking of surveys in ports to identify the main oceanographic features, and the distribution and abundance of exotic species may provide a basis for reducing risk. By small alterations to ship ballasting and de-ballasting behaviour, or altering berthing sites, especially during periods when exotic species larval stages are abundant in the plankton, a significant reduction of risk may be possible. Such precautionary measures will also need inputs from state managers, industrialists, ships' masters and port authorities.

Surveys in port regions will identify species that may have a high risk of transmission and known harmful impacts. By adopting a precautionary approach as a port-donor of exotic species, rates of transmission worldwide could be reduced.

Additional measures of managing the non-shipping vectors in port regions may be important. Reducing vector overlap may assist in reducing secondary type spread. These vectors could include aquaculture, marinas, and holding ponds for maintaining living products.

15 UPDATES AND REPORTS ON BALLAST WATER STUDIES

Details on currently undertaken and recently completed shipping studies in ICES Member Countries can be found in the 2001 report of the ICES/IOC/IMO Study Group on Ballast Water and Other Ship Vectors [SGBOSV].

16 RECOMMENDATIONS TO ICES COUNCIL

The recommendations to the ICES Council are listed in Annex 11 of this report.

17 ADJOURNMENT OF THE MEETING

A final review of the 2001 terms of references was made shortly before adjournment of the meeting on 23 March at 13.30 hrs. Final draft recommendations were discussed, revised and approved by the WGITMO participants followed by a discussion on the venue and dates of the next meeting (Sweden, 20–22 March 2002).

Dr S. Gollasch, as Chair, thanked all WGITMO members, guests and observers for their dedicated work and further thanked the Laboratori Botanica of the Facultat de Farmacia at the Universitat de Barcelona for hosting the 2001 meeting, especially the host M. Ribera, Luca Lavelli and all other helping hands that worked very hard during the meeting and spent many hours of preparational work. He also extended his most sincere gratitude and thanks to the rapporteur Dorothee Kieser (Canada), who did a magnificent job of keeping the meeting and Chair organised, with the especially challenging task of tracking endless pieces and parts of the agenda and collecting contributions to the meeting report.

ANNEX 1: AGENDA

Working Group on Introductions and Transfers of Marine Organisms (WGITMO)

21 MARCH 2001 WEDNESDAY

9:00 Opening Session

Welcome Remarks (Antonio Diaz, Vice President of the Facultat de Farmacia, Universitat de Barcelona)
Introductory Remarks (S. Gollasch)
Appointment of Rapporteur
Logistical Announcements
Introduction of Participants and Guests
Review of Agenda and changes, corrections, additions
WGITMO Report Deadline
Relevant comment from ICES
Note from Jim Carlton
Review of the Recommendations from previous meeting: 2000, Parnu, Estonia
Terms of Reference (TOR) for the 2001 Barcelona meeting

10:00 New Publications, Journals, Websites, Data Bases (TOR c)
Database of invaders in the Baltic Sea, Baltic Marine Biologists (BMB)
Book project Erkki Leppäkoski, Sergej Olenin, Stephan Gollasch (eds.)
Other News

10:30 Coffee Break

11:00 Multinational invasion/introduction/transfer initiatives and programs
2nd National Conference on Marine Bioinvasions (April 2001, New Orleans, USA)
Update on Baltic NEMO Activities
EU Impact Cluster (S. Gollasch)
Outcome of the EU Concerted Action: Introductions with Ships (S. Gollasch)
Exotic species and the EU Framework Directive on Water Quality (D. Minchin)
Summary on Montpellier meeting (D. Minchin)
Other News

11:30 Summary of Theme Session at 2000 ICES Annual Science Conference:
"Marine Bioinvasions: Retrospectives for the 20th Century,
Prospectives for the 21st Century"
88th Statutory Meeting, ASC, Belgium (Bruges) (speaker D. Minchin)

11:40 *Paralithodes camtschatica* in Norway

12:00 I. Wallentinus: New Swedish research initiative on introduced species, funded by the Swedish EPA

12:10 Erik Sparrevik: Problems with live imports of seafood - the American lobster as example

12:40 Zebra mussel (*Dreissena polymorpha*) in Ireland: Current distribution and impacts (D. Minchin)

13:00 Group Photo

13:15 – 15:15 Lunch

15:15 Round table discussion TORs a) and d)

16:45 Coffee Break

17:15 Round table discussion TORs a) and d), continued
Review of Tomorrow's Agenda

18:30 Adjourn day one

22 MARCH 2001 THURSDAY

9:00 Review of Previous Day
Today's Agenda
Announcements

9:10 National Reports and national report equivalent presentations (*)
Belgium*
Canada
Estonia
Finland
France
Germany
Ireland*
Italy
Netherlands
Norway
Spain*
Sweden
Scotland
UK England and Wales
USA*

11:00 Coffee Break

11:30 National Reports, continued

13:00 – 14:30 Lunch

14:30 National Reports, continued & Round table discussion TOR g)

16:00 National Reports, continued & Round table discussion TOR b)
Preparation of table relevant to TOR b) to be included in the meeting report

16:30 Coffee Break

17:00 Draft Recommendations

17:30 Adjourn for the day

23 MARCH 2001 FRIDAY

9:00 Review of Previous Day
Today's Agenda
Announcements

9:30 Round table discussion TORs e) and f)

10:45 Coffee Break

11:15 Round table discussion TORs e) and f), continued

12:15 Review of Recommendations: Discussion and Final Editing
Principal Agenda Items for 2002 WGITMO Meeting
Place & Dates for 2002 Meeting

13:30 Adjournment of Meeting

ANNEX 2: LIST OF PARTICIPANTS

WGITMO

21–23 MARCH 2001

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ANNEX 3: NATIONAL REPORTS

NATIONAL REPORT FOR BELGIUM

1 LAWS AND REGULATIONS

The Belgian law of 20 January 1999 on the protection of the marine environment in the marine areas under Belgian jurisdiction (MMM wet) published in the Belgian Official Journal (BOJ) on 12 March 1999, forbids the intentional introduction of non-indigenous species in the marine environment (art. 11 § 1). This is a provision mirroring those included in international instruments such as the Biodiversity Convention.

The unintentional introduction of non-indigenous species via ballast water of ships can be penalised by royal decree (art. 11 § 2). Due to the specific and international character of the issue of non-indigenous species in ballast water of ships, however the new Belgian framework law did not specifically touch this issue, and this activity is to be regulated by an implementation decree.

For the protection of the marine biota, measures can be taken (by royal decree and after scientific consultation) for the extermination of non-indigenous nuisance species (art. 11 § 3). The new law also prohibits the intentional introduction of genetically modified organisms into marine areas (art. 11 § 4).

In the Flemish region, the introduction of non-indigenous species is prohibited, except with a licence, by the decree of 21 April 1993 of the Flemish Executive (published in the BOJ on 31 June 1993). The Flemish Regional Government is preparing a further regulation.

2 DELIBERATE INTRODUCTIONS AND TRANSFERS

2.1 Finfish

Reintroduction project of Atlantic salmon (*Salmo salar*) in the river Meuse: Salmon 2000 (Philippart, Ulg); restocking of turbot (*Scopthalmus rhombus),* offspring from fish from the French Atlantic coast, and sole (*Solea solea).* Apparently no other planned deliberate introductions.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Spreading and establishment of several new species in recent years. Several introductions are now very abundant.

Haliplanella lineata: Spuikom in Oostende 1998, first record for Belgium.

Nemopsis bachei: 1996 – 1997 abundant in the harbour of Zeebrugge (Dumoulin, 1997) still present, also recorded some years earlier from the Netherlands.

Ficopomatus enigmaticus: first recorded in 1952, this species is now again regularly recorded.

Crassostrea gigas: although present earlier, this species became very abundant after 1995; it has been spawning regularly since that time, and settling occurs by the end of September. The species now forms dense populations in the harbours of Zeebrugge, Oostende, Nieuwpoort and Blankenberge. It is present on the groins, living between the mussels, and on offshore buoys. It has been introduced frequently by oyster farmers in earlier years from Japan and Canada but also from France, Portugal, the Mediterranean, etc., in the Spuikom at Oostende. However until the 1990s this species was never able to establish self-sustaining populations.

Crepidula fornicata: present almost everywhere and very abundant, offshore as well as in littoral areas, in fully marine conditions as well as in brackish conditions, on groins, as fouling on buoys, ships, harbour installations, also benthic. A recent increase in the abundance has been observed along the Belgian coast.

Corbula gibba: introduced after 1983 in the harbour of Zeebrugge. First records from Belgium in 1998 (Kerckhof, 1998). Also recorded recently in 1996 from the harbour of Dunkerque (Pruvot *et al.* 2000).

Ensis directus: first record from Belgium in 1987 (settled 1986). Now the most common bivalve on Belgian beaches; also recently recorded from the Spuikom in Oostende.

Petricola pholadiformis: still common, but *Barnea candida* seems now to be the more abundant species. *B. candida* is also the more common species in Northern France, e.g., Boulonnais.

Mytilopsis leucophaeata (=*Congeria cochleata*): present in the harbour of Antwerp, causing nuisance by the obstruction of water intake pipes of some chemical plants.

Barnacles: several new species (Kerckhof and Cattrijsse, in print), e.g., *Balanus amphitrite*: established on places that are not artificially warmed, e.g., the harbours of Oostende and Nieuwpoort and on buoys off the Belgian coast. Several records on buoys off the Belgian coast from *Megabalanus coccopoma* and *M. tintinnabulum*, the former probably established in the southern North Sea. Also records on the buoys from *Balanus reticulatus* and *B. variegatus*. *Elminius modestus* is now by far the most common barnacle of the Belgian coast.

Caprella mutica: (= *C. macho* = *C. acanthogaster*): first record in 1998. Present on several buoys marking the entrance to the harbour of Zeebrugge. Also recorded from the Marina of Zeebrugge, but not yet from other places.

Hemimysis anomala: first record in Belgium in 1999 (Verslycke *et al.* 2000).

Several first records of some *Bugula* (Bryozoa) species, e.g., *Bugula stolonifera* (established), Oostende, whole harbour; *Bugula simplex*, new record in 2000, Oostende, Mercator Marina, extending its range?; also in the Netherlands; *Bugula neritina* recorded once in 1999, Oostende, Mercator Marina (Kerckhof 2000; Kerckhof 2001; De Blauwe & Faasse in prep.).

Tricellaria inopinata: range extension. First observations in Belgium in 2000 (Blankenberge, Marina and Oostende, Mercator Marina); also recorded from France and the Netherlands in 2000 (De Blauwe & Faasse in prep.).

Callinectes sapidus: since 1995, after a period of approximately 10 years of no records, each year several catches along the coast of northern France and Belgium (North Sea and also the Scheldt estuary), mature animals, even females carrying eggs. Possibly a population in the Scheldt (Antwerpen?).

Eriocheir sinensis: after a marked decline until the early 1990s, this species is again regularly recorded along the coast, in inland waters and the Scheldt.

Rhithropanopeus harrisii: established in the Scheldt estuary (J. Maes pers. comm.).

Hemigrapsus sp.: not yet recorded, although sought after.

3.3 Algae

Continuous spreading and establishment of some macroalgae.

Undaria pinnatifida: recent range extension. Recorded from Calais (Northern France) in 1998, (it was not present there in 1997) and now very common (Leliaert *et al.*, 2000); first record for Belgium in 2000 (Marina Zeebrugge) (Dumoulin & De Blauwe, 1999; De Blauwe, 2000), small population, still present in 2001. Not yet recorded elsewhere from the Belgian coast. Recorded from the Netherlands in 1999 (Stegenga, 1999).

Sargassum muticum: recent establishment in Belgium. Known washed ashore on Belgian beaches since 1977. First time *in situ* records for the Belgian coast, from the harbour of Zeebrugge in 1999 (De Blauwe, 2000), not recorded there anymore after that date. Also present in the Spuikom in Oostende since 1999, probably already present there in 1998. Relation with oyster imports?

Codium fragile subspecies *tomentosoides*: known washed ashore becoming more abundant the last years. *In situ*, forming dense populations during 1998–2000 in the Spuikom, Oostende. Some earlier records. Relation with oyster imports (Canada). Apparently not present any more in 2001 probably due to competition with *Sargassum*, growing on the same places.

Antithamnionella spirographidis: first accidental record in 1992, epiphytic on *Polysiphonia fucoide*s on a groin in Oostende, not established then; established in the harbour of Zeebrugge (after 1983) and the Mercator Marina, Oostende; also present in northern France, e.g., the Marina at Calais.

4 LIVE IMPORTS AND TRANSFERS

In Belgium, there is a lot of (uncontrolled) import and export of a wide variety of marine and fresh water species, for research, human consumption, aquaculture and aquariums.

Since 1996 an oyster farmer restarted farming and importing oysters in the Spuikom at Oostende. Japanese oysters *Crassostrea gigas,* were imported from Canada (British Columbia), and France; Hard-shell clams, *Mercenaria mercenaria,* from France(?); Manila clam, *Tapes phillipinarum,* from France(?); *Ostrea edulis* (UK, Canada). Apart from oysters and other well-known commercial species, he imported also several other species virtually without any control, e.g., *Spisula polynyma* and *Cyrtodaria siliqua* from Canada.

At the nuclear power plant of Tihange, there is some aquaculture of warmwater fish: rainbow trout from California; African Catfish, Tilapia.

A trader in Zeebrugge imports *Homarus americanus* from Canada. The species is also imported by the oyster farmer operating around the Spuikom at Oostende.

Prof. Dr Volckaert (KUL) is worried about the impact (gene-pool interactions) on existing populations of imports of the same species from elsewhere (e.g., for restocking).

7 MEETINGS, PROJECTS

A shipping study entitled "Study of the Potential Role of Transportation of Ships Ballast Water on the Geographical Extension of Blooms of Toxic Algae" was carried out at the Université Libre de Bruxelles. The main results of the study were that risks do exist concerning the introduction of non-indigenous toxin-producing phytoplankton species into European waters with ballast water or sediment discharges. It is recommended to implement ballast water management guidelines at an international level (Vanden Boeck 1995, G. Houvenaghel, Université Libre de Bruxelles, LOBA CP 160/19, Avenue F.D., Roosevelt 50, B-1050 Brussels, Belgium pers. comm.).

8 BIBLIOGRAPHY

See Annex 10.

Submitted by: Francis Kerckhof

NATIONAL REPORT FOR CANADA

1 LAWS AND REGULATIONS

Canada is nearing completion on its National Code on Introductions and Transfers. The purpose of the code is to establish scientific criteria for the intentional introduction of live aquatic organisms while minimising the risks inherent in such transfers (i.e. undesirable ecological changes to native ecosystems, undesirable genetic alterations in native stocks, transfer of disease agents). The Code will apply to transfers of aquatic organisms into fish habitat and fish rearing facilities, but not to live food fish, baitfish or aquarium fish or plants. The enabling legislation is Section 55 & 56 of the *Fishery (General) Regulations* which applies in most provinces of Canada in both marine and fresh waters. We expect the Code to be sent to the Canadian Council of Fisheries and Aquaculture Ministers for signature in early 2001. There will then be an 18-month implementation period at the end of which there will be a review and recommendations for changes, if required.

In addition, Canada is proposing a new National Aquatic Animal Health Program for which a consultation document has been prepared.

Genetically Modified Organisms, including aquatic species, are currently regulated under the Canadian Environmental Protection Act. New regulation is being drafted under the Fisheries Act to regulate activities in relation to aquatic organisms that are a product of biotechnology. This will include conditions of their release, notification and assessment requirements.

2 DELIBERATE INTRODUCTIONS AND TRANSFERS

2.1 Finfish

Eggs and fish of established cultured species (primarily salmonids) continue to be imported into the country and transferred into and within a province in support of aquaculture (not intended for release into the natural environment) and enhancement programmes (intended for release into the natural environment).

Pacific Region

In 2000, 2.5 million Atlantic salmon eggs were imported into a British Columbia (BC) quarantine unit from a health-certified farm in Washington State. In addition, under the Canada-US Trans-boundary agreement, 11 million fry were returned to Northern rivers in Canada after initial incubation in an isolation unit at an Alaskan Hatchery. BC also obtained its first shipment of Tilapia fingerlings for culture from a health-certified source in Idaho.

Atlantic Region

Regional Introductions and Transfers Committees are developing protocols for reviewing the genetic, ecological and fish health implications for the introduction of new species of interest to aquaculture (e.g., Atlantic cod, *Gadus morhua*; witch flounder, *Glyptocephalus cynoglossus*; winter flounder, *Pleuronectes americanus*; summer flounder, *Paralichthys dentatus;* yellowtail flounder, *Limanda ferruginea*; haddock, *Melanogrammus aeglefinus;* Atlantic halibut, *Hippoglossus hippoglossus;* striped bass, *Morone saxatilis*).

2.2 Invertebrates

Pacific Region

As before, the BC shellfish industry depends on imports of seed for the main culture species: *Tapes philippinarum*, *Crassostrea gigas*, and more recently, *C. sikamea*. All imports must be from health-certified facilities.

Atlantic Region

In Atlantic Canada, American oysters (*Crassostrea virginica*), European oysters (*Ostrea edulis*), blue mussels (*Mytilus edulis*), soft-shell clams (*Mya arenaria*), hard-shell clams (*Mercenaria mercenaria* and the selected variety *M. m. notata*), bar clams (*Spisula solidissima*), ocean quahaug (*Polynema mactromeris*), giant sea scallops (*Placopecten magellanicus*), and bay scallops (*Argopecten irradians*) were transferred as seedstock, broodstock or for relay purposes throughout the region in 2000. As in previous years, all official movements of shellfish destined for hatchery-use or for remote setting are screened for parasites, pests and diseases, prior to transfer. Exceptions are exemptions under Nova Scotia's General Transfer Licence for intra-provincial movements if they fall within like-to-like molluscan health zones.

The hard-shell clams (*Mercenaria mercenaria* var. *notata*) introduced via quarantine from Rhode Island to Prince Edward Island (PEI) have now been established via seedstock throughout New Brunswick (NB), Nova Scotia (NS) and PEI. No post-quarantine health problems have been detected.

In 2000 Department of Fisheries and Oceans researchers at the Bedford Institute of Oceanography in Nova Scotia imported blue mussels (*Mytilus edulis*) from British Columbia and Poland and Japanese scallops (*Patinopecten yessoensis*) from British Columbia, for genetic research purposes. These animals are being held in strict quarantine.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Invertebrates

Pacific Region

Green crabs (*Carcinus maenas*) which were listed in the 1999 report have extended their range northward along the west coast of Vancouver Island. A total of 7 animals have been confirmed to date.

Zebra mussels (*Dreissena polymorpha*) were found on a boat entering BC from the USA. Please see attached report.

Varnish clams (*Nuttallia obsurata*) have recently become established in BC, both on the west and east coast of Vancouver Island. They are thought to be dispersing both south and north. Because of the density of clams in some areas, a commercial and recreational fishery is being considered.

Juvenile Atlantic salmon were first discovered in BC in 1996; since then a total of 359 juveniles have been observed or captured in ten different river or lake systems. The majority of the discoveries are assumed to be escapees from hatcheries and lake-pen rearing sites. That changed in 1998 when twelve juvenile Atlantic salmon were recovered from the Tsitika River on the northeast coast of Vancouver Island. These fish were subjected to otolith microstructure analysis using a double-blind test structure and were found to be of wild origin. These are the only fish to be tested in this fashion. Subsequent surveys in 1999, by BC Ministry of Environment, Lands, and Parks (MELP), discovered populations of juvenile Atlantic salmon that are believed to be feral in the Adam River and Amor de Cosmos Cr. In 2000 MELP, Fisheries and Oceans Canada and BC Ministry of Fisheries conducted the most extensive survey for Atlantic salmon to date in BC. During the course of the survey, eight juvenile Atlantic salmon were observed in the Amor de Cosmos Creek and three in the Tsitika River.

Atlantic Region

As mentioned in past reports, the spread of the green crab (*Carcinus maenas*) has become a major concern in Atlantic Canada and in Prince Edward Island (PEI). It is now viewed as a ‘major problem’. Eel net fishers on PEI are reporting that the species is dominant in their eel traps to the exclusion of the target eel species. The PEI Department of Fisheries and Tourism reports that their 2000 survey indicates that the species has extended its range along the southeast shore of the Island. There was also a confirmed report of green crabs in Malpeque Bay – a major oyster producing area. The Malpeque Bay report seems to indicate a significant “jump” in the range rather than a natural extension along PEI’s northern shores and it is speculated that the crabs were inadvertently moved to the bay with oyster seed.

The clubbed tunicate (*Styela clava*), which was first identified on a market mussel crop from the Brudenell River (eastern end), PEI, in January 1998 has also become a “major problem”. In areas where it was only noted in the past (the eastern portion of the Island) the population has exploded and there is evidence that the tunicate has extended its range along the northern shore of PEI to as far as Tracadie Bay. Mussel farmers on PEI are reporting that the tunicate is covering their mussel lines to a point where it is competing with the mussels for food causing reduced mussel growth; it is actually smothering some mussels, fouling the surrounding area with added faecal material leading to localised anaerobic conditions, and increasing labour and other harvesting costs. There are unconfirmed reports that as much as 1/3 of the weight of some mussel harvests are *Styela clava*.

Shipments of oyster spat (2–3 cm in length) to the Magdalen Islands in the Gulf of St. Lawrence were found to contain crabs, identified as *Dyspanopeus sayi* (Smith), belonging to the Xanthidae. The crab is not native to this area. It prefers warmer waters and was previously known only from the warm inshore waters of Prince Edward Island and Chaleur’s Bay. Its larval phase is short and requires very warm water, so under the current and past climatic conditions the species probably could not have bridged the distance (waters are rather cool and prevailing currents are transverse) that separates the Magdalen Islands from PEI. However, the lagoons of the Magdalen Islands where oyster is cultured offer a very warm and hospitable summer climate and there is little doubt that the crab will now begin to thrive.

3.2 Algae and higher plants

Pacific Region

Cochlodinium polykrikoides, a toxic microalga, was the single biggest killer of farmed salmon in BC last year. It is thought to have been introduced to the West coast by ships. However, because of our limited understanding of native micro-flora, we cannot substantiate this. (See attached report)

Central and Arctic Region

Regional personnel became aware of the introduction and establishment of a non-native aquatic plant, fanwort (*Cabomba caroliniana*) in Lake Kasshabog (44° 38' 00" N - 77° 58' 00" W), Ontario. Fanwort is a common aquarium plant and was probably introduced to Kasshabog Lake by someone carelessly dumping their aquarium. The infestation of fanwort has been described as being extremely dense, with plants occurring as deep as 6.5 m. It appears as if fanwort is crowding out native plant species in the location in which it has been observed. A multi-agency working group has been convened to examine the situation, to determine possible remedial actions, and to develop a public awareness strategy. There have been instances of other non-native aquarium species having been introduced and spread in this manner. Floating heart (*Nymphoides peltatum*), a water garden plant, has escaped and been found in Loughborough Lake (44° 27' 00" N - 76° 25' 00" W), and Cootes Paradise (43° 17' 00" N - 79° 56' 00" W) near Burlington. Discoveries of European frog-bit (*Hydrocharis morsus-ranae*), another water garden plant, in lakes throughout eastern Ontario and Chandos Lake (44° 49' 00" N - 78° 00' 00" W) in the Peterborough area have also been recently made.

Atlantic Region

The spread of the seaweed *Codium fragile tomentosoides* in Atlantic Canadian waters has been mentioned in our reports since the 1996 meeting. The PEI Department of Fisheries and Tourism continues to monitor the *C. fragile* populations around PEI with the great fear being that it will soon spread into the Island's major oyster producing bays. The seaweed is already causing major problems in some areas with reports in 2000 of significant numbers of oysters being washed ashore from public beds and private leases due to the buoyant effect of the seaweed. Mussel farmers are also reporting that *Codium* – while not yet seen as a specific problem to the mussels themselves — is becoming a significant fouling problem on their lines. Some mussel farmers are reporting that when they handle their *Codium*-covered lines, they get a strong reaction on their skin – and particularly their eyes, if anything splashes into them. They have asked if other jurisdictions are reporting a similar problem with *Codium*. Could *Codium,* or possibly some epiphyte on it, be the cause?

4 LIVE IMPORTS AND TRANSFERS

Pacific Region

Seafood outlets in the Pacific Region import a large variety of live finfish and invertebrates. There are annual reports in the news media of exotic species being found in waters near Vancouver, BC (e.g., Atlantic lobsters). One of the potential avenues of release of such species is through religious ceremonies for which live seafood is purchased for release.

Other exotics found with increasing frequency are from the aquarium trade. There have been reports from Fisheries Officers of Koi (ornamental) carp being found in a number of streams on Vancouver Island.

Central and Arctic Region

The live food-fish industry in Ontario is rapidly expanding, particularly in the Greater Toronto Area. Over 700,000 kg of live freshwater food fish and over 1,000,000 kg of live invertebrates and marine fish species are imported into the area annually. Both the Ontario Ministry of Natural Resources and the Department of Fisheries and Oceans have expressed concern over this pathway/vector. The primary risk associated with the live food-fish industry is the potential for non-indigenous freshwater fish to be introduced to the local ecosystems which could result in significant environmental, social or economic impacts. There are also risks that "grey water" used to transport live fish will contain non-target aquatic organisms that could be introduced or pathogens/parasites that could be transferred to indigenous aquatic species.

Atlantic Region

No update available.

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES

Pacific Region

A variety of species of finfish and invertebrates are collected annually and shipped to aquariums in other countries. During 2000, BC exported 25 different local, marine invertebrates to aquariums in the Netherlands, France, England, Norway, Portugal, and Kuwait. Finfish, primarily rockfish species, were exported to the Netherlands, France, and Portugal.

A farm in the Yukon Territory exported Arctic charr (*Salvelinus alpinus*) eggs to USA, Austria, China, and Japan (and Scotland?).

Central and Arctic Region

A farm in Alberta which obtains glass eels from Nova Scotia for grow-out, exported *Anguilla rostrata* to the Netherlands.

Atlantic Region

An aquaculturist in Quebec exported rainbow trout (*Oncorhynchus mykiss*) fingerlings, brook trout (*Salvelinus fontinalis*) eggs, Arctic charr (*Salvelinus alpinus*) eggs, and Arctic charr X brook trout hybrid eggs to the USA (New Hampshire, Massachusetts, and West Virginia). One Prince Edward Island aquaculture operation sent Arctic charr fingerlings to the USA (Virginia). As well, a Quebec aquaculturist sent Arctic charr eggs and Arctic charr X brook trout hybrid eggs to France and to Germany.

6 PLANNED INTRODUCTIONS AND TRANSFERS

6.1 Finfish

Pacific Region

We expect the pattern of importations to remain similar to previous years.

Atlantic Region

We expect the pattern of importations to remain similar to previous years.

6.2 Invertebrates

Pacific Region

We expect the pattern of importations to remain similar to previous years.

Atlantic Region

As reported last year, abalone (*Haliotis rufescens* and *H. discus hannai*) have been approved for introduction, for research purposes into quarantine facilities, from Iceland. No imports have taken place yet.

7 MEETINGS, CONFERENCES, SYMPOSIA, AND WORKSHOPS

10th Annual Aquatic Nuisance Species – Zebra Mussel Conference – Toronto ON, 13-17 February, 2000 – co-hosted by DFO.

Aquaculture Association of Canada - Finfish and Shellfish Health Sessions (including I&T risk analysis issues) - Moncton, NB May 2000.

National Aquatic Animal Health Program - Regional Meetings on Disease and Surveillance to establish zones that are equivalent/exceed OIE guidelines - Moncton, August 2000.

8 RECENT PUBLICATIONS

See Annex 10.

9 CANADIAN DATABASES ON EXOTIC SPECIES

While there are likely a number of Regional databases from Introductions and Transfers Committees, and collections held by individual researchers, there appears to be no centralised database on exotic species, especially on unintentional introductions.

The Department of Fisheries and Oceans under its proposed Code on Introductions and Transfers will collect information from each of the Regional and/or Provincial I &T Committees on intentional introductions. This information will be put into a national database. Under the Code, there will also be a registry of risk assessments for intentional introductions.

Prepared by: M. Campbell and D. Kieser, March 2001

Note on zebra mussels discovered in British Columbia, September, 2000

Prepared by P.G. Lim, HEB DFO, Vancouver.

In September 2000, Fisheries and Oceans Canada (DFO) in Vancouver, British Columbia, Canada was notified that a pleasure boat being shipped to Richmond, BC had been observed with zebra mussels on the trim tabs. Four zebra mussels had been found by US authorities during a routine stop at a way station near Spokane, Washington. The 43-foot boat was being shipped from Michigan to a ship broker in Richmond crossing the international border at Blaine, BC.

The Washington officials contacted a DFO Fisheries Officer in Langley, BC which is near the international border to alert Canadian authorities of the potential importation of zebra mussels. It was not known at this time if the boat still had mussels on its hull, but it was suggested that the boat's cooling system would probably have some individuals remaining in it.

DFO's Habitat and Enhancement Branch and Science Branch found out the exact delivery location of the boat, a marina in Richmond on the Fraser River. It was quickly decided that all steps must be taken to prevent launching of the boat into the Fraser and risking introduction of zebra mussels to the region. DFO staff met the shipper and proceeded to carefully inspect the hull. Almost 200 juvenile zebra mussels were collected from the trim tabs. Many were alive. The larger ones were preserved and the smaller ones kept loose in containers.

The individual responsible for importing the boat was very cooperative and understood the potential problems with launching the boat. DFO staff requested examination of the boat's cooling system and consulted with marine engineers about the procedure for doing this. As this would be an expensive operation without promise of revealing much information, it was decided to flush the cooling system to kill any remaining zebra mussels.

A Canadian Coast Guard LANDA steam pressure washer was brought to the marina. This is the equipment used to clean the beaches in Alaska after the "EXXON VALDEZ" oil spill. A constant flow of 180 degrees F water was used to flush the boat's cooling system. The treatment started with filling the system with the hot water and leaving it there. After sitting for forty minutes the water was flushed out. An attempt was made to collect the water, but the temperature made it difficult to handle. Approximately 700 gallons of fresh water was used to flush the boat's raw water systems for the two main engines and one auxiliary.

March 2001

Cochlodinium polykrikoides **- an introduced species to the coast of British Columbia?**

Cochlodinium polykrikoides, a major fish and shellfish killer in Korea, was identified for the first time on 30 July 1999 as a bloom-forming organism in the northern part of Clayoquot Sound on the west coast of Vancouver Island. A bloom in a more northerly inlet, Quatsino Sound, moved east into Holberg Inlet causing the death of maricultured fish worth about $2 million. Cells of *Cochlodinium* have rarely been reported in water samples taken from the west coast of Vancouver Island prior to 1999. Does this imply that *Cochlodinium polykrikoides* has been present on the coast for many years and simply been overlooked, or is it a recently introduced species? In August 1999 a sampling cruise of selected inlets along the west coast of Vancouver Island indicated higher concentrations of *Cochlodinium* mainly in Nootka Sound and Esperanza Inlet, both of which are inlets for ships taking on cargo at Gold River and Tahsis, respectively. Such cargo ships taking on ballast water in Korea during a *Cochlodinium* bloom, would likely have viable cysts in the water being discharged prior to loading cargo at these ports. Although this is circumstantial evidence of an introduced species, the distribution of *Cochlodinium* appears to be increasing. In 1999, on the east side of Vancouver Island *Cochlodinium* was observed in only one out of eight sites monitored, at Simoom Sound in the Queen Charlotte Strait. By comparison in 2000, seven out of 16 sites monitored on the east side of the Island contained *Cochlodinium*, even those at the north end of the Strait of Georgia. It would appear therefore that the species is spreading southwards down the east side of Vancouver Island. If this distribution increases in future years, we might deduce that *Cochlodinium polykrikoides* was introduced to our coast in ballast water from a cargo ship.

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NATIONAL REPORT FOR ESTONIA

2 DELIBERATE RELEASES

Fish

For enhancement of commercial fish stocks, the following species have been released to the Baltic Sea: salmon (*Salmo salar*) 263 thousand; whitefish (*Coregonus lavaretus*) 117 thousand; and sea trout (*Salmo trutta trutta*) 30 thousand individuals.

3 ACCIDENTAL INTRODUCTIONS

Unintentional introductions of new species were not observed in Estonian waters of the Baltic Sea in 2000. Of the already known alien species, a report on consequences of the invasion of *Cercopagis pengoi* was published. In addition, new field studies, accompanied by laboratory experiments were carried out on the polychaete *Marenzelleria viridis*.

In 1992, a carnivorous species of Ponto-Caspian origin - the cladoceran *Cercopagis pengoi* (Ostroumov, 1891) – was first discovered in two sub-basins of the Baltic Sea: Gulf of Riga and Gulf of Finland. By the end of the 1990s, distribution area of the species increased remarkably by encompassing the Bothnian Sea in the north and Gulf of Gdansk and Vistula Lagoon in the south. Monitoring of the species in the Gulf of Riga revealed a linear increase in abundance since the first year of detection. Concomitant to invasion of *C. pengoi*, population abundance of the small-sized cladoceran *Bosmina coregoni maritima* has significantly decreased. Invasion of *C. pengoi* has led to changes in the diet of several fishes. Although the long-term mean share of *C. pengoi* in the diet of most abundant planktivorous fish in the Gulf of Riga - herring, *Clupea harengus membras*, smelt, *Osmerus eperlanus,* and three-spined stickleback, *Gasterosteus aculeatus*, was low, the species constituted up to 100 % in fish stomachs in some shallow coastal ecosystems during the warm season. The introduction of *C. pengoi* to the Baltic Sea probably influences fish stock structure by favouring visual zooplanktivores. The introduction may prove beneficial to commercial fisheries production if it enhances transfer of previously less-utilised mesozooplankton production to planktivorous fishes. However, through biofouling of fishing gear, *C. pengoi* has a direct economic impact on the fishing industry. Invasion of *C. pengoi* obviously complicates energy flow to higher trophic levels, but probably increases the overall stability of the Baltic ecosystem. As this euryhaline species originates from warmer climate conditions, the global warming should favour increase in population abundance of the species and facilitate, thus, further shifts in functioning of the Baltic Sea ecosystem (Ojaveer *et al*. 2000).

Owing to the large potential effect on the whole ecosystem, the Ponto-Caspian bivalve *Dreissena polymorpha* and the North American polychaete *Marenzelleria viridis* are ranked among the most influential exotics in the northeastern Baltic Sea. *D. polymorpha* is established in most of the coastal sea of the Gulf of Riga and in a few localities in the Gulf of Finland. In more eutrophied regions, where the abundance of the species is higher, *D. polymorpha* has an important role as a regulating, linking organism between the pelagic and benthic systems. *M. viridis* has invaded the Gulf of Riga, the Väinameri and the western and central parts of the Gulf of Finland. At present, it is slowly expanding its distribution area towards the eastern parts of the Gulf of Finland. The population of *M. viridis* has not yet stabilised in the study area. The establishment of the species has been more successful in more eutrophic regions and in more uniform biotopes. Because of competitive interactions for food *M. viridis* has a potential to reduce the growth of a native amphipod, *Monoporeia affinis*, and, hence, prolong amphipod recruitment and reduce its fecundity (Kotta, 2000).

The experiments showed that the polychaete *Marenzelleria viridis* is able to reduce the survival of the native polychaete *Nereis diversicolor* in the field. Furthermore, the presence of *N. diversicolor* increased the survival of *M. viridis*. The bivalve *Macoma balthica* caused a significant mortality on the population of *M. viridis*. Unlike *M. balthica*, the bivalve *Cerastoderma glaucum* had no effect on *M. viridis* and vice versa. The bivalve may still indirectly affect *M. viridis* through its negative impact on *N. diversicolor*. Hence, the dispersal of *M. viridis* is likely to be unsuccessful in the communities which are strongly dominated by *M. balthica*. As *M. balthica* is one of the most prevalent species on the soft-bottom biotopes of the Baltic, *M. viridis* should prevail only in those biotopes where the polychaete can escape from the competitive interactions with *M. balthica*. According to field observations the establishment of *M. viridis* has been most successful in highly eutrophied parts of the sea. Food is in excess at sea areas adjacent to river mouths or municipal wastewater outflows. Consequently, the competitive interactions for food between *M. viridis* and the resident fauna is less intense and the dominance of both opportunistic species *M. viridis* and *M. balthica* is very likely in these areas (Kotta *et al.* submitted).

4 LIVE IMPORTS

Country Fish	Quantity (kg)
Germany freshwater species	30
Russia freshwater species	362
Finland freshwater species	250
Denmark trout and salmon	12
Finland trout and salmon	19970
Sweden trout and salmon	530
UK eel (*Anguilla anguilla*)	260

5 LIVE EXPORTS

Russia trout and salmon	10 kg
USA unidentified fish (other than all above)	3 kg

7 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS ON INTRODUCTIONS AND TRANSFERS

A national workshop on "Alien Species in Estonia" was held. This was the first meeting dealing with alien species problems at the national level. Scientists, representatives from the Ministry of Environment and governmental agencies (e.g., Environmental Inspection) attended the workshop. The expert meeting identified "state of the art" of alien species issues in Estonia and suggested further steps to be made.

8 BIBLIOGRAPHY

See Annex 10.

Prepared by H. Ojaveer and J. Kotta

NATIONAL REPORT FOR FINLAND

1 LAWS AND REGULATIONS

Finnish disease regulations concerning import of live aquaculture and fishery animals and products from EU countries and from non-EU countries, as well as GMO-regulation, have been harmonised according to EU directives. The only legislative change in 2000 was incorporating of restriction areas in the eastern Gulf of Finland (Pyhtää) and in the Archipelago Sea (Åland Islands) due to the VHS disease observed in fish farms. The restrictions concern transportation of fish into restricted areas and out of them.

2 DELIBERATE RELEASES

2.1 Fish

Preliminary estimations of the deliberate releases into the Baltic Sea (including rivers draining into the Baltic) for fisheries and fish stock enhancement purposes in 2000 are as follows:

4.1 million salmon (*Salmo salar*), newly hatched – 4-years old

1.6 million sea trout (*Salmo trutta* m. *trutta*), newly hatched – 4-year old

28 million newly hatched and 10 million one-summer-old whitefish (*Coregonus lavaretus*) (1999)

The statistics on the production of food fish in 2000 are not yet available. In 1999 the total amount of food fish cultivated in net cages in the Finnish Archipelago was about 13 million kg. The fish supplied for food consisted almost exclusively of rainbow trout (*Oncorhynchus mykiss*). A small amount of other species, e.g., whitefish and grayling (*Thymallus thymallus*), was also produced.

As in previous years, veterinary authorities allowed the import of elvers (*Anguilla anguilla*) via Swedish quarantine to be released in natural waters.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

Invertebrates

No significant changes since 1999.

Fish

A Russian sturgeon (*Acipenser gueldenstaedti*) was reported from the southwestern coast of Finland (Rymättylä) and a similar one from the eastern Gulf of Finland in 2000. Four observations of starry sturgeon (*Acipenser stellatus*) have been made in Finnish coastal waters since the first one in 1999.

4 LIVE IMPORTS

Fish

- Arctic char (*Salvelinus alpinus*) from Germany to Åland Islands
- Elvers from Sweden to natural waters (amount not known)
- Rainbow trout from Sweden to Åland Islands to be slaughtered (222 000 kg)
- Tropical aquarium fish

Invertebrates

As in previous years, aquarium shops and some restaurants and stores have imported live tropical marine animals such as oysters, lobsters and crabs for sale or consumption. Since it is obvious that these animals cannot survive in natural Finnish waters, no authorisation by the Veterinary department is required.

Algae and higher plants

None apart from aquarium plants.

5 LIVE EXPORTS

Whitefish (*Coregonus lavaretus*) from northern Finland to Sweden.

8 BIBLIOGRAPHY

See Annex 10.

Submitted by Paula Böhling, Erkki Leppäkoski and Lauri Urho

NATIONAL REPORT FOR FRANCE

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

Besides the well-known introduction cases, additional species can be listed. In the National marine sanctuary of Port-Cros (Mediterranean seaside), descriptions of *Bractechlamys vexillum* (Reeve, 1853), a bivalve from Northern

Australia, *Megabalanus* sp., a crustacean cirriped from the western part of the Pacific, and *Acanthaster planci* were confirmed.

Moreover, we should emphasise a recent and emerging trend concerning the increasing non-commercial fishing activities which are using live baits. Therefore, a resulting trade is observed and concerns annelids as well as small finfish (Paguridae). By way of example, a *Coenobita rugosus* H. Milne Edwards (1837) specimen was described in the field, and may lead to the species introduction.

3.1 Molluscs

Mollusc: the gastropod *Rapana venosa*

Since its first sighting in 1997, 11 individuals of the mollusc *Rapana venosa* have been observed in the same location. They are systematically distributed in low depths (−5 m) and in sandy bottoms. No geographic extension nor population increase for this species has been considered. All the individuals are 5–7 year-old adults, and no juveniles have been sighted. The sandy bottom is likely impeding the species spread since the lack of hard substrate limits the spatfall capacity, egg settlement and therefore survival rate. The introduction origin is unknown in spite of enquiries. Information campaigns at the public and shellfish industry levels were carried out to support an eradication campaign and strengthen the species destruction. Although unsuccessful, diving (day and night) – dredging campaigns and harvest trials by using crab pots were performed to test an eradication process. Tissue samples were mailed to the US research team at the VIMS in Chesapeake Bay to study their genetic characteristics and specify population origin.

Mollusc : the muricid gastropod *Ocinebrellus inornatus*

A new species of drilling gastropod *Ocinebrellus inornatus* has been observed along the French Atlantic coastline, in the Marennes Oléron and Arcachon Bays. The first sighting was observed in April 1997. Presently, this species has shown a significant spatial extension due to the shellfish tradeswhile the population has locally exploded. The three last mild winters have facilitated the species reproduction, and major impacts on shellfish rearing beds are currently observed. Species distribution is likely to increase in the near future by shellfish transport. An ongoing research programme focusing on this species is assessing biological characteristics (growth and predatory rates, spawning effort, population dynamics as well as genetic markers) and will compared those with worldwide samples.

3.2 Crustaceans

Crab: *Hemigrapsus penicillatus*

First reported in 1994 around La Rochelle harbour (Atlantic coastline, the crab *Hemigrapsus* then spread quickly northward to the Loire estuary and southward to Laredo (Spain). In Northern Spain, strong populations of *Pachygrapsus* marmoratus tend to limit the *Hemigrapsus* spread (habitat competition). For unknown reasons, the northern distribution limit, Southern Brittany, seems a significant obstacle for further colonisation. In contrast, the species is proliferating locally in Le Havre harbour (Normandy, English Channel). Since 1997, the species distribution has not shown further extension.

Crab: *Rhithropanopeus harrisii*

A brachyuran species originating from the American North Atlantic sea waters is now commonly observed in the Berre lagoon in the Mediterranean seaside. This species is now considered as permanently established and might lead to further expansion to other nearby Mediterranean lagoons.

3.3 Other Invertebrates

Polychaete Serpulidae: *Ficopomatus (Mercierella) enigmaticus*

This species was first noticed in France in 1921 (Fauvel, 1923). Local population outbreaks showing rapid build-up were recently reported in the Bays of Veys and Honfleur harbour (Normandy), in southern Brittany (Lorient and Vannes harbours) and in the Atlantic southwest coast of France (Poitou-Charentes). Although without significant environmental impacts reported, these outbreaks had several impacts on harbour management and structures (e.g., pipe clogging, blocking tide-gates) as well as on ships. The latter case facilitates spread by dispersal of mobile adults on ships' hulls. A national monitoring and enquiry was carried out in 1999 to assess the species distribution and impacts. This facilitated the drawing of the first distribution map along the French coastline and the arrival timing. This species is now well distributed along the English Channel, Atlantic coastline and the Mediterranean Sea. Reaching Southern Brittany around the 1970s, the species spread to the Southwest Atlantic coastline during the 1980s (1982) and was first observed in the Mediterranean lagoons in 1999.

3.4 Algae and Plants

Caulerpa taxifolia

Since the first sighting of *Caulerpa taxifolia* on the French Mediterranean seaside, this species has extended its distribution considerably (4600 ha in 1998), colonising areas in Croatia, Monaco, Italy and Spain. Since that introduction, yearly campaigns are carried out showing a continuous expansion. First sightings of *Caulerpa* within dense *P. oceanica* seagrass occurred in 1998. Depth distribution showed *C. taxifolia* pieces down to 108 m, while the sampling was carried out to 182 m. Several destruction trials using electrodes as well as chemicals are currently under investigation, although preliminary tests are inconclusive. Several websites concern the *Caulerpa* issue: http://www.unice.fr/leml, http://ifremer.fr/delec/bb/reponse/reponse.htm, http://www.ifremer.fr/delec/bb/caulerpe.htm.

3.5 Vertebrates

Finfish

On 27 December 1999, the southwest French coastline was hit by a severe hurricane, which resulted in several flooded areas. Several finfish farms were partly or totally destroyed. One of them, located in the Gironde estuary, is specialised on sturgeon farming (Siberian sturgeon) *Acipenser baëri*. The hurricane resulted in a 20 % loss of the rearing biomass including mature adults, with an unknown number of individuals released into the nearby Gironde river. Although, professional fishermen were contracted to catch the released animals, the latter might interbreed with the local and endangered European species *Acipenser sturio*.

4 LIVE IMPORTS

4.2 Invertebrates

The shellfish farming industry imported Pacific cupped oysters *C. gigas* for direct marketing from Ireland, Portugal, Netherlands, and the UK.

The aquarium trade imported several invertebrate species in 2000, and specifically from Canada the following species: pink anemones (*Anthopleura elegatissima*), giant anemones (*A. xanthogrammica*), white spotted anemones (*Urticina lofotensis*), sunflower stars (*Picnopodia helianthoides*), California cucumber (*Parastichopus californianus*), giant barnacle clusters (*Balanus nobilus*), and the Pacific giant octopus (*Octopus dofleini)*. No release into the environment is expected due to the aquarium seawater management.

6 PLANNED INTRODUCTIONS AND TRANSFERS

6.2 Invertebrates

Several strains of *C. gigas* were imported and are currently being held under total quarantine (closed system) at the IFREMER's research hatchery in La Tremblade for genetic studies. A management plan is under progress aiming to transfer these strains which did not show any abnormal mortality rates, nor any pathogen, in spite of a comprehensive monitoring. Although based on the ICES recommendations, the plan will be proposed with further and stricter constraints.

7 BALLAST WATER STUDIES IN FRANCE: RECENT DEVELOPMENTS

A study was carried out in spring 2000 in the five largest French harbours: Dunkerque, Le Havre, St Nazaire, La Pallice, and Marseille. Ballast waters were sampled from 29 ships: bulk carriers (most of them), container carriers, a gas tanker and an OBO (ore but oil), by different means (checking valves, pumping, overflow…). As a result, we found in 50 % of the samples, several strains *Clostridium perfringens*, *Vibrio parahaemoliticus* in one sample, and several minor pathogens (*Aeromonas, Pseudomonas*). Noxious phytoplankton species such as *Dinophysis acuminata, Heterosigma akashiwo* were also present onboard ships coming from Spain or the West Indies. In sediments sampled inside a container carrier's ballast, a dinoflagellate cyst was observed (likely being the *Scripsiella* genus). Further studies will assess a treatment product's efficacy over a ship's journey from France to North Africa.

8 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS ON INTRODUCTIONS AND TRANSFERS

Several meetings in France among State Administrations and Research Institutes concerning the OSPAR Convention and the Working Group on Impacts on the Marine Environment (IMPACT).

A workshop organised by IFREMER and the University of Western Brittany on the restoration of marine ecosystems (Brest, November 2000).

The GISP (Global Invasives Species Program) initiated in 1996 has been followed by the 2000 conference in Le Cap, South Africa. At the European level, a scientific group was nominated to develop a "platform for a research strategy in biodiversity". A first meeting was organised under the European French Presidency in Montpellier, 4–6 December 2000 on "Biological invasions". Research priorities were specified within the three tasks: 1) to develop methods to assess potential invasive species and sensitive ecosystems so as to develop a modelling and predictive approach, 2) to improve the monitoring networks for an early detection and risk assessment, including social and economic side effects, and 3) to sustain a multidisciplinary scientific programme to facilitate decision-making to prevent, control, manage and inform decision makers and increase public awareness over these issues.

Moreover, the GMOs issue was discussed since acquired genetic advantages against diseases and/or ecological constraints might lead to an invasive behaviour. Therefore, one research aspect will focus on developing approaches to predict and prevent further spread of GMOs when naturally introduced into the environment.

A French research programme supported by the French Ministry of Environment is under development to respond to the previous conference. Several experiments are already initiated and a conference will be held in Paris on "Biological Invasions", in June 2001.

MEPC (Marine Environment Protection Committee) meeting from IMO, London 6–13 March 2000. The ballast water issue was discussed and the French point of view presented (based on ongoing studies).

8 BIBLIOGRAPHY

See Annex 10.

Report prepared by P. Goulletquer, with
D. Hamon, IFREMER DEL/EC, Brest,
D. Masson, IFREMER DEL La Tremblade
P. Noël, Museum d'Histoire Naturelle, Paris.

NATIONAL REPORT FOR GERMANY

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

No new accidental introductions were reported from German marine or brackish waters in 2000. The following paragraphs present news of previously reported non-indigenous species.

3.2 Invertebrates

Crassostrea gigas

The oyster farm located on the island of Sylt in the North Sea is continuing its operation (rack culture) according to the increasing demand. In 2000 the company sold 1 million oysters in Germany. Because of logistic problems of the German oyster farm in the end of the 1990s seed oysters (*Crassostrea gigas*) had to be "parked" for a few days (up to two weeks) outside the hatchery in Ireland. As a result the following non-target species were transmitted into the Wadden Sea: *Sargassum muticum*, *Ascophyllum nodosum*, *Aplidium nordmannii* and *Styela clava* (see previous German National Reports). These unintentionally introduced species constantly spread further.

Culturing the Pacific oysters has resulted in an increasing rate of settlement outside the farm, particularly on mussel beds in the adjacent Wadden Sea. The oysters showed good growth and seem to have reached maturity and spawning may have taken place. So far no impact of the Pacific oyster on native species is reported (Diederich; 2001, Reise, pers. comm.).

Recently completed field studies document the spread of the Pacific oyster; including habitat structure and abundance of adult oysters as well as recruitment of the invader in the Wadden Sea (Diederich, 2001).

Anguillicola sp.

The reported level of the swimbladder nematode infestation remains unchanged (up to 90 % of the eels caught are infested). In eutrophic freshwater lakes of northern Germany the ruffe (*Gymnocephalus cernuus*) continues to act as a reservoir of *A. crassus*.

Dreissena polymorpha

As in many other countries, the zebra mussel is spreading and this seems to take place mainly at the fringes of previous distribution patterns in Europe, probably caused by the improvement of the water quality condition in some German rivers (Elbe and Weser Rivers) over the past few years, mainly due to additional urban wastewater treatment plants installed in former Eastern Germany.

At present several companies in Hamburg harbour, which depend on secured cooling water supply, are suffering from extensive costs (an estimated 1 Mio US$ in 1999). The Institute for Marine Research, Kiel has in 1999 undertaken a monitoring programme on the settling pattern of zebra mussels in the port of Hamburg which serves several industries. Distribution and growth at various sites including the cooling water systems were investigated over a period of 9 months (March – December 1999). The data are presently being analysed and will be reported next year.

Further, it is likely that a re-introduction of zebra mussel to Europe from areas where it has been transmitted to several decades ago occurred (e.g., Great Lakes and Mississippi River basin) by ships.

***Eriocheir sinensis*, Chinese Mitten Crab**

At the end of 1999 one specimen of the genus *Eriocheir* was found that carried mitten-like claws but was of the size of juvenile *Eriocheir sinensis* which do not carry these kind of claws at juvenile stages. It is suspected that this specimen may represent a closely related species and taxonomic identification of this specimen is presently under way (Senckenberg Institut Frankfurt, Germany).

Chinese studies on the mitochondrial cytochrome oxidase I gene have shown that the crabs found in the Thames River originate from the Yangtsekiang River in China (Chu, pers. comm.). Specimens from Germany will be analysed in the future.

A new project is planned using genetic techniques to analyse its population dynamics and historic invasion pattern in German waters (Hänfling, pers. comm.).

Teredo navalis

The alien species has caused massive damage to local harbours, especially marinas, and continues to be a significant problem in the Baltic Sea area (Mecklenburg-Vorpommern and Schleswig-Holstein coasts), causing damage of several million US$ per year. Preventive measures are presently being studied by several institutions, considering the use of alternative substances replacing wood and toxic paints (specifically preventing larval settling on wood surfaces). However, all of these measures are expensive.

4 Live Imports

4.1 Fish

Aquaculture and power plants

Several aquaculture facilities are in operation (since more than 20 years) using warm water effluents of power plants. Species are cultured for the aquarium industry (ornamental species: Koi carp, goldfish and *sterlett*), human consumption (Asian carp, *Tilapia* species) and restocking (glass eels). The total annual production in 2000 of all kinds of species cultured was approximately 250 tonnes.

Glass eels are imported from various countries (e.g., France, Italy, Ireland, Netherlands, and Sweden) according to the ICES Code of Practice. With a weight of 25 g the individuals are used for restocking in German inland waters.

Several sturgeon species are still imported from Russia by local farmers for small-scale culture, among them is the Siberian sturgeon *Acipenser baeri*. Occasionally, there are records of captures of escapees although these are rare events.

Imports of salmonid species continued in the year 2000 at a comparable level to previous years. In particular rainbow trout was imported mainly from Denmark, the Netherlands, Poland, and the Czech Republic. Substantial quantities were transferred by trucks to local farmers and wholesalers not only to the northern States but also downward south to Bavaria. The tonnage of trout imported overall varied over the past few years between 15,000 tonnes and 19,000 tonnes.

Live Atlantic salmon were imported from Sweden for human consumption in an unknown quantity.

Common carp is another species that is regularly imported alive. While during the 1980s the tonnage was gradually declining from about 4,400 tonnes (1980) to 1,400 tonnes (1989), imports gradually increased again (sources: Poland, Hungary, Czech Republic) to 3,150 tonnes (1997).

Ornamental trade

Large quantities of marine, brackish water and freshwater organisms were imported from South America, Southeast Asia and other regions (inner European trade) to serve the aquarium and hobby industry. Reliable statistics are difficult to obtain, however, the tonnage is gradually increasing while also live corals and other marine invertebrates (e.g., *Tridacna* sp. which is prohibited to import: CITES red list) are becoming increasingly popular. *Tridacna*, however, is presently also cultured in several places in Germany and, therefore, it is difficult to prove illegal imports.

At present, a survey on trading of live marine animals by Public Aquaria and Oceanaria has been started at the Institute for Marine Science, Kiel, the results of which are hopefully fully available at the next Working Group meeting.

4.2 Invertebrates

Live blue mussels (*Mytilus edulis*) were imported from Denmark for human consumption in an unknown quantity while German mussel production is to a large extent targeted for the Belgian and Dutch market.

Live crustaceans (*Nephrops norvegicus*, *Homarus gammarus*, *H. americanus*, *Callinectes sapidus* and *Cancer pagurus*) have been imported for human consumption from various countries in an unknown dimension. *Homarus* spp. originate mainly from Canada, Ireland and Norway.

5 LIVE EXPORTS

5.2 Invertebrates

Living juvenile Chinese mitten crabs were shipped to China for restocking purposes in 1998. Chinese authorities are concerned of gene-pool interactions between German and native individuals, but still consider importing specimens in huge quantities.

A German commercial fisherman holds a permit to ship 10 tonnes of crabs to China annually. Neighbouring countries (Taiwan, Korea and Japan) indicated their interest to import juveniles from Germany as well as recent efforts in culturing this species in Southeast Asia signals the existence of a potential market.

7 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS ON INTRODUCTIONS AND TRANSFERS

7.1 Fishing People's Knowledge on Chinese Mitten Crab

A study gathering fishing people's information on the distribution and population density of the Chinese mitten crab in German waters during the last decades was completed. Results will be published soon.

7.2 NEOBIOTA group

The new German Group on Biological Invasions

Biologists and ecologists from Germany founded a research consortium on biological invasions. This group will co-ordinate responses to the ever increasing problems caused by the invasion of non-native plants, animals, fungi and micro-organisms. These "new species" (Neobiota) can threaten the biodiversity of existing native species, alter the structure and function of ecosystems and can eventually cause severe economic and human health problems.

The scientists in the new group will work together on theoretical and applied aspects of biological invasions, but also aim at educating the public and consulting with policy makers.

The tasks of the consortium are as follows:

1) Enhance communication and contact between scientists from different fields.
2) Collect all available information on non-native species in Central Europe, their invasion pattern and their distribution. Identify information deficits and coordinate efforts to solve them.
3) Disseminate and coordinate research progress on theoretical and applied aspects: causes, mechanisms, effects of biological invasions; and potential control methods.

Meetings of experts in the field will be held regularly. A conference in Berlin, with international participation, was held in October 2000. The proceedings of this conference will be published as special issue of Invasion Biology.

Coordinator of the group: Prof. Dr. Ingo Kowarik, Institut für Ökologie und Biologie der TU Berlin, Rothenburgstr. 12, 12165 Berlin.

7.3 Marine Environment Protection Committee 45 (MEPC45), International Maritime Organization (IMO), Ballast Water Working Group (BWWG) Agenda Item 4 Harmful Introductions with ships. Germany submitted two contributions:

- Proposal for a tool box of standardised ballast water sampling techniques.
- Proposal for a Standardised Assessment Method of Ballast Water Treatment Options that remove organisms from the ballast water.

7.4 Outcome of European Union Concerted Action

Highlights of the European Union Concerted Action "Introductions with ships", coordinated by Germany. Of special interest were the results of the intercalibration workshops comparing the efficiency of previously used ballast water sampling techniques. For more details see Bibliography and earlier WGITMO reports.

7.5 EU IMPACT Cluster

The first meeting of the IMPACTS cluster was held in Brussels on 2 March 2000 and was organised by the European Commission/DG RTD-D1. IMPACT is a new cluster formed following FP-V requirements and objectives. It includes projects on anthropogenic impacts on the marine environment under the Environment and Sustainable Development

Programme. It integrates studies on Marine Pollution, Contaminant transport, Ecotoxicology and Key element cycling. Members of the following project were involved (in alphabetical order): ACE, BIOHAB, BIOMARK, CA Introductions with ships, CYCLOPS, EUROHAB, MARA, MATBIOPOL, MEAD, MEDAR, MEDNET, NUTOX, and SIGNAL.

Key objectives of the IMPACT Cluster are: (a) Exchange of data between the projects, and (b) Coordination of publications from projects in the Cluster.

Meetings of the IMPACT Cluster group are planned annually or semi-annually. The next meeting is planned for fall 2001.

7.6 Ballast Water Study: Canada – Germany

A complimentary Canadian and German research fund covers the costs for a ballast water sampling study on ships travelling between Canada and Europe.

The team of Marine biologists, headed by a Canadian Mr. Michel Gilbert along with Mr. Frederick Blouin (Canadian) from the Maurice Lamontagne Institute of the Canadian Department of Fisheries And Oceans, and a German Marine Biologist Mr Sven Christopher Neulinger from the Institut für Meereskunde (Institute for Marine Science) in Kiel, Germany boarded a vessel in Europort on 2 September 1999. Dr Stephan Gollasch from Institut für Meereskunde, Kiel, also visited the vessel along with the other scientists.

During the voyage samples from the ballast water were taken daily (weather permitting) from departure in Europort (Rotterdam) to arrival in Sept-Îles (Canada). All the ballast water on board was taken in Europort and was divided into three different categories. Ballast water in Wing tank No. 5 was retained on board without any exchange. Wing Tank No. 7 water was de-ballasted about 50 % volume, then refilled and overflowed for an additional 50 % of the tank capacity to complete the 100% exchange, as normally done on board. Wg. Tank No. 4 water was exchanged using IMO described method of flow through by volume of 300 % the capacity of the tank. Samples were taken in starboard and portside tanks No. 4, 5, and 7 on a daily basis to monitor changes in ballast water communities and to determine the effects of ballast water exchanges on these communities. In addition, samples were taken in Wg. Tk. No. 4 after each 100 % volume exchange by IMO’s flow-through methods to follow changes in ballast water communities with each renewal of ballast water.

7.7 Ballast Water Study: Brazil – Germany

A similar study to the above mentioned (Section 7.6) is planned involving ships travelling between Brazilian and German ports.

7.8 Experimental work

H. penicillatus was introduced to France in the mid-1990s and continuous to spread. In 2000 it reached the Dutch coast.

During the intersessional period, the experimental work on behavioural interactions between the green crab (*Carcinus maenas*) and the Asian crab (*Hemigrapsus penicillatus)* was completed. Both species prefer similar habitats and tolerate high temperature and salinity variation. The aim of the study was to evaluate behavioural cues as to the potential interaction (dominance) of one over the other species under a variety of environmental conditions. Two methods were examined to describe interspecific competition. First, interspecific distances maintained between individuals of both species were tested at different densities of both species. Second, the effect of crevices as a factor to reduce interspecific competition for space was investigated as the dominance of one over the other species and may have predictive value when considering North Sea shores (e.g., Wadden Sea areas and rocky shores) with different habitat structures as suitable habitats. When offered, both species preferred to use hiding places frequently. Dominance was also related to size of either species. Relatively high mortalities were observed in *Carcinus maenas* juveniles in the presence of adult *H. penicillatus*, suggesting that the Asian decapod has some potential to dominate our native green crab.

7.9 Ballast Water treatment

A recently completed Diploma thesis summarised and assessed the various methods of ballast water treatment discussed (Mühr, 2000).

8 BIBLIOGRAPHY

See Annex 10.

Submitted by S. Gollasch & H. Rosenthal

NATIONAL REPORT FOR IRELAND

2 DELIBERATE RELEASES

2.1 Invertebrates

Exotic species in cultivation in Ireland are:

1) The abalone *Haliotis tuberculata,* and *Haliotis. discus hannai.* All seed are hatchery produced in Ireland and then cultivated in barrels on longlines, no releases to the wild are known;

2) The Pacific clam *Venerupis philippinarum*. Production is based on Irish hatchery seed. Cultivation is on screened trays and then beneath mesh;

3) The Pacific oyster, *Crassostrea gigas*, is produced in Irish hatcheries but hatchery seed is imported from France and the UK (including Guernsey). Wild seed is also imported from France. Irish oyster growers were advised against bringing in half-grown oysters, at an oyster fair in March 2001, because of the high risk of importing unwanted biota and that samples of imported seed would continue to be examined. The species is cultivated on bags on the shore: there is some bottom culture in Cork Harbour. Settlements in the wild occur in Donegal and Galway bays and Cork Harbour. Numbers settling are very small and unprofitable to harvest.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Anguillicola crassus: The nematode parasite, surrounding the airbladder of the freshwater eel *Anguilla anguilla, Anguillicola crassus,* was first identified from the Waterford area (south coast) in 1997. In 1999 it was found on the lower Shannon River in Lough Derg (McCarthy, 2000). It has also been recorded from the Erne Catchment (Milton-Mathews, pers. comm.) in 1999. This species appears to be expanding; its future impact in Ireland remains unknown. It was probably introduced to Ireland by its infective stage being released in water used to refresh eels in viviere trucks making collections in Britain and then in Ireland.

Dreissena polymorpha: The zebra mussel arrived in Ireland in 1994 or perhaps 1993 and was rapidly spread through the navigable waterways as fouling on the hulls of boats. Annual monitoring surveys of the zebra mussel, *Dreissena polymorpha,* revealed increases of abundance in the northern lakes of the Shannon navigation. However, it does not occur in Lough Allen, possibly due to the more acidic water. It has become established in a lake, Lake Garadice, on the canal joining the Shannon and Erne systems (NW Ireland). The species also is present and may be established in a canal harbour at Tullamore (central Ireland). (see separate report).

Calyptraea chinensis: The Chinese hat limpet lacks a planktonic stage that was probably spread to Ireland in the middle of the last Century with native oyster imports used for restocking Clew and Ballinakill bays (west coast of Ireland). The species has recently appeared in Eastern Galway Bay and was first noted in 1999 probably as a result of oyster movements from the bays where it was formerly established. A separate introduction to Cork Harbour was noted in 2000 and has probably been established there for at least three years and may have come from Loch Ryan in Scotland.

Ficopomatus enigmatica: This tube worm was first recorded in Ireland in 1998 in a recently formed lagoon, controlled with lock gates, on the Shannon Estuary. It is moderately abundant and causes only a small impact, fouling structure and craft within the confines of the lagoon.

Oyster Copepoda: Pacific oysters examined in 1999 from Dungarvan Bay had the gut parasite *Mytilicola orientalis* present when examined in 1999. The species became established following imports of half-grown Pacific oyster in 1993. No samples from this area were examined in 2000; the species may still be present there. The species *Myicola ostraea* was found in Pacific oysters from the same region in 1999. In 2000 large numbers of a gill copepod were found in Pacific oysters in Cork Harbour. In areas with highest copepod frequencies there was an undulating gill condition present.

4 LIVE IMPORTS

4.2 Invertebrates

Pacific oyster seed continue to be imported from France and the UK.

Imports:

Month	Species	Numbers (quantity)	Origin
4–8	*Crassostrea gigas* (hatchery)	34 million	France
All year	*Crassostrea gigas* (hatchery)	31 million	Great Britain
3–11	*Crassostrea gigas* (hatchery)	3 million	Guernsey

Pacific oysters from hatcheries in France were imported to Carlingford, Bannow, Dungarvan, Kinsale, Roscarberry, Roaring Water Bay and Castlemaine Harbour. Wild spat were imported from Arcachon Bay. Approximately 100 million wild spat may have been imported in 2000.

4.3 Fish

Month	Species	Numbers (quantity)	Origin
1,2,4,7	*Oncorhynchus mykiss*	558K (fry)	N. Ireland
1,3,4, 6,11	*Oncorhynchus mykiss*	2000K (ova)	Denmark
3	*Oncorhynchus mykiss*	(4000 kg)	England
1,2	*Oncorhynchus mykiss*	120K	N. Ireland
10	*Oncorhynchus mykiss*	40K	Scotland
11	*Oncorhynchus mykiss*	100K ova	Isle of Man
7	*Oncorhynchus mykiss*	150K	South Africa
1–3,12	*Salmo salar*	9,053K ova	Scotland
2,3,12	*Salmo salar*	1,177 eyed ova	Scotland
1–3	*Salmo salar*	625K ova	Iceland
1,2,11	*Salmo salar*	6,500K eyed ova	Iceland
9	*Scophthalmus maximus*	4750 small fish	Isle of Man

Aquarium fishes imported, see separate submission.

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES AND OTHER AREAS

Month	Species	Numbers (quantity)	Destination
4, 10	*Mytilus edulis*	(12K kg + 16K kg)	Jersey
6	*Crassostrea gigas*	100K (500 g)	N. Ireland
7	*Haliotus tuberculata*	500 (250 g)	Jersey
10	*Haliotis discus hannai*	4K (200 g)	N. Ireland
10	*Pecten maximus*	400 (100 kg)	N. Ireland

Month	Species	Numbers (quantity)	Destination
11	*Cyprinus carpio*	3,375 (27.5 kg)	N. Ireland
5	Roach	63 (15.75 kg)	England
6	Arctic charr	15K (10.5 kg)	England
1	*Salmo salar*	100 ml milt	Scotland
8	*Salmo salar* (fry)	115K (1840 kg)	Scotland
1	*Salmo salar*	30K	France
2,6	*Salmo salar*	95K	England
5,6,7,8	*Salmo salar*	3,050K	Scotland
2	*Salmo salar*	100K	Wales
10	*Salmo salar*	40K	N. Ireland

7 MEETINGS

Attended by Dan Minchin (consultant on exotic species)

1) Best management practices for the preventing and controlling invasive alien species, 22–24 February 2000, Cape Town, South Africa.
2) 100 years of Science under ICES, 1–4 August 2000, Helsinki, Finland.
3) Theme Session on Marine Biological Invasions: Retrospectives for the 20th Century – Prospectives for the 21st Century. ICES Statutory Meeting, Bruges, Belgium, 30 September 2000.
4) 8th Aquaculture Insurance and Risk Management Conference, Oaklands, Park Hotel, Surrey, UK. 19–20 October 2000.
5) Workshop on phytoplankton monitoring in Ireland, Castleconnell, Ireland, 1–2 November 2000.
6) Biodiversity, a natural national resource, 10–11 November 2000, Dublin
7) European Platform for Biodiversity Research Strategy – Biological Invasions. Montpellier, 4–6 December 2000.

8 REFERENCES

See Annex 10.

Report prepared by D. Minchin with assistance from C. Duggan, J. Silke, T. McMahon, F. Geoghan, M. Lyons, G. Gough.

TOPIC: MANAGEMENT OF AQUARIUM ORGANISMS

Aquarium fishes introduced to Ireland in 2001

In Malaysia goldfish were assessed as being free from:

Viral haemorrhagic septicaemia (VHS)
Spring viraemia of carp (SVC)
Oncorhynchus masou virus
Epizootic haematopoetic necrosis (IHN)

In Singapore the fish were assessed as coming from areas free of VHS, SVC and IHN and had no endangered species present in the consignment.

Species	**Malaysia**	**Singapore**
Balantiocheilos melanopterus – sliver shark		Yes
Betta spendens – Siamese fighting fish, male		Yes
Botia macracantha – clown loach		Yes
Botia morleti – horae botia		Yes
Brachydanio albolineatus – pearl danio		Yes
Carassius auratus - Goldfish	Yes	
Cichlasoma severum – severum cichlid albino		Yes
Colisa lalia – golden gourami	Yes	
Corydoras aenus – aenus cory	Yes	
Cyprinus carpio – koi carp	Yes	
Gymnocorymbus ternetzi – black tetra		Yes
Haplochromis spp. – cichlids		Yes
Hemigrammus erythrozonus – glowlight tetra	Yes	yes
Hemigrammus ocellifer – head and tail light		Yes
Hyphessobrycon erythrostigma – bleeding heart tetra		Yes
Hyphessobrycon flammeus – red flame tetra		Yes
Hyphessobrycon herbertaxelrodi – black neon tetra		Yes
Hyphessobrycon herberxa – black neon tetra	Yes	
Labeo bicolor – red-tail black shark		Yes
Macropodius opercularis – paradise fish		Yes
Osphronemus goramy – pearl gourami		Yes
Paracheirodon axelrodi – cardinal tetra		Yes
Paracheirodon innesi – neon tetra	Yes	Yes
Poecilia latipinna – golden molly	Yes	
Poecilia reticulata – red fantail guppy		Yes
Poecilia sphenops – black molly		Yes
Pontius conchonius – rosy barb		Yes
Pseudotrophaeus zebra – golden zebra cichlid		Yes
Pseudotropheus spp. - cichlids		Yes
Pterophyllum scalare scalare - angelfish		Yes
Pterophyllum scalaris – golden angel	Yes	
Puntius sachsi – neon golden barb	Yes	Yes
Rasbora heteromorpha – harlequin rasbora	Yes	Yes
Sphaericthys osphromenoides – chocolate gourami		Yes
Thayeria boehlkei - penquin		Yes
Trichogaster tricopterus – golden gourami	Yes	
Trichogaster leeri – pearl gourami		Yes
Xiphophorus helleri – red platy		Yes
Xiphophorus maculatus – red wagtail platy	Yes	Yes

Temperate aquarium fish imports in 2001 to Ireland

Species	Czechoslavia	UK
Lepomis gibbosus – pumpkin seed	Yes	
Rhodeus sericeus	Yes	
Jordanella floridae	Yes	
"Golden oranda"		Yes
"Loach"		Yes
Cyprinus carpio – koi carp		Yes

Aquarium plants imported

Species	Singapore
Acorus pusillus	Yes
Bacopa caroliniana-submerse	Yes
Cabomba aquatica	Yes
Cabomba caroliniana	Yes
Cabomba piauhyensis	Yes
Ceratopteris siliquosa-emerge	Yes
Echinodorus cordifolius	Yes
Echinodorus tenellus-submerse	Yes
Heteranthera zosterifolia-emerge	Yes
Limnophila sessiliflora-submerse	Yes
Myriophyllum elatinoides-submerse	Yes

Note: Aquarium and garden-pond plants are likely to be imported through garden centres. Pond fishes may be introduced in this way and not through the aquarium trade.

NATIONAL REPORT FOR THE NETHERLANDS

2 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

2.2 Invertebrates

After its successful establishment in the southwest of The Netherlands, the Japanese oyster *Crassostrea gigas* is still expanding in the Dutch Wadden Sea. Essink (2000) reports the spreading of the Japanese oyster over the entire Wadden Sea. Cadeé (2000) describes the history of the Japanese oyster in The Netherlands and more specifically the increase in numbers on dikes along the Wadden Sea of southern Texel.

In 2000 at least 3 blue crabs *Callinectes sapidus* were caught in the Westerschelde estuary in The Netherlands. In July shrimp fishermen caught a female blue crab *Callinectes sapidus* (ca. 14 cm) in their nets, fishing near Walsoorden (Provinciale Zeeuwse Courant, 27 and 28 July 2000). An egg-carrying blue crab was caught in August by a fisherman in the Pas van Terneuzen, a gully in the Westerschelde (Provinciale Zeeuwse Courant, 23 August 2000); as far as is known, this is the third observation of an egg carrying blue crab in The Netherlands. The third blue crab (carapace 16.5 cm) was caught in September by a shrimp fisher (Visserijnieuws, 13 October 2000).

After the first recordings in European waters, the north-west Pacific grapsid crab *Hemigrapsus penicillatus* was expected to colonise a wide range of habitats along the North Sea and the Baltic (Gollasch, 1999). More specifically, *Hemigrapsus penicillatus* was also expected to occur in The Netherlands and Belgium (Compaan, 1997; d'Udekem d'Acoz, 1998). In March 2000 *Hemigrapsus penicillatus* was found for the first time in The Netherlands in the marine tidal basin Oosterschelde by Reindert Nijland (Nijland and Beekman, 2000; Bionieuws, 6 May 2000); at Sas van Goes (51°33' N, 03°56' E one specimen was found between rocks in the eulitoral. Another 18 specimens were found in April by Reindert Nijland and Marco Faasse, of which one was an adult male with a carapace width of 20 mm, suggesting the species was already present in 1999. During later months in 2000, the crab was still found at Sas van Goes with local densities of 5 animals m^{-2} (Nijland, 2000). During visits in mid-July and end of September also females carrying almost hatching eggs were observed. Despite intensive searching along the Oosterschelde, *Hemigrapsus penicillatus* was not found at other locations.

Hemigrapsus sanguineus, a western Pacific grapsid crab, was found for the first time in The Netherlands. In August 1999 two crabs were found at the location Schelphoek in the northwestern part of the Oosterschelde (pers. comm. Marco Faasse).

To date, large amounts of live American lobsters, *Homarus americanus*, are imported from the American and Canadian east coast to Yerseke, The Netherlands. Heerebout (2000) wonders when this will lead to escape and establishment of an American lobster population in the Oosterschelde, thereby threatening the reproduction success of the European lobster *Homarus gammarus*.

3.3 Algae and Higher Plants

After its introduction into the marine tidal basin Oosterschelde in March 1999 (Stegenga, 1999), the Japanese kelp *Undaria pinnatifida* (Phaeophyta) rapidly colonised the Oosterschelde. On some places *Undaria* fields cover areas of 5 to 6 ha (pers. comm. Henk van den Bosch, LNV-Directie Visserijen, Yerseke). On the North Sea side of the Oosterschelde *Undaria pinnatifida* was found washed ashore (Sloof, 2001). *Undaria pinnatifida* was also seen in the salt water Lake Grevelingen with densities much smaller than in the Oosterschelde; transport of small *Crassostrea gigas* with attached *Undaria* from oyster plots in the Oosterschelde into Lake Grevelingen might have been the transport vector (pers. comm. Henk van den Bosch, LNV-Directie Visserijen, Yerseke).

In the Oosterschelde *Undaria pinnatifida* is growing on the Japanese oyster *Crassostrea gigas*, but also attached to mussels on mussel plots. Because of the slippery kelps it is difficult (for smaller ships) to dredge the oysters with mussel nets and fishermen have to investigate in time to clean up the plots before dredging becomes possible (pers. comm. Henk van den Bosch, LNV-Directie Visserijen, Yerseke and Pauline Kamermans, RIVO, Yerseke, The Netherlands).

8 REFERENCES

See Annex 10.

Report prepared by B. Wetsteyn.

NATIONAL REPORT FOR NORWAY

1 LAWS AND REGULATIONS

No new law or regulation regarding matters relevant to WGITMO has been suggested or passed in 2000, but it could be useful to recapitulate the ones that are operative.

Law on cultivation of fish and shellfish, etc. (14.06.1985 # 68).

Paragraph § 20: On import of living marine organisms (added in a law of June 16, 1989 #58 and bylaw of 15 May 1992 # 42) states:

Without permission from the department, nobody is allowed to import viable marine fish, shellfish, etc., for aquaculture or restocking purposes.

Bylaws on supervision and control of import and transit, etc., of animal staple and products of animal origin, etc., from third party countries of September 18, 1999, # 63.

2 DELIBERATE RELEASES

2.2 Invertebrates

The red king crab (*Paralithodes camtschatica*) introduced by the Russians to the Barents region is still expanding its living area. Single specimens have been captured as far west as "Vesterålen", but it is suspected that "well-intended" fishermen have contributed to the translocation. The main living area is still east of "Nordkapp".

The stock and the quotas have been substantially increased, but poor muscle quality in the claws may indicate that the population has reached a level where food shortage will become more usual.

Several specimens have been collected to enable genetic analyses of whether some of the atypical colour varieties captured in 2000, in fact are specimens of blue king crab: *P. platypus*. These samples are now being analysed. (Jan Sundet and Knut Jørstad, pers. comm.).

Apparently no new specimen of the snow crab (*Chionoecetes opilio*) has been detected.

The American lobster (*Homarus americanus*) was discovered in Norway in 1999. During 2000 a network of collecting stations was established in southern Norway. During December, 24 lobsters were collected, and 5 of these were confirmed to be *H. americanus* when studied by genetic tools. In addition to the 5 confirmed *H. americanus*, 3 specimens had morphological features resembling the American Lobster.

Circumstantial evidence indicated that the lobsters had been released. The captured specimens were all found in close vicinity to cities with airports.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Caprella mutica was found in 2000 at Kvitsøy near Stavanger. This means that the caprellid species either has spread against the dominating coastal current, or that the species has been introduced in several places. Anecdotal information indicates further spread, but solid and systematic data have yet to be collected. The slipper limpet *Crepidula fornicata* has not been reported north of Kvitsøy, where it was found two years ago.

3.3 Algae and Higher Plants

Sargassum muticum is consolidating its position where it has established itself. It is not confirmed how far north of Sognefjord it has migrated, but it has still not become common in Hordaland.

The red alga *"Dasysiphonia"* sp. seems to spread rapidly both northwards and southwards. It has now migrated against the coastal current and is found in the outer Skagerrak east of Lindesnes. This rapid migration could revitalise a hypothesis that the alga has had several routes of introduction.

4 & 5 LIVE IMPORT & LIVE EXPORT

Live import:

From Canada: 4 squid (species?) to a public aquarium
From Iceland: 130,000 juveniles of the Atlantic Halibut *Hippoglossus hippoglossus* to a commercial halibut farm.
From France: 12,000 juveniles of sea bass, *Dicentrarchus labrax* to an experimental facility for wastewater treatment
10 penguins from Japan (not specified) to a public aquarium

Live Export:

To Spain: approximately 5 million Turbot larvae *Scopthalmus maximus*
To Chile: 4.4 million eggs (eyespot stage) of Atlantic salmon *Salmo salar*.

7 MEETINGS, CONFERENCES, ETC.

Clean Seas, London 2000 –Practical Strategies for Achieving Clean Seas, 20–21 June.
An effective treatment for ballast water. Presented by Anders Jelmert (IMR) on behalf of OptiMarin A/S.
ICES Annual Science Conference in Brugges 27–30 September 2000.
Gro van der Meeren (IMR) participated at the theme session on marine Biological Invasions.
IMO, MEPC (45) meeting. Official delegates from Norway participated

7.1 Ballast water research

A pilot project: "On the application of gas supersaturation for removal of marine organisms in ballast water". Supported by the Norwegian Research Board. Scientist: Anders Jelmert, Inst. of Marine Research.

EMBLA; Ballast Water Management Decision Support (http:/projects.dnv.com/embla/) is under development and proposed finalised by the end of year 2002. EMBLA 2000 (project activities for year 2000) have focused on:

- Assessment (GAP-analysis) of proposed EMBLA 5-step risk methodology (Initial screening/ detailed screening, ballasting, transfer, deballasting).
- Development of demo pilot risk calculator based upon risk methodology (under development).
- Data collection - Data requirement assessments including GAP-analysis and GAP-consequence assessments.
- Risk-reducing measures - Identifying common dominators enabling comparison between measures to be undertaken.

Ballast Water Treatment by Ozonation; This study included laboratory studies on the effects and efficiency of ozone treatment. Ballast water operations were simulated and pre-defined organisms were applied. Dosage, density, etc., varied. The study also included a corrosion assessment study. The ozonation study provided input to a full-scale study which will be undertaken in 2001.

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8 BIBLIOGRAPHY

See Annex 10.

Report prepared by: Anders Jelmert, Institute of Marine Research, Norway 17.03.01

NATIONAL REPORT FOR SPAIN

2 DELIBERATE RELEASES

2.2 Invertebrates

Since many years ago**,** *Ruditapes philippinarum* and *Crassostrea gigas* populations have been found in coastal waters dispersed from aquaculture ponds and farms

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Protozoa

Marteilia refringens, Paramyxea. In 1975, it was found infecting *Ostrea edulis* in Galicia, Atlantic coast (Figueras and Montes, 1988). In 1992, it was found infecting *Ostrea edulis* in Catalonia and mar Menor, Mediterranean coast (Riera *et al.* 1993; Lama *et al.,* 1993). In 1992, it was detected in *Crassostrea gigas* in Ebro river delta on seeds imported from France.

Bonamia ostreae, Haplosporidea. In 1982 was first detected in *Ostrea edulis* cultivated in Galicia (Polanco, 1984). Detected in mar Menor in 1993, the first record in the Mediterranean coast (Montes and Lama, 1993). Widely distributed in Galician oyster populations due to massive imports (Durfort, 1995).

Perkinsus atlanticus, Apicomplexa. Detected in Galicia in 1983 in *Venerupis decussatus* imported from Portugal (González *et al*., 1987) and also in Huelva in 1987. In 1994 was widely distributed in most of the sites sampled along the Catalan coast (Riera et al., 1995). Found in *Ruditapes decussatus* and *Ruditapes philippinarum* in the Ebro river delta, associated to high mortalities of both bivalve species in 1990 (Santmartí *et al*., 1995, Sagristà *et al*. 1996) and also in *Ostrea edulis* and *Crassostrea gigas.*

3.2 Invertebrates

Molluscs

Gibbula albida, (Gmelin, 1790). Mediterranean species (Ebro Delta, Almería) introduced in Galicia (1981–1984) associated with *Ostrea edulis* imported from Chioggia, near Venice, Adriatic (Rolán *et al.,* 1985); presently there is a stable population.

Cyclope neritea (L. 1758) Mediterranean species found in Galicia (Rolán, 1992) directly related with the transport of *Crassostrea gigas* from Mediterranean oyster-culture sites (Sauriau, 1991).

Gibbula adansoni (Payraudeau, 1826), Mediterranean species found in Galicia (Rolán, 1992).

Crepidula fornicata (L. 1758), origin in the eastern coast of USA, found in ría de Aldán, Vigo and Arousa (Galicia), imported with oysters from France and Ireland (Blanchard, 1997).

3.3 Fish

Fundulus heteroclitus (L.), Cypronodontidae, common name mummichog, origin in the Atlantic coast of North America, introduced in southwestern Spain (Atlantic coast) in 1973–1976 from Maine or Nova Scotia (Bernardi *et al*., 1995) by unknown way; slowly expanding towards Portugal (Gutiérrez-Estrada *et al.,* 1998).

3.4 Algae and Higher Plants

Phytoplankton

Recurrent blooms of the dinoflagellate *Alexandrium taylori* Balech, a PSP agent, have been detected in the Catalan coast recently (Garcés *et al.,* 1999). This species was described in Arcachon (Atlantic French coast) in 1994 and it has also been recorded recently in Sicily.

Phytobenthos

First record of *Caulerpa racemosa* on the Spanish coasts, in Mallorca (Balearic Islands) (Ballesteros *et al*., 2000). This species was detected in summer 1998 in two localities along the Palma de Mallorca bay. During autumn 1998 the population experienced a regression but in summer 1999 it showed a big increase, with a total affected area of 30,000 m^2. Nowadays the presence of this species is common in the entire Palma bay. Riera (pers. comm.) indicates that the total concerned area may have increased about 20 times. A small population has also been reported on the Ibiza coast (Balearic Islands) near the Ibiza port (F. Riera, pers. comm.) and in the Grao de Castellón. (Mediterranean coast) (Aranda *et al,*. 1999). Concerning *C. taxifolia*, no new settlements have been detected on the Spanish continental coasts. In Mallorca (Balearic Islands) the known populations (Porto Petro and Cala d'Or; Meinesz *et al*., 1998) have become stable. A new affected locality (Porto Colom), situated near the other two populations, was observed in 1998 and presently (year 2000) the total concerned area is 62.8 Ha and the affected coast distance is 9.4 km (F. Riera, pers. comm.).

On Spanish coasts, an increase of filamentous red algae records, and the spectacular spread of their populations, are detected. Ships are the most probable introduction vector of such algae. This possibility is supported by the fact that the first record for most of them was in Balearic Islands where the pleasure maritime traffic is increasing. The following are the outstanding species:

Acrothamnion preissii. The first record of this species on the Spanish coast was on the Mallorca coast (Balearic Islands) (Ferrer *et al.*, 1994). Later *A. preissii* has been observed in other localities of this island and on the north coast of Menorca (Balearic Islands). This species produces dense turfs specially on *Posidonia oceanica* beds removing the characteristic epiphytic species of the *P. oceanica* rhizomes (Ballesteros, pers. comm.).

Antithamnion amphigeneum. This species has been observed on the Mallorca coast (Balearic Islands) (Ribera and Soto, 1992). Later it has also been reported from Medes islands (Catalonian coast) (Ballesteros *et al.*, 1997) and Valencia coast (Spanish Mediterranean mainland coast) (Aranda and Solano, 1999) but none of these populations has experienced a high development.

Lophocladia lallemandii. This species had already been sighted on the South Mediterranean Spanish coast (Soto and Conde, 1988; Conde *et al.,* 1996) but nowadays it is producing an invasive process on Ibiza coasts (Balearic Island) where population coverage reaches in some cases 100% (Patzner, 1999). Although this alga produces seasonal blooms this author indicates that some algae and sessile invertebrates have disappeared from the local benthic communities because of the dense turfs of *L. lallemandii*.

Womersleyella setacea. This species occurs on the Balearic Islands coasts (Cabrera: Ballesteros, 1993; Menorca: Ballesteros *et al.*, 1997) and in Alboran island (Rindi and Cinelli, 1995). In all cases this species produces very dense turfs with negative impacts in the benthic local communities and also on fisheries (Ballesteros, pers. comm.).

8 REFERENCES

See Annex 10.

Prepared by M. Antonia Ribera & F. Pagès

NATIONAL REPORT FOR SWEDEN

1 LAWS AND REGULATIONS

New regulations and a strategy have been introduced during 2001 by the National Board of Fisheries for farming, release and transfer of fish (including crustaceans and molluscs). It is not permitted to farm or release non-native species, except rainbow trout, brook char, lake char, grass carp, American crayfish and hybrids between Brook char and Lake char. Also other stocks of fish than those occuring are to be treated as introductions, with exceptions for those occurring also in other parts of Scandinavia.

2 DELIBERATE RELEASES

2.1 Finfish

There are yearly releases into the Baltic Sea of about 2.4 million Baltic salmon (*Salmo salar*), 0.8 million sea trout (*Salmo trutta*) and 0.4 million glass eel (*Anguilla anguilla*) coming from France and/or England. There are also yearly transfers of 20 to 70 tonnes of small adult eels from the Swedish west coast into the Baltic Sea.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Finfish

A sturgeon, probably *Acipenser stellatus* (preliminary DNA-identification), was caught at Kalmar, SE Sweden in the summer of 2000 (S.O. Kullander, Museum of Natural History, Stockholm, pers. comm.).

There are still no reports of *Neogobius melanostomus* from Swedish coastal waters, despite its common occurrence in the Bay of Gdansk.

3.2 Invertebrates

The polychaete *Marenzelleria viridis,* known in Swedish waters since 1990, continues to increase (Figure A31) in the northern part of the Bothnian Sea, especially at Holmöarna (east of the city of Umeå) but no increase further south in the Bothnian Sea (K. Leonardsson, Umeå Univ., pers. comm.). In the Stockholm archipelago it occurs at depths around

5–20 m in the inner part and down to around 50 m in the outer area. The numbers might have increased slightly during the last two years, but no drastic increase has been seen (A. Stehn, Stockholm Water Company; pers. comm.). In the Himmerfjärden-Askö-Landsort area, northern Baltic proper, the species is seen, but not in high abundances (found in this area for the first time in 1999, H. Cederwall, Stockholm Univ., pers. comm.) and occurs as far in as close to the town of Södertälje (close to one of the outlets of Lake Mälaren, S. Hansson, Stockholm Univ., pers. comm.). The species is still not present in high abundance in the southern Baltic (L-E. Persson, Kalmar Univ., pers. comm.). There are no reports of *Marenzelleria* from the Swedish west coast.

The crustacean *Cercopagis pengoi* has been recorded since 1997 from the bay of Himmerfjärden, northern Baltic proper and in one very low saline bay in Stockholm (Gorokhova *et al.*, 2000).

American lobster (*Homarus americanus*) has not been reported in the wild from the Swedish west coast, but is kept alive in cages in the sea for later consumption. However, there are reports from fishermen of catches of lobsters that resemble the American lobster. The DNA-identification of the lobsters is not finished.

3.3 Algae and Higher Plants

Phytoplankton

The following dinoflagellates, not previously known from Europe, have been recorded (http://www.marbot.gu.se/SSS/dinoflagellates/dino_frame.htm) at the Swedish Skagerrak coast since 1997: *Alexandrium angustitabulatum* (known from New Zealand), *Discroerisma psilonereiella* (known from Kamchatka and British Columbia) and *Gyrodinium corallinum* (known from California). Whether they are new introductions or previously have been overlooked is not known. *Alexandrium angustitabulatum* is a small, potentially toxic species difficult to separate from *A. minutum*, while *Discroerisma psilonereiella* is relatively rare, but quite easy to recognise with the internal skeleton and *Gyrodinium corallinum* is quite a large species (M. Kuylenstierna, Göteborg Univ., pers. comm.)

The raphidophyte *Chattonella* (cf. *verruculosa* occurring in two morphological forms, first seen in the N. Kattegat, the Skagerrak and adjacent parts of the North Sea in 1998) occurred but did not form any blooms on the Swedish west coast in 2000, but did bloom along the Danish coasts (Informationscentralen, Länsstyrelsen Göteborg, http://www.dmu.dk/marineecologyandmicrobiology/alger/mar2000.htm). It is not known if the species has been introduced or previously been overlooked.

Macroalgae

No major changes have been reported for the distribution of the Japanese brown alga *Sargassum muticum* along the Swedish west coast (the southernmost record of attached plants from the middle part of the province of Halland). Around Göteborg it is more common in the outer archipelago than further in, but was in February 2000 also found (small winter forms, I. Wallentinus) close to the surface at a shore within the southern part of the city.

The red alga *Dasysiphonia* reported from Norway in 1999 and spreading south (see Norwegian National Report), has not been recorded in Sweden.

4 LIVE IMPORTS (during 2000)

4.1 Fish for consumption/processing

	Eel from: metric tonnes	**Carp from:** metric tonnes
Norway	68	
UK	1	
Poland		21
Denmark	1	
Total	70	21

4.2 Invertebrates for consumption/processing

	Lobsters from: metric tonnes	**Oysters from:** metric tonnes
Canada	111	
Norway	7	
USA	21	
Ireland	1	
Netherlands	11	3
France		2
Denmark		13
Total	151	18

5 LIVE EXPORTS (during 2000)

5.1 Fish for consumption/processing

	Rainbow trout and trout to: metric tonnes	**Eel to:** metric tonnes
Finland	22	
Estonia	1	
Norway	2	
Germany		335
The Netherlands		116
Belgium/Luxemburg		16
Denmark		259
Total	24	726

5.2 Invertebrates for consumption/processing

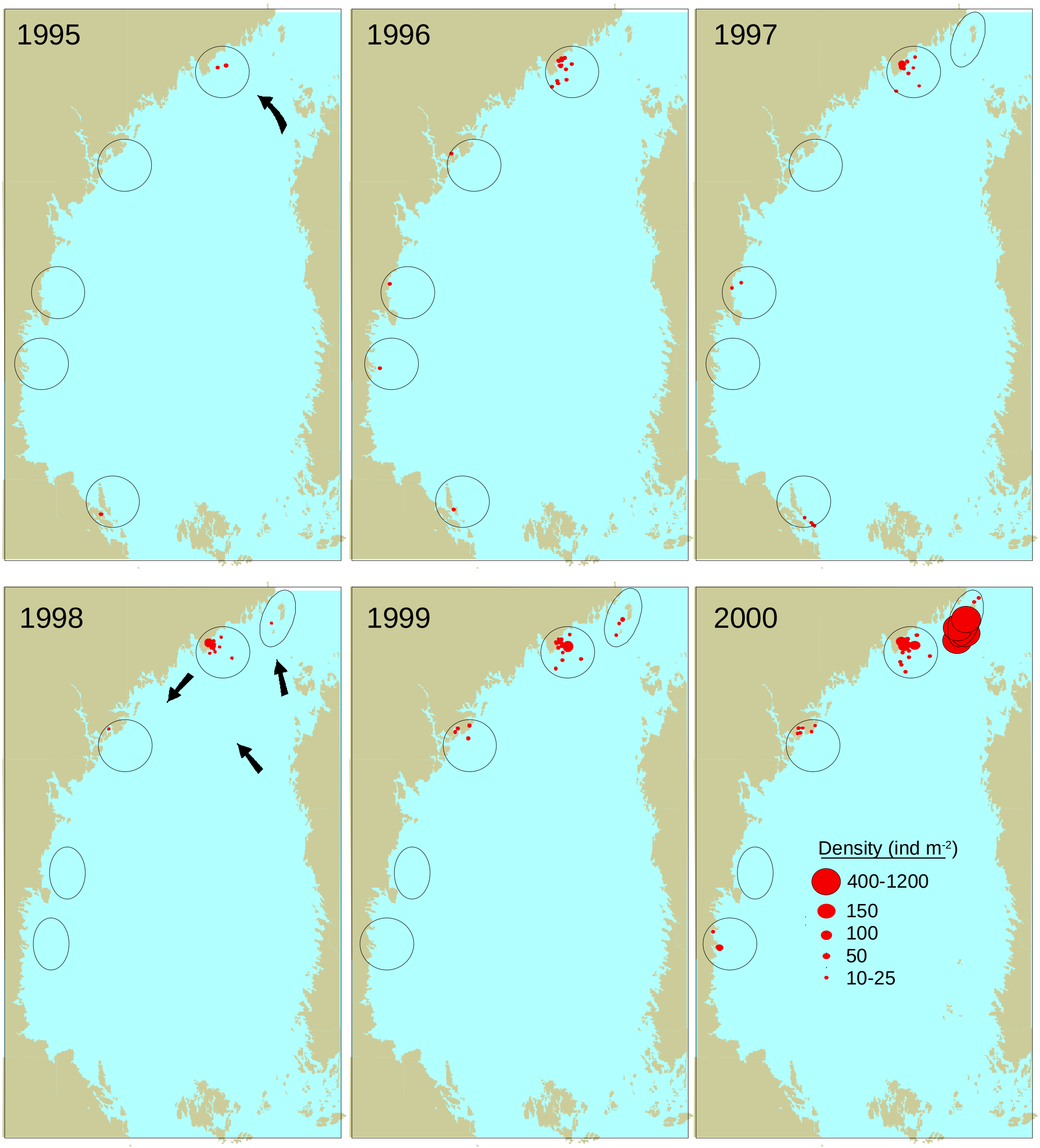
	Lobsters to: metric tonnes
Finland/Denmark/ Russia	1

8 BIBLIOGRAPHY

See Annex 10.

Report prepared by: Erik Sparrevik and Inger Wallentinus

Figure A31. The dispersal of *Marenzelleria viridis* on the Swedish coast of the Gulf of Bothnia (so far there are no records further north on the Swedish coast). The black circles denote samples from 20 coastal and 10 open sea stations within the circle. The ellipse denotes 10 sampling stations within the area (off the coast). N.B. The highest density in 2000 occurred on several stations in the northernmost area. From Leonardsson, 2001.



NATIONAL REPORT FOR UNITED KINGDOM (ENGLAND AND WALES)

2 DELIBERATE INTRODUCTIONS AND TRANSFERS

2.2 Invertebrates

Deliberate releases of Pacific oysters continued at about the same scale as in previous years. There has been some natural recruitment of Manila clams in Poole Harbour. A fishery for these clams has developed and has been licensed by the Southern Sea Fisheries Committee. The current annual level of exploitation is 80–100 tonnes. There is an on-going study into the management of this stock.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Eriocheir sinensis, the Chinese mitten crab, is reported to have spread northwards on the east coast, into the River Tyne.

4 LIVE IMPORTS AND TRANSFERS

4.1 Fish

Imports of rainbow trout eggs fell to 27.7 million, the lowest total since 1995. These came from disease-free sources within ICES boundaries including Denmark (5 companies), Northern Ireland (2 companies), and the Isle of Man (1 company), as well as from South Africa (1 company). These were reared at 40 farm sites.

4.2 Invertebrates

The imports of live American/Canadian lobsters and oysters for human consumption was continued. Some of the imported animals are held in tanks before consumption and there are strict quarantine conditions applied to this activity. The hatchery on Guernsey sent 11 shipments of Pacific oyster seed to shellfish farm sites in England.

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES

5.1 Fish

One consignment of Dover sole eggs was exported to Spain.

5.2 Invertebrates

Pacific oyster seed was produced in UK hatcheries and 76 consignments were exported to Ireland and one to Guernsey. One shipment was exported to the Falkland Islands. Seven consignments of *Mytilus edulis* were sent to Guernsey.

NATIONAL REPORT FOR UNITED STATES OF AMERICA

1 LAWS AND REGULATIONS

There were many developments in laws and regulations surrounding the introduction of marine organisms to the U.S., focusing primarily on transfer by ships' ballast water. In addition to national regulations (below), legislation has been introduced in many individual states. To date, legislation has been approved in 4 states (California, Washington, Maryland, and Virginia) and is pending in two others (Michigan and Oregon). The scope and timetable for implementation of regulations varies among the states:

California implemented its regulations in January 2000, requiring all commercial ships that enter the state with ballast water from outside the U.S. to (a) conduct ballast water exchange and (b) report ballast water discharge characteristics (i.e., source and management) under penalty.

Washington will implement similar regulations in 2001, extending the requirement for exchange and reporting to coastwise traffic from other states – also under penalty.

Maryland and Virginia are currently developing their regulations, which will require reports of ballast water discharge characteristics from commercial ships under penalty.

On a national level, the National Invasive Species Council (a multi-agency group formed under Presidential Executive Order in 1999) has released a National Management Plan to minimise the risks and impacts associated with invasions by non-native species. The plan is inclusive of marine, freshwater, and terrestrial habitats, recommending action items across a broad range of topic areas – research, information management, control and management, education, and policy.

2 DELIBERATE INTRODUCTIONS AND TRANSFERS

2.1 Fish

Current information on fish introductions is pending and will be included in the report for 2001.

2.2 Invertebrates

The commercial shellfish industry relies heavily upon the culture and release of multiple non-native invertebrate species. Along the Pacific coast, these species include the oyster *Crassostrea gigas*, mussel *Mytilus galloprovincialis*, and clam *Venerupis philippinarum*. Non-native species cultured and released along the Atlantic coast include *Ostrea edulis*. Use of these species for fisheries represents an on-going activity.

In addition, limited experiments are being conducted to test the performance of the Asian oyster *Crassostrea ariakensis* in Chesapeake Bay waters. The proposed tests will use triploid oysters, and each individual is to be tested for triploidy prior to the tests.

Finally, a semi-terrestrial Nereid polychaete is routinely imported live into the U.S. from southeast Asia and used as bait in tidal waters along the Pacific and Atlantic coasts of the United States. Recent analyses have shown that many associated organisms (including diatoms, protists, nematodes, and bacteria) are transferred in the process. To date, no established introductions associated with this transfer have been reported. A more thorough analysis of live bait transfers into the U.S. is now under way by the U.S. Fish and Wildlife Service and Smithsonian Environmental Research Center.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Numerous non-native marine species, previously established in the U.S., have continued to spread. This pattern of continued range expansion within North America, often many years after the initial introduction, is evident for scores of species. Here, a few are used to exemplify the pattern.

A. Pacific Coast

The varnish clam *Nuttallia obsurata* has become established at many sites throughout Puget Sound, Washington, and is being reported in protected bays of Oregon. The southern-most record is for Coos Bay, Oregon.

The tunicate *Botrylloides violaceus* is established at multiple sites in Alaska, including Sitka and Tatilek.

To date, two specimens of the mitten crab *Eriocheir sinensis* have been reported from the Columbia River, Oregon, although it does not yet appear to be established there. (The spread of the mitten crab, and the crab *Carcinus maenas*, have become the focus of great concern along the western U.S., where possible management actions are being considered.)

B. Atlantic Coast

The crab *Charibdys helleri*, previously known from Florida, now is being found in South Carolina. Records include ovigerous females.

The crab *Hemigrapsus sanguineus* previously reported from Massachusetts to North Carolina has extended its northern range into Maine.

The polychaete *Ficopomatus enigmaticus* is now established in Chesapeake Bay.

Although the whelk *Rapana venosa* appears to be established and reproducing successfully in Chesapeake Bay, it has not yet been found outside to the north or south of the Chesapeake. This snail remains a serious concern with the

Chesapeake Bay region, due to its potential impact on commercially important bivalves (oysters and clams). In addition, the spread of the species to other bays appears possible via either larval dispersal or coastwise shipping (and ballast water transfer).

In addition to spread of non-native marine species within and among coasts of the United States, underscoring the potential importance of secondary human transfer mechanisms, new invasions are being detected. In particular, a great deal of attention is now focused on the Gulf Coast of the U.S., due to the appearance of a new colonial tunicate and a jellyfish. Although the taxonomic identifications have not yet been published, both species are believed introduced and have achieved great abundance. Although many mechanisms of introduction are possible, the transport of exploratory drilling platforms (with their intact communities) is now being considered and investigated as a potential source of many introductions to the region.

3.3 Algae and Higher Plants

The alga *Caulerpa taxifolia* was discovered in a small embayment near San Diego, California, and it appears to be the aquarium strain which has become invasive in the Mediterranean Sea. Due to the great concern about spread and impacts of this invasion, and the isolated nature of the established population, a substantial effort to contain and eradicate this invasion was undertaken. The effort was coordinated across multiple federal and state agencies and will include long-term evaluation of the success.

Parasites, Pathogens, and Other Disease Agents

Recent DNA evidence suggests strongly that the pathogenic protist *Haplosporidium nelsoni* (MSX), which has been known from the Chesapeake Bay and eastern North America since at least the 1950s, is introduced. The pathogen is one of two protists responsible for widespread mortality, contributing to the collapse of the oyster fishery in the Chesapeake – now at approximately 1 % of its historical yield. Although first detected half a century ago, it has remained uncertain whether this was an introduction or a native species. However, recent DNA analysis supports introduction from the Pacific, most likely with the oyster *Crassostrea gigas*.

7 MEETINGS, CONFERENCES, SYMPOSIA, AND WORKSHOPS

A minimum of 50 national and regional meetings occurred in the U.S. during 2000, in which the transfer and invasion of marine species was included or a primary focus. The number of papers presented on marine invasions has increased at meetings of biological societies (e.g., American Association for the Advancement of Science, American Society of Limnology and Oceanography, American Fisheries Society). In addition, scores of workshops and symposia on marine invasions, and especially ship-mediated transfer, were convened by state, regional, and national groups. It is now the case that each coastal region, if not state, has sponsored several such workshops and symposia during the past year – both to distribute information and to develop management and policy to prevent further introductions.

8 BIBLIOGRAPHY, RECENT PUBLICATIONS

See Annex 10

ANNEX 4: NATIONAL REPORT NON-ICES MEMBER COUNTRY- ITALY

NATIONAL REPORT FOR GEORGIA

No National Report was received. Relevant details are given in the Section: Highlights of National Reports.

NATIONAL REPORT FOR ITALY

Note: This report is the outcome of a special working group of the Italian Marine Biology Society (SIBM) on a voluntary basis. It does not reflect an official position or knowledge of the relevant Italian Government bodies.

It has been prepared according to the guidelines for National Reports; it updates the Italian status presented at WGITMO in Parnu, March 2000.

1 LAWS AND REGULATIONS

The Protocol for Protected Areas and Biological Diversity in the Mediterranean, issued during the Convention for the Protection of the Mediterranean Sea against Pollution, held in Barcelona (Spain) in June 1995 has been ratified by Italy in May 1999, entered into force on December 12, 1999 and all of its relevant new articles are to be officially considered in force.

Italy has adopted the European Directive of sanitary policy for aquaculture products 91/67/EEC, January 28, 1991 with decree of the President of the Republic (D.P.R.) N. 555, December 30, 1992. Directive 92/43/EEC, May 21, 1992 “Habitats” has been adopted with D.P.R. N. 357, September 8, 1997. Art. 12.3 of D.P.R. 357 declares that the introduction of alien species can be authorised only if a proper study has been conducted and only if the study has been favourably evaluated by either the National Institute for Wild Fauna or by another competent technical-scientific organisation assuring that neither natural habitats nor wild flora and fauna will be damaged.

National legislation in Italy delegates the authorisation and control for transfer and introduction of non-indigenous species to the Regions, that have issued a number of Regional Laws. Intended introductions of marine fish may exclusively occur prior the authorisation of the Regional Authorities and are subjected to sanitary inspection measures and veterinary controls also according to: Ministerial Decree (D.M.) N. 454, 1988; Law Decree (D.L.) N. 263, 1997 in accordance with the EEC Directive N. 93/53 (fish diseases). The common sanitary control measures in the regional laws, require:

- Certificate for introduction and control by Customs Offices;
- Establishment of an appropriate quarantine site for species preservation;
- Use of recirculated seawater systems and/or sterilisation of all the effluents from the facility;
- Sampling and sanitary controls to be carried out by the competent authority (Istituti Zooprofilattici Sperimentali) to monitor the health of the introduced species and the first generation of individuals.

Since 1996, the planning documents (4th and 5th Triennial Plan of Fishery and Aquaculture)—drawn out by the Ministry of Agricultural Policies (MiPA)—have analysed the principles of the precautionary approach to species introduction according to FAO. In July 1999, the board of directors of MiPA, in cooperation with FAO, promoted the Consultation for application of Article 9 of the FAO Code of Conduct for Responsible Fisheries (CCFR) in the Mediterranean region (1997). The Consultation stressed the need of controlling the introduction of new species in aquaculture, with the aim of establishing an effective public control on activities generally carried out by the private sector, to enforce forbiddance in appropriate cases, and assessing justification. New impact studies on non-indigenous species are also recommended to evaluate associated environmental risks.

2 DELIBERATE RELEASES

2.1 Fish

The introduced marine fish species used in aquaculture in Italy are *Paralicthys olivaceus* (Pleuronectidae), *Sciaenops ocellatus* (Sciaenidae) and *Pagrus major* (Sparidae). *P. major* has been introduced since the end of the 1980s and it is currently reproduced in several commercial hatcheries. Intensive breeding techniques have been adopted in land-based farms, yielding a 100 tonnes of production, approximately. The same species is also utilised for hybrid production with other sparids. Broodstock of *S. ocellatus* and *P. olivaceus* have been introduced since 1994. The juveniles, reproduced under controlled conditions, were cultured in intensive and semi-intensive systems. *S. ocellatus*, a rustic species resistant to a wide range of environmental conditions, has been recently observed in semi-natural habitats used for extensive aquaculture, the so-called "valli da pesca" in the Northern Adriatic. No new pathogens associated to this species have been reported for the time being. Studies and quantitative risk analysis are available to assess the potential genetic and disease impacts related to introduced species.

2.2 Invertebrates

The crayfish *Penaeus japonicus*, as well as *Penaeus monodon* and *Penaeus vannamei,* are reared in ponds using semi-intensive systems, but only once they have been recorded in an open habitat.

P. monodon introduction was planned under controlled and restrictive condition for semi-intensive rearing in ponds. The introduction of this species has underlined the risk of introducing pathogenic agents such as the *Baculovirus*, a pathogen to be notified to the OIE (Office International Epizooties) when using larvae and postlarvae. Fertilised eggs are preferred to reduce the risk of disease.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFER

3.1 Fish

Three new immigrants in the Mediterranean from the Atlantic Ocean, *Seriola carpenteri, Pisodonophis semicinctus* and the toadfish *Chaunax suttkusi* have been recently found.

A fourth new record of a fish species has been reported in 2000 from the small Island of Lampedusa, halfway from Sicily to North Africa. It belongs to the genus *Stephanolepis* cf. *dispros*, and is probably a Lessepsian migrant; some species of this genus have already established in the Eastern Mediterranean. Further taxonomic studies are in progress in order to confirm the identification.

The marlin *Makaira indica* has been also added to the list of the 2000 Italian report but was recorded in the 1980s.

3.2 Invertebrates

A few species will be commented here, in addition to the data presented in the 2000 report.

The Nudibranch *Doris bertheloti* has to be added to the list of exotics in the lagoon; it was recorded from 1974 to 1977 and not mentioned later on.

The whelk, *Rapana venosa* (Mollusca, Gastropoda) is widespread in the Northern and Middle Adriatic, the southern limit to date is Civitanova Marche (40 km South of Ancona). No damage to the mussel cultures or exploited clam beds has been reported.

At least two new species of the genus *Anadara* have been recorded in 2000 in addition to the established soft-bottom clam, *Scapharca (=Anadara) inaequivalvis* (Mollusca Bivalvia). *Anadara demiri* has been reported from the Middle Adriatic, while a different species, not yet identified, but different from *A. inaequivalvis, A. demiri* and *A. natalensis* (found in the Mediterranean but not in Italy), has been found in the Lagoon of Venice.

The mussel*, Musculista senhousia,* very abundant in the Adriatic brackish basins south of the Po River, has been found also in the Lagoon of Venice, even if in low numbers and scattered locations.

Dyspanopeus sayi (Crustacea, Decapoda) after having been the most widespread crab in the Lagoon of Venice, is now strongly reduced in many areas and has disappeared from the canals in the center of the town, where it used to have mass development.

Rhithropanopeus harrisi is now common in the brackish lagoons of the Emilia Romagna coast.

Pilumnus inermis might have been present along the Italian coast since a longer period than 1987, when found in the Messina Strait. It is associated with *Erinna aspera* and with Laminarians, and it is known also from the Sea of Alboran.

The most recent invading crab, *Percnon gibbesi,* found at Linosa Island in summer 1999, has been also found in another small island off Sicily, Lampedusa, together with the fish *Stephanolepis* cfr *diaspros.* The population is well established, comprising many adults, mature and young individuals. A few individuals have been observed also in the Ustica island and in the main coast of Sicily (Western sector),

The Bryozoan *Electra tenella*, has been recorded twice along the Sicilian coast in 1990, but the area has not been surveyed since then.

An interesting study of the coexisting populations of the introduced Ascidian *Botrylloides violaceus* and the autochthonous *Botrylloides leachi* in the Lagoon of Venice has shown that the competitive advantage of the former resides in the ability of withstanding temperatures as low as 10 °C in the active state while the latter undergoes wintering.

3.2 Algae and Higher Plants

Phytoplankton

Phytoplankton composition of the Adriatic Sea was studied since the 19th century, so the appearance of potentially toxic *Alexandrium* spp. was a recent new phenomenon. The very first appearance of *Alexandrium tamarense (=Gonyaulax tamarensis)* in the Adriatic Sea was August 1982, *Alexandrium pseudogonyaulax* was found in June-July 1987, *A. lusitanicum* in the same year.

It cannot be excluded, however, that cryptogenic species could be present, especially because of the occurrence of a large number of resting cysts in the shallow water sediments of this sea. For instance, in long core samples, cysts of *Gonyaulax grindleyi (=Protoceratium reticulatum)*, not known from historical lists and present in the plankton with small abundance in samples in the first years of 1990, displayed peaks of 4000 cysts per gram of sediment dating around 12.3 and 9.5 kg BP.

Phytobenthos

Two species have been added to the list of benthic algae reported last year: the Rhodophyta *Polysiphonia morrowii,* Harvey and the Pheophyta *Desmarestia viridis* (O.F.Muller) Lamouroux, both found in the lagoon of Venice.

The only introduced seagrass is *Halophila stipulacea,* apparently a Lessepsian species.

A recent set of studies on the two species of the green alga *Caulerpa* has investigated the relationships with autochthonous plants. Vegetative fragmentation plays a leading role in spreading of the tropical seaweed *Caulerpa taxifolia*. Fragment establishment varies in relation to season and a higher recruitment is found in summer especially in shallow waters. Competition between *Caulerpa taxifolia* and the autochthonous seagrass *Cymodocea nodosa* is enhanced in nutrient-enriched sediments, as the invasive weed has been found to grow faster at high nutrient supply outcompeting the seagrass. As far as interaction between *C. taxifolia* and the seagrass *Posidonia oceanica* is concerned it has been shown that dense *P. oceanica* meadows are likely to be less vulnerable to seaweed invasion, and that a meadow widely distributed and characterised by high shoot density should be more protected.

Competitive success of C*aulerpa racemosa* with *Posidonia oceanica* meadows is also a function of seagrass density and of edge-meadow orientation; unhealthy seagrass beds characterised by low shoot density are more susceptible to colonisation and seaweed penetration is higher on seagrass margins oriented towards the coastline. Competition between *C. racemosa* and *Cymodocea nodosa* seems to favour the expansion of another seagrass which usually occurs in the same habitat, *Zostera noltii*; hence, the introduced seaweed shows a contrasting effect on both native seagrasses modifying the interaction between the two. Areas colonised by *C. racemosa* experience decreases in cover, number and diversity of native macroalgal assemblages: turf and encrusting weed species are readily affected as soon as colonisation begins, while erect species have been shown to survive for one year after the invasion. Structural changes seem to be irreversible and even during winter, when cover and biomass of *C. racemosa* diminish, the indigenous macroalgal community does not return to its initial condition.

A survey of exotic algae was carried out in the enclosed and brackish sector of the Gulf of Taranto (Ionian Sea), the site of an active shellfish culture.

Caulerpa racemosa was recorded in small patches in the Mar Grande of Taranto near the Cheradi Islands (1996) and it actively propagated in this zone. More recently, it was collected in the Second Inlet of the Mar Piccolo, attached on both hard and soft substrata. In 1998, *Undaria pinnatifida* was collected in the Mar Piccolo of Taranto, where it arrived by means of the oysters imported from France. At the moment, the species is monitored monthly, to investigate its life cycle and propagation. *Agardhiella subulata* and *Solieria filiformis* were reported since the second half of the 1980s in the enclosed basin of Mar Piccolo di Taranto, where they now represent a consistent part of the drifting algal bed in the basin.

A follow up study on the introduced algae in the Lagoon of Venice has been carried out.

The introduction site has been invariably in the Chioggia sector, near the fish market and the sites where imported sea food (mainly shellfish) is treated. Both container water and part of fish food products are directly discharged in the lagoon canals.

Undaria pinnatifida since 1992 has gradually invaded the banks of the canals in the town of Chioggia and later those of the city of Venice. In Chioggia it is competing with *Sargassum muticum* and *Desmarestia viridis*, two other large brown algae. In the urban center of Venice no other large seaweeds are present and the development of *Undaria* has been more rapid. It has not reached other islands of the lagoon, nor the sand and stone barriers that separate the lagoon from the Adriatic Sea. The autochthonous species in the areas covered by *Undaria* have decreased in biomass but no extinction of species has occurred. The competition for space is won by *Undaria*, thanks to its large attachment organ. Some of the algal species succeed in overgrowing it, but are lost when it detaches from the substrate (usually in July). For an ephemeral few months the other algae find a bare substrate free, but are overgrown when *Undaria* returns. The competition for light has damaged photophilous species, that were already jeopardised by the increase in turbidity of Lagoon waters.

Sargassum muticum has taken more time to expand, being found until 1999 only in Chioggia and the nearby island of Pellestrina. A large population has been observed in 2000 and has increased in 2001 near the sea entrance of Lido, in direct connection with the city center of Venice. In that place it has outcompeted almost completely the large brown alga *Cystoseira barbata*.

Polysiphonia morrowii is a red alga known from Japan, China and Korea, and is recorded for the first time in the Mediterranean Sea. It was found in spring 1999 in Chioggia and in several places of Venice centre one year later.

Desmarestia viridis has been found in the same site of Chioggia as the previous ones. It poses a problem because the records of this or similar species are only four in the Mediterranean. One was in the Adriatic in 1849, another in Croatia in 1948 and the recent ones are from Etang de Thau (France, 1981) and from Malaga (Spain, 1984). It could also be an introduction from Asia with oysters.

Antithamnion feldmaniae was previously found only once at Leghorn (Tyrrhenian Sea) and has been found recently in Chioggia.

3.4 Parasites, Pathogens, and Other Disease Agents

Photobacterium damsela (sub sp. *piscicida*) (=*Pasteurella piscicida*) causative agent of Pasteurellosis and *Nodavirus*, a picorna-like virus associated with the encephalopathy of some marine fish species (notifiable to the Office International Epizooties), were introduced in Italy with live fry imported for aquaculture purpose. Scientific reports indicated the first introduction of *P. piscicida* occurred in north Adriatic valli in 1992 and then spread along the Italian coast. Viral encephaloretinopathy was introduced in 1995; the risk of spread was suddenly underlined and specific control measures are under study.

7.0 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS ON INTRODUCTIONS AND TRANSFERS

Under contract of the Italian Ministry for the Environment (Inspectorate for the Defence of the Sea) the Italian Society of Marine Biology (coordinators Giulio Relini and Anna Occhipinti) has performed a survey of the ports of Genova, Salerno and Palermo. The final report on the activity, aimed at preparing the information basis and guidelines for regulatory activities in the field of marine biological invasions, is due in June 2001. The report will include sheets illustrating the main introduced species.

The study group of the Italian Society of Marine Biology on invasive species has met at Sharm el Sheik (Egypt) on May 2000.

8 BIBLIOGRAPHY

See Annex 10

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ANNEX 5: EXOTIC CIRRIPEDIA BALANOMORPHA FROM BUOYS OFF THE BELGIAN COAST

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Introduction

During recent years much attention has been given to the occurrence of non-indigenous species in Europe. This has resulted in many papers and reports on the subject. Recent overviews for the situation in Northwest Europe are given by Bouderesque *et al.,* (1994), Eno *et al.,* (1997), Munro *et al.,* (1999), Nehring & Leuchs (1999) and Reise *et al.,* (1999).

With the increase of transcontinental shipping activities, the chance for the dispersion of species into new habitat increased. As a result, many exotic species reached European waters as fouling, in ballast or in bilge water, or via aquaculture activities.

In particular barnacles, well-known fouling species, took advantage of the opportunity to reach new regions which they successfully colonised (Bishop, 1951; Southward, 1975). Many barnacle species expanded their geographical range worldwide, an evolution which is still going on (Zullo 1992). As Newman & Ross (1976) stated: “we are living in the age of barnacles”.

The most recent checklist of the Belgian cirriped fauna lists only five Cirripedia Balanomorpha: *Elminius modestus* (Darwin, 1854), *Semibalanus balanoides* (Linnaeus, 1767), *Balanus crenatus* Bruguière, 1789, *B. improvisus* Darwin, 1854, and *B. balanus* (Linneaus, 1758) (Van Frausum 1989). She based her checklist on samples collected in 1985 and on the collections of the Royal Belgian Institute of Natural Sciences. Van Beneden (1861) was the first to give a list of the Belgian crustacean fauna. He only mentions one balanomorph species. As he had no access to the work of Darwin (1854), he clearly mixed up under the name of *B. ovularis*, at least *S. balanoides* and *B. crenatus*. Subsequently, Pelseneer (1881a,b; 1882), added two more species namely *B. perforatus* Bruguière, 1789 and *Megabalanus tintinnabulum* (Linneaus, 1758). As he too did not have the work by Darwin at his disposal, he stated that he was not able to distinguish between the white intertidal species, although he noticed the occurrence of several species. Next, Lameere (1895) lists four species. He was the first to make the difference between *S. balanoides*, *B. crenatus* and *B. improvisus.* In addition he also includes *B. balanus*. As such, *B. balanus* is not a true member of the Belgian fauna, since it is a boreal deepwater species brought to the Belgian coast by fishermen. This species was also collected farther off shore by Gilson during his sampling campaigns “Explorations de la Mer” in the early 1900s. As his material was deposited in the collections of the Royal Belgian Institute of Natural Sciences, Van Frausum (1989) added this species to her list.

In his checklist of the Dutch and Belgian fauna, Maitland (1897) made a synthesis, including all the species known at that time from the coastal waters of Belgium and the Netherlands. He lists seven species. Besides the species already mentioned above, he added *Balanus hameri* (Ascanius 1767), which similar to *B. balanus* is a deepwater species that was included in the checklist, due to its occasional occurrence in the catch of trawlers. Maitland (l.c.) states furthermore that *B. perforatus* was only known for Belgian waters and that *M. tintinnabulum* and *B. hameri* were only occasionally recorded.

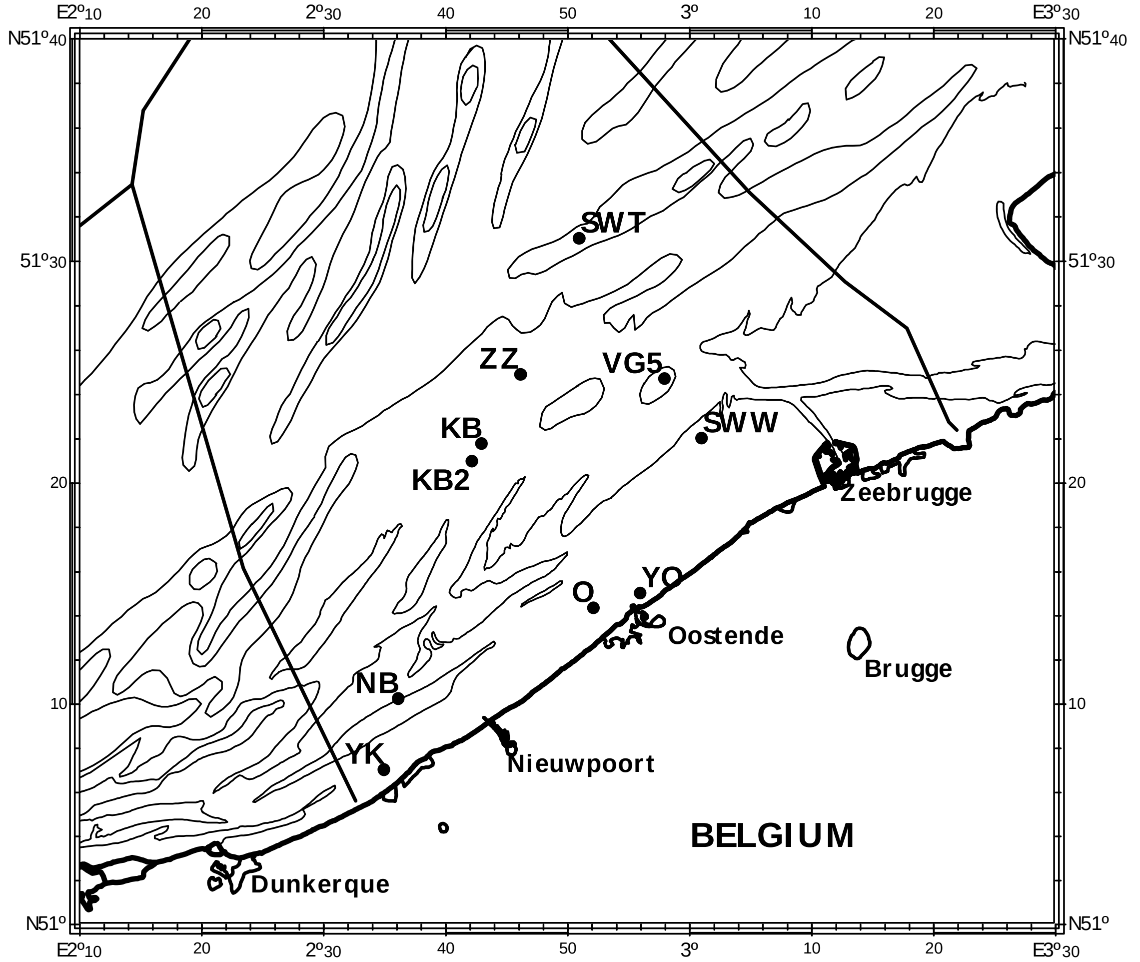
Material and Methods

The North Sea and the Channel are amongst the most heavily sailed seas worldwide. In the nearshore areas buoys demarcate the sailing routes and the subtidal obstacles for vessels. The buoys positioned in the Belgian coastal waters serve mainly the shipping routes for the harbours of Oostende, Zeebrugge, Vlissingen and Antwerpen (Figure A5.1). These buoys are fairly large objects measuring up to 6 metres high above the sea surface and with a hull of approximately 3 metres diameter. Further inshore a much smaller type of buoy is being deployed in summer for navigational purposes of recreational sailing and shipping (so-called “yacht-buoys”). All buoys investigated were located within 25 km off the coast. The organisms found on them thus belong to the Belgian fauna.

In the Belgian coastal zone 184 buoys are present, of which 56 were investigated between November 1997 and November 1999. Shortly after the buoys were brought ashore the hull was examined for sessile fauna. These surveys were not performed in a systematic way and no quantitative data can be produced. The main focus was given to specimens having a conspicuously different habitus from the species constituting the local fauna, i.e. the two native species *Semibalanus balanoides* and *Balanus crenatus* and the two introduced species *B. improvisus* and *Elminius modestus*.

Both empty and live specimens were collected. The species was determined and the rostro-carinal length was measured. If possible, the age class of the specimens and their reproductive condition were also noted.

Figure A5.1. Map of the Belgian coastal waters showing the position of the buoys on which exotic cirripeds were found. KB, Kwintebank - KB2, Kwintebank 2 - SWW, Southwest Wandelaar - SWT, Southwest Thornton - NB, Nieuwpoort Bank Buoy - O, Oostende (Sparboei) - YK, Yacht buoys Koksijde - YO, Yacht buoys Oostende - ZZ, Zeebrugge Zand - VG 5, Vaargeul 5 -.



Results

*Semibalanus balanoides***,** *Balanus crenatus*, *B. improvisus* and *Elminius modestus* occurred on all of the 56 buoys. We have no data on the relative abundance of each of these species but *E. modestus* dominated the barnacle fauna of most of the buoys. In 11 occasions out of the 56 cases investigated exotic cirripeds were present, belonging to seven species: *B. amphitrite*, *B. reticulatus*, *B. variegatus*, *B. trigonus*, *B. perforatus*, *Megabalanus coccopoma* and *M. tintinnabulum*.

Table A5.1 summarises how many specimens of each of these species were found on the different buoys. Figure A5.1 presents a map of the Belgian coastal waters showing the position of the buoys on which exotic cirripeds were found. In the following, species by species, the results of the field survey and of the literature survey on the past and recent distribution are given.

Table A5.1. Observations of the new exotic species found on 11 buoys from the Belgian coastal waters.

Buoy	**Immersion period**	***Balanus amphitrite***	***Balanus variegatus***	***Balanus reticulatus***	***Balanus trigonus***	***Megabalanus coccopoma***	***Megabalanus tintinnabulum***	***Balanus perforatus***
Kwintebank	05/97 – 11/97	16	1	5		10		
Kwintebank 2	03/97 – 10/98	1						
Southwest Wandelaar	07/97 – 03/98	1				2	1	
Southwest Thornton	11/96 – 08/98	1				3	1	3
	08/98 – 12/98	1				1		1
Nieuwpoort Bank	06/97 – 10/98	5			1	3		
Oostende (Sparboei)	04/98 – 10/98	Numerous					1	
Yacht buoys Koksijde	04/98 – 10/98	Numerous						
Yacht buoys Oostende	04/98 – 10/98	Numerous						
Zeebrugge Zand	01/98 – 08/98					1		
Vaargeul 5	12/98 – 11/99	2	4					

Table A5.2. Classification of the 11 balanomorph cirripeds into five faunal categories.

	Native	**Non-native**	**Alien**	**Cryptogenic**	**Vagrant**	**New record for Southern Bight**	**New autochthonous record**
S. balanoides	*						
B. crenatus	*						
B. improvisus		*		?			
E. modestus		*					
B. amphitrite		*					
B. reticulatus		*?				*	*
B. variegatus		*?				*	*
B. trigonus			*				*
B. perforatus			*		?		
M. coccopoma		*				*	*
M. tintinnabulum			*				

Balanus amphitrite Darwin, 1854

We found *Balanus amphitrite* on all but one of the eleven buoys (Table A5.1). On the smaller inshore buoys this species was so numerous that their numbers were no longer recorded. *B. amphitrite* is a cosmopolitan tropical and subtropical species (Newman & Ross 1976) that normally occurs intertidally, often in brackish waters (Henry & McLaughlin 1975). It is a typical fouling and harbour species well capable of withstanding lowered salinities (Southward 1975; Utinomi, 1960). It is often abundant in habitats exposed to physical stress and pollution (Lipkin & Safriel 1971; Shkedy *et al.,* 1995; own observations). It is even capable of withstanding covering with oil.

Based on fossil records its origin is believed to be the Southwestern Pacific and Indian Oceans (Eno *et al.* 1997), possibly the Hawaiian Islands (Utinomi 1960). From this mid-Pacific area it may have spread much earlier and more rapidly in all seas than did *Elminius modestus.* However, Davadie (1963) and Menessini & Casella (1988) describe European fossil records of *B. amphitrite*. It has been introduced in the U.K. in 1937 and in the Eastern Channel North to 49°N it formerly only appeared in artificially warmed harbour environments (Bishop 1950; Southward and Crisp 1963; Hayward and Ryland 1999). The species is common in the Mediterranean (Rellini 1980; Kououra *et al.*, 1998) while along the Iberian and French Atlantic coast it occurs in intermittent populations, predominantly in harbours (Fisher-Piette & Prenant 1956, 1957; Bishop *et al.,* 1957). Early French records date back to 1914 from La Rochelle at the Atlantic coast and to 1928 from the harbour of Le Havre in the Channel (Prenant 1929), where the species is still present (Breton *et al.*,1995).

Bishop (1950) found it in Shoreham in 1937, which constituted the most northern distribution at that time (Crisp & Molesworth 1951). The species has gradually extended its distribution to the east of Le Havre and was recorded for the first time in the Southern Bight of the North Sea in 1962 (Borghouts-Biersteker 1969). In 1983 the species was found for the first time in the harbour of Dunkerque (Davoult *et al.,* 1993) where it is now very abundant in the whole harbour region (own observations). All of these records were made in harbour environments where the water temperature was artificially raised.

The first autochthonous record for Belgium was made in 1995 when it was found on a groin in Koksijde (Kerckhof 1996). One year later Kerckhof (1997) found it to be very abundant in the harbours of Oostende and Nieuwpoort. In both harbours the water temperature is not artificially raised. In the open harbour of Nieuwpoort it was present only on the hulls of yachts, in the harbour of Oostende also on the masonry of the docks and on other harbour constructions. In Oostende the species is now outcompeting *B. improvisus.*

The first French and Belgian records were probably made far too late to picture the true spread of *B. amphitrite* along the eastern part of the Channel and the Southern North Sea. Bishop (1950) recorded the species from a motor launch that operated in 1917 between Dover and Dunkerque making an earlier presence in Dunkerque likely. Material from the Royal Belgian Institute of Natural Sciences in Brussels showed that in 1952 Leloup collected some specimens near an oyster farm in the harbour of Oostende. These have later been misidentified as *Megabalanus tintinnabulum*. This record has never been published.

In the tropical and subtropical areas *B. amphitrite* occurs abundantly in the intertidal zone of sheltered coasts, usually below the mean seawater level. In the more northern temperate areas, such as the Japanese and Californian coasts, the species is generally restricted to quiet bays or harbours of enclosed water (Utinomi 1960). The occurrence of this species in fully marine conditions is noteworthy since it is known as a harbour species capable of withstanding lowered salinities (Southward 1975). *B. amphitrite* has been recorded before in southwestern Europe outside harbour environments in fully marine conditions, for instance on buoys (Crisp & Molesworth 1951; Kish 1958). The occurrence on the buoys could result from colonisation from the harbours. Yet, the presence of two-year-old individuals and gravid individuals on the buoys indicate that the species is capable of surviving the winters and reproducing within the area even outside harbour areas.

Balanus reticulatus Utinomi, 1967

Five live specimens of *Balanus reticulatus* were found on the Kwintebank buoy. This species had not been recorded before for the area. Utinomi (1967) described it originally from Japan, where it occurred in fully marine conditions (Utinomi 1967, 1970). He remarked that it probably had a worldwide distribution due to transportation by ships, but escaped attention owing to the resemblance with *B. amphitrite*. Later Southward (1975) indeed gives evidence for its worldwide distribution and Henry & McLaughlin (1975) describe its circumtropic distribution. Southward (1975) noted that it was less a fouling species than *B. amphitrite* and was mostly restricted to sublittoral conditions with normal or moderate salinity. Utinomi (1970) remarked that before World War II this species was predominant rather than *B. amphitrite* but now apparently does not occur in the Sea of Japan.

The species is figured by Southward & Crisp (1963) (as *B. amphitrite* variety), as occurring throughout the tropics on ships and therefore as a likely candidate for introduction into European waters. In the Mediterranean it was sampled at Toulon harbour in 1977, in the fouling community from a ship arriving from the Indian Ocean (Zibrowius 1991). During the summer of 2000, we found many live specimens on the hull of a Belgian Navy vessel one month after its return from the East-Indian archipelago.

***Balanus variegatus* Darwin, 1854**

We found 5 individuals of *Balanus variegatus* on two buoys (Table A5.1). Similar to *B. amphitrite* we found gravid and two-year-old individuals indicating a potential to maintain self-sustaining and self-regulating populations within the area. *B. variegatus* has not been observed before in the area. This Indo-Pacific species (Henry & McLaughlin 1975) is also typically found on man-made structures in rather sheltered bay waters (Utinomi 1968; Foster 1978). Like *B. amphitrite* it is also mainly a harbour species, being able to withstand varying salinities and pollution (Henry & McLaughlin 1975).

***Balanus trigonus* Darwin, 1854**

We found only one empty specimen of *Balanus trigonus* on an offshore buoy. *B. trigonus* is a species of tropical and warm temperate seas. The species is common in the Mediterranean (Relini 1980; Kououra *et al*., 1998). In the eastern Atlantic, the northern limit of its distribution is believed to lie somewhere along the Atlantic coast of the Iberian Peninsula (Zullo 1992). *B. trigonus* is sometimes recorded in intertidal locations but is more common in the sublittoral. It has been found growing on a variety of substrates: on the external skeletons of living invertebrates, inside sponges and sometimes completely covering all sorts of floating objects. It is a euryhaline species and is relatively intolerant to both high and low temperatures (Werner 1967). In the Mediterranean and on the Atlantic coast of Africa it often occurs together with *B. perforatus* (Zullo 1992).

For the southern North Sea no autochthonous records are available. Only one record of a specimen on a drifting object was made for the Netherlands (Adema 1990). As a common biofouler the species was several times recorded in Great Britain from ships returning from warmer areas and on drifting objects (Bishop 1947; Bassindale 1964). According to Zullo (1992) the species seems to expand its geographical range in the Atlantic northwards. He suggests the species was introduced into the South Atlantic in the late 1860s by ships from the Pacific and Indian Ocean and assumes that it was brought to the Central and North Atlantic by whaling ships. Darwin (1854) did not mention *B. trigonus* from the Mediterranean, where the species was not recorded until the 1920s. It was unknown to the Atlantic and Gulf coasts of the U.S. until the 1950s.

***Balanus perforatus* Bruguière, 1789**

On the Southwest Thornton Bank buoy we observed specimens of this species twice. *Balanus perforatus* is an eastern Atlantic warm-water species, occurring commonly in the Mediterranean (Relini 1980; Kououra *et al*., 1998). Its range extends southward to the northwestern coast of Africa. Along the Channel, it occurs up to the Isle of Wight (Stubbings 1967). In the southern North Sea, the species is regularly found on floating objects washed ashore (Pelseneer 1881; Huwae 1985; own observations). In 1978 it was recorded from buoys off the Dutch coast (Buizer 1978, 1980).

Pelseneer (1882) gives autochthonous records from the Belgian coast. He reports finding this characteristic barnacle, although not abundant, in 1882 on the piers of Blankenberge and Oostende. Amongst the common white species of intertidal barnacles, different to *B. perforatus,* the presence of this species was conspicuous. Maitland (1897) includes this species in his checklist, but it was omitted in the later checklists. It is possible that in the last century *B. perforatus* spread temporally to the northeast, but later its range declined again. In 1982 its presence was noted in the harbour of Boulogne (Davoult *et al.,* 1993). the species is possibly again extending its distribution northeastwards and should therefore be regarded as a vagrant.

B. perforatus is a shallow-water species common on wave-exposed shores. It is usually found near the low water mark and does not extend far into the subtidal zone. It may be found as high as mid-tide level on suitable places. Near the northern limit of its distribution it tends to be confined to the sub-littoral and to embayed positions (Bassindale 1964). In the lower shore regions of the Southern Bight it could be in severe competition with *B. crenatus* where the latter is the dominant species. The hatching period of nauplii of *B. crenatus* starts earlier and lasts longer than that of *B. perforatus*. The period of settling of the cyprids is also later and shorter in *B. perforatus* (Bassindale 1964). This might cause difficulties for *B. perforatus* to establish itself, e.g., on the groins along the Belgian coast.

B. perforatus is the largest common shore barnacle of northwest Europe, but on floating objects usually only small individuals occur. However, on the buoys the specimens are much larger. The fact that specimens of this species living on buoys were growing faster and larger than other individuals was already noted by Bishop *et al.* (1957).

***Megabalanus coccopoma* (Darwin, 1854)**

We found the species on quite a number of buoys and on one occasion in relatively high numbers (Table A5.1, Kwintebank: 10 live specimens). *Megabalanus coccopoma* originates from the tropical eastern Pacific coasts of Central and South America. The species has been "successfully" introduced in Southern Brazil (Lacombe & Monteiro 1974). It is a common littoral barnacle found in shallow marine waters (Newman & McConnaughey 1987). These authors typify *M. coccopoma* as a typical fouling species preferring clean man-made structures to settle.

Buizer (1978) records *B. perforatus* from buoys off the Dutch coast. In a re-examination of his material Buizer (1980) admits he first wrongly determined some of the specimens as *B. perforatus* and considers them now to belong to *M. tintinnabulum*. However, we had reasons to believe he misidentified specimens of *M. coccopoma* as *M. tintinnabulum*. The photographs in Buizer's (1978) publication of the terga and the scuta actually show that he was dealing with *M. coccopoma*. *B. perforatus* has indeed sometimes a deep red coloured appearance like *M. coccopoma*. This is further substantiated by the fact that Buizer (1980) did not have the revision of Henry & McLaughlin (1986) at his disposal, which would have helped him identify the specimens. Therefore we asked Buizer to re-examine his material and indeed he now also admits that he was dealing with *M. coccopoma*.

To our knowledge the first European record of this species was made in 1851 in Le Havre probably originating from a ship's hull (Nilsson-Cantell 1932). Newman & McConnaughley (1987) state that *M. coccopoma* is an unlikely candidate for transport with ballast water. Given its restricted distribution we could argue that the occurrence of this species in coastal waters is due to the settlement of larvae released by individuals occurring within the area. Indeed, we did find two-year-old and gravid individuals leading us to believe the species has the potential of forming a self-sustaining population within the southern North Sea.

***Megabalanus tintinnabulum* (Linneaus, 1758)**

We found *Megabalanus tintinnabulum* on three different buoys (Table A5.1). This cosmopolitan species has been recorded several times washed ashore on the Dutch and Belgian coasts (Pelseneer 1881a, 1881b; Holthuis & Heerebout 1972; own observations). Like *Balanus amphitrite, M. tintinnabulum* is a well-known fouling species.

M. tintinnabulum is one of the best known sessile barnacles. For three or four hundred years it has constantly been brought into almost every port in the world. There are many records from the 18th and 19th century, most specimens originating from fouling of ship hulls. As such it is well represented in many museum collections. Our observations, however, are the first autochthonous records for the Belgian coast and also for the Southern Bight, because Buizer's records of *M. tintinnabulum* (Buizer 1980) for the Dutch coast are in fact *M. coccopoma,* as mentioned earlier.

Discussion

In this paper we adopt the definitions given by Eno *et al.,* 1997. Accordingly, we distinguish four categories of species. "Native species" are the ones that occur in the region within its natural range and dispersal potential. Introduced species are those species that, as a result of human activity, occur in a region outside their natural range. A non-native species is an introduced species that has become established in the wild and has self-maintaining populations. Alien species are introduced species incapable of establishing self-maintaining populations without deliberate intervention by man. Sometimes, the term alien species is used in a broader sense, e.g., by the IUCN and is simply used as a synonym for introduced (non-indigenous, exotic) species. In the above definitions the role of human action in the spreading is emphasised. Species may also spread by natural means. Vagrants are those species that by natural means move outside their natural range, and which do not establish a self-maintaining, self-regenerating population in the new region. If they do form self-maintaining populations, the term "recent colonist" is used by Eno *et al.,* (1997). Cryptogenic species as defined by Carlton (1996) and adopted by Eno *et al.,* (1997) are those which are not demonstrably native or introduced.

As shown in Table A5.2, only 2 of the 11 barnacle species found are definitely native. The other 9 are either introduced or vagrant.

Possibly one of the earliest barnacles introduced into the southern North Sea was *Balanus improvisus* followed by *B. amphitrite.* Both are closely related (Henry & McLaughlin 1975) and well-known foulers with a marked preference for ships' hulls (Darwin 1854; Broch 1924; Bishop 1951, Utinomi, 1960).

As older cases are not always well documented, it is often unclear whether a certain species has really been introduced or not. It is often difficult to establish the true origin and the moment of introduction. Mainly in Scandinavian and Baltic publications, *B. improvisus* is considered as a species introduced from warmer seas (Broch 1924; Nilsson-Cantell 1978) or from (North) America (Gislén 1950; Reise *et al*., 1999). The species may also have been introduced in the 19th century into the Baltic, where it has been spreading during the past decades (Gislén 1950; Nilsson-Cantell 1978). Reise *et al.,* (1999) and Nehring & Leuchs (1999) included it in their lists of exotic species. Many other, mainly Dutch, French and English publications, e.g., Bassindale (1964) and Huwae (1985), do not even mention a possible exotic origin. The species is simply regarded as autochthonous to the cirriped fauna of the region. *B. improvisus* is not mentioned by Eno *et al.,* (1997). Darwin (1854) mentions *B. improvisus* from England and, though with a question mark, also from Belgium. However, as Hoek (1876) pointed out, the species was already recorded from Holland as early as 1827. This is much earlier than 1854, the date of the first description by Darwin. Even in the Southern Baltic the first record of *B. improvisus* dates back to 1844 (Gislén 1950). This is also earlier than 1850, the year given by Reise *et al.,* (1999). The problem is that before, and even decades after the publication of the work by Darwin, the species was not properly recognised, as it was difficult to make the difference between *B. improvisus, B. crenatus* and *Semibalanus balanoides*, all three, white intertidal barnacles of a similar size (Van Beneden 1861; Hoek 1876; Pelseneer 1882).

According to Davadie (1963) and Newman & Ross (1976) there where no reliable fossil records of *B. improvisus.* However, Menesini & Casella (1988) found it to be present in the Pliocene of the Almeria Province, Southern Spain. We recently found *B. improvisus* in archaeological material from Antwerpen, Belgium, dating back from the 17th century. If this species is really an introduction, it must have been an early one, probably comparable with the bivalve *Mya arenaria* Linneaus, 1758. This species invaded the European coast probably between the 13th and the 17th century for the second time after its disappearance during the glaciation of the Pleistocene (Strasser 1999). Maybe Gislén (1950) is right in supposing that *B. improvisus* reached Europe with trading vessels from America.

Also in the case of *B. amphitrite*, the second introduced barnacle, it is unclear where and when it reached Europe for the first time. Darwin (1845) already mentioned the species from the Mediterranean and the Portuguese coast. However, in the early 1900s it was recorded for the first time for the Channel area (Prenant 1928).

These two earlier introductions were followed by the well-documented case of *Elminius modestus*. This species, originating from Australia and New Zealand, reached Europe between 1940 and 1943 (Bishop 1947; Crisp 1958). While *E. modestus* now dominates the local fauna, none of the three exotics have been able to outcompete the two native species *S. balanoides* and *B. crenatus*.

We regard the following species as non-native: *B. amphitrite*, *B. improvisus*, *B. variegatus*, *B. reticulatus, E. modestus* and *Megabalanus coccopoma*. As the status of *B. improvisus* remains unclear, this species could be regarded as cryptogenic. *B. improvisus*, *B. amphitrite* and *E. modestus* are already forming extensive populations in the Belgian coastal waters. For the remaining species we consider our observations of gravid and/or two-year-old individuals indicative for their classification as non-native. However we question this status for *B. reticulatus* and *B. variegatus* due to the low number of records. They both belong to the "*B. amphitrite* group" (Henry & McLaughlin 1975). Regarding the evolution of some other members of this group, like *B. amphitrite* and *B. improvisus* they may have the potential to become non-native. Especially *B. reticulatus* is probably a regular fouling species (Zullo 1992; own observations).

Buoys are very favourable habitats for cirripeds. We not only found a large species diversity but the individuals were also larger. Caspers (1952) and Buizer (1978) already mentioned this.

Like all submerged objects, buoys are subject to fouling. The succession of settling follows classic patterns. On buoys the "mature" situation is the *Mytilus edulis* (Lineaus, 1758) association. At this stage the hull of the buoy is completely covered with a thick layer of mussels, sometimes accompanied by oysters, *Crassostrea gigas* (Thunberg, 1793). This forms a major difference with fouling on ship hulls where the mussel layer never grows so thick (Caspers 1952). This thick mussel layer suffocates all earlier settled organisms and inhibits new settlement. After settlement of the mussels the barnacles disappear. Consequently, we only observed exotic cirripeds on a small number of buoys and only on those that had been in place for a limited period of time. During storms, collisions with ships or simply due to its own weight, parts of the mussel layer can drop off the hull, leaving clean areas that are available for new settlement of barnacles. Since the buoys are left at sea no longer than 2 years and are completely cleaned before replacement, they form only a temporary habitat. Barnacles colonise the empty surface of the hulls very quickly. They suffer less from competition with other barnacles or other organisms. Crowding only rarely hampers their occurrence, especially with the offshore buoys where plankton densities are much lower. Consequently larvae of rare species get the opportunity to settle and a higher diversity is obtained. *B. perforatus* will take advantage of this. Noteworthy is the absence of *Verruca stroemia* (O.F. Müller, 1776) on the buoys although this species is also commonly found on drifting objects (own observations). When exotics occurred on the buoys we often found several species (Table A5.1).

Some of the recorded species occur predominantly in man-made and heavily disturbed habitats. Such substrates are in general very suitable for invasive species (Den Hartog & Van der Velde 1987). Buoys are thus ideal habitats. This is also shown by the fact, already mentioned above, that the barnacles seem to grow faster and become larger on the buoys.

The use of antifouling without TBT does not seem to affect their occurrence. Once a silt/microbial layer has been formed, nothing seems to stop settlement of cirripeds. Barnacles incorporating the antifouling paint into their shell have been observed (Neu 1932; own observations). Additionally many of these exotic barnacles are quite resistant to pollution.

Traditionally, shipping has been considered a major route of introduction (Carlton 1998). The amount of transoceanic shipping increased greatly and modern vessels tend to move faster through the waters. Cirripedia can be transported as fouling on the hulls of the ships or as larvae in ballast water.

The Southern Bight has dense ship traffic. Both the Kwintebank and the Kwintebank 2 buoys are situated near an anchorage area where ships await piloting to the harbours of Zeebrugge, Vlissingen or Antwerpen. Ships start emptying their ballast water before entering the coastal zone. Indeed, ballast water in most cases contains larvae of Cirripedia (e.g., Carlton 1985; Carlton & Geller 1993; Lavoie *et al.* 1999). Larvae released from ballast water will thus settle on the buoys. Many of the exotic species are littoral or harbour species that are susceptible to transport in ballast water. One might question whether, after the long stay in the ballast tanks, the larvae are still viable and able to settle in the new environment. Newman & McConnaughley (1987) for instance strongly doubt that *M. coccopoma* is capable of surviving in ballast water. Larvae may also originate from gravid individuals present on ships. In the case of *B. amphitrite* the important autochthonous population will supply most of the larvae to the buoys.

Besides travelling with ships and favourable physical factors, recent climate changes favour the establishment and survival of sub-tropical and tropical species in the coastal waters of Europe. There is the fact of the global warming (e.g., Delworth & Knutson 2000). Especially for the North Sea the past decade was the warmest of the century and the mean sea temperatures during the first half of the year have been higher than during the previous three decades (O'Brien *et al.* 2000). Consequently warm-water species may survive or reproduce and the larval stage has a better chance of survival and settlement. Small increases in temperature may already cause improved reproduction for some of the species under consideration (Platel & Crisp 1960). Yearly and decadal cycles in temperature fluctuations have an effect on the abundance and the occurrence of barnacles (Southward 1991).

More exotic barnacle species may take advantage of the favourable habitat characteristics of the buoys and the recent climate changes. There are of course many candidates but especially species from the *M. tintinnabulum* group such as *M. tulipiformis* (Ellis, 1758) or from the *B. amphitrite* group such as *B. eburneus* Gould, 1841 may reach the Southern Bight as well. We found *M. tulipiformis* along the coast of Portugal and it is known from the Bay of Biscay (Kish 1958). *B. eburneus* has been recorded in the Netherlands (Stock 1995). This American subtropical species was probably introduced in Europe during the last century. It is now locally common in harbours in Spain and the French Atlantic coast (Bishop *et al.* 1957; Southward & Crisp 1963). The species was also present in 1997 on the hull of a yacht in the harbour of Nieuwpoort that returned from the Caribbean.

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See bibliography in Annex 10.

ANNEX 6: REVISED GUIDELINES FOR PREPARATION OF WGITMO NATIONAL REPORTS

1.0 LAWS AND REGULATIONS: New, revised, or amended laws, regulations, policies, or guidelines on introductions and transfers of marine organisms

2.0 DELIBERATE RELEASES: Species deliberately released or held in open waters
To be included here are:
(1) releases with the expressed intent of establishing new populations
(2) hatchery-reared species that are subsequently placed out into open waters for grow-out, by government agencies or industry, and under conditions such that the species could reproduce and release gametes, larvae, or postlarval juveniles into the open environment
(3) releases with the intent of experimental evaluation, but under conditions such that the species could reproduce and release gametes, larvae, or postlarval juveniles into the open environment
2.1 Fish
2.2 Invertebrates
2.3 Algae and Higher Plants

3.0 ACCIDENTAL INTRODUCTIONS AND TRANSFERS (details on introducing vectors should be included here wherever possible, see vector list)
3.1 Fish
3.2 lnvertebrates
3.3 Algae and Higher Plants
3.4 Parasites, Pathogens, and Other Disease Agents

4.0 LIVE IMPORTS
To be included here are:
(1) Species held in open waters prior to use but without the intention of establishing the species in the importing country
(2) Species imported directly for consumption (not held in open waters prior to use), but which, through the activities of industry or the public, could be released into the open waters of the importing country
4.1 Fish
4.2 Invertebrates
4.3 ALGAE and Higher Plants

5.0 LIVE EXPORTS TO ICES MEMBER COUNTRIES
5.1 Fish
5.2 Invertebrates
5.3 Algae and Higher Plants

6.0 PLANNED INTRODUCTIONS OF NEW SPECIES
6.1 Fish
6.2 Invertebrates
6.3 Algae and Higher Plants

7.0 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS ON INTRODUCTIONS AND TRANSFERS

8.0 BIBLIOGRAPHY

ANNEX 7: DATABASES RELATED TO INVASIVE SPECIES

Collected at the ICES ITMO meeting, Barcelona March 2001:

1) Bulletin Board for marine pests (e-mail) marine-pests@hba.marine.csiro.au

2) Information for Baltic Region: http://www.ku.lt/nemo/mainnemo.htm

3) Information for Mediterranean Region: http://www.ciesm.org (Atlas Preview) including site for *Rapana* information http://www.ciesm.org/atlas/Rapana venosa.html/ http://com.univ-mrs.fr/gisposi/gisposi.htm

The GIS Posidonie bibliographic database on the spread of the tropical algae Caulerpa taxifolia in the Mediterranean Sea is now available at the following web address: http://www.com.univ-mrs.fr/basecaul [in French]

4) UNESCO-IOC Project Global Directory of Marine (and Freshwater) Professionals: http://ioc.unesco.org/glodir/default.htm

5) Centre for Research on Introduced Marine Pests (CRIMP) (Australia)

A database of non-indigenous species established in Australian waters was compiled by CRIMP. The folder contains more than 75 records including taxonomical remarks of the species (picture), area of origin, the current distribution, associated effects / impacts to the environment and economy (Furlani 1996).

Distribution information available at: http://www.ml.CSIRO.au/~spinks/CRIMP/index.html

6) Database on identification material (Inger Wallentinus) and material from Christina Jansen (not available on the Internet)

Jansson, K. (1994): Alien Species in the Marine Environment. Introductions to the Baltic Sea and the Swedish West Coast. Swedish Environmental Protection Agency, 68 pp.

7) Russian Group on Aquatic Alien Species (GAAS), located at the Russian Academy of Sciences: http://www.zin.ru/projects/invasions/

8) GISP website: http://jasper.stanford.edu/gisp/invfeatures.htm

9) List of top 100 invasive species: www.issg.org with overview at www.issg.org/database/welcome

10) IUCN Guidelines for the prevention of biodiversity loss caused by invasive species: http://iucn.org/themes/ssc/pubs/policy/invasivesEng.htm

11) Norwegian database: http://www.naturforvaltning.no/

12) Database for the North Sea (not available on the Internet)

Reise, K., Gollasch, S. & Wolff, W. J. (1999): Introduced marine species of the North Sea coasts. Helgoländer Meeresunters. 52, 219-234

13) Alien species in Finland : http://www.vyh.fi/luosuo/lumo/lumonet/aliens.htm

14) Canadian Biodiversity Information Network (CBIN): http://www.ec.gc.ca/ecs/biodiv/biodiv.html

15) Alien species invasions of U.S. Ecosystems (with links to organizations involved) http://www.consci.tnc.org/library/pubs/dd/toc.html

16) The Smithsonian Environmental Research Center (SERC) Edgewater, MD, USA, in collaboration with scientists around the world developed an international database of researchers and research studies in the field of Aquatic Invasion the Aquatic Invasions Research Directory (AIRD) : http://invasions.si.edu/aird.htm

17) IOC - Intergovernmental Oceanographic Commission; Harmful Algal Blooms. Via IOC's Home Page you can find information on IOC's Harmful Algal Blooms Programme (HAB) and the IOC Science and Communication Centre on Harmful Algae: http://www.unesco.org/

Electronically available documents include reports from meetings and workshops, the newsletter Harmful Algae News, and access to IOCs databases, e.g., HABDIR - IOC Harmful Algae Bloom Expert Directory at

18) Nature Conservancy (1998): America's Least Wanted: Alien Species Invasions of U.S. Ecosystems: http://www.consci.tnc.org/library/pubs/dd/toc.html

19) Alien species of crayfish in Europe (University of Firence, Italy): http://www.unifi.it/

20) Exotic Phytoplankton from Ships´ Ballast Water. Risk of Potential Spread to Mariculture Sites on Canada's East Coast. A summary of Canadian activities, some case histories of introduced species and shipping studies is included at: http://www.maritimes.dfo.ca/science/mesd/he/ballast.html

21) "Harmful Non-Indigenous Species in the United States": http://www.ota.nap.edu/pdf/1993idx.html

22) US Great Lakes, Exotic species in the Great lakes: http://www.great-lakes.net/

23) Woodshole Oceanographic Institution lists a page on harmful algae: http://habserv1.whoi.edu/hab/

24) Zebra Mussel links : http://www.science.wayne.edu/~jram/zmlinks.htm http://www.nfrcg.gov/zebra.mussel/

25) Inventory of non-native species along the British coasts (not available on he Internet):

Eno, N. C. (1996): Non-native Marine Species in British Waters: Effects and Controls. Aquatic Cons.: Mar. & Freshwater Ecosystems, 6, 215-228 pp.

Eno, N. C., Clark, R. A. & Sanderson W. G. (eds.) (1997): Non-native Marine Species in British Waters: a Review and Directory. Joint Nature Conservation Committee, 152 pp. http://www.jncc.gov.uk/marine/dns/

26) FAO - Food and Agriculture Organization, the FAO Database on Introductions of Aquatic Species (DIAS): http://www.fao.org/waicent/faoinfo/fishery/statist/fisoft/dias/index.htm

27) NAS – Non-indigenous Aquatic Species (U.S.). The NAS information resource for the United States Geological Survey. Located at the Florida Caribbean Science Center, this site has been established as a central repository for accurate and spatially referenced biogeographic accounts of nonindigenous aquatic species: http://www.nfrcg.gov/nas/nas.htm-http://nas.er.usgs.gov/

28) Overview of the study on non-indigenous species in the Gulf of Mexico ecosystem: Work contained herein identifies exotic and non-indigenous species in the Gulf of Mexico Ecosystem and research needs for these species. Gulf of Mexico Program: http://lionfish.ims.usm.edu/~musweb/invaders.html

29) The Sea Grant Nonindigenous Species Site (SGNIS). The Sea Grant Nonindigenous Species Site is a project of the National Sea Grant College Program, produced by the Great Lakes Sea Grant Network: http://www.sgnis.org/

30) The Nonindigenous Aquatic Species Program of the Florida Carribean Science Center. It tracks the status and distribution of introduced aquatic organisms and provides this information in a timely manner for research, management and education: http://www.fcsc.usgs.gov/Nonindigenous_Species/nonindigenous_species.html

ANNEX 8: REPORTING FORMAT FOR THE COLLECTION OF DATA ON NON-INDIGENOUS SPECIES (TOR D)

The WGITMO suggests the following reporting format for the collection of data on non-native species or unexpected occurrences of species:

Species

- taxonomic group
- generic and specific name
- common name(s) as appropriate (different languages)
- identification
- include the best available drawing or picture of the species (refer to webpages)

Biogeography and expansion

- date of first record (possibly back-calculated if adult species found that was likely introduced at an earlier life stage) or from museum material of earlier collections and locality (see distribution map) including close-up insert(s) in world maps
- date of deliberate introduction
- natural range (continent, country, region) (see distribution map)
- primary / secondary inoculation. If secondary, indicate source if known
- range expansion in ICES Member Countries

Method of introduction

- give details according to ICES list of dispersal vectors
- list more than one vector if appropriate

Relative abundance and distribution in invaded region

- habitat
- biomass
- densities: numbers, mass occurrences or individuals (occasional records)
- list nearest population

Life history

Provide paragraph(s) on life history, including (as appropriate), but not limited to the following: lethal temperatures, temperature tolerance, temperature range required for reproduction, longevity, resting stages, asexual reproduction, known predators, grazers, survival in other habitats, tolerances, habitat, larval duration, trigger of spawning, etc.

Impact and Benefit

Provide table and fill in as appropriate (example used below: *Undaria pinnatifida*):

Impact: (* = possibly harmful, ** = harmful, *** = very harmful, ? = not known, $ = beneficial)

Resources/Environment			Uses of the Sea		
Commercial stocks	$	Commercially harvested or farmed in some areas.	Fisheries	*	Algal canopy may hinder fishermen spotting abalone.
Other biota	* or $	Competing with other seaweeds. Eaten by many grazing animals.	Aquaculture	** or $	Fouling on lines, cages, also growing on molluscs or competing for space. Used to feed abalone.
Human health	$	Nutritional value when eaten.	Water abstractions	?	May grow on openings of water intakes.
Water quality	$	Take up nutrients (as all plants) which are removed if harvested.	Aquatic transport	**	Fouling on boats, buoys etc., including costs for cleaning.
Habitat modification	* or $	Large canopies change habitat, reduce light and water movements. Provide shelter for animals.	Tourism	*	Detached plants can accumulate on beaches (similar to native species).

Other impacts, such as hybridisation should be added.

Control measures and management options

The mitigation in invaded country and other information as outlined in the following paragraphs for *Undaria pinnatifida* should be added wherever possible:

Since the microscopic gametophytes are very tolerant and not visible by the naked eye, eradication is extremely difficult and manual eradication tried in Italy has not been successful. Studies on effects of herbicides and antifouling paints have shown that some antifouling paints are effective in stopping zoospore germination or cause gametophyte mortality, while some herbicides are not. Patches not painted (e.g., covered by supporting structures during painting) or single corroded plates may develop dense lumps of sporophytes. Ships' hulls should only be cleaned out of the water and organisms be dumped out of the reach of the sea. Since sporophytes have been found surviving and growing on the hulls for voyages over 4000 km they should be removed before sporophylls are developed (in some cases sporophylls are small and difficult to see) to avoid seeding of other areas. If fertile, detached plants should be kept in containers when removed to avoid release of zoospores, since slightly dried sporophylls which are reimmersed release zoospores very quickly. Since pontoons, towed buoys or drifting objects such as ropes, plastics, etc., also contribute to the dispersal they should preferably be taken out of water and cleaned more thoroughly than just by scraping off plants or be disposed of, when carrying *Undaria* plants.

Gametophytes can survive temperatures around 30 °C for up to 10–40 days, and thus high temperature treatment is needed for cleaning hulls, and one must be reassured that the hot water penetrates into crevices and other openings. Gametophyte survival in small moist crevices in the hulls, anchor wells, etc., is possible even during dry docking as well as transportation on land for days up to at least about a month. Since they can stand darkness for more than seven months, ballast transport is a likely vector, especially as the gametophytes may form thick-walled resting stages, with a potential of surviving also in the sediment. Exposure to UV light can be effective on growing gametophytes, although it is not known if this affects the thick-walled resting stages.

Farming of *Undaria* should not be considered in areas where it does not yet grow, nor should lines and supporting structures in aquaculture be moved from sites with *Undaria* to areas where it does not grow. Proper quarantine treatment is needed in aquaculture to prevent unintentional introductions with molluscs. Movements of molluscs from *Undaria*-infested areas to algal-free areas should be avoided.

Information on colonised sites should be distributed and great care taken not to perform scientific experiments in the field or in open flow-through systems in areas where the species does not yet occur. Also material brought in for demonstrations should be carefully disposed of on land, especially when plants with sporophylls are used.

Further likely areas of colonisation

Similar species in area of invasion

Reference material

- indicate if reference material exists, if possible, where this is stored (identification number)
- details on taxonomist who confirmed the identification
- details on collector

References

- include taxonomic identification literature
- refer to web-pages and other sources of information for further information (further reading)

ANNEX 9: STRUCTURE FOR THE DIRECTORY OF DISPERSAL VECTORS OF EXOTIC SPECIES (TOR E)

Vessels (including ships, boats, mobile platforms)

On the hull

- Attached organisms
- Entrained and entangled organisms
- Within mantle cavities or tissue
- Within cavities of dead organisms
- Sea chest
- Bow thruster area

Hull-associated structures and ship equipment

- Anchor systems
- Scientific equipment
- Fishing gear (including nets, traps, trawls)
- Sounding equipment
- Water intakes and outlets
- Propeller systems
- Fenders
- Rudder
- Trailer for boats
- Entrained/entangled species
  - Within mantle cavity of organism
  - Within tissue of organism
  - Within cavities of organisms

In the hull

- Within excavation of non-steel hulls
- Damaged hulls
- Sheathing
- Boring organisms
  - Within mantle cavity of organism
  - Within tissue of organism
  - Within cavities of organisms

Inside the vessel

- Ballast compartments and tanks
  - Walls, floor, ladder, stringers, platforms
  - Solid ballast
  - Ballast water and sediments
- Refrigerated sea water (fishing vessels)
- Cargo holds (wet cargo):
  - Bait wells
  - Aquaculture species
  - Lash vessels

- Bilge systems
- Chain lockers
- Ship internal pipework
  - E.g., fire fighting
  - Potable water supply
  - Engine cooling
  - Sewage

- Living supplies (ornamental organisms for aquariums, trade species, supplies for human consumption on board, etc.)
- Swimming pool

Living trade and transfers (ship, plane, land transportation)

Aquaculture

- Packing material (shipping containers, algae…)
- Transport media (water, fluids…)
- Target species
    - External surfaces (incl. pests, parasites and disease agents)
    - Associated organisms (incl. pests, parasites and disease agents)
    - Within target species (incl. pests, parasites and disease agents)

- Food materials (fish and invertebrate feed, including feed used for aquarium species)

Aquarium and garden pond trade

Releases

- Accidental (flood events, storms, sabotage, collision, earthquakes, ignorance)
- Deliberate
    - Stocking
    - Reintroduction
    - Mitigation
    - Biocontrol
    - New product
    - Release of GMOs

Commercial, recreational and community activities

Fishing

- Angling
    - Bait (see 2.A)
    - Equipment (i.e., keepnet)
- Net capture (fyke net, buoys)
- Trapping (buoys)
- Redistribution of target species
- Discards

Water sports (SCUBA diving, water skiing…)

- Equipment

Collections (shells, living species, beach combing,…)

- Discards and re-distribution of collected material
- Movement of substrate
    - Solid material (sand, gravel, groynes)
    - Living material (fish eggs on algae, …)
- Water discharge (firefighting, water supply)
- Habitat management (including seagrass and marsh grass transfers for remediation, zebra mussel for water quality)

Other commercial activities

- Flying crafts
- Log booms
- Navigation buoys
- Overland transportation equipment (trailers, etc.)

Research and education

Public aquaria

Experiments

- Field work
- Non-quarantine experiments
- Research vessels

Biocontrol

Release of GMOs

Man-made waterways

Canals, locks

Irrigation

Municipal supply

Altered watercourses

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ANNEX 11: RECOMMENDATIONS TO THE COUNCIL

1) WGITMO recommends that ICES establish a homepage introducing the group and its activities, as well as the Code of Practice and *ICES Cooperative Research Reports* produced by the Working Group. Relevant material such as information brochures, linkages to other invasive species sites and databases on introduced species will be prepared by WGITMO at its next meeting and be provided to ICES for inclusion into the homepage.

2) WGITMO recommends that the Working Group meets in conjunction with the next meeting of the Study Group on Ballast Water and other Ship Vectors (SGBOSV) in Sweden (see below).

3) WGITMO recommends that ICES establish formal dialogs with international agencies, such as the European Commission, European Inland Fisheries and Aquaculture Commission, and the International Maritime Organization to discuss matters of joint interest with the view to a) promote the Code of Practice on the Introduction and Transfers of Marine Organisms as a major tool of minimising the risk of unwanted species introductions by deliberate releases, and b) minimise accidental introductions.

4) Further, it is recommended that ICES facilitate the cooperation between WGITMO and other relevant ICES working groups and study groups such as the ICES/IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD), Working Group on Environmental Interactions of Mariculture (WGEIM), Working Group on the Application of Genetics in Fisheries and Mariculture (WGAGFM) for mutual benefit such as database input, preparation of public awareness material and input into certain aspects of the Code of Practice on the Introduction and Transfers of Marine Organisms.

5) Unfortunately, not all ICES Member Countries are able to provide information at the WGITMO meeting and as a result our knowledge on introductions and range expansion of exotic species is incomplete. Consequently, ICES is asked to urge member countries and other jurisdictions to inform WGITMO of any new record of non-indigenous species and changes in the distribution and abundance of previously introduced exotic species in their jurisdiction.

6) WGITMO requests approval for

   (i) the proposed standardised reporting format to collect information on non-indigenous species;

   (ii) the template for the proposed information brochures;

   (iii) the template for the *ICES Cooperative Research Report* on the Status of Introductions of Non-indigenous Marine Species to North Atlantic Waters 1992–2001 based on National Reports and other published material and to include information from non-ICES Mediterranean countries when available;

   (iv) the template to finalize the "Directory of Dispersal Vectors of Exotic Species" to be published in the *ICES Cooperative Research Report* Series including examples for each vector where available;

   (v) the revised template on Guidelines for the Preparation of National Reports;

   (vi) merging of the Code of Practice and the manual of procedures (as outlined in the ITMO report 1996) to be published together.

7 WGITMO recommends that ICES consider establishing a dialogue with international agencies, such as the EU Commission, relative to the increasing movements through trade agreements of live aquatic organisms and their products, to insure that potential ecological and genetic impacts of such movements are taken into consideration, not just the prevention of the spread of disease agents. In relation to the revision of the EU Shellfish Disease Directive, advanced notice of shellfish movements between countries should be given so that monitoring of consignments or relaying can be undertaken.

8 ITMO recommends that future annual meetings include the opportunity for the participation of observers from non-ICES-Mediterranean countries because of their expertise on the spread of important invasive species from the Mediterranean to areas of ICES Member Countries.

9 ICES should urge scientists in member countries to register at the Smithsonian Environmental Research Centre (SERC) database entitled “Aquatic Invasions Research Directory (AIRD)” to enable collaborative projects, networking and to prevent duplication of research effort.

10 WGITMO should meet in Sweden (the exact meeting place to be announced) immediately after the meeting of the ICES/IOC/IMO SGBOSV (18 to 19 March 2002) from 20 to 22 March 2002 to:

a) collect and discuss National Reports;

b) provide annual updates on the spread and impact of exotic species (including *Carcinus maenas, Hemigrapsus sanguineus, H. penicillatus, Undaria pinnatifida, Sargassum muticum, Dreissena polymorpha, Rapana thomasiana, Ocinebrellus inornatus*, and the American lobster *Homarus americanus*) including updates from non-ICES Mediterranean countries;

c) invite an expert on *Rapana* for the development the Special Advisory Report;

d) develop information for WGITMO homepage at the site to be established by ICES. This would include linkages to other databases on exotic species, the ICES Code of Practice, relevant CRR, previous meeting reports after approval, information brochures, contact addresses;

e) finalise the standardised reporting format to collect information on non-indigenous species;

f) continue to develop information brochures;

g) continue work on the Status of Introductions of Non-indigenous Marine Species to North Atlantic Waters 1992–2001

h) finalise the workplan to prepare on the *ICES Cooperative Research Report* on the “Directory of Dispersal Vectors of Exotic Species”

i) develop relevant material to be included in the WGITMO homepage;

j) continue revising the ICES Code of Practice as a matter of high priority.