Advisory Committee on the Marine Environment

ICES CM 1999/ACME:1
Ref.: E + F

REPORT OF THE

WORKING GROUP ON INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

Conwy, United Kingdom
14–16 April 1999

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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1 OPENING OF THE MEETING AND INTRODUCTION

The 1999 meeting of the ICES Working Group on Introductions and Transfers of Marine Organisms (WGITMO) was held at the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) Conwy Laboratory, Benarth Road, Conwy, UK from 14 April to 16 April 1999. Mr John Wickins, acting Head of Laboratory welcomed the Working Group. The objectives of the 1999 meeting were reviewed; the agenda for the meeting was considered and approved (see Annex 1). At this meeting, there were 25 participants (representing 11 Member Countries), five invited guests (from Georgia, Israel, Australia, and Italy), and one representative from IMO. See Annex 2 for the complete list of participants. The meeting was chaired by Dr J. Carlton.

Dr Carlton noted that this was the Twentieth Anniversary Meeting of the Working Group on Introductions and Transfers of Marine Organisms. The first reconvened meeting of WGITMO was held on 2–4 April 1979, also in Conwy, Wales, under the chairship of Dr C.J. Sindermann. It was noted that it was appropriate that the 20th anniversary meeting met again in Conwy, especially as this laboratory, after a productive career, is closing this year.

2 TERMS OF REFERENCE

The terms of reference for the 1998 meeting of the WGITMO (ICES C. Res. 1998/2:5:1) were to:

a) review the value in promoting the establishment of reference collections of the alga *Caulerpa* based on specimens being moved through the aquarium trade (TOR 2:5:1:a);

b) develop plans for a proposed Theme Session on 'Marine Biological Invasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' to be convened for the ICES Annual Science Conference in Belgium 2000 (TOR 2:5:1:b);

c) continue work on a 'Directory of Dispersal Vectors' as an ICES Cooperative Research Report, including a continued review of aquarium-related transportation of exotic species as well as transfer via aquaculture (TOR 2:5:1:c);

d) continue the rationale for listing as endangered or protected species, or under other actual or proposed conservation measures, non-native species in Member Countries (TOR 2:5:1:d);

e) report on the current status of fish, shellfish, algal, and other introductions in and between Member Countries, through (TOR 2:5:1:e);

   i) submission of the National Reports, to further newly include information on genetically modified organisms;

   ii) standardisation of a database questionnaire;

   iii) review of the status of selected current invasions, as well as any biocontrol programmes that are under consideration;

   iv) continued coordination with the Baltic Marine Biologists' Working Group on Non-indigenous Estuarine and Marine Organisms (NEMO) and the EC Concerted Action Plan on ballast water;

   v) review information on unprocessed and partially processed materials (e.g., fish, algae) as a dispersal vector for invasive species (such as pests, parasites, and disease agents) and describe any potential impacts;

   vi) assemble a comprehensive list of major invasive marine and estuarine animal and plant taxa of Europe and Atlantic North America as a basis for interannual tracking through the National Reports.

3 REVIEW OF 1998 HAGUE REPORT AND RECOMMENDATIONS FROM 1998 MEETING IN THE HAGUE

There were no addenda/errata to the 1998 report.

Recommendation 1998-1, to hold a theme session entitled 'Marine Biological Invasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' was accepted.

Recommendation 1998-3 that ICES should establish a dialogue with international agencies, such as the European Commission, on the potential risks from the increasing movement of aquatic species as a result of free trade markets between Member States, was noted in the ACME report (C2, 10.1) such that 'further research should be conducted to assess risks and how they might be minimised'.

Recommendation 1998-6 was adopted under TOR 2:5:1 (see above in Section 2, Terms of Reference).

4 STATUS OF COOPERATIVE RESEARCH REPORTS

The 'Aalborg Ballast Water Symposium' report has been published as 'Ballast Water: Ecological and Fisheries Implications' (Dr J. T. Carlton, editor), 1998, ICES Cooperative Research Report No. 224, 146 pp.

The 'Summary of Introductions in ICES Member Countries as of 1990' which was submitted in 1996, is expected to be published very soon.

The 'ICES Code of Practice: Guidebook and Case Examples', which deals with the information that is necessary to prepare and submit to ICES when considering the introduction of a new species, and the mechanisms by which ICES responds, is now close to submission.

The WGITMO also recommends that another new Cooperative Research Report, 'Directory of Dispersal Vectors', should be produced. Over the past two years a large amount of information has been collated by WGITMO which would serve as a useful reference manual for scientists and policy makers (see also Section 14).

5 ICES CODE OF PRACTICE 1994

Dr Carlton brought the ICES Code of Practice (1994) to the attention of the invited guests.

During 1998 there had been no contact between EIFAC and ICES WGITMO regarding a revised ICES/EIFAC Code of Practice. Such possible contact had been discussed at previous WGITMO meetings. In the report of the 20th session of EIFAC meeting in Portugal in June 1998, 'it was requested that the Ad hoc Working Party on Introductions and Stocking instigate liaison with the ICES WGITMO to ensure alignment of codes relating to ballast water' (Paragraph 19 of report). Mr Ian Cowx had been asked to make contact with the Chairs of the joint ICES/IMO/IOC Study Group on Ballast Water and Sediments and the ICES WGITMO (i.e., Dr Carlton in both cases). Also, Dr P. Tuunaimen (Finland) was asked to represent EIFAC at the WGITMO 1999 meeting in Conwy, which he did.

The potential ways forward that were discussed were:

- concerning ballast water and the IMO Convention, that ICES and IMO contact the EIFAC Secretariat in Rome directly with regard to EIFAC participating in future work;
- that EIFAC Member Countries would be likely to participate in the Theme Session for the 2000 ICES Annual Science Conference (see Section 8, below);
- concerning the ICES Code of Practice and the use of GMOs, that Dr Tuunaimen would contact Ian Cowx and the Working Party on Introductions and Stockings on the potential for future collaboration.

6 MULTINATIONAL INVASION DATABASES

6.1 CIESM Atlas Series on Exotic Species in the Mediterranean Sea

The CIESM Atlas aims to provide a comprehensive survey, group by group, of recent marine immigrants in the Mediterranean Sea. It is developed as a guide for researchers, environmental planners, and non-specialists. Ultimately there will be 12 volumes; currently three are nearing completion on molluscs, decapod crustaceans and fishes. Demonstration pages of the three volumes are in digital format and can be accessed on the CIESM website (www.ciesm.org/atlas/index.html). They include an overall list of exotic species as well as illustrated species sheets as examples. A short description of each species, distinguishing characteristics, biology and ecology, size, first Mediterranean record, likely mode of introduction, distribution and expansion, key references and where to find more

information are some of the aspects described. The following table illustrates the numbers of exotic species of mollusks, decapods, and fish under consideration:

	Number of species in the Mediterranean	Number of exotic species	Number of established exotic species
Bivalves	360	43	23
Decapods	320	64	29
Fish	330	83	62
Gastropods	1300	90	46

(122 from the Red Sea and 38 from other sources)

6.2 Databases (TOR 2:5:1 eii / eiv)

It was noted that there are several databases on introduced species, as well as native species, beginning to be established in a number of ICES Member Countries and beyond. Some are lists of species that can be found (such as that organised through the EU MAST initiative listing marine species in European waters) while others (such as the CIESM Atlas) are more detailed. United Nations agencies are increasingly building up information on marine biodiversity as well through UNEP, IOC and FAO. In the future, the availability of information on a global scale - especially through the web - was seen to be particularly important for the identification of species and for identifying and understanding pathways of invasion of aquatic organisms.

WGITMO recommended that as part of the ICES website, a page be devoted to WGITMO and its activities and from there provide links to major invasive species websites of interest to ICES Member Countries. This would increase awareness and communication on the subject of potential invasive species.

6.3 New Journal: Biological Invasions

The first issue of the new journal, *Biological Invasions* (Senior Editor: Dr J. Carlton) is due to be published in the summer of 1999 by Kluwer Academic Publishers (Netherlands).

7 INVASIONS INITIATIVES AND PROGRAMMES

7.1 USA First National Conference on Marine Bioinvasions

A total of 250 people attended this meeting held at the Massachusetts Institute of Technology, Cambridge, Massachusetts from 24–27 January 1999. Papers and posters on a diverse range of subjects were presented. The main subject areas were ecology, models, vectors, control and evolution. Many of the presentations dealt with preventing introductions and documenting the mechanisms of introductions (49 papers/posters). Many other contributions covered impact, demography and biology of invaders. Most researchers are dealing with prevention, spread and impacts of exotic species, with little effort on controlling established invaders. At the end of the meeting there was a panel discussion, which focused on prevention versus control, based on the philosophy that prevention is better than cure. Abstracts have been published (see bibliography).

7.2 EU Concerted Action on 'Testing monitoring systems for risk assessment of harmful introductions by ships to European waters'

Dr Stephan Gollasch gave an update on this initiative (see 1998 report of WGITMO and the 1999 report of the ICES/IOC/IMO Study Group on Ballast Water and Sediments (SGBWS) for more details). During the last decades, ballast water discharges have increased throughout the world in most of the major ports. The intensity of shipping and the structure of vessels have undergone major changes over the past decade. In conjunction with this development, dredging of harbours and river estuaries has also changed the hydrodynamics of these systems, and there are further altered environmental conditions in coastal habitats, all possibly leading to an increased opportunity for survival of exotic species.

The objectives of the Concerted Action include the following: State of the art of European ballast water studies, documentation and intercalibration of ship sampling techniques, an assessment of potential treatment options to reduce the risks arising from ballast water releases and a public awareness campaign. Furthermore, European waters will be

considered as donor areas so documentation of information from previous European studies on introduced species (case histories) will be undertaken. Additionally, through the case histories, the Concerted Action will consider the major pathways of introductions in an attempt to understand the requirements for the development of adequate treatment techniques. At the same time, the Concerted Action will aim to create an awareness about the dimension and nature of the problem within the science community, the regulatory and inter-governmental bodies as well as in the shipping industry and with the public.

During a series of land-based, ocean-going and intercalibration workshops, the Concerted Action partners and invited experts meet and work on the objectives listed. The most recent has been a three-day workshop held at the CEFAS Conwy Laboratory from 9–11 April 1999. Since this meeting had been held immediately before the ICES WGITMO and the joint ICES/IMO/IOC SGBWS meeting, a number of invited experts had been able to attend. So far, eight case histories of introduced species, regional-ocean-going workshops and the intercalibration of ballast water sampling techniques have been finalised. The public awareness programme is an ongoing objective during the entire period of the Concerted Action. Handouts, flyers and posters have been prepared. The Concerted Action Internet homepage is under construction and will be available soon.

Brief results of the ocean-going workshops of the EU Concerted Action are as follows: Two vessels were accompanied on their European voyages. The Russian hydrographic ship 'Sibiryakov' was joined on its voyage from St. Petersburg to Lisbon and the oil carrier 'Nordic Torinita' on its trip from Cork to Sture, Norway. During both trips various sampling methods were applied to several ballast water tanks. The initial results and recommendations are:

- That the temperature variation in short-term voyages, when mostly undertaken in one climate zone, is not a critical factor controlling the survival of the specimens in the ballast water.
- That the main factors causing the mortality of species in ballast water during the first days are damage during the pumping process, lack of light (orientation problems) and wind-induced currents in the ballast tank.
- For future ocean-going workshops, the number of sampling techniques should be limited to the most effective methods. During the trips, one sampling trial took about two hours to complete. A limited number of sampling techniques would enable the sampling of one ballast tank more than once a day.
- The cone-shaped net and bucket samples revealed the highest numbers of organisms in both wing tanks that were investigated.
- The recommended methods for zooplankton sampling are 55 µm cone net, 55 µm net, bucket and hand pump.
- A new method of using traps inside ballast tanks to catch species in ballast water was not successful. It is possible that a new trap design and a longer period of exposure during better weather conditions will reveal better results. The traps should be tested during longer-term ocean-going voyages. Chemical light sticks in traps may attract organisms to the traps.

7.3 Baltic NEMO Activities

A workshop on 'Non-native species in the Baltic and Black Seas' was held from 1–4 December 1998 at the Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia.

Rivers and man-made canals connect the Black Sea and the Baltic Sea to each other. Species introductions by shipping have resulted in major changes in coastal habitats in both seas. As an example, the inner parts of the Gulf of Finland have been infested by five new alien species during the last six years. Four of these species are of eastern (Ponto-Caspian) origin, the fifth one from North America. More than 25 non-indigenous species are known from the Black Sea, including the comb jelly *Mnemiopsis leidyi* which has caused severe economic losses in the fishing industry and large-scale changes, both structural and functional, in the pelagic ecosystem. Several of the alien species presently living in the Black Sea can be regarded as potential invaders into the Baltic Sea. Therefore, a closer cooperation within research and training between the Baltic Sea and Black Sea is a necessity.

The main aim of the Workshop (and the planned research course in 2000) was to increase insight into the ecology and biogeography of and risks associated with introductions to the Baltic Sea. There is a need to develop tools for early warning, better prediction, and more effective assessment of risks and costs of aquatic alien species introduced to the Baltic Sea. Measures to control the spread and to minimise the impacts of harmful alien species should also be developed and implemented.

The first step towards achieving the objectives is the development of a database on alien species in the Baltic Sea area in order to understand and evaluate the scope of the problem. The second step is the development of cost-effective monitoring programmes for early detection of these species in high-risk areas as well as careful evaluation of the

environmental and economic threats posed by known introductions. The third step is an assessment of the effectiveness of existing and developing new practical control measures, and elaboration of recommendations.

A listing of the research interest on exotic species and ships as vectors of species introductions expressed by the participants (ranking is not according to importance) were:

Research interests of the participants:

1) The biology of potentially harmful species.
2) Information on population dynamics in ballast tanks during ship voyages.
3) Ballast sediments as a vector (ballast exchange may not be as effective as estimated because of residual sediments).
4) Documentation of resting stages and their viability in ballast tank sediments.
5) Stimulation of further work on ballast water treatment methods.
6) Survival (and tolerance) of brackish water species in ballast tanks.
7) Comparison of hull fouling and ballast water as vectors of species introductions.
8) Stability and future development of coastal ecosystems.
9) Inland waterways need to be considered as a pathway of species introductions.
10) Documentation of native fouling communities.

7.4 Tenth International Congress on Marine Corrosion and Fouling, Melbourne

Dr S. Gollasch presented a summary of this meeting, which was held from 8–12 February 1999 at the University of Melbourne, Melbourne, Australia. Introductions of species by hull fouling were not discussed in depth during the conference. The main issues were (number of contributions shown in parentheses):

- Development of environmentally friendly (TBT-free) antifouling paints (40)
- Problems caused by TBT (16)
- Documentation of the fouling communities (13)
- Biofilms (10)
- Understanding the adhesion and the structure of adhering molecules (9)
- Natural antifouling substances (8)
- Unwanted introductions of exotic species via hull fouling of ships (7)
- Corrosion problems (6)
- The molecules that organisms secrete to stick to these structures? (5)
- Other (9)

During the opening lecture presented by Prof. A. Clarke, Australia and the plenary address of Dr M. Julian (Chairman, IMO MEPC), it was indicated that the use of TBT coatings in the 1970s yielded savings estimated at about US$ 2.4 billion per annum, with a fuel saving of about 7.2 million tonnes. However, the economic saving came at a cost to the marine environment. It is well known that what is toxic to the organisms on the surface of ships is also toxic to organisms living in the sea. In 1998, the IMO resolved to introduce a global ban on the application of anti-fouling paints containing TBT from the year 2003 and to prohibit the use of TBT in ship coatings acting as biocides from the year 2008. It will be a challenge however, to find an effective alternative to TBT.

8 THEME SESSION FOR 2000 ICES ANNUAL SCIENCE CONFERENCE (TOR 2:5:1:B)

Dr Carlton presented a list of potential subject areas for papers during the planned Theme Session on 'Marine Bioinvasions: Retrospectives for the 20th Century, Prospectives for the 21st Century'. The subject areas included overviews (both introductory and concluding), vectors, GMOs, invasion science and invasion impacts (including ecological, genetic, economic, human health, mariculture, diseases and pathogens, and factors influencing invasions), techniques and tools, and management.

This Session will be held during the 88th ICES Statutory Meeting (the Annual Science Conference) in Bruges, Belgium. Delegates from Member States were asked to propose speakers for the Theme Session. Speakers will be invited to present papers by September 1999. Since it is likely that there will be a number of contributions offered, WGITMO thought it best that poster presentations should also be included.

9 NATIONAL REPORTS (TOR: 2:5:1:E/I)

National reports were received from the following ICES Member Countries: Canada, Estonia, Finland, France, Germany, Ireland, the Netherlands, Norway, Poland, Sweden, the UK (England and Wales), and the USA.

9.1 Highlights of the National Reports

National Reports (Annex 3) contain details of new laws and regulations, deliberate releases, accidental introductions and transfers, live imports, live exports, planned introductions, and meetings. References cited in the National Reports, and elsewhere in the report, are listed in the Bibliography in Annex 5.

9.1.1 Canada

A number of changes to legislation relating to introductions and transfers of aquatic organisms (including aquatic plants) and transgenics organisms are in various stages of implementation.

There is interest in 'new' aquaculture species (e.g., Atlantic cod, *Gadus morhua*; winter flounder, *Pleuronectes americanus*; yellowtail flounder, *Limanda ferruginea*; and Atlantic halibut, *Hippoglossus hippoglossus*.). An Atlantic halibut facility in Nova Scotia imported 50,000 juvenile halibut from Iceland in 1998 (and an additional 50,000 so far in 1999) to be grown to market size in totally enclosed seawater tanks.

A number of new introductions or range extensions occurred. The water flea (cladoceran) *Cercopagis pengoi* was discovered along the north side of Lake Ontario in the summer of 1998 and, by late August, these exotic crustaceans were reported throughout Lake Ontario. The amphipod *Echinogammarus ischnus* became common throughout Lake Erie in 1997 and was collected in the St. Lawrence River west of Montreal in 1998. The green crab *Carcinus maenas* was first reported along the eastern end of Prince Edward Island (Northumberland Strait) in the early fall of 1998. It was found by eel fishermen and appears to be at high densities in certain bays. The clubbed tunicate, *Styela clava*, was first identified on a market mussel crop from the Brudenell River (eastern end), Prince Edward Island, in January 1998.

9.1.2 Estonia

Amendments/new legislation occurred in 1998 in relation to introductions/release of species into the wild.

A number of aquatic species were used for fisheries enhancement programmes.

The water flea *Cercopagis pengoi*, reported first in 1992, has spread throughout Estonian waters.

9.1.3 Finland

Amendments to legislation have been introduced, associated with EU Directives and mainly in relation to disease control.

9.1.4 France

Shellfish farms now have to register movements of shellfish into and out of the farm. Proposals for legislation to prevent and control the introduction of the seaweed *Caulerpa* are under review.

The slipper snail *Crepidula fornicata*, a competitor to oysters and mussels, has reached high densities in some areas of commercial bivalve cultivation (e.g., 250,000 metric tonnes in the Bay of St Brieuc). A research programme has begun to investigate methods of reducing the population.

A new snail, the oyster drill *Ocinebrellus inornatus* (= *Ocenebra japonica*) has been observed along the French Atlantic coastline, in the Marennes Oleron and Arcachon Bays.

Three live adults of the snail *Rapana venosa* were collected in the Bay of Quiberon, southern Brittany in 1998.

The northern spread of the crab *Hemigrapsus penicillatus* appears to have slowed although further extension of the range is anticipated.

9.1.5 Germany

Co-introductions of the seaweeds *Sargassum muticum* and *Ascophyllum nodosum* and the seasquirts (ascidians) *Styela clava* and *Aplidium nordmanni* occurred in the Wadden Sea with introductions of Pacific oyster (*Crassostrea gigas*) seed from Ireland.

There was further spread of the zebra mussel *Dreissena polymorpha.*

High concentrations of the mitten crab *Eriocheir sinensis* were found in German rivers. For example, 3000 kg of juvenile crabs were estimated as the daily catch in the Elbe River. This exceeds the maximum density recorded in the 1930s. The crabs are causing structural damage to riverbanks.

9.1.6 Ireland

Range extensions occurred of the zebra mussel *Dreissena polymorpha*, into northern Lough Erne, and of the eel nematode *Anguillicola crassa*, into the River Shannon.

9.1.7 Netherlands

There was a reappearance in coastal waters and Yssel Lake of the fish, the houting (*Coregonus oxyrhynchus*). These houting were probably the result of the Danish houting programme (River Ribe) and the German restocking programme in the River Eider.

9.1.8 Norway

As of January 1, 1999, Norway is part of the EEA agreement, and serves as a controlling body for imports from non-EC countries. Regulations of imports and exports have generally been harmonized with the EC-community.

The population of the introduced red king crab (*Paralithodes camtschatica*) in the north Norwegian coastal area east of the Varangerfjord has grown considerably.

A novel species was reported for Norwegian waters, a red alga *Dasysiphonia* sp. (Dasyaceae, Rhodophyta). It was probably accidentally transported from the North Pacific Ocean (via ballast water or hull fouling) and was observed in the Netherlands in 1994.

9.1.9 Poland

Polish regulations on fish and fish material products are being adjusted in line with rules which are in force in European Union countries.

A total of 537,850 salmon smolts and 1,330,000 sea trout smolts were released into the natural environment (as an enhancement) and 120,000 juvenile whitefish (*Coregonus lavaretus*) were released into Puck Bay as a part of programme of fish resources restoration.

9.1.10 Sweden

A new law on environmental issues has been introduced which will promote sustainable development and protection of nature. It also addresses protection of biodiversity and valuable cultural environments. One chapter regulates the use of Genetically Modified Organisms

A new parasitic worm, *Pseudobacciger harengulae*, was detected in about 20 % of juvenile herrings from the Swedish west coast (collected 1994–1996). Previously this species has mainly been recorded from clupeid fish in tropical to warm-temperate waters of the Atlantic, Pacific and Indian Oceans and the Black Sea.

In April–May 1998, an algal bloom (*Chattonella* sp. cf. *C.verruculosa*, a species previously known from Japan) occurred in the Skagerrak and northern Kattegat waters and adjacent parts of the North Sea, with reports of fish kills from the Swedish west coast, the Norwegian south and southwest coasts and the Danish coasts. If the species identification is correct, this is the first record of the species in Europe.

9.1.11 United Kingdom: England and Wales

Natural recruitment of the Pacific oyster (*Crassostrea gigas*) was recorded in new areas on the east and west coasts.

The mitten crab *Eriocheir sinensis* occurs in the Thames River along a distance of 63 km. Up to 28 burrows per square metre have been found causing considerable damage by weakening the bank structure and causing areas of bank to collapse. Chinese mitten crabs have also been found in other estuaries along the east England coast.

In August, 1998, a population of the invasive bryozoan *Tricellaria inopinata* was found along an 80 km section of the central southern coast of England, representing the first Atlantic record for this taxon.

Documents supplied by Dr Elspeth MacDonald were in hand relative to the report that in early May 1998, ISA (infectious salmon anaemia) was suspected in marine-farmed salmon in Scotland. Restrictions on salmon movements were immediately placed in the immediate vicinity and in a wider area where surveillance was increased.

9.1.12 United States of America

On 3 February 1999, President William Clinton signed and released an Executive Order on invasive species replacing an earlier well-known EO signed by President Jimmy Carter. The new Order creates a federal panel, The Invasive Species Council, with broad interagency duties to oversee federal government management of exotic species.

In June 1998 the first specimens of the large, clam-eating Asian whelk (snail) *Rapana venosa* were found in the lower Chesapeake Bay. This species was earlier introduced to the Black Sea and the Mediterranean Sea, from where it may have arrived to America.

Range extensions have been found for the crab *Eriocheir sinensis* (within San Francisco Bay, California) and the zebra mussel *Dreissena polymorpha* which was recorded for the first time from the State of Connecticut in summer 1998.

Studies on the potential for using *Crassostrea ariakensis* and/or *C. gigas* for cultivation on the east coast of the US continue with triploid animals. The rate of reversion from triploid to diploid state is less in *C. ariakensis* than in *C. gigas*.

10 STATUS OF SEAWEED *PORPHYRA YEZOENSIS* IN USA

Dr Ike Levine gave a presentation on the current status of Phycogen's farming of *Porphyra*. A full report of the studies with *Porphyra* is given in Annex 4. He described the development of culture sites and farming of nori since the establishment of the farm in 1992. The alga has also been used in polyculture with salmon. It is an ideal candidate for bioremediation since the alga absorbs considerable quantities of nitrogen and phosphorus resulting in a significant increase in phycoerythrin content. *Porphyra yezoensis* that is grown in polyculture alongside salmon cages is used solely for the extraction of phycoerythrin and not for human consumption.

A minimum temperature of 6–7 °C limits the growing season for *P. yezoensis*. Experimental studies were carried out to assess the potential for the alga to become established in the wild outside the culture site. The conclusions of the 4–year study were: 1) *P. yezoensis* plants are present but uncommon in the summer on the shoreline adjacent to the PhycoGen farm during the farming season, 2) local *Porphyra* species out-recruit *P. yezoensis* on netting substrates, and 3) there is no evidence to date that *P. yezoensis* will over-winter in Cobscook Bay and replace local *Porphyra* species.

For the future development of *P. yezoensis* farming in the Gulf of Maine, the farming of a tetraploid (as opposed to the current diploid) is being assessed. To date a tetraploid *P. yezoensis* has been artificially produced which has a growth rate that is double that of the diploid. This could have ecological implications if there was a request for this new variant to be released to the natural environment for farming purposes. WGITMO recommends that the ICES Working Group on the Application of Genetics in Fisheries and Mariculture (WGAGFM) be consulted for advice on the potential differences that should be anticipated from the farming of polyploid as opposed to diploid aquatic organisms and the assessments that should be carried out.

11 STATUS OF INVASIONS

11.1 Rapa Snail (*Rapana venosa*) in the USA

Dr Roger Mann gave the following presentation to the WGITMO.

The Veined Rapa Whelk, *Rapana venosa*, was first identified as present in the Hampton Roads region of the lower Chesapeake Bay in the summer of 1998. The species is native to the Sea of Japan, was introduced to the Black Sea in the 1940s, and has since spread to the Aegean and Adriatic Seas. He presented evidence that this recent range extension is mediated by transport of early life history stages in ballast water. The current knowledge of distribution of *R. venosa* in the Chesapeake Bay suggests that the majority of the population is limited to a swath from the James River Bridge, through Hampton Roads and along the shoreline of Willoughby and Oceanview inshore of the Thimble Shoals Channel. A small number of individuals have been recorded from the mouth of the York and Rappahannock Rivers. None have been collected in Maryland waters.

Egg cases of *R. venosa* have been collected from Hampton Roads, and larval forms cultured in the laboratory. Estimates of the salinity tolerance of the early larval stages of *R. venosa* can be used as a precursor to estimating a potential range of distribution of the species within the Chesapeake Bay and its subestuaries. These estimates can then be used to examine possible range extension within the Mid Atlantic should a stable, reproducing population become established in the lower Chesapeake Bay.

The presence of *R. venosa* in the lower Chesapeake Bay has ecological consequences beyond the obvious potential for predation on commercially valuable shellfish prey species (e.g., the oyster*Crassostrea virginica* and the clam (quahog) *Mercenaria mercenaria*). In the Black Sea and in their native Sea of Japan *R. venosa* have been reported primarily from hard-bottom habitats. Adult Chesapeake Bay *R. venosa* have been collected from both hard- and soft-bottom habitats. Laboratory observations indicate that adult *R.venosa* burrow almost completely into the sand at water temperatures > 20 °C (i.e., not overwintering behavior). Burrowing behaviour by these large apex predators expands the potential suite of vulnerable prey items to include infaunal shellfish (e.g., the bivalves *Mya arenaria, Ensis directus, Cyrtopleura costata*). The presence of large (> 100 mm) empty *R. venosa* shells in Chesapeake Bay may enhance growth of the local hermit crab (*Clibanarius vittatus*). Recent collections of *C. vittatus* from the Hampton Roads area indicate they use empty *R. venosa* shells as shelters and are reaching unusually large sizes. This has implications of creating abnormally large crustacean scavengers on Chesapeake Bay benthic epifauna (e.g., oyster spat).

Rapana venosa has also been reported from French waters (see National Report for France) and there was an unsubstantiated report of the gastropod being found in UK waters (see National Report for England and Wales 1993). Considering the potential movement of *Rapana* on a global scale in ballast water and its risk to commercial bivalve fisheries, WGITMO recommends that ICES alert Member Countries to this invasive species.

11.2 Invasion of Adriatic and UK waters by bryozoan *Tricellaria inopinata*

Peter Dyrynda and Anna Occhipinti-Ambrogi presented the following report, based on their own work and work by Roger Fairall.

A population of the invasive bryozoan *Tricellaria inopinata* has recently (August 1998) been discovered on the central southern coast of England, representing the first Atlantic record for this species. The only other known European record for *T. inopinata* is the northern Adriatic, its type locality. It is now believed that *T. inopinata* is of Pacific origin, where it is known under two synonyms, at least one of which is shared with another distinctly different morphospecies. Recent systematic reappraisals of the *T. inopinata* 'complex' in the Pacific have revealed its widespread presence in both northern and southern temperate regions including Japan, North America, Australia and New Zealand (the last as an invasive species).

Significant differences are evident between the invasion ecology of this taxon in the northern Adriatic and NE Atlantic. The invasion of the northern Adriatic has been slow. After 17 years this taxon is still largely confined to the Venice Lagoon, and although it has recently been found in a second lagoon, it has not been recorded on the open coast to date. In the Northeast Atlantic, evidence suggests a recent arrival and a rapid population build up. It is already abundant within harbours and marinas located in estuarine basins along an 80-km section of the central southern coast of England. A more detailed survey of the Poole Harbour area has revealed its presence in natural habitats, both within the harbour and on the open coast, as well as within marinas. The different ranges of substrates colonised by *T. inopinata* in the Adriatic and Northeast Atlantic are indicative of an opportunistic and flexible substratum selection strategy.

11.3 Increasing abundance of the Chinese Mitten Crab *Eriocheir sinensis* in German Rivers

Dr S. Gollasch gave an update on this invasive crab. The first European findings of the Chinese Mitten Crab were in the German river Aller in 1912. Today specimens can be found up to 700 km upstream in German rivers (such as the River Elbe). From tagging experiments, it was found that the maximum rate of spread of larvae in German rivers was 3 km per day in an upstream direction. Adult species migrating downstream can cover 12 to 16 km daily. Via the Kiel Canal, the species migrated into the Baltic Sea. First records in the Baltic Sea were in 1926, but the centre of occurrence in Europe today is still the German rivers Elbe and Weser. It was generally agreed that shipping (ballast water and/or hull fouling of vessels) was the vector of introduction. In other areas, imports of living species for aquaria or human consumption represent additional vectors.

The success of this invader was positively influenced by comparable conditions of climate and salinity in the area of origin (China) and recipient region (in Europe). Additionally, the lack of native decapods in estuarine waters and rivers of the North Sea area supported the establishment due to low competition. The optimal abiotic conditions and low competition, as well as an immense food supply, enabled a mass occurrence in German waters during the 1930s–1940s. Since then an increase in the population has been observed approximately every 15 years. Since the beginning of the 1990s, about 60 years after the known extreme mass occurrence in German rivers, the Chinese Mitten Crab is now becoming very abundant again. In spring 1998, 850 kg of juvenile crabs were caught by hand in the river Elbe in two hours only. Therefore, the daily catch could amount to more than 3,000 kg of juvenile crabs. This amount is comparable or even higher than that of the 1930s (during which a maximum of 2,500 kg of crabs were caught in one day), the peak years of the former mass occurrence in German waters. In 1999 the same trend was observed.

During these mass occurrences of the crab, a decline in natural fisheries in the estuarine and inland waters is known due to the crab's feeding activity on the fish and the fish food. The crabs cause damage to dams, retaining walls and irrigation channels by penetrating them with their burrows. Openings of the burrows reach 12 cm and a length of 50 cm. During the mid-1930s, up to 30 holes per meter square were found in river banks at the mouth of river Elbe.

Further information on the status and spread on the Chinese mitten crab can be found in the National Reports (Annex 3).

11.4 Status of the Zebra Mussel *Dreissena polymorpha* in Ireland

Dr Dan Minchin has been assessing the spread of zebra mussels in Ireland. The mussels probably arrived in Ireland in 1994 or earlier with the movement of second hand boats on trailers from either Britain or the Netherlands, or from both countries. Zebra mussels have expanded their range rapidly within the navigable areas of the Boyle, Shannon and Erne systems, a distance of approximately 250 km. Significant increases in abundance took place in most of the major lakes in the navigable areas of the afore-mentioned rivers. Densities of almost 10,000 m^2 have been found in the largest Lake on the Shannon River, Lough Derg. Here the native unionid clams *Anodonta anatina* are densely covered in zebra mussels, many having >1000 zebra mussels per individual. Large numbers of dead clams, *Anodonta*, were found in shallow water.

The zebra mussels are readily spread throughout inland navigable waters while attached to a wide range of craft from barges to paddle boats. More than 20 % of the barges sampled were infested. Barges are capable of carrying some millions of individuals and should they spawn in a region where zebra mussels do not occur, can produce larvae that can settle to form a new population. There may be six populations presently established in the lakes, Lough Erne, Lough Key, Lough Bofin, Lough Ree, Lough Derg and in the Limerick Docks, based on the different larval and later stages found in July 1998.

Based on the experience of the range expansions of mussels in Europe and North America, it is likely that mussels will colonise all navigable waterways to include in Ireland the Royal and Grand Canals and the Barrow River. However, lakeboats, normally used by anglers and frequently carried overland are likely to bring mussels to other lakes, either attached to boats or on the weed snagged by trailers. Zebra mussels can survive for several days under the right conditions. Individuals have survived out of water in March for 18 days. The transfer to lakes is therefore a very likely mode of introduction. Accordingly, anglers, in particular, have been involved in assisting to reduce its rate of spread. Information leaflets and extensively distributed warning notices at slip sites together with media coverage have made the problem widely known by the public.

11.5 Water flea *Cercopagis pengoi* in the Baltic Sea

Dr Henn Ojaveer reported that the recent newcomer to the Baltic Sea, the cladoceran *Cercopagis pengoi*, was first found in the Gulf of Riga in 1992. The species is native to the Ponto-Caspian region and was probably introduced to the

Baltic by ship's ballast water. The animal has now spread over the Gulf of Riga and Gulf of Finland. It occurs very abundantly in calm weather conditions in summer, above a water temperature of 16–18 °C. In these conditions, it can reach a density of 1000 individuals per m^3. However, some specimens were found as late as in October at water temperatures of 8–12° C. The waterflea is actively consumed by several pelagic and bentho-pelagic species in this area, including commercially exploited herring. It is too large to be preyed upon by 0-group fish. Other possible impacts of the species to the ecosystem could include changes in the zooplankton community as a result of direct predation effects and competition for the same food resources with 0-group fishes.

The species is represented by two different morphological forms in the Baltic. The typical representative of the species was dominant from mid-summer and was characterised by a relatively long caudal process with an S-bend and backwardly-bent tips or barbs. Representatives of the other morphological form were found only in spring to early summer and they had a straight and relatively short caudal process with forwardly-bent tips or barbs. Although the last form could be identified as a separate species, it is suggested that it represents the first parthenogenic generation of *C. pengoi*, hatched from resting eggs in spring.

11.6 Japanese seaweed *Undaria pinnatifida* in France

Two recent papers (Castric-Fey *et al.*, 1998a, 1998b) describe the presence of the Japanese kelp *Undaria pinnatifida* in the rocky shore ecosystem of the St Malo area in France. The alga spread quickly in the area after being introduced for farming in the surroundings of the Rance estuary in 1984. The population then extended over several hectares (15 km along the shoreline) below the lower zone of the native brown alga *Fucus serratus*, mainly on gently sloping beaches with large areas of cobbles and boulders, reaching depths down to 12 m in 1992. After that it retreated, in 1994 being found as a narrow belt down to 3 m depth and was heavily grazed by the ormer (abalone) *Haliotis tuberculata*. However, in 1996 it suddenly increased again and distribution was further enhanced in 1997. Then it also extended its geographical spread to Normandy in the north. Two morphologically different forms were found around St Malo, the typical form being dominant in autumn and *F. disticha* mainly occurring during winter and summer, while both growth forms were found in spring. Furthermore, two generations succeeded each other as a result of two annual recruitments in April–June and October, respectively. Thus both juvenile and old sporophytes occurred together throughout the year, except for a short period in August–September. There was no information on recent harvests in the area.

11.7 Lessepsian migration and molecular tools

Dr Avigdor Abelson gave a presentation on an assessment of routes and models of Lessepsian migration through the Suez Canal by means of molecular tools. The opening of the Suez Canal in 1869 provided a passageway for the invasion of more than 300 species from the Red Sea to the Mediterranean. It was noted that the migration was unidirectional, into the Mediterranean, even though the reasons are not clear. It may be due to one or more of the following phenomena: dispersal steps, donor sites, routes of invasion, modes of transport, environmental conditions and the organisms' characteristics that lead to colonisation of the eastern basin of the Mediterranean Sea. Using molecular tools, the aim of a current study is to address these issues by carrying out studies with species possessing different dispersion capabilities and invasion histories. For example, the preliminary results of molecular studies on the bivalve *Brachidontes variabilis* showed that the Mediterranean genotype does not occur in the Red Sea, the Suez Canal or the Gulf of Suez. Therefore, this suggests that ship transport from elsewhere may have occurred for this species rather than natural migration.

11.8 Italian studies on invasions

A study group, coordinated by Dr Anna Occhipinti (University of Pavia, Italy) has been recently created by the Italian Society of Marine Biology with the aim of bringing together Italian researchers working on marine exotic species found in Italy. This group first met during the last congress of the Society, held in Ustica in June 1998. One of the aims of this group is the production of an updated list of exotic species in Italian waters. The procedures and objectives of the ICES Working Group provide very useful guidelines for the new group.

More recently a project proposal involving the study of fouling communities in the main Italian ports has been submitted to the Inspectorate for the Defence of the Sea. This study will comprise the gathering of information on the presence and impacts of exotic species. It will include some pilot monitoring work using settlement panels and visual surveys undertaken by divers.

A symposium on invasive species, organised by Dr Richard Mack (Washington State University, Pulman, WA, USA) and Anna Occhipinti (University of Pavia, Italy) was part of the Intecol meeting held in Florence in July 1998. More then 20 papers and posters considering different terrestrial and marine subjects were presented. Some of these papers will form a special issue of the new journal 'Biological Invasions' (Kluwer Press).

An international meeting on *Caulerpa* was held in Lerici in February 1999.

12 ECOSYSTEM MODELS FOR INVASIVE SPECIES

Dr Inger Wallentinus presented two ecosystem models (based on the energy circuit language by H.T. Odum) illustrating the ecosystem impact and trophic cascading effects of some introduced species in the Great Lakes and the Mediterranean Sea. The models aimed at emphasising effects other than just predation and competition for food, effects that are often less obvious in the ecosystem. By incorporating quantitative data on abundances, growth, uptake rates etc., the models can also be simulated, preferably as submodels.

For the Great Lakes a similar type of model was published in 1988, before the many invasions taking place in the 1980s. The new model presented included the impact of two *Dreissena* mussels, affecting the phytoplankton community through their enormous filtering capacity (however, different algal groups are cleared at different rates, but with an overall effect of decreasing abundance and turbidity). The mussels have an impact on other hard substrate organisms by occupying the substrate and can have a negative effect on the native unionid mussels by clogging and competition. However, the diversity of the hard-bottom community also increased due to accumulation of sediment among the mussels. Also included in the model were other introduced species, such as the more recent arrivals of two cladocerans, the European ruffe and the round goby, *Neogobius*, as well as older introductions of fish, such as alewife, salmonoids and sea lamprey.

The introduction of the tropical green alga *Caulerpa taxifolia* in the Mediterranean has been the subject of many research projects focusing on both the toxicity of the species and its competition with the important seagrass beds of *Posidonia* and other species. Including space available for growth is one major part of the *Caulerpa* model presented. Examples of more indirect effects are reducing the number of epiphytic algae (which provide food for many grazers), shading of microalgae, depriving benthic suspension feeders of food by impeding sedimenting particles and not allowing animals to reach the water column.

13 NORDIC COUNCIL REPORT: INITIAL RISK ASSESSMENT OF ALIEN SPECIES INTRODUCTIONS IN NORDIC COASTAL WATERS

Dr Stephan Gollasch presented the following report (prepared by S. Gollasch and E. Leppäkoski).

Some 3,000 to 4,000 species ranging from unicellular algae to fishes travel at any given time from one of the world's seas to another in the ballast tanks of ships. Exotic aquatic organisms are known to cause considerable ecological and economic harm in the new areas and environments into which they are introduced. Here are several 'What's' and 'Why's' to be answered: Why did they arrive now and not tens of years ago? Are they here to stay? Why are some areas more open for introductions than others? Why do some of the invaders spread rapidly and become pests? Some of them have appeared to be beneficial—are they a potential source or threat?

The report provides a first attempt to assess the environmental risks related to alien invasions into the Nordic seas. Knowing that most of the newly introduced species world-wide have become introduced by ships, port studies were undertaken. Ports considered were Nordhordland region (Norway), Stenungsund (Sweden) Klaipeda (Lithuania), Turku (Finland) and St. Petersburg (Russia). By knowing port details (e.g., shipping patterns, traffic routes, occurrence of previously introduced species), a risk assessment was undertaken according to known criteria for species introductions, such as matching climate and salinity in the area of origin and in Nordic waters, if shipping routes into the areas of origin exist.

Then, general discussion criteria such as matching climate and salinity were used to compile a target list of species, which had the potential to become introduced into Nordic waters. Invasions are of present and future concern for shipping agencies and maritime authorities and pose a challenge for marine biologists. (This report is in print and can be obtained via the authors.)

14 DISPERSAL VECTORS (TOR 2:5:1:C)

14.1 Seaweed *Caulerpa* Reference Collection (TOR 2:5:1:a)

It was recognised that there is a need to obtain samples of *Caulerpa* that are in the aquarium trade (in catalogues, pet shops, fish/aquarium stores, on display in public aquaria) and start preserving them for genetic studies in order to establish what species are available from such sources and what is being moved around the world. A letter (9 April 1999) had been received from Professor Alexandre Meinesz (Laboratoire Environnement Marin Littoral, Université de

Nice) indicating that such collections are now being archived. It is apparent that there can often be a problem in correct species identification. He also pointed out that there are few *Caulerpa* species in the aquarium trade since most of them do not grow well and usually die immediately after the sexual reproduction phase. *Caulerpa* is frequently added to a shipment of fish, as a temporary decoration. The most frequent types used are *C. taxifolia, C. prolifera* and *C. racemosa.*

14.2 Processed/Unprocessed Fish/Algae (TOR 2:5:1:e)

There was no additional information presented.

14.3 Treatment of Water/Packing Materials Used for Shipping

Dr Dorothee Kieser reported that in 1996, a bilateral agreement (Modele 10) was developed between France and Canada regarding the health and certification of shipments of live aquatic organisms from Canada to France for aquarium display. Under this agreement, the exporter of animals must obtain an inspection of the animals to be exported to ensure that no clinical disease is apparent. This inspection must be carried out by a government-approved agent (usually a veterinarian) and must be countersigned by a Local Fish Health Officer of the Canadian Government. The documentation must accompany the shipment. The organisms can only be shipped through certain designated border posts in France. Following the initiation of the France-Canada agreement, informal contacts were made with other representatives to the ICES WGITMO. Wherever possible, the same procedure is followed for exports of aquarium species to ICES Member Countries.

14.4 Fish Packing Boxes

Dr Inger Wallentinus alerted the WGITMO to the potential for frigolite/wood boxes acting as potential vectors. The sale and reuse of used frigolite boxes (costing $3 US as new but only 10 cents US if used before) seems to be quite common in Sweden. It may be indicative of practice in other countries too. The boxes may be used for transferring fisheries products between farms within a country or for export, e.g., with mussels from Sweden to the European continent (and beyond?).

14.5 Ship Hull Fouling

Organisms attaching to ships' hulls experience a wide range of temperatures depending on the route a ship may take. In harbour areas there may be significant diurnal changes in temperature, and these changes may stimulate spawning events. Such events are known for inshore littoral organisms, where temperatures of < 2 °C may result in profuse spawning of species from several taxa. Spawning events in port could result in the establishment of new populations. Hull fouling is a significant problem, and with the decline in the use of TBT antifouling paint coatings, together with recent management of industrial and other discharges, port areas will become less toxic, enabling greater opportunities for exotic species to become established. TBT is to be phased out between 2003 and 2008.

From the general discussion that ensued, relative to the aquarium trade, fish packing boxes, ship hull fouling, and many other vectors, it was apparent that information should be made available concerning the range of dispersal vectors and the WGITMO recommended that an *ICES Cooperative Research Report* should be produced. It was suggested that if possible some relative weighting be given to the array of dispersal vectors. This would make policy-makers both aware of the situation and could assist them in their decision making.

15 LISTING OF NON-NATIVE SPECIES AS ENDANGERED OR PROTECTED SPECIES (TOR 2:5:1:D)

There were no further examples provided following upon the 1998 discussion. However, Inger Wallentinus said that some marine reserves in Sweden contained non-native species. This is also true in the UK in the proposed marine reserve in the Menai Strait, North Wales for example. Also, in the Wash on the east coast of England, the introduced American razor clam *Ensis directus* is found in a Special Conservation Area. Although there is strong interest in the commercial exploitation of this razor clam, it is unlikely to occur due to the invasive harvesting method that would be required and the potential impact on other benthic species.

16 RECOMMENDATIONS TO ICES COUNCIL

The recommendations are listed in Annex 6 of this report.

17 CLOSING OF THE MEETING

A final review of the 1999 terms of reference was made and the proposed agenda and action points for 2000 were considered. Final draft recommendations were discussed, revised and approved by WGITMO participants.

Discussion followed on the future Chair of WGITMO. It was decided unanimously that a recommendation be made that Dr Carlton should be elected for a further three years.

Finally, the Chair thanked all WGITMO members and guests for their dedicated work and thanked CEFAS for hosting the 1999 meeting in Conwy. The Chair adjourned the meeting at 12.15 hr on Friday, 16 April.

ANNEX 1: AGENDA

14 April 1999 Wednesday

9:00 Opening Session
- Welcome and Introductory Remarks
- Appointment of Rapporteur
- Introduction of Participants and Guests
- Logistical Announcements
- Review of Agenda and changes, corrections, additions
- ITMO Report Deadline

9:30 Review of the Previous Meeting: 1998, The Hague, Netherlands
- Review of 1998 Hague Report and Addenda/Errata
- Review of Recommendations from 1998 Hague meeting
- Status of Cooperative Research Reports

9:45 Terms of Reference (TOR) for the 1998 Hague meeting

10:00 New Publications, Journals, Websites, Data Bases
- CIESM Atlas Series on Exotic Species in the Mediterranean Sea
- New Journal: Biological Invasions
- Other News
- Databases: TOR 2:5:1 e-ii/e-vi: Standardization of a Database Questionnaire; List of Major Invasive Taxa for Interannual Tracking through NRs

10:30 Coffee Break

11:00 Invasion initiatives and programs
- National Conference on Marine Bioinvasions (January 1999, USA) (J. Carlton)
- EU/Concerted Action Plan (S. Gollasch)
- Update on Baltic NEMO Activities (S. Gollasch)
- Other News

11:30 Theme Session for 2000 ICES Annual Science Conference (TOR 2:5:1:b)
'Marine Bioinvasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' 88th Statutory Meeting, ASC: Belgium (Bruges)

11:50 Group Photo

12:00 Lunch

2:00 Reconvene for the Afternoon Session
National Reports
- Canada
- Estonia
- Finland
- France
- Germany
- Ireland
- Netherlands
- Norway
- Poland
- Sweden
- UK (England and Wales)
- USA

3:30 Coffee Break

4:00 **National Reports (continued)**

5:00 Review of Tomorrow's Agenda

5:30 Adjourn

15 April 1999 Thursday

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

9:15 Status of Nori (Japanese Red Alga *Porphyra yezoensis*) in the Gulf of Maine, (I. Levine) followed by Questions and Discussion

10:00 Dispersal Vectors: The Directory of Vectors (TOR 2:5:1-c)

- TOR 2:5:1:e Processed/unprocessed fish/algae
- D. Kieser Treatment of water/packing materials used for shipping
- D. Minchin Ship hull fouling

10:30 Coffee Break

Status of Invasions

11:00 The current status of the Rapa Whelk (*Rapana venosa*) in Chesapeake Bay USA (R. Mann)

11:20 A comparative study of the invasion of northern Adriatic and north-east Atlantic coasts by the bryozoan *Tricellaria inopinata* (P. E.J. Dyrynda and A. Occhipinti-Ambrogi)

11:40 Increasing Chinese Mitten Crabs (*Eriocheir sinensis*) in Germany (S. Gollasch)

12:00 Lunch

2:10 Zebra mussel (*Dreissena polymorpha*) in Ireland: Current distribution and impacts (D. Minchin)

2:30 Assessment of routes and modes of Lessepsian migration by molecular tools: preliminary results (S. Shefer, E. Geffen, and A. Abelson)

3:00 Draft Recommendations

3:30 Adjourn

4:00 Visit to Conwy Castle: A Complimentary Visit, in Honor of the ICES Working Group

6:00 Reception in Honor of the ICES Working Group, Presented by the County Council and Town Council

16 April 1999 Friday

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

9:15 *Cercopagis pengoi* in the Baltic Sea (H. Ojaveer)
Update on Italian studies on marine bioinvasions (A. Occhipinti-Ambrogi)
Conceptual Model Approach for Invasive Species (I. Wallentinus)
Nordic Risk Assessment Approach for Invasive Species (S. Gollasch)
Dispersal Vectors: Fish packing boxes (frigolite/wood) (I. Wallentinus)
Dispersal Vectors (TOR 2:5:1:a): *Caulerpa* reference collections

10:30 Coffee Break

11:00 Discussion item: *The listing of non-native species as endangered or protected species* (TOR 2:5:1 d)

11:20 Review of Recommendations: Discussion and Final Editing
Principal Agenda Items for 2000 WG Meeting
Place & Dates for 2000 Meeting

12:00 Adjournment

ANNEX 2: LIST OF PARTICIPANTS

Name	Address	Telephone No.	Fax No.	E-mail
Avigdor Abelson	Institute for Nature Conservation Research Tel Aviv University Tel Aviv 69978 Israel	972 3 6407690, 9813	972 3 6407304	avigdor@post.tau.ac.il
Malcolm I. Campbell	Fish Health Unit Maritimes Region P.O. Box 5030 Moncton, New Brunswick E1C 9B6 Canada	506 851 6247	506 851 2079	campbellm@mar.dfo-mpo.gc.ca
James T. Carton (Chair)	Maritime Studies Program, Williams College – Mystic Seaport P.O. Box 6000, 75 Greenmanvill Avenue Mystic, Connecticut 06355 USA	860 572 5359	860 572 5329	jcarton@williams.edu
Katherine Colgan	Australian Quarantine and Inspection Service (AQIS) Ballast Water Section GPO Box 858, Canberra ACT 2601 Australia	61 2 6272 3198	61 2 6272 3036	katherine.colgan@aqis.gov.au
S.J. (Bas) de Groot	Netherlands Institute for Fisheries Research (RIVO-DLO) 1970-AB IJmuiden The Netherlands	31 255 564 646	31 255 564 644	els@rivo.dlo.nl
Annette Dehalt	West Coast Ballast Outreach Project University of California Sea Grant Extension 300 Piedmont Ave, Room 305A San Bruno, CA 94066 USA	650 871 7559	650 871 7399	acdehalt@ucdavis.edu
Peter E.J. Dyrynda	School of Biological Sciences Unicersity of Wales Swansea Singleton park Swansea SA2 8PP Wales			p.dyrynda@swan.ac.uk
N. Clare Eno Senior Maritime Policy Officer	Countryside Council for Wales Plas Penrhos, Fford Penrhos Bangor Gwynedd LL57 2LQ Wales UK	44 (0) 1248 385674	44 (0) 1248 395510	c.eno@ccw.gov.uk
Michel Gilberg	Fisheries and Oceans Canada Maurice Lamontagne Institute 850, route de la Mer, P.O. Box 1000 Mont-Joli Québec G5H 3Z4 Canada	418 775 0604	418 775 0718	gilbertm@dfo-mpo.gc.ca
Tenguiz Gogothishvili	Georgian Ministry of Environment Convention Inspection Office for Protection of the Black Sea 9 April Street no. 6 Batumi, Georgia	995 222 7 28 50	995 222 7 63 96	(care of) mechat@pop.kheta.ge
Stephan Gollasch	Institut für Meereskunde Düsternbrooker Weg 20 20146 Kiel, Germany	49 431/597 3917	49 40/360 309 4767	sgollasch@aol.com

Name	Address	Telephone No.	Fax No.	E-mail
Norbert Hülsmann	Institute of Zology Free Unicersity Berling Koenigin-Luise-Str. 1-3 14195 Berlin – Dahlem Germany	49 30 838 3921	49 30 838 3916	hulsmann@zedat.fu-berlin.de
Anders Jelmert	Institute of Marine Research Austevoll Aquaculture Research Station N-5392 Storebø Norway	47 56 18 03 42	47 56 18 03 98	anders.jelmert@imr.no
Dorothee Kieser	Pacific Biological Station 3190 Hammond Bay Road Nanaimo, British Columbia Canada	250 756 7069	250 756 7053	kieserd@pac.dfo-mpo.gc.ca
Joel A. Kopp Project Manager	Prince William Sound Regional Citizens' Advisory Council P.O. Box 3089 Valdez, Alaska 99686 USA	907 834 5020	907 835 5926	kopp@valdez.pwsrcac.org
Ian Laing	CEFAS, Conwy Laboratory Benarth Road Conwy LL32 8UB Wales UK	44 1492 593 883	44 1492 592 123	i.laing@cefas.co.uk
Ike A. Levine	Coastal Plantations International, Inc. P.O. Box 209 1219 Maine Street Poland, Maine 04274 USA	207 998 4909	207 998 4909	ikelevine@aol.com
Ian Lucas	Unicersity of Wales, Bangor School of Ocean Sciences Menai Bridge, Anglesey LL59 5EY Wales UK	44 1248 382871	44 1248 382871	oss066@bangor.ac.uk
Roger Mann	School of Marine Science Virginia Institute of Marine Science College of William and Mary Gloucester Point VA 23062 USA	804/684 7360	804/684 7045	rmann@vims.edu
Daniel Masson	IFREMER-DEL La Tremblade B.P. 133 17390 La Tremblade France	33 546 36 98 36 (direct): 33 546 36 76 07	33 546 36 37 51	dmasson@ifremer.fr
Tracy McCollin	University of Wales, Bangor School of Ocean Sciences Manai Bridge, Anglesey LL59 5EY, Wales UK	44 1248 382906	44 1248 382906	oss138@bangor.ac.uk or t.a.mccollin@bangor.ac.uk
Dan Minchin	Fisheries Research Centre Marine Institute Abbotstown, Dublin 15 Ireland	353 1 8210 111	353 1 8205 078	dminchin@frc.ie or minchin@indigo.ie
Toril Loennechen Moen	Museum of Natural History and Archaeology Department of Natural History Erling Skakkes gt. 47a N-7004 Trondheim Norway	47 73 59 66 52	47 73 59 95	tolomo@nvg.ntnu.no or torilm@stud.ntnu.no

Name	Address	Telephone No.	Fax No.	E-mail
Toril Loennechen Moen	Museum of Natural History and Archaeology Department of Natural History Erling Skakkes gt. 47a N-7004 Trondheim Norway	47 73 59 66 52	47 73 59 95	tolomo@nvg.ntnu.no or torilm@stud.ntnu.no
Manfred K. Nauke	Marine Environment Division International Maritime Organization IMO) 4 Albert Embankment London, SE1 7SR, England UK	44 171 587 3124	44 171 587 3210	mnauke@imo.org
Anna Occhipinti	Universitá degli Studi di Pavia Sezione Ecologia – Dipartimento de Genetica e Microbiologia Via Sant'Epifanio, 14 27100 Pavia Italy	39 0382 304610	39 0382 528496	anna.occhipinti@unimi.it or occhipin@unipv.it
Henn Ojaveer	Estonian Marine Institute Viljandi Rd. 18b 11216 Tallinn Estonia	372 6 281 584	372 6 281 563	henn@sea.ee
Anna Shotadze	Georgian Ministry of Engironment Convention Inspection Office for Protection of the Black Sea 9 April Street no. 6 Batumi Georgia	995 222 7 28 50	995 222 7 63 96	(care of): mechat@pop.kheta.ge
Pekka Tuunainen	Finnish Game and Fisheries Research Institute P.O. Box 6 FIN-00721 Finland	358 205 751 1	358 205 751 201	pekka.tuunainen@rktl.fi
Susan D. Utting	CEFAS, Conwy Laboratory Benarth Road Conwy LL32 8UB Wales UK	44 1492 593 883	44 1492 593 123	s.d.utting@cefas.co.uk
Inger Wallentinus	Department of Marine Botany Goteborg University P.O. Box 461 SE 405 30 Gothenburg Sweden	46 (0)31 773 27 02	46 (0)31 773 27 27	inger.wallentinus@marbot.gu.se

ANNEX 3: NATIONAL REPORTS

NATIONAL REPORT FOR CANADA

1 LAWS AND REGULATIONS

The Department of Fisheries and Oceans is continuing to develop a National Policy on Introductions and Transfers of Aquatic Organisms. In 1997 and 1998 there was a major national review of a draft document. DFO has identified this policy as a priority for completion in 1999.

As indicated in previous reports, Canada presently has no federal regulations (Fisheries or Agriculture) which can prohibit or control the movements of marine plants. Efforts are continuing to have aquatic plants added to the 'Fishery (General) Regulations' made under the Federal Fisheries Act, or to some other appropriate legislation. It is hoped that, in the not too distant future, there will be a federal legislative authority to manage introductions and transfers of marine algae and higher plants.

The Department of Fisheries and Oceans is continuing to develop a national Policy on Research with, and Rearing of, Transgenic Aquatic Organisms. A draft policy was distributed for review during 1998. Reviews are presently being considered in Ottawa and it is hoped that a final draft will be completed in 1999.

The Department of Fisheries and Oceans (DFO) continues to work on amendments to the Fish Health Protection Regulations (FHPR) and hopes to have the major revision completed in the near future.

The first draft of the Canadian Shellfish Health Protection Regulations was compiled for release to federal, provincial and non-government specialists for technical review in March 1998. Regional Technical Committees for each coast have been organised and are holding meetings to discuss regional issues pertaining to the draft. The diagnostic technical aspects were sent out for review by international experts in shellfish pathology and diagnostics (USA, France and New Zealand). The disease lists and pertinent information have been put onto a Web Site (http://www.pac.dfo-mpo.gc.ca/sci/sealane/aquac/pages/title.htm) to permit non-regulatory updating as conditions and information evolves.

2 DELIBERATE INTRODUCTIONS AND TRANSFERS

2.1 Finfish

In general, all planned fish movements continue to receive rigorous scrutiny by regional/provincial introductions and transfers committees, which consider disease, genetic and ecological risks. In addition, all transboundary movements of salmonids must satisfy the Canadian FHPR.

Significant numbers of eggs and fish of the established cultured species continue to be transferred into the country, between provinces and intra-provincially, in support of aquaculture (not intended to be released into the natural environment) and enhancement programmes (released into the natural environment).

Atlantic salmon (*Salmo salar*) transfers into British Columbia are restricted to eggs only, as stipulated in the Pacific Region Policy for the Importation of Atlantic Salmon.

Eggs from sockeye salmon (*Oncorhynchus nerka*) returning to two USA/Canada transboundary rivers, Tahltan and Tatsamenie, are collected in British Columbia. They are then transferred to an Alaska quarantine unit using a fish free water supply. Upon hatching and completion of health testing, fish are returned to their native system in B.C.

There continues to be interest in 'new' aquaculture species (e.g. Atlantic cod, *Gadus morhua*; winter flounder, *Pleuronectes americanus*; yellowtail flounder, *Limanda ferruginea*; and Atlantic halibut, *Hippoglossus hippoglossus*) which has resulted in introductions and transfers into the country, between provinces, and intra-provincially for research and developmental purposes.

An Atlantic halibut facility in Nova Scotia imported 50,000 juvenile halibut from Iceland in 1998 (and an additional 50,000 already in 1999) to be grown to market size in totally enclosed seawater tanks. They also have locally-caught adult halibut broodstock which they plan to spawn in 1999.

2.2 Invertebrates

Movements of invertebrates, with the current exclusion of lobsters (*Homarus americanus*), destined for open-water live-holding or release, are reviewed by provincial introductions and transfers committees (ITC). Factors taken into account when assessing risk of adverse effects on the receiving waters include possible disease, genetic and ecological impacts.

In Atlantic Canada, American oysters (*Crassostrea virginica*), European oysters (*Ostrea edulis*), blue mussels (*Mytilus edulis*), soft-shell clams (*Mya arenaria*), hard-shell clams (*Mercenaria mercenaria* and *M. m.* var. *notata*), bar clams (*Spisula solidissima*), giant sea scallops (*Placopecten magellanicus*) and bay scallops (*Argopecten irradians*) were transferred as seedstock, for broodstock or for relay purposes, throughout the region in 1998. As in previous years, all official movements of shellfish destined for hatchery use or for remote setting, are screened for parasites, pests and diseases, prior to transfer (1997 = 78 cases; 1998 = >100 cases). Research on 'new' shellfish species for aquaculture, is principally responsible for the increase in ITC requests over the last two years.

As mentioned in the 1998 Canadian report, an official introduction of 125 hard-shell clams, *Mercenaria mercenaria* var. *notata* was made from Massachusetts, USA into quarantine at a Provincial hatchery on Prince Edward Island. Twenty-five adults were sampled on arrival and their seed were released from quarantine in early 1998. All remaining broodstock were sampled from quarantine and examined histopathologically. Tissues were also cultured in Fluid Thioglycollate Medium for screening for *Perkinsus* spp. No pathogens of disease concern were detected.

In British Columbia, Manila clam (*Tapes philippinarum*) and Pacific oyster (*Crassostrea gigas*) seed continue to be imported from shellfish health-certified sources in the Pacific North-West States and Hawaii, USA for beach seeding purposes.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

The St. Lawrence/Great Lakes

The zooplankton crustacean (cladoceran) *Cercopagis pengoi*, was discovered along the north side of Lake Ontario in the summer of 1998 and, by late August, these exotic crustaceans were reported throughout Lake Ontario. The long caudal appendage of this waterflea becomes entangled on fishing lines of anglers and gill nets. As with other recent exotic invertebrates, *C. pengoi* was believed to have been transported by ballast water from its native range in the Ponto-Caspian region of Eastern Europe (MacIsaac *et al.*, 1999). *Cercopagis pengoi* is a predatory crustacean which, like Bythotrephes (another exotic species to the Great Lakes), may compete for zooplankton prey with juvenile fish.

The amphipod *Echinogammarus ischnus*, which became common throughout Lake Erie in 1997, was collected in the St. Lawrence River west of Montreal in 1998. The Ministère de l'Environnement et de la Faune de Québec is concerned about the potential impacts of this exotic amphipod on the native biota in the St. Lawrence River and about future range expansion.

Atlantic Canada

The green crab (*Carcinus maenas*) were first noted in St. Andrews, New Brunswick (Bay of Fundy) in the mid 1950s, and in southern Nova Scotia not long after. Since then there has been a continual northward expansion along the Atlantic Ocean shore of Nova Scotia to just east of Cape Sable by 1961, as far as St. Margaret's Bay in the 1970s, and, according to a 1998 report, along the Atlantic coast of Cape Breton. Discussions with lobster and eel fishers have indicated that green crabs have been caught in the Bras d'Or Lakes and along the western (Gulf of St. Lawrence) coast of Cape Breton as well. A 1972 report indicates that green crabs were found along the Nova Scotian shore of the Northumberland Strait (Port Howe, Pugwash, St. Patrick's Channel, Merigonish Harbour) back as far as 1960; however there have been no substantiated reports of green crab along the Gulf of St. Lawrence coast of New Brunswick.

The green crab was first reported along the eastern end of Prince Edward Island (Northumberland Strait) in the early fall of 1998. It was found by eel fishermen and appears to be at high densities in certain bays. The PEI Department of Fisheries and Tourism has circulated a poster with a picture and description of the crab to active rock crab fishers in an attempt to determine its distribution around the Island. The PEI Department of Fisheries and Tourism is also working to establish an exploratory fishery during the 1999 field season to determine if the crab has any commercial potential and if numbers can be controlled in clam culture areas.

The clubbed tunicate, *Styela clava*, was first identified on a market mussel crop from the Brudenell River (eastern end), Prince Edward Island, in January 1998. This is the first report of this fouling organism occurring in PEI. The PEI Department of Fisheries and Tourism believes that it may have been introduced to PEI by ship or boating activities in the area. The tunicate successfully survived the winter of its discovery and, although the numbers appear to be low, there were reports of sporadic colonies from the area just prior to the freeze-over of this past winter. They will continue to monitor its population, with the shellfish industry, in the Brudenell River area to try to determine if the species will become a fouling problem.

3.3 Algae and Higher Plants

The apparent spread of a seaweed identified as *Codium fragile tomentosoides* in Atlantic Canadian waters was reported at the 1996, 1997, and 1998 meetings. The 1998 report highlighted the effect that *C. fragile* was having on shellfish, particularly oyster culture, in Prince Edward Island. The PEI Department of Fisheries and Tourism continues to monitor the *C. fragile* populations in Enmore Bay (Northumberland Strait side of the Island) and Malpeque Bay (Gulf of St. Lawrence side) and has identified one isolated finding on mussel lines in Tracadie Bay (also on the Gulf of St. Lawrence side).

They are still experimenting with various treatment immersion trials in an attempt to control the seaweed's spread with shellfish movements. Although they have not yet analysed all of the field data from 1998, it appears that immersion treatments which seemed to be effective in the 1997 trials (4% hydrated lime; saturated brine; - as reported last year) may not be as effective as first believed. It appears that over long periods the plants may recover from treatments with the speculation that holdfast material in the crevices of shells may survive to grow new plants. As well, they had manually removed all *C. fragile* from an area by diving in 1997 and by late 1998 the population had almost totally recovered. The PEI Department of Fisheries and Tourism is continuing their efforts to find a way of minimising *C. fragile's* effect on their shellfish industries and, in conjunction with the federal Department of Fisheries and Oceans, are also performing growth, reproductive, and DNA studies on the seaweed.

4 LIVE IMPORTS AND TRANSFERS NOT LIKELY TO BE RELEASED OR USED IN AQUACULTURE

A wide variety of marine and freshwater organisms continue to be imported into Canada and/or transferred between provinces for research, display or for human consumption purposes. The organisms are usually held in quarantine or other containment facilities, and are generally destroyed after research is completed or used as food. Although we believe that the stringent conditions of quarantines and many containment facilities effectively eliminates the risks that such importations may pose to Canadian fisheries resources, we are still unable to assess the true risks from other cases, such as the large scale importation of live fish for human consumption.

Fish brought in for live table market sales are now primarily under the jurisdiction of the Canadian Food Inspection Agency (CFIA) and, thus, are no longer reviewed by the federal-provincial introductions and transfers committees. (Species regulated under the Pacific Fisheries Regulations, 1993, must be reviewed by the federal-provincial Fish Transplant Committee in British Columbia. In 1998 there were no applications to import marine species listed in these Regulations.) Annex 1 summarises the live fish importation information provided by CFIA.

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES

Canadian aquaculturists continue to ship Atlantic salmon (*Salmo salar*), Arctic charr (*Salvelinus alpinus*), brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*) and Arctic charr x brook trout hybrid, eggs and fish to the USA subject to US Title 50 fish health conditions.

In 1998 an aquaculturist in Quebec with a facility certified under the Canadian Fish Health Protection Regulations (FHPR) sent shipments of Arctic charr and brook trout eggs to France. Arctic charr eggs were also exported from a Yukon farm certified under the Canadian FHPR to France, Germany, Ireland, and Poland.

British Columbian marine fishes were exported for aquarium use in the following countries: Belgium, China, France, Netherlands, and Portugal. The species exported are listed in Annex 2.

One hundred and twenty-five 2-year-old European oysters (*Ostrea edulis*) were shipped to research quarantine facilities at the University of Maine, Orono, from southeast Nova Scotia, in March 1998, as part of ongoing investigations in collaboration with IFREMER (as reported last year), The Netherlands and Eastern US, on bonamiasis and oyster susceptibility (c.f. ICES CM 1997/F:6 Tor (i)). All oysters were sacrificed for diagnostic examination in September 1998; no infections were detected. In addition, a commercial supplier of European oysters from Atlantic Canada was

certified free of any contagious disease agents, including all EC and OIE agents of disease concern (*Marteilia refringens* and *Bonamia ostreae*). This grower shipped stock to Belgium in late Spring 1998 for fattening and marketing for human consumption only.

6 PLANNED INTRODUCTIONS AND TRANSFERS

6.1 Finfish

Continued importations and transfers of various species of finfish for aquaculture, enhancement and research purposes from other provinces in Canada and from international sources are likely.

6.2 Invertebrates

Continued importations and transfers of invertebrates for aquaculture, enhancement and research purposes from other provinces in Canada and from international sources are likely.

7 MEETINGS, CONFERENCES, SYMPOSIA OR WORKSHOPS

Eighth International Zebra Mussel and Aquatic Nuisance Species Conference, Sacramento, California. March 1998 (R. Dermott).

Marine Bioinvasions Conference, Boston. January 1999 (Dr. A. Niimi)

The formation of a new Regional (Great Lakes, St. Lawrence River) Ballast Water Working Group was initiated. A preliminary meeting was held in February 1999 to discuss the Terms of Reference and membership (C. Wiley, A. Niimi, R. Dermott).

ANNEX 1

Species	Country of origin	Lots Imported
Abalone	China	4
Abalone	Hong Kong	4
Abalone	United States	44
Amur	United States	20
Aquatic Snail	United States	16
Bass, Freshwater	United States	131
Bass, Sea	United States	11
Blackfish	United States	26
Bream, Sea	United States	1
Buffalofish	United States	5
Carp	United States	159
Catfish, Freshwater	United States	13
Clams	New Zealand	15
Clams	United States	1083
Cockles	New Zealand	2
Cod, Unsp	United States	36
Conch	United States	168
Crab	Chile	2
Crab	China	21
Crab	Hong Kong	18
Crab	India	4
Crab	Trinidad &Tobago	3
Crab	United States	1355
Crayfish	United States	9
Eel	China	38
Eel	Hong Kong	39
Eel	New Zealand	7
Eel	United States	27
Fish (Misc)	Cuba	
Fish (Misc)	United States	21
Geoduck	United States	609
Grouper	United States	1
Kingfish	United States	1
Loach	Japan	1
Lobster	Canada	1
Lobster	Chile	3
Lobster	Cuba	300
Lobster	Mexico	3
Lobster	United States	4791
Mackerel	United States	1

Species	Country of origin	Lots Imported
Mussels	Canada	4
Mussels	New Zealand	27
Mussels	United States	428
Oyster	United States	674
Periwinkle	Canada	2
Periwinkle	United States	58
Rockfish	Cuba	1
Salmon, Atlantic	Chile	1
Salmon, Atlantic	United States	2
Scallop	United States	44
Sea Urchin	United States	170
Shark	Hong Kong	1
Shrimp	Hong Kong	1
Shrimp	United States	93
Snakehead	China	1
Snakehead	Hong Kong	39
Sucker	United States	13
Tilapia	United States	258
Trout	United States	1
Whelk	United States	16

Information from the Canadian Food Inspection Agency

ANNEX 2: British Columbia marine species shipped to aquariums in other countries

Finfish

Amphisticus rhodoterus, Anarrichthies ocellatus, Apodichthies flavidus, Blepsias cirrhosus, Brachyistus frenatus, Citharichthies sordidus, Coryphopterus nicholsi, Cottidae (various), *Cymatogaster aggregata, Embiotoca lateralis, Enophries bison, Eumicotremus orbis, Hemilepidotus hemilepidotus, Hexagrammus lagocephalus,Hexogrammus decagrammus, Hyperprosopon ellipticum, Jordania zanope, Leptocottus armatus, Nautichthies oculofasciatus, Oxylebius pictus, Pholidae* sp., *Porichthies notatus, Rhamphocottus richardsoni, Sebastes caurinus, Sebastes maliger, Sebastes melanops, Sebastes mystinus, Sebastes nebulosus, Sebastes nigrocinctus, Syngnathus griseolatus.*

Invertebrates

Coelenterata

Anthopleura elegantissima, Anthopleura xanthogrammica, Corynactis californica, Cribrinopsis fernaldi, Metridium senile.

Mollusca

Astraea gibberosa, Ceratostoma foliatum, Cryptochiton stelleri, Octopus dofleini,Tegula funebralis.

Echinodermata

Cucumaria miniata, Dermasterias imbricata, Henricia leviuscula, Mediaster aequalis,Orthasterias koehleri, Parastichopus californicus, Patiria miniata, Pycnopodia helianthoides, Pisaster brevispinus, Pisaster ochraceus, Solaster dawsoni, Solaster stimpsoni, Strongylocentrotus droebachiensis, Strongylocentrotus franciscanus, Strongylocentrotus purpuratus.

Crustacea

Lopholithodes mandtii, Paguridae, *Pandalus platyceros, Scyura acutifrons.*

NATIONAL REPORT FOR ESTONIA

1 LAWS AND REGULATIONS ON INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

Law on Protected Natural Objects (1994, amended 1998): in order to prevent danger to ecosystems, release of non-native species into the wild is prohibited, with the exception of scientifically justified re-introduction with the approval of the Ministry of Environment.

Act on the Protection of Wild Fauna (1998): release of non-native animals into the wild is prohibited except in cases of re-inhabiting of specimens of alien populations of native species or reintroduction of animals that become extinct in the territory of Estonia is permitted with a permit issued by the Minister of Environment on a basis of expert analysis and in concordance with veterinary requirements.

2 DELIBERATE RELEASES TO THE BALTIC SEA

2.1 Fish for the enhancement of fishery resources

Sea trout: 2-summers - 30.46 thousand, eel: fry - 1 000, whitefish: 0-group Ð 123.05 thousand, pike: larvae - 1 million., fry - 3 million, 0-group - 8.56 thousand, pikeperch: 0-group - 38.94 thousand.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

The latest known newcomer to the Baltic, the cladoceran *Cercopagis pengoi*, which was first found in the northeastern

part of the Gulf of Riga in 1992, has spread over the Estonian coast during subsequent years, including the Gulf of Finland. Another alien species, the worm *Marenzelleria viridis*, was found to be widely distributed in the Gulf of Riga during 1994–1997.

4 LIVE IMPORTS

4.1 Fish. 1000 specimens of eel fry from the UK.

NATIONAL REPORT FOR FINLAND

1 LAWS AND REGULATIONS

Disease regulations concerning import of live aquaculture and fishery animals and products from EU countries and from non-EU countries have been modified according to EU Directives. At present, the whole territory of Finland has an approved programme status for viral diseases IHN and VHS and import of live fish, eggs or gametes of susceptible species is allowed only from zones or farms approved free of IHN and VHS according to the Council Directive 91/67/EEC.

The Act on Fisheries concerning the import of new fish and crayfish species was amended in 1998 to include new stocks as well.

In 1998, amendments were made to the Decision on Animal Diseases to be combated and Disease Notification.

The decision on restricting transports of live fish, eggs and gametes from the coastal areas to the continental areas (1087/1998) concerning IPN, VHS and ISA came into force in 1998.

2 DELIBERATE RELEASES

2.1 Fish

Deliberate releases into the Baltic Sea area (including rivers draining into the Baltic) for fisheries enhancement purposes were as follows in 1998:

3.3 million salmon (*Salmo salar*) juveniles

1.5 million salmon eggs and fry

1.8 million sea trout (*Salmo trutta* m. *trutta*) juveniles

1.1 million sea trout eggs and fry

Whitefish (*Coregonus lavaretus*) releases like previous years, exact numbers not available

About 16 mill. kg of rainbow trout (*Oncorhynchus mykiss*) was cultivated in net cages for human consumption in the Finnish Archipelago. Natural reproduction of rainbow trout does not occur in Finland.

As in previous years, veterinary authorities allowed the import of elvers from England via Swedish quarantine to be released into inland waters in southern Finland.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

No reported or known cases.

4 LIVE IMPORTS

4.1 Fish

Rainbow trout juveniles (40 900 kg) from Sweden to land, elvers (see 2.1) from Sweden, tropical aquarium fish.

4.2 Invertebrates

As in previous years, aquarium shops and some restaurants and stores may import live marine animals such as oysters, lobsters and crabs for sale or consumption without the authorisation of the Veterinary Department because it is obvious that they cannot survive in natural Finnish waters.

4.3 Algae or Higher Plants

None apart from aquarium plants.

6 PLANNED INTRODUCTIONS

6.1 Fish

There is growing interest to introduce grass carp (*Ctenopharyngodon idella*), sheatfish (*Silurus glanis*) and nelma (*Stenodus leucichthys*) in Finland.

6.2 Invertebrates

None apart from signal crayfish.

NATIONAL REPORT FOR FRANCE

1 LAWS AND REGULATIONS

A new State Decree enacted in May 1998 (N 98-391) has updated the N 95-100 (01-95) decree regulating the zoosanitary conditions for aquaculture of living molluscan and crustacean species. This decree specifies that every farmer involved in rearing and marketing shellfish must be able to provide a register containing the information on shellfish deliveries (inputs and outputs), total weight, number and origins so as to facilitate the traceability of living shellfish products. The registers should be kept at least 4 years and can be controlled by EU experts with State representatives. Moreover, a compulsory declaration by the farmers is required in case of abnormal mortality rates, defined as a 15% loss of the living stock over 15 days, or in the hatchery when larval production still fails after a month of successive spawnings with several individuals. In case of an abnormal mortality, a zoning can be established by the State administration to impede any transfer. After zoosanitary monitorings, this zone remains closed until the end of the abnormal mortality rates and until, if observed, the risk of disease spread or pathogen transfer has ceased.

A law proposal on the prevention and control of the spread of *Caulerpa taxifolia* is currently under review. If enacted, this law would complement the N 92-3 law on Water and the N 95-101 law on natural risks prevention, which already has regulations to forbid any exotic species introduction into natural ecosystems. The proposal focuses on increasing public information on the *Caulerpa* issue, a compulsory declaration of any sighting, as well as on site cleaning of boat anchors and any material which can facilitate the spread, to forbid any *Caulerpa* sale except for the native species *Caulerpa prolifera*, and to equip any boat using ballast water with a filtration system aimed to protect maritime routes and harbours of any further spread. A coordination among state agencies, and research institutes will be developed to propose a framework for monitoring, eradication methods and controls.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Molluscan

The 'Slipper Limpet' *Crepidula fornicata* (Gastropoda)

This species, well distributed along the French Atlantic coastline, has reached in specific locations, a very high density

(e.g., 250 000 metric tons in the Bay of St Brieuc) interacting significantly with other species, including commercial species and fisheries (e.g., scallop *Pecten maximus*). A comprehensive research program (RP LITEAU) is currently under development by four research institutes and funded by the French Ministry of the Environment. It aims to assess 1) interactions between environmental factors and species proliferation, 2) effects on biodiversity, 3) interactions with species of commercial interest, 4) improve knowledge on proliferation mechanisms for this species to develop a spatialised model to simulate population removal, and 5) the efficiency of management practices to limit invasion. Four sites along the Atlantic coastline will be the focus of this research programme.

The 'Rapa Whelk' *Rapana venosa* (Gastropoda)

Three living adult gastropods *Rapana venosa* were collected in a subtidal area of the Bay of Quiberon (Southern Brittany) (Biometric characteristics, height 140 and 136 mm; width 101-102mm). Originating from the tropical Indo-Pacific region, this species was introduced into the Black Sea and Marmara Sea during the 1940s and then has spread to Aegean and Adriatic Seas. The first animal was sighted in June 1998 and no individual has been observed since then. A local enquiry permitted to track and verified another sighting back to summer 1997. In the quarantine station at the research laboratory before destruction, these individuals could efficiently prey on the locally reared cupped oyster *C. gigas*, and therefore is a potential threat in case of further development. No juvenile has been found and there is yet no evidence that a local population is established. An on-going investigation is assessing the potential sources and origin of this introduction.

The 'Oyster Drill' (Muricidae) *Ocinebrellus inornatus* (Gastropoda)

A new species of gastropod *Ocinebrellus inornatus* (= *Ocenebra japonica*) has been observed along the French Atlantic coastline, in the Marennes Oleron and Arcachon Bays. The first sighting was observed in April 1997, but seems to be more common since 1998, a year showing a large recruitment of gastropod species. The species spread is likely increased by shellfish trades. With a native NW Pacific range and distributed in the NE Pacific as well, the introduction vector is unknown and might be related to either ballast waters or shellfish trade.

3.2 Crustacea

The Shore Crab *Hemigrapsus penicillatus*

The first sighting of *Hemigrapsus* was reported in 1994 around La Rochelle harbour (Atlantic coastline), then spread quickly northward to the Loire estuary and southward to Laredo (Spain). In 1997, the species distribution did not show further extension. However, a new sighting was reported in wet-docks waters in Le Havre (Normandy, English Channel). This subtidal population, sampled by scuba diving, is likely to facilitate further extension in nearby waters (English Channel, North Sea). This disjunct distribution suggests spread by remote dispersal of mobile adults. The 1998 monitoring demonstrated a further spreading along the Spanish coasts. No northern spread has been observed up to March 1999, and no sighting has been reported in southern Brittany. However, a further progression to the northern coastline is still expected in the near future. The population observed in 1998 in Le Havre harbour docks is still growing.

The Portunid Crab *Callinectes* sp.

Following the inventory of decapods in France, a first sighting of a juvenile *Callinectes* sp. was reported in 1998 within the national marine sanctuary waters of Port Cros (Mediterranean Sea). Later this sighting was identified as *Portunus hastatus*, a European species from the Eastern Mediterranean Sea, and new to the French coastline.

3.3 Invertebrates

Tube Worm *Ficopomatus enigmaticus* (= *Mercierella enigmatica*) (Polychaeta, Serpulidae)

This species was first noticed in France in 1921 (Fauvel, 1923). Local population outbreaks showing rapid buildup were recently reported in the Bays of Veys (Normandy), in southern Brittany (Lorient) and in the Atlantic southwest coast of France (Poitou-Charentes) at the near vicinity of harbours in brackish waters. Although without significant environmental impacts reported, these outbreaks had several impacts on harbour management and structures (e.g., pipe clogging, blocking tide-gates) as well as on ships. The latter case facilitates spread by dispersal of mobile adults on ships' hulls. A national monitoring will be carried out in 1999 to assess the species distribution and impacts.

3.4 Algae and Plants

Caulerpa taxifolia

Since the first sighting of *Caulerpa taxifolia* on the French Mediterranean seaside, this species has extended its distribution considerably (4600 ha. in 1998), colonising areas in Croatia, Monaco, Italy and Spain. An additional exotic species *C. racemosa* is presently observed in the oriental Mediterranean Sea and was recently reported in Genoa (Italy) and Marseille (France). In 1998, several campaigns were carried out to assess the present distribution of *Caulerpa taxifolia* (first estimates 4600 ha.). This species is increasing in Monaco as well as in the Larvotto marine sanctuary, where eradication trials failed and resulted in further extension of this species by dissemination. In Monaco, (Fontvieille harbour) several overlaid strata are now observed and an extension to depths reaching 100 m. Around the French-Italian border, the majority of harbours are colonised, with *Imperia* entirely covered by *Caulerpa*. Monitorings demonstrated that colonization is occurring from the harbours where the highest density is observed. Therefore, fishing and maritime activities appear to be the main vectors for the species spreading. Outside the harbours, *Caulerpa* colonizes Cymodocea and decayed *Posidonia oceanica* seagrasses. First sightings of *Caulerpa*, within dense *P. oceanica* seagrass, were observed in 1998. Besides the spread, a direct predation on *Caulerpa taxifolia* was observed for the first time from the molluscan *Lobiger serradifalci*, a rare and tiny species, which is known to feed on local caulerpales and might be a potential species for biological control. More monitorings are scheduled in 1999 on this species.

Salt Marsh Cord Grass *Spartina anglica* (*S. townsendii*)

The common cord grass species, initially resulting from the crossing of the North American species *Spartina alterniflora* with the native *S. maritima* (occurrence in the UK prior to 1870) was first observed in France in 1906 (Bays of Veys, Normandy). The first sighting in the Bay of Arcachon (southwest of France) occurred in 1985 and has spread quickly since then on the mudflats. Presently, hundreds of hectares have been colonized by this species. The pilot study conducted in 1997 and 1998 to limit the species colonization was based on quicklime injection into the mud (15 cm deep) to destroy the rhizome over several hectares. The first results showed that quicklime was partly efficient; although not eliminated, it induced a significant decline of the *Spartina* population over time. However, quicklime concentration required for a total destruction (40T/ha.) is too high for an ecological use.

4 LIVE IMPORTS

4.2 Invertebrates

Based on the farming industry, Pacific cupped oysters *Crassostrea* gigas were imported for direct marketing from Ireland, Portugal, Netherlands, and the UK.

6 PLANNED INTRODUCTIONS

6.2 Invertebrates

Several strains of *C. gigas* were imported and are currently being held under total quarantine (closed system) at the IFREMER's research hatchery in La Tremblade for genetic studies.

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

The fourth International Workshop on Caulerpa taxifolia in La Spezia, Italy, 1–2.02.99/44 oral communications, 17 posters and 2 videos.

Several meetings in France among State Administrations and Research Institutes concerning the OSPAR Convention for the Region IV, Bay of Biscay. Comprehensive review of the knowledge incorporating, among others, data on pests and disease transfers.

NATIONAL REPORT FOR GERMANY

1 LAWS AND REGULATION

A Federal law on Nature Preservation (BNatSchG) prohibits the treatment of any native species. Native is defined as A wild animal or plant species is native if its area of distribution or of regular migration wholly or partly, 1. lies in the area

of jurisdictions of this act or has done so in historical periods, or 2. spreads by natural means into the area of jurisdiction of this act. A wild animal or plant species is equally regarded as native, if animals and plants of that species have reverted to the wild state or have become naturalised by human influence and have maintained populations in the natural environment during several generations without human help in the area of jurisdiction of this Act. According to this definition former introduced species are native if they become established for several generations in a certain region. The treatment of an introduced pest species would be illegal under this Act if the species establishes a self-sustaining population for several generations.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

No new accidental introductions were reported from German marine or brackish waters in 1998. The following paragraphs present news of previously reported non-indigenous species.

Near the island of Sylt in the North Sea, *Crassostrea gigas* are grown on oyster trestles. The oyster farm has been active for more than 10 years. While the seed oysters usually originate from certified hatcheries in Ireland, there were several times that it was necessary to postpone direct importation from the hatchery because of long winters and the extreme weather conditions. Because of the space needed to keep seed oysters longer than anticipated by contract, juvenile oysters had to be 'parked' for a few days or at most for two weeks outside the hatchery in Ireland. This has led to some fouling, and gradually through this (but also through other pathways) non-indigenous species were transmitted. Therefore, through these oyster imports, the culture site served as a gateway for other species into this part of the Wadden Sea. These include the seaweed *Sargassum muticum* and the ascidian *Styela clava*, which originate from the Northwest Pacific and the seaweed *Ascophyllum nodosum* and the ascidian *Aplidium nordmanni* from the north Atlantic. All species have been found previously, but were re-introduced accidentally by this aquaculture farm.

3.2 Invertebrates

The Shipworm *Teredo navalis* (Mollusca, Bivalvia)

In former times it was believed that *Teredo navalis* was introduced several times with water currents or ships ballast water from the North Sea. Nowadays, *Teredo navalis* can be considered as fully established with self-sustaining populations also in the Kiel Bight and further east of Rostock (Baltic Sea). Damage to wooden installations occurs in ports and experimental trials are presently undertaken to test alternative materials, mainly synthetics based on fibre glass components, instead of wood. A feasibility study for several materials is in progress.

The Worm *Marenzelleria viridis* (Polychaeta)

In the German part of the Baltic Sea *Marenzelleria viridis* continues to show intensive populations supporting increasingly benthic feeding fish populations such as the flounder.

The eel nematode *Anguillicola* sp.

The reported level of the swimbladder nematode infestation remains unchanged (up to 90% of the caught eels are infested).

The Zebra Mussel *Dreissena polymorpha*

As in many other countries the Zebra Mussel is spreading further. The improvement of the water condition in the Elbe river in the last years, mainly due to additional urban waste water treatment plants supported this trend. A major company, located near Hamburg, spent about 1,1 million US$ to clean the pipes and water intakes mechanically from the increasing fouling of the Zebra Mussel in 1998.

The Mitten Crab *Eriocheir sinensis*

Since the beginning of the 1990s, about 60 years after the known extreme mass occurrence in German rivers, the Chinese Mitten Crab is now becoming very abundant again. In spring 1998, 850 kg of juvenile crabs were caught by hand in the river Elbe in two hours only. It is supposed that the daily catch could summarise to more than 3,000 kg of juvenile crabs. This amount of species is comparable or even higher than the data of the 1930s (in max. 2,500 kg of crabs were caught in one day), the peak of the former mass occurrence in German waters. In 1999 the same trend was observed. During mass occurrences of the crab a loss of the harvest of the estuarine and inland fishing industry is

known due to its feeding activity on the fish and the fish food. The crabs cause damage to dams, retaining walls and irrigation channels by perforating them with burrows. Openings of the burrows reach 12 cm and a length of 50 cm. During the mid 1930s up to 30 holes per meter square in river banks of the mouth of river Elbe were found. Very recently, the crab was found in the Kiel fjord. It has not been found in the regions since 1910 and the record might be quoted as an indication of an increasing tendency in the population size.

4 LIVE IMPORTS

4.1 Fish

Several sturgeon species are still imported from Russia by local farmers for small-scale culture. Among them is the Siberian sturgeon *Acipenser baeri.* Rare records of wild caught exotic Sturgeon species (mostly *Acipenser baeri*) and hybrids were reported.

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

As in 1996 and 1997 further public aquaria will be opened along the German North Sea and Baltic coast in the next two years making the import of living species necessary.

4.2 Invertebrates

The oyster farm located on the most northern German island (Sylt) of the Wadden Sea imports several 10,000 juvenile oysters annually. The exact number of the *Crassostrea gigas* imported (mostly from hatcheries in Ireland) is not known. The Pacific oyster culture resulted in the establishment of the species itself in the Wadden Sea outside the oyster farm. *Crassostrea gigas* has reproduced successfully, and strong spatfalls occurred already in 1991 and 1994 on natural mussel beds. The wild oyster population comprised about one million in number during the summer of 1995. Re-sampling by scientists from the Biologische Anstalt Helgoland in 1996 revealed a survival of 66% in spite of a foregoing severe winter. Oysters growing on mussel beds attained a length of 20 to 50 mm in their 1st year and 50 to 80 mm in their 2nd year. Some of the oysters were larger and presumably much older, indicating that some specimens had survived since the 1991 reproduction. Abundance was highest (up to 8 oysters per m^2) on exposed mussel beds at low tide level. These mussels were not covered by any of the common macroalgae. It is expected that *C. gigas* will become a permanent member of the biotic community in the Wadden Sea. It does not invade the vacated niche of the regionally extinct European *Ostrea edulis* but lives as an epibiont on densely packed mussels. *C. gigas* here constitutes an r-selected species invading a crowded community in an undisturbed habitat.

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

Live crustaceans (*Nephrops norvegicus, Homarus gammarus, H. americanus, Callinectes sapidus* and *Cancer pagurus*) have been imported for human consumption from various countries in unknown quantities.

5 LIVE EXPORTS

5.2 Invertebrates

Living juvenile Chinese Mitten Crabs were shipped to China for re-stocking purposes. In the first test 60 kg of crabs were collected and sent by an air courier from Germany via The Netherlands. The commercial fisherman holds an option to ship 10 tonnes of crabs to China annually. Neighbouring countries (Taiwan, Korea and Japan) indicated their interest to import juveniles from Germany as well.

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

EU Concerted Action 'Testing Monitoring Systems for Risk Assessment of Harmful Introductions by Ships to European Waters'

The first workshops of the EU Concerted Action had been held during the last year. Case histories of well-known introduced species in European waters were compiled and public awareness material (including posters, handouts, flyer and press releases) was prepared. Shortly an Internet homepage will be designed. During two intercalibration workshops various sampling techniques on ballast water were compared. A known density of zoo- and phytoplankton

species was sampled from a plankton tower. The results of the effectiveness of the applied methods varied from >95% to <4%. Short-term ocean-going workshops have been undertaken in order to investigate the survival rate of species in ballast water during ship voyages. In 1999 long-term voyages will be undertaken. The Concerted Action invites open discussion and opportunities for joint studies by means of land based or sea going workshops. We welcome those who would like to become involved who have interests in this regard and are prepared to contribute. For further information, please contact: sgollasch@aol.com

Presently work is going on regarding genetic studies (including DNA finger prints) on populations of *Teredo navalis* and *Marenzelleria* spp. both above mentioned species in both, the North Sea and the Baltic Sea.

A study is underway gathering fishing peoples information on the distribution and population density of the Chinese Mitten Crab in German waters during the last decades.

8 BIBLIOGRAPHY

The bibliography on 'Transplantations of Aquatic Organisms' is nearly finished now and includes over 11,000 entries. With the existing search profile and various indices, the only reasonable means would be to publish the bibliography as CD-ROM. It is hoped to publish the bibliography in the end of 1999.

NATIONAL REPORT FOR IRELAND

2 DELIBERATE RELEASES

2.1 Invertebrates

The abalones *Haliotis tuberculata* (from the Channel Islands) and *H. discus hannai* (from Japan) continue to be cultivated on west, southwest and south Irish coasts. *H. discus hannai* has been cultivated in open sea barrels for 10 years, by means of grow-out of reared spat.

The clam *Venerupis philippinarum*, is cultivated using hatchery seed. This is grown under mesh in a number of bays and estuaries on all Irish coasts. The brown-ring disease-like symptoms in clams on the north-west Irish coast may be from an endemic and less virulent form of the disease.

The Pacific oyster *Crassostrea gigas*, is produced in Irish hatcheries and is also imported from Northern France. Cultivation takes place on all Irish coasts with the main production from Carlingford Lough (east coast) and Dungarvan Bay (south coast).

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Ship and boat fouling. Two barques visiting Dublin during the 'tall ships' event in Dublin during August 1998 had extensive colonies of barnacles. These included *Balanus amphitrite* and several non-native species. The samples are being examined in Australia and compared with a sample collected in Australia earlier in the same year. A small boat returning to Cork from the Mediterranean Sea had some thousands of *B. amphitrite* attached to the hull, together with the mussel *Mytilus galloprovincialis*.

The nematode parasite of eels, *Anguillicola crassa*, has been found in 1998 on the Shannon River.

The zebra mussel, *Dreissena polymorpha*, has expanded its range into northern Lough Erne. It is now present throughout the Shannon and Boyle Rivers where small craft may pass. Small numbers were found in the winter of 1998/99 in the western region of the Grand Canal, which links the Shannon to Dublin. There are indications of increased water clarity in Loughs Derg and Ree and many dead shells of *Anodonta anatina* were found in Lough Derg with >1000 attached zebra mussels, these populations are likely to expire soon. Fouling of power plants and municipal water works was noted during the year. The public awareness campaign on advising anglers on the risks of transporting zebra mussels to lakes by overland transport appear to have been successful.

4 LIVE IMPORTS

4.1 Fish

Atlantic salmon eggs were imported from Iceland (7.1 million), Scotland (2.9 million), England (1 million). Fingerlings were imported from Northern Ireland (0.6 million).

Arctic charr eggs were imported from Canada in three consignments (1.2 million).

Rainbow trout eggs were imported in three consignments from South Africa (0.65 million), six consignments from Denmark (1.5 million) and northern Ireland ((0.26 million).

Turbot fry were imported for research (350) and cultivation (5000) from the Isle of Man.

Glass eels were imported for cultivation from England (150 kgs).

4.2 Invertebrates

Pacific oyster seed has been imported from France (31.6 million) and the UK (36.7 million) and half-grown oysters from Cumbria, UK, were of six consignments amounting to 16.3 tonnes.

The flat oyster *Ostrea edulis* was imported from the NW coast of England (38,000 seed).

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES AND OTHER AREAS

5.1 Fish

No significant changes since last year.

5.2 Invertebrates

No significant changes since last year.

7 MEETINGS

Societas Internationales Limnologia (Limnological Congress) met in Dublin in August 1998. Several papers on zebra mussels were presented. In addition there was an unplanned meeting addressing the question of exotic species, and from this a special group on species introductions has been set up.

The Royal Irish Academy in Dublin (February 1999) held a meeting entitled 'Biological invaders: the impact of exotic species'. This covered exotics introduced by gardeners, farmers, silviculturalists and by other means, including shipping. Proceedings are expected to be published in autumn 1999.

10th International Congress on Marine Corrosion and Fouling, Melbourne (February 1999). The presentations consisted of new paint coatings, corrosion, effects of TBT, biochemistry and biofilms and some papers on fouling and exotic species movements. Selected papers will be published.

NATIONAL REPORT FOR THE NETHERLANDS

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Fish

No significant addition to the 1997 report, however, the reappearance in our coastal waters and Yssel Lake of the houting (*Coregonus oxyrhynchus*) was noticeable. It is assumed that these houting are the result of the Danish houting programme (River Ribe) and the German restocking programme in the River Eider. Another coregonid (*C. lavaretus*) is caught yearly in large rivers (e.g., Rhine). The source of the release is likely to be found in German waters.

Another remarkable observation was that several labrid species, rare for the Netherlands, were recently caught in stake nets in the 'artificial' estuary of the Rhine near Rotterdam (Nieuwe Waterweg). The large scale use of boulders and concrete blocks offered a suitable habitat for the species, in our normally sandy shore.

3.2 Invertebrates

On an annual basis, the blue crab (*Callinectes sapidus*) is reported from the ports at Amsterdam and Rotterdam.

3.4 Parasites, pathogens and other disease agents

Summer last year was not warm enough, hence the absence of reports of *Vibrio haemolyticus* in the Amsterdam-Rign channel. Monitoring of the incident spot was ended. *V. haemolyticus* caused a very serious hospital case 5 years ago. However, this was not fatal (only amputation).

Starting in 2000, the study of fish and shellfish diseases will be transferred from the Netherlands Institute of Fisheries Research (RIVO-DLO) to the Institute of Veterinary Science (ID-DLO). RIVO-DLO will form part of ID-DLO, however, disease work will be carried out in Lelystad and not in Ymuiden.

5 LIVE IMPORTS

The trade in marine pet fish and other aquarium species introduces a very large variety of animals from world wide sources. An insight is at present lacking. Only Canada reported back on a number of marine species sold alive to The Netherlands. No releases of such species in the Dutch waters are known. Still, incidental live freshwater aquarium species are caught in inland waters. At present all records of sturgeon, concern hybrids, released voluntarily or not in Dutch waters. No *Acipenser sturio* records are known from recent years.

NATIONAL REPORT FOR NORWAY

1 LAWS AND REGULATIONS

From 1 January 1999, Norway is part of the EEA-agreement, and serves as a controlling body for imports from non-EC countries. Regulations of imports and exports have generally been harmonised with the EC-community, with some exceptions. Export/import for aquaculture or sea-ranching for the specified life-stages of the following species were also allowed in 1998:

Sea bass (*Dicentracus labrax* L.): eggs only
Black bream (*Spondyliosoma cantharus* Gmelin): eggs only
Atlantic halibut (*Hippoglossus hippoglossus* L.): alevins only
Turbot (*Scophthalmis maxima* L.): eggs and alevins
Eel (*Anguilla anguilla* L.): glass eel and marketable size
Lobster (*Homarus gammarus* L.): living specimens for consumption

Regulations of marine enhancement and sea ranching have been proposed and are under evaluation at the Ministry of Fishery. An expert group on potential problems associated with the commercial import of ornamental fish has finalised its work and has given several recommendations. These recommendations are now under evaluation and adjustment to the EEA-regulations.

A report on the implementation of the Rio COB is still under elaboration at the Environmental Ministry.

2 DELIBERATE RELEASES

2.1 Fish

The large scale Norwegian Sea Ranching Program (PUSH) was completed in 1997. The detailed results from the releases of two fish species (*Salmo salar*; *Gadus morhua*) are now compiled in final reports of spring 1998. Both species have been recruited from national stocks. The results and conclusions will be a baseline for evaluation of the potential for commercial activities.

2.2 Invertebrates

130,000 microtagged lobster (*Homarus gammarus*) juveniles were released around the Kvitsøy islands from 1990 to 1994, and a comprehensive recapture system is now being conducted during the commercial fishery in the area. The recapture rate to 1999 represents 3.5% of the released lobsters. To our knowledge, this is the highest recapture percentage ever recorded for lobster releases of this magnitude. Some of the later cohorts are still under the minimum legal size and will enter the recapture fraction in the years to come. Preliminary data from 1998, indicates that more than 55% of the captured lobsters were from the released stock.

According to capture trial records, the population of the introduced Red King crab (*Paralithodes camtschatica*) in the North Norwegian coastal area east of the Varangerfjord has grown considerably. Seemingly, some growth in the populations west of the Varangerfjord has occurred, as some trials indicate harvestable populations. The investigations on the King crab in 1998 were made within the Varangerfjord and adjacent fjords, thus little reliable information on a westward migration is available (Kuzmin and Løkkeborg, 1998).

Two commercial hatcheries started cultivation of the Manila clam (*RI*) in 1988–1991. Juveniles were released into the wild environment at five different localities along the Norwegian coast. Recently, large live specimens of Manila clam were found at the three most southern localities. These individuals were all mature, but no successful reproduction, in term of juveniles, was detected (Mortensen and Strand, submitted)

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

The first specimen of the slipper limpet (*Crepidula fornicata*) was found in 1962 in Norwegian waters on the Skagerrak coast, and several observations of this species have been reported since, mainly in the same region. In summer, 1996, a new live individual was found at Kvitsøy, in the western part of Norway (K. Sjøtun, IMR, pers. comm.), indicating an increase in the distribution range.No signs of further migration of the slipper limpet have been reported. The first specimens of snow crab (*Chionoecetes opilio*) were taken in bottom trawl catches at Goose Bank in the south eastern part of the Barents Sea in 1996 (S. Kuzmin/PINRO, Murmansk), and later four additional specimens (all males) were caught mainly in the same region. Another specimen of the Snow crab was found in 1998, bringing the total number up to 14 specimens. No systematic investigations for snow crab have however been carried out in 1997.

3.3 Algae and higher plants

Sargassum muticum is well established in the southern part of the Norwegian coast (Skagerrak). Recently, the alga was also found in large quantities on the western coast at Rogaland and Hordaland. The northern movement in the establishment of the species is suggested by new observations on the northern side of Sognefjord (T.E. Lein, Univ. of Bergen, pers. comm.), indicating that the alga has the potential to spread even further. No reports of further northward migration have been obtained for 1998.

A novel species for Norwegian waters, a red alga *Dasysiphonia* (Dasyaceae, Rhodophyta) has been reported recently (Lein, 1999). The algae is probably accidentally transported from the North Pacific and was observed in the Netherlands in 1994 (references in Lein 1999). The species has to our knowledge not been observed in Denmark or Sweden. Introduction of this species may well have been facilitated by ballast water or hull fouling.

The alga is apparently able to grow in winter temperatures encountered in Norwegian waters, and is observed to rapidly colonise the areas where it has been found.

NATIONAL REPORT FOR POLAND

1 LAWS AND REGULATIONS

The present Polish regulations on fish and fish material products are being presently adjusted to the rules which are in force in European Union countries.

2 DELIBERATE RELEASES

2.1 Fish

537,850 salmon smolts and 1,330,000 sea trout smolts were released into natural environment (as an enhancement) and 120,000 juvenile whitefish (*Coregonus lavaretus*) were released into Puck Bay as a part of program of fish resources restoration.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Fish

The round goby (*Neogobius melanostoma*) distribution presently covers the entire Puck Bay. It increased its range up to the middle part of the Polish coast in the west and up to the mouth of the Vistula River in the east. It is found within a depth range of 1 to 35 m. In the spring months CPUE reaches 20–30 kg per fyke.The impact of the round goby on the ecosystem is probably larger than it was some years ago. This species may become a serious competitor for food with other fish species of the coastal zone. It is also a main food component in the diet of predators such as cod, turbot, and the black cormorant. In 1998 several hundred round goby were tagged in Puck Bay.

Another pontocaspian species *Pecotus glehni* was found in the Vistula Lagoon and in estuaries of Vistula River (Skora, pers. comm.).

One specimen of *Mugil labrosus* (64 cm total length) was caught in Puck Bay in September 1998 (Skora, 1998). The identification of this fish was done with the help of the Ichthyological Laboratory, Montpellier, France. It is the first record of this species in Puck Bay.

Another rare species, *Lepomis gibbosus*, was found in the lower Odra River and in the Szczecin Lagoon (Heese, pers. comm.).

3.2 Invertebrates

The river Odra estuary belongs to those water bodies in the Baltic sea area which are most exposed to the immigration of alien species. In the last year alien species in the Odra estuary were found as follows: the oligochaete worm *Branchiura sowerbyi*, the mitten crab *Eriocheir sinensis*, and the crayfish *Orconectes limosus*. Most recent newcomers include the polychaete worm *Marenzelleria viridis*, and the amphipods *Gammarus tigrinus* and *Pontogammarus robustoides* (Gruszka, 1998).

4 LIVE IMPORTS

The import of tropical fish and crustacean species for aquariums was continued in 1998 and the import level was similar as in previous years. Salmon eggs from Dougava River (Latvia) were imported by private farmers for salmon enhancement purposes. Sanitary controls of the above imports were carried out.

6 PLANNED INTRODUCTIONS

The State Commission for Fish Restocking will continue in 1999 restocking of salmon and sea trout at the level at least as in 1998. There are experiments conducted in Hel Maritime Station with breeding of Siberian sturgeon for introduction of this species into the Gulf of Gdansk.

7 MEETINGS, CONFERENCES, SYMPOSIA

The paper, 'The Odra river as a gateway for alien species immigration to the Baltic' by P. Gruszka was presented in the International Odra Research Conference, 16–19 June 1998 in Krakow, Poland.

NATIONAL REPORT FOR SWEDEN

1 LAWS AND REGULATIONS

From January 1st, 1999, there is a new law on environmental issues ('Miljöbalken', 1998: 808.) It is built on creating a sustainable development and protection of nature, implementing the human responsibility when using and changing nature. It also addresses protection of the biodiversity and valuable cultural environments. One chapter (13) regulates the use of Genetically Modified OrganismsThe law regulating fishery ('Fiskelagen') has been partly revised (1998:848), legally valid from January 1999. There is a new paragraph saying that the Government or authority named by the Government can demand an analysis of the impact of new fishery techniques or release of new species on the environment, to be carried out by those who intend to do so.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.1 Finfish

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

3.2 Invertebrates

The polychaete worm *Marenzelleria viridis*, known in Swedish waters since 1990, is still not present in high abundance in the southern Baltic (100 ind/m^2 or less; L-E. Persson Kalmar univ., pers. comm.) while it continues to increase somewhat in the northern part of the Bothnian Sea (K. Leonardsson, Umeå univ., pers. comm.). The spread from the north towards the southern Bothnian Sea seems slow but the numbers are increasing at previously known sites in the southern part. It has also been found in inner parts of the archipelago south of Stockholm (Himmerfjärden, Svärdsfjärden) but not in the outer part of the archipelago at Askö (H. Cederwall, Stockholm univ., pers. comm.).

The Chinese mitten crab *Eriocheir sinensis* was reported several times during the summer and early autumn of 1998 from Swedish coastal and inland waters (Kungsbackafjorden, S of Göteborg, in the Hanö Bight in the southern Baltic proper, the island of Lisö in the archipelago south of Stockholm, the northern Baltic proper and in Vänersborg at lake Vänern). On the Swedish coast of the Bothnian Sea it appears very rarely (K. Leonardsson, Umeå univ., pers. comm.). Lately it seems to be found more frequently across the Gulf of Bothnia, around the Finnish town of Jakobsstad (L. Eriksson, teacher in biology in Jakobsstad, pers. comm.), probably due to the increase in the ferry traffic with Bremerhafen, Germany, where there has been one ship arriving each 10 days, soon to be doubled. It turned up in 1994 and now it has been encountered quite often and kept in aquaria by school pupils. It seems to be favoured by the dumping of fish 'leftovers' since there is a fishing harbour close to the main traffic route.

The parasitic worm *Pseudobacciger harengulae* (Digenea: Fellodistomatiae) was detected in juvenile herrings from the Swedish west coast collected 1994–96 (Rahimian 1998: Paper III). It was found in about 20% of the herrings. Previously this species has mainly been recorded from clupeid fish in tropical to warm-temperate waters of the Atlantic, Pacific and Indian Oceans and the Black Sea. A survey of intermediate bivalve hosts of sporocysts of this parasitic worm was attempted but gave no results (Rahimian 1998: p. 21). The author raised the question if it had been distributed via ballast water transport. He also drew attention to the fact that sporocysts could have come with the introduction of the American mussel *Ensis directus*, which has occurred in this area since the late 1980s.

The amphipod crustacean *Orchestia platensis*, living on the shores of the sea and earlier listed for the southernmost Swedish coast, has been reported by some authors as an introduced species, while this has been doubted by others. It has now been recorded far more to the north in the Baltic proper (Kalmar and Öland) as well as in northern Bohuslän on the Swedish west coast (L-E. Persson Kalmar univ., pers. comm., 1999).

3.3 Algae and Higher Plants

Phytoplankton

In April–May 1998 there was an algal bloom caused by a species of the genus *Chattonella* (Raphidophyceae) in the Skagerrak and northern Kattegat waters and adjacent parts of the North Sea, with reports of fish kills from both the Swedish west coast, the Norwegian south and southwest coasts and the Danish coasts (Aure *et al.*, 1999, Backe-Hansen *et al.*, 1999, Edler & Hernroth 1999, H. Kaas, DMU, Denmark, pers. comm., B. Karlson Göteborg univ., pers. comm.).

The highest cell concentrations were found west of Jutland. The species has not been identified with certainty so far and has been referred to as *Chattonella* sp. cf. *C. verruculosa*, a species previously known only from Japan. Several species in this as well as in the closely related genus Heterosigma are known to be toxic to fish and recurring blooms have caused significant losses for fish-farming in Japanese waters and a bloom of *Heterosigma* occurred in Danish waters in 1988. If the species identification is correct the species has not been recorded before in European waters and thus transportation from other areas cannot be ruled out.

During September 1997 the potential PSP-producing dinoflagellate *Alexandrium ostenfeldi* was for the first time recorded for the Baltic proper in a dense bloom outside the island of Öland (Larsson *et al.*, 1998). The same authors also described the spread of the potentially toxic dinoflagellate *Prorocentrum minimum*, being very common (60–90% of the biomass during October) both offshore and in coastal waters. It is a late incomer to the Baltic Sea, but bloomed in 1992 in the Askö area, after which it had occurred very sparsely until 1997. There were no blooms of these species during 1998. The dispersal of this and other phytoplankton species has also been followed by the Finnish Marine Research Institute within the project 'Algaline' analyzing samples from ferries (J. Tamelander, pers. comm.).

In 1998 results were presented (Ellegaard 1998, Ellegaard & Oshima 1998, Ellegaard *et al.*, 1998) showing that the *Gymnodinium catenatum*-like cysts found in the Scandinavian and German waters are not identical to the true *G. catenatum* and the species will be described under the new name of *Gymnodinium nolleri* Ellegaard et Moestrup. So far none of these Danish strains have shown to be toxic and the cysts are smaller than those of *G. catenatum*, although with the same morphological structure. There also were molecular biological differences to the Australian and Spanish strains of *G. catenatum*, while the two latter were the same and could hybridize.

The brown alga *Sargassum muticum*

No major changes have been reported for the distribution of the Japanese brown alga *Sargassum muticum* along the Swedish west coast.

4 LIVE IMPORTS

4.1 Fish for consumption/processing

Eel from	**metric tonnes**
Denmark	29
Norway	69
Germany	2
The Netherlands	87
UK	1

4.2 Invertebrates for consumption/processing

Country of origin	**Lobster metric tonnes**	**The mussel *Mytilus* spp. metric tonnes**	**The mussel *Perna* spp. metric tonnes**
Denmark	<1	7	<1
Norway	4	145	4
Belgium/Luxembourg	<1		
The Netherlands	10	13	<1
Ireland	1		
Canada	118		
U.S.A.	108		
New Zealand			35

Country of Origin	Small flat oysters metric tonnes	Other oysters metric tonnes
Denmark	8	<1
Norway	<1	3
The Netherlands	2	1
Ireland		6
France		5

5 LIVE EXPORTS to ICES Member Countries (based on permissions to export)

5.1 Fish

Eggs to:

ICES Member Countries		Outside ICES	
Estonia	Arctic charr, Rainbow trout	Bulgaria	Rainbow trout
Finland	Salmon	Chile	Rainbow trout
Germany	Arctic charr, Salmon	Croatia	Rainbow trout
Ireland	Arctic charr	Greece	Trout
Norway	Rainbow trout	Montenegro	Rainbow trout
		Taiwan	Trout
		Turkey	Trout

Live fish to:

Estonia	Arctic charr
Finland	Rainbow trout, Carp
Norway	Trout

Live eels (for consumption?) to:

Poland

7 MEETINGS

Seminar on 'Aliens species and marine litter', Swedish Pavilion, EXPO 98, Lisbon, 30 June 1998 arranged by Swedish Environmental Protection Agency.

NATIONAL REPORT FOR UK: ENGLAND AND WALES

1 LAWS AND REGULATIONS

Amendments to Directive 90/219/EEC on the contained use of GMMs (genetically modified micro-organisms) were adopted in October 1998. This Directive is effected within the UK under the GMO (Contained Use) (Amendment) Regulations 1998. The major change will be that any proposed work in relation to GMMs will have to take account of environmental impacts in addition to the current controls which cover any impact on human health and safety. The regulations also cover any work on other GMOs (animals and plants) in relation to human health protection.

Directive 90/220/EEC deals with the deliberate release of GMOs (animals and plants). In the UK, this is enacted by the Genetically Modified Organisms (Deliberate Release and Risk Assessment Amendment) Regulations 1997. These most recent Regulations (and previous Regulations) have been introduced under the Environmental Protection Act 1990 and the European Communities Act 1972.

GMOs– General

In 1998, there has been increased public awareness of research involving GMOs and strong negative reaction to the use of GMOs as food or food additives. At present, there appears to be no interest from the UK salmon or trout industries in continuing with any trials on GMO salmonids.

Research on species other than salmonids continues at the academic level primarily in university laboratories.

2 DELIBERATE RELEASES

2.2 Invertebrates

The situation is much the same as reported previously in WGITMO annual reports. The UK shellfish industry is dependent on the production of *Crassostrea gigas* seed and to a lesser extent *Tapes philippinarum* seed that are both produced in commercial hatcheries and then planted out in the wild. *C. gigas* is the second most important bivalve species farmed in the UK.

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

3.2 Invertebrates

Natural spatfall of the Pacific oyster *C. gigas* has occurred in some of the Essex estuaries on the east coast of England. This has probably resulted from the renewed interest in culture of this oyster in that area since TBT was banned. This has led to the intensification of culture. Spat have been found in the upper reaches of the estuaries where the water is more shallow and the spring and summer water temperatures are likely to be higher than further downstream. Although no studies have been carried out, the adult oysters probably spawn in mid-summer giving the larvae and spat sufficient time to recruit before sea water temperatures fall in the autumn.

In late summer 1998, a small population of adult *C. gigas* was found in the Conwy Estuary, North Wales. Shell length (average 82 mm) showed that they were at least 3-years-old and the majority were in spawning condition. There was no sign of smaller individuals in the immediate vicinity. suggesting that settlement and recruitment do not occur on a regular basis in this estuary. The oysters were found in the upper intertidal area generally attached to stones. Their distribution was extremely patchy.

Sexually mature *C. gigas* have also been found in south-west Wales in the Carrew River and the upper reaches of Milford Haven. These oysters were the result of natural spatfalls. This is another area where commercial culture of oysters occurs. It is of note that there was also a good settlement of native oysters (*Ostrea edulis*) in the same area.

Eriocheir sinensis, the Chinese mitten crab, has been reported in the River Thames since 1935. Since the 1930s, their numbers in the Thames have increased significantly. From surveys carried out by the Environment Agency since early 1998, it has been shown that burrows are present at every suitable site from Grays in Essex to Richmond half tide weir, which is a distance of 63 km. The crabs dig and use burrows even when there is no tidal cycle and burrows are permanently submerged. Up to 28 burrows per square metre have been found and it was believed that burrows were less than one year old. This is the first evidence of burrowing behaviour from the British Isles. The burrows are reported to have caused considerable damage by weakening the bank structure and causing areas of bank to collapse. Chinese mitten crabs have also been found in other estuaries along the east England coast, from the R. Tyne in the north to the R. Rother on the southern Kent coast.

The razor clam *Ensis directus* continues to spread along the east coast of England. In the Wash, fishermen are keen to develop a fishery for this razor shell. However, harvesting would have to be by disruptive techniques, which would cause environmental damage in an area, that has been designated as a Special Area of Conservation (SAC). Such actions are currently being prevented although there is a keen interest to develop a commercial fishery.

In August, 1998, a population of the invasive bryozoan *Tricellaria inopinata* was found on the central southern coast of England, representing the first Atlantic record for this taxon. It is already abundant within harbours and marinas located in estuarine basins along an 80 km section of the central southern coast of England. A more detailed survey of the Poole Harbour area has revealed its presence in natural habitats, both within the harbour and on the open coast, as well as within marinas.

Twenty specimens of the Mediterranean prawns (*Hippolyte longirastris*) were caught at Hannafare Point, Looe, Cornwall. There have been two previous records from the UK.

3.3 Algae and higher plants

Sargassum muticum has been found on the south-west coast of Wales, in West Angle Bay, Pembrokeshire. This represents an extension of the known range.

3.4 Parasites, Pathogens and Other Disease Agents

In early May 1998, ISA (infectious salmon anaemia) was suspected in marine-farmed salmon in Scotland. Restrictions on salmon movements were immediately placed in the immediate vicinity and in a wider area where surveillance was increased. Tests to determine the presence or absence of the agent are being carried out. If the occurrence of ISA is confirmed, legislation requires that the fish are slaughtered either for disposal by an approved method, or for harvest if of market size and not showing clinical signs of disease.

ISA had previously only been recorded in Norway and eastern Canada.

4 LIVE IMPORTS

4.1 Fish

There was a regular import/export trade in marine ornamentals including several species of ornamental fish, soft corals, molluscs and crustacea. A large proportion of the trade is through Heathrow Airport via a nearby distribution centre (in Chorley Wood).

The import of trout eggs (as reported in other annual reports) continued.

4.2 Invertebrates

Live Canadian lobsters and oysters (the latter primarily from Europe) are imported for immediate consumption although some can be kept in holding tanks before sale. (See 4.1 also, for ornamentals).

Ten lots of *C. gigas* seed were imported from Guernsey.

5 LIVE EXPORTS to ICES Member Countries

5.1 Fish

Turbot juveniles are still exported to Europe for on-growing but in smaller quantities than previously. Alternative export markets for turbot juveniles beyond ICES Member Countries are being developed, currently with China.

5.2 Invertebrates

Seed *C. gigas* were exported for farming purposes, mainly to Ireland (20.25 million) but also to Guernsey (2 million) and Jersey (1 million). In 1999, the UK hatcheries are planning to increase their production of *C. gigas* potentially to increase sales to shellfish farmers in France. This is because natural settlement of *C. gigas* spat in France in 1998 was insufficient to meet the perceived demand for seed in 1999.

Two lots of *Ostrea edulis* seed were exported to Ireland and three lots of *Mytilus edulis* were sent to Guernsey.

NATIONAL REPORT FOR UNITED STATES OF AMERICA

1 LAWS AND REGULATIONS

Work continues at the federal level to carry out the mandates and regulations called for in The National Invasive Species Act of 1996 (NISA 1996). The Aquatic Nuisance Species Task Force (ANSTF), a consortium of a number of federal agencies, holds several meetings a year pursuant to the legislation. The ANS web site is: www.anstaskforce.gov

Pursuant to the above-named legislation, the United States Coast Guard is preparing to release this spring ballast management regulations focused on the open-ocean exchange of ballast water. These regulations will be reviewed in 24–36 months to determine compliance by the shipping industry; if compliance is found to be not sufficient, the law requires that ballast exchange must become mandatory.

On February 3, 1999, President William Clinton signed and released an Executive Order on invasive species, replacing an earlier well-known EO (11987, of May 1977, signed by President Jimmy Carter). Among other initiatives, the EO establishes a multi-agency Invasive Species Council.

2 DELIBERATE RELEASES

2.3 Algae

Work continues in the State of Maine with the Asian cultured red algae *Porphyra yezoensis*. Reference is made to a separate report filed by Coastal Plantations, Inc., (presentation by I. Levine, as a separate agenda item).

3 ACCIDENTAL INTRODUCTIONS AND TRANSFERS

Ballast water research relative to the transport of non-native species and to management prospects remains an intensive area of study in the USA (see presentations by A. Cangelosi, G. Ruiz, and J. Kopp, separate agenda items).

3.2 Invertebrates

Rapa Whelk *Rapana venosa*

Established in Chesapeake Bay USA

In June 1998 the first specimens of the large, clam-eating Asian whelk *Rapana venosa* were found in lower Chesapeake Bay. This species was earlier introduced to the Black Sea and the Mediterranean Sea, from where it may have arrived to America. A separate presentation by R. Mann will provide a detailed overview and update of this new invasion, which is now well-established.

Mid-Oceanic Squid *Illex illecebrosus* Found Alive in Great Lakes

In June 1998 approximately 12–14 squid, identified as *Illex illecebrosus*, were found in Lake Huron. Specimens were retrieved from near a beach which were both dead and alive; the live ones were temporarily able to latch onto objects. It is believed that these specimens represent squid picked up in the North Atlantic Ocean (the species ranges in Gulf Stream waters from Florida to Iceland and the British Isles) during open ocean ballast exchange, and had been discharged shortly before being discovered. The species is entirely marine, and cannot survive in fresh or brackish water.

Chinese Mitten Crab *Eriocheir sinensis* Well Established in CaliforniaThe Chinese mitten crab is well established and continues to expand its range within San Francisco Bay, California. In the late summer and early fall of 1998, tens (10s) of thousands (1000s) of mitten crabs were being caught on screens in the Sacramento -- San Joaquin Delta (San Francisco Bay) at Tracy, California, during the course of the crab's catadromous downstream migrations. At University of California at Berkeley Ph.D. student, Debbie Rudnick, is studying *Eriocheir* in San Francisco Bay.

Zebra Mussel *Dreissena polymorpha* Continues to Spread

The zebra mussel was first recorded from the State of Connecticut in summer 1998, in East Twin Lake, Litchfield

County. D. polymorpha now ranges south to Louisiana, west to Oklahoma, and east to the lower Hudson River in New York.

5 LIVE EXPORTS TO ICES MEMBER COUNTRIES

5.1 Invertebrates

Large (up to 30 cm) live sea hares, *Aplysia californica* [Mollusca: Opisthobranchia: Anaspidea] native to California but raised in Florida, were exhibited at the World Expo in Lisbon, Portugal, from May to September 1998 in the U.S. Pavilion. The sea hares were displayed in a 'touch tank'. *Aplysia* shipments to Portugal, their dates, and number shipped are as follows. There was a total of 20 shipments between May 15, 1998 and September 22, 1998. Each shipment contained 50 non-reproductive animals (each weighing approximately 125 grams) for a total of 1,000.

Number	Date	No. of animals
1	5/15/98	50
2	5/19/98	50
3	5/19/98	50
4	6/01/98	50
5	6/11/98	50
6	6/16/98	50
7	6/23/98	50
8	6/30/98	50
9	7/7/98	50
10	7/14/98	50
11	7/21/98	50
12	7/28/98	50
13	8/4/98	50
14	8/11/98	50
15	8/18/98	50
16	8/25/98	50
17	9/1/98	50
18	9/8/98	50
19	9/15/98	50
20	9/22/98	50
Total		1,000

After display, animals were only given to three organisations with closed seawater systems. These organisations were made aware of their responsibility not to introduce or allow the animals to escape into local waters:

1) Bar-Ilan University, Israel, Dr. A. Sussewein, 150 animals

2) Universidad Minho, Lisbon, 35 animals

3) Oceanario de Lisboa, Dr. M. Smith, 100 animals.

All other dead, moribund or severely stressed animals (715) were euthanized by either freezing, disposed of in plastic bags and discarded with the solid waste or disposed in the chlorinated sanitary sewer system. Information provided by: Tom Capo, University of Miami Experimental Hatchery, RSMAS, MBF, 4600 Rickenbacker Causeway, Miami, Florida USA, 33149; Aplysia Website: http://www.rsmas.miami.edu/groups/sea-hares/

7 MEETINGS, Conferences, Symposia or Workshops

Puget Sound Expedition: A Rapid Assessment Survey of Non-Indigenous Species in the Shallow Waters of Puget Sound [State of Washington], September, 1998.

First National Conference on Marine Bioinvasions, January 1999 Held at MIT, Cambridge, Massachusetts. The abstract booklet can be obtained for $10US from MIT Publications, Attention Christine Cristo, MIT Sea Grant, 292 Main Street, E38-300, Cambridge, MA 02139 USA. The abstracts can also be downloaded from a web site: http://massbay.mit.edu/exoticspecies/conference.html

Greater New England Symposium on the Ecology of Invasive Species, February 27, 1999, Yale University, Yale School of Forestry and Environmental Studies, New Haven, Connecticut. See web site: http://www.yale.edu/forestry/special/invasive.html. Papers will be published in the new journal Biological Invasions.

The Mitten Crab Workshop, March 23, 1999, Sacramento, California.

Ninth International Zebra Mussel and Aquatic Nuisance Species Conference, April 26–30 1999.

8 BIBLIOGRAPHY

Public Information and Brochures:

- 'A Quick Guide to Marine Bioinvasions' (MIT Sea Grant College Program)

Copies were made available at the meeting. For additional copies: email: chardi@mit.edu, or write: MIT Sea Grant, Publications Ordering, 292 Main St., Building E38-300, Cambridge MA 02139

- 'Protect the Environment: Don't Dump Live Aquarium Pets or Animals', produced by State of Washington Sea Grant
- 'Exotic Species—an Ecological Roulette with Nature' produced by MIT Sea Grant College Program

Addendum to the USA Report

Studies of the Genetics of Non-Native Oysters

Dr Standish K. Allen, Jr.

Director, Aquaculture Genetics and Breeding Technology Center

Virginia Institute of Marine Science Gloucester Point, VA 23062 USA

A large scale study on the problem of reversion of triploids to a mosaic (2n/3n) state was completed in *Crassostrea gigas*. Similar studies are beginning on *C. ariakensis* because of their perceived high commercial value in Chesapeake Bay. Reversion seems to be a regular feature of *C. gigas* triploids and varies among cohorts in its severity. Percent of individuals among populations that undergo reversion ranges from 3% to 10%, and is lower overall in triploids produced from tetraploid x diploid matings. *C. ariakensis* triploids have a very low rate of reversion, although sampling in this species to date has been limited. New deployments of *C. ariakensis* triploids will begin later this year. We have also looked at reproductive capability in mosaics and found no indications of diploid (normal) gametogenesis in either species, so far. Development of tetraploid C. ariakensis remains a high priority because it is seen as the only feasible way to produce large numbers of triploids either for research or industrial scale plantings. We anticipate importing new stocks of non-native brood stock from time to time as we expand our investigations of non-native germ plasms.

Field studies with non-native oysters

Dr Mark Luckenbach

Virginia Institute of Marine Science Wachapreague, VA 23480 USA

Declines in standing stocks of native oysters, *Crassostrea virginica*, throughout the mid-Atlantic coast of the U.S. have focused attention on management options for using non-indigenous species for the purposes of enhancing wild fisheries, re-establishing ecosystem services and promoting aquaculture development. To evaluate both the utility of non-indigenous species for these purposes and the risks posed by their introduction, we are conducting a series of laboratory and field experiments using the Pacific oyster species *C. gigas* and *C. ariakensis*. Laboratory experiments are being conducted in fully quarantined facilities using diploid animals. In one set of experiments we are evaluating the interactive effects of temperature and salinity on gametogenesis, larval development and metamorphosis in both exotic

species. In other laboratory experiments we are investigating predator-prey relationships between the exotic species and the major decapod predator in the region, *Callinectes sapidus*. These experiments are focusing on determining the relationships between prey size and predation rate, prey density and predation rate and prey species and predation rate by crabs. Competition experiments between juvenile native and non-native oysters are planned in a quarantine flume system.In field experiments we are using sterile, triploid oysters to evaluate growth, survival and disease dynamics in relation to salinity. *C. gigas* triploids used in field experiments (conducted between May 1997 and May 1998) were produced by mating tetraploids to diploids to produce 100% triploid progeny. Six hundred juvenile *C. gigas* were deployed at each of 9 locations in Virginia waters. Monthly assays for ploidy status were conducted during the reproductive season (April–October). When a single male animal was found with haploid gametes in May 1998, we removed all *C. gigas* from the field. *C. ariakensis* field experiments are currently underway using 300 triploid animals at each of 6 locations. Triploids were produced with Cytochalasin B manipulation and flow cytometry used to confirm their ploidy status. If ongoing sampling reveals a significant risk of reproduction in these animals, the experiment will be terminated. Our results to date predict regional differences in performance of these species across estuarine environments and provide needed information for evaluating introduction potentials.

ANNEX 4: THE RED ALGA (NORI) *PORPHYRA YEZOENSIS* IN MAINE, USA

The following is the sixth annual report to the ICES WGITMO from PhycoGen, Inc. (formerly Coastal Plantations International Inc.) on the status of the cultivation of the Japanese seaweed *Porphyra yezoensis* in the State of Maine, USA.

Culture Sites

1992: Two culture sites were established; Johnson Cove and Mathews Island. In Johnson Cove a 24 net system was assembled. The system was removed within 60 days of assemblage due to regulatory restraints. A 30 net system was established just off of Mathews Island which was maintained from July – December, 1992.

1993: Three culture sites were established. Two sites in waters off Eastport, Maine USA and one site in Harbour de Lute, Campobello Island, New Brunswick, Canada. The Eastport sites, just east and north of Goose Island, were established in June and removed in December, 1993. The Canadian effort was established in late September 1993 on the aquaculture lease site of Mr. John Mallack.

1994: The two Maine lease sites established in 1993 were utilised in 1994. The lease site just north of Goose Island has been shifted approximately 600 feet due west. The lease site east of Goose Island has been shifted approximately 300 feet to the east to establish a 1320 foot buffer zone between PhycoGen cultivation lease sites and the seabird nesting areas on Goose and Spectacle Islands. An additional 80 acre tract, Huckins Ledge, was permitted and utilised as PhycoGen's nursery tract. It is located 4000 yards west south west of Goose Island, just west of Seaward Neck on 'Huckins Ledge' in waters off of Lubec, Maine. Six experimental nori (*Porphyra yezoensis*) nets were placed out in the waters adjacent to Blue Hill, Maine by the Blue Hill Nori Farming Cooperative.

1995: The three 1994 PhycoGen culture lease sites were similarly utilised in 1995. Additionally, as part of a National Marine Fishery Service (NMFS) grant, PhycoGen established a small, 15 net, pole farm during the 1995 growing season. The farm was located just north of Mathews Island. The experimental system was reassembled in 1996 at the company's Goose Island Aquaculture lease site. The Blue Hill Nori Farming placed eight experimental nori (*Porphyra yezoensis*) nets out in the waters adjacent to Blue Hill, Maine.

1996: PhycoGen efforts included the establishment of a 20 net test polyculture system at the Connors Aquaculture Deep Cove, Eastport, Maine salmon lease site, and the licensing of a 100 net effort by a fisherman in Grand Manan, New Brunswick. The nori:finfish integrated polyculture system was installed relatively late in the 1996 growing season (October) but the nori quality, as measured by color, growth rates and nitrogen content was significantly greater than the Maine Nori Company's nori harvested from its monoculture operations. A cooperative study of nori samples from the mono and polyculture systems was initiated by researchers from the University of Connecticut (Dr. Charles Yarish) and University of New Brunswick (Dr. Thierry Chopin). The study clearly indicated the ability of *Porphyra* to rapidly and continuously absorb high amounts of nitrogen and phosphorous, making *Porphyra* an ideal bioremediation candidate. Significant increases (> order of magnitude) in phycoerythrin content was recorded.

The progress made by the Peninsula Nori Farming Cooperative (formerly Blue Hill Nori Farming Cooperative) was impeded by permitting difficulties which resulted in zero cultivation during the 1996 and 1997 cultivation seasons. Presently, this organisation is applying for additional grant funds to continue their earlier efforts to expand nori farming to the central Maine coastal waters.

1997: The three 1996 PhycoGen culture lease sites were not similarly utilised in 1997. The company's Spectacle Island lease site was not utilised in 1997 and may be abandoned due to extreme hydrographic conditions. As in the previous year, PhycoGen established a 30 net, pole located at the company's Goose Island Aquaculture lease site. The pole farm was the only utilisation of the Goose Island site also due to extreme hydrographic conditions. The Peninsula Nori Farming Cooperative placed twenty-five nori (*Porphyra yezoensis*) nets out in the waters of the Bagaduc River, Maine. Five experimental nori (*Porphyra yezoensis*) nets were placed out in the waters off of Grand Manan Island, New Brunswick, Canada. A modified pole farm was established in Grand Manan by a commercial fisherman. Significant staffing and financial difficulties were experienced by this operation and future participation is questionable.

1998: Two of PhycoGen's lease sites, Goose Island and Spectacle Island were returned to the State of Maine (total 36 acres) due to extreme hydrographic conditions resulting in logistical difficulties in maintaining the cultivation system integrity. Additionally, the Company reduced its Huckins Ledge lease site by 69% due to the increase in system productivity of the utilisable acreage.

PhycoGen repeated its 1996 integrated aquaculture efforts in the hope of developing a sustainable nori:finfish polyculture system. The test farm effort incorporated the Treats Island Fisheries, Inc.'s Treats Island site, Cobscook Bay, Maine. Twenty nori nets were strategically deployed throughout the salmon cage system to determine optimal net depth, orientation and placement.

Cultivation/Reproduction

The *Porphyra yezoensis* cultivation season is limited by the minimum growing temperatures of 6–7 °C. The cultivation season in the waters of Cobscook Bay usually comprises the first week in June to the first week in December. The 1998 season commenced June 4, 1998 and was completed December 12, 1998. The region-wide ice storm of January 1998 and the subsequent 14 day power outage resulted in the destruction of the Company's 1997 season frozen nori nets. The 1998 cultivation season was entirely dependent upon nets seeded in June and September, 1998. The 1998 seeding resulted in the freezer storage of 500 nori nets for the 1999 cultivation season.

Monospore production was observed from both our indoor facility in addition to the outdoor nursery site (Huckins Ledge). Evidence of monospore production was observed from June through October during the nursery phases of 1998's seeding process. Successful recruitment was evident upon the seeded nets, cultivation system support ropes and the anchor lines.

PhycoGen, as compared with previous years, did not independently examine the adjacent salmon cages as the Company did not utilise the Spectacle and Goose Island Sites.

As stated in PhycoGen's previous reports to the ICES WGITMO, a four year study entitled 'Establishment of a Monitoring Program for the Mariculture of the Non-Indigenous Seaweed *Porphyra yezoensis* in the Gulf of Maine' has been and continues to be sponsored by PhycoGen. The study, conducted by Dr. Donald Cheney and a graduate student from Northeastern University, has completed a manuscript prepared for the Journal of Applied Phycology which is attached. The study's conclusions reflect similar results as those previously reported by PhycoGen. The conclusions are: 1) *P. yezoensis* plants are present but uncommon on the shoreline adjacent to the PhycoGen farm during the farming season, 2) local *Porphyra* species out-recruit P. yezoensis on our netting substrates, and 3) there is no evidence to date that *P. yezoensis* will over-winter in Cobscook Bay and replace local *Porphyra* species. PhycoGen will continue to support this study and the research grant which expands the original Northeastern

University study entitled 'Effect of Nori Aquaculture on the Marine Flora of Cobscook Bay and Selected Sites Within the Gulf of Maine' funded by the University of New Hampshire/Maine Sea Grant College Program by multiple Principle Investigators from University of New Hampshire and Northeastern University (Grant Proposal submitted as Appendix II of the March 17, 1997 report to Dr. Carlton).

Recruitment

Determination of natural or anthropogenic dispersal of *Porphyra yezoensis* has been the subject of a four year study by Northeastern University researchers. Artificial substrates were placed adjacent to PhycoGen's Goose Island site < 100 yards from PhycoGen nets. (Figure 1, Appendix I). From prepared substrates samples were collected in the fall of 1996 which resulted in the identification of *P. yezoensis* in 5 of 47 nori plants collected and analyzed. Over-wintering potential of *P. yezoensis* was examined from the March 1998 collections analyses, which resulted in zero *Porphyra* plants being classified as *P. yezoensis*. Additionally, in the Fall of 1997, PhycoGen seeded nori (*P. yezoensis*) net strands were tied to the sampling substrates and allowed to over-winter. The strands were collected (March 10, 1998) and microscopically examined both in Eastport and again at the Northeastern University laboratory. Analyses of the strands revealed zero evidence of *P. yezoensis* thalli or holdfasts. These tests reinforce the company's initial conclusions that the local environmental conditions do not support independent existence by the introduced species. The 1998–1999 over wintering of seeded nori net strands will be collected in April 1999 and analyzed for *P. yezoensis* survival. The data will be included in next year's final report.

Future Plans

PhycoGen is in the secondary stages of planning nori cultivation efforts outside of the ICES WGITMO's mandated 'waters of the Gulf of Maine'. Sites off the coasts of Connecticut and New York are being considered. *Porphyra yezoensis* is not intended for these cultivation initiatives at this time. Results from the Sea Grant College Program research grant have been the domestication of indigenous New England *Porphyra* species. PhycoGen anticipates its next farming effort will be installed prior to the 2000 cultivation season.

Presently there is resurgence of interest in the establishment of *Porphyra*:salmon polyculture efforts in the Province of New Brunswick. The increased interest is in large part due to the pioneering efforts of Dr. Thierry Chopin of the University of New Brunswick and the Provincial Government's pledge to issue permits to any existing salmon farms wanting to install nori nets within 60 days. The introduction has previously received Canadian Federal and Provincial New Brunswick approvals.

Biomonitoring of an aquacultured introduced alga, *Porphyra yezoensis* (Rhodophyta, Bangiophycidae) in Cobscook Bay, Maine

Katherine L. Watson and Donald P. Cheney
Northeastern University, Marine Science Center, East Point, Nahant, Massachusetts
Ira Levine
Phycogen Inc., 4 Moulton Road, Portland, Maine

Abstract

The intentional introduction of organisms for the purpose of mariculture requires a balance between minimizing ecological impact and maximizing economic gain. Phycogen Inc. (formerly Coastal Plantations International) has commercially farmed an introduced species, *Porphyra yezoensis*, in Cobscook Bay, Maine, for the past 8 years. Permits were granted based on the presumed inability of the alga to sexually reproduce under Gulf of Maine temperature regimes. This study examined the potential for dispersal and establishment of *P. yezoensis* via asexual reproduction in the intertidal zone near CPI's farm sites. Surveys on recruitment and survival of *P. yezoensis* were conducted in the intertidal area surrounding the mariculture sites. Both artificial substrates, consisting of nori netting, and transect surveys have been employed. The overwintering potential of *P. yezoensis* was also examined. Here we present preliminary results that suggest that *P. yezoensis* can recruit ephemerally during CPI's limited summer/autumn farming season, but that it does not persist and has not formed an established population.

Introduction

Porphyra yezoensis is a commercially valuable red alga widely cultivated in Japan, China and Korea for the production of 'nori', which is eaten as dried and roasted sheets primarily in sushi. In 1990 an American company, Phycogen Inc. (formerly Coastal Plantations International), received state, federal, and international permits to introduce *P. yezoensis*, a species native to Japan, to the Cobscook Bay region of Maine for the purpose of aquaculture. Phycogen is the second American commercial enterprise to attempt to farm *Porphyra* in North America. The first attempt occurred in Washington state in the 1980's but failed due to permitting difficulties (Mumford, 1990). In the current farming attempt, permitting was granted based on temperature restrictions in the reproductive cycle of the alga. *P. yezoensis* demonstrates an alternation of heteromorphic generations typical to the genus *Porphyra*, with a haploid foliose blade stage alternating with a diploid filamentous conchocelis stage (Mumford and Miura, 1988). The diploid conchocelis stage, however, requires temperatures of at least 28 °C to mature and release conchospores (Melvin, et al, 1986). Since haploid fronds can reproduce asexually by releasing monospores at ambient temperatures (12–16 °C), concerns have been raised regarding the potential establishment of the alga in the local intertidal via asexual reproduction. Thus, a monitoring study was initiated to evaluate potential asexual spore settlement and recruitment occurring in the intertidal around farm sites in Cobscook Bay in order to address concerns about the ecological impact of farming this exotic seaweed.

Materials and Methods

Phycogen's farming operation has involved two sites in Cobscook Bay; a grow-out site at Mathews Island, northwest of Eastport, and a nursery site at Huckins Ledge, southwest of Eastport on Sewards Neck. Farming at Mathews Island was discontinued in May 1997, and grow-out nets were combined with nursery nets at the Huckins Ledge site in August 1997. The grow-out site at Mathews Island was monitored in a preliminary investigation conducted from August 1996 to May 1997. Monitoring was initiated at the Huckins Ledge nursery farm site in August 1997, and is still ongoing.

Specialized nori netting was suspended between poles in low and high tide locations and arrayed at varying distances surrounding both farm sites. The Japanese netting was considered an idealized substrate for *P. yezoensis* blade settlement because the specialized netting was formulated with specific synthetic fibers to which *Porphyra* spores readily attach (Mumford and Miura, 1988). Netting pieces (2m x 1m) were suspended vertically between metal sign posts, approximately 0.5 meters off the substrate. Eight nets were deployed at high and low tide locations around the Huckins farm site. Two were deployed upstream and downstream of the Mathews Island site, and 5 artificial substrates were affixed to boulders at high, mid and low tide locations. In addition, 10 meter transect surveys were made at both farm sites, in the vicinity of the artificial substrates. Artificial substrates and transect samples were collected in August,

December, March and May of 1996 to 1998.

Porphyra species were initially identified by microscopic examination using the key of Bird and McLachlan (1992), and then by electrophoretic analysis. Starch-polyacrylamide isoenzyme electrophoresis, using phosphoglucose isomerase (PGI) markers, was used to distinguish *P. yezoensis* from local *Porphyra* species (Cheney and Babbel, 1978; Cheney, 1985). The *P. yezoensis* PGI protein exhibits shorter migration distances than the local species in a reproducible pattern, and samples were run using stock laboratory cultures as standards.

To test the ability of *P. yezoensis* blades to overwinter, individually seeded strands of netting with established *P. yezoensis* were affixed to bare netting suspended between poles at high and low intertidal locations at the end of Phycogen's growing season in the autumn. The established *P. yezoensis* was grown and supplied by Phycogen, with plants ranging from 1mm–10cm long, in densities >100 blades/strand. The nets were analyzed the following spring for survival of the original blades, and for potential recruitment and establishment on the surrounding netting. Strands recollected in the spring were cultured in the laboratory under optimal conditions (aerated, sterile enriched seawater media, 15°C, 12:12 light-dark cycle) to determine regeneration potential of *P. yezoensis* blades.

Results

The distribution and density of *Porphyra* plants varied with location, however the size, color and shape of the blades was similar between the two locations sampled. Most *Porphyra* plants from both artificial substrate and transect collections were light to dark brown in color, lanceolate, and 5 – 35 cm long. Transect samples were primarily epilithic on small cobble, with few epiphytic on fucoid algae. Microscopic evaluation of cross sections revealed most of the blades were monostromatic, which is characteristic of *P. yezoensis* and most of the local species. Low intertidal samples that were darker red and diastromatic were identified as *P. amplissima* and were only run electrophoretically for contrast.

Three *P. yezoensis* blades were identified at Mathews Island in August, 1996, transect sampling, directly following the summer farming season. One *P. yezoensis* blade was identified on artificial substrates collected in January, 1997, after the autumn farming season. When *P. yezoensis* was absent from the spring samples, it was hypothesised that *P. yezoensis* might not over-winter successfully in Cobscook Bay.

At the Huckins Ledge farm site, none of the transect samples between August, 1997, and December, 1998, were electrophoretically identified as *P. yezoensis*. On the artificial substrates collected in November, 1997, five plants were electrophoretically identified as *P. yezoensis*. During sampling in the spring and autumn of 1998, however, none of the collected *Porphyra* were identified as *P. yezoensis*.

Six seeded pieces of netting used in the overwintering study at Huckins Ledge were collected and analyzed in March, 1998. No *P. yezoensis* was found on the original strands or on the surrounding netting. The strands were overgrown with filamentous green algae and *P. yezoensis* blades did not regenerate after a month in laboratory culture. This study was repeated in December, 1998, with 11 seeded strands and the strands will be collected in April, 1999, and analyzed for *P. yezoensis* survival.

Discussion

The aquaculture of nonindigenous species is strictly regulated in the US, with a rigorous permitting process involving state, national and international (ICES) agencies. *Porphyra yezoensis* was permitted for aquaculture in the Gulf of Maine specifically because it is not suited to grow and reproduce there. It is a Japanese winter plant, requiring tropical (>28 °C) summer temperatures for conchocelis to grow, release conchospores and repopulate the winter intertidal with haploid blades. Although able to release asexual monospores during Phycogen's farming season, *P. yezoensis* 'blades appear to only recruit ephemerally in the intertidal surrounding the farm sites. During the two and a half years of this study, limited recruitment was seen at both Mathews Island, in transect sampling and on artificial substrates, and at Huckins Ledge, on artificial substrates alone, however it was observed only during and immediately after a farming season. Where local *Porphyra* populations succeed in persisting, due to their ability to sexually and asexually reproduce, *P. yezoensis* fails because it is restricted to asexual reproduction. *P. yezoensis* blades persist through the autumn and into December, then disappear over the winter and do not reappear when temperatures rise in the spring. The intertidal in Cobscook Bay is noticeably barren of *Porphyra* during the winter months, with the exception of winter annuals like *P. linearis*. However, local species rebound quickly in the spring as subtidal conchocelis populations release conchospores, giving rise to another season's blades. Although asexual reproduction does permit *P. yezoensis* to recruit in the intertidal, it appears that this species cannot withstand harsh winter conditions to persist and form a lasting population. Our study presents evidence that, in this particular case, the introduction of the nonindigenous seaweed *Porphyra yezoensis* for aquaculture does not appear to pose an environmental threat.

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NOTE: *The following figures are available from the authors (whose addresses are shown at the beginning of this section) to accompany the above assessment.*

Figure 1: Phycogen farm sites in Cobscook Bay, ME, showing sampling locations.

Figure 2: Artificial substrate at Mathews Island.

Figure 3: Example of polyacrylamide-starch gel stained for PGI. Lanes 1–2 = P. yezoensis control, 3–4 = P. purpurea control, 5–16 = Artificial substrate samples from Huckins Ledge, 17–18 =P. umbilicalis control, 19–20 =P. yezoensis control.

Figure 4: Results from electrophoretic analyses of transect samples taken from Mathews Island from August, 1996 and May, 1997.

Figure 5: Results from electrophoretic analyses of artificial substrate samples taken from Mathews Island from January, 1997 to May, 1997.

Figure 6: Results from electrophoretic analyses of artificial substrate samples taken from Huckins Ledge from November, 1997, to December, 1998.

Figure 7: Results from electrophoretic analyses of transect samples taken from Huckins Ledge from August, 1997, to December, 1998.

ANNEX 5: BIBLIOGRAPHY

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ANNEX 6: RECOMMENDATIONS TO THE ICES COUNCIL

The following recommendations to the Advisory Committee on the Marine Environment (ACME) were formulated by the WGITMO:

1) WGITMO unanimously recommends that Dr J T Carlton be reappointed as Chair of the WGITMO for a further three years.

2) WGITMO recommends that as part of the ICES website, a page be devoted to the WGITMO and its activities and from there provide links to major invasive species websites of interest to ICES Member Countries. This would increase awareness and communication on the subject of potential invasive species.

3) On the basis of the growing complexity and scale of transport vectors for aquatic organisms (including pests, competitors, predators, and disease agents of potentially profound economic and ecological significance, such as may directly impact the rapidly growing mariculture industry), WGITMO recommends that ICES consider mechanisms to increase Member Country awareness of the impending wave of invasions in the next decade and the compelling need to take immediate action to help reduce the number of introductions that are now occurring or may occur in the near future. This 'vector network' includes the movement of live marine organisms between ICES Member Countries and the worldwide community that are surveyed solely for disease agents and not for other associated species; the importation of live marine organisms for immediate human consumption that are not surveyed for any associated organisms, diseases or otherwise; the evidence that ship hull fouling may be increasing, bringing with it a plethora of species that themselves may have diseases; the movement of vast amounts of water with live animals and plants intended for human consumption or the ornamental trade, with little or no supervision as to the fate of that water and other transporting or packing materials, all of these in addition to the 'traditional' vectors such as the movements of fouled oysters, ballast water, etc. Specifically, WGITMO recommends that a new *ICES Cooperative Research Report*, 'Directory of Dispersal Vectors', be published and include if possible weighting of the array of dispersal vectors and the potential impact that they could have. This would be beneficial not only to scientists internationally but also alert policy-makers to the situation and assist them in their decision making.

4) WGITMO recommends that a 'Rapana Alert' be issued immediately to ICES Member Countries, based on the arrival of this voracious large (15+ cm) snail (*Rapana venosa*), capable of consuming commercial clams and oysters, in Chesapeake Bay, USA, a major port system that exports large amounts of ballast water to western and northern Europe. This invasive species, native to the Sea of Japan and subsequently introduced in ballast water to the Black Sea, the Aegean and Adriatic Seas, and most recently to Chesapeake Bay, and with recent records in France as well, may potentially have critical impacts on a global scale.

5) WGITMO recommends that the ICES Working Group on the Application of Genetics in Fisheries and Mariculture be consulted for advice on the potential differences that should be anticipated from the farming of polyploid as opposed to diploid aquatic organisms. Tetraploid and triploid oysters (particularly *Crassostrea gigas*) are already being tested or used for commercial practices and tetraploid seaweed *Porphyra yezoensis*, with a growth rate double that of the diploid, has been produced in the laboratory. The WGITMO seeks advice as to assessments that should be carried out and any other considerations that should be taken into account before a polyploid can be considered for release to the environment.

WGITMO recommends that it meet at the Estonian Marine Institute, Tallinn, Estonia, from 10–13 April 2000 to:

a) continue the assessment of ballast water research and management until the proposed reconvening of the expanded ICES/IOC/IMO Study Group on Ballast and Other Ship Vectors in 2001;

b) continue discussion on risk assessment techniques;

c) finalize arrangements for the Theme Session on 'Marine Biological Invasions: Retrospectives for the 20th Century, Prospectives for the 21st Century' to be convened at the ICES Annual Science Conference in Bruges, Belgium, September 2000;

d) finalise the 'Directory of Dispersal Vectors' as an *ICES Cooperative Research Report*, including a continued review of aquarium-related transportation of exotic species as well as transfer via aquaculture;

e) continue work on a standardised format for collating data on non-native species, and the method and fate of introduction;

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

through:

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

ii) continuing to review of the status of selected current invasions, and in particular the status of the invasion of the snail *Rapana* in Atlantic USA and other ICES Member Countries,

iii) continuing coordination with the Baltic Marine Biologists Working Group and EIFAC, and reviewing the outcomes and future projects of the EC Concerted Action Plan on Ballast Water.