Advisory Committee on the Marine Environment

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REPORT OF THE

Working Group on Introductions and Transfers of Marine Organisms

Gothenburg, Sweden
20–22 March 2002

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 2002 meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was held at the Swedish National Board of Fisheries, Gothenburg, Sweden jointly hosted by Inger Wallentinus (Gothenburg University) and Frederik Nordwall (Swedish National Board of Fisheries), from 20 to 22 March 2002.

The terms of reference of the 2002 meeting were reviewed; the agenda for the meeting was considered and adopted. The agenda is attached as Annex 1.

This meeting, the 24th of WGITMO, was chaired by Stephan Gollasch (Germany). Dorothee Kieser (Canada) was appointed as Rapporteur. There were twelve participants representing ICES Member States and one invited guest from Italy attended. The list of participants is given in Annex 2.

2 TERMS OF REFERENCE

According to the Recommendations of the 2001 meeting of the WGITMO, the following Terms of References were received for the 2002 meeting (ICES C.Res. 2001/2:ACME07):

a) update and finalise for publication the Code of Practice on Introduction and Transfer of Non-indigenous Organisms as a matter of highest priority;
b) finalise a report on the status of Introductions of Non-indigenous Marine Species to North Atlantic Waters 1992–2001;
c) prepare a Draft Advisory Report on the status of *Rapana*;
d) collect intersessionally National Reports;
e) provide updates and assessment of the significance of the impact of exotic species (based on item d);
f) develop relevant material to be included in an ICES/WGITMO website.
g) prepare a draft Cooperative Research Report on the "Directory of Dispersal Vectors of Exotic Species" using the approved format and examples as appropriate.

Status of the terms of reference

a) completed (Annex 7);
b) continued;
c) completed (Annex 8);
d) completed for 2001 (Annexes 3, 4 and 5);
e) completed for 2001 (see Study Group on Ballast and other Ship Vectors (SGBOSV) meeting report 2002 for details);
f) partly completed, continued (Annex 8);
g) continued.

3 REVIEW OF THE 2001 WGITMO REPORT

There were no addenda/errata to the 2001 WGITMO report.

4 UPDATE OF THE CODE OF PRACTICE (TOR A)

The update of the 1994 ICES Code of Practice on the Introductions and Transfers of Marine Organisms was given the highest priority. In order to enable substantial progress at the meeting, an intersessional discussion group was launched in December 2001. In January 2002 the Chair and Rapporteur met in British Columbia, Canada to discuss in greater detail the comments received and options to proceed.

For the meeting in Sweden, a 28-page document was prepared summarizing all comments received intersessionally. Taking this as a starting point, the Rapporteur and Chair prepared a working draft of the Code of Practice based on the 1994 version of the Code and the comments received.

At the meeting in Sweden, the majority of the workload during the three full-day meeting was spent to prepare a new and updated version of the Code of Practice. The group started early in the day, shortened the lunch and coffee breaks and worked long hours on all three meeting days (see Agenda 1). This resulted in enormous headway. The discussion on the Code began with a review of the existing definitions from the 1994 version of the Code. These were updated and new definitions were added as appropriate.

Subsequently, the principles of the Code were discussed paragraph by paragraph and rewritten accordingly.

As a result, a new version of the Code was agreed upon and is attached to this report as Annex 7.

The new document includes a Preamble, Principles of the Code and six Appendices:

Appendices A to D will be applied to all new introductions and transfers as required. The Appendices outline the details required for the Prospectus (Appendix A), Risk Review (Appendix B), Quarantine (Appendix C), and Monitoring (Appendix D). Detailed versions of these Appendices A to D are not available yet, but will be prepared as soon as possible and should be available no later than the next WGITMO meeting in 2003.

Appendix E provides a flowchart of the process and Appendix F outlines an example of a species that has been introduced using an earlier ICES Code of Practice and covers the main concerns expressed by the WGITMO following presentation of the prospectus.

In order to enable a maximum of flexibility and to avoid frequent reprinting of the Code following future adjustments, WGITMO suggests:

- to print the Code as agreed by WGITMO (including the introductory paragraphs of the Appendices A to D);
- to include Appendices E (Flow chart) and F (Outline of an example of a species that has been introduced using an earlier ICES Code of Practice) in the printed version;
- not to include the detailed Appendices A to D (to be developed by WGITMO) in the printed version, but to make them available via the ICES WGITMO homepage that the WG recommends to be established by ICES in the near future to ensure that appendices are current and that the most recent information is included. WGITMO plans to frequently review the Appendices (available via the Internet) and to provide a new version (if needed) to ICES with its annual meeting reports.

On Thursday, 21 March 2002, an e-mail was sent to all WGITMO members not participating at the meeting in person asking for comments and approval of the updated version of the Code. The deadline was set for Friday afternoon. Comments received were reviewed by WGITMO and positively influenced the final version of the Code.

Following the meeting in Gothenburg WGITMO continued to finalise the Code until the deadline to deliver the meeting report.

5 NEW PUBLICATIONS, JOURNALS, WEBSITES AND DATABASES

Relevant material was reviewed by the Study Group on Ballast and other Ship Vectors (SGBOSV). Extended abstracts are available in the 2002 SGBOSV meeting report.

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

WGITMO agreed that a summary of National Reports 1992–2001 could serve as a starting point for an *ICES Cooperative Research Report* (CRR) and started to prepare relevant material (Tables 6.1.1, 6.2.1, and Annex 6). Further, it was agreed that each country would designate a "volunteer" to collect relevant information for presentation at future WGITMO meetings. WGITMO's recommendation in 2001 that information from Mediterranean Countries and other invited guests and observers be included into the planned CRR and the Advisory Report on *Rapana* (Annex 8) serves as a proof of how effectively this information may be compiled at future meetings. Further, the CRR will benefit from the knowledge of the SGBOSV, and close cooperation between both groups is therefore recommended. The format of the CRR was agreed by ACME and is outlined in the 2001 WGITMO meeting report.

6.1 Meetings (1992–2001)

Table 6.1.1. Meetings of WGITMO 1992–2001.

Year	Date	Location	Chair	Meeting number
1992	April 14–17	Lisbon, Portugal	J.T. Carlton	14
1993	April 26–28	Aberdeen, Scotland	J.T. Carlton	15
1994	April 20–22	Mystic CT, U.S.A.	J.T. Carlton	16
1995	April 10–13	Kiel, Germany	J.T. Carlton	17
1996	April 22–26	Gdynia, Poland	J.T. Carlton	18
1997	April 22–25	La Tremblade, France	J.T. Carlton	19
1998	March 25–27	The Hague, Netherlands	J.T. Carlton	20
1999	April 14–16	Conwy, United Kingdom	J.T. Carlton	21
2000	March 27–29	Parnu, Estonia	J.T. Carlton	22
2001	March 21–23	Barcelona, Spain	S. Gollasch	23

6.2 National Reports (1992–2001)

Table 6.2.1. Availability of National Reports from Member Countries and invited guests (1992–2001) documenting the geographical range covered by WGITMO over time.

National Report	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Australia							X			
Belgium										X
Canada	X	X	X	X	X	X	X	X	X	X
Denmark		X								
Estonia								X	X	X
Finland	X	X	X	X	X	X		X	X	X
France		X	X	X		X	X	X	X	X
Georgia										X
Germany			X	X	X	X	X	X	X	X
Ireland	X	X	X	X	X	X	X	X	X	X
Israel							X			
Italy							X		X	X
Netherlands							X	X	X	X
Norway	X	X	X		X	X	X	X	X	X
Poland		X			X	X		X	X	
Portugal	X									
Spain	X	X								X
Sweden	X	X	X	X	X	X	X	X	X	X
England & Wales	X	X	X	X	X	X	X	X	X	X
Scotland	X	X	X	X						
U.S.A.	X	X	X	X	X	X	X	X	X	X
Total	**10**	**12**	**10**	**9**	**9**	**10**	**12**	**12**	**13**	**15**

6.3 List of participants

A list of participants and invited guests at WGITMO meetings 1992–2001 for inclusion in the summary report was prepared (Annex 6) documenting the audience reached by WGITMO over time.

7 PREPARATION OF ICES ADVISORY REPORT ON *RAPANA VENOSA* (TOR C)

To complete the Advisory Report on *Rapana venosa,* two experts in this field were invited: Anna Occhipinti (Italy) and Roger Mann (USA). These experts prepared, with the help of WGITMO, a draft Advisory Report on *Rapana venosa.* This draft was reconsidered and approved by WGITMO with minor additions on the last day of the meeting (Annex 8). The group wishes to express its sincere thanks to the two experts. Without their help, it would not have been possible to finalize the work at the 2002 meeting.

8 AN OYSTER GILL CONDITION IN THE PACIFIC OYSTER FROM TWO IRISH SOUTH COAST BAYS

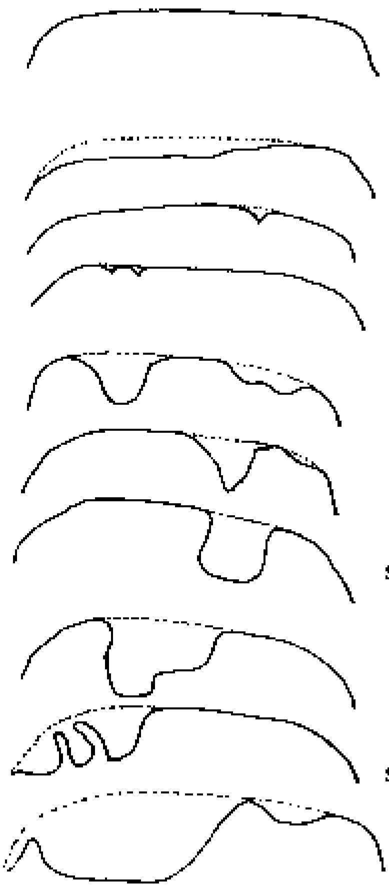
Dan Minchin (Ireland) reported that a wavy gill margin and reduced gill surface area in about 22 % of Pacific oysters and 12 % of native oysters in Cork Harbour and in 15 % of Pacific oysters in Waterford Harbour was found in October 2001. The condition was first noted in Pacific oysters from Cork Harbour in the autumn of 2000 held in bags on trestles, and in those broadcast on the seabed. Three levels of gill damage are described (Figure 8.1):

Stage 1: undulations of the gill margin not extending more than half way to the gill base.
Stage 2: undulations extending more than half way to the gill base; and
Stage 3: undulations extending to the gill base.

Damage to the gill margin will almost certainly result in impairment to the feeding process. This may explain their relatively poor physiological state. Cilia collecting food in mucus carry it forward within the marginal groove. Should the gill margin be disrupted, the food string may become displaced and carried away with the exhalent water flow. This could take place with stages 2 and 3. Consequently, gill tissue lying posterior to the damaged region may render that part of the gill functionless for food procurement. Should this be the case, a reduced size and weight of affected oysters may be expected. Although the sample size is small, there was a trend where by damaged oysters had a reduced wet weight. Indications are that this gill condition is likely to significantly modify growth.

A copepod was found associated with the gill condition in only some Pacific oysters in Cork Harbour and none were found in Waterford Harbour samples. Copepods lay on gill tissue, and some appeared to be attached. Yet, there was no obvious gill damage where they lay. Some of the oysters with a copepod had no obvious reduction of the gill surface area. However, it is worth noting that in the 1980s a gill condition was found in native oysters *Ostrea edulis* in Cork Harbour (and elsewhere on the south and west Irish coasts). A copepod *Herrmannella duggani*, subsequently described for the first time, was found attaching to gills (Holmes and Minchin, 1991).

Figure 8.1. Length-weight relationships of the same year class of Pacific oysters and stages of gill condition, Cork Harbour, October 2001.



References

Holmes, J. M. C., and Minchin, D., 1991. A new species of *Herrmannella* (Copepoda, Poecilostomatoida, Sabelliphilidae) associated with the oyster *Ostrea edulis* L. Crustaceana, 60(3): 258–269.

9 POTENTIAL RANGE EXPANSION AND INTRODUCTIONS OF BOREAL SPECIES

Dan Minchin (Ireland) reported that climate changes may provide opportunities for a new trading link between the North Atlantic and North Pacific as the northern polar ice sheet reduces its extent during summer periods, so allowing shipping to pass via northern Russia or via the Northwest-passage. Fluctuations in sea temperature associated with the seasonal melting of ice may allow for range expansions but also the transmission of exotic species via shipping with the new trading routes.

10 NATIONAL REPORTS (TOR D)

As recommended by ICES, the National Reports were prepared and distributed intersessionally in order to allow maximum time for discussion at the meeting to work towards an update of the Code of Practice (see above). National reports were received from twelve member countries: Belgium, Canada, England and Wales, Estonia, Finland, France, Germany, Ireland, Norway, Poland, Sweden, and the United States of America. These are attached as Annex 3. In addition, national reports were received from Australia and Italy (Annexes 4 and 5).

National reports were briefly presented following the opening of the meeting.

10.1 Highlights of the National Reports (ICES Member Countries, countries with observer status and Italy)

National Reports contain details of new laws and regulations, deliberate releases, accidental introductions and transfers, live imports, live exports, planned introductions, and meetings.

Australia

Australia established a National Taskforce in 1999 by the Joint Standing Committee on Conservation (SCC)/Standing Committee on Fisheries and Aquaculture (SCFA) to identify options and develop a framework for the rapid detection and response to new introduced marine species incursions, resulting in a report adopted by the SCC/SCFA. The new structure expands Australia's focus from barrier control of ballast water-related introductions to incorporate rapid detection and response capabilities. The Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) has responded to two new incursions in its first year: the alga, *Caulerpa taxifolia* in New South Wales and the tubeworm, *Hydroides sanctaecrucis* in Queensland. The Australian Quarantine and Inspection Service (AQIS) Ballast Water Management Decision Support System (DSS) went "'live" on 1 July 2001, details of which can be found on the AQIS website: http://www.affa.gov.au/ under Quarantine and Inspection/Ballast water DSS. The National Port Survey Program using a single, consistent survey design and sampling protocol has now been implemented at some stage in 34 ports in Australia.

Belgium

The procedure to obtain permission for the intentional introduction of non-indigenous species was published in the Belgian Official Journal (BOJ) of 14 February 2002. It is chapter VII (art. 13–17) of the Royal Decree of 21 December 2001 on the protection of species in the marine areas under Belgian jurisdiction. For obtaining the permit, an environmental impact assessment procedure is required.

One new introduction, namely the red alga *Polysiphonia senticulosa*, was discovered. During a survey of the fish fauna of the western Schelde in 2001, there were findings of the Atlantic croaker *Micropogonias undulatus* and of the Baltic vimba *Vimba vimba*. There were also additional records of the barnacle *Megabalanus tintinnabulum* from buoys off the Belgian coast.

Canada

Canada and its Provinces have signed a National Code on Introductions and Transfers of Aquatic Organisms. The backbone of the code is a consistent risk assessment process based on a thorough biological review of the species to be transferred or imported and of the receiving environment. The code applies to all intentional movements of fish (including finfish, crustaceans, molluscs, echinoderms and other invertebrates and aquatic plants) where the destination is a fish rearing facility or fish habitat. It does not apply to the introduction or transfer of live baitfish, ornamental species, species for consumption, or transgenic organisms, nor does it apply to unintentional introductions.

News on invasive species: A lake in New Brunswick was depopulated because of the finding of an exotic predator species, *Esox niger.* Also *Esox masquinongy* was found in the St. John River. *Codium fragile* and *Carcinus maenas* are continuing to spread in Prince Edward Island. As well, *Styela clava* continues to be a problem for mussel farmers in PEI. In British Columbia, there have been no additional juvenile *Salmo salar* found. Also, only three additional *Carcinus maenas* were found. There are reports that an exotic mussel, *Musculista stenhousia*, has been found sporadically with the exotic *Nuttallia obscurata*.

England and Wales

Sargassum muticum has appeared further north on the UK West Coast, moving from Milford Haven to the Menai Strait, where it is flourishing. *Perophora japonica*, a Japanese sea squirt, was discovered for the first time in the Fleet lagoon, Dorset. This was previously reported in a marina in Plymouth, Devon in 1999.

Trade in pacific oysters and rainbow trout continues as in previous years. Ormers (*Haliotis tuberculata*) have been imported from Guernsey and are being held at various sites around the coast of Cornwall, to assess the potential for cultivation of this species. The yield from the managed manila clam fishery in Poole Harbour was the highest amount to date.

Estonia

The interest for deliberate release of fish for enhancement of commercial fish stocks is increasing in Estonia. In addition to previous years, pikeperch (*Stizostedion lucioperca*) and pike (*Esox lucius*) have been released. The geographical range of live exports has widened by involving in 2001 such countries as Cyprus, Luxembourg, Marshall Islands, and Saint Vincent and the Grenadines.

New accidental introductions were not reported in 2001. Of the already known non-indigenous species, the abundance of *Cecopagis pengoi* has increased exponentially during the first ten years of invasion (1992–2001). Presence of *Cercopagis* tended to last longer in the mesozooplankton community over the years by shifting its population development to an earlier time. Besides significantly lower abundance of *Bosmina* after the *Cercopagis* invasion, seasonal development of nauplii of copepods and *Acartia* spp. has changed, which might be attributed to the invasion as a direct effect of predation. The adverse effect of *Cercopagis* on fish growth could occur as a result of altered zooplankton community structure that may reduce availability of prey for larvae and young fish by affecting this way of recruitment.

Finland

The following species were deliberately released into the Baltic Sea, or rivers draining into the Baltic: Atlantic salmon (*Salmo salar*), sea trout, (*Salmo trutta*), whitefish (*Coregonus lavaretus*) and eel (*Anguilla anguilla*).

During a storm, there were accidental releases of rainbow trout (*Oncorhynchus mykiss*) from a farm. A Russian sturgeon (*Acipenser guildenstaedti*) was found from the southwestern coast of Finland.

Finland has the following live imports: Rainbow trout for farming and eels for release, tropical aquarium fish, and oysters, lobsters, and crab for consumption.

France

Additional *Rapana venosa* were found in Southern Brittany. Egg cases have been found and juveniles from these are being reared in quarantine. It appears that the *Rapana* may have been introduced from the Adriatic via shipments of *Tapes philippinarum* and likely for marketing.

There are two research programmes focusing on *Crepidula fornicata*: one studies the impacts of this species on benthic populations and sedimentation rates, the other looks at the industrial exploitation of the species in Northern Brittany.

The spatial expansion of *Caulerpa taxifolia* is being monitored.

A new ballast water sampling campaign focused on phytoplankton and bacteria.

Germany

No new accidental introductions were reported. Germany reported on the status of following, previously introduced non-indigenous species: *Crassostrea gigas, Anguillicola* sp*., Dreissena polymorpha, Eriocheir sinensis, Portumnus latipes, Teredo navalis* and associated species. The mitten crab *Eriocheir sinensis* shows decreasing abundances in German rivers. An exact quantification was not possible in Spring 2002 as the water level of rivers was extraordinarily high due to heavy rainfalls earlier in the year.

Activities on aquaculture and restocking focused in 2001 on eels, sturgeon and salmon. Ornamental trade of freshwater and marine organisms is becoming increasingly popular. For direct human consumption, various crustaceans, blue mussels, common carp, and *Tilapia* species are imported.

NEOBIOTA, a research consortium on biological invasions launched in 1999, continues its work with additional meetings in 2002.

Together with Vadim Panov (Russia), Germany coordinates an initiative to link European working groups in the field of biological invasions (European Research Network on Aquatic Invasive Species (ERNAIS)) for the mutual benefit of working groups, concerted action relevant to invasions and to gather data on impacts of non-indigenous species (see 2002 SGBOSV meeting report for details).

Further, a new project on ballast water treatment methods was launched in 2001 coordinated by GAUSS, Bremen. During this three-year project, currently used treatment systems will be compared in large scale and it is hoped that at the end of the project a new, effective, safe, and environmentally sound method may be developed (see 2002 SGBOSV meeting report for details).

Ireland

The Pacific brown alga *Sargassum muticum* was discovered at three new locations in Ireland (southwest and west coasts). In two of the locations, there are established populations that may have been present for two years. The presence of a drift fragment at a separate location (southeast coast) suggests that colonisation from natural drift is possible, but small boat activity and oyster transfers could be involved. The red alga *Asparagopsis armata* is locally common on some Irish coasts and is currently in cultivation to produce products for cosmetics.

Zebra mussels (*Dreissena polymorpha*) and the Japanese nematode of eels *Anguillicola crassus* continue to expand to separate river basins. Pacific oysters with a reduced gill surface area were found in Cork Harbour and Waterford Harbour; no pathological effects were found associated with this condition.

Italy

This report is the outcome of a special working group of the Italian Marine Biology Society (SIBM) on a voluntary basis. It updates the findings of previously reported non-indigenous species by adding several species to the earlier lists. Among them are: *Epinephelus coioides* in the Gulf of Trieste; *Halosarus ovenii* near Sardinia; *Protodorvillea egena*, *Isola pulchella*, and *Questa caudicirra* in the Gulf of Noto (Sicily); *Dispio uncinata* in the harbour of Salerno; a species of *Rullierinereis* in Messina Strait; and the alga *Lomentaria hakodatensis* in the lagoon of Venice. The identification of the latter species needs to be confirmed. All species are considered unintentional introductions. Some already established non-indigenous species have enlarged their distribution.

Norway

The red king crab *Paralithodes camtschatica* has extended its range westward at an unexpectedly high pace. It is now established and commonly encountered at "Nordkap", and individuals are occasionally found even further west. Year 2002 will be the first year with a regular commercial catch of the red king crab in Norway.

Another confirmed specimen of the American lobster (*Homarus americanus*) was found last year in Oslofjorden, bringing the total number of confirmed cases up to eleven.

Two species of the dinoflagellate genus *Pfiesteria* have been confirmed in samples from one locality in the Oslofjord area in southeastern Norway, the already well-known fish-toxin producer *P. piscicida* and the closely related *P. shumwayae.*

Sargassum muticum has established itself in the inner basin of Oslofjord.

Dasysiphonia sp. has apparently extended its geographical range during 2001 and is now recorded in the Sognefjord area.

Poland

A total of 251,241 salmon (*Salmo salar*) smolts and 67,000 juveniles as well as 944,135 smolts and 550,000 fry of sea trout (*Salmo trutta morpha trutta)*, also 180,000 juvenile and 900,000 fry whitefish (*Coregonus lavaretus)* were released into the natural environment as deliberate releases for the enhancement of wild stocks.

Round goby (*Neogobius melanostomus*) is recently spreading up to the eastern Polish coast and coming into the Vistula River. The round goby became a stable element of the trophic chain in the Gulf of Gdansk. One specimen of sea lamprey (*Petromyzon marinus)* was found in Puck Bay in 2002.

A mass invasion of the Ponto-Caspian cladoceran *Cercopagis pengoi* has been observed every year in Vistula Lagoon since 1999. It causes a lot of trouble to fishermen during summer days.

A decapod shrimp *Atyaephyra desmaresti*, which originates from the Mediteranean area, was found for the first time in 2000 in the lower part of the Odra River. The continuous presence of *Gammarus tigrinus, Dikerogammarus villosus,* and *D. haemobaphes* is recorded in western Polish rivers. Those species most probably came to Poland through a net of canals linking the main rivers.

Live imports covered: rainbow trout (*Oncorhynchus mykiss)* eggs and ornamental fish (originated mostly from Far East). Export was limited to 12 tonnes of rainbow trout.

Sweden

The polychaete *Marenzelleria* cf. *viridis,* known in Swedish waters since 1990, continues to move north and was in 2001 found as far north as at Malören outside Luleå in the Bothnian Bay, and the densities have also increased at other stations in the northern part of the Bothnian Bay. It has also been recorded in the southern part of the Øresund, however, in quite low densities (not previously mentioned in the WGITMO reports). Its distribution thus covers localities from the entire Baltic coastline of Sweden.

The crustacean *Cercopagis pengoi*, recorded since 1997 from the bay of Himmerfjärden, the northern Baltic Proper, appeared there in masses in 2001 with intense clogging of the fishermen's nets as a result.

The swimbladder parasite *Anguillicola crassus* was first recorded in eel in Sweden in 1987. This parasite is now well established not only in thermal discharge areas (off nuclear power stations) but also in other brackish waters along the coasts, as well as in some freshwater lakes.

USA

The commercial shellfish industry continues to culture and release multiple non-native invertebrate species: the oyster *Crassostrea gigas*, mussel *Mytilus galloprovincialis*, and clam *Venerupis philippinarum* (Pacific Region), *Ostrea edulis* (Atlantic).

Experimental research has continued to evaluate the potential introduction of the Asian oyster *Crassostrea ariakensis* into Virginia waters of the Chesapeake Bay.

Accidental introductions include: Fish: *Oreochromis niloticus*, *Pterois volitans*. Invertebrates: On the Atlantic Coast: *Didemnum* sp., *Ianiropsis* sp., *Phyllorhiza punctata*, *Sargatia elegans, Caprella mutica*, *Lipara rufitarsis, Lasioptera hungarica, Tetramesa phragmates, Chaetococcus phragmites*; On the Gulf Coast: *Drymonema dalmatinum*, *Phyllorhiza punctata, Callinectes bocourti*. Plants: *Caulerpa taxifolia, Polysiphonia harveyi*, *Undaria pinnafida*. Parasites, pathogens, and other disease agents: Infectious Salmon Anemia virus (in Maine) *Pseudodactylogyrus anguillae* and *Pseudodactylogyrus bini*.

10.2 Summary of National Reports

The following table (Table 10.2.1) summarizes live imports of aquatic species according to higher taxa and area of origin based on National Reports considered at the meeting. It has to be noted that this table does not claim to be fully comprehensive as not all ICES Member Countries submitted National Reports to the meeting. Further, the origin of several species importations remains unclear as some countries exhibit a lack of import documentation. Ornamental trade is excluded.

Table 10.2.1. Summary of live imports of aquatic species according to National Reports submitted to WGITMO 2002. Ornamental trade excluded. (cr = crustacean, fi = fish, mo = molluscs, Bel = Belgium, Can = Canada, Cze. R = Czech Republic, Den = Denmark, Est = Estonia, Fin = Finland, Fra = France, Ger = Germany, Hun = Hungary, Ice = Iceland, Ire = Ireland, Ita = Italia, Lat = Latvia, Net = the Netherlands, Nor = Norway, Pol = Poland, Rus = Russia, S. Afr = South Africa, Spa = Spain, Swe = Sweden, UK = United Kingdom, USA = The United States of America).

	Import (limited to ICES member countries)																
Export	**Bel**	**Can**	**Den**	**Est**	**Fin**	**Fra**	**Ger**	**Ire**	**Lat**	**Net**	**Nor**	**Pol**	**Rus**	**Spa**	**Swe**	**UK**	**USA**
Can							cr								cr, mo		fi
Cze. R							fi										
Den				fi			fi, mo	fi			fi	fi			fi, cr, mo	fi	
Est									fi				fi				
Fin				fi							fi		fi		fi		
Fra	Fi						fi	mo			fi	fi			mo		
Ger	Mo											fi			fi		
Hun							fi										
Ice		mo									fi						
Ire						fi, mo	fi, cr								cr	fi	
Ita						mo	fi								fi		
Net	Mo	fi				mo	fi								fi, mo		
Nor			fi				cr								fi, cr, mo	fi	
Pol							fi						fi				
Por		fi, mo				mo											
Rus				fi			fi										
Spa						mo					fi						
S. Afr.												fi				fi	
Swe	fi, mo		fi, mo	mo	fi, mo	mo	fi, mo	fi		fi, mo	fi, mo	fi		mo		mo	
UK				fi	fi	mo		fi, mo				fi			fi, mo		
USA		fi					cr								cr, mo	cr	

The most commonly moved species in 2001 were Atlantic salmon *Salmo salar* and Pacific oysters *Crassostrea gigas*. Figures 10.2.1 and 10.2.2 provide an overview on the species movements on a global scale based on National Reports considered at the meeting. It has to be noted that the figures do not claim to be fully comprehensive as not all ICES Member Countries submitted National Reports to the meeting. Further, the origin of several importations remains unclear as some countries exhibit a lack of import and/or export documentation.

Figure 10.2.1. Movements of *Salmo salar* (eggs, fry, juveniles and adults) based on data of National Reports considered at WGITMO 2002.

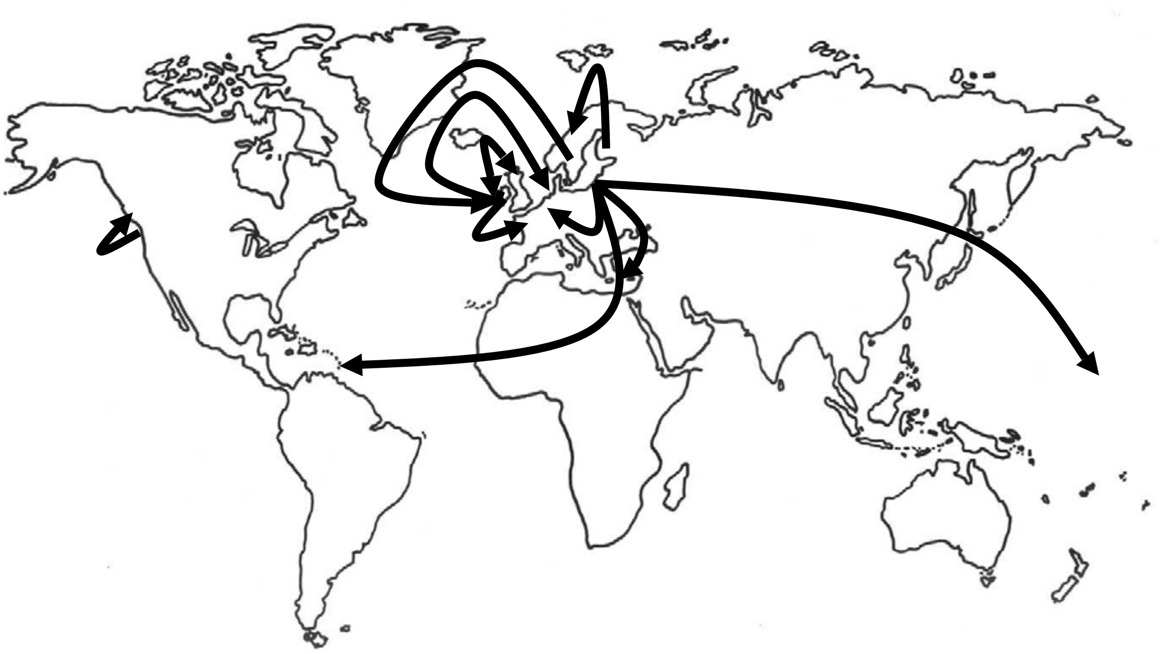
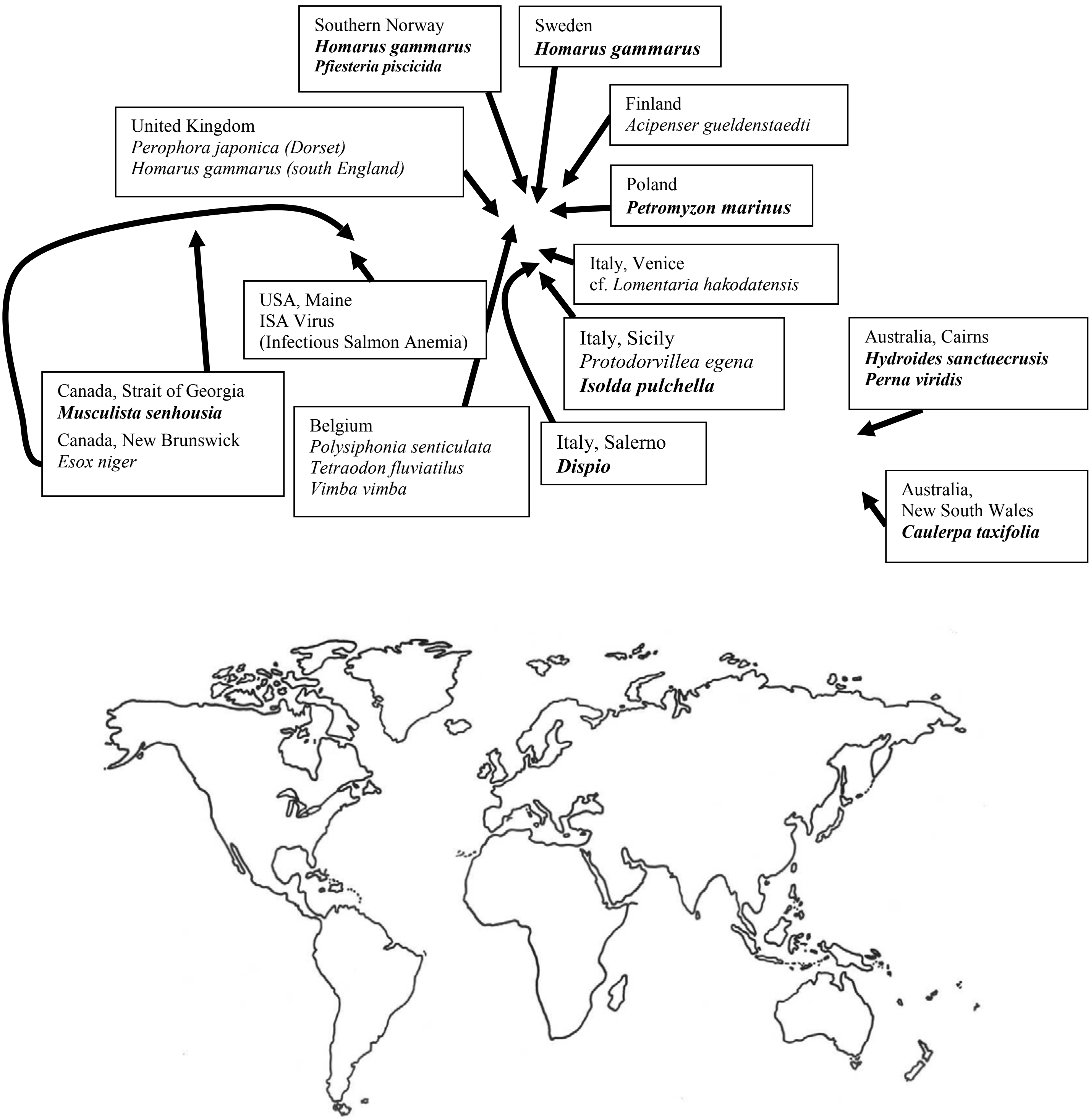


Figure 10.2.2. Movements of *Crassostrea gigas* (all life stages) based on data of National Reports considered at WGITMO 2002. Please note that France reported that *C. gigas* was exported to various European countries (grey arrows).

Further, first records of various non-indigenous species are reported in National Reports considered at the meetings (Figure 10.2.3).

Figure 10.2.3. First records of non-indigenous species (accidentally released or introduced) in 2001 based on data of National Reports considered at WGITMO 2002.



11 PROVIDE UPDATES AND ASSESSMENT OF THE SIGNIFICANCE OF THE IMPACT OF EXOTIC SPECIES (TOR E)

The significance of the impact of non-indigenous species was discussed in great detail using the case history of *Rapana venosa*. Details of the discussion are reflected in the Advisory Report on *Rapana venosa* (Annex 8).

The 2002 SGBOSV meeting report provides in Section 3.2, Update on Case Histories of Selected Invaders, details on seven taxa: the red king crab *Paralithodes camtschatica*, bacteria and pathogens in ballast tanks, the first record of *Pfiesteria piscicida* in European waters, the first record of *Dreissena polymorpha* from Spain, calcareous tubeworms, and biocontrol options for the ctenophore *Mnemiopsis leidyi* in the Black Sea (see 2002 SGBOSV meeting report).

12 PREPARATION OF MATERIAL FOR THE ICES WGITMO HOMEPAGE (TOR F)

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. As a starting point, WGITMO suggests to include the Advisory Report on *Rapana venosa* on the WGITMO homepage and to add relevant new material as developed by WGITMO.

Further, WGITMO suggests to add relevant background information on exotic species invasions addressed to the general public and legislators and other non-scientists, including references to activities at a) ICES; b) SGBOSV; c) International Maritime Organization (IMO), especially the Marine Environment Protection Committee, Ballast Water Working Group and the GloBallast Programme; as well as d) International Chamber of Shipping (ICS).

In addition, WGITMO suggests that general information material (e.g., flyers and posters) should be developed on invasion biology and invasive species with an emphasis on their impact. A model for such information for the general public could be the CITES material seen in airports and other areas frequented by travellers. WGITMO asks for advice on the availability of an artist supporting this initiative with drawings and professional layout. This should take account of the increasing activities in ornamental trade and should further indicate the risks involved when releasing species, e.g., from hobby aquariums into the wild.

Furthermore, WGITMO recommends making the ICES Code of Practice available via the WGITMO homepage to increase awareness of the existence of the Code. It was suggested that not all ICES Member Countries use the Code when introducing new non-indigenous species, as policy-makers and other relevant stakeholders are unaware of this Code. As the Code is not a legally binding instrument, awareness is believed to be crucial. WGITMO further recommends to announce the new version of the Code using relevant Internet-based discussion fora (e.g., Aliens list server) and newsletters (e.g., IUCN Invasive Species Specialist Group (ISSG)). The latter published a short note on WGITMO activities and the source to download the meeting report from the Barcelona meeting in 2001.

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

The directory of dispersal vectors of exotic species was restructured and improved at the 2001 WGITMO meeting (see Annex 9, 2001 WGITMO meeting report). The time-consuming work to update the Code of Practice did not permit a further development of the directory of dispersal vectors of exotic species. As agreed earlier, wherever possible, the directory should include examples of species invasions according to dispersal vectors to provide a clear picture of the dimension of species transportation. WGITMO suggests that the material for the CRR on dispersal vectors be compiled at the WGITMO meeting in 2003.

14 UPDATES AND REPORTS ON BALLAST WATER STUDIES

Details on current and recently completed shipping studies in ICES Member Countries can be found in the report of the SGBOSV meeting in 2002. The report further provides extended abstracts on:

a) Details of concerned parties, i.e., IMO, ICS, EU and Ministerial declaration of the 5th International Conference on the Protection of the North Sea (Bergen, Norway, 20–21 March 2002);
b) Progress Reports of Ongoing Shipping Studies and Related Projects;
c) Update on Case Histories of Selected Invaders;
d) Databases and Networks;
e) Ballast Water Treatment; and

f) Ballast Water Treatment Standards.

15 RECOMMENDATIONS TO ICES COUNCIL

The recommendations to the ICES Council are provided in Annex 9 of this report.

16 ADJOURNMENT OF THE MEETING

A final review of the 2002 terms of reference was made shortly before adjournment of the meeting on Friday 22 March at 19.30 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 (Vancouver, Canada, 26–28 March 2003).

Stephan Gollasch, as Chair, thanked all WGITMO members, guests and observers for their dedicated work, including the intersessional activity, and further thanked the Swedish National Board of Fisheries, Gothenburg for hosting the 2002 meeting, especially the hosts Inger Wallentinus (Gothenburg University) and Frederik Nordwall (Fiskeriverket), as well as all other helping hands that worked very hard during the meeting and spent endless hours to prepare the meeting. 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 organized, with the especially challenging task of collecting contributions to the meeting report.

ANNEX 1: AGENDA

Working Group on Introductions and Transfers of Marine Organisms, Gothenburg, Sweden, 20–22 March 2002

Wednesday, 20 March

9.00 am

- Welcoming remarks and housekeeping issues
- Review of the Terms of Reference
- Adoption of the Agenda
- National Reports, Highlights:
  Australia
  Belgium
  Canada
  England and Wales
  Estonia
  Finland
  Germany
  Ireland
  Italy
  Poland
  Scotland
  Sweden
  USA

- ICES Special Advisory Report on *Rapana*
- An oyster gill condition in the Pacific oyster from two Irish south coast bays (D. Minchin)

1.00 pm–2.30 pm (Lunch)

- Results of intersessional discussion regarding the Code of Practice update
- Update of the Code of Practice (definitions)

3.45 pm–4.05 pm (Coffee Break)

- Update of the Code of Practice (definitions)

6.30 pm (Adjourn of day 1)

Thursday, 21 March

8.30 am

- Update of the Code of Practice (code principles)
- Introduction to ICES and ACME procedures (Stig Carlberg)
- Update of the Code of Practice (code principles)

10.20 am–10.40 am (Coffee Break)

- Update of the Code of Practice (code principles)

1.00 pm–2.30 pm Lunch

- Update of the Code of Practice (code principles)

3.45 pm–4.05 pm (Coffee Break)

- Update of the Code of Practice (content of Appendices, in two subgroups)

6.00 pm–6.15 pm (Evening Break)

- Update of the Code of Practice (Round table discussion on Appendices)

8.00 pm (Adjourn of day 2)

Friday, 22 March

8.30 am

- Update of the Code of Practice, Round Table Discussion

10.30 am–10.50 am Coffee Break

- Standardised reporting format to collect information on non-indigenous species
- Status of Introductions of non-indigenous marine species to North Atlantic Waters 1992–2001
- Directory of Dispersal Vectors of Exotic Species
- Material to be included in the WGITMO homepage

1.15 pm–2.15 pm (Lunch)

- Special Advisory Report on *Rapana*

3.45 pm–4.05 pm coffee

- Final discussion on Code of Practice
- Rewriting of definitions according to input by correspondence
- WGITMO Recommendations
- Concluding Remarks
- Planning of next meeting

7.45 pm Adjournment of the 24th Meeting of the WGITMO

ANNEX 2: LIST OF PARTICIPANTS

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ANNEX 3: NATIONAL REPORTS (ICES MEMBER COUNTRIES)

National Reports tabled at the ICES WGITMO meeting, Gothenburg, Sweden, March 20–22, 2002

NATIONAL REPORT FOR BELGIUM

F. Kerckhof

1 Laws and Regulations

The procedure to obtain permission for the intentional introduction of non-indigenous species was published in the Belgian Official Journal (BOJ) of 14 February 2002. It is chapter VII (art. 13 – 17) of the Royal Decree of 21 December 2001 on the protection of species in the marine areas under Belgian jurisdiction. This Royal Decree is an implementation of the Belgian frame law of 20 January 1999 on the protection of the marine environment in the marine areas under Belgian jurisdiction (the 'MMM-law') published in the Belgian Official Journal (BOJ) on 12 March 1999. This law forbids the intentional introduction of non-indigenous species in the marine environment, unless permission is given.

For obtaining the permit, an environmental impact assessment procedure is required (the procedure for the EIA was published in the BOJ on 25 January 2001). According to the MMM law, a permit is also needed for the intentional introduction of indigenous species that can carry the risk to introduce with them other, non-indigenous, species.

2 Deliberate Releases

2.1 Fish

Restocking by the Sea Fisheries Department (CLO-SFD, Oostende, Belgium) of turbot (*Scophthalmus rhombus),* offspring from fish from the French Atlantic coast, and sole (*Solea solea)* continues. Two thousand individuals of each species were released in 2001.

3 Accidental Introductions and Transfers

One new introduction, namely the red algae *Polysiphonia senticulosa*, was discovered.

3.1 Fish

Tetraodon fluviatilis (or *T. nigroviridis*?), (green puffer; Dutch: groene koffervis): a fisherman caught a specimen of this fish off the Belgian coast, on 10 October 2001. This fish originates from Asia, where it lives in fresh or slightly brackish waters of estuaries. It is common in the aquarium trade and was probably deliberately or accidentally released. It probably reached the open sea after a period with heavy rain, when massive quantities of fresh water had to be evacuated from the hinterland.

Micropogonias undulatus (Atlantic croaker, Dutch: Atlantische ombervis): a specimen measuring 15 cm was caught in May 2001 during a survey of the fish fauna in the Schelde estuary (Stevens *et al.,* 2001). The Atlantic croaker can be found along the East coast of the United States and Northern Gulf of Mexico where it is one the most abundant fish species. It is an opportunistic bottom-feeder. It was probably introduced via ballast water in the port of Antwerp.

This is the second record of this species for Belgian waters. In August 1998 a fisherman caught a specimen off the Belgian coast (Eneman, 1998). However, it then was incorrectly determined as *Sciaena umbra.*

Vimba vimba (Baltic vimba, Dutch: blauwneus) During 2001, two juveniles of this species were caught in brackish waters during a survey of the fish fauna in the Schelde estuary, (Stevens *et al.* 2001). This species, naturally occurring in the Black Sea, the Caspian basins and the Sea of Azov, is recently invading western Europe. There are records from the Netherlands: Neder-Rijn, port of Rotterdam and streams in Limburg. This could be a natural expansion of the species although specimens are also sold as living bait for anglers.

3.2 Invertebrates

Mytilopsis leucophaeata (= *Congeria cochleata*): present in the harbour of Antwerpen, causing nuisance by the obstruction of water intake pipes of some chemical plants. A study is started by the University of Gent, to seek means for a possible biological control of this species.

Caprella mutica: first recorded 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.

Megabalanus tintinnabulum: this cosmopolitan barnacle was recorded in 1998 for the first time autochthonous in the southern North Sea, on buoys off the Belgian coast (Kerckhof and Cattrijsse, 2002). In 2001 and 2002 individuals of this species were recorded, although in small numbers, from buoys off the Belgian coast.

Balanus amphitrite: this species is well established in the harbour of Oostende and occurs in the harbour of Nieuwpoort. As yet it has not been found in the harbour of Zeebrugge.

3.3 Algae and Higher Plants

Polysiphonia senticulosa: this species has been found in the Spuikom of Oostende, on 28 March 2001 (Kerckhof and Stegenga, 2002). During the winter of 2002 the species was again present. It then formed a zone on the dyke, on the same spot where during 1999 and 2000 *Sargassum muticum* flourished. The latter species was not present any more.

P. senticulosa was recorded in 1993 in the Dutch Easter Schelde where it is now very common (Stegenga, 1994). The Belgian findings are the second record for Western Europe. The species was probably imported with oysters, but not from the Eastern Schelde, as no oysters have been imported from that region. During the last years, oysters have been imported from England the Atlantic coast of France and British Colombia, Canada. As *P. senticulosa* is also known from the latter region, maybe it could originate from that region.

Undaria pinnatifida: After the first record in 2000, this species is still present on the same site in the port of Zeebrugge, but apparently not spreading.

4 Live Imports

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.

The imports of live American/Canadian lobsters and oysters, *Crassostrea gigas* and *Ostrea edulis,* for human consumption continue. It is almost impossible to obtain figures on quantities or on origin.

There are also a lot of (uncontrolled) imports of other shellfish, e.g., the hard shell clam (*Mercenaria mercenaria*), Manila clam *Tapes philippinarum,* imports of bait and of aquarium species.

7 Meetings

On 14 December 2001, a symposium was organised at the Royal Belgian Institute of Natural Sciences titled “Status and trends of the Belgian fauna with particular emphasis on exotic species”.

A new working group on alien species has been established, with scientists from the three regions and the federal level. The working group is coordinated by the National Focal Point of the CBD.

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March 2002

NATIONAL REPORT FOR CANADA

D. Kieser

1 Laws and Regulations

Canada has a new National Code on Introductions and Transfers of Aquatic Organisms. The purpose of this Code is to establish an objective decision-making framework regarding intentional introductions and transfers of live aquatic organisms that is designed to protect aquatic ecosystems.

The Code sets in place a mechanism (Introductions and Transfers Committees) for assessing proposals to move aquatic organisms from one water body to another. It also provides all Canadian jurisdictions with a consistent process (the Risk Analysis Procedure) for assessing the potential impacts of intentional introductions and transfers of aquatic organisms.

The Code applies to all aquatic organisms in fresh water and marine habitats. These include finfish, molluscs, crustaceans, echinoderms, and other invertebrates, as well as aquatic plants. It applies to all activities in which live aquatic organisms are introduced or transferred into fish-bearing waters, or fish-rearing facilities such as aquaculture, and for commercial and recreational fishing including biological control programs, e.g., control of aquatic vegetation.

Aquarium fish, live baitfish, live fish for the food trade and transgenic aquatic organisms are not covered by this Code. The Code also does not cover accidental introductions and transfers, where the transfer of an aquatic organism (and its eventual release into natural waters) is not intentional. Socio-economic analysis of introductions and transfers are not addressed in this Code, and while important in the overall assessment of introductions and transfers, these aspects are covered by mechanisms outside the Code.

To assess the implementation and application of the new Code there will be an 18-month review period to provide opportunity for feedback on the implementation and application of the Code; to identify areas where improvements to the Code are warranted; and to strengthen the Introductions and Transfer review process.

2 Deliberate Releases and Planned Introductions

Planned Introductions of Finfish and Shellfish

All regions expect the pattern of importations to remain similar to previous years.

Deliberate Releases

2.1 Finfish

Pacific Region

Under the Canada-US Trans-boundary agreement, 11 million sockeye (*Oncorhynchus nerka*) fry were returned to the Stikine River system in Canada after initial incubation in an isolation unit at an Alaskan Hatchery.

2.2 Invertebrates

Pacific Region

Because generally shellfish are grown on beaches (not contained) and could release gametes, larvae, etc. to the environment, these aquaculture activities are listed here. The BC shellfish industry depends on imports of seed for the main culture species: *Tapes philippinarum*, *Crassostrea gigas*, *C. sikamea* and *Mytilus galloprovincialis* and *M. edulis*. All imports must be from health-certified facilities. While these species are not intended for establishment *per se*, several of them are now well established through the activities of the shellfish aquaculture industry. The industry is also interested in further imports of *Ostrea edulis* and *O. virginica*. Both species were introduced earlier, but have not established themselves significantly. We expect that these importations will continue.

Interest is also shown in importing seed for the local species of geoduck (*Panope abrupta*). However, before transfers can be approved, genetic concerns must be addressed.

3 Accidental Introductions and Transfers

3.1 Fish

Pacific Region

Despite an intensive effort in 2001 when Fisheries and Oceans Canada partnered with coastal First Nations, no juvenile Atlantic salmon were discovered in BC rivers and streams.

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. In 1998 twelve juvenile Atlantic salmon were recovered from the Tsitika River on the Northeast coast of Vancouver Island. These fish were found to be of wild origin.

Atlantic Region
New Brunswick

Muskies (*Esox masquinongy*) from Quebec have been found in the Saint John River system. The transfer may have occurred in 2000.

A lake in the Miramichie drainage was found to contain the exotic chain pickerel, *Esox niger*. Because of its threat to the wild fish in the system and fears of its establishment, the lake was treated with Rotenone to eradicate the pickerel.

3.2 Invertebrates

Pacific Region

Three more green crab (*Carcinus maenas*) were found in August 2001, in Esperanza Inlet on the west coast of Vancouver Island, near 50ºN 127ºW, which is the most northerly occurrence of this species recorded for the Pacific Coast. These were mature male crab with a carapace width greater than 70 mm, likely of the same year class as the 9 other green crabs which have been found on this coast since 1999. Hundreds of green crabs have been found further south in Washington State since their first recorded appearance there in 1998, including smaller crabs which suggest additional recruitment in those waters (source: WDFW). As the first appearance of green crab in both Washington and British Columbia corresponded to the 1997–1998 El Niño event, the suggestion of a possible re-establishment of El Niño conditions in 2002 is of some interest.

Washington State has also distributed information to the public indicating a concern for mitten crab (*Eriocheir sinensis*), which are presently found in California, and for zebra mussels (*Dreissena polymorpha*). Mitten crab is not known to be present in Washington State or Canadian waters at this time. The only known occurrence of zebra mussels in British Columbia was the interception of a pleasure craft fouled with zebra mussels in 2000, just prior to its launching into the lower Fraser River.

Varnish clams (*Nuttalia obscurata*), first recorded from the Gulf of Georgia in the 1990s, were found in Barkley Sound on the west coast of Vancouver Island by 1997 including areas within Pacific Rim National Park. They have now extended their range further north.

Together with the first finding of varnish clams, a small exotic mussel from Japan, *Musculista senhousia*, was found. It had been known in Puget Sound since the 1940s, but apparently not reported from BC. Now they have been found at several sites in the Strait of Georgia (Saanich Inlet, Departure Bay, Lantzville, Parksville and Savary Island). There are comments in the literature about this species forming dense mats of intertwined byssae on tidal flats, but so far only uncommon scattered individuals have been found.

Atlantic Region
Prince Edward Island

Until last fall, the waters of PEI (Prince Edward Island) were considered continuous by the local Introductions and Transfers Committee and shellfish could be freely moved about within PEI waters without permits. The continuing problems with the clubbed tunicate changed that situation in the fall 2001, and now permits are required to move products within or out of the areas in which the tunicate is established (Murray River, Orwell Bay, Montague River, Brudenell River and St. Mary's Bay). The tunicate invasion is a very serious issue for mussel growers because it is definitely causing increased labour and costs related to grow out and harvesting.

The green crab continues its spread and can be now found as far south as Victoria on our Southern Coast and as far as Savage harbor on our Northern coast. It continues to be a worry for soft-shell clam growers and a major headache for eel fishers.

Codium continues its spread on both shores, and has even been found on mussels and mussel gear on the most southeastern coast—an apparent jump.

4 Live Imports

4.1 Finfish
Pacific Region

In 2001, 800,000 Atlantic salmon (*Salmo salar*) eggs were imported into a British Columbia quarantine unit from a health-certified farm in Washington State. As well, two freshwater species were imported. Tilapia (*Oreochromis niloticus*) from the USA went into an aquaculture facility and sturgeon (*Acipenser transmontanus*) were imported for short-term rearing in a quarantine unit prior to return to Idaho, USA.

Central and Arctic Region

Ontario

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
New Brunswick

The following species were shipped from Nova Scotia, Prince Edward Island, Quebec, Ontario and Maine:

Rainbow trout (*Oncorhynchus mykiss*).

Brook trout (*Salvelinus fontinalis*)
Atlantic salmon (*Salmo salar*) eggs were imported from Washington State.

New Brunswick also received live haddock (*Melanogrammus aeglefinus*) and Atlantic halibut (*Hippoglossus hippoglossus*).

Newfoundland

The following species were imported into the Province as eggs for aquaculture purposes: Arctic char (*Salvelinus alpinus),* Atlantic salmon, cod (*Gadus morhua*). In addition juvenile rainbow trout and all-female diploid steelhead (*Oncorhynchus mykiss*), as well as Atlantic halibut were imported.

Nova Scotia

Atlantic salmon eggs from Maine, rainbow trout eggs from Idaho, and Atlantic halibut from Iceland were imported for aquaculture.

4.2 Invertebrates
Pacific Region

See entry above.

Atlantic Region
Nova Scotia

In 2001, Fisheries and Oceans Canada staff at the Bedford Institute of Oceanography imported Japanese scallops (*Patinopecten yessoensis*) from British Columbia and red abalone (*Haliotis rufescens*) from Iceland and Arctic surf clams (*Mactomeris polynyma*) for research purposes. Researchers at Dalhousie University imported cuttlefish (*Sepia officinalis*) into quarantine holding.

Newfoundland

The Province imported 50,000 pounds of oyster (*Crassostrea virginica*) seed.

5 Live Exports to Other Countries

Pacific Region

For aquaculture purposes, a farm in the Yukon Territory exported Arctic char (*Salvelinus alpinus*) eggs to several states in the USA, Italy, Bolivia, Slovenia, and France.

A variety of species of finfish and invertebrates are collected annually and shipped to aquariums in other countries. During 2001, BC exported a number of different local, marine species:

Common Name	Latin Name	Exported to
Finfish		
Wolf eel	*Anarrichthys ocellatus*	Portugal Netherlands
Monkey face eel	*Xiphister mucosus*	Portugal
Invertebrates		
Purple urchin	*Strongylocentratus purpuratus*	Netherlands
Red urchins	*Strongylocentratus franciscanus*	Netherlands
Keyhole limpet	*Diodora aspera*	Netherlands
Lined chiton	*Tonicalla lineata*	Netherlands
Black turban snail	*Tegula funebralis*	Netherlands
Anenome	*Corynacticus californica*	France
Giant Pacific Octopus	*Enteroctopus dofleini*	France Portugal Netherlands

7 Meetings, Conferences, Symposia on Introductions and Transfers

11 th Annual Aquatic Nuisance Species – Zebra Mussel Conference – Washington, DC, was postponed due to events of 11 September. The conference was re-scheduled and held 25 February–01 March 2002. C&A Region represented by Mr Alex Salki and Chris Wiley.

2001 meeting of the Western Regional Panel on Aquatic Nuisance Species Task Force, postponed due to events of September 11. Meeting was re-scheduled and held 7–9 January, 2002, Las Vegas Nevada. Central and Arctic Region represented by Dennis Wright, DFO and Marcy Bast, Sask Dept Environment and Resource Management.

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NATIONAL REPORT FOR ENGLAND AND WALES

I. Laing

2 Deliberate Introductions and Transfers

2.2 Invertebrates

Deliberate releases of Pacific oysters for cultivation are at about the same level as in previous years. Small and sporadic spatfalls of this species occur. The managed Manila clam fishery in Poole Harbour yielded 176 tonnes in 2000, the highest amount to date. There are also two small commercially exploited populations of the introduced hard-shell clam (*Mercenaria mercenaria*) in the Solent and in the River Roach, Essex. Ormers (*Haliotis tuberculata*) have been imported from Guernsey and are being held at various sites around the coast of Cornwall, to assess the potential for cultivation of this species.

3 Accidental Introductions and Transfers

3.2 Invertebrates and Plants

Sargassum muticum has appeared further north on the UK West Coast, moving from Milford Haven to the Menai Strait, where it is flourishing. *Perophora japonica*, a Japanese sea squirt, was discovered for the first time in the Fleet lagoon, Dorset. This was previously reported in a marina in Plymouth, Devon in 1999 and in Northern France in the 1980s. It has become well established in the Fleet, where there is concern that it may compete with native species.

4 Live Imports and Transfers

4.1 Fish

Imports of rainbow trout eggs were 50.8 million, a significant (67 %) increase over the low total of the previous year. These came mainly from South Africa (62 %), as well as from disease-free sources within ICES boundaries including Denmark (13 %), Northern Ireland (4 %), and the Isle of Man (21 %).

4.2 Invertebrates

The imports of live American/Canadian lobsters and oysters for human consumption continues. This activity, together with storage of these lobsters in water at near-coastal facilities, is licensed. One report of an American lobster caught by a fisherman on the south coast of England was received. This animal was tested for gaffkeamia, the result being negative. The hatchery on Guernsey sent nine shipments of Pacific oyster seed to shellfish farm sites in England.

5 Live Exports to Ices Member Countries

5.2 Invertebrates

Pacific oyster seed were produced in UK hatcheries and 63 consignments were exported to Eire, one to Guernsey and one to Northern Ireland. Seven consignments of *Mytilus edulis* were sent to Guernsey and two to Northern Ireland.

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NATIONAL REPORT FOR ESTONIA

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2 Deliberate releases

Official data for 2000

Salmon (*Salmo salar*) - 98.6 thousand at age-1 and 34.8 thousand at age-2; whitefish (*Coregonus lavaretus*) - 116.9 thousand; sea trout (*Salmo trutta trutta*) – 30.0 thousand at age-2 into the sea and additionally ca. 35 thousand 0-group fish to ditches and rivers from which ca. 30 % is expected to reach the sea.

Preliminary data for 2001

Salmon (*Salmo salar*) – 184.2 thousand at age-1 and 33.8 thousand at age-2; whitefish (*Coregonus lavaretus*) – 85.4 thousand; sea trout (*Salmo trutta trutta*) – 20.8 thousand 0-group fish into rivers and ca. 30 thousand age-2 fish to ditches and coastal sea; pikeperch (*Stizostedion lucioperca*) – 9 thousand 0-group fish; pike (*Esox lucius*) - ca. 800 larvae.

3 Accidental introductions

New introductions were not reported in 2001. Of the already known non-indigenous species, below is reviewed the new information on *Cercopagis pengoi* and *Marenzelleria viridis*.

Temporal dynamics of the *Cercopagis pengoi* population were studied in the shallow sheltered northeastern part of the Gulf of Riga. As a long-term mean (1992–2001), *Cercopagis* peaked in abundance during the first week of August (mean 269 ind m^{-3}) and the seasonal population development followed closely the course of surface water temperature. The density of *Cecopagis* has increased exponentially during the first ten years of invasion by peaking with the annual mean of 420±109 (S.E.) in 2001. Presence of *Cercopagis* tended to last longer in the mesozooplankton community over the years by shifting its population development to earlier time, similar to that of the copepod *Eurytemora affinis*. After invasion of *Cercopagis*, the annual mean abundance of *Bosmina coregoni maritima* was significantly lower than during the pre-invasion time. Although populations of other mesozooplankton taxa did not follow this pattern, seasonal development of abundance of nauplii of copepods and *Acartia* spp. has changed which might partly be attributed to the invasion as a direct effect of predation. Although the mean share of *Cercopagis* in the diet of most abundant planktivorous fish remained low (< 7 %), the cladoceran made up a substantial portion in fish diet in warm months. Consumption of *Cercopagis* has increased with increasing fish size in case of herring, *Clupea harengus membras*, and smelt, *Osmerus eperlanus*, but not in case of sticklebacks, *Gasterosteus aculeatus* and *Pungitius pungitius*. The study suggests that invasion of *Cercopagis* has affected mesozooplankton dynamics and food-web interactions where dietary overlap with fish larvae and planktivorous fish is likely to occur (Ojaveer *et al.,* manuscript).

Effects of the North American polychaete *Marenzelleria* cf. *viridis* on a simple shallow-water benthic community of the northern Baltic Sea were studied in a field experiment combining natural densities of dominating macrofaunal species. The presence of *M.* cf. *viridis* increased benthic production (chlorophyll *a*) and reduced the survival of the native polychaete *Nereis diversicolor*. The adult clam *Macoma balthica* caused a significant mortality on *M.* cf. *viridis* whereas the adult cockle *Cerastoderma glaucum* had no effect on *M.* cf. *viridis*. We suggest that the competitive interactions between *M.* cf. *viridis* and *M. balthica* are a possible key factor determining the distribution pattern of *M.* cf. *viridis* in the Baltic Sea. The loose lying mat of the commercially exploited red algae *Furcellaria lumbricalis* is amongst the most preferred biotope for *M. viridis*. The biomass of the polychaete increased with the coverage of *F. lumbricalis* (Kotta and Orav, 2001; Kotta *et al.,* 2001).

4 Live imports

Country	Fish	Quantity (kg)
Denmark	ornamental freshwater fish	30
Finland	ornamental freshwater fish	167.5
Russian Federation	ornamental freshwater fish	559.4
Denmark	*Oncorhynchus apache* and *O. chrysogaster*	70.0
Finland	*Oncorhynchus apache* and *O. chrysogaster*	320.0
Finland	trout (*Salmo trutta*) and salmon	13500.0
United Kingdom	eel (*Anguilla anguilla*)	150
Denmark	unidentified fish	10.0

5 Live exports to ICES countries

Latvia	trout (*Salmo trutta*) and salmon	39.7
Russian Federation	trout (*Salmo trutta*) and salmon	41.9

Live exports to other countries

Cyprus	salmon	4.9
Luxembour	salmon	31.8
Marshall Islands	salmon	56.5
Saint Vincent and the Grenadines	salmon	4096

7 Meetings, Conferences, Symposia or Workshops on Introductions and Transfers

Participation (H. Ojaveer) at the Regional Workshop on "Managing Invasive Alien Species: Forging Cooperation in the Baltic-Nordic Region" held in Copenhagen 21–23 May 2001.

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NATIONAL REPORT FOR FINLAND

E. Leppäkoski and L. Urho

1 Laws and Regulations

2 Deliberate Releases and Planned Introductions

2.1 Fish

Deliberate releases into the Baltic Sea were (including rivers draining into the Baltic) for fisheries and fish stock enhancement purposes in 2000 (2001 data not yet available) as follows:

0.9 million newly hatched and 3.7 million older salmon (*Salmo salar*);
0.4 million newly hatched and 1.9 million older sea trout (*Salmo trutta* m. *trutta,*);
61.5 million newly hatched and 9.5 million one-summer-old whitefish (*Coregonus lavaretus*).

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

3.1 Fish

Thousands of rainbow trout (*Oncorhynchus mykiss*) escaped from string bags during some storms in the southwestern Finland.

A Russian sturgeon (*Acipencer gueldenstaedti*) was reported from the southwestern coast of Finland (Merikarvia).

4 Live Imports

4.1 Fish

- Elvers (*Anguilla anguilla*) from England (River Severn) via Swedish quarantine to be released in fresh waters and some farmed in coastal waters;
- Rainbow trout (*Oncorhynchus mykiss*) from Sweden to Åland Islands to be farmed and slaughtered. Also rainbow trout eggs from Sweden to inland cultivation;
- Tropical aquarium fish.

4.2 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 authorization by the Veterinary department is required.

5 Live Exports

- Whitefish (*Coregonus lavaretus*) and sea trout (*Salmo trutta*) from northern Finland to northern Sweden (local introductions in tributaries of River Tornio).
- Eggs of grayling (*Thymallus thymallus*), Arctic char (*Salvelinus alpinus*), trout (*Salmo trutta m. lacustris* and *S. t. m. fario*), rainbow trout to Austria.
- Whitefish eggs and rainbow trout to Russia.
- Whitefish eggs to Israel.

All exports to countries outside EU are not systematically collected.

6 Planned introductions of new species

7 Meetings

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NATIONAL REPORT FOR FRANCE

P. Goulletquer

3 Accidental Introductions and Transfers

The *Rapana venosa* case

Following an enquiry, the introduction vector for this species is now explained: transfers of *Tapes philippinarum* from the Adriatic Sea (Italy) towards Southern Brittany. *Rapana* individuals were used to ballast clam bags, and likely for marketing. In 2001, two more individuals were captured by fishermen. One in the same area and same depth that previous captures, and another one from flat oyster spat collector (using metallic structure and bags of mussel shells). At about 30 cm high on the same structure, ten ootheques were found (2.5 cm long each), representing the first description of reproductive success in this area for *Rapana*. Brought at the laboratory in quarantine, juveniles have been obtained and are still alive. Maintained in this facility, they are used for research purpose. Although unsuccessful, new trials using nets, and dredge were carried out to eradicate the species. Leaflets and information campaigns to the public and fishermen are currently used to disseminate information and to reward any catch.

The *Crepidula fornicata* case

Two on-going research programmes are focusing on the gastropod *Crepidula*: LITEAU and AREVAL programmes. The first one focuses on the impacts of this species on benthic populations and sedimentation rates. A population dynamic model is under development for Northern Brittany populations coupled with a hydrodynamic model related to English channel currents. The AREVAL programme focuses on the industrial exploitation of *Crepidula fornicata* populations located in Northern Brittnay. Spatial mapping for those populations has been developed. A pilot study monitoring exploited populations is on going. Larval studies are also under development in a cooperative research programme with the Tufts University (USA).

The *Caulerpa taxifolia* case

The monitoring campaigns are carried out on a regular basis to assess spatial expansion. Areas used by leisure boating for mooring are heavily colonized (within Hyères and Toulon Bays). In 2000, over 17,338 ha and 3777 ha were prospected in Hyères and Toulon bays, respectively; 7358 ha and 992 ha were heavily colonised by *Caulerpa*. A new software using GPS positioning and simultaneous treatment of video tapes now facilitates the data treatment.

Ballast water research

In 2001, a new sampling campaign was carried out aboard ships arriving in French ports (Le Havre, Saint Nazaire, Marseille), focused on phytoplankton and bacteria.

As results, the genera *Pseudomonas-Aeromonas* were present in 25 % of the samples, *Clostridium (perfringens* in 90 % of the cases) in 29 %, *Vibrio* in 50 % (including *V. parahaemoliticus* in one case).

The most interesting result in phytoplankton is *Dinophysis* (*acuminata* or *sacculus*) in 16 % of the samples; on the other hand, *Heterosigma cartere* was observed once (ballast water from Tunisia).

The genus *Protoperidinium*, observed, must be confirmed (if *P. crassipes*, it is a new threat).

4 Live Imports

Invertebrates

The Pacific giant *Octopus* and the Anemone *Corynacticus californica* was imported from Canada for aquarium activity.

The shellfish farming industry imported Pacific cupped oyster for direct marketing from Ireland, Portugal, Netherlands and the UK; clams from Italy; mussels from Spain, and the Netherlands.

5 Live exports

Most of the exports concern *C. gigas* spat and medium size to various European countries for growing.

7 Meetings – Conferences

INVABIO meetings concerning the multidisciplinay research programmes on invasive species were organized in 2001, and new meetings are scheduled for 2002. Following the "Erika" oil spill, a consortium of research institutes and universities was developed in Brittany to study benthic communities, biodiversity and establish a monitoring network to study and map coastal communities. This network called REBENT aims to facilitate the development of a national network, therefore to also facilitate implementation of European directives (Habitat, Water).

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http://www.ifremer.fr/depot/com/stbrieuc

Review:
Geochronique, 77, March 2001: review of the IFREMER's report "Study of the sediments and populations of *Caulerpa taxifolia*" (IFREMER editions).

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NATIONAL REPORT FOR GERMANY

S. Gollasch and H. Rosenthal

1 Laws and regulations

Animal protection rates high with the German air cargo at Lufthansa (!). “No Room for Wild Animals” is now the motto of the company. The commercial transport of wild animals is no longer a service offered by the logistics subsidiary of the Lufthansa group. A package of measures was put together, which only allows the transport of wild animals for meaningful animal and species protection activities (Lufthansa Magazin, 12, 2000, 58).

3 Accidental Introductions and Transfers

No new accidental introductions were reported from German marine or brackish waters in 2001. However, it is assumed that the Asian shore crab *Hemigrapsus penicillatus* will invade German waters in the very near future as records are known from Belgium and the Netherlands indicating its eastwards directed spread in the German Bight. Danish colleagues are aware of *Hemigrapsus* eastwards spread, but have not found any specimens yet. To the benefit of those being interested in *Hemigrapsus* you may wish to subscribe to a relevant mailing list run by S. Park, University of Delaware, USA (hemi-list@udel.edu).

The long-term daily sampling station Helgoland Roads revealed that the number of non-native warm-temperate species is increasing possibly due to mild winter conditions or global warming. Introducing vector is shipping and secondary spread from southern European shores.

The early warning system on algal blooms in German parts of the North and Baltic Seas was established in 1989 and is continuously operated as a result of a *Chrysochromulina* bloom that negatively affected Norwegian salmon farms in 1988. A weekly algal report is available at www.algenreport.de and provides information for the aquaculture and tourist industry.

The following paragraphs present news of previously reported non-indigenous species.

3.2 Invertebrates

Crassotrea gigas
The oyster farm located on the island of Sylt in the North Sea is continuing its operation (rack culture) according to the unchanged demand. In 2001 the company sold about 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 nordmanni* and *Styela clava* (see previous German National Reports). These unintentionally introduced species are well established near the oyster farm now and constantly spread further.

Culturing the Pacific Oyster 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 Oysters in the Wadden Sea (Diederich, 2001).

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

Dreissena polymorpha
As in many other countries the Zebra Mussel continuously spreads. At present several companies in Hamburg harbour, which depend on secured cooling water supply are suffering from extensive costs (an estimated 1 Mio US$ annually). Further, it is likely that a reintroduction 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. Further, the spread of the species into new European localities (i.e., Spain) is of concern. However, the source of the Spanish population is unknown.

Eriocheir sinensis, Chinese Mitten Crab
The shipments of juvenile Chinese Mitten Crabs, *Eriocheir sinensis*, to China for re-stocking purposes, as reported in last year's National Report, were not successful. Before being released into the wild, all specimens died as the customs procedure was too time consuming and the transport method was not adequate to account for the excess oxygen consumption and temperature fluctuations over so many time zones.

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 underway (Senckenberg Institut Frankfurt, Germany).

Portumnus latipes
Occasional records in German waters, possibly due to natural spread from warmer European regions.

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 damages of several million US$ per year. Preventive measures are presently 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.

Recent (February 2002) "*Teredo* alert". Investigations at one of the most popular tourist sites along the German Baltic coast (Timmendorfer Strand) revealed that the shipworm has substantially damaged a 100 m long pier being a popular marina and sightseeing location. Costs to replace wooden installations are estimated as high as 115,000 Euro.

4 Live Imports

4.1 Fish

Aquaculture and powerplants

Several aquaculture facilities have been in operation for decades using warm water effluents of powerplants. Species are cultured for the aquarium industry (ornamental species: koi carp, gold fish and sterlett), human consumption (Asian carp, *Tilapia* species) and restocking (glass eels). The total annual production annually was approx. 250 tonnes.

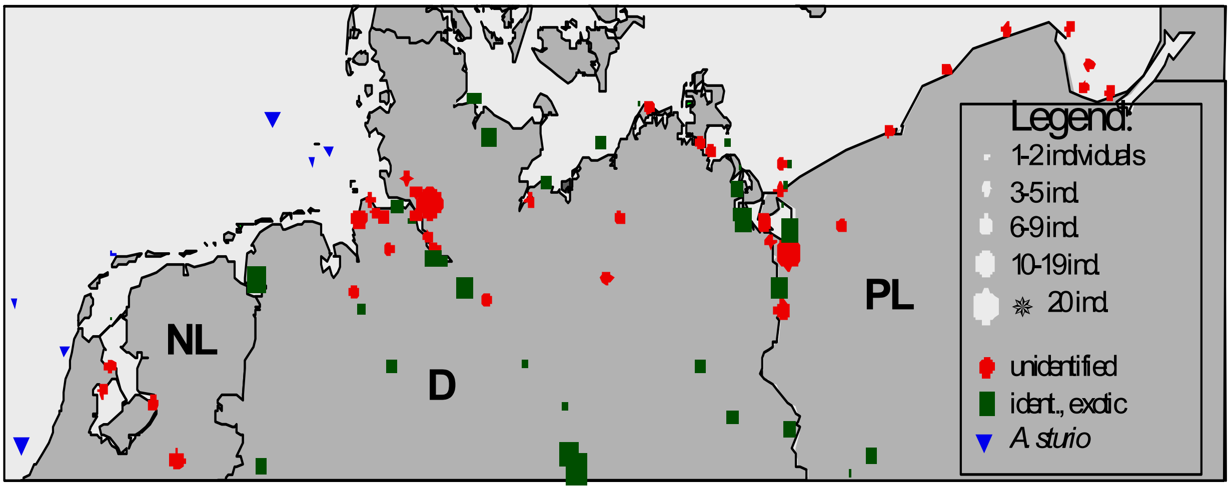
Glass eels are imported from various countries (e.g., France, Italy, Ireland, Netherlands, and Sweden) according to the ICES Code of Practice. With a weight of 25 g the individuals are used for restocking in German inland waters.

Several Sturgeon species are still imported from Russia by local farmers for small-scale culture, among them is the Siberian sturgeon *Acipenser baeri*. On and off there are records of captures of escapees although these are rare events.
The continuous reproduction and import of live sturgeon species for aquaculture and pet-trade has resulted in increased availability of sturgeons on the market. As a consequence the fish have been transferred into many open water bodies of Central and Western Europe (Gessner *et al.*, 1999; Arndt *et al*., 2000; Rochard *et al*., 2001). According to fishermen the number of sturgeon caught in natural water bodies exceed the reported ones by far.

A new trade for juvenile sturgeons has developed to serve the pet fish industry in several parts of the country. Juvenile sturgeons are increasingly placed in garden ponds. Once reaching a certain size, these are not always killed but often released into natural water bodies. Figure A3.1 shows the increasing records of various sturgeon species in German waters.

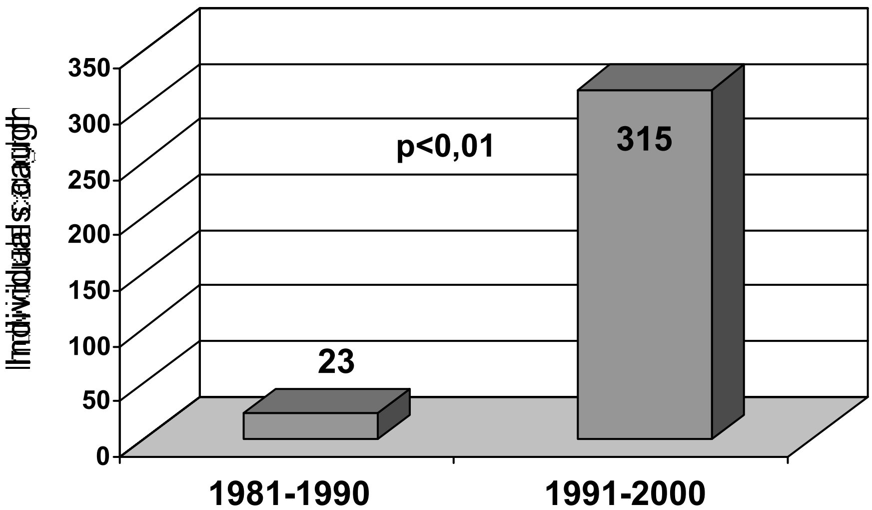
A total of 338 sturgeons of various species and hybrids were reported in Central European waters since 1981 until today. The main catches (nearly 90 %) were reported from coastal waters and large rivers such as the Odra, Elbe, Weser, and Rhine (Figure A3.1).

Figure A3.1. Location of records of non-native sturgeons in Central European waters (North Sea and Baltic Sea drainage systems) since 1980 to date (after Arndt, Gessner, and Raymakers, in press).



Differences in frequencies of catches and species composition were detected between the two periods (1981–1990 and 1991–2000). The catches in the second decade exceeded those from 1981–1990 highly significantly (p< 0,01, Figure A3.2).

Figure A3.2. Development of reported sturgeon catches in Polish, German, and Dutch coastal and inland waters since 1981 (after Arndt, Gessner, and Raymakers, 2002, in press).



Beside the total catch, species composition and variety revealed significant changes in the last 20 years too ($p < 0,001$). From 1981–1990 (total catch only 23 individuals) only *A. baerii* was caught in noticeable amounts apart from *A. sturio*. From 1991 up to recent years the species variety in the catches of sturgeons was increased to nine pure species as well as additional hybrids (Figure A3.3).

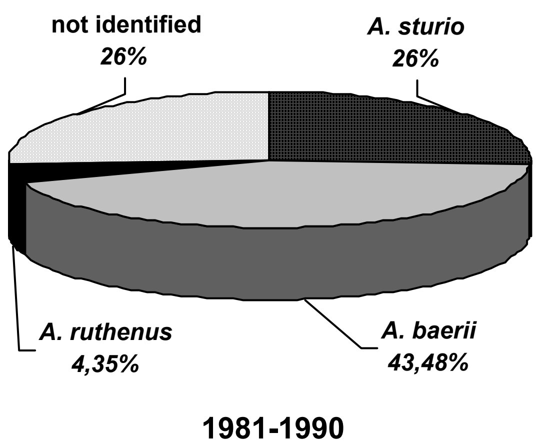
Table A3.1. Presence of different sturgeons in aquaculture or scientific facilities in the catchments area (modified after Rosenthal and Gessner, 1992; Bronzi *et al*., 1999; and Williot *et al*., in press).

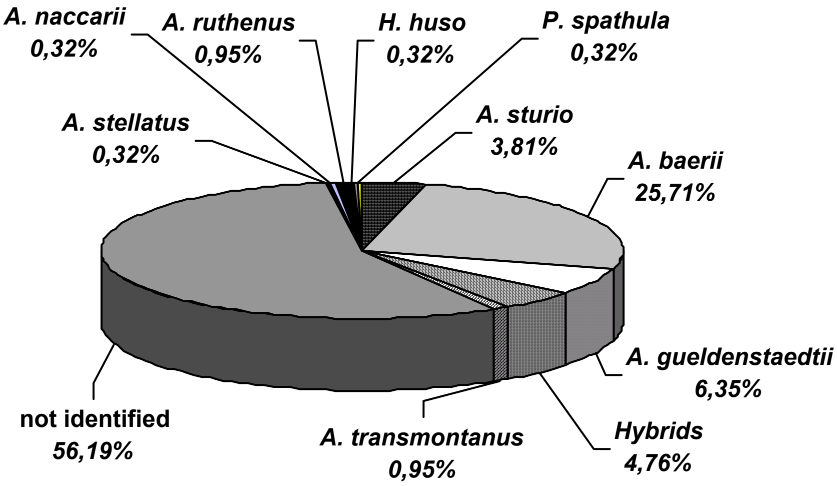
	92	95	96	97	99	92	95	96	97	99	92	95	96	97	99
Species	Germany					The Netherlands					Poland				
A. baerii	x	x	x	x	x				x	x		x	x	x	x
A. ruthenus	x	x	x	x	x							x	x	x	x
A. gueldenstadtii		x	x	x	x				x	x		x	x	x	x
A. oxyrhinchus				x	x										
H. huso		x		x	x							x	x	x	x
A. sturio			x	x	x					x					
P. spathula				x	x										
Bester	x	x	x	x	x										
other Hybrids	x	x	x	x	x										x

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 trouts imported overall varied over the past few years between 15,000 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 increased again (sources: Poland, Hungary, Czech Republic) to 3,150 tonnes (1997) and the level presently is around 5,000 tonnes (2001).

Figure A3.3. Increasing species variety and changes in dominating species of sturgeon catches in Polish, German, and Dutch coastal and inland waters between 1981 – 2000, $p < 0,001$. (after Arndt, Gessner, and Raymakers, 2002, in press).





1991-2000

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. It is estimated that several 10,000s German hobbyists run seawater aquariums. Germany is one of the top three importers following USA and Japan. Annually 6 million fish are imported predominantly from the Philippines, Indonesia, Thailand, Singapore and Hawaii. According the Washington World Watch Institute 600 million marine ornamental fish are shipped annually on a global basis. Several commercial companies offer their service to ship living marine organisms (e.g., www.coastalreef.com/animals.htm). Reliable statistics are difficult to obtain. However, the tonnage is gradually increasing while also live corals and other marine invertebrates are becoming increasingly popular. It is safe to assume that the order of magnitude of such trade is in the order of millions of individuals. In 1980 the estimated biomass weight of imported tropical fish into Germany from around the world was in the order of 60 metric tonnes. In 2000, 105 tonnes of freshwater and 45 tonnes of sea water fish were imported. Little is known on deliberate releases of petfish, however, such releases do occur during the summer. Sporadic records of tropical fish are becoming available. None of these fish survive during the winter and records are temporary and only known to be valid the year of reporting. Repeatedly, swimming crabs, sunfish and other warm water species are found at powerplant effluents during summer.

At present, a survey on trading of life marine animals by Public Aquaria and Oceanaria has been started at the Institute for Marine Science, Kiel, the results of which are still not yet available. Although the Kiel aquarium itself displays mainly indigenous species, several exotics are also regularly imported to attract the public by colourful tropical marine life. Located at the Baltic Sea, a wide spectrum of the North Sea fish fauna is also displayed. Table A3.2 depicts a few examples.

Table A3.2. Non-indigenous species displayed at the Kiel public aquarium during winter 2001–2002 (Waller, Rosenthal, personal communication).

Display No.	Species	Kreislauf	Aquarium size [L]
2	Pike *Esox lucius*, from Lower Saxony	S	1230
3	Rotfeder, Rotauge, Karausche	S	1230
4	Karpfen, Schleie	S	2500
6/7	Bitterling, Teichmuschel	S	440
8/9	Elritze, Gründling, Schmerle	S	440
10	Meerforelle, Strandkrabbe	O	4400
12	Schnäpel, Aalmutter, Seebull	O	4400
13	North Sea plaice *Pleuronectes platessa* Dover sole, *Solea solea*, sturgeon *A. baeri*	O	11000
14	Seeigel, Gefleckter-, Kuckucks-Lippfisch, Klippenbarsch, Goldmaid, Seespinne	N	4400
15	Gem. Seewolf, Kleingefleckter shark *Anarhichas canicula*	N	4400
16	*Limulus, Nephrops* (Skagerak)	N	2500
17	Froschdorsch, Roter Knurrhahn, Wittling, Kuckucks-Lippfisch, Rotzunge, Eßb. Seeigel, Sonnenstern, Petermännchen, Hummer	N	4400
18	*Dicentrarchus labrax*, *Sparus aurata*	M	4400
19	Gemeine Meeräsche, Gestreifter Bleniide, Meerjunker, Kardinalsfisch	M	1230
20	Schnepfenfisch, Eberfisch,	M	1230
21	Pollack, Köhler, Kabeljau, Gestreifter Seewolf, Aal, Nagelrochen, Scholle, Taschenkrebs, Eisseestern,	N	11000
22	Seepferdchen *H. hippocampus*	N	260
23	Lippfisch, Seedahlie, Einsiedler	N	170
24	Katzenhai-Eier, Meerhand, Seestichlinge, Schlangenseestern, Kammmuschel	N	260
25	Hummer, Schwimmgrundel	N	170
26	Gestr. Seebader, Harlekin-Lippfisch, Gelber Seebader, Mirakelbarsch, Fuchsgesicht,	T	1230
27	Clown-Anemonenfische, Tridacna, Anemonen, Weißbinden-Anemonenfisch, Rotfeuerfisch (Pterois volitans)	T	1230
32	Seepferdchen	T	650
8	Gelbe Symbiosegrundel. Gelbschwanzjunker,	T	280
30	Gelber Lippfisch, Garnelen	T	280
9	Demoisellen, Putzergarnelen	T	280
31	Kardinalsbarsch	T	280

There are several other public aquaria along the German coast that certainly display a similar spectrum of species and the Kiel example may also serve as a model for others around the European coastal institutions within the ICES area.

4.2 Invertebrates

Live Blue Mussels (*Mytilus edulis*) were imported from Denmark for human consumption in an unknown quantity.

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. are regularly imported live for markets in various parts of the country. Depending on season, shipments originate mainly from Canada, Ireland and Norway. Trading ports in which live lobsters are held in tanks are Hamburg and Bremen.

5 Live exports to ICES Member Countries

Live Blue Mussel (*Mytilus edulis*) production is to a large extend targeted for the Belgium and Dutch market.

The former Biologische Anstalt Helgoland continues to operate its service to deliver (mainly European-wide) local species to research and other institutions. It is unknown if the ICES Code of Practice or other quarantine measures apply.

7 Meetings, Conferences, Symposia or Workshops on Introductions and Transfers

7.1 Fishing peoples 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.

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 (see last year's National Report).

The first conference organized by NEOBIOTA was a great success. Workshop proceedings will be published soon, both in German and English as a special volume of Biological Invasions (www.tu-berlin.de/~neobiota). The next meeting is planned for October 2002.

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

An international follow-up workshop is planned for late 2002. A steering Committee has just been formed and detailed information on the upcoming activity should be available shortly.

7.3 Marine Environment Protection Committee 47 (MEPC47), International Maritime Organization (IMO), ballast Water Working Group (BWWG)

Agenda Item 2 Harmful Introductions with ships

The number of papers submitted for consideration of the Ballast Water Working Group was never higher than at the last meeting indicating the increasing awareness regarding biological invasions with ballast water. A Diplomatic Conference on Ballast Water is planned for 2003.

7.4 European Research Network on Aquatic Invasive Species (ERNAIS)

Initiated by Vadim Panov, Russia, Germany joins the ERNAIS network as co-coordinator. The idea to develop ERNAIS was discussed for the first time in 1999 at the 16th Baltic Marine Biologist Meeting in Klaipeda, Lithuania. Key objectives of this initiative include:

- the development of the international database on aquatic invasive species;
- creation a network to exchange information on port and ballast water studies;
- assessment of ecosystem impacts of aquatic invasive species;
- studies on the potential effects of introduced parasites and disease agents;
- research on genetically modified organisms.

In 2001, SIL Working Group on Aquatic Invasive Species and BMB WG NEMO initiated a broad discussion of the ERNAIS concept, sending electronic call for cooperation to the known European experts. As a result, a first directory of European experts in the area of aquatic invasions was developed, and at present it includes contact information and area of expertise for 58 experts from 21 countries (www.zin.ru/projects/invasions/gaas/ ernaismn.htm).

Interlinks were developed between illustrated descriptions of some invasive aquatic species on website of the Group on Aquatic Alien Species (GAAS), sub-program of the Regional Biological Invasions Center (RBIC, server in St. Petersburg), and Baltic Alien Species Database (server in Klaipeda). Also, currently GAAS is hosting websites of some international working groups, and provide useful links to the appropriate websites in Europe and worldwide (CIESM atlas of exotic species, for instance).

7.5 Workshop on *Teredo navalis*

A workshop on *Teredo navalis* will be held at the end of April 2002 in Bremerhaven, Germany. Agenda items include: current distribution and impacts globally seen with the emphasis on German waters.

7.6 Ballast Water Study: Canada – Germany

The cooperative Canadian and German ballast water sampling study on ships travelling between Canada and Europe was successfully completed in 2001. Results will be published soon.

7.7 Experimental work

H. penicillatus was introduced to France in the mid-1990s and continues to spread and has reached the Belgium and Dutch coasts. 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. The results will be published soon.

7.8 Ballast Water Treatment Full-Scale Treatment of Ballast Water (GAUSS Project)

Various attempts of monitoring the unintentional introduction from ballast water have been undertaken and in some cases these attempts are under full-scale testing. Examples include an already existing methodology aiming to improve the process of changing the ballast water. This methodology has been developed in Brazil. Australian scientists have conducted experiments where they are heating up the ballast water, while micro-filtration has been carried out in the US. Laboratory testing of a recently developed chemical mitigation tool are being conducted in Germany. Norwegian companies are aiming at developing methodologies that are ozone based, as well as a methodology that consists of cyclone separation followed by UV treatment.

The project is funded by the City of Bremen (Germany) and will summarize the up-to-date information on ballast water treatment options (Phase 1, to be completed July 2002). Phase 2 (August 2002 – July 2003) includes practical test of port water operating selected treatment options from a barge, in Phase 3 (August 2003 – June 2004) full-scale tests onboard vessels are planned. Project partners: MWB Motorenwerke Bremerhaven AG, Kraeft GmbH, Bremerhaven, GAUSS, Gesellschaft für Angewandten Umweltschutz und Sicherheit im Seeverkehr, Bremen.

Cooperative partners: Alfred-Wegener-Institut für Polar- und Meeresforschung in Bremerhaven, GoConsult, Hamburg.

Contact:

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www.gauss.org

7.9 Offshore Wind Parks

Large-scale offshore wind parks are planned off the German Baltic and North Sea coasts. The newly man-made hard substrates in the area where soft-bottom habitats prevail should be designed to (a) enable the colonization with native hard-bottom species and (b) establish new maritime users as, e.g., aquaculture sites for oyster and macroalgae cultures (although initially mainly native species will be considered during the test phase, it is anticipated that non-indigenous species may be included in the near future).

7.10 Biological diversity

In Germany 2002 is dedicated to the biological diversity including public awareness campaigns with the objective to bring relevant stakeholders together to exchange relevant information. Approx. 300 institutions and initiatives joined the campaign (www.biologischevielfalt.de).

7.11 100 Years German Scientific Commission for Marine Research

A one-day meeting was scheduled to celebrate 100 Years German Scientific Commission for Marine Research, June 2001. Lecturers frequently referred to the importance of ICES.

7.12 Copenhagen Meeting, GISP, Government of Denmark and United States Government

The meeting was held in May 2001 as Regional Management Workshop on Invasive Alien Species. The participants recognized the existence of invasive alien species as a threat to biodiversity and further declared the need for (a) regional cooperation sharing scientific and technical resources, (b) the implementation of guiding principles, such as CBD and guidelines developed by IMO, ICES, IPPC, EPPO, Bern Convention and GISP.

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NATIONAL REPORT FOR IRELAND

D. Minchin with assistance from M. Lyons Alcantara and F. Geoghegan

1 Laws and Regulations

Statutory Instrument 34 of 2001 (signed 8 February 2001). An order implements *inter alia* Council Directive 2000/27?EC of 2 May 2000, amending Council Directive 93/53/EEC introducing minimum measures for the control of certain fish diseases. It takes account of *inter alia* new scientific and technical evidence relating to the treatment of List I diseases and allowing for vaccination of some List I and List II diseases.

2 Deliberate Releases and Planned Introductions

2.2. Invertebrates

The abalones *Haliotus tuberculata* and *H. discus hannai* continue to be cultivated on west, southwest and south Irish coasts.

The clam *Venerupis philippinarum* is cultivated using hatchery seed. This is grown under mesh in several bays and estuaries on all Irish coasts.

The Pacific oyster *Crassostrea gigas* is produced in Irish hatcheries but is also imported from France from hatcheries. The majority of seed imports are from Guernsey and the United Kingdom. Cultivation takes place on all Irish coasts with the main production from Carlingford Lough (east coast) and Dungarvan Bay (south coast). Irish oyster growers continue to be advised against bringing in half-grown oysters because of the high risk of importing unwanted biota and that some samples of imported seed would continue to be examined. Summer mortalities result in some losses in the late summer and were recorded from the Irish south coast in 2001. A gill condition was found in the native oyster (*Ostrea edulis*) in 2001 from Cork Harbour and was noted in Pacific oysters in 2002 in both Cork and Waterford Harbours and may affect growth (see separate report in Section 8 above).

2.3 Algae and Higher Plants

The exotic red alga *Asparagopsis armata* has been known in Ireland since 1939 and it is presently distributed on Irish west, southwest, and south coasts. The species is common in the wild in some sheltered localities. The species presently is involved in aquaculture trials for providing extracts used for cosmetics. On account of the bromophenols present the species must be handled in well-ventilated areas and gloves should be worn. The species is cultivated on longlines on the west coast of Ireland and there are plans for further cultivation.

3 Accidental Introductions and Transfers

3.2 Invertebrates

The parasite of eels, *Anguillicola crassus,* was found on the River Barrow in 1997 and 1998 and on the Shannon River, Lower Lough Erne in 1998 and 1999 (Derek Evans). It is now known from the Corrib System, in the west coast of Ireland (Oisin Naughton).

The zebra mussel, *Dreissena polymorpha,* is thought to have arrived in Ireland in 1994 or earlier and its appearance may have been aided by a greater freedom of trade within the EU as value added tax was removed at a time when the Irish pound was strong. Many leisure craft, including used craft fouled with zebra mussels, were imported to Ireland at this time. The species became established in the Lower Shannon and spread to most of the Shannon navigation and Lower Lough Erne in 1996. The species is now present throughout most of the interconnected navigable waterways where water conditions are suitable. The species has now been found in some separate river systems and lakes. It is abundant in Kilgory Lake on the Ratty River (W. region) and has been established there for at least two years. A very small number were recovered from Lough Gill (NW region) but were all of two years of age and no younger specimens were present; and some hundreds from two or more year classes were found in a small isolated lake in Co Sligo. These were found at one boat launching site and were probably scraped off a boat during launching. These were removed by diving. These last two localities are thought to have resulted from overland transport of angling boats By characterising the shell features of those found in this small lake two likely source regions for these zebra mussels were deduced. Surveys place in 2001 on the Shannon-Boyle-Suck navigations, The Shannon-Erne Waterway (which connects the Shannon and Erne waterways) and on the Erne navigation. Zebra mussels were found in the Grand Canal basin in Dublin for the first time. The impact of zebra mussels on water quality is being examined at Lough Key, on the Boyle River (connected to the Shannon navigation) and the genetics of zebra mussels throughout its Irish range are being studied.

3.3 Algae and Higher Plants

The Pacific alga *Sargassum muticum* was first noted in Strangford Lough, Northern Ireland (NE Irish coast) in 1995 by Prof. Patrick Boaden at a Pacific oyster growing site. These may have been originally imported as attached plantlets with oysters from the Channel Islands. The species has since become well established and dispersed to other localities within the Lough.

In the autumn of 2001 a ca. 1.5 m long fragment of *S. muticum* was found at a marina within Kilmore Quay (on the Irish SE coast) by Dr Stephan Kraan. This plant had an attaching population of hydroids and when lifted from the water released eggs.

Two further records of fixed populations were found in 2001, in Bertraghboy Bay on the west coast of Ireland and on the SW coast of Ireland in Kenmare Bay. These populations may have been established for two or more years. The finding of these small populations in disparate sites is of concern and a field study of sites that are likely to have become infested is due to take place during the summer of 2002 by The Marine Institute and the National University of Ireland, Galway. A series of leaflets has been printed to aid in establishing the current distribution of the species. It is likely that the algal fragment found in Kilmore Quay may have been carried as surface drift from Britain or northern Continental Europe. The presence of hydroids often found on such drift material make this a likely explanation. The vectors responsible for the two established populations on the SW and W coasts are presently unknown, however, three possible vectors have been discussed: natural drift, carried with visiting leisure craft or with imported oysters.

3.3 Parasites, Pathogens, and Other Disease Agents

Pacific oysters with a reduced gill surface area were reported in 2001 from Cork Harbour. The condition was noted in 2002 from Cork Harbour and Waterford Harbour on the south coast of Ireland. A summary of the condition appears in Section 8 above.

4 Live Imports

4.1 Finfish

Species and stage	Quantity (Consignments)	Origin
Salmo salar eggs	4,261,000 (6)	Scotland
Salmo salar eggs	100,000 (1)	Sweden
Salmo salar parr	140,000 (1)	Scotland
Oncorhynchus mykiss eggs	500,000 (2)	Denmark
Oncorhynchus mykiss fingerlings	380,000 (7)	Northern Ireland
Psetta maxima fry	23,000 (2)	Isle of Man
Hippoglossus hippoglossus	1,300 (2)	Isle of Man

4.2 Invertebrates

Species	Quantity	Origin
Haliotus tuberculata broodstock	1,100 (4)	Guernsey
Crassostrea gigas seed	18,844,000 (39)	England
Crassostrea gigas seed	8,150,000 (16)	Guernsey
Crassostrea gigas seed	22,800,000 (14)	France
Crassostrea gigas seed	10,000 (1)	Northern Ireland
Crassostrea gigas half-grown	26 tonnes (5)	England

5.0 Live Exports to Other Countries

5.1. Finfish

Species	Quantity (Consignments)	Destination
Salmo salar eggs	13,870,000 (9)	Scotland
Salmo salar eggs	170,000 (3)	England
Salmo salar eggs	1,415,000	Germany
Salmo salar parr	687,000 (9)	Scotland
Salmo salar parr	100,000 (1)	France
Salmo salar smolts	207,000 (2)	Scotland
Salmo salar smolts	1,056,000 (6)	Shetland
Salmo salar smolts	20,000 (1)	Northern Ireland
Psetta maxima	100,000 (1)	China

5.2 Invertebrates

Species	Quantity (Consignments)	Destination
Mytilus edulis/galloprovincialis adult	42 tonnes (4)	Jersey
Mytilus edulis/galloprovincialis seed	1,508 tonnes (15)	Northern Ireland
Haliotus tuberculata	6,000 (3)	Jersey
Haliotus tuberculata	2,600 (1)	Northern Ireland
Haliotus discus hannai	3,100 (1)	Northern Ireland
Crassostrea gigas	200,000 (1)	Northern Ireland
Crassostrea gigas half-grown	consignment	Germany
Pecten maximus	20,000 (1)	Northern Ireland

7 Meetings, Conferences, Symposia or Workshops on Introductions and Transfers

11 th International Conference on Aquatic Invasive Species, Alexandria, Virginia, USA 25 February to 1 March 2002 (Paper presented: The association between zebra mussels and aquatic plants in the Shannon River system).
Irish Hydrobiology Research group Meeting, Royal Irish Academy, Dublin, 23 November 2001.
(Paper presented: *Exotic species and water quality*) summary appended.

Estuarine and Coastal Sciences Association. Marine biodiversity in Ireland and adjacent waters, Ulster Museum,

Belfast, 26–27 April 2001. (Paper presented: *Biodiversity and Marine Invaders*)

12 th Irish Environmental Researchers Colloquium, Cork, 25–27 January 2002. (Paper presented: *Zebra mussels in* Lough Erne).

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NATIONAL REPORT FOR NORWAY

A. Jelmert

1 Laws and Regulations

No new laws or regulations regarding matters relevant to WGITMO have been suggested or passed in 2001. A working group has been established to update and amend laws and bylaws relevant to the CBD.

2 Deliberate releases

2.2 Invertebrates

The red king crab *Paralithodes camtschatica* has extended its range westward at an unexpectedly high pace. It is now established and commonly encountered at "Nordkapp", and individuals are occasionally found even further west. In 2001, 123 vessels were participating in a research catch. Year 2002 will be the first year with a regular commercial catch of the red king crab in Norway. At present, the red king crab will be managed as a resource species rather than a feral species. No decision has yet been made on how to prevent the species from migrating south and westwards. A three year post-doc research project has been established at "Fiskeriforsk" in Tromsø (by January 2002 the resource and environmental research sections are parts of IMR). The project will study biological effects of the king crab, and will especially look at impact on the fauna in *Chlamys islandica* scallop beds. (Jan Sundet, IMR, pers. comm.).

3 Accidental Introductions and Transfers

3.2 Invertebrates

Slipper limpet (*Crepidula fornicata*). No signs of further migration northward from the Kvitsøy area of the slipper limpet have been reported.

Snow crab (*Chionoecetes opilio*). No further information on catches of the snow crab has been obtained.

The NW Pacific caprellid found along the western coast of Norway have been conformed as *Caprella mutica* Schurin 1935. (Dr Ichiro Tacheuci, Otsushi Marine Research Center, Univ. of Tokyo.) The particular appearance of *C. mutica* corresponds very well with the observations of the red algae *Dasysiphonia* sp. (3.3). No further dedicated study on the eventual spread of the caprellid species has been undertaken.

Another confirmed specimen of the American lobster (*Homarus americanus*) was found last year in Oslofjorden, bringing the total number of confirmed cases up to eleven specimens. Thanks to considerable public awareness work, a substantial number of suspected cases were brought in for evaluation. Attempts to develop primers for identification of eventual hybrids between European and American lobsters have been unsuccessful in Europe, but will be continued in the USA.

3.3 Algae and higher plants

Two species of the dinoflagellate genus *Pfiesteria* have been confirmed present in samples from one locality in the Oslofjord area in southeastern Norway (Jakobsen *et al*., 2002). The already well-known fish-toxin producer *P. piscicida* and the closely related *P. shumwayae* were found at 13 m depth at the mouth of "Sandvikselva". The entire 18S rDNA region was analysed and the Norwegian *P. shumwayae* was found to be identical to the American isolate, while a difference of three base-pairs was found when comparing the Norwegian to the American strain (GeneBank, accession no. AY033488) of *P. piscicida*. Between the Norwegian *P. piscicida* and *P. shumwayae* it was found differences in 58 nucleotide sites, including both indels and point mutations.

With the observed difference between the Norwegian and the American strain of *P. piscicida,* an introduction in either direction as one singular event in the distant past is rather unlikely. The most likely explanation is either a singular translocation relatively recently, or a homogeneous Atlantic distribution with an on-going gene flow. Samples from "Espegrend" outside Bergen have revealed "*Pfiesteria*-like" organisms *sensu* Burkholder (L.-J. Naustvoll, I.M.R., pers. comm.). When employing new and sensitive methods, it has recently been shown that *Pfiesteria* spp. is present in approximately 30 % of the localities examined in S.E. Norway. While usually present in low numbers, this genus is apparently fairly common in the brackish water biota (Dag Klaveness, Univ. of Oslo, pers. comm.).

Sargassum muticum is well established in the southern part of the Norwegian coast (Skagerak). It has now also established itself in the inner basin of "Oslofjord". The alga is found in large quantities along the southwestern coast in Rogaland and Hordaland. *Sargassum muticum* has reached the "Sognefjord", but no confirmed reports further north have been obtained.

A novel species for Norwegian waters, the red algae, "*Dasysiphonia* sp*."* (*Dasyaceae, Rhodophyta*) was found in 1996 and reported in 1999 (Lein, 1999; Sarsia 84(1):85–88). It was found in the Netherlands in 1994 (Stenega *et al.,* 1997). While the taxonomic affiliation of "*Dasysiphonia* sp*."* is still somewhat unresolved, the algae is naturally belonging to the Pacific, and has no known close relatives in the Atlantic Ocean. It should still be considered an introduced species (Jan Rueness, Univ of Oslo, pers. comm). "*Dasysiphonia* sp*."* has apparently extended its geographical range during 2001 and is now recorded in the "Sognefjord" area.

4 Live imports

4.1 Fish

300 salmon (*Salmo salar*) fry from Finland.

33,500 halibut (*Hippoglossus hippoglossus*) fry from Iceland.

160,000 turbot (*Scopthalmus maximus*) from France, Spain and Denmark.

An unaccounted number of several species of aquarium fishes.

4.2 Invertebrates

An unaccounted number of aquarium species.

5 Live Exports

5.1 Fish

Between 500 and 1000 turbot (*Scopthalmus maximus*) fry exported to Great Britain (research purposes).

Approximately 3 million turbot larvae (*Scopthalmus maximus*) to Denmark.

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

March 18, 2002

NATIONAL REPORT FOR POLAND

W. Pelczarski

1 Laws and Regulations

Polish regulations on fish and fish products are being continuously adjusted to the rules, which are in force in European Union countries.

2 Deliberate Releases

2.1 Fish

251,241 salmon (*Salmo salar*) smolts and 67,000 juveniles as well as 944,135 smolts and 550,000 fry of sea trout (*Salmo trutta morpha trutta)* were released into the natural environment (as an enhancement of wild stocks).

Total of 180,000 juvenile whitefish (*Coregonus lavaretus*), origin of Pomeranian Bay stock, were released into Puck Bay as a part of a program of reintroduction of whitefish, which is carried out since 1991. Also 900,000 fry of whitefish were released in Szczecin Lagoon to enhance existing wild stock.

3. Accidental Introductions and Transfers

3.1. Fish

The presence of round goby (*Neogobius melanostomus*) is recently spreading up to the eastern Polish coast. In 1999 the first specimen was found in Vistula Lagoon This fish, which lived in the mouth of Vistula River, recently is moving up to the river. A few specimens were found on the coast of Rugen Island - west Baltic. New settlements of round goby in the west Baltic are probably the effect of its introduction by means of ballast waters. The round goby became a stable element of trophic chain in the Gulf of Gdansk.

One specimen of sea lamprey *Petromyzon marinus* (92 cm length) was found in February 2002 in Puck Bay (part of Gulf of Gdansk).

3.2 Invertebrates

A mass invasion of the Ponto-Caspian cladoceran *Cercopagis pengoi* has been observed every year in Vistula Lagoon since 1999. It makes a lot of troubles to fishermen during summer days because it covers nets with a dense layer, making them less efficient.

The decapod shrimp *Atyaephyra desmaresti* (Millet, 1831), which originates from Mediteranean area, was for the first time found in 2000 in lower part of Odra River. Amphipods *Pontogammarus robustoides* and *Gammarus tigrinus* have been present since 1988 in western part of Baltic and in Szczecin Lagoon. In 1999 both species were recorded in eastern part of Polish coast; *Gammarus tigrinus* in Vistula Lagoon, *Pontogammarus robustoides* was found in estuary of Vistula River (Gruszka, pers. comm.). The continuous presence of *Gammarus tigrinus, Dikerogammarus villosus,* and *D. haemobaphes* is recorded in western Polish rivers (Müller, Zettler and Gruszka, 2001). Those species most probably came to Poland through a net of canals linking the main rivers.

4 Live Imports (data available for 1st half of 2001 only)

4.1 Fish

Eggs of *Oncorhynchus mykiss* - mainly: Denmark, France, South Africa.
Eel fingerlings - total 4,800 kg: Denmark, Germany, UK, Sweden.

Poland imported also ca. 1.4 tonnes of live marine ornamental fish and ca. 31 tonnes of freshwater live ornamentals. The main countries of origin: Thailand, Singapore, Nigeria, Indonesia, Israel, and Columbia.

4.2 Invertebrates

Import of crustaceans and other marine organisms for aquariums was continued in 2001 but no detailed data are available at present.

5 Live Exports to ICES Member Countries

Rainbow trout (*Oncorhynchus mykiss)* -11.8 t: Germany, Russia.

6 Planned Introduction

As in previous years, in 2002 Poland will continue restocking of salmon and sea trout at the level of at least as in 2001. Also the program of reintroduction of whitefish in Puck Bay will be continued with emphasis given to assess share of wild and reared population. The assessment will be done on the basis of mass markings with fluorescent external markers.

Continuous experiments with rearing of Siberian sturgeon (*Acipenser baeri*) in salt water with crossbreeding with Sakhalin sturgeon (*A. medirostris*) are conducted, as a part of research program in University of Gdansk which is aimed for restitution of *Acipenser sturio* in Baltic.

7 Meetings, Conferences, Symposia

The paper "*Atyaephyra desmaresti"* (Millet, 1831) (Crustacea: Decapoda) a new species for the Polish fauna in Odra River was presented by P. Gruszka in Scientific Session of Agricultural Academy in Szczecin in June 2001.

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Prepared by:

Wojciech Pelczarski, Sea Fisheries Institute, Gdynia

NATIONAL REPORT FOR SWEDEN

F. Nordwall, E. Sparrevik, and I. Wallentinus

1 Laws and Regulations

The Swedish legislation for release of GMOs is based on National legislation (Miljöbalken 1998:808; the Regulation on enclosed use of GMOs SFS 2000:271) which mainly follow the current EG directive 90/220/EEG. The latter will in October 2002 be replaced by the new EU Directive 2001/18/EG.

2 Deliberate Releases

2.1 Finfish

In 2000 (no figures available for 2001) 2.3 miljon individuals of smolt of Baltic salmon (*Salmo salar*), and 0.7 millon individuals of smolt of sea trout (*Salmo trutta*) were released in rivers and coastal areas (both probably mainly of Swedish origin). In 2001, 65,000 individuals of pikeperch (*Sander lucioperca;* young of the year) were released in the province of Östergötland and 10,000–15,000 in the province of Södermanland (probably mainly of Swedish origin; and since not all county councils have replied the figure might be higher). Five tonnes of eel (*Anguilla anguilla*) were released in 2000. There are also yearly transfers of around 50 tonnes of small adult eels from the Swedish west coast into the Baltic Sea.

3 Accidental Introductions and Transfers

3.1 Finfish

The sturgeon reported last year as, "probably *Acipenser stellatus*" caught at Kalmar, SE Sweden in the summer of 2000 more likely is *Acipenser gueldenstaedti* (SO 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* cf. *viridis,* known in Swedish waters since 1990, continues to move north and was in 2001 found as far north as at Malören outside Luleå in the Bothnian Bay and the densities have also increased at other stations in the northern part of the Bothnian Bay (K. Leonardsson, Umeå Univ., pers. comm.). It has also since 1996 (Peter Göransson, Miljökontoret, Helsingborg pers. comm.) been recorded at several localities in the southern part of Øresund (south of Lundåkrabukten) in quite shallow waters (0.5–2 m), however, in quite low (2–10 ind m^{-2}) densities, while no individuals have been found in samples from 3–29 m depth in the same area. He had also found the species on the south coast of Skåne in 1993–1995 in low densities (no samples taken later). There are NO reports of *Marenzelleria* from the Swedish west coast.

The crustacean *Cercopagis pengoi*, recorded since 1997 from the bay of Himmerfjärden, the northern Baltic proper, appeared there in masses on fishermen's nets in 2001 (S. Hansson, Stockholm Univ., pers. comm.). It has not yet been found in the northern part of the Bothnian Sea, although it is spreading northwards along the Finnish coast (K. Leonardsson, Umeå Univ., pers. comm.).

Also in 2001, a lobster resembling the American lobster was caught. It is together with previous individuals kept alive in aquaria awaiting development of specific primers within a EU-project (M. Ulmestrand, Inst. of Marine Research, Lysekil, pers. comm.).

The first record of the swimbladder parasite *Anguillicola crassus* in eel was made in 1987 in Blekinge, southern Sweden in silver eels imported from Poland (Wickström, 2001). Nine years later this parasite was well established not only in thermal discharge areas (off nuclear power stations) but also in other brackish waters along the coasts as well as in some freshwater lakes. Today it can be found in high prevalences in most freshwater lakes that have eel (H. Wickström, National Board of Fisheries, pers. comm.) and occurs in high prevalences also along the coast at least as far north in the

Baltic as to Östergötland, and possibly further where eels occur (Jan Andersson, National Board of Fisheries, pers. comm.). In the 1990s the infection rate was higher in some areas affected by thermal discharges than in freshwater and in one coastal stock. It is believed that stocking in freshwater of yellow eels caught at the Swedish west coast has been one vector before 1993 (Wickström *et al.,* 1998; Wickström, 2001) while also cormorants (now increasing in many coastal and inland areas) regurgitating half-digested prey could act as a vector (Wlaslow *et al.,* 1996 in Wickström, 2001). In the Baltic Sea the black goby (*Gobius niger*) and the ruffe (*Gymnocephalus cernuus*) act as paratenic hosts and recent studies have shown that this also is the case for many other organism groups (e.g., insect larvae, gastropods; Moravec 1996; Moravec and Skorikova, 1998; Wickström, 2001) perhaps making choice of prey one way to start an infection in the eels.

3.3 Algae and Higher Plants

Phytoplankton

Also in 2001 the raphidophyte *Chattonella* (cf. *verruculosa* occurring in two morphological forms, first blooming in the N Kattegatt, the Skagerrak and adjacent parts of the North Sea in 1998) bloomed in March-April on the Swedish west coast and on the Norwegian south coast nearly 1000 tonnes of farmed salmon were killed. The densities were about 1–8.5 million cells per litre. It is not known if the species has been introduced or previously been overlooked, but a recheck of old samples has shown that it occurred in small amounts also earlier in the 1990s, although then not recognized (Informationscentralen för Västerhavet).

Macroalgae

The distribution of the brown alga *Fucus evanescens*, which first appeared in 1924 in the the province Bohuslän, the northern part of the Swedish west coast and in Öresund area in 1948 (see Wallentinus (1999) for references) has been reinvestigated in its northern and southernmost areas in Sweden (Wikström, 2002; S. Wikström, Stockholm Univ., pers. comm.). In Öresund, where it increased drastically in the 1960–1970s, it has since increased slightly in the northern part but decreased in the southern part. Laboratory experiments have shown that it can reproduce (99 %) at salinities of 24 psu, but only 12 % reproduced at 10 psu, which can explain why no individuals have been found in the Baltic proper. The amounts of epiphytes on it are smaller compared to on the native *F. vesiculosus*, which might affect biodiversity in areas where it becomes common at the expense of the native fucoids (Wikström, 2002). Also in the province of Bohuslän (Tjärnö-Strömstad) it seems to have increased in the outer archipelago around Tjärnö, although there are no previous monitoring of those stations to compare with (Wikström, pers. comm.).

There have been NO major changes reported for the distribution of the Japanese brown algae *Sargassum muticum* along the Swedish west coast (the southernmost record of attached plants is still from the middle part of the province of Halland).

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

4 Live Imports (during 2001, preliminary figures)

4.1 Fish for consumption/processing

Eel from:

	metric tonnes
Denmark	107
Norway	62
The Netherlands	43
U.K.	26
Germany	2
Italy	2

4.2 Invertebrates for Consumption/Processing

	Lobsters from:	"Edible crab" from:
	metric tonnes	**metric tonnes**
Canada	90	
Ireland	No data on amounts	315
Denmark	No data on amounts	No data on amounts
Norway	1	76
USA	4	

	Scallops from:	Oysters from:
	metric tonnes	**metric tonnes**
Norway	131	
Denmark	6	12
USA	7	
U.K.	4	
The Netherlands	2	1
Canada	1	
France	No data on amounts	

	Mytilus spp. from:
	metric tonnes
Norway	206
Denmark	4

5 Live Exports (during 2001, preliminary figures)

5.1 Fish for consumption/processing

	Rainbow trout and Trout to:	Eel to:
	metric tonnes	**metric tonnes**
Finland	38	
Norway	3	
Germany		322
Denmark		237
The Netherlands		122
Belgium		33
Italy		3

5.2 Invertebrates for Consumption/Processing

	Mytilus spp to: metric tonnes	Scallops to: metric tonnes
Italy		62
The Netherlands	97	28
Belgium	35	24
Norway	170	23
Germany	9	8
Spain		8
U.K.	5	
Denmark	3	No data on amounts
Finland	22	No data on amounts
Luxemburg		No data on amounts
France		No data on amounts
Estonia	No data on amounts	

7 Others on Introductions and Transfers of Marine Organisms

7.1 Research Projects

The planning of the new SEPA programme "AQUALIENS - Aquatic alien species - where and why will they pose a threat to the ecosystem and economy?" is completed and decision on its implementation will be taken by SEPA in April 2002 (suggested coordinator Prof. Inger Wallentinus, Göteborg univ.). With a positive decision the programme will encompass ecosystem impact studies on Macroalgae, Vascular plants, Invertebrates and Fish. One group will study species used in aquaculture and the American signal crayfish and crayfish plague will be another item. One group will work on risk assessment/analysis and one group on economics.

7.2 Ballast Water Studies (see also the Report of the ICES/IOC/IMO Study Group on Ballast and Other Ship Vectors)

A new project has started at Malmö Högskola (project leader Dr Alexander Zolotarevski) which is is a part of a research project "Underwater Technology and Biological Interfaces", which started in the end of year 2000 with the financial support from the KKS (The Knowledge Foundation, Sweden). Adsorption of biological macromolecules and adhesion of microorganisms are central areas in the program and they cooperate with Dr Robert Baier, Center for Biosurfaces, Buffalo, USA whose research focuses on the organic biofilms that cover internal tank and hold surfaces.

The Wallenius Lines has a project devoted to ballast water management and a Ph.D. student (Joanne Ellis) at SSPA, Göteborg, is taking part in the EU-programme MARTOB, in which SSPA is a partner.

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NATIONAL REPORT FOR THE UNITED STATES

G. Ruiz

1 Laws and Regulations

New laws and regulations on the introduction of marine organisms to the U.S. have continued to emerge at the state level, focusing primarily on ballast water of ships. Thus, ships that arrive to U.S. ports are now subject to both federal and state regulations, creating requirements that differ geographically.

For all ships arriving to U.S. waters from outside the Exclusive Economic Zone (EEZ), federal regulations require that all ships submit reports on ballast water discharge and management to the National Ballast Water Information Clearinghouse. In addition, under federal regulations, ships arriving to the Great Lakes and upper Hudson River from outside the EEZ are required to exchange ballast water prior to discharge, whereas those arriving to all other ports are requested to voluntarily undertake mid-ocean ballast water exchange prior to discharge. Federal regulations and guidelines do not presently apply to ballast water from domestic shipping traffic.

In addition to federal regulations, six states have now passed laws concerning ships' ballast water. The scope of these regulations varies among 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 and Oregon are implementing similar regulations, 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. However, unlike the western states, there are no specific requirements for ballast water management in Maryland and Virginia.
- Michigan has passed a law requiring development of treatment options for ballast water, to be available within the next year.

2 Deliberate Introductions and Transfers

Fish

Current information on fish introductions is pending and will be included in the report for 2002.

Invertebrates

The commercial shellfish industry continues to culture and release 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.

Experimental research has continued to evaluate the potential introduction of the Asian oyster *Crassostrea ariakensis* into Virginia waters of Chesapeake Bay waters. Limited field trials were used to test performance of non-native oysters in Chesapeake Bay waters, as follows:

- Contained laboratory brood stock (F4 generation) was used by Virginia Institute of Marine Sciences to create triploid oysters;
- Triploid oysters were placed in Chesapeake Bay waters to evaluate growth performance, susceptibility to diseases, and marketability;
- Oysters were routinely tested to confirm triploidy.

The experimental evaluation of *C. ariakensis* to date indicates rapid growth and good survivorship, even when challenged by the two oyster pathogens *Perkinsus* spp. and *Haplosporidium nelsoni* present in the Chesapeake Bay. Although controversial in the region, these results have prompted a great deal of support in Virginia for continued development of *C. ariakensis* as a potential fishery.

Proponents for development of this fishery are expected to submit a multi-year proposal for further evaluation and development of a *C. ariakensis* fishery. The proposal, expected this spring (2002), will be evaluated by an ad-hoc review committee of the EPA Chesapeake Bay Program. The review committee recommendations are advisory in nature, and Virginia will make final decisions on the scope and tempo of this effort.

We are requesting that a similar proposal be submitted simultaneously by the proponents to ICES, serving as the prospectus called for by the ICES Code of Practice.

In addition, to further evaluate the risks associated with introduction of *C. ariakensis* to Chesapeake Bay, a proposal has been submitted to the U.S. National Academy of Sciences to conduct such a study. Should this advance, the report and findings would be completed in approximately 1 year. These results will be made available to the Working Group on Introduction and Transfers of Marine Organisms (WGITMO).

3 Accidental Introductions and Transfers

Fish

Oreochromis niloticus (Nile Tilapia). Reported in the Pascagoula River estuary, Mississippi. Apparently established, survived 1–2 winters, in brackish water. First established North American record for this euryhaline cichlid, although five other “tilapias” established in Florida, Texas, and California. Native to Africa. Possible vector: Aquaculture escape.

Pterois volitans (Lionfish). From Indo-Pacific. Released aquarium specimens were seen in Biscayne Bay, Florida in 1992, and occasional individuals since then in Florida waters. In 2001, juveniles were collected as far north as Long Island, and a persistent population of mixed ages were seen on wrecks off North Carolina (Landis, 2001; National Oceanic and Atmospheric Administration, 2002a,b; Pam Fuller, personal communication). Native to Indo-Pacific. Possible vector: Aquarium release, but ballast water is possible.

Invertebrates

A. Atlantic Coast.

Didemnum sp. (Colonial Ascidian). The ascidian, *Didemnum* sp. forms pale yellow or beige colonies that may reach 1–2 feet in length and hang or “drip” off hard surfaces. The ascidian was initially described as *D. lutarium*, however it is the same species that has appeared in New Zealand (Gretchen Lambert, personal communication). It is as yet not identified to species, but prolific in its biomass where it does appear. During the August 2000 survey, *Didemnum* sp. was distributed from Cape Cod, Massachusetts and Rhode Island (J. Pederson *et al.*, unpublished data). Possible vector: ships’ hull fouling.

Ianiropsis sp. (Isopod). The isopod *Ianiropsis* sp. was collected during a rapid assessment survey in Massachusetts and Rhode Island during the summer of 2000 (Pederson *et al.*, unpublished data). It is a new record for the northwestern Atlantic and does not appear to match any of the 25 described species in the genus *Ianiropsis* (John Chapman, Oregon State University).

Phyllorhiza punctata (Australian Spotted Jellyfish). Established along the Gulf coast and the Atlantic coast of Florida. Reported from the Indian River Lagoon (Cape Canaveral, Florida) in 2001 (Kathy Hill, Smithsonian Marine Station, personal communication; Anonymous 2001). Possible vectors: Currents from Caribbean (where it is also established), and ships' ballast water or hull fouling (polyps) are possible vectors.

Sagartia elegans (Sea Anemone). The purple anemone, *Sagartia elegans* ssp. *roseacae* was found on the sides and underside of a floating dock at a marina in Salem, Massachusetts during a rapid assessment survey in August 2000 (Larry Harris, University of New Hampshire). It has not been found outside of a single marina. The anemone is believed to have originated in Europe. Possible vector: May have arrived on the hulls of vessels. It has not been found outside of this marina.

Caprella mutica (Amphipod). Although the caprellid, *Caprella mutica*, was probably present earlier, the August 2000 rapid assessment survey is the first record of this species in the northwestern Atlantic where it was found throughout Massachusetts and Rhode Island. It was extremely abundant and appears to be rapidly expanding it range. *Caprella mutica* originated in Japan and was introduced to the northeast Pacific and to Europe in the 1990s (initially identified as *C. macho*; Platvoet *et al.,* 1995). Possible vector: ships' hull fouling or ballast water.

Lipara rufitarsis (Insecta/Diptera), *Lasioptera hungarica* (Insecta/Diptera), *Tetramesa phragmites* (Insecta/ Hymenoptera), *Chaetococcus phragmites* (Insecta, Homoptera). First North American dates: C.p., before 1996; L. h. 1999; L. r. 2000; T. p. before 1979). All of these *Phragmites*-eating insects were collected on Chesapeake Bay tidal wetlands for the first time in 2000 (Blossey and Weber, 2001). Introduced from Eurasia. Blossey mentions the apparent recent invasions of about 15 Eurasian *Phragmites* specialist insect herbivores (unpublished and gray-literature), and spreading rapidly in Northeastern marshes. Possible vector: Shipping, unspecified (e.g., insects on *Phragmites* blown into shipping containers).

B. Gulf Coast

Drymonema dalmatinum (Jellyfish), Established from Florida to Mississippi, Gulf of Mexico, 2000 (Graham, 2000a). Possible vectors: Natural dispersal (established in Brazil and Carribean --- Larson, 1987), ships' ballast or hull fouling, oil drilling platforms.

Phyllorhiza punctata. (Australian Spotted Jellyfish). From Indo-Pacific, via Caribbean and/or Gulf Coast. To Alabama-Louisiana, 2000. (Graham, 2000b). Rare and sporadic in 2001–2002. Possible vectors: Currents but ballast water or fouling (polyps) are possible.

Callinectes bocourti (Venezuelan Brown Crab). From Caribbean to southern Florida (Indian River Lagoon, Biscayne Bay, West Indies, Colombia-Brazil). Recent appearance in Alabama and Mississippi, Mobile and Biloxi Bays, Gulf of Mexico. Single individuals caught in 1971, 1990, 1997, 1998, 1 juvenile in 2001 in Alabama. Possible vector: Ballast water. Establishment in the northern Gulf is uncertain.

3.3 Algae and Higher Plants

Caulerpa taxifolia (Chlorphyta). Established in Aqua Hedionda Lagoon, Carlsbad, California, and in Huntington Harbor, California, 2000. Possible vector: Aquarium release. Eradication program under way (Dalton, 2000; Kaiser, 2001).

Polysiphonia harveyi (Rhodophyta). Positively identified in surveys of Massachusetts and Rhode Island during 2000 (J. Pederson, unpublished data). This species was also detected apparently a few years earlier by Art Mathieson.

Undaria pinnatifida (Phaeophyta). Established in Santa Barbara Harbor; Cabrillo Beach (San Pedro); Channel Islands Harbor (Oxnard), southern California (Goddard, 2000; California Sea Grant 2001). Native to Northwest Pacfic (Japan, China, Korea). Possible vectors: Fouling or ballast water.

Parasites, Pathogens, and Other Disease Agents

Infectious salmon anemia (ISA; virus). The virus was detected for the first time in the U.S. in February 2001. It was detected at 14 different pen sites in Maine, associated with Atlantic salmon (APHIS 2002). The state "depopulated" approximately 900,000 fish ($12 million loss) and has implemented a control plan.

Pseudodactylogyrus anguillae (Platyhelminthes, Trematoda, Monogenea). From Asia/NWPacific (Native host is *Anguilla japonica*), probably via Europe. Established in Schubencadie River, Gulf of Maine, Nova Scotia 1992 (Cone and Marcogliese, 1995). Collected in 1999 in Wicomico and Choptank Rivers, Chesapeake Bay (Maryland), and in the Cooper and Edisto Rivers of South Carolnia (Hayward *et al.,* 2001). The first record was published in 1995, but not recognized then as an invader by the Cone and Marcogliese (1995). They considered this an ancient, cosmopolitan parasite of all *Anguilla* spp. Ribosomal RNA studies (Hayward *et al.,* 2001) support a recent Asian origin for European and North American populations of *P. anguillae*. This gill trematode is mostly present in freshwater but survives and can be transmitted in salinities up to 20 ppt (Hayward *et al.,* 2001). Possible vector: Eel shipments or eels in ballast water (Hayward *et al.,* 2001).

Pseudodactylogyrus bini (Platyhelminthes, Trematoda, Monogenea). From Asia (Native host is *Anguilla japonica*), probably via Europe. Established in Cooper and Edisto Rivers of South Carolnia, 1999. This parasite seems to be confined to eels in freshwater (Hayward *et al.,* 2001). Possible vector: Eel shipments or eels in ballast water (Hayward *et al.,* 2001).

7 Meetings, Conferences Symposia, and workshops

A minimum of 50 national and regional meetings occurred in the U.S. during the past year, in which the transfer and invasion of marine species was included or a primary focus. Examples include the Second International Marine BioInvasions Conference (New Orleans, Louisiana) and the 11 th International Aquatic Invasive Species Conference (Alexandria, Virginia). Talks on marine invasions were included at most meetings of biological societies (e.g., American Society 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 – both to distribute information and to develop management and policy to prevent further introductions.

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ANNEX 4: NATIONAL REPORT AUSTRALIA (OBSERVER STATUS)

NATIONAL REPORT FOR AUSTRALIA

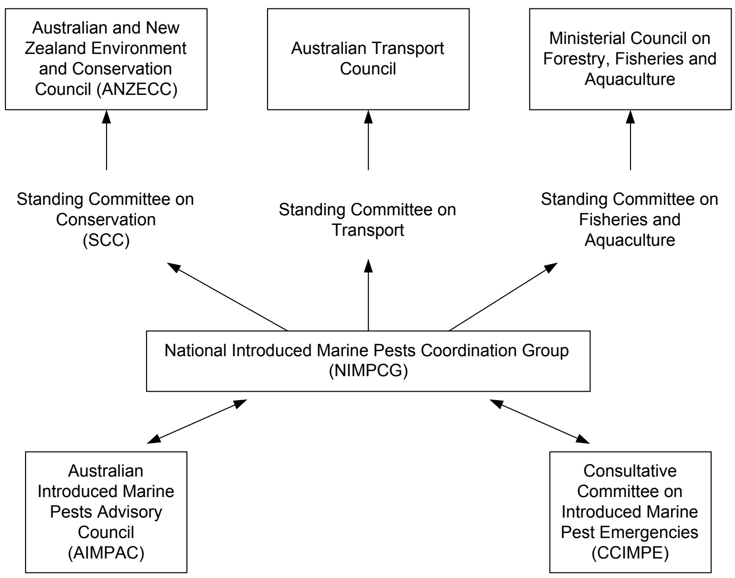
C. L. Hewitt

1 Laws and Regulations

The incursion of the hull fouling associated black striped mussel, *Mytilopsis sallei*, in Darwin, Northern Territory (Bax 1999; Willan *et al*., 2000), brought to the fore the issues of "other vectors than ballast water." As a direct result, a National Taskforce was established in 1999 by the Joint Standing Committee on Conservation (SCC)/Standing Committee on Fisheries and Aquaculture (SCFA) to identify options and develop a framework for the rapid detection and response to new introduced marine species incursions. The National Taskforce on the Prevention and Management of Marine Pest Incursions made recommendations on the immediate actions required to establish a national ready response capability as well as to determine the longer term reforms necessary for a permanent and comprehensive national system for the prevention and management of introduced marine pests in a report submitted in December 1999 (AFFA 2000).

Interim coordination arrangements have been implemented as outlined in Figure A4.1. The Australian Ballast Water Management Advisory Coucil (ABWMAC) is transformed into the Australian Introduced Marine Pests Advisory Council (AIMPAC) to reflect a broader focus than ballast water. The National Introduced Marine Pest Coordinating Group (NIMPCG) has been established to oversee policy coordination and development and to secure long-term funding. NIMPCG reports directly to three Ministerial Councils through separate Standing Committees. In order to fulfill the needs of an immediate incursion response capability, a Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) has been created. CCIMPE has responded to two pest incursions in its first year (the alga, *Caulerpa taxifolia* in New South Wales and the tubeworm, *Hydroides sanctaecrucis* in Queensland).

Figure A4.1. Interim arrangements established to develop a National System for the Prevention and Management of Introduced Marine Pests (SOURCE. - Report of the National Taskforce on the Prevention and Management of Marine Pest Incursions, 2000).



The Australian Quarantine and Inspection Service (AQIS) Ballast Water Management Decision Support System (DSS) went "live" on 1 July 2001. The DSS assesses the biological risk of specific target taxa on a vessel by voyage basis (Hayes and Hewitt 1998, 2000). Details of the DSS can be found on the AQIS website: http://www.affa.gov.au/ under Quarantine and Inspection/Ballast water DSS. A domestic trial of the DSS is occurring in Victoria at the Port of Hastings (Westernport).

1 Deliberate Releases

Mariculture operations continue to result in spawning release of oyster (*Crassostrea gigas*) spat in Tasmania, New South Wales, and South Australia, and blue mussel (*Mytilus galloprovincialis*) spat in Western Australia, South Australia, Victoria, Tasmania, and New South Wales. No new deliberate releases of marine species have been reported in 2001/02.

3.0 Accidental Introductions and Transfers

Three new accidental introductions were reported from Australian marine or brackish waters in 2001/02. An incursion of *Caulerpa taxifolia* into New South Wales, and reports of a serpulid polychaete, *Hydroides sanctaecrucis*, and the Asian green mussel, *Perna viridis*, from Cairns, Australia.

The *Caulerpa taxifolia* incursions were initially discovered by the New South Wales Fisheries in May 2000 and additional incursion sites reported by the public resulting in a total of five incursions. *Caulerpa taxifolia* is native to tropical Australia and further molecular identification was necessary to determine if these incursions were natural range extensions of native strains, human-mediated translocations of native strains or introductions of the "Mediterranean-aquarium" strain. Recent reports have indicated that at least three separate incursion events from different source populations have occurred (Jousson *et al.,* 2000; Schaffelke *et al.,* 2002). Two of the incursions appear to have been human-mediated translocations (probably via recreational vessels) of northern Queensland populations. The third population appears to be closely related to the Moreton Bay (Brisbane) population, however this clade includes the Mediterranean-aquarium strain. At present, no full-scale eradication is occurring, however eradication trials are being conducted by NSW Fisheries.

The serpulid polychaete worm, *Hydroides sanctaecrucis*, was identified from settlement plates placed in Cairns, Queensland by the Defence Science and Technology Organisation (DSTO) and subsequently found to be in high densities on hulls and propellers of adjacent navy vessels. Subsequent surveys do not indicate that this species has spread significantly to other structures or natural substrates.

The Asian green mussel, *Perna viridis*, has been detected in Cairns, on the hull of an impounded vessel. Subsequent surveys have indicated that a spawning event occurred resulting in a widespread distribution of the species in Trinity Inlet. *Perna viridis* has entered Australia previously, an incursion in South Australia was manually eradicated in 1998 (V Neveraskus pers comm) and following the black striped mussel, *Mytilopsis sallei*, incursion in Darwin, a hull inspection program conducted by the Northern Territory Fisheries has detected both *M. sallei*, and *P. viridis* on the hulls of entering vessels. These vessels were both treated prior to entry.

The following paragraphs present news of previously reported non-indigenous species. Additional information on ABWMAC pest species can be obtained from http://crimp.marine.csiro.au/Marine_pest_infosheets.html

3.1 Fishes

No new fish introductions have been recorded from Australia in 2001/02.

3.2 Invertebrates

Asterias amurensis (ABWMAC pest species)
The northern Pacific seastar, *Asterias amurensis*, has spread from the east coast of Tasmania to Port Phillip Bay (PPB) in 1996 (Hewitt *et al*., 1999). The seastar is now estimated to have a population in the 100s of millions in PPB. Current activities include monitoring the population and evaluation of aquaculture facilities (mussel lines and spat collecting areas) to prevent translocation from PPB to adjacent (uninfected) embayments such as Westernport.

Carcinus maenas (ABWMAC pest species)
No change in the distribution of *Carcinus* has been observed.

Charybdis japonica
A single male was found in Port River, Adelaide, South Australia in 2000 (J Gilliland, pers comm). Further sampling has not detected this northern Pacific species and it is believed not to have established a viable population.

Corbula gibba (ABWMAC pest species)
Corbula has been found in several port surveys and is currently known from Victoria and Tasmania.

Crassostrea gigas feral (ABWMAC pest species)
As previously mentioned, mariculture operations continue to result in spawning release of oyster (*Crassostrea gigas*) spat in Tasmania, New South Wales, and South Australia resulting in feral populations. Victoria has declared *Crassostrea gigas* a noxious species under legislation to prevent the establishement of mariculture operations. *Crassostrea* is one focus species in a domestic evaluation of the AQIS DSS by the Victorian Government.

Sabella spallanzanii (ABWMAC pest species)
Sabella spallanzanii has established populations in all southern states of Australia: Western Australia, South Australia, Victoria, Tasmania and New South Wales (Hewitt *et al.,* 2001). The baseline port surveys of Devonport, Tasmania and Eden (Twofold Bay), New South Wales detected the presence of low numbers of *Sabella.*

The Devonport population was detected in 1996 during a CRIMP port survey, and subsequent quarterly surveys did not detect any additional individuals until December 2000 when large numbers (> 400) were found (P. Waterman, pers. comm). This population appears to be a new incursion, likely from Port Phillip Bay, Victoria (Devonport's primary trading partner). An eradication attempt is currently being made.

The Eden population was detected in 1996 during a CRIMP port survey. The population appeared to be limited to < 10 individuals. An eradication/monitoring strategy was developed by NSW Fisheries and the New South Wales Department of Transport. Quarterly surveys continue to detect low numbers of individuals. These are believed to be new incursions from either ballast water or hull fouling.

Musculista senhousia (ABWMAC pest species)
The Asian date mussel has been known from Australia since 1978, originally detected in the Swan River, Western Australia (Slack-Smith and Brearley, 1978). It has now been identified from a variety of temperate Australian locations, including recent surveys in Tasmania, Victoria and South Australia.

Paracerceis sculpta
The eastern Pacific isopod, *Paracerceis sculpta*, was originally collected in Townsville, Queensland in 1975. Results from the Australian National Port Survey program have demonstrated a widespread distribution in many ports around Australia (Hewitt and Campbell, 2001). The local pattern of distribution appears to be largely associated with hull fouling vectors rather than ballast water.

3.3 Algae

Eighty-six species of algae are currently recognised as introduced or cryptogenic in Australian waters (Hewitt, unpub. data). The vast majority of these are not considered to be pests (i.e., causing significant social, economic or environmental degradation). Below are listed the species identified by ABWMAC as pests species of concern or species known to cause degradation overseas:

- *Alexandrium catenella* (ABWMAC pest species)
  No change in the distribution has been observed.
- *Alexandrium minutum* (ABWMAC pest species)
  No change in the distribution has been observed.
- *Alexandrium tamarense* (ABWMAC pest species)
  No change in the distribution has been observed.
- *Gymnodinium catenatum* (ABWMAC pest species)
  No change in the distribution has been observed.
- *Undaria pinnatifida* (ABWMAC pest species)
  Undaria pinnatifida was first recorded in 1988 at the woodchip port of Triabunna on the east coast of Tasmania (Sanderson, 1990) with subsequent spread to the surrounding Maria Island channel. Both ballast water and hull fouling are considered to be potential vectors of *U. pinnatifida* and the local spread along the Tasmanian and New Zealand coasts is likely to be due to local translocation by fishing, recreational boating and aquaculture activities. Established populations of *U. pinnatifida* were also found on the Australian mainland in 1996, in Port Phillip Bay, Victoria (Campbell and Burridge, 1998). The morphology of thalli at this location indicate that the populations are not derived from the Tasmanian populations and are either derived from New Zealand or Asia (Campbell and Burridge, 1998). No new incursions have been recorded in Australia.

- *Codium fragile* ssp. *Tomentosoides*
  Trowbridge (1999) provides the most comprehensive evaluation of the known distribution of *Codium fragile* ssp. *Tomentosoides,* however, recently identified locations include Eden (Twofold Bay) and Port Hacking in New South Wales.

4 Live Imports

No information available.

5 Live Exports to ICES Member Countries

No information available.

6 Planned Introductions of Introduced Species

No information available.

7 Meetings, Conferences, Symposia or Workshops on Introductions and Transfers

7.1 Quarantine and Market Access Conference

The Agriculture, Forestry and Fisheries - Australia (AFFA) and Biosecurity Australia hosted the Quarantine and Market Access Conference in Canberra, ACT. The symposium on Ballast Water included talks on risk assessment, the Australian Decision Support System, and New Zealand Marine Biosecurity initiatives. A publication of the Proceedings is scheduled to occur.

7.2 Asian-Pacific Economic Cooperation (APEC) MRC Working Group Meeting

The APEC MRC Working Group Meeting was held in Hobart, Tasmania, 12–15 November 2001 to discuss the devlopment of a regional risk management framework for APEC economies for use in control and prevention of introduced marine pests. The outcome of this workshop will be published as a working document.

7.3 Fifth Invertebrate Biodiversity and Conservation Conference

Held in Adelaide, South Australia, 1–4 December 2001, the 5th Invertebrate Biodiversity and Conservation Conference had two symposia that were relevant to marine invasions. Impact of Invasive Species and Marine Invertebrate Biodiversity. Additional information can be found at: http://www.waite.adelaide.edu.au/bio2001/

7.4 Australian Marine Science Association (AMSA) 2001 Conference

The AMSA 2001 conference was held in Townsville, July 2001. An introduced species symposium was chaired by B. Schaffelke and N. Bax with > 30 speakers. AMSA 2002 will be held in Fremantle, Western Australia, from 10–12 July 2002 and will also have an introduced marine species symposium.

7.5 Recent additions to the AFFA Ballast Water Research Series

Taylor, A. H., and Rigby, G. 2001. Suggested designs to facilitate improved management anbd treatment of ballast water on new and existing ships. Ballast Water Research Series Report No 12. AFFA, Canberra ACT, AUSTRALIA.

Rigby, G., and Taylor, A. H. 2001. Ballast water treatment to minimise the risks of introducing nonindigenous marine organisms into Australian ports. Ballast Water Research Series Report No 13. AFFA, Canberra ACT, AUSTRALIA.

7.6 Recent additions to the CRIMP Technical Report Series

Hewitt, C. L., Campbell, M. L., Thresher, R. E., and Martin, R. B. (Eds.). 1999. *The Introduced Species of Port Phillip Bay, Victoria*. Centre for Research on Introduced Marine Pests Technical Report No. 20. CSIRO Marine Research, Hobart, Australia.

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Executive summaries or full text can be obtained at: http://crimp.marine.csiro.au/reports/publications.html#techrpt

The CRIMP introduced marine species database developed in conjunction with the Smithsonian Environmental Research Centre will be available in April, online.

7.7 CRC Reef Technical Report Series

Hoedt, F. E., Choat, J. H., Cruz, J. J., Collins, J.D. 2001. Sample collection methods and practical considerations for introduced species' surveys at tropical ports. CRC Reef Research Centre, Technical Report No. 35. CRC Reef Research Centre, Townsville, Australia.

7.8 Port Surveys

The Australian National Port Surveys program began in 1995 as a jointly developed project between CSIRO CRIMP and the Australian Association of Port and Marine Authorities. The baseline port surveys are conducted to a standardised set of design and methodological protocols outlined in Hewitt and Martin (1996) and subsequently revised in 2001 (Hewitt and Martin, 2001).

Since 1995, CSIRO CRIMP and other state government, University and private consulting agencies have conducted surveys to the protocols outlined above and adopted by the ABWMAC. Thirty surveys have been completed, and an additional five are currently in train (Table A4.1). These surveys are funded in part by the various port and statutory authorities.

Table A4.1. Current status of baseline port surveys in Australia as of March 2002.

State	Port	Survey Organisation	Date of Survey	Citation
NSW	Eden (Twofold Bay)	CRIMP/NSWF	1996	Hewitt *et al.* 1997c
	Newcastle	CRIMP/NSWF	1997	Hewitt *et al* 1999a
	Botany Bay	NSWF/CRIMP	1998	Pollard and Pethebridge 2000
	Port Kembla	NSWF/CRIMP	2000	Pollard and Pethebridge 2001
	Sydney	AM	2001	
NT	Darwin	MAGNT/CRIMP	1998 (dry)	Russel and Hewitt 2000
			1999 (wet)	
QLD	Hay Point	CRIMP	1997	Hewitt *et al* 1998c
	Mackay	CRIMP	1997	Hewitt *et al* 1998b
	Mourilyan	JCU/CRC Reef	1999	Hoedt *et al* 2000a
	Abbot Point	JCU/CRC Reef	1999	Hoedt *et al* 2000a
	Lucinda	JCU/CRC Reef	1999	Hoedt *et al* 2000b
	Brisbane	CRC CZM	2000	Fearon and O'Brien 2001
	Gladstone	UCQ/CRIMP	2000	Lewis *et al* 2001
	Weipa	JCU/CRC Reef	2001	Hoedt *et al* 2001
	Karumba	JCU/CRC Reef	2001	Neil *et al* 2001
	Cape Flattery	JCU/CRC Reef	In train	
	Rockhampton (Port Alma)	UCQ	In train	
	Bundaberg	UCQ	In train	
	Port Lincoln	CRIMP	1996	Hewitt *et al* 1997d
SA	Outer Harbour, Port Adelaide	MAFRI	2001	Cohen *et al* 2001b
	Devonport	CRIMP	1995	Martin *et al* 1996
TAS	Lady Barron (Flinders Island)	CRIMP	1997	Hewitt *et al* 1998a
	Launceston	Aquanel	2001	Aquanel 2001
	(Bell Bay)			
	Hobart	Aquanel	In train	
VIC	Portland	MAFRI	1996	Parry *et al* 1997
	Westernport (Hastings)	MAFRI	1997	Currie and Crookes 1997
	Geelong	MAFRI	1998	Currie *et al* 1998
	Melbourne	MAFRI	2001	Cohen *et al* 2001a
WA	Albany	CRIMP	1996	Hewitt *et al* 1997b
	Bunbury	CRIMP	1996	Hewitt *et al* 1997a
	Port Hedland	CRIMP	1997	Hewitt *et al* 1999b
	Fremantle	CRIMP/MAFRL	1999	Hewitt *et al* 2000
	Geraldton	GPA	2001	
	Esperance	GPA/CPM	In train	

Abbreviations as follows: AM - Australian Museum; Aquanel - Aquanel Pty Ltd, Hobart, TAS; CPM - Corporate Process Management, Stoneville, WA; CRC CZM - Cooperative Research Centre Coastal Zone, Estuaries and Waterways Management, Brisbane, QLD; CRC Reef - Cooperative Research Centre Reef Research Centre, Townsville, QLD; CRIMP - CSIRO Marine Research Centre for Research on Introduced Marine Pests, Hobart, TAS; GPA - Geraldton Port Authority, Gerladton, WA; JCU - James Cook University, Townsville, QLD; MAFRI - Marine and Freshwater Resources Institute, Queenscliff, VIC; MAFRL - Marine and Freshwater Research Laboratory Murdoch University, Fremantle, WA; MAGNT - Museum and Art Gallery of the Northern Territory, Darwin, NT; NSWF - New South Wales Fisheries, Cronulla, NSW; UCQ - University of Central Queensland, Gladstone, QLD.

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ANNEX 5: NATIONAL REPORT FOR ITALY

A. Occhipinti Ambrogi

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 Barcelona, March 2001.

SUMMARY: *The report updates the findings of NIS in Italian marine waters adding ten species to the previously established list. All of them are considered involuntary introductions. Some of the already established species have enlarged their distribution.*

1 Laws and Regulations

The Ministry for the environment has circulated for comments a document aimed at establishing guidelines for a strategy of sustainable development in Italy. The problem of introduced species is treated in some detail. After the public consultation, the document will be adopted by the Council of Ministers as the basis for environmental action of the Government.

2 Deliberate releases

Tapes philippinarum has been released in the brackish coastal Lake Fusaro (near Naples).

3 Accidental Introductions and Transfers

3.1 Fish

A juvenile specimen was caught in 1998 in the Gulf of Trieste (Northern Adriatic) and is being kept in the aquarium of the town. When completely developed it proved an orange-spotted grouper *Epinephelus coioides,* a tropical species probably transported from the Eastern Mediterranean (Parenti and Bressi, 2001).

The bathyal species *Halosarus ovenii* was recorded for the first time by Cau and Deiana (1979) from trawl surveys in Sardinia; it is now regularly caught by fishing boats in the offshore grounds of the island.

3.2 Invertebrates

The following species have been added to the list of NIS for Italian coasts.

In the Gulf of Noto (Sicily) two polychaete species, *Protodorvillea egena* (Dorvilleidae) and *Isolda pulchella* (Ampharetidae) have been reported by Cantone (2001), as the first findings for the Mediterranean Sea. The former was described for South Africa and then found in the Red Sea, the latter is circumtropical in the Atlantic and Indian Ocean. They could be lessepsian migrants as well as transported via ballast water.

Dispio uncinata (Spionidae), known from the Atlantic (Gulf of Mexico, North Carolina, Iberian peninsula), the Pacific (Japan) and the Red Sea was first found by Giangrande (unpublished data) in the harbour of Salerno. *Questa caudicirra* (Questidae), known from both coasts of America, was first found by Somaschini and Gravina (1993) along the coasts of Ponza Island (Tyrrhenian Sea). Both species have been recently recorded by Cantone (2001) in Sicily (Gulf of Noto). They might have entered the Mediterranean through Gibraltar, or transported via ballast water.

Another Polychaete species has been found in Sicily (Messina Strait), belonging to the genus *Rullierinereis*, known from the Pacific and Atlantic Ocean. It might be different from *Rullierinereis anoculata* that was found in Catania by Cantone (1982).

The lessepsian polychaete *Pseudofabriciola filamentosa* was found by Giangrande and Castelli (1986) in the soft bottoms of Porto Cesareo lagoon (Ionian Sea), the capitellid polychaete *Mediomastus capensis* has been found in several locations (Gravina and Somaschini, 1990): both species have been recently found in the harbour of Salerno (Tyrrhenian Sea).

The following species have shown a spread in their distribution along the Italian coasts.

Molluscs

The colonisation of the bivalve *Brachidontes pharaonis* (formerly *B. variabilis*) has been followed in Sicily (Chemello pers. comm.). The species is probably transported via ballast water (even if some Authors think of a lessepsian migrant) and the first records have been in ports. A secondary distribution in nearby locations has been recorded. In many locations it reaches initially very high densities (3000–6000 ind. m^{-2}) and declines in about 3–5 years.

Cerithium scabridum (Gastropoda) has been recorded in two more locations in Sicily (Chemello pers. comm.): also in this case a ballast water transport is likely.

The mussel, *Xenostrobus securis* (Lamarck, 1819), known from the lagoon of Venice and the Po river Delta, has been found also in the lagoon of Grado in summer 2001 (personal observation).

Populations of the Bivalve *Anadara demiri,* firstly reported by Morello and Solustri in 2000 in the Central Adriatic, are since then commonly collected northernmost, also as epibiont on *Rapana venosa* (Savini and Occhipinti, 2002). Young individuals can easily be confused with *A. inaequivalvis* making it difficult to recognise them, until they fully develop. The spread of the population of *Musculista senhousia* in the Sacca di Goro (Po River Delta) has been studied by Mistri (2002a, 2002b). *Anadara demiri* and *Musculista senhousia* have been recorded also in the lagoon of Venice (Mizzan and Trabucco, in press).

Crustaceans

The crab, *Percnon gibbesi*, continues its expansion in Sicily and in the small islands around Sicily (Pipitone *et al.*, 2001); in the Lampedusa island a density of 4–16 ind. m^{-2} has been reached, and some records have been made in the Pantelleria island.

Tunicates

Microcosmus exasperatus, known from the Atlantic, had been overlooked from the previous reports, having been found in the harbour of Genova (Zibrowius, 1971) and Taranto (first finding 1977, Mastrototaro, pers. comm.)

Other tunicate species have been found in the harbour of Palermo and are currently being identified (Riggio pers. comm.).

3.3 Algae and Higher Plants

One more non-indigenous alga (probably from the Pacific) has been found associated with the already established *Sargassum muticum* in the Southern sector of the lagoon of Venice. The identification as *Lomentaria hakodatensis* Yendo needs confirmation (Curiel personal communication).

Asparagopsis armata has increased its abundance in the Ustica island (Sicily) and is present also in the Egadi islands and along the northern coast of the main island of Sicily.

Caulerpa racemosa is now very abundant in Lampedusa and has been recorded also in the southern coast of Sicily (Chemello pers. comm.). It has also been studied in a small island near the Ligurian coast (Molinari and Diviacco, in press).

7 Meetings, Conferences, Symposia or Workshops on Introductions and Transfers

The program funded by the Ministry of Environment performed by the Italian Marine Biological Society has come to an end. Besides the description of the main NIS that can be found in the Italian waters and an assessment of the Italian legislation related to the main international treaties signed by Italy, the results of a survey in three harbours have been reported. The number of NIS found is as follows: Genoa 3 (10 stations), Palermo 5 (10 stations), Salerno 14 (7). Some new records for Italian coasts are still being identified at the species level.

The Zoological Station of Naples will co-ordinate a task (life history and biochemical traits) in a recently started EU programme called ALIENS (ALgal Introductions to European Shores), and will also make ballast studies and molecular genetics assessments.

In a recent paper, Bianchi and Morri (2000) have discussed the importance of invasions for marine biodiversity in Italy.

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ANNEX 6: SUMMARY OF NATIONAL REPORTS 1992–2001 (TOR B)

List of Participants at WGITMO (1992–2001).

Country	Name	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
USA	J. T. Carlton	X	X	X	X	X	X	X	X	X	
	I. Levine		X		X	X	X		X		
	F. G. Kern			X							
	D. Smith			X							
	J. Joseph			X							
	R. Harbison			X							
	J. Goldman			X							
	S. Lindell			X							
	J. Tinsman			X							
	S. Allen			X							
	S. Crawford			X							
	H. Gollamudi						X				
	A. Cangelosi							X			
	B. Holohan							X			
	J. A. Kopp							X	X		
	W. Miller							X			
	J. Pederson							X			
	A. Dehalt								X		
	R. Mann								X		
	G. Ruiz										X
Australia	L. Goggin						X				
	R. Thresher						X				
	C. L. Hewitt							X			
	P. Lockwood							X			
	D. Oemcke							X			
	G. Rigby							X			
	C. Colgan								X		
Belgium	F. Kerckhof										X
Bermuda	A. Knap							X			
Canada	T. Carey	X	X	X							
	R. Dermott	X									
	M. I. Campbell		X	X		X	X	X	X		
	R. Randall		X				X				
	D. Kieser			X	X	X		X	X	X	X
	R. H. Cook			X							
	R. Arthur					X					
	M. Gilbert						X	X	X		X

Country	Name	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Estonia	H. Ojaveer					X			X	X	X
	M. Eero									X	
	A. Pollumäe									X	
Finland	R. Rahkonen	X		X							
	E. Leppäkoski					X				X	
	P. Tuunainen								X		
	L. Urho										X
France	H. Grizel	X	X		X		X				X
	P. Goulletquer						X	X		X	
	M. Heral						X				
	A. Meinesz						X				
	P. Y. Noel						X				
	T. Thibaut						X				
	D. Masson								X		
Georgia	A. Shotadze							X	X		X
	T. Gogothishvili								X		
	B. Tengiz										X
Germany	S. Gollasch		X	X	X	X	X	X	X	X	X
	M. Dammer		X		X						
	H. Rosenthal				X						
	N. Huelsmann				X		X	X	X		
	S. Schulz					X					
Ireland	D. Minchin	X	X	X	X	X	X	X	X	X	X
	D. Clarke									X	
Israel	A. Abelson							X	X		
	B. Galil							X			
Italy	G. Relini							X			
	A. Occhipinti								X	X	X
Lithuania	S. Olenin				X	X		X			
Poland	P. Gruszka					X					
	A. Janta					X					
	W. Pelczarski					X				X	
	M. R. Sapota					X					
	K. E. Skora					X					
	Z. Sobol					X					
	M. Wolowicz					X					
Portugal	M. Figueiredo	X									
	M. Brogueira	X									
	G. Cabecadat	X									
	F. Ruano	X									

Country	Name	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Netherlands	S. J. (Bas) de Groot							X	X		
	L. P. M. J. (Bert) Weststeyn									X	X
New Zealand	J. Hall							X			
	C. Hay							X			
Norway	S. Tilseth		X	X							
	K. E. Jorstad					X	X	X			
	A. Jelmert						X	X	X	X	X
	H. Botnen							X			
	T. Loennechen								X		
Russia	E. Karasiova					X					
Sweden	B. Dybern	X	X		X	X					
	B. Holmberg	X	X			X	X				
	I. Wallentinus	X	X	X	X	X	X	X	X	X	X
	K. Jansson				X	X	X	X			
	T. v. Wachenfeld					X					
	E. Sparrevik									X	X
Spain	M. A. Ribera						X				X
	F. Pages										X
United Kingdom	A. Munro	X	X								
	S. Utting	X	X	X	X		X	X	X	X	
	A. McVicar		X								
	J. Side		X								
	D. McGillivary		X								
	D. Frazer		X								
	K. Hayes			X	X						
	C. Eno				X	X	X	X	X		
	K. Mueller				X						
	J. Hamer						X				
	T. McCollin						X	X	X		
	I. Lucas							X	X		
	E. Macdonald							X			
	P. E. J. Dyrynda								X	X	
	I. Laing								X		
Total		15	19	21	17	26	27	36	29	18	18

Organization	Name	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
IMO	M. Nauke					X	X	X	X		

ANNEX 7: 2002 VERSION OF THE CODE OF PRACTICE

ICES CODE OF PRACTICE ON THE INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS 2002

Preamble

Global interest in marine aquaculture began to increase dramatically in the 1950s and 1960s. A natural complement to this interest was the search for fish, shellfish (molluscan and crustacean, echinoderm), and plant species that already had achieved or could achieve success in extensive cultivation or which could be of interest in activities such as research on aquatic organisms. Those species are referred to as introduced species and are defined as species transported intentionally or accidentally by a human-mediated vector into aquatic habitats outside their native range, including secondary introductions by human-mediated or natural vectors. Other publications may use other terms for such introductions, e.g., alien, exotic, "invasive", foreign, non-native, immigrant, neobiota, naturalized, or non-indigenous.

The ICES Code of Practice sets forth recommended procedures and practices to diminish the risks of detrimental effects from the intentional introduction and transfer of marine (including brackish water) organisms. The Code is aimed at a broad audience since it applies to public (commercial and governmental), private, and scientific interests including introductions into closed containment. In short, any persons engaged in activities that could lead to the intentional or accidental release of exotic species should be aware of the procedures covered by the Code of Practice. While the Code tries to manage the intentional movement of exotic species (including any intentional release into the wild even if establishment was not intended), it is unable to manage those issues related to shipping and other vectors, and thus the Code does not include the unintentional introduction of exotic species. Attempts to control the shipping vector ballast water are being undertaken at the International Maritime Organization (IMO Resolution 868(20)) (1998).

While introduced and transferred species have positively contributed to the economies of many coastal communities worldwide, species movements have subsequently, in several cases, compromised future production and ecosystem health because appropriate quarantine measures were not undertaken. This has resulted in the unintentional movement of harmful non-target species with varying consequences, including serious alterations of the environment and local economies. The movement of large numbers of organisms without inspection, quarantine, or other management procedures has led to the simultaneous introduction of disease agents, causing harm to the development and growth of new and native fisheries (e.g., Leppäkoski *et al*., 2002).

A further concern is the environmental impact of introduced and transferred species, especially those that may escape the confines of cultivation and become established in the receiving environment. The genetic impact of introduced and transferred species is also of high concern, owing to the potential mixing of stocks from different origins as well as the release of genetically modified organisms.

In order to provide scientifically based advice to reduce negative impacts in the future, ICES has adopted a Code that continues to be updated in the light of improved scientific understanding.

The Code is presented in a manner that permits broad and flexible application to a wide range of circumstances and requirements in many different countries, while at the same time adhering to a set of basic scientific principles and guidelines.

The **ICES 1973 "Code of Practice"** was the first version of what was to become an internationally recognized code on the movement and translocation of introduced species for fisheries enhancement and aquaculture purposes. The Code was created to reduce the risks of adverse effects arising from introductions by non-indigenous marine species. Subsequent modifications proposed by the ICES Working Group on Pathology and Diseases of Marine Organisms in 1978 and by the then newly established ICES Working Group on the Introduction of Non-indigenous Marine Organisms (WGITMO) in 1979, led to the publication of a **"Revised Code" adopted by ICES in 1979**. The 1979 Code became the standard for international policy and the version of the Code most widely used, cited, and translated for the next ten years. Minor revisions and additions over the decade resulted in the adoption of a **1990 Revised Code** followed by the **1994 Code** that took into account several updates and included genetic issues for the first time.

The **2002 Code**, presented here, includes all concerns expressed in the 1994 Code of Practice and follows the precautionary approach adopted from the FAO principles (FAO, 1995) with the goal of reducing the spread of exotic species. It accommodates the risks associated with trade in current commercial practices including ornamental trade and bait organisms, research, and the import of live species for immediate human consumption, as well as species that are utilized to eradicate previously introduced harmful and native species as well as genetically modified organisms (GMO). It outlines a consistent, transparent process for the evaluation of a proposed new introduction, including detailed biological background information and an evaluation of risks.

ICES Member Countries contemplating new introductions are requested to present to the Council a detailed prospectus on the rationale and plan for any new introduction of a marine (brackish) species; the contents of the prospectus are detailed in Appendix A (see summary below and www.ices.dk). A flowchart outlining the ICES review process is attached. While the principles of the Code do not need frequent updates, the guidelines to prepare the prospectus need to be adjusted more often to capture the state of the art and developing expertise. The currently applicable appendices are therefore only available on the Internet. However, a short introductory paragraph introducing the Appendices is included in this printed version. Other countries/regions are urged to adopt similar procedures.

An example of an introduction using the ICES Code of Practice is given in Appendix F.

If any introduction or transfer proceeds following approval, ICES requests Member Countries to keep the Council informed about it, both through providing details of the brood stock established and the fate of the progeny, and through submitting progress reports after a species is released into the wild.

ICES has published two extended guides to the Code, one in 1984 as *Cooperative Research Report* No. 130, entitled “Guidelines for Implementing the ICES Code of Practice Concerning Introductions and Transfers of Marine Species”, and one in 1988 as ICES *Cooperative Research Report* No. 159, entitled “Codes of Practice and Manual of Procedures for Consideration of Introductions and Transfers of Marine and Freshwater Organisms”. These reports are available in many libraries and from the ICES Secretariat.

ICES views the Code of Practice as a guide to recommendations and procedures. As with all Codes, the current one has evolved with experience and with changing technological developments. This latest version of the Code reflects the past 30 years of experience with the evolution of new fisheries and genetic technologies. While initially designed for the ICES Member Countries concerned with the North Atlantic and adjacent seas, all countries across the globe are encouraged to implement this Code of Practice. Public awareness of the concerns associated with introductions and transfers of marine organisms is essential to assist in the prevention of such problems. Countries are therefore encouraged to ensure widest distribution of this code.

We are pleased to present the ICES Code of Practice in this fashion for wide consideration, and we welcome advice and comments from both Member Countries and our colleagues throughout the world. Recommendations and suggestions should be directed to the General Secretary of ICES in Copenhagen, Denmark. (http://www.ices.dk/informat/how.html)

S. Gollasch, Chair of ICES Working Group on Introductions and Transfers of Marine Organisms.

D. Kieser, Rapporteur, ICES Working Group on Introductions and Transfers of Marine Organisms.

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ICES CODE OF PRACTICE
ON THE INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

2002

All transfers and introductions of marine organisms carry risks associated with target and non-target species (including disease agents). Once established, introduced species can spread from foci of introductions and have undesirable ecological, genetic, economic, and human health impacts.

Introductions of marine organisms occur in the course of many human activities, including but not limited to aquaculture, stocking, live trade (e.g., species used for aquaria, ornamentals, bait, and food), research, biocontrol, and the use of genetically modified organisms. Even species introduced intentionally into closed systems can be released accidentally. Thus, introductions can result whenever live organisms are moved, regardless of the original intent. As a result, a risk of introduction and subsequent impacts exists with any movement and should be considered explicitly.

This Code of Practice provides a framework to evaluate new intentional introductions, and also recommends procedures for species that are part of current commercial practices to reduce the risk of unwanted introductions, and adverse effects that can arise from species movement.

Definitions

For the application of this Code, the following definitions shall be used.

Aquarium (= ornamental) species

All species imported or transferred into confinement for ornamental indoor and outdoor use.

Biocontrol species

The intentional release of an organism that is intended to consume, infect, or debilitate a selected species to decrease its population size. Note: The possible limited specificity of biocontrol species is of concern as native species might be negatively affected.

Bait organisms

Live specimens used (e.g., on a hook or in a trap) to allure target species.

Broodstock

Specimens of a species in any life stage from which a first or subsequent generation/growth may be produced for possible introduction to the environment.

Current commercial practice

Established and ongoing cultivation, rearing, or placement of an introduced or transferred species in the environment for economic or recreational purposes, which has been ongoing for a number of years.

Disease agent

Any organism, including parasites and prions, that causes or contributes to the development of a disease.

Donor location (= source localities)

Specific localities in a country or zone from which the import or transfer originates.

Genetic diversity

All of the genetic variation in an individual population, or species.

Genetically modified organisms (GMO)

An organism in which the genetic material has been altered anthropogenically, including genetically modified microorganisms (GMM), genetically engineered organisms (GEO), genetically engineered microorganisms (GEM), but excluding polyploids and hybrids (after EU Directive 2001/18/EC).

Indigenous (= native) species

A species or lower taxon living within its natural range (past or present) including the area which it can reach and occupy using its natural dispersal systems (modified after CBD, GISP).

Introduced species (= non-indigenous species, = exotic species)

Any species transported intentionally or accidentally by a human-mediated vector into aquatic habitats outside its native range. Note: Secondary introductions can be transported by human-mediated or natural vectors.

Marine species

Any aquatic species that does not spend its entire life cycle in fresh water.

Native range

Natural limits of geographical distribution of a species (modified after Zaitsev and Ozturk, 2001).

New Introduction

The human-mediated movement of a species outside its present distribution.

Non-target species

Any species inadvertently accompanying in, on, or with the species intended for introduction or transfer.

Progeny

Next generation(s) of an organism. Also included are new stages/fragments of seaweeds, protists, and clonal organisms.

Quarantine

The facility and/or process by which live organisms and any of their accompanying organisms can be held or reared in isolation from the surrounding environment including sterilization procedures.

Release

Any liberation of aquatic organisms to the natural environment. Release can be unintentional, as in the accidental escape of target and non-target organisms.

Transferred species (= transplanted species)

Any species intentionally or accidentally transported and released within areas of established populations and continuing genetic flow where it occurs.

Zone

Part of a coastal area or an estuary of one or more countries with the precise geographical delimitation that consists of a homogeneous hydrological system (modified after OIE).

I Strategy for implementation

i) To protect indigenous as well as previous intentionally introduced species and to meet international obligations (e.g., Convention on Biological Diversity), agencies of Member Countries should fully implement the Code of Practice and apply all regulatory measures possible to prevent unauthorized introductions.

ii) To reduce illegal and unauthorized introductions, Member Countries are also encouraged to increase public awareness about the risks associated with importing live products.

iii) Non-ICES Member Countries are encouraged to adopt such management measures.

II Recommended procedure for all species prior to reaching a decision regarding new introductions

a) Member Countries contemplating any new introduction are expected to submit to the Council well in advance a detailed prospectus (see Appendix AI) on the proposed new introduction(s) for evaluation and comment.

b) The prospectus should include the purpose and objectives of the introduction, the stage(s) in the life cycle proposed for introduction, the native range, the donor location, and the target area(s) of release. The prospectus should also include a review of the biology and ecology of the species as these pertain to the introduction (such as the physical, chemical, and biological requirements for reproduction and growth, and natural and human-mediated dispersal mechanisms) and information on the receiving environment.

c) The prospectus should also provide a detailed analysis of the potential impacts on the aquatic ecosystem of the proposed introduction. This should include wherever possible assessments from previous introductions. This analysis should include a thorough review of:

  i) the ecological, genetic, and disease impacts and relationships of the proposed introduction in its natural range and donor location;

  ii) the expected ecological, genetic, and disease impacts and relationships of the introduction in the proposed release site and projected range, as well as vectors for further distribution;

  iii) economic assessment where appropriate.

d) The prospectus should conclude with an overall assessment of the issues, problems, and benefits associated with the proposed introduction. An evaluation of risks (see Appendix B) should be included.

e) Upon review of the prospectus, the ICES Council will provide comments and recommendations on the proposed introduction.

III If the decision is taken to proceed with the introduction

a) Using internationally recognized protocols, such as the Office International Des Epizooties (OIE), or any other appropriate protocols available at the time, review the health records of the donor location and surrounding area of the organisms to be introduced.

b) The introduced organisms should be used to establish a broodstock for the production of progeny. The organisms should be transferred into a quarantine facility (see Appendix C). This facility should be in the recipient country or other location agreed to by the recipient country.

c) The imported consignment(s) is not to be released to the wild, and should be separated from subsequent progeny.

d) Only progeny of the introduced species may be transplanted into the natural environment provided that:

  i) a risk assessment indicates that the likelihood of negative genetic and environmental impacts is minimal,

  ii) no disease agents, parasites, or other non-target species become evident in the progeny to be transplanted, and

iii) no unacceptable economic impact is to be expected.

e) During the pilot phase, the progeny, or other suitable life stages, should be placed on a limited scale into open waters to assess ecological interactions with native species, and especially testing of risk assessment assumptions. Contingency plans, including the removal of the introduced species from the environment, should be ready for immediate implementation.

f) A monitoring programme addressing specific issues (see Appendix D) of the introduced species in its new environment should be undertaken, and annual progress reports should be submitted to ICES for review at meetings of the Working Group on Introductions and Transfers of Marine Organisms until the review process is considered complete.

IV Recommended procedure for introduced or transferred species which are part of current commercial practice

a) All products should originate from sources in areas that meet current codes, such as OIE International Aquatic Animal Health Code or equivalent EU directives.

b) Live products destined for consumption, processing, and aquarium or display should not be placed into the natural environment.

c) For organisms to be released into the natural environment, there should be documented periodic inspections (including microscopic examination) of material prior to exportation to confirm freedom from exotic accompanying (non-target) species including disease agents. If an inspection reveals any undesirable development, it must be immediately reported and importation must be immediately discontinued. Findings and remedial actions should be reported to the International Council for the Exploration of the Sea.

d) If required, there should be inspection, disinfection, quarantine or destruction of the introduced organisms and transfer material (e.g., transport water, packing material, and containers) based on OIE or EU directives.

e) Consider and/or monitor the genetic impact that introductions or transfers have on indigenous and previously introduced species or distinct genetic stocks, to reduce or prevent detrimental changes to genetic diversity.

Note: It is recognized that different countries will have special requirements for the inspection and control of the consignment in the donor and recipient countries.

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This code was produced with the able help and assistances of the Working Group on Introductions and Transfers of Marine Organisms (WGITMO) at the 2002 meeting in Sweden (participants in alphabetical order):

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Appendices

The following provides an overview of the five Appendices referred to in the 2002 version of the ICES Code of Practice on the Introductions and Transfers of Marine Organisms. To ensure that appendices are current and that the most recent information is included, appendices are only available on the Internet at www.ices.dk.

Note:

Appendices A to D will be applied to all new introductions and transfers as required.

Appendix E provides a flowchart of the process.

Appendix F outlines an example of a species that has been introduced using an earlier ICES Code of Practice and covers the main concerns expressed by WGITMO following presentation of the prospectus. In 1989 the proposed introduction of the Japanese scallop from Japan to Ireland was brought before the Working Group on Introductions and Transfers of Marine Organisms of the International Council for the Exploration of the Sea for evaluation. The purpose of the project was to introduce this scallop for intensive hanging culture, as this had been a proven method in Japan. WGITMO carefully considered the proposal and requested that specific questions relating to a possible introduction of pests, parasites and diseases, possible impacts on native European scallops, and its expected growth and development be addressed. Accordingly, a study visit to Japan to obtain specific information addressing these concerns was made in advance of the 1990 WGITMO meeting. This Appendix addresses in Part I the progression of the project and in Part II a comprehensive appraisal of those concerns presented to the 1990 meeting. Although the project did not progress beyond the pilot stage, the procedures adopted were those based on the 1988 modified Code of Practice and this project led to some changes to the 1994 Code of Practice. These same approaches are essentially enshrined in the 2002 Code of Practice. The example provided here is aimed to give guidance as to the procedures involved. Undoubtedly there will be different concerns in accordance with the species being considered for introduction.

Appendix A. Prospectus.

This Appendix provides detailed information on suggested requirements for the prospectus, including, but not limited to:

- potential of transfer of disease agents, parasites and non-target species;
- life history features of the species;
- physiological performance, and tolerances;
- role in the ecosystem;
- characteristics of the receiving waters and native species;
- potential for interactions with the native species;
- review of previous introductions of the candidate species.

This information is used to conduct the biological risk review (see Appendix B). To be scientifically valid, the information provided needs to be based on a thorough literature review.

The prospectus also needs to include a contingency plan in case immediate eradication of the introduced species needs to be carried out.

The proponent has to design an appropriate monitoring programme that will document impacts in the receiving environment.

Appendix B. Risk Review.

This Appendix provides a detailed, consistent approach for evaluating the risk of genetic, ecological, and disease impacts in the proposed receiving environment, as well as the potential for introducing non-target species. This review should be based in part on the information provided in the Prospectus (see Appendix A).

There will be an assessment of each potential hazard as to the probability of the establishment and consequences of the establishment in the receiving environment. Mitigation factors and management issues will also be reviewed.

The precautionary principle will be taken into account in the final outcome of the risk review.

Appendix C. Quarantine.

The intention of the quarantine process is to:

- prevent the escapes of target and non-target species into the environment;
- ensure freedom from disease agents in broodstock and progeny prior to release from the quarantine system;
- protect broodstock.

The size of the facility, and the extent of the quarantine measures, will depend on the characteristics of the species being introduced. Quarantine measures may also be required for some species transfers.

The Appendix provides detailed information on suggested requirements for quarantine facilities, including, but not limited to:

- transport of broodstock;
- quarantine facilities;
- stock management in isolation;
- record keeping;
- disinfection.

Appendix D. Monitoring.

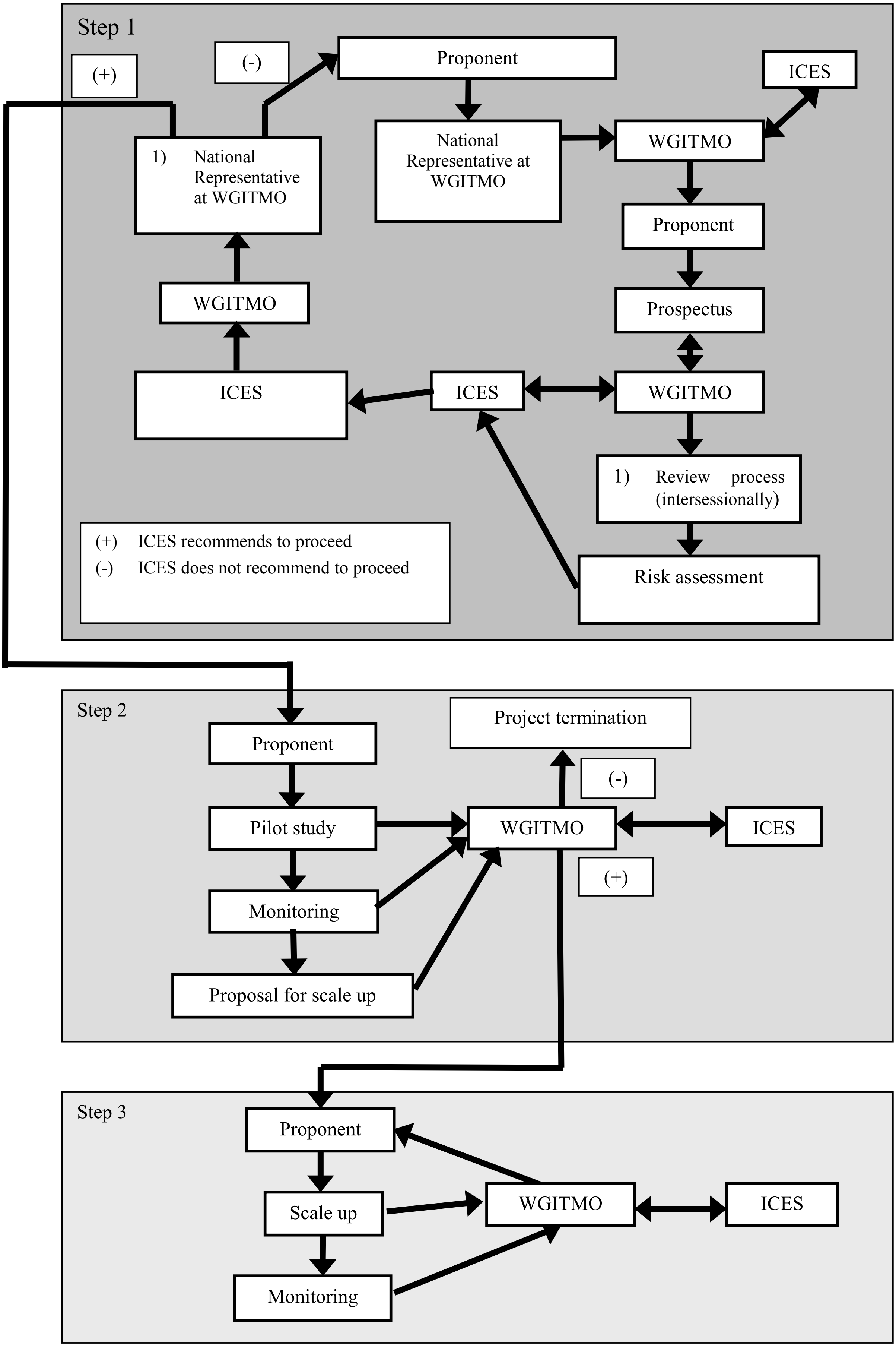
The purpose of the monitoring programme is to assess the impact of the introduced organisms on the environment, ecosystem function, and biodiversity (including genetic biodiversity). The monitoring should be adjusted according to the type of organism and its potential dispersal range. The vectors responsible for further dispersal need to be identified.

Appropriate monitoring has to be carried out in phases:

- initial baseline monitoring study before the introduction,
- continuing monitoring subsequent to pilot study release, and
- continuing monitoring following increases in scale of project.

The results of the monitoring are to be reported to and approved by WGITMO before the next phase is undertaken. Questions outlined in the Appendix need to be addressed.

Appendix E. Flow chart of application and review process.



Appendix F: *Patinopecten yessoensis*—a model of a previous introduction

A CASE HISTORY OF THE INTRODUCTION OF THE JAPANESE SCALLOP FROM JAPAN TO IRELAND USING THE ICES CODE OF PRACTICE ON THE INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

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and the ICES Working Group on Introduction and Transfers of Marine Organisms (WGITMO)

Carl Sindermann (United States of America, Chair – 1989, 1990), **Malcolm Campbell** (Canada, 1990), **James T. Carlton** (United States of America, 1989-1990), **Richard Cutting** (Canada, 1990), **Jacqueline Doyle** (Ireland, 1989-1990), **Bernt Dybern** (Sweden, 1990)**, Henri Grizel** (France, 1989-1990)**, Y. Harache** (France, 1989), **V. Jacobsen** (Denmark, 1989), **John McArdle** (Ireland, 1990)**, Dan Minchin** (Ireland, 1989-1990), **Alan Munro** (United Kingdom, 1990), **R. Porter** (Canada, 1990), **Snorre Tilseth** (Norway, 1990)**, Sue Utting** (United Kingdom, 1990), **Inger Wallentinus** (Sweden, 1989-1990).

And the Irish Management Team (Department of the Marine, Fisheries Research Centre)

David de G. Griffith (Director and Scientific Advisor to the Minister for the Marine), **Jacqueline Doyle** (Inspector), **John McArdle** (Pathologist), **Dan O'Sullivan** (Senior Chemist), **Dan Minchin** (Assistant Inspector).

Introduction

The Japanese scallop, *Patinopecten yessoensis* (Jay), was introduced to Ireland following requests by an Irish fish and shellfish processor, the promoter, to cultivate the species on the southeast coast of Ireland. The earliest discussions took place in late 1988 at which time it was agreed to follow the procedure set forth in the revised ICES Code of Practice of 1988. Essentially the principles followed in this version of the Code appear in the 2002 version. The use of the Code was rigorously tested and was subsequently modified based on the experience of this introduction. Two meetings of the Working Group on Introductions and Transfers of Marine Organisms (WGITMO) in 1989 and 1990 were required before the modified project was approved. Progress reports were submitted at subsequent annual meetings of WGITMO and continued until 1994.

In this account, the case history is covered in two main parts:

1) Historical summary of the management of the introduction.
2) Response to concerns raised by the members of the ICES Working Group on Introductions and Transfers of Marine Organisms.

Part I

HISTORICAL SUMMARY OF MANAGEMENT OF THE INTRODUCTION OF THE JAPANESE SCALLOP FROM JAPAN TO IRELAND

1988–1989: Initial Discussions

In early 1989, a leading processor of fish and shellfish, the promoter, made a formal request for developing a Japanese scallop (*Patinopecten yessoensis*) aquaculture business on the Irish coast. The project was first discussed with scientists of the Irish Department of the Marine (DOM), in November 1988, at which time the ICES Code of Practice was adopted as the protocol for proceeding with the proposed introduction. The promoter's initial plan was to introduce spat for direct release into the sea at a later stage following clearance from pathogens and parasites. However, the Code does not permit the release of the original broodstock imported. The spat would need to be cultured to maturity to produce an F1 progeny, which then could be released, and only if no parasites or pathogens were associated with this generation. Thus, based on the Code, the initial proposal to introduce spat following a short period of quarantine was rejected by the Irish Minister for the Marine, on the advice of the management team.

A further proposal based on the introduction of hatchery-reared eyed umbonate larvae to quarantine, which at a subsequent time could be released to culture in the sea, was discussed. There was uncertainty about whether this would be permissible, because the larvae could be classified as the original import (i.e., comparable to broodstock) being released to the sea. This proposal was based on what had become at this time standard practice for the international transmission of the eyed unbonate larvae (the stage before settlement) of the Japanese oyster, *Crassostrea gigas*. Thus, the principle of transferring eyed oysters had already been established, but the Irish DOM considered this an unacceptable approach for *P. yessoensis* unless these were to be used as broodstock. The ICES General Secretary was informed about the intended project to introduce the Japanese scallop to Ireland and the DOM sought advice on this matter through the Working Group on Introductions and Transfers of Marine Organisms (WGITMO).

1989

At the WGITMO meeting in Dublin during May 1989, the planned introduction of *P. yessoensis* to Ireland was described. A presentation was made by the proposer as to the reason for the introduction, based on economic projections and known ease of culture. The following documents were provided in advance of the meeting:

- Status report on the Japanese scallop, *Patinopecten yessoensis* (Jay), with reference to Proposal for introduction into Irish waters: with a review of its biology, culture techniques and possible consequences of introduction (17 pp.) by William Crowe, Shellfish Research Laboratory, University College Galway.
- Status report on the Japanese scallop, *Patinopecten yessoensis* (Jay). Information relating to the biology, fisheries and cultivation of scallops, together with supporting documentation on:

  i) *Patinopecten yessoensis* (39 pp.) by William Crowe,

  ii) *Pecten maximus* (16 pp.) by William Crowe,

  iii) Inspection and Certification (7 pp.) by John McArdle, Fisheries Research Centre.

WGITMO members wished to discuss the project further with their national experts before comment, but did not oppose the introduction of adult broodstock to Irish waters provided that the correct quarantine measures were adhered to. A number of questions were raised:

1) Unexplained mass mortalities of scallops in culture in Japan,
2) Genetic risk,
3) Possible competition with other scallops,
4) Possible introduction of other organisms with the scallops,
5) Would Japanese scallops thrive in Irish waters?
6) Would Japanese scallops become established outside Irish waters?

These required further consideration and the DOM endeavoured to answer these questions for the 1990 WGITMO meeting. The subject was tabled as a special discussion topic for the 1990 meeting in Halifax, Canada. The advice provided by ICES, following the recommendations of the WGITMO, in the meantime was as follows (ICES, 1990):

The Department of the Marine of Ireland submitted to the ICES General Secretary a proposal for introduction of the Japanese scallop, *Patinopecten yessoensis*, for consideration by the Working Group on Introductions and Transfers of Marine Organisms. The review determined that further information is needed before definitive advice can be developed on this proposed fisheries management measure.

Background

WGITMO summarised relevant information and points of concern, as follows:

1) The introduction is being proposed principally because the native species are not as suitable as the proposed species for cultivation and local stocks are at low levels.
2) The introduced species is expected to establish viable populations in Ireland.
3) Small numbers of this species have been introduced to Denmark and to France on the Atlantic coast and on the Mediterranean coast, and the species is being used in laboratory studies in Newfoundland, Canada.
4) Available information on environmental data and on inter-specific competition with native species is inadequate to enable full evaluation of the proposal.
5) Greatest detrimental impact is likely to occur mainly in ecological interactions; pathological problems via unwanted disease movements are possible; and genetic risks through hybridisation are expected to be low.
6) Late receipt of the proposal prevented consultative meetings within member countries.
7) Additional ecological and pathological information on this species in the native habitat is necessary, as required by the ICES Code of Practice.

Preliminary Advice

On the basis of the foregoing points of concern, WGITMO offers the following preliminary advice and comment:

1) The dominant issue is that of ecological impact, e.g., recruitment success in the British Isles is probable and spread of the species from Ireland would be expected and, thus, competition with valuable local species may occur.
2) Several disease problems with scallops are known, mass mortalities of unknown causes are frequent, and high losses of this species occur in Japan; thus, significant effort is required to prevent disease introduction to Ireland.
3) If Ireland wishes to establish a broodstock, adult scallops should be held in quarantine following the ICES Code of Practice. All scallops, including the F1 generation, should be held in quarantine pending definitive advice.
4) WGITMO does not support the introduction of eyed scallop larvae unless they are destined only for use as broodstock and held in quarantine.
5) To improve international communication in the matter of introductions of *Patinopecten yessoensis* in ICES Member Countries, the General Secretary should query all Member Countries requesting summaries of past, present, and future actions related to introduction and culture of Japanese scallops, to be provided by May 1990.

1990 Assessing Information

In January–March 1990, letters of concern relating to the introduction were published in Irish national newspapers. A United Kingdom agency sought further clarification about the importation. The DOM endeavoured to collate further relevant literature and carry out a risk assessment of such an introduction, which included a study visit in Japan in March–April 1990. At the same time, a quarantine facility was constructed under the supervision of the DOM by the promoter.

At the ICES WGITMO meeting in June 1990 in Halifax, Canada, additional support of information already presented in 1989 and from the study-visit in Japan to address the concerns endorsed by the ICES Council were presented (see Part II).

In addition, further presentations included statements on the layout of the quarantine facility, procedures to be employed at this facility, health certification, histological studies, and administrative matters and policy.

Following two days of discussion, WGITMO reported to the ICES Council (ICES, 1991):

The Department of the Marine, Ireland, has submitted to the Council a request for advice on the introduction of Japanese scallops, *Patinopecten yessoensis*, to open waters of Ireland. Steps outlined in the ICES Revised Code of Practice have been followed meticulously by the Department. The following advice is offered by the Working Group to go forward to Council:

The Working Group:

1) does not oppose the continued development of *Patinopecten* culture in Ireland, in the form of field trials that would assess their survival, growth, and gametogenesis in open waters pending verification of a pathogen-free F1 progeny and hatchery brood, including the stock destined for open release;
2) finds that upon careful examination of available scientific evidence assembled by Ireland, commercial-scale development of *Patinopecten yessoensis* populations in the open sea will very likely lead to the establishment of natural (wild) populations and possibly their eventual (albeit slow) spread;
3) urges that Ireland should provide to the Working Group annual records of release sites, dates, and numbers as part of their national report, and carefully monitor the occurrence, extent, micro habitats, health and concomitant ecological relationships, if any, with native biota, of wild populations if such become established (with a particular focus on any competitive interactions with the native scallops).

While the appraisal of the proposal was in progress, the DOM permitted the importation of the first broodstock consignment to the quarantine facility in April 1990 on the understanding that these, and their progeny, would remain in quarantine until such time as definitive advice on the overall proposal was received from ICES. It was necessary to import the broodstock at this time (their normal reproductive period) so that larvae could be produced at the quarantine facility because otherwise the project would be delayed a year. ICES, following the 1990 Statutory Meeting, informed DOM that they did not oppose the development of field trials subject to the condition that there would be status reports of the project presented to the WGITMO for review.

1991 Summary of Report to WGITMO

The main points in the subsequent status report submitted to WGITMO in June 1991 were:

- Histological studies, using 150 Japanese scallops produced in each batch of scallops at the quarantine facility, in the spring of 1990, showed no indication of disease or parasitic organisms. The scallops in quarantine were then released to the wild in pearl nets on longlines.
- Comparative growth between the native scallop *Pecten maximus* and the Japanese scallop, *P. yessoensis,* of the 1990 year-class took place in pearl nets at the longline site at varying densities 20:40:80:160 per pearl net. Both species suffered shell distortions and interrupted growth and had high mortalities (about 90 %). There was poor growth, with dense fouling of pearl nets from hydroids, tube-building amphipods, sponges and bryozoa. Some native scallop *Aequipecten opercularis* had settled on the outside of the pearl nets.
- Japanese scallops of the 1990 spawning, released to the sea, did not show any indication of reproductive development.
- Twenty males and 51 female broodstock of *P. yessoensis* were imported in March 1991 from the same source as previous broodstock. These spawned and produced a settlement after 20–28 days, the higher survival and reduced larval period indicated a better condition than in 1990.

1992 Summary of Report to WGITMO

The 1992 report was as follows:

Three introductions of adult broodstock were brought into quarantine under the supervision of the Department of the Marine. Scallops were released from quarantine in September 1990 and were held in hanging culture near Carnsore Point on the southeast coast alongside native scallops (*Pecten maximus*). Of this year class, 118 remain. Samples of these animals taken in April did not show any pathological condition or parasite loading.

In March 1991, the quarantine facility was re-opened in advance of receiving 20 male and 51 female broodstock. The adults came from Utatsu Bay in Miyagi Prefecture, Japan – the same source as the 1990 introduction. There were five spawnings over a twenty-day period during March and April. All adults, after spawnings, were destroyed. Settlement of larvae took place 20–28 days after spawnings. In June there were noticeable mortalities of spat following strong south-easterly winds that caused large amounts of algal debris to accumulate on the shore close to the sea water intake. At this time, scallop mortalities were high and the rate of growth declined. There was a vibrio infection of the mantle margin and all spat were then destroyed. On no occasion did scallops from the 1991 year-class leave quarantine.

There will be no importation of broodstock in 1992.

1993 Summary of Status Report to WGITMO

In 1993, the status report of the project to WGITMO was as follows:

Japanese scallops that survived their importation from Japan were introduced to a quarantine facility in Ireland during April 1990. Following spawnings, all adult broodstock were destroyed. The surviving F1 generation, which cleared quarantine in September 1990, was expected to spawn during the spring of 1993. It will appear that spawning will now take place during spring 1994. The surviving 75 scallops are held in lantern nets off the Wexford coast, southeast coast of Ireland.

There were no further importations in 1992 and none are planned for 1993 or 1994.

1994 Summary of Status Report to WGITMO

In 1994 the project was terminated, the longline holding the F1 broodstock was torn from its moorings in a storm. The longline was recovered but all of the scallops were dead.

Although the project ultimately failed, given different circumstances it could have been successful. The onshore quarantine laboratory was made secure in advance of any consignments and adult broodstock were imported close to breeding condition. Sufficient numbers of F1 individuals were produced but their subsequent culture in the sea on completion of quarantine requirements took place in an exposed area on the insistence of the promoter. On account of the exposed culture site, there was entanglement and fouling of the longline system and shell overlapping that resulted in high mortality. Servicing of the cultures could only take place when the sea-state was suitable, limiting the possibilities for practical management. Despite these difficulties, the procedure adopting the ICES Code of Practice was successfully carried out.

Part II

RISK ASSESSMENT ON THE INTRODUCTION OF THE JAPANESE SCALLOP (*Patinopecten yessoensis*) TO IRISH WATERS

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June 1990, Halifax, Canada

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Introduction

The ultimate objective of introducing the Japanese scallop *Patinopecten yessoensis* to Irish waters was to develop commercial hanging culture. Initially its survival and growth in a pilot culture scheme would be compared with that of *Pecten maximus*, the main commercial scallop species in Ireland, to determine whether it was suitable for large-scale culture. Sites on the south and west coasts were selected for possible ongrowing following quarantine. All parent *P. yessoensis* were introduced to a quarantine facility on the southeast coast of Ireland, under the supervision of the Irish Department of the Marine.

Introductions of larvae from Japan, intended to eventually act as broodstock, did not survive. Importations of adults took place in April 1990 and March 1991. These were spawned and the subsequent F1 generations settled. All adults were destroyed following spawning. The young scallops remained in quarantine until the F1 generation of the 1990 importation was released to the sea in September 1990. Those spat produced in the quarantine laboratory in 1991 were destroyed following a large mortality during a period of poor water quality. The surviving 2,500 spat of the 1990 spawning were to form the basis of a parental broodstock on which the project would depend.

The main contents of this document were presented to address concerns raised by the Working Group on Introductions and Transfers of Marine Organisms and subsequently by the Mariculture Committee of the International Council for the Exploration of the Sea (ICES) at 1989 meetings, and were reported in the following year. The preparation of the report is based on studies of the literature, a visit to Japan (to meet with biologists, oceanographers, pathologists and fishermen), and correspondence with internationally recognised scallop biologists, affiliated with the International Pectinid Workshop.

Summary of the Impact Hypotheses

1. That Japanese scallops could become established outside Irish waters

The scallops are to be cultivated in intensive hanging culture. Their growth and reproductive development will be monitored using spat released from quarantine. The project will proceed on a pilot programme in advance of becoming a commercial production with an option of withdrawing all cultivated scallops should any significant and negative effect be predicted or determined.

Japanese scallops, once mature, have the capability of spawning and small initial releases would provide a small inoculum with a low probability of the species becoming established. Increased production of scallops would undoubtedly increase this risk. In tandem ecological studies, including dredging of areas near the culture site, should provide sufficient information on the extension of the cultured population to the wild. Because the conditions in Ireland are suitable for growth and reproduction, it is likely that the species will eventually become established in the wild. It is probable that a large source population is required before the establishment of a wild self-reproducing population becomes likely. The critical size of the source population required is not known, but will depend on local hydrographic conditions. For this reason, a small adult biomass is recommended in pilot studies so that a full evaluation of scallop growth and reproductive development can be undertaken, to ensure that its expectations for culture can be realised.

In Japan the establishment of cultivation in new areas is thought to have produced some recruitment to the natural populations in nearby regions, but this has not been quantified. Larval numbers will clearly be dependent on population size, and in Mutsu Bay a direct relationship between spawning stock biomass and settlement onto collectors has been found to exist. Annual settlements are known to be highly variable in most scallop species, however.

2. That Japanese scallops may compete with native scallop species

It is not possible to determine the full interaction with other species in advance of an introduction; however, the study of scallop shell morphology does provide some basis for a reasoned argument in advance of an introduction. *P. yessoensis* has features intermediate between *Pecten maximus* and *Aequipecten opercularis.* For this reason, it is considered that the range of *P. yessoensis,* once established in the wild in Europe, is unlikely to coincide with that of native scallops. Although there is some overlap with the ranges of other scallop species in Japanese waters, there is no apparent competition. The Japanese *Pecten albicans*, which resembles *P. maximus*, has a geographical range just overlapping that of *P. yessoensis*, and has a preference for finer sediment.

It can be deduced from the Japanese literature that the larvae or settled spat of *P. yessoensis* are unlikely to compete with those of Irish pectinids, because spawning takes place in the early spring. However, there may be competition as juveniles or adults, where its distribution overlaps with that of other scallops, but this is not seen in Japan. Studies in tanks, and in the field, of *P. yessoensis* with European native scallop species would be required to determine the interactions, behaviour and sediment preferences as juveniles and adults.

3. That the introduction of Japanese scallops may result in a spread of pests, parasites or diseases.

Prior to introductions, *P. yessoensis* adults were selected by size and condition, and their shells scrubbed. The consignment was met on arrival at customs by an officer of the Irish Department of the Marine, who brought the scallops directly to the awaiting and supervised quarantine facility. Following unpacking, all waste was burned and dead tissues buried in lime. Living scallops, and their remaining epibionts, remained in quarantine. Wastewater was treated by chlorination at 250 ppm with a minimum treatment holding time of 4.5 hours.

Following spawning, all eggs were sieved, washed, and separated from adults and their water. The original broodstock was then destroyed and the quarantine facility was operated until such time as the F1 or subsequent generations were devoid of known pathogens and parasites, determined by histology, and were in a healthy condition. These measures were considered sufficient to control and eliminate the risk of an introduction of known pathogens or parasites to the sea.

4. There was concern over the mass mortalities of Japanese scallops in culture in Japan.

There was no evidence of any direct pathological implication in scallop mortalities in Japan. Causes appear to have been one or more of the following, most of which arose from over-intensive cultivation:

a) Physiological stress arising from premature development or high sea temperatures,
b) Wave action, resulting in soft tissue damage from shell overlapping,
c) Oxygen depletion.

5. That Japanese scallops may hybridise with commercially important European scallops

In Japanese waters there are no known examples of hybridisation of *P. yessoensis* with any other pectinids with overlapping ranges. This scallop has a different shell morphology and is dioecious, and is unlike European commercial species.

Further, hybridisation is unlikely because *P. yessoensis* spawns at lower temperatures (in the early spring) than *P. maximus*, which spawns from May to August. *A. opercularis,* which has a different chromosome number, has three periods of spawning - a small peak in January/February (in the Irish Sea), summer and autumn. *Chlamys varia* occurs within shallow bays and spawns at temperatures above 14 °C.

For these reasons, it was concluded that there was no predictable genetic risk.

6. That Japanese scallops are unlikely to thrive in Irish conditions

All indications are that conditions in Ireland are favourable, sea temperature ranges fall within the optimum range for the species, and all likely cultivation areas have appropriate salinities.

Main Account of the Risk Assessment of the Introduction of the Japanese Scallop, *Patinopecten yessoensis,* to Irish Waters

Scallops were introduced to Ireland following strict adherence to the ICES Code of Practice in effect at that time. The 1988 Code was updated during the course of the introduction of Japanese scallops. Recommendations for some changes were made and subsequently contributed to the 1994 Code of Practice.

Species summaries of the three main scallop species in Irish waters are provided. These are distilled accounts of lengthy submissions made to the Working Group (Boxes 1–3) to enable comparison with the biology of the Japanese scallop (Box 4).

Following the study visit to Japan in March 1990, the following responses (below) in relation to the concerns expressed by the ICES Council in 1989 were addressed at the WGITMO meeting in Halifax, Canada in June 1990. In addition, a description of culture methods and general conditions at the donor site was included. During this time adult *P. yessoensis* broodstock were imported to the prepared quarantine reception facility in Ireland (to produce spawnings in March/April their normal spawning time) so that a year's work was not lost.

Cultivation Techniques on the Sanriku Coast, Japan

Scallops were sourced from Utatsu Bay on the southern Sanriku coast in Miyagi Prefecture (Figure 1). In this region of intensive cultivation, the main species utilised from the sheltered shore to the more open bay is generally in the following sequence:

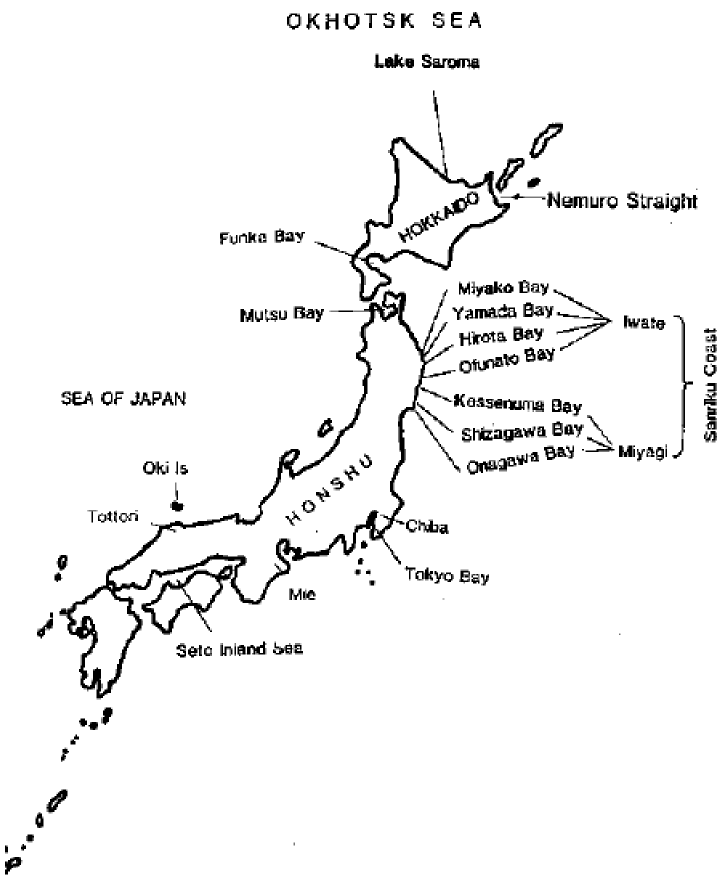
Oysters → Ascidians → Undaria → Salmon → Scallops

Scallops are normally cultivated at the most open end of these bays, sometimes 5–6 km offshore over depths of 40–60m. Scallops are held on submerged longlines with marker floats that extend to the surface. The majority of the floatation is from subsurface floats; most of these were glass. As scallops grow and become heavier, additional floatation is added. The longlines are arranged in rows, with corridors of 50–100 m between them. Cultivation is extensive and activities in the production provide employment for most of the year.

Environmental conditions

Onagawa Bay lies adjacent to the area where the Irish consignments of scallops were sourced. Much of the environmental data from this area are based on studies made by students at the University of Sendai. Annual sea temperatures range from about 6–22 °C, however, temperatures at the depths of culture range from 6–20 °C, with cooler and warmer temperatures inshore in winter and summer, respectively (Misu, 1990; Arimoto, 1977). In Onagawa Bay, which gradually deepens to almost 50 m at its entrance, sediments range from sandy mud to sand (Misu, 1990). Seasonal transects passing through the centre of Onagawa Bay were made to determine the distribution of nitrogen, silicates, phosphates, and chlorophyll *a* together with temperature and salinity (Shibakuki, 1990). In spring, silicates and phosphates are concentrated below 20 m. Levels are low in summer but are well mixed throughout the water column in autumn and winter. Chlorophyll *a* levels were highest close inshore in spring and summer. The tidal range within this region is 1.8 m (Uno, 1990).

Figure A7.1. Location of Japanese localities referred to in the text.



Japanese scallop cultivation

The industry in Japan is totally based on natural spat settlements. The main areas of cultivation are Mutsu, Funka, Saroma, Tenora, and Sanriku districts (Figure A7.1). No laboratories currently rear *P. yessoensis* larvae apart from some small experimental studies on the Sanriku coast, although efforts were made to produce hatchery-reared spat to stabilise production in the 1960s and early 1970s when there were large fluctuations of natural settlements (Imai, 1967). Hatchery production was expensive and was discontinued when natural settlements became more reliable (Sanders, 1973).

In Miyagi Prefecture more than 70 % of the seed used in culture is obtained by placing collectors locally. Larval occurrence and spat production have been studied by Sasaki *et al.* (1984). Settlement takes place over the period May–June and the spat are removed from the collectors in July–August once they are approximately 10 mm shell height. At some localities on the Sanriku coast, there are two separate appearances of larvae in the plankton (end of May–first week of June, last week of June first week of July in 1984 (Sasaki *et al.,* 1984)). The source of these settlements is not known. There is a local and natural unexploited population below the longline culture areas. It is not clear whether both cultured and natural scallops provide larvae that settle within these areas, but it is considered likely. Scallops in culture may spawn in advance of those on the sea floor and this could account for the two peaks of larval abundance appearing in the plankton.

Scallop spat,when removed from collectors, are transferred to pearl nets at densities ranging from 40–100 per net. A second grading to a larger-meshed pearl net takes place when scallops are 30 mm+ shell height, when densities are reduced to 15 per net. The mesh floors of these pearl nets were not as fouled as their upper surfaces. It was noticed that *Polydora* can be found on shells of this size (pers. obs.).

Importations of scallops from Northern Hokkaido to the Sanriku coastline have not taken place. However, scallops for hanging culture, once about 6 cm, are imported from Funka and Mutsu bays. The exact quantities imported are not known because fishermen do not wish to disclose their suppliers. Transfers normally take place in December, six months following settlement. Scallops are transported in boxes lined with sacking soaked in sea water. The consignments are held at 2–4 °C in temperature-controlled containers. Transportation times are usually planned so that scallops are not held out of water more than 10–11 hours. Funka Bay scallops, that are not used in hanging culture, normally go for sowing culture in the Othotsk Sea and the Nemura Straight. The majority of the Mutsu Bay scallops are transferred to Iwate Prefecture. Here scallop production is greater than in Miyagi Prefecture.

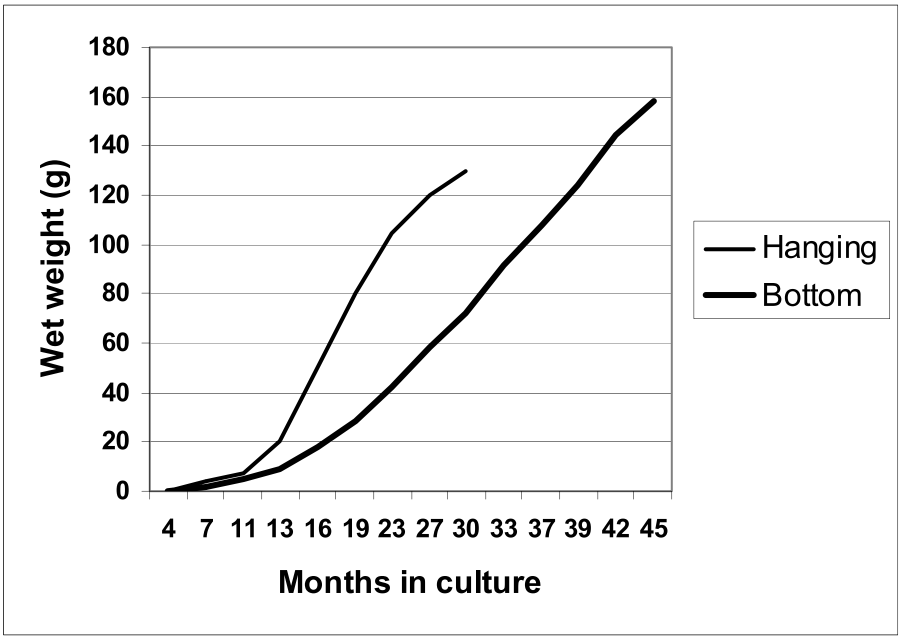
After nine months, scallops can be large enough for sale. This market for small scallops has developed as a result of the large quantities being reared with insufficient capacity for growing them to a larger size. These small scallops tend to be slower growing or may have sustained some damage while handling and are usually sold entire. The better quality and larger scallops continue to be ongrown, those that exceed 6 cm in shell height are ear (auricle) drilled and hung in vertical arrays from longlines. Ear hanging culture takes place at depths of 10–39 m, on dropper lines spaced approximately 1 m apart suspended from a subsurface buoyed horizontal line. Scallops are fixed to the dropper lines in pairs using 1mm diameter monofilament line, or barbed plastic tabs. In the more exposed areas, shells can be lost due to wear of the monofilament. Scallops using this system normally develop with a greater shell volume (are more globose) with thin shells.

Those not cultured in this way are held within subsurface lantern nets at stocking densities of about 10 per level until they reach a size of 100 mm shell height. However, fishermen are inclined to overstock using 13–15 individuals per level. Scallops generally grow more rapidly when held in suspended culture (Figure A7.2). In the Sanriku region there are few areas where scallops are sown on the sea floor.

Scallops are normally marketed following two years of culture, although some may require to be ongrown a further year. This depends on local conditions and cultivation densities. Growth in the Miyagi district (Figure A7.1) is the fastest known in Japan. This is due to the extensive period of warmer sea temperatures resulting in optimal growth. Mortalities do, however, take place once temperatures exceed 21 °C.

The method of cultivation is intensive; many longline systems are installed within suitable ongrowing areas. Fishing vessels in these areas use hydrojet propulsion to avoid entanglement with the surface marker floats. The equipment used for working the longlines is highly specialised and consists of rollers and lifting gear on shallow-drafted, low-gunwhale vessels.

Figure A7.2. Comparison of growth for scallops held in hanging culture with those sown on the sea floor (based on Imai, 1967).



Mass Mortalities of Scallops in Culture

In Japan scallop losses have taken place at most production sites, and also in the warmer water areas outside of their natural range, where experimental cultivation trials took place. Extensive histological studies at main cultivation sites (when there have been high mortalities) have not indicated any pathological cause. The most likely explanation for these mortalities would appear to have been physiological stress due to over-intensive cultivation. Saito (1984) suggested diseases as being one of a number of possible contributory causes of decreased production in Hokkaido following the dramatic twelve-fold expansion in production over the years 1971 to 1977. During this period, annual production rose from less that 6,000 metric tonnes to 70,000 metric tonnes. No evidence is adduced, however, to support this hypothesis. No further information relating to diseases was available during the 1990 visit to Hokkaido. Although mortalities still occur from time to time, the levels of losses that took place since 1972 have not been repeated. The following possible explanations for high mortality were offered.

Cultivation technique

Long exposure to air

Scallops, as they grow larger, need to have their cultivation density reduced and placed in containers with progressively larger mesh sizes. This reduces fouling, enhances water flow and thereby promotes growth. During this grading process, the scallops are exposed to the air. There is apparently a great variability in stock survival between different family units who cultivate scallops in close proximity to each other according to the handling they receive. For example, in Saroma Lake adjacent units have had >50 % mortality and <10 % mortality (Hayashi, 1988). Some cultivators handle their stock at sea to reduce aerial exposure and return them to the water as soon as possible. Survival under these circumstances is greater. Those who bring their stock ashore to grade expose the scallops for longer periods and these scallops have higher mortalities (Hayashi, pers. comm.).

Exposure to sun and rain

Scallops handled in the early morning in the warmer months avoid being exposed to high solar radiation and are handled at a time with cooler air temperatures. Scallops handled in this way have a lower mortality (Anon., 1980). Survival is greater when tarpaulins are used as a sunshade or as a shelter to deflect rain. Once sea temperatures are high, >20 °C, handling is normally avoided.

High-density cultivation

High-density cultivation has continued to result in high mortality. In Funka Bay, large interconnected longlines are owned by a fishermen's cooperative, and sections of this are allocated to family units. Because of the limited space available, each family produces as much as possible from the apportioned area. Ear hung scallops are usually hung in groups of three, where optimally there should be one or two, and correct densities in lantern nets are exceeded. Such overstocking results in reduced growth, requiring a longer cultivation cycle, and poorer quality scallops with significant losses (Hayashi, pers, comm.).

High-density culture in pearl and lantern nets may result in deformed shells; more importantly, this can lead to additional mortality. Many die from shells overlapping ("biting"). The ventral (leading) edges of the overlapping shells may penetrate and cut the soft tissues within the shell cavity. Small scallops of 15 mm to 30 mm shell height are particularly vulnerable, because at this size they can gape widely. This was a serious problem 15–16 years ago in Hokkaido when densities of 300–600 scallops were held within each pearl net, where normally two hundred 3 mm shell height individuals would be stocked (Hayashi, 1988). The effects of density on growth have been well described by Querellou (1975) and Ventilla (1982). The optimum density for cultivation is considered to be 50–66 % shell surface area to cage floor area (Anon., 1980).

Incorrect drilling of cultured shells

Scallops can be drilled through the shell auricles ("ears") to take a monofilament which is then attached to vertical arrays of hanging dropper lines suspended from a horizontal subsurface longline. Scallops with incorrectly drilled shells often perish. Mortalities of 10 % are frequent. Losses from this source are accepted because of the lower overall capital cost of this method of cultivation. Higher losses occur in areas of wave exposure. Currently, there is about 2 % shell distortion among drilled shells (Sasaki, pers. comm.).

Physiological Stress

Abnormal sexual development

Scallops grown in the Miyagi and Iwate Prefectures grow more rapidly, and females can mature during their first year, unlike the populations in Mutsu Bay and Hokkaido. In warmer waters, abnormal sexual development in scallops of less than one year can take place (Osanai, 1975). Development may be incomplete and so result in only partial spawnings at the normal time of spawning. This is followed by partial adsorption of the remaining sexual products.

Reproductive cells are formed during a decline of sea temperature in the autumn. Throughout the coldest period, maturation takes place and spawning occurs with a sea temperature rise, usually in March–April in Iwate and Miyagi Prefectures. If scallops are held at a low temperature for insufficient time, they will enter the spawning period without full maturation, and this may explain the presence of sexual products found during summer months, as was found in Yamada Bay, Iwate Prefecture (Mori and Osanai, 1977). At higher temperatures, the maintenance of gonadal tissue is greater (Mori, 1975). These conditions impose stresses that may result in mortality, particularly if exposed to additional handling.

Mortalities of 30 million scallops (>50 %) were recorded in Yamada Bay in 1972, and similar mortalities were recorded for Ofunato and Hirota bays (Figure A7.1). The following year mortalities in these bays in Miyako Bay, all in Iwate Prefecture, were as high as 90 %. In Miyagi Prefecture, high mortalities were recorded during 1972 and 1973 in Kessenuma and Shizagawa bays. Scallops that were dying usually had a deformity and browning of the shell margin and pallial atrophy (Mori, 1975). Mortalities occurred in other years, but they were not quantified. More recently, mortalities have declined considerably as a result of modified longline systems and reduced culture densities.

Stress arising from high sea temperatures

P. yessoensis is a cold-water species tolerating temperatures from −2 °C to 21 °C. Once temperatures exceed 21 °C to 24 °C, physiological stress results in reduced growth and often death. Mortality increases in those cases where scallops become exposed to additional stress, such as high-density cultivation.

Trial cultivation in Chiba and Mie Prefectures and the Seto Inland Sea (Yamamoto, 1977) showed high losses once summer temperatures attained 23 °C (Koike, pers. comm.). In Mutsu Bay once temperatures attain 23 °C, mortalities were normally noted. In many areas, at the southern end of this scallop's range, mortality could be reduced by suspending them in deeper water to avoid those periods when there were high temperatures in the near-surface water.

Effects of high density

High densities result in poor growth, competition for food, and greater fouling. Slow-growing scallops may become overgrown by fouling organisms; this may lead to distorted growth of the shell and death.

The effect of wave action on scallops in hanging culture

Scallops ongrown on longlines may be subject to strong vertical movements, particularly near the sea surface at exposed localities. Under these conditions, when scallops tap each other, shell margins and mantle tissues can become damaged, commonly resulting in shell chipping, mantle retraction, and death. Mortality from this source has been significantly reduced with a redesign of longlines and culture of scallops at greater depth. There is also some indication that poor food availability as well as effects of wave action, termed "vibration", result in high mortalities (Mori *et al.*, 1974).

Oxygen depletion of the water column

Pseudofeces, waste matter, and fouling organisms that descend to the seabed in areas of intensive off-bottom cultivation can result in a high organic loading, particularly in those areas where there is low dispersion. Locally the redox-discontinuity layer can appear at the sediment surface and the bacterial flora can produce sulphurous gases causing environmental deterioration (Anon., 1980). These conditions are also known to occur beneath both mussel rafts, in the rias of Spain, and salmon farms, in northern Europe (Pearson and Gowan, 1990).

Local events, such as the collapse of an algal bloom, may result in oxygen depletion causing mortality in the benthos. In Japan, sheltered areas with large accumulations of detritus can have poor growth and high mortalities. This can be ontrolled, in part, by moving in rotation the position of the cultivation units, to avoid continuous accumulation of waste, thus providing an opportunity for recolonisation of the sediments by benthic organisms (Anon., 1980).

Genetic Risk

Absence of hybrids in Japanese waters

There are no known hybrids between *P. yessoensis* and other scallop species found within its range. These include *Pecten albicans, P. sinensis, Chlamys swiftii,* and *C. farreri nipponensis* (Kijima pers, comm.).

Different chromosome numbers

P. yessoensis has 19 chromosome pairs, three of which are acrocentric, whereas in *P. maximus* there are the same number of chromosomes but 14 of these are acrocentric (Beaumont and Zouros, 1991). *A. opercularis* has 14 chromosome pairs (Rasotto *et al.,* 1981) or 13 (Beaumont and Gruffydd, 1975). Recombination with European species is very unlikely. In Japan both *P. albicans* and *Chlamys farerri* have 19 chromosome pairs.

Scallops morphologically different

P. yessoensis is morphologically different from other European pectinids. In addition, this species is dioecious, unlike the two main northern European commercial species *P. maximus* and *A. opercularis*.

Different spawning periods

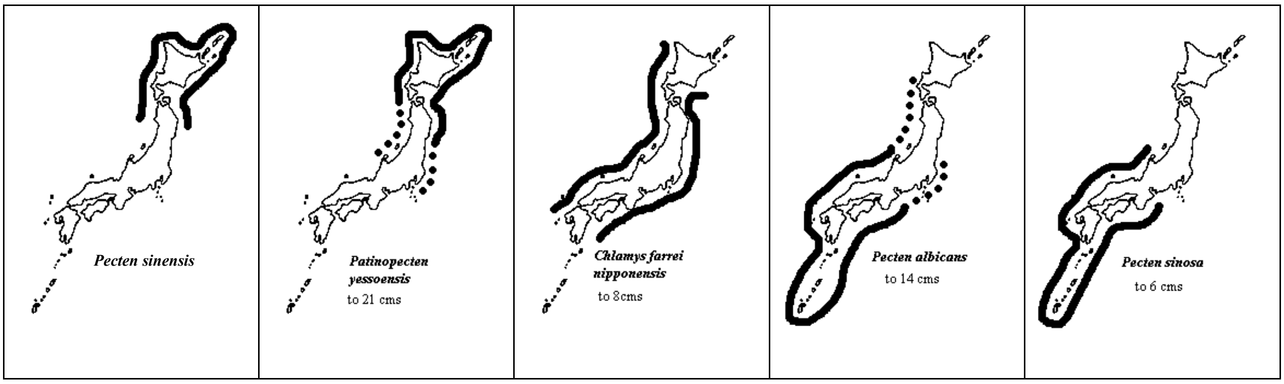
The expected spawning period of *P. yessoensis* in Irish waters (March and April) is unlikely to overlap that of *P. maximus*. In many coastal areas of Ireland, spawning of *P. maximus* occurs form May to August (Gibson, 1956), except perhaps on occasions within the Irish Sea where spawning has been recorded over a sea temperature range of 7.2–13.7 °C (Mason, 1958). *A. opercularis* spawn predominantly in the autumn, with smaller spawning peaks in the early spring and summer (Paul, 1978), mainly outside the anticipated spawning time of *P. yessoensis*. The opportunity to hybridise, should this for some reason be possible, is thereby considerably reduced.

COMPETITION WITH OTHER SPECIES IN JAPAN

Scallops that overlap the range of P. yessoensis

The range of *P. yessoensis* overlaps that of other pectinid species, but only at the edge of its range or habitat (Figure A7.3). *Chlamys swiftii, C. nobilis,* and *C. farrei nipponesis* are normally found attached to stones and usually in shallower water, and here *P. yessoensis* is seldom encountered. *P. albicans and P. sinensis* infrequently overlap the range of *P. yessoensis*.

Figure A7.3. Distribution of the principal scallop species that overlap the distribution of *Patinopecten yessoensis.*



***Patinopecten yessoensis* in Japan**

P. yessoensis is found naturally in Northern Honshu and Hokkaido. Off Hokkaido it is found to depths of 60 m, mainly on gravels (0.5–4 mm diameter) in areas of swift water movement. The gravels in these areas are often well polished. These same areas are also sown in rotation, using scallops from culture (Hayashi, 1988), with densities of up to 6–7 scallops per square metre.

In the partially enclosed Mutsu Bay, scallops occur on finer sediments. The chosen sowing areas consist of a community which includes *Echinocardium cordatum* and *Lepidopleurus assimilis*, both of which are used as biological indicators for sediment suitability. These sediments of sand, silt, and gravel must have a silt (<0.1 mm diameter) composition of less than 30 % (Yamamoto, 1968). Higher levels of silt are unsuitable and in such areas scallop growth and survival are reduced. Settlement in muddy or silty areas normally results in high mortalities of spat, and so explains the absence or low numbers of scallops in these areas. Densities of less than six per square meter are needed to obtain 200 g scallops in 3–4 years (Aoyama, 1989).

***Pecten albicans* in Japan**

P. albicans, a commercial species in the Sea of Japan on the west coast of Honshu, has a preference for sand and sandy mud. It normally occurs at depths of 30–80 m (Ayama, 1986). It is cultivated in Tottori Prefecture and the Oki Island. Landings have been variable depending on recruitment of good year classes. Currently, production is stabilising as a result of cultivation. Attaining 100 mm in its third year (maximum size, 140 mm), it is cultivated in a similar way to *P. yessoensis* (Kunizou, 1986). *P. albicans* is very occasionally found on the east coast of Japan where it occurs northward to Tokyo Bay, where occasional sporadic year classes recruit. Overlapping of its range with *P. yessoensis* is not known on this coast (Koike, pers comm.).

***Pecten sinensis* in Japan**

P. sinensis attains 60 mm shell height, and has a similar geographic distribution to *P. albicans* within Japan, occurring in shallows where there is fine sand.

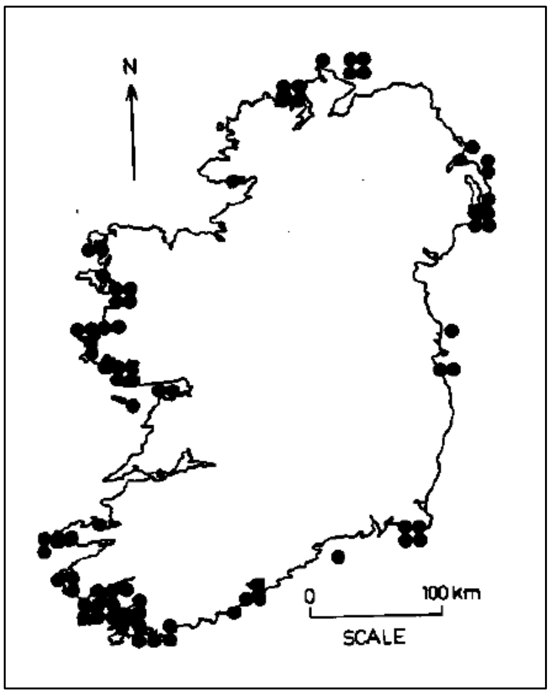
COMPETITION WITH OTHER SPECIES IN NORTHERN EUROPE

Likely range overlap with main European species

Pecten maximus ranges from Norway to the Canaries (Figure A7.4), but is exploited from Spain to Norway from the lowest tidal level to depths of 180 m. It is found on all Irish coasts, particularly within shallow bays (Figure A7.5). *P. maximus* is found on a wide range of sediments, from soft mud to coarse gravels, although there would appear to be a preference for sandy mud (Minchin, 1984). These substrata and greater depth range represent a wider distribution than has been described for the Japanese scallop. Should *P. yessoensis* become established in Irish waters, it is expected that it will overlap the range of *P. maximus*. However, it is unlikely that their ranges would coincide. *A. opercularis* is also found over a wide range of substrata, but is more frequently associated with muds and sands to depths of 46 m (Mason, 1983).

Figure A7.4. Distribution of *Pecten maximus* in Europe (Minchin, 1984).

Figure A7.5. Distribution of *Pecten maximus* in Irish water (Minchin, 1984).



Likely behaviour in European waters

Shell shape provides some indication of behaviour among pectinids (Gould, 1971). The shell of *P. yessoensis* differs from that of *P. maximus* and *A. opercularis*, yet has some similarities. *P. maximus* recesses within a pit in the sediment, and normally has a thick layer of sediment covering the upper (left) flat valve so that the upper surface of the shell lies flush with the level of the surrounding sediment. In *P. yessoensis* recessing also take place, but within shallow pits and some sediment can cover the left valve. *P. maximus* has an overlapping lower curved (right) valve, an adaptation for a deeper recessed mode.

A. opercularis has a biconvex shell without shell overlap, and, like *P. yessoensis*, is an active swimmer. The Japanese scallop has characteristics common to both of the afore-mentioned species and lives for a similar length of time. For these reasons, *P. yessoensis* may be expected to become dispersed over a similar depth range with a preference for coarser sediments.

Chlamys varia is principally found in shallow-water bays. It attaches with a byssus throughout its life and like the Japanese *Chlamys* species is unlikely to be found in areas where free-swimming scallop species are found. It is capable of detaching the byssal mass and then swimming and subsequently secreting new byssal threads. Swimming seldom takes place, and then usually as an escape response to sea-stars.

P. maximus and *A. opercularis* coexist in European waters with overlapping ranges without apparent detriment. It is expected that *P. yessoensis* would behave in a similar manner should it become established. The only likely competition is expected to be for food, and this may not be significant when compared with the biomass of other filter-feeding organisms present.

POSSIBLE INTRODUCTION OF OTHER ORGANISMS

Introduction of algal cysts

Distribution of algal blooms in Japan

In Onagawa Bay and the Sanriku coast, close to the region of the source population of scallops to be introduced to Ireland, movements of coastal and oceanic water masses into the Bay determine the phytoplankton successions. The dominant species were diatoms, mainly composed of *Chaetoceros radicans* and *Thalassiosira decipiens* in May, changing to *Nitzschia seriata* (now *Pseudonitzschia seriata*) and *Rhizosolenia fragilissima* in July. In October *Asterionella glacialis* and *Skeletonema costatum* predominated (Hashimoto, 1990). In Hashimoto's study in 1989 dinoflagellates did not consist of more than 1.5 % of the marine algal counts. Arimoto (1977), who examined the same bay in 1974 and 1975, did find small numbers of *Prorocentrum micans* in the late summer, and recorded the presence of *Dinophysis ovum* and *D. homunculus var. tripos* during the summer and autumn.

On the Sanriku coast, DSP has occurred close inshore, and scallops (as well as other species) sampled in the summer of 1976 and 1977 were found to be contaminated (Yasumoto *et al.,* 1978). The organism responsible is thought to be a *Dinophysis* species. Seed collection areas that supply Miyagi Prefecture with some of the scallops used in the suspended cultivation to the adults do have problems with DSP contamination. Species found associated with this problem are *Dinophysis fortii* and *D. acuminata*, although *D. norvegica, D. rotundata* and *D. mitra* were all recorded in Funka Bay, Hokkaido, in 1989 (Hayashi, 1989). In Mutsu Bay, Honshu, DSP contamination is also known (Yasumoto *et al.,* 1978); it is principally caused by *D. fortii*, which can be present from March to October/November (Satoh, pers. comm.). DSP is known to have occurred in this area since 1976, and there were serious outbreaks over the period 1978–1980 (Ventilla, 1982). This species does not appear to interfere with the growth of scallops, and sales can take place provided the hepatopancreas, in which the toxin accumulates, is removed. PSP contamination is not known from the Miyagi Prefecture, but is known in Funka Bay, an area that has sent scallops for adult cultivation on the Sanriku coast. The problems in Funka Bay are serious and sales of scallops can be restricted for most of the year. The causative organisms are *Alexandrium (Protogonyaulax) tamarense*, which was first recorded in the autumn of 1988, and *A. catenella* (Hayashi, 1989). Scallops are contaminated from May to October, and restrictions on sales of fresh meat for some localities can extend for as much as 290 days.

Treatment of used water in the Irish quarantine facility

All water was filtered in stages down to 5 µm and then treated with ultra-violet light before being used within the quarantine facility. All water introduced to the quarantine area was contained. In the unlikely event of all tanks being damaged, the quarantine area had a bund to contain all spilt water so that it could then be treated in the way intended. Sterilisation of all used water was by means of an injected solution of sodium hypochlorite. Wastewater was contained within a 500 gallon drainage tank which, when filled to a predetermined level, activated a pump. The pump was linked to the hypochlorite injection system. The treated water was then held within a series of tanks at 250 ppm chlorine before being neutralised at the point of discharge. The required treatment to destroy algal cysts is not presently known, but the precautions were considered to be adequate at the time for treatment. The tanks also acted as settlement traps and will have contained particles for longer than the minimum residence time of 40 hours. Procedures to ensure correct management of the quarantine area are laid down in Table A7.1.

Control of the introduction of non-native organisms

Shell-fouling organisms

There is considerable fouling of the shell surface of scallops held in hanging culture. Arakawa (1990) describes fouling in the hanging culture of the Pacific oyster, *Crassostrea gigas*, in Japanese waters. He describes 45 species that attach to the shell; the same species are likely to be found on the shell surface of scallops. In Utatsu Bay, colonial and solitary tunicates, hydroids, bryozoa and mussels were the principal fouling organisms seen. Scrubbing the shells prior to transportation can control the majority of these species.

Parasites and diseases of scallops

First described in 1971 in Mutsu Bay in sown scallops was a rhizocephalan-like parasite to become known as *Pectenophilus ornatus* (Nagasawa *et al.,* 1988). This parasite attaches in the region of the gill or adductor muscle and is claimed to impede growth. It is presently widely distributed in Mutsu Bay and is also found on the Sanriku coast. It can infest all scallops in a locality and can result in marketing problems (Elston *et al.,* 1985). This species cannot be transferred to the F1 generation using standard quarantine procedures; all scallop parent stock will be destroyed following spawnings.

Branchial rickettsiales-like infections are known in *P. yessoensis* and *Tapes japonica* and have been implicated in myodegeneration and mortality (Elston, 1986).

Table A7.1. Procedure used for operating quarantine area.

1) The quarantine area was clearly indicated with a notice. Restricted regions within the compound were indicated, a health and safety statement was on display and included the following matters:
    - Labelling of electrical switches and fuses according to function.
    - Low-level warning alarm for chlorination injection system.
    - Spring closures on hatchery doors
    - Handwashing facilities at entry/exit point of hatchery
    - Separate broodstock and larval culture areas
    - Separate equipment for use with each tank
    - Intruder alarm system
    - An established daily opening up and closing procedure
    - Identification and notification of trip points, wet areas, obstructions, and unguarded equipment, hazardous chemicals and sharps.
2) Only authorised personnel were permitted entry to the hatchery, all non-operatives signed a logbook on arrival. Visitors wishing to gain access to the facility required prior approval from the proposer and the Irish Department of the Marine.
3) White coats (regularly laundered as for hospital clothing) were worn by all entering the hatchery.
4) Boots were provided for on-site use in the hatchery and compound area. Separate footwear was used for work outside of the compound area.
5) Both boots were bathed in a disinfectant solution (with a colour indicator) within the footbath before entry/leaving the hatchery area.
6) Hands were washed frequently with disinfectant soap, especially after handling broodstock, or between working separate scallop bins.
7) Equipment entering or leaving the hatchery was disinfected using absolute alcohol, in a 100 ppm solution of chlorine, or by being autoclaved.
8) All rubbish was regularly removed to the compound and burnt.
9) Non-flammable materials were soaked in chlorine and buried.
10) All organic material (dead broodstock, larval cultures) was soaked in chlorine and buried in lime.
11) Smoking and eating within the hatchery area was not permitted.
12) The main gate to the compound perimeter fence was either kept locked or overseen.

13) Regular inspections of:

- all running pumps;
- sea-water pump house for flooding;
- chlorine and metabisulphite tanks for levels;
- sand-filter tanks;
- flowmeters and UV indicator lights;
- temperature, salinity and pH in larval and broodstock tanks.

14) Working procedures:

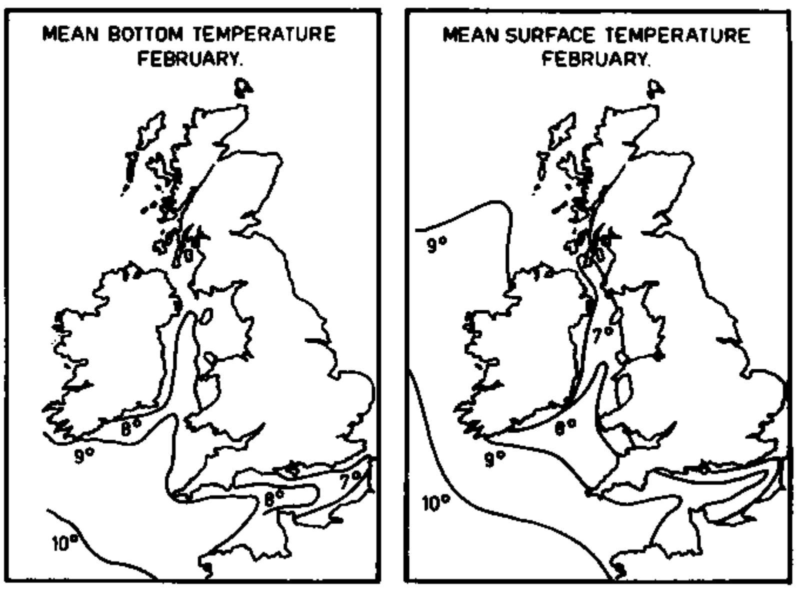
- Chlorine levels in the waste treatment system were measured thrice daily at points of entry to the waste tanks and at the point of discharge.
- Assist in the hatchery practice, under the supervision of the hatchery manager, and be familiar with the hatchery purpose and routine.
- A diary of observations, measurement and hatchery operations.
- Aquire and prepare samples of material for histological study.

LIKELY PHYSIOLOGICAL EXPECTATIONS FOLLOWING TRANSFER

Time of spawning in Irish waters

In Japan development of the gonad begins once sea temperatures fall below 10 °C, and it is important that at least two months of temperatures below 10 °C are maintained (Matsutani, pers. comm.). Sea temperatures below 10 °C are found about Irish coastal areas (Figures A7.6 and A7.7, from Irish lightship records), and those regions within shallow bays may be expected to have lower and higher temperatures, more closely corresponding to air temperatures. With a rise in sea temperature spawning commences, and lasts approximately one month with no further subsequent spawning until the following year. This is unlike the native European species, which in Irish waters have a number of spawning periods throughout the year, but principally over the period late spring to autumn. In *P. yessoensis* the time of spawning depends on the geographical locality, those farther north spawning later. Spawning at the southern end of the range, in Miyagi Prefecture, takes place in March/April (Sasaki, pers comm.) and in Posjet Bay in the Soviet Union in late May to August (Golikov and Scarlato, 1970). Expectations of spawning in Ireland would coincide with a steady rise in sea temperature in March/April.

Figure A7.6. Mean bottom and surface sea temperatures for February about the Irish coast.



Growth of scallops in Irish waters

The temperature for optimal growth in *P. yessoensis* is 15 °C (Figure A7.8) and at some localities in Japan the depth of cultivation is adjusted to coincide with these temperatures (Sanders, 1973). Hanging culture on the Sanriku coast for most of the year is well suited for the growth of this species (Figure A7.9). Throughout the range of *P. yessoensis* in Japan there is a greater range of sea temperature, −2 °C to 24 °C, but scallops are probably very seldom exposed to a full temperature range this great (Figure A7.10). It is very unlikely that sea temperatures will rise as high in Irish waters even inshore. The highest bay temperatures at the sea surface that have been measured in Ireland have been 21 °C in August (Minchin, 1984). Lowest sea temperatures in Ireland are probably about 2 °C in shallow bays during periods of sustained cold in late winter, and *P. yessoensis* can clearly function in Japan at these temperatures. Conditions in Irish waters would appear to be optimal for good growth rates for *P. yessoensis*.

Figure A7.7. Mean sea surface temperature for the southeastern coast of Ireland close to the quarantine station at Carne, Co Wexford.

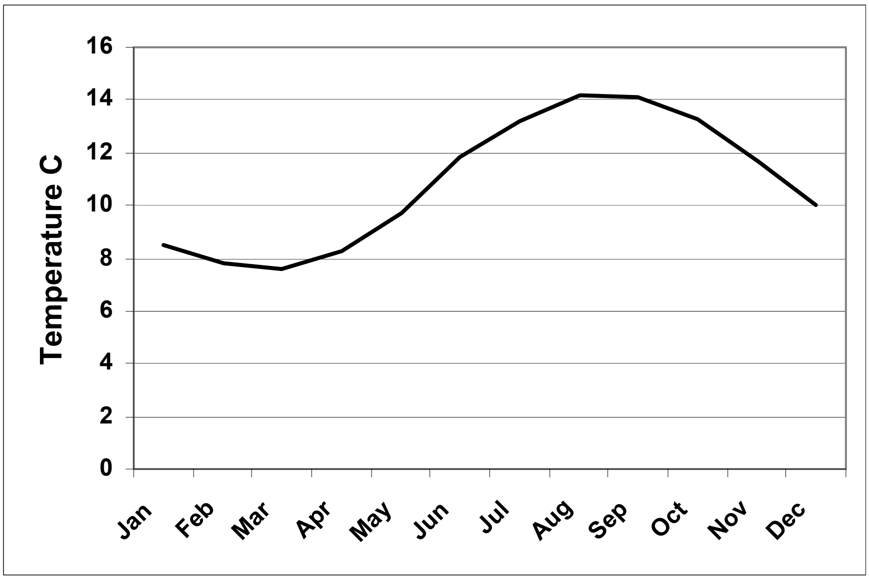


Figure A7.8. Optimal temperatures for the growth of *P. yessoensis* over a wide-range of environmental conditions (based on Muller-Fuega and Querellou, 1973).

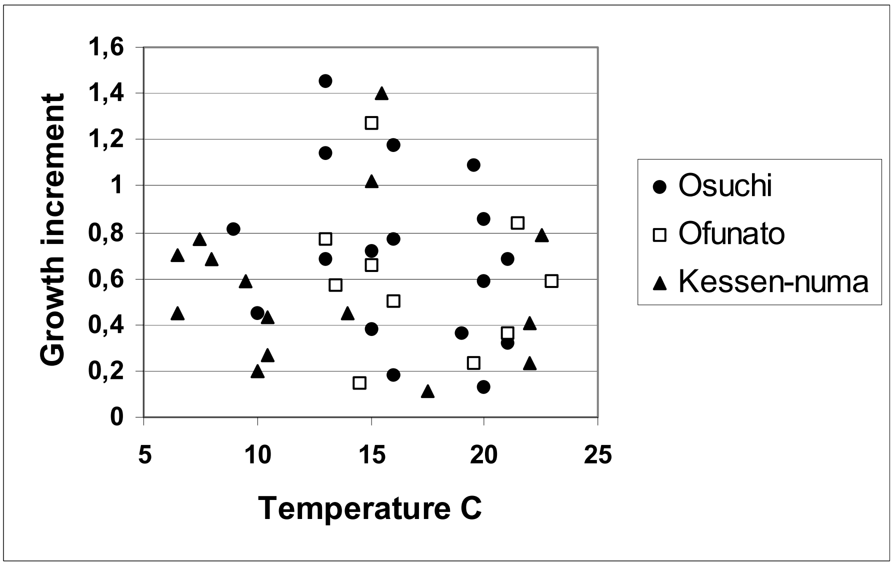


Figure A7.9. Full known range of growth, from ear-hanging culture (Kessen-numa Bay in Honshu – to the south) to pocket-net culture (Saroma Lake a shallow water lagoon on the north coast of Hokkaido – to the north) (provided by R. Sasaki).

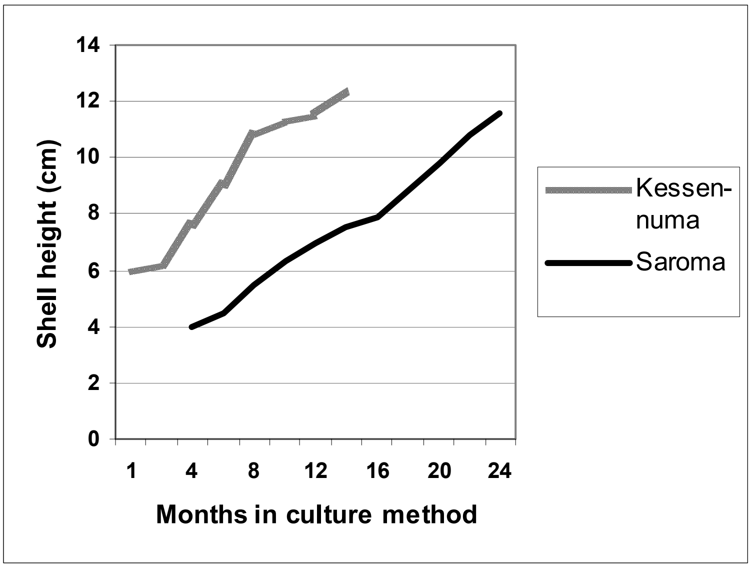
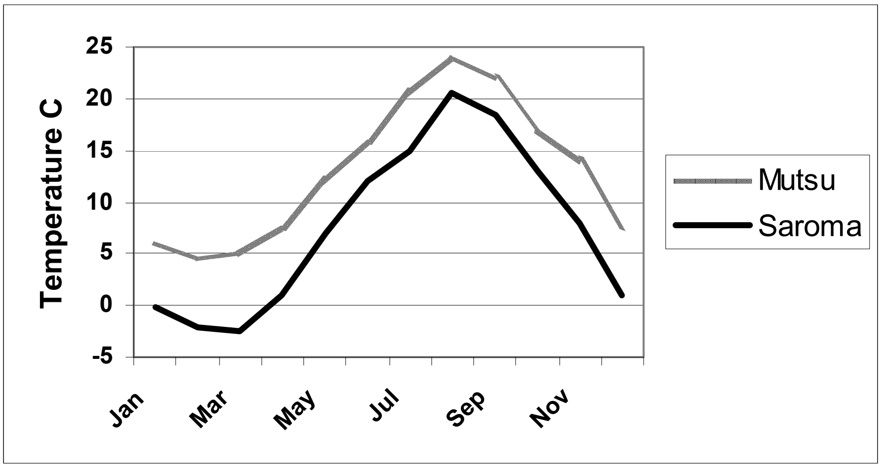


Figure A7.10. Sea-surface temperature ranges for Mutsu Bay and Saroma Lake covering the range of the main production areas (based on Ventilla, 1982).



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BOX 1. *Pecten maximus* (L.), the great scallop, escallop, coquille Saint Jacques

Distribution: Northern Norway to the Azores, Madeira, West Africa and the western Mediterranean. Principally in areas of sandy mud to muddy sand but also occurs on muds to coarse gravels. Experimental introductions to Japan and Chile.

Depth range: Known to be exposed at low-water spring tides to depths of 180 m, most usually at depths of 3–45 m.

Habit: Attaches at settlement with byssal threads, which can remain until about 4–13 mm. Capable of swimming/recessing once 6 mm. Adult scallops lie within depressions on the sea floor with sediment covering the upper valve. Can orientate to current flow.

Reproduction: A protandrous hermaphrodite spawning from late spring to early autumn. In Irish bays this is normally over the period May to September at temperatures of >13 °C. A number of spawnings can take place within the same population during the year.

Larval development: Larvae occur from April to September. Laboratory studies indicate a planktonic duration of 16-33 days at 15-20 °C. Settle at 190–260 µm, depending on temperature.

Settlement: Commercial settlements known from Mulroy Bay and the west coast of Scotland. Collected on onion-bag type collectors, settlement time is predicted by examining the size of larvae in the plankton. Settlement takes place June to September principally on hydroids and algae.

Growth: Exceptionally attains 215 mm shell length, however, those of 180 mm are considered large. Commercial size is 100 mm, normally exceeding this size within three to four years. Depth, available food, sea temperature, and density influence growth.

Longevity: Known to live to 22 years, most fished populations have some specimens exceeding ten years.

Diseases and parasites: Diseased animals are seldom encountered. The coccidian, *Pseudoklossina pectinis*, has been found in scallop kidneys in France. Copepod symbionts frequent. *Odostomia* frequently associated with scallops in some populations.

Predators: The blenny *Blennius gattorugine*, anenome *Anthopleura ballii,* and small sea stars feed on 0-group scallops. Green crabs (*Carcinus maenas*), swimming crabs (*Liocarcinus* spp.), hermit crabs in shallow water feed on juveniles. The edible crab *(Cancer pagurus*), crawfish (*Palinurus elephas*), sea stars (*Asterias rubens, Marthasterias glacialis*) feed on adults. There is a swimming response to sea stars.

Competition and other interactions: Organotin leachates have resulted in settlement failures in some areas. Occasionally during prolonged cold winters scallops become torpid and die. Scallops can concentrate a toxin resulting in amnesic shellfish poisoning (ASP) if eaten.

Fisheries: Range from shallow bays to offshore areas. In depths of less than 5 m they may be collected using a pole-net. Dredges of different designs either single light frames (in shallow water) or in gangs with heavy chain bags and sprung teeth (in deep water) are used. In some bays, where regulations permit, scallops are collected to depths of 25–30 m by diving. Densities of up to 2.33 m^{-2} are known but seldom exceed 0.6 m^{-2} within established fisheries. Fisheries inshore normally take place during the winter and offshore during the spring and summer.

Aquaculture: Currently under development, limited by available natural spat collections. Hatchery production is small, except in France and Norway. Intensive cultivation of all later stages in cages, nets, ear-hanging culture, and ranching. Extensive ranching is possible but there can be extensive predation due in part to thinner shells arising from their earlier intermediate culture.

Main references: Brand *et al.* (1980); Gruffydd and Beaumont (1972); Minchin (1992); Mason (1983); Le Gall *et al.* (1988); Paul *et al.* (1981).

BOX 2. *Chlamys (Aequipecten) opercularis* (L.), the queen scallop, princess scallop, petoncle blanc.

Distribution: Northern Norway to the Mediterranean and Adriatic Seas, generally ranges on the western coast of Europe from 30–70 °N. Found over a wide range of sediments from muds to coarse gravels, may be found on coarser sediments than *Pecten maximus.*

Depth range: From 2–180 m, more usually 3–45 m.

Habit: Can remain bysally attached to 2 cm. Readily swims when disturbed. Not normally known to recess but has been found within shallow depressions, lies on the less convex valve. Can occur in large concentrations.

Reproduction: A hermaphrodite with a proximal white testis and a distal red ovary. About the Isle of Man there would appear to be two main spawnings in spring and autumn, but spawning spans over the period January to October. Spawns at temperatures 7–11 °C. Probably a “dribble” spawner.

Larval development: Little is known of larval duration as the species is difficult to culture. Spawning requires careful management and in relation to its precise sexual cycle.

Settlement: Commercial settlements known from the west coast of Scotland. Collected on onion-bag type collectors, settlement is monitored by examining plankton samples. Settlement takes place February to October principally on hydroids and algae. Settles at 210–260 µm.

Growth: Attains 95 mm shell height. Acceptable to the market once 55 mm, attaining this size in culture after 14–18 months.

Longevity: Known to live to eleven years.

Diseases and parasites: Diseased animals seldom encountered. The ciliate *Licnophora auerbachi* has been found attached to the eyes.

Predators: Young individuals are consumed by plaice and cod, swimming crabs (*Liocarcinus* spp.), hermit crabs in shallow water; edible crab *(Cancer pagurus*). It has a swimming response to sea stars *Asterias rubens, Marthasterias glacialis*.

Competition and other interactions: Byssogenesis can be influenced by the insecticide endosulphan. Can occur as a significant fouling organism on fish netting resulting in hand laceration. Presence of amnesic shellfish poisoning (ASP) can influence fishing effort.

Fisheries: Principal fisheries are in the Faroes, western Scotland, Irish Sea and La Manche. Exploitation varies because sporadic recruitments can result in pulse fisheries in some regions. Can exceptionally attain densities of up to 1000 m^{-2} on the Scottish west coast, precise measurements of 5.7 m^{-2} have been made. A variety of gear is used in their capture including beam trawls, spring dredges, rock hopper trawls.

Aquaculture: Cultivated in Scotland under the name “princess scallop”. It grows rapidly to consumer size when held within suspended cages. The market is limited as the species has a relatively small meat and reproductive organ. Cultivations have been dependent on natural settlements.

Main references: Mason (1983); Paul (1980, 1981); Broom (1976).

BOX 3. *Chlamys (Mimachlamys) varia*, variegated scallop, black scallop, petoncle noire.

Distribution: Ranges from North Sea (Denmark to Britain), Ireland, Mediterranean Sea to Senegal in West Africa. Found on coarse sediments attaching to shell, gravel, stones, and bedrock.

Depth range: Attains greatest densities in shallow waters of fully marine sheltered inlets. Exposed at low-water spring tides to depths of 40 m, more usually occurring at depths of less than 20 m.

Habit: Attaches at settlement with byssal threads, which remain throughout life. May be found within crevices, beneath stones and inside paired shell remains, often on shell banks, frequently where oysters *Ostrea edulis* naturally occur. Juveniles often cryptic.

Reproduction: A successive hermaphrodite functioning either as males or females, can change sex following spawning. Spawns during May to September. Spawning is triggered by 1–2 °C fluctuations, associated with spring tidal movements or prolonged periods of sunshine at temperatures exceeding 15 °C. Requires 318–359 day degrees to the first spawning and 271–308 day degrees to the second spawning on the west coast of Ireland.

Larval Development: At 18 °C settles after 25 days.

Settlement: Commercial settlements of up to 50,000 spat per collector have been obtained in the Rade de Brest, France and several thousands in Lough Hyne, Ireland, in onion-bag type collectors. Natural settlement takes place June to September on shells, stones, and algae.

Growth: Exceptionally attains 105 mm shell length, specimens of 70 mm are considered large. French commercial size is 35 mm, normally attained in two years.

Longevity: Known to live six years.

Diseases and parasites: Diseased animals seldom encountered. Some *Odostomia* sp. have been seen associated with adults. The ciliate *Licnophora auerbachi* is rarely found on the eyes.

Predators: Small scallops preyed upon by the blenny *Blennius gattorugine*. Juveniles fed upon by green crabs (*Carcinus maenas*) and swimming crabs (*Liocarcinus* spp.). Adults fed on by sea stars (*Marthasterias glacialis* and *Asterias rubens*) to which it has a swimming response.

Competition and other interactions: Organotin antifouling leachates have influenced larval survival in some areas.

Fisheries: Occur within shallow bays, none are known in deep water. Collected by hand picking at lowest tides or by dredges. Densities of up to 28 m^{-2} in Ireland and 3.2 m^{-2} in France.

Aquaculture: Cultivation to the adult does not presently take place due to the relatively low value of the market product. Collected spat on collectors are ranched in Rade de Brest. It is tolerant of a wide range of conditions and handling. Only experimentally produced in the hatchery.

Main references: Burnell (1991); Conan and Shafee (1978); Shafee (1980).

BOX 4. *Patinopecten (Mihuzopecten) yessoensis* (Jay), Japanese scallop, Hotategai.

Distribution: From the south Kurile Islands and southern part of the Sea of Othotsk to Sakhalin Island, North Korea, northern Japan south to Tokyo Bay and China north of 39 °N. Found on a wide range of sediments but most frequently on coarse sands and fine gravels. Introductions to: Canadian Pacific and Atlantic coasts (in culture); Denmark (failed); France (in storage); Ireland (discontinued).

Depth range: 0.5 m to over 50 m.

Habit: Attaches at settlement with byssal threads to algae and hydroids until 6–10 mm. Juveniles and adults recess in shallow depressions.

Reproduction: It is a dioecious species, spawning coincides with a rise in sea temperature following the lowest winter temperatures in Mutsu Bay. This is between March and May at temperatures of 6–8.5 °C.

Larval development: Larvae exist within the plankton 15 days at 17–19 °C, 22–35 days at 7–13 °C and may remain for 40 days. Larvae concentrate at different horizons at varying states of the tide and time of day. Larvae appear late March to the end of June in Mutsu Bay reaching densities of 4,600 m^{-3}. They attain 230–286 µm at settlement.

Settlement: Settlements greater in coastal gyres and in regions with slow flow rates. In Mutsu Bay optimum settlements in March–June, in Hokkaido from May–June, in Posyet Bay in June–July and Vostock Bay in July–September. Optimum settlements normally at 6–16 m.

Growth: Sown scallops attain commercial size in 2.5–3.5 years in Mutsu Bay, longer in cooler northern regions. Can attain 6 cm within a year in hanging culture and 10 cm in two years. Sown scallops attain 150 g in three years.

Longevity: Known to live to ten years.

Diseases and parasites: The shell-boring worm *Polydora ciliata* can weaken the shell and result in severe mortalities. The copepod *Pectinophilus ornatus* infects the gills and adductor muscle and impairs growth.

Predators: In bottom culture and fisheries *Asterias amurensis* can result in up to 90 % mortality. Crabs, cottid and hexagrammid fishes are predators.

Competition and other interactions: Unexplained mortalities may be due to oxygen depletion in relation to stratification of the water column, poor husbandry and high-density cultivation. Algal blooms influence the marketing of scallops due to DSP and PSP. Mortalities are known arising from sudden temperature changes and high temperatures, high turbidity, prolonged exposure in air and from storms causing strandings.

Fisheries: In Mutsu Bay the fishery was subject to pulses of abundance probably due to local hydrographic conditions. Presently most fisheries are under management by enhancement. Maximum production is 1200 g m^{-2} with up to 6 scallops m^{-2} from sowings of 50–250 spat m^{-2}.

Aquaculture: Developed in 1963–1964 using mesh-bag collectors in Mutsu Bay and landings resulting from this rose to 47,000 mt in 1974, but declined to 16,000 in 1977 due to high mortalities. With guidance from state laboratories 35,000 mt were produced in 1982. This form of culture is also practised on Hokkaido, in Korea and Federated Union of Soviet States.

Main references: Aoyama (1989); Ito *et al.* (1991); Kasyonov (1991); Ventilla (1982); Yamamoto (1977).

ANNEX 8: ADVISORY REPORT ON *RAPANA VENOSA*

ICES Special Advisory Report on the Current Status of Invasions by the Marine Gastropod *Rapana venosa*

Prepared at the 24 th meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO), Gothenburg, Sweden, March 20–21, 2002.

by:

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With Editorial Review by WGITMO:

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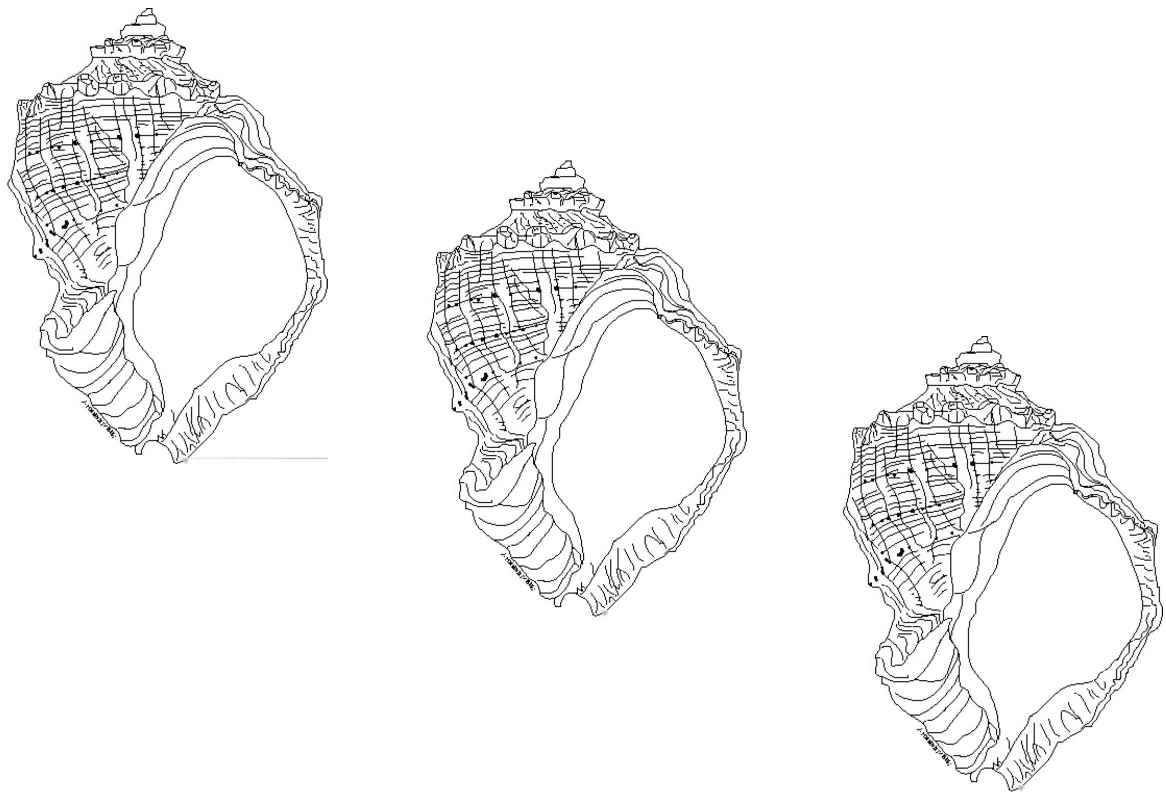


Contents

1 Introduction

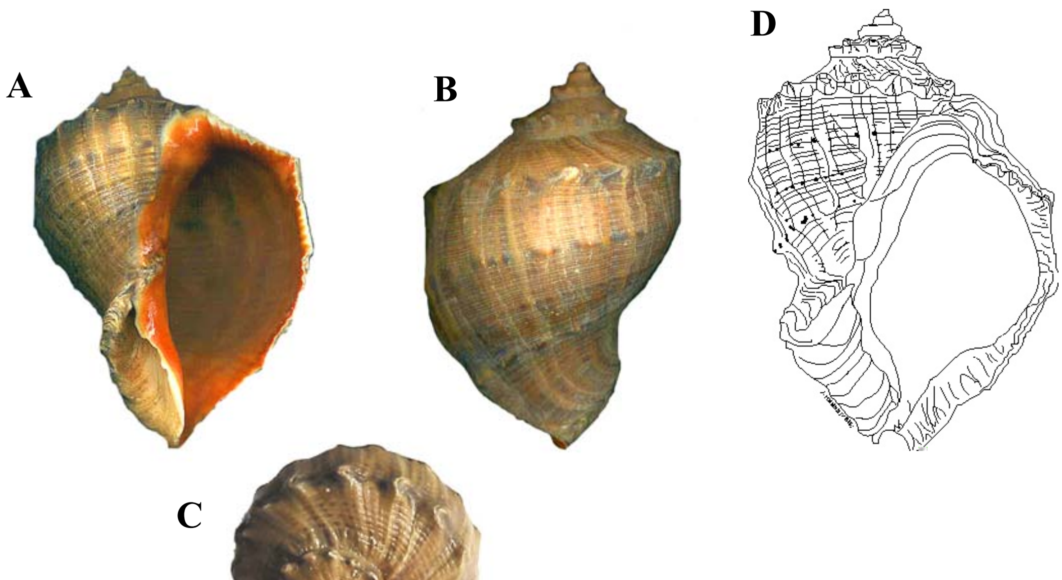
The large Asian gastropod mollusc *Rapana venosa* Valenciennes 1846 (Neogastropoda, Muricidae) is native to the Sea of Japan, Yellow Sea, Bohai Sea, and the East China Sea to Taiwan. This species has been introduced to the Black Sea with subsequent range expansion to the Adriatic Sea and Aegean Sea, the Chesapeake Bay on the East Coast of the United States, and the Rio de la Plata between Uruguay and Argentina. Reproductive populations are or appear to be present in all three receptor regions. In addition, there are a limited number of reports of the species from the Brittany coastline of France, Washington State (USA), and two collections from the North Sea and New Zealand. The life history of this species makes it a viable candidate for continuing range expansion and new invasions facilitated by ballast water vectors. This review describes the current status of knowledge of the species in its home range and introduced populations.

2 Identification

Rapana venosa Valenciennes 1846 (English: Rapa whelk, Italian: Cocozza or Bobolone) has also been described with the junior synonyms *Rapana thomasiana* Crosse 1861, and *Rapana thomasiana thomasiana* (Thomas' Rapana venosa). For simplicity, *R. venosa* is consistently used in the current text. The taxonomic status of the genus *Rapana* has been recently reviewed by Kool (1993).

Class	**Gastropoda**
Subclass	Orthogastropoda
	Apogastropoda Caenogastropoda Neogastropoda
Superfamily	Muricoidea
Family	Muricidae
Subfamily	Rapaninae
Genus	*Rapana*
Species	*venosa*

Figure A8.1. An adult *Rapana venosa*, A. opercular view, B. back view, C. Spire view, D. Sketch of an adult rapa whelk (shell length of 165 mm; courtesy of J. Harding, VIMS). Scale bar represents 5 cm.



Rapana venosa has a short-spired, heavy shell with a large inflated body whorl and a deep umbilicus (Figure A8.1). The columella is broad, smooth, and slightly concave. Small, elongate teeth are present along the edge of the outer lip of the large, ovate aperture. The external shell ornamentation includes smooth spiral ribs that end in regular blunt knobs at both the shoulder and the periphery of the body whorl. In addition, fine spiral ridges are crossed by low vertical riblets. Older specimens can be eroded, but the color is variable from gray to orange-brown and atypically blonde, with darker brown dashes on the spiral ribs. The aperture and columella vary from deep orange to yellow or off-white. Spiral, vein-like coloration, varying from black to dark blue, occasionally occurs internally, originating at the individual teeth at the outer lip of the aperture. Local variation may occur in morphometry and coloration depending on substrate. Individual specimens can be large. The maximum dimension, hereafter termed shell length (SL), used throughout this contribution and cited from previous work is from the apex of the spire to the tip of the siphonal canal. The largest individual *R. venosa* reported by Chung *et al.* (1993) is an individual of 168.5 mm SL from Korean waters. Individuals of more than 170 mm SL have been collected from Chesapeake Bay, U.S.A.

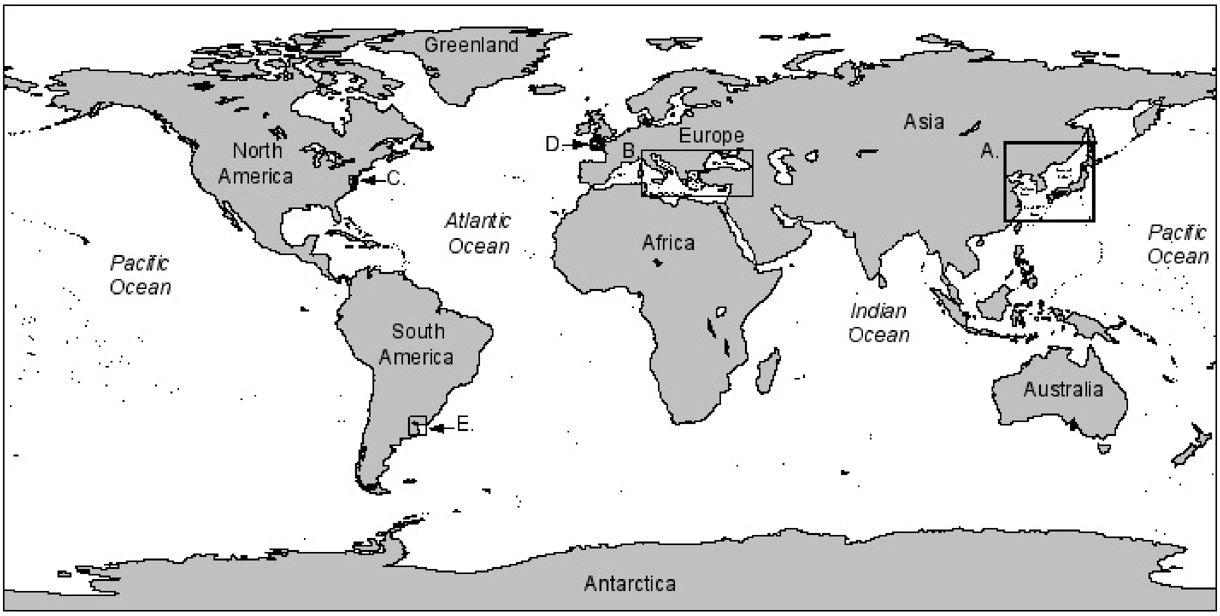
3 Biology in the native range

Rapana venosa is one of three species of *Rapana* in Chinese waters being native to the Sea of Japan, with the northern limit at Vladivostok, the Yellow Sea, Bohai Sea, and the East China Sea to Taiwan (Tsi *et al.*, 1983; Lai and Pan, 1980; Figure A8.2). *Rapana bezoar* occurs off the southern provinces bordering the South China Sea (Cai and Huang, 1991) and is more widely distributed in the Western Pacific and Indian Ocean. *R. bezoar* is distinguished by a more scaly sculpture overall and a white aperture. *Rapana rapiformis* occurs in the East and South China Seas. It has a lower spire and lighter shell than *R. venosa.*

3.1 Current status and population demographics

We can find no comprehensive studies of the current populations in the native range. Green (2001), as part of a study of comparative morphometrics of populations from Korea, Turkey and the Chesapeake Bay, suggests that the demographics of the Korean population are indicative of intense fishing effort on size frequencies that recruit to the fishing gear.

Figure A8.2. Map showing the known global distribution of reproducing rapa whelk populations including the native range in Korean, Japanese, and Chinese waters (A.) as well as locations where the animal has been introduced. Non-native populations in order of introduction and/or discovery are the Black Sea and Mediterranean region (B.), Chesapeake Bay, U.S.A. (C.), the Brittany coast of France (D.), and the Rio del Plata, Uruguay and Argentina (E.). Additional information regarding the distribution within habitats, local biology, and abundance estimates for each population is provided in the text and accompanying site-specific figures. (World map template is from MapArt, copyright 1995, Cartesia Software, Lambertville, N. J., U.S.A.).



3.2 Natural history

In its native Korean range, adult *Rapana venosa* demonstrate large annual temperature tolerances (4 °C to 27 °C for the location described by Chung *et al.*, 1993). The upper thermal tolerance of the species occurs between 27 °C and the summer maximum for Hong Kong (35 °C; Liu, 1994), where *Rapana venosa* is displaced by *Rapana bezoar* (Tsi *et al.*, 1983; see also Morton, 1994). The ability to exploit estuarine regions with warm summer temperatures but possible surface freezing in winter is facilitated by the winter migration into deeper water in these regions (Wu, 1988). We can find no data on salinity tolerance of the species in its native range. In Korea it is commercially exploited on hard sand bottoms by a mesh pot fishery.

3.3 Growth rate

We can find no data on growth rate or longevity of *Rapana venosa* in Korea. Wang *et al.* (1997) report that the snail reached an adult size of 74 mm within 13 months in Laizhu Bay, China.

3.4 Reproduction

Rapana venosa is dioecious with separate sexes. Size at first maturation has not been examined for female whelks. Chung and Kim (1997) examined maturation of male *R. venosa* (n = 557, size range 31 to 160.2 mm SL) in its native range and observed maturity in 66.7 % of individuals from 71 to 80 mm SL, and 100 % maturity for individuals exceeding 121 mm SL.

Seasonal reproductive behavior in Korea is described by Chung *et al.* (1993). Mating occurs over an extended period during the winter and spring preceding egg laying. *Rapana venosa* lays masses of egg cases in April to late July based on gonadal examination, this period corresponding to a temperature range of 13 °C to 26 °C. The egg cases are attached basally to hard substrate, and may contain as many as 1000 developing embryos. One female adult can lay multiple egg masses throughout the course of one summer without intervening mating events. Imposex, the development of a male penis by adult females, has been observed (Choi, personal communication) although quantitative data are not available.

When laid, the egg cases are white, turning sequentially darker (through lemon to yellow) as the enclosed larvae are first visible as distinct white swimming individuals. The larvae darken and eventually turn black just prior to release, at which time the dorsal tip of the case opens to liberate the swimming larva. Chung *et al.* (1993) report a 17-day incubation period between egg laying and first hatching at 18.3 °C to 20.4 °C. Upon hatching, the larvae swim with a bilobed velum, and are planktotrophic. A four-lobed velum appeared at 4 days post-hatching and a length of approximately 385 µm. Apparent morphological competency was reported by Chung *et al.* (1993) at 14 to 17 days and 623 to 686 µm SL with development of a distinct foot and eyestalks. Harding and Mann (manuscript in preparation) have observed significant plasticity in the duration of the planktonic phase with metamorphosis being observed as late as 80 days after hatching. The variable duration of the planktonic period allows for a variety of dispersal and recruitment strategies by the species, and facilitates invasions.

Chung *et al.* (1993) do not describe post-metamorphic stages. Harding and Mann (manuscript in preparation) have observed spontaneous metamorphosis of competent larvae in the absence of substrates.

4 Non-native distribution

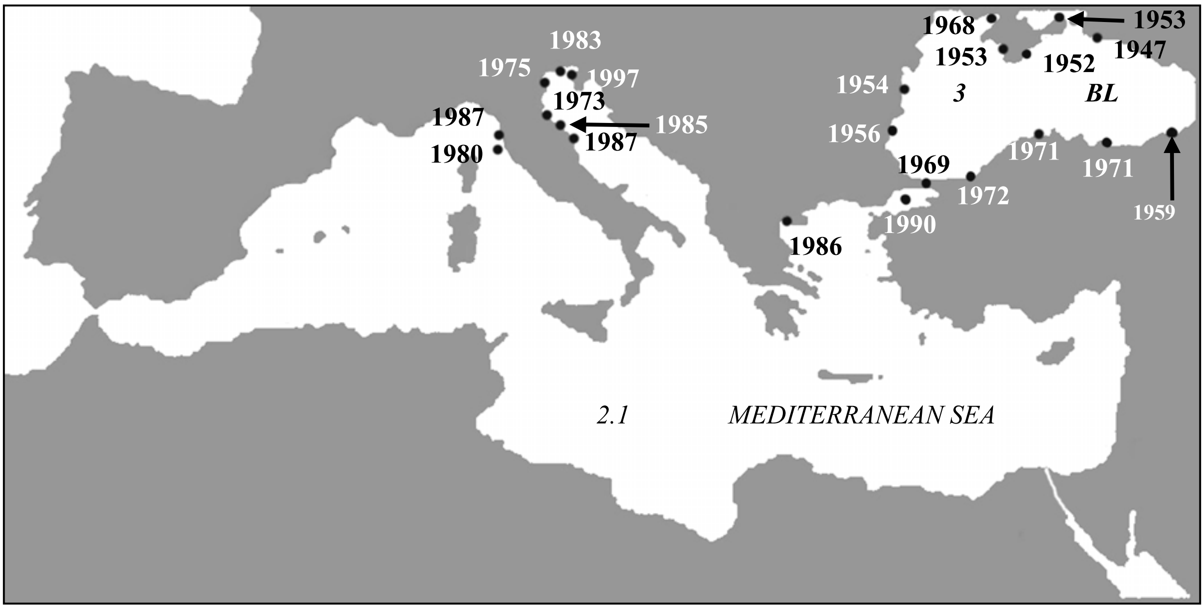
Since the mid-twentieth century, rapa whelks have been successfully introduced to multiple regions worldwide. Currently, there are five known geographic regions containing reproducing populations of rapa whelks that are distinct from the native (Asian) population (Figure A8.2). The modern global economy and associated human vectors for transport across oceans provide continuous means of introduction of this robust animal into new receptor regions. Examination of the biological and ecological effects of this animal on native ecosystems post-introduction will provide valuable insight as to potential control mechanisms and the course of subsequent invasions.

4.1 Black Sea to Adriatic Sea

4.1.1 Date and mode of arrival, initial population size, and source of introduction

The introduction of *Rapana venosa* into the Black Sea is suspected to have occurred some time in the 1940s, with the first record of observation being for Novorossiysky Bay (Drapkin, 1963; who originally misidentified the species as *R. bezoar*). The vector of introduction is not certain. Ballast water remains an option, although this is considered unlikely given the combination of distance from home range, typical vessel transit speed at the time of introduction, and limitation of ship passage in the early 1940s from the Orient to the Black Sea because of World War II naval actions. Transport as part of a hull fouling community is a second option. Oyster culture of Japanese oysters (probably *Crassostrea gigas*) was recorded in the region of first observation in the early 1940s, presenting a third option of introduction as an associated species with oyster seed; however, this remains a speculation. Once established in a founder location, the Black Sea invasion could have been facilitated by planktonic larval dispersal alone without the need to invoke other vectors. Range extension occurred along the Caucasian and Crimean coasts and to the Sea of Azov within a decade of the first report, and subsequently to the Northwest Black Sea, where populations are reported as "stable" and not "numerous" according to Zolotarev (1996), and the coastlines of Romania, Bulgaria, and Turkey (Grossu, 1970; Bilecik, 1975; Ciuhcin, 1984; Marinov, 1990; Zolotarev, 1996). Subsequent invasion of the Marmara Sea (see Zibrowius, 1991) and the Aegean Sea in 1986 (Koutsoubas and Voultsiadou-Koukoura, 1990), and finally the Adriatic Sea is described by Ghisotti (1971, 1974), Mel (1976), Cucaz (1983), Rinaldi (1985), Bombace *et al.* (1994) and by De Minn and Vio (1997) for the Slovenian coast. The large population in the Northern Adriatic Sea is generally considered to have had no major detrimental effect. A record from Elba in the Tyrrhenian Sea is provided by Terreni (1980) and by Paolini (1987) near Leghorn. The gradual but sustained nature of this range expansion suggests that *Rapana* has yet to exploit all susceptible locations within the Mediterranean.

Figure A8.3. Distributional map: Black and Mediterranean Seas with the years of the first finding derived from Drapkin, 1963; Grossu, 1970; Bilecik, 1975; Ciuhcin, 1984; Koutsoubas and Voultsiadou-Koukoura, 1990; Zibrowius, 1991 for the Black and Aegean Seas and by Ghisotti, 1974; Mel, 1976; Cucaz, 1983; Rinaldi, 1985; Bombace *et al.*, 1994; De Minn and Vio, 1997; Terreni, 1980; Paolini, 1987 for the Adriatic and Tyrrhenian Seas.



4.1.2 Current status and population demographics

In the Black Sea, *Rapana venosa* occurs on sandy and hard-bottom substrates to 40 m depth. The highest abundance occurs in the Kerch Strait at the entrance to the Sea of Azov, near Sevastopol and Yalta (Ukraine), and along the Bulgarian coast. A substantial fishery exists for the species along the Bulgarian and Turkish coasts, with the product being exported to the Orient. The total stock size of *Rapana venosa* along the coast of the former USSR was estimated at 10,000 tonnes in the period 1988–1992 (Serobaba and Chashchin, 1995; Zaitsev and Alexandrov, 1998).

In a comparison of morphometrics of populations from Korea, Turkey and the Black Sea, Green (2001) demonstrated lower higher rates of allometric growth in Black Sea populations compared to native Korean and Chesapeake Bay populations. Vermeij (1993) states that such intraspecific allometry is indicative of food limitation in gastropods in general. This is in agreement with long-term observations of the Black Sea invasion, with an initial phase of establishment in which *Rapana* depleted many endemic prey species (see *Ecological impacts* section below) resulting in a subsequent phase of very high densities of invaders effecting intraspecific competition for limited available prey resources. Allometric inferences may be challenged where n values are limited; however, one of the strengths of Green's study is the very large n value (Korea = 226, Black Sea = 74, and Chesapeake Bay = 107) and the range of sizes examined for all geographic populations.

4.1.3 Natural history in receptor region

In the Black Sea, where winter temperature minima are approximately 7 °C and summer maxima approximately 24 °C, *R. venosa* occupies a salinity range 25 to 32 ppt (Golikov, 1967). In the Sea of Azov, which is ice covered for 2 to 4 months per year, *R. venosa* was restricted to the southernmost region adjoining the Kerch Strait by low persistent salinity in the remaining water body (mean annual value < 12 ppt); however, range extension did occur during 1975–

1979 when river discharge into the Sea of Azov was markedly reduced by water diversion projects. These projects were discontinued in 1990 and the fresher environment again persists. The status of *R. venosa* in the main body of the Sea of Azov and its precise distribution with respect to prevailing salinity is unclear at this time.

Savini and Occhipinti (unpublished data, manuscript in preparation) examined *Rapana venosa* at the western extreme of its invading range in the Northern Adriatic in 2001. In this location, it is found on both soft bottom and rock breakwaters that have been installed along 55 km out of 135 km of the Emilia Romagna regional coastline in order to prevent beach erosion. Individuals in this location exhibit the previously mentioned variation in shell spination and coloration. Populations on hard rock substrate have predominantly dark-coloured shells, whereas populations on adjacent sand exhibit a higher frequency of white or pale brown shell.

Information on daily by-catches of *Rapana* from commercial fisheries working on soft bottoms in the North Adriatic was provided by local fishermen and trawlers from five marinas distributed along approximately 130 km of coastline, including the ports of Goro, Porto Garibaldi, Cesenatico, Fano, and Senigallia. A total of 572 *Rapana venosa* were collected from May to October 2001 for biometrical and shell morphology analysis. Shell lengths of the samples ranged from 67.0 mm to 136.7 mm and total weight (shell+body wet weight) from 46.0 g to 553.9 g. Individuals collected on sand substratum were significantly smaller than individuals collected on breakwaters; the size distribution using all the parameters always shows smaller modal values in sand-collected individuals. Most of the individuals (306) were caught by squid fishermen along the coast of Cesenatico marina on sand substrate (Latitude: 44°12'.2–44°24'.7 N; Longitude: 12°23'.7–12°26'.6 E) from 2 m to 10 m depth. Squid fishermen's daily by-catches ranged from 30 to 80 specimens per boat (4–5 squid-nets) during this period. Focused SCUBA examination of three sections of breakwaters, each section being 15 m long, at a site facing the beach of Cesenatico and located 300 m from the coastline allowed collection of another 245 individual rapa whelks. These hard substrates present valuable, prey-rich resources for rapa whelks, as demonstrated by the rapid invasion of the resource when resident adults are intentionally removed. Individuals in such locations have been observed feeding in temperatures as low as 8° C. A notable feature of the population was the absence of dead individuals and of individuals smaller than 67 mm (Savini and Occhipinti, manuscript in preparation).

Growth rate

Ciuhcin (1984) estimates that individuals in Sevastopol Bay grow to 20 to 40 mm SL in the first year of life, with mean values of 64.6 mm, 79.4 mm, 87.5 mm, and 92.1 mm SL in years two through six, respectively. This terminal size is smaller than the maximum of 120.1 mm SL reported by Smagowicz (1989) for a specimen in a collection from Bulgaria and Georgia; the exact location of collection of the largest specimen is not reported. Black Sea specimens would appear to live in excess of 10 years based on these observations.

Reproduction

Ciuhcin (1984) reports that spawning (egg laying) in the Black Sea is marked by a shell thickening and that first spawning occurs in the second year at sizes in the range 35 to 78 mm SL, with a mean value of 58 mm SL. Ciuhcin (1984) describes the reproductive period of *R. venosa* in the Black Sea (site not given) as July to September, this corresponding to a temperature window of 19 ^{o}C to 25 ^{o}C. Sahin (1997) reports a spawning period of May to November in the eastern Black Sea.

Savini and Occhipinti (unpublished data) have developed a sequence of five egg-case maturation stages, from deposition to larval release after approximately 14 days, by parallel daily observations in the field and laboratory. Deposition of egg masses starts at the end of March in the Northern Adriatic Sea (when fishermen find the first egg-case clusters laid on squid nets) and ceases at mid-September. Spawning is continuous throughout the reproductive season. High densities of egg laying are observed on hard substrates. For example, Savini and Occhipinti (manuscript in preparation) describe an average 1340 ± 387 new egg-cases/week laid on a 15-m section of protective breakwater (see earlier commentary.) No live young individuals have been found to date at this site; only two young dead individuals of 4 mm and 25 mm length have been found stranded on the adjacent beach after a storm. Rinaldi (1985) also found the shells of small individuals after a storm event. These ranged in size from 12–40 mm SL, with a modal class size of 25–30 mm SL.

Ecological impacts

Despite the passage of decades since the original introduction, there is evidence that the Black Sea population of *Rapana* has yet to reach a stable equilibrium in parts of this environment. Zolotarev (1996) comments that *R. thomasiana* is "very fertile and is tolerant of low salinities, water pollution, and to oxygen deficiency", yet he further comments that *Rapana* is not numerous in the northwestern Black Sea despite the fact that food resources (molluscs) are abundant and levels of water contamination are lower than in some other sites where *Rapana* is very common.

Establishment of substantial populations of *Rapana* in the Black Sea (Marinov, 1990; Zolotarev, 1996; Alpbaz and Temelli, 1997) appears to have been facilitated by the general lack of competition from other predatory gastropods, a lack of direct predation on *Rapana* by resident predators, and an abundance of potential prey species.

The ecological impacts in the Black Sea have been severe. Zolotarev (1996) suggests a broad dietary preference for bivalve molluscs including the soft-sediment infaunal mollusc species *Venus gallina*, *Gouldia minima*, and *Pitar rudis*. Marinov (1990) and Rubinshtein and Hiznjak (1988) identify *R. venosa* predation as the prime reason for decline in *Mytilus galloprovincialis* in Bulgarian waters, the Kerch Strait and the Caucasian shelf, respectively. Ciuhcin (1984) attributes the near extinction of the native bivalves *Ostrea edulis*, *Pecten ponticus*, and *M. galloprovincialis* on the Gudaut to predation by *R. venosa*.

We can find no records of associated species that may have been introduced to the Black Sea with *Rapana venosa.* The species is subject to attack by a local parasite; Gutu and Marinescu (1979) report the presence of the *Polydora ciliata* in shells of *Rapana venosa* from Romanian waters of the Black Sea. There is no evidence that this parasite can compromise the fitness of *Rapana venosa* in the Black Sea.

Control options
There are no obvious control measures in place to prevent continuing range expansion for *Rapana venosa* westward in the Mediterranean Sea. As described earlier, a substantial fishery for the species now exists in the Black Sea.

Estimates of final range establishment in receptor region
At this time there appears to be no limiting function on the westward movement of *Rapana venosa* in the Mediterranean Sea. The current progression rate is slow, but expected to continue in the future.

4.2 Chesapeake Bay, U.S.A.

4.2.1 Date and mode of arrival, initial population size, and source of introduction

The first record of *Rapana venosa* in the Chesapeake Bay was a single specimen collected in the lower James River, Virginia (lat. 36^{o} 57.12' N, long 76^{o} 24.86' W) in June 1998 in an otter trawl (38 mm stretch mesh body, 6.35 mm mesh cod liner) by the Virginia Institute of Marine Science (hereafter VIMS) Fisheries Trawl Survey (Harding and Mann 1999). Subsequently, adult *Rapana venosa* have been collected from the Lower Chesapeake Bay from August 1998 through March 2002 by the VIMS staff using an oyster dredge (2.5 cm mesh size) or donated to the VIMS *Rapana* research collection by local citizens (mostly stranded animals on exposed beaches after storms), commercial fishermen and seafood processors. The size of the specimens in the initial collections is large (see below) but the lack of growth rate data for *Rapana venosa* compromises our ability to estimate the date of introduction. Estimates of age given by experienced malacologists, together with extensive anecdotal information from local commercial fisherman, suggests that initial specimens may be on the order of 10 years old, indicating an introduction date of as early as 1988. This estimate is subject to revision as the ability to determine the age of individual specimens improves. Current population demographics (see below) suggest a single introduction event, although this cannot be proven conclusively.

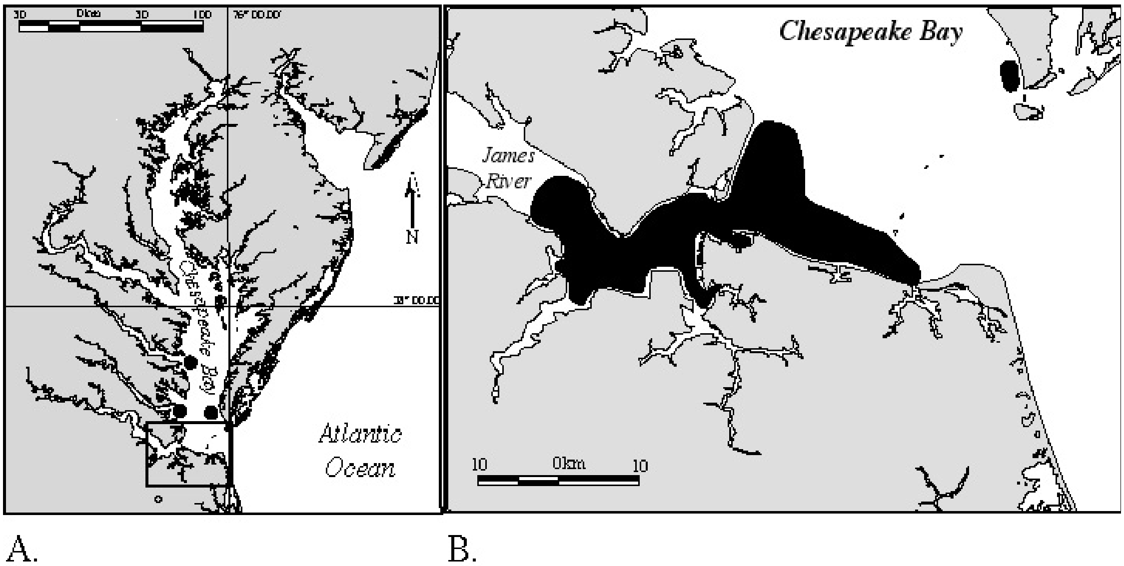
There is strong evidence, in the form of vessel transit time from the eastern Mediterranean, a coal export trade to the Mediterranean originating in Hampton Roads and resulting in vessel return in ballast, and duration of the pelagic phase of early life history, that range extension across oceanic basins is mediated by transport of pelagic early life history stages in ballast water. This evidence has been supported by limited comparisons of both mitochondrial and nuclear DNA from *Rapana venosa* populations in Korea, Turkey and the Chesapeake Bay (Gensler *et al.,* 2001). While there is strong evidence for a significant founder effect in the Black Sea population compared to the native range, the Chesapeake Bay population appears to exhibit strong similarity to the Black Sea population. This line of investigation is continuing.

4.2.2 Current status and population demographics

The majority of specimens collected to date have been as by-catch of commercial fishing gear including crab pots, patent tongs, and crab dredges (6 cm bag ring size). The fishing gear is size selective so both absolute numbers and population data may reflect only a subsample of the population. Since the initial observation, over 4000 individuals have been recorded. The majority remain within the range as described by 1999 collections (see Harding and Mann, 1999; Mann and Harding, 2000, Figure A8.3). The documented range of *Rapana venosa* in the Chesapeake Bay is from the mouth of the Rappahannock River in the north, to the Chesapeake Bay Bridge tunnel in the southeast, to just above the James River Bridge in the southwest, to the Lafayette River in the south (Figure A8.4). The majority of the individuals collected in 1998–1999 were in the size range 120–160 mm SL, with a smaller proportion < 120 mm SL and a few individuals as large as 170 mm SL. Data for 1998–1999 did not distinguish distinct size classes, but rather a continuous distribution within the size range. By 2001 size class structure was beginning to emerge in the 100–160 mm SL, again with a smaller proportion < 100 mm SL range suggesting > 1 year class and therefore successful local recruitment. A general commentary on the status of the invading population is maintained, with regular updates, on the VIMS World-Wide Web site at www.vims.edu/mollusc.

As noted earlier Green (2001), in comparing morphometrics of populations from Korea, Turkey and the Black Sea, demonstrated the lower higher rates of allometric growth in Black Sea populations compared to native Korean and Chesapeake Bay populations. The suggestion of no food limitation for Chesapeake Bay populations is particularly troubling given the population demographics (see above) and the co-location of the invasion with a native hard clam (*Mercenaria mercenaria)* population that supports a local fishery worth in excess of $3 million per year dock landing value.

Figure A8.4. Distributional map: Chesapeake Bay region, U.S.A. A) Known distribution of rapa whelks (*Rapana venosa*) in Chesapeake Bay, U.S.A. as of March 2002 (after Harding and Mann, 1999), B) Enlarged view of the lower James River and Chesapeake Bay where a majority of collections have been reported (after Harding and Mann, 1999).



4.2.3 Natural history in receptor region

Growth rate

Harding and Mann (manuscript in preparation) report that, once settled onto hard substrates, young *Rapana venosa* are generalist predators and consume large numbers of barnacles, mussels, oyster spat, and small oysters. Recently settled individuals grow at > 1 mm per week, reaching shell lengths of 40–50 mm within 5 months post-settlement and > 60 mm SL at age 1. These extremely fast growth rates, combined with cryptic coloration, nocturnal habits, and preference for oysters as both food and habitat, offer serious cause for concern particularly in light of ongoing oyster restoration efforts in the lower Chesapeake. Evidence suggests (see *Ecological impacts* below) that *Rapana venosa* occupy shallow hard-substrate habitats until reaching shell lengths in excess of 70 mm and then migrate into deeper habitats with sand or mud substrates where they forage on infaunal bivalves including soft clams (*Mya* sp.) and hard clams (*Mercenaria mercenaria*).

At this time, we do not have good estimates of growth rate or longevity of *Rapana venosa* in the Chesapeake Bay. Collaborative studies are in progress with Dr Christopher Richardson (Bangor University, Wales) to investigate the use of statolith ring structure in age determination of this species.

Reproduction

Westcott (2001) and Westcott *et al.* (2001) have observed a high incidence of imposex in females collected from upstream regions in the James River, an area formerly subjected to tributyl tin (TBT) contamination associated with shipbuilding activity. Extensive investigation of the relationship between imposex in gastropods and TBT exposure has been described by Smith (1971), Gibbs *et al.* (1987, 1988), Ellis and Pattisina (1990), Huggett *et al.* (1992), Bryan *et al.* (1993), Foale (1993), Wilson *et al.* (1993), and Tester and Ellis (1995). This anomaly does not appear to limit reproductive activity in the afflicted female individuals.

Laboratory populations of animals collected from Chesapeake Bay and maintained at local temperatures and salinities have been observed mating from September through July. Field collections of adult *Rapana venosa* (SL > 80 mm) were made year-round by Westcott (2001) using opportunistic sampling based on commercial fishery by-catch. Representative individuals were sampled from the extreme ends of the environmental and spatial gradient of the observed population distribution. Individual animals were sacrificed and examined for gross external morphology as an indicator of sex ratio and incidence of imposex. Histological analyses were used to describe progression of gametogenesis in individual animals. The observed relationship between gametogenesis and water temperatures in animals from Chesapeake Bay is consistent with previously described seasonal reproductive activity in native (Korean) populations, laboratory observations of egg laying from mid-May through mid-August, and field collections of egg masses in Chesapeake Bay. Collectively, these data sets indicate that the Chesapeake Bay population of *Rapana venosa* is successfully completing gametogenesis and egg laying throughout the range of collection.

Rapana lays mats of eggs with 50–500 egg cases per mat. Each case may contain 200–1000 eggs (Ware *et al.,* 2001). The period from egg laying to hatching varies typically between 14 and 21 days, depending on temperature and salinity. As mentioned earlier, *Rapana venosa* veliger larvae display considerable variation in time from hatch to settlement, although they are typically morphologically competent to settle after 21 days at local temperatures and salinities. Veligers grow quickly on mixed algal diets, reaching shell lengths in excess of 0.5 mm at 21 days (Harding and Mann, in prep.). *Rapana venosa* veligers settle successfully on a wide range of locally available attached macrofauna including bryozoans and barnacles, but have also been observed to effect spontaneous metamorphosis with regularity in laboratory cultures.

Ecological impacts

Early work in the VIMS laboratory demonstrated the susceptibility of native hard clams *(Mercenaria*) to *Rapana* predation (Harding and Mann 1999). Parallel observations of distinctive boring signatures of *Rapana* (chipping or rasping of the shell margin as described by Morton, 1994) on hard clams in the field were made by a number of collaborating commercial fishermen, again underscoring the importance of this interaction in data collection throughout the invasion. Estimated rates of predation and size preference for prey in this relationship were examined by students Dario Savini, and Peter Kingsley-Smith (both visiting students from the University of Wales in 2000). Savini *et al.* (2001) demonstrate that whelks with a SL > 101 mm are capable of consuming up to 2.7 grams of clam tissue daily. Smaller whelks (60–100 mm SL) ingest on average 3.6 % of their body weight every day, which is more than four times the weight-specific ingestion rates of larger whelks. The limited data set suggests a preference by both size classes of *Rapana venosa* for large hard clams (SL > 71 mm); however, no prey size is immune and predatory signatures have been observed in a wide range of sizes in the field by commercial fishermen. Both Savini and Kingsley-Smith have contributed to an expanding database that we are building of signature predatory scars for a matrix of gastropod predator-bivalve prey organisms over size ranges for both predator and prey. The intent is to provide field biologists and commercial fishermen with a visual aid to identifying gastropod predation and discriminating between the predators in the absence of direct collection of the latter. The distribution and employment of such tools have profound effect on the collective ability of the benthic ecologists and commercial fishermen alike to track any expansion in range of an invader, like *Rapana*, in near real time and where direct observations may be limited by low predator densities.

In addition to the initial focus of *Rapana* predation on hard clams, we (Harding and Mann, unpublished data) have presented both field-collected adults and post-metamorphic juveniles from our laboratory cultures with a variety of local bivalves including oysters (*Crassostrea virginica*), mussels (*Mytilus edulis*), and soft-shell clams (*Mya arenaria*). All prey are consumed with ease by the invader. Indeed, the combination of these broad dietary capabilities with broad salinity tolerance suggests that no substantial extant bivalve resources in the lower Chesapeake Bay are in a spatial refuge from predation. Further, the possibility remains that the native oyster drill, *Urosalpinx cinerea*, will suffer from direct competition with *Rapana venosa. Urosalpinx* populations were once extensive and abundant within the bay, but the freshets associated with Hurricane Agnes in 1972 decimated their populations. Post Agnes survival was limited to a region near the bay mouth; essentially all oyster beds in the subestuaries of the bay were purged of *Urosalpinx* by this sngle event. Unlike *Rapana, Urosalpinx* has no pelagic larval stage. Juveniles hatch and crawl away from the substrate-attached egg masses. *Urosalpinx* has literally been recolonizing its former bay habitat over the past three decades by crawling up the bay bottom over "islands" of suitable substrate. In the absence of an invader, the temporary displacement of *Urosalpinx* is but a minor perturbation in evolutionary time; however, the introduction of *Rapana* adds a new component to this re-establishment process. There now exists a race to reoccupy this temporarily vacated niche between the crawling native and the invader with the pelagic larva.

Rapana shells provide shelter for expanded range of the striped hermit crab *Clibanarius vittatus* which has demonstrated ability to eat significant numbers of oyster spat when they reach sizes commensurate with their newly found "import size" shelters.

We have no observations of predation on *Rapana venosa* by native species in the field. In laboratory experiments, the native blue crab, *Callinectes sapidus,* has been shown to be a voracious predator on small, post-metamorphic stages (Harding, unpublished data). In the field, we suggest that *Rapana venosa* reaches a predator refuge size at several years of age in part due to its shell morphology. Rapa whelk shells are thicker and very broad with respect to SL when compared to large native gastropods such as *Busycon* and *Busycotypus.* Given that predation by seasonally migrating large predators (turtles) is related to mouth gape size, the wide aspect ratio of the shell of *Rapana venosa* makes it less susceptible, for a given length, than native gastropods (see Harding and Mann, 1999). Once this predator refuge size is attained, we suggest that *Rapana venosa* may remain as an unchallenged predator for up to a decade.

We can find no records of associated species that may have been introduced with *Rapana venosa.* The whelk is, like the Black Sea populations, subject to attack by a local species of *Polydora*. Examination of shells of local *Rapana venosa* was effected in 1998–1999 (Mann and Harding, 2000) based on the premise that epifaunal and infaunal populations of the whelk in the Chesapeake Bay would be subject to differing suites of predators, epibionts, and potential parasites. Frequent, but not universal, boring of the shell in the apical region was observed, corresponding to internal mud blisters characteristic of *Polydora websteri* (see Haigler, 1969). Boring was clearly restricted to the early life span of the individual and decreased in prevalence as the diameter of the spire increased. Adult *Rapana* maintained in laboratory systems burrow completely when provided with sand substrate, only a single siphon is visible. This observation suggests that the size at which the *Polydora* external boring signal disappears may well coincide with a transition size for *R. venosa* to a infaunal existence, that is more typical of predatory muricids (see comments in Morton, 1994).

Control options

No widely effective control options to eliminate the species are available at this time. An extensive public education programme and a joint effort with local commercial fishermen (110 collaborating fishermen as of 2002) pays a bounty to remove any *Rapana venosa* collected in local waters and delivered to the Virginia Institute of Marine Science. In addition, the programme has widely distributed descriptions of egg cases with guidance to destroy such egg cases when found. While successful in stimulating collections to date, this programme does not address early post-settlement stages that are below the size selectivity of typical commercial fishing gear. Efforts are under way to develop specialized local markets for the species to provide economic stimulus for continued collection by commercial fishermen in the event that either the bounty programme is terminated or the resources of that programme are unable to keep pace with the annually increasing numbers of adult specimens collected.

Estimates of final range establishment in receptor region

Potential distribution limits of adult *R. venosa* in the Chesapeake Bay bottom can be inferred using Chesapeake Bay salinity and temperature data (Rennie and Neilson, 1994), data from Chung *et al.* (1993), Golikov (1967), and the observation of a single adult specimen in a location where winter salinities may reach 16 ppt. A projected range of adult *Rapana* survival in the Chesapeake Bay extends across the entire Bay to a northern limit at the mouth of the Rappahannock River. Marginal limits of this range encroach several km into all major Virginia subestuaries. Summer values of surface salinity and temperature can be used to infer distribution limits of pelagic *R. venosa* larvae, making the assumption that larval forms depth regulate at or near the surface in stratified subestuaries that typify the Chesapeake Bay. The demonstrated low salinity tolerance of at least the early post-hatch larval stages (see Figures 4 and 5 in Mann and Harding, 2000) and the relative position of winter bottom and summer surface isohalines (Figures 6A and 6C in Mann and Harding, 2000) suggest survival of larvae transported into the major subestuaries in the summer to positions upstream of the currently documented or estimated limits for benthic adult *R. venosa*. Surface circulation within the Chesapeake Bay, combined with the duration of the pelagic larval phase, suggest that extant adult populations can support recruitment to projected benthic populations if larvae can locate and successfully metamorphose on suitable substrates. Local population centres of adult *R. venosa* are concurrent with that of the hard clam (*Mercenaria mercenaria*) (see Figure 7 in Harding and Mann, 1999). The projected establishment range for *R. venosa* in the Chesapeake Bay suggests continued predation pressure on *M. mercenaria* populations, but less on the native oyster, *Crassostrea virginica*, populations which are currently limited to lower salinity habitats by endemic diseases.

Invasive range estimates for the Atlantic coast employ comparative temperature data from susceptible and known ranges of *Rapana*. Mann and Harding (2000) present a summary of temperature data from a number of sites on the eastern seaboard of the United States extending from Charleston, South Carolina to Portland, Maine with an inclusion of the temperature data from Chung *et al.* (1993) for the native Korean range. Summer temperatures from the mouth of the Chesapeake Bay in the south to at least New York in the north in typical (mean temperature value) years appear capable of supporting larval development (21 days at 24 ^{o}C to 26 ^{o}C and salinities > 18 to 21 ppt (Mann and Harding, 2000), and similar periods at 18.3 ^{o}C to 20.4 ^{o}C (Chung *et al.,* 1993) for Korean waters and 20–22 ^{o}C (Ciuhcin, 1984) for Black Sea populations). Boston, Massachusetts may encounter amenable temperatures for larval survival in atypically warm years. Given the common zoogeographic boundary of Boreal molluscs with temperate species at Cape Cod (see Franz and Merrill, 1980), a northern limit of potential distribution at Cape Cod appears tenable. A potential boundary to the south of the Chesapeake Bay mouth may occur at Cape Hatteras, another distinct zoogeographic boundary described by Franz and Merrill (1980), or towards Charleston, South Carolina. The critical temperature comparison is that of Charleston with Hong Kong where, as mentioned earlier, *Rapana venosa* is displaced by *Rapana bezoar* (Tsi *et al.*, 1983; see also Morton, 1994, species separation confirmed by mitochondrial and nuclear DNA markers by Gensler *et al.*, 2001). While both Charleston and Hong Kong share a similar annual temperature minimum (approximately 17 ^{o}C), the mean summer maximum in Charleston (28 ^{o}C) is considerably less than that in Hong Kong (35 ^{o}C), suggesting that the Charleston coastline may be susceptible to invasion by *Rapana venosa*. Further, based upon the statements of broad dietary preferences of *R. venosa* as reported earlier, there appears to be ample potential prey species for *R. venosa* throughout the Cape Cod to Charleston region. Dispersal rate may be enhanced in that Hampton Roads, Virginia serves as a major container port for shipping along the Atlantic coast and in trade with Europe and Asian ports, and is the location of Norfolk Naval Base, the largest naval installation in the western hemisphere.

4.3 Rio de la Plata, Uruguay and Argentina

A single published report describes collection of *Rapana venosa* in the north of the Bahia Samborombon on Rio de la Plata in 1999 (Pastorino *et al.,* 2000). A single female specimen of 97.1 mm SL and egg capsules were found at approximately lat. 35.3 ^{o}S long 55.4 ^{o}W in 13 m depth of water. An independent collection of *Rapana venosa* by scientists from Uruguay was made in the same year (Scarabino, 2000). Local populations of mussels (*Mytilus edulis platensis*) and oysters (*Ostrea puelchana*) are probable prey items. The current status of the South American population is that *Rapana* is now widely distributed on the Uruguayan (northern) coast (Montevideo-Punta del Este) of the estuary of the Rio de la Plata (the junction of the Parana and Uruguay Rivers with the Atlantic), but not on the Argentinean (southern) coast (personal communications to Roger Mann from Fabrizio Scarabino and Guido Pastorino, respectively, March 2002). It is restricted to the estuarine salinities. In summer months reproductive activity is evident with egg cases often being abundant on some beaches after strong winds. No data are available for this invasion concerning ecological impacts or potential extent of establishment over time. No control measures are being attempted.

4.4 Brittany coast of France

The date of first introduction of *Rapana venosa* into the Brittany coast of France has not been firmly established, although the first confirmed sighting was in 1997. In the 1999 ICES WGITMO report, the collection of three large individuals in a subtidal area of the Bay of Quiberon in June 1998 is described, together with the sighting of others in the summer of 1997. Patrick Camus (J.P. Joly and P. Goulletquer, IFREMER, La Trinité Sur Mer, France, personal communication to Roger Mann, 1999) indicated that up to ten large individuals (average SL of 140 mm) were collected from the Bay of Quiberon in southern Brittany by local and coastal fishermen using gillnets. No specific location and depth records are available. Philippe Goulletquer (IFREMER, La Tremblade, France, personal communication to Roger Mann, 1999, J.P. Joly, IFREMER, La Trinité Sur Mer, France, personal communication) also reported that adults had been collected in Brittany, although there did not appear to be substantial populations and they did not present evidence of active breeding or the presence of multiple year classes. Two individuals were collected in 1997, followed by 3, 2, 4, and 2 from 1998 to 2001. Since the first sighting, a total of 11 individuals was observed in 2000 and an intense effort was made to search for other specimens with the intent of eradication (J.P. Joly, IFREMER, La Trinité Sur Mer, France, personal communication, ICES WGITMO Report 2001). The vector for introduction of these animals remained in question until 2001, when two more whelks were collected (National Report for France, ICES WGITMO Report 2002). *Rapana* were apparently used to ballast clam culture bags of *Tapes philippinarum*, that were transferred from the Adriatic, where *Rapana* is now established (see earlier section on Black Sea through Adriatic invasion), and meanwhile were likely imported for shell collectors (P. Goulletquer, IFREMER, La Trinité Sur Mer, France, personal communication). No size information is available on the 2000 or 2001 *Rapana* collections. The National Report for France for 2001 to ICES WGITMO states that one individual was collected in the "same area and depth" as previous capture (3–5 m depth range, sandy bottom), with a second individual on settlement substrate for flat oysters. The oyster substrate is an off-bottom structure made of metal and mussel shells. Ten egg cases, each 25 mm long, were found on the same structure approximately 30 cm off the bottom. This is considered to be the first evidence of reproductive success of *Rapana* in Brittany. The egg cases were collected, maintained in the laboratory, and subsequently released larvae which grew until metamorphosed. These observations are troubling given that annual water temperature ranges in Brittany are arguably marginal for establishment of *Rapana venosa* based on comparison with previously described native and invaded ranges. However, in the Bay of Quiberon the temperature range is 18–22 °C and salinity ranges from 33 to 34 ppt, enabling a successfully development of larvae. The juveniles are being maintained for research purposes in quarantined systems. Following only one mating, 742 egg cases were obtained in 4 spawnings lasting from early July to August 2001. In total, 13 adult individuals have been collected until now, mainly in the "Anse du Pô" location, with only one individual in Crach river (Bay of Quiberon) (Goulletquer, P. Goulletquer, IFREMER, La Trinité Sur Mer, France, personal communication). Both a renewed eradication programme using nets and dredges, and a public education programme are under way at the time of preparation of this report. Control measures to prevent continued introduction in association with commercial clam shipments are strongly endorsed.

5 Limited records, not suggestive of established introductions

5.1 North Sea

A single report of occurrence of *Rapana venosa* was made for the North Sea, approximately 30 km south of the Dogger Bank (London Times, August 26, 1992). This may have been associated with disposal from a ship's galley. No other specimens have been collected from this location. ICES (WGITMO Report 1993) suggests that the specimen was misidentified. The collected specimen has not been examined by the authors, so definitive confirmation of the species is not possible for this record.

5.2 Willapa Bay, Washington State, USA

Hanna (1966, page 47) provides a picture of *Rapana thomasiana* and the following text: "The first specimen of this species which was made available to me for illustration was furnished by Dr D.B. Quayle of the Fisheries Research Board of Canada. The shell does not appear to be fully grown. It measures 22.4 mm in length and 16.9 mm in diameter. Locality information is not available. A much larger specimen (length 100 mm, diameter 73.4 mm) was given to Mrs Eleanor Duggan by Professor Kincaid. It, along with others, was collected in Willapa Bay, Washington, a locality from which Burch (1952, p. 16) (reference lacking) recorded it." The citation to Burch is apparently a notation in the minutes of the Conchological Club of Southern California for August 1952. The original material is not available to the authors.

The shell of a single specimen exists in collections maintained by Washington State Department of Fisheries, this having been collected in Willapa Bay (Brett Dumbault, personal communication to Roger Mann, 2001, date and specific location information not given). This specimen is considered to have been introduced with historical seed oyster shipments from Japan, and was probably collected in a similar time frame to the Willapa Bay specimens described above. Oyster seed shipments were discontinued several decades ago. Summer water temperature in Willapa Bay is too low to support reproduction of *Rapana venosa*.

5.3 New Zealand

A report of occurrence in New Zealand (Powell, 1979, p. 172) is for shells only and implicates disposal of non-native species from ship's galleys as the probable vector.

6 Prospectus for further invasions

The emergence of ballast water as a major vector in marine introductions over the past half century, combined with the imposing volumes of water moved as part of commercial ship traffic, suggest that continued dispersal of *Rapana venosa* will occur within the native and established introduced ranges as well as new regions. The Black Sea through the western Mediterranean invasion has progressed for approximately 60 years and appears to be still expanding. The Chesapeake Bay invasion appears on the verge of expansion, given increasing numbers of individuals collected and recent demographic changes within the population. The limited data on the Rio de la Plata invasion must also be viewed as threatening. In all of these locations, there are one or more major ports which may, through ballast water vectors, serve as potential donor locations to support new introductions.

The possibility of attached fouling as a vector for introductions of *Rapana* was discussed earlier with respect to the initial introduction in the invasion of the Black Sea. Modern hull anti-fouling treatments reduce, though do not eliminate, the viability of this vector in potential future introductions. To this point, we have not addressed the potential role of transport in ship's sea chests as a vector mechanism for further introductions of *Rapana venosa*. Richards (1990) elegantly describes the transport of the tropical muricid *Thais blandfordii* in the sea chest of a cargo vessel over extended periods from tropical to northern latitudes and back again. *T. blandfordii* emerges from the egg capsule as a crawling juvenile. There is no dispersing pelagic phase and the initial introduction of individuals into the sea chest, must have been as adult animals. Once established and feeding on fouling barnacles within the confines of the sea chest, the population of snails could be maintained. Although the possibility exists that small *Rapana* could be drawn into sea chest on floating debris, their possible transition to a preferred infaunal habit with an associated change in dietary preference with increasing size, maturation at a large size and production of pelagic larvae, suggests that facilitated dispersal by this vector would be less successful than for *T. blandfordii.*

The introduction of *Rapana* together with oysters or clams transferred for aquaculture purposes is another suggested vector of introduction that has been raised for the Black Sea and Brittany (France).

The native range of the species shows comparable temperature (low single digit-value with mid-to high 20s) and salinity (a broad range from mid-estuarine (approximately 15 ppt) through oceanic values to that encountered in established invasions. If the temperature remains above 20 ^{o}C for extended periods, then egg case deposition, hatching and larval development may occur. Plasticity in the duration of the pelagic larval phase, the absence of specific larval settlement cues, broad dietary options in the early post-settlement stage, rapid growth to possible predation refuge, relatively early onset of sexual maturity, high fecundity, considerable longevity, and tolerance of challenging environments with respect to anthropogenic stressors make *Rapana venosa* a formidable invasion threat to regions that are both served by the identified vectors and within the broad niche descriptors. It may be possible to predict further areas to where it may expand given a better understanding of likely vectors of further transmission.

7 Prospects for control or management where introductions occur

As with many introductions, the probability of observing the initial introduction event is minimal. The cryptic nature of *Rapana venosa* contributes to the improbability of observing invading individuals until they are large and imposing members of either the benthic community or a fishery catch. Given that the larval stage is considered a probable candidate for introduction via ballast water vectors, any observation of large adults in a receptor site will occur only after considerable time delay during which accompanying invading individuals will have dispersed and, if they survive, established elsewhere. Further, if the invaders have survived in sufficient densities and to sufficient size, recalling the relatively modest size at first maturity, then the probability of mating and egg laying in the receptor location before first record is high. Prospects for control or eradication of an invading population are bleak when physical conditions and potential prey concentrations are amenable to establishment. The complex life cycle of the species involves minimally a pelagic dispersal phase and a benthic adult. The latter optionally, indeed probably, involves a size-dependent transition from an epifaunal to an infaunal habit common to large predatory muricid gastropods. Further, seasonal aggregation for mating and subsequent egg mass deposition on hard substrates contribute to a complex pattern of resource utilization by the species over its life cycle. Attempts to target the species for control or eradication must choose the most susceptible stage or stages for practical control measures. Unfortunately, any such strategy has notable weaknesses. Egg case mats, although visible and often concentrated, may be spread over vast areas, and, given the high numbers of developing embryos per case, represent considerable propagule pressure when present even in small numbers. Larval forms are too dispersed to be considered tractable targets when free swimming in receptor environments. Identification and collection of post-settlement forms on hard substrates is difficult in complex community structures, given that the probability of confusion with other gastropods is high, while total community destruction is untenable. While large epifaunal individuals are identified with comparative ease, their selective collection represents an enormous investment of diver time. Collection of infaunal individuals is tractable with commercial dredges or pots/traps designed for target infauna. Extensive dredging for disparate populations of the invader would precipitate unacceptable levels of environmental destruction with accompanying debilitation of native species. In summary, there are no proven methods currently available for control or eradication of this species should it become established in a receptor environment. Investigations are in progress to examine the use of such techniques as side-scan sonar to identify significant mating aggregations on open sand substrate regions in the lower Chesapeake Bay. These may prove useful in guiding removal of those aggregations with reduction in propagule pressure, but they are not universally applicable and will not result in complete removal of reproductively capable or active individuals. As such, this is a possible control but not eradication option, and becomes less attractive should the observed range begin to rapidly expand.

Commercial fisheries still represent, by far, the most significant avenue for collection of *Rapana venosa* in numbers to implement control. While the development for a fishery can be argued to support maintenance of the population for economic reasons, public education can and must be supported to underscore the potential damaging effects of this species on native species of commercial and/or ecological importance. As such, the argument for a temporary focused fishery, even a subsidized effort, is worthy of consideration.

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ANNEX 9: RECOMMENDATIONS TO THE COUNCIL

The update of the ICES WGITMO Code of Practice was given the highest priority at the 2002 meeting in Sweden. In addition the Special Advisory Report on *Rapana* was completed. However, other objectives could not be achieved (Directory of Dispersal Vectors of Exotic Species and *ICES Cooperative Research Report* 1992–2001). As a result some of the recommendations listed below were already stated in 2001, but need closer consideration at the next meeting.

1) WGITMO recommends that ICES establish a homepage introducing the group and its activities, as well as the Code of Practice, and its Appendices. To enable frequent updates, the Appendices should only be included on the homepage rather than in the printed version. Further, *ICES Cooperative Research Reports* produced by the working group could be added.
2) To increase acceptance of the Code of Practice and its implementation, WGITMO is prepared to work intersessionally by receiving and evaluating prospectuses on proposed new introductions.
3) Further, it is recommended that WGITMO approach other relevant ICES working groups and study groups for input on the Appendices of the updated version of the Code of Practice, to ensure that all aspects of concern are properly addressed.
4) 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.
5) The Working Group recommends that ICES consider establishing a dialogue with international agencies, such as the EU Commission, with respect to the increasing movements through trade agreements of 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.
6) WGITMO recommends that future annual meetings include an opportunity for the participation of observers from non-ICES countries (e.g., Mediterranean countries) on the basis of their expertise on species that are invasive elsewhere and that may be of concern to ICES Member Countries. The very detailed information provided by the Italian observer was greatly appreciated by the WGITMO.
7) WGITMO recommends that an expert on risk assessment of marine invasions (from, e.g., Australia) be invited for input on the relevant Appendices of the Code of Practice.
8) To intersessionally prepare a list of agencies, universities, and institutions that will announce and implement the Code of Practice. Copies of the Code should be sent to these organisations in sufficient numbers to ensure wide distribution.

The **Working Group on Introductions and Transfers of Marine Organisms** [WGITMO] (Chair: S. Gollasch, Germany) will meet in Vancouver, Canada from 26–28 March 2003 to:

a) collect and discuss National Reports;
b) review the appendices for the Code of Practice;
c) provide annual updates on the spread and impact of exotic species including information from countries that are not members of ICES;
d) continue the development of information for a WGITMO homepage to be established by ICES with special emphasis on the Code of Practice Appendices;
e) jointly meet with the North Pacific Marine Science Organization (PICES);
f) continue work on the Summary of National Reports 1992 to 2001. It is recommend to publish this document as CD-ROM enabling addition of a copy of all annual reports during the period covered;
g) finalise the workplan to prepare an *ICES Cooperative Research Report* on the "Directory of Dispersal Vectors of Exotic Species";
h) collect information on impacts which intentional introductions may have on the receiving environment (e.g., Red King Crab in Norway) with the option to consider this species for a Special Advisory Report.

WGITMO will report by 14 April 2003 for the attention of ACME and the Mariculture and Marine Habitat Committees.