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REPORT OF THE ICES WORKING GROUP ON THE INTRODUCTION OF NON-INDIGENOUS MARINE ORGANISMS

Conwy, U. K., April 2-4, 1979

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Note: The Working Group would like to express its appreciation to Dr. Hepper and the staff of the MAFF Laboratory at Conwy for hospitality and assistance during the meeting.

REPORT OF THE ICES WORKING GROUP ON THE INTRODUCTION OF NON-INDIGENOUS MARINE ORGANISMS

1.0 INTRODUCTION

The Working Group met at the MAFF Fisheries Laboratory, Conwy, U.K. between 2-4 April 1979. Those present were:

Dr. C. J. Sindermann (Chairman)	U.S.A.
Mr. A. Franklin (Secretary)	U.K.
Dr. G. Newkirk	Canada
Dr. R. Meixner	Federal Republic of Germany
Dr. C. Maurin	France
Dr. C. Duggan	Ireland
Mr. P. van Banning	Netherlands
Dr. E. Egidius	Norway
Mr. M. Helm	U.K.
Dr. A. Munro	U.K.
Dr. R. Lincoln	U.K.
Dr. D. Solomon	U.K.
Mr. A. Farley	U.S.A.
Dr. J. Carlton	U.S.A.
Dr. A. Rosenfield	U.S.A.

Apologies for absence were received from Dr. V. H. Jacobsen (Denmark) and Dr. B. I. Dybern (Sweden).

Terms of reference for the working group, as outlined in Council Resolution 1971/2:7 and 1978/2:28 were reviewed and are attached as Appendix 10.1.

The chairman indicated his disappointment at the absence of Working Group participants from a number of the ICES member countries, and it was resolved that these member countries should be strongly urged to send representatives to future meetings. It was further resolved that the title of the Working Group should be altered and should now be: WORKING GROUP ON INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS, since the term "non-indigenous" can be ambiguous.

The proposed agenda (Appendix 10.2) was adopted, with the exception that separate subgroup meetings were deleted and the case history review of Anguilla was dropped. A brief history of the Working Group was given by the Secretary, including details of the publications produced by the Group. It was resolved that the principal previous report (Cooperative Research Report No. 32) should be reviewed and updated at the next Working Group meeting, with a view to presentation of a new report at the 1980 Statutory Meeting.

2.0 NATIONAL SUMMARIES

National summaries of recent data on introductions were then given by the Working Group members.

2.1 Canada

Information was given by Dr. Newkirk of increased interest in producing Ostrea edulis in Nova Scotia, and stock has been introduced to a quarantined hatchery from the U.S.A. (Maine) and the U.K. (Conwy), with a planned release of F_2 stock. The bay scallop, Argopecten irradians, will be introduced to Prince Edward Island from the east coast of the U.S.A., again as F_2 stock through a quarantined hatchery. Both introductions are under the control of the Canadian Federal Non-indigenous Species Committee.

2.2 Federal Republic of Germany

Gammarus tigrinus introductions from Canada, which had commenced into the Weiser river system in the 1960's, have resulted in improved fish food supplies, especially in areas where the potassium effluent (>29/l) from mining operations had resulted in the disappearance of the native Gammarus pulex.

Elvers continue to be introduced (about 7 tons per year) from neighboring countries. Other recent introductions include Crassostrea gigas from a hatchery in Scotland (1.6 million individuals since 1970, all certified as being pest and disease free); and the coho salmon Oncorhynchus kisutch eggs from Canada and the U.S.A. (pond culture only in lower Saxony).

2.3 France

Crassostrea gigas is now considered an established species; sufficient recruits have been produced naturally or from hatcheries to supply commercial needs, and no further introductions from foreign countries are considered necessary. Commercial interests, however, now wish to reintroduce C. angulata from Portugal. At the moment this is only being allowed under quarantine conditions at La Tremblade. Interest has also been expressed in O. edulis from Greece, but this species has not been imported, except for consumption.

C. rhizophorae from Guyana, held in quarantine for two years, showed promise with regard to growth and condition, but all adults were killed by low winter temperatures. Some spawning had, however, taken place in 1978 and the spat produced appear more resistant.

Venerupis semidecussata (= Tapes japonica) also showed promise, but its introduction into open waters was restricted for fear it might replace the native Venerupis decussata. Seed of the latter from a Guernsey hatchery were being used to try to replenish native stocks destroyed during the "Amoco Cadiz" oil spill.

The red alga Eucheuma spinosum has been successfully introduced for carrageenan production into Djibouti (East Africa) from the Indian Ocean (Indonesia), but progress has been halted following political changes in the country.

2.4 Ireland

There has been little recent pressure from the fishing industry to import non-indigenous species. Introductions of O. edulis and C. gigas continued from the U.K. Ormers or abalones (Haliotis tuberculata) were now being imported into quarantine from Guernsey; previous imports from France were stopped following the outbreak of oyster disease there. There were plans to place some in open waters, but few survived the severe 1978/79 winter.

2.5 Netherlands

C. angulata and C. gigas have been imported (since 1885 and 1963 respectively) largely from Belgium and France, but stocks are low at present due to a decreasing interest in farming these species. These species were introduced for growth and fattening, since normally the water temperatures were too low for reproduction to take place. In the exceptionally hot summer (23°C) of 1976, however, some C. gigas spat settlement had taken place, and the subsequent survival of some of the spat was causing some concern that interference could result on O. edulis collectors.

All Ostrea edulis seed oyster imports have been carefully checked since 1974, following the occurrence of diseases in France. No evidence of infection by Marteilia refringens had been noted so far, though a few oysters have been affected by Minchinia amoricana. O. edulis has also been imported from Greece. No diseases have been observed in these imports, but eggs of one of the predatory snail Murex species were found on some shells. No drills have been seen in the wild.

O. edulis is also still imported from the south coast of England. These are being closely examined for the presence of Sargassum muticum. Requests for imports of molluscs are expected to increase following extensive mortalities of O. edulis during the severe winter of 1978/79.

A risk of Gaffkaemia infection from lobster imports in holding units is thought to exist, but this is considered to be of minor importance, since the stocks of native lobsters are extremely low due to overfishing.

2.6 Norway

There have been no important recent developments with regard to introductions. The results of the Soviet attempts to introduce the king crab Paralithodes camtschatica in waters off the north-western (Barents Sea) coast are still unknown (Orlov and Ivanov, 1978, Mar. Biol. 48: 373-375).

American lobsters were felt to have brought Gaffkaemia into holding areas in 1976 and native lobsters were attacked. The disease was not found in any wild stocks.

2.7 Sweden

100,000 C. gigas spat were introduced in 1974-1976 into mussel beds on the northern part of the west coast of Sweden from the U.K. hatchery at Conwy. There seemed little possibility of the introduction being successful, as many oysters had been killed by severe winter conditions.

2.8 U.K.

Legislation in Scotland has been strengthened by the Import of Live Fish (Scotland) Act of 1978, which restricted the import, keeping or release of live fish or shellfish, or the live eggs or milt of fish or shellfish of certain species.

In Scotland, Haliotis tuberculata has been introduced from Guernsey for hatchery rearing.

Strains of rainbow trout (Salmo gairdneri) imported from the United States, have been established at various hatcheries throughout England and Wales and the migratory form, the steelhead trout, is currently being reared at the MAFF laboratory at Lowestoff.

Post-larvae of the prawn Penaeus monodon have been imported to the MAFF laboratory from the Phillipines, Tahiti and Thailand. Hatchery-reared progeny were supplied to various organizations within the U.K. for closed-cycle cultivation. Also, Penaeus stylorostris may in the future be brought from Mexico to the MAFF Fisheries Conwy Laboratory for experimental rearing.

Small numbers of C. gigas have been imported as brood stock to the Conwy laboratory from the U.S.A. (Oregon).

2.9 U.S.A.

Procedural development include a statement by the President on official U.S. policy concerning introduction of exotic species -- Executive Order 11987 -- and a possible Mariculture Bill now undergoing revision.

Many problems exist in the U.S.A., due to the number of hatcheries already in existence producing and transferring species of oysters and clams. Many of these hatcheries have little or no quarantine arrangements, and often production is such that seed must be placed in open waters. Two new problems have arisen recently -- a virus disease in C. gigas in one west coast hatchery, and Mytilicola orientalis in oysters in another.

3.0 REVIEW DOCUMENTS CONCERNING INTRODUCTIONS

Following the presentation of the national summaries, consideration was given to recent reviews on the introductions question. These were: "Implications on Transplantations to Aquaculture and Ecosystems", by H. Rosenthal; "Exotic Species in Mariculture", edited by R. Mann, and a personal presentation of work on the "Invertebrate Introductions to the Pacific coast of North America", by J. Carlton.

The current inactive status of the FAO Consultation on the "Convention for Control of the Spread of Major Communicable Fish Diseases" was also discussed, and reasons for inactivity reviewed.

4.0 CASE HISTORIES OF INTRODUCTIONS

The Working Group then went on to consider case histories of several recent introductions of major importance.

4.1 Sargassum muticum

This immigrant seaweed in Europe is still limited to the U.K. and France. In France, extension of the range of Sargassum was reported as slight, and the major area affected was the eastern part of the Cotentin peninsula. In some Places, the seabed was completely covered by the weed, but the effect was localized and no major problems have been yet encountered. No complaints have been received from fishermen. In the Netherlands, S. muticum has been seen washed ashore since April 1977, but no attached plants have been observed.

In the U.K., the weed has greatly extended its range and continues to spread along the south coast of England despite various attempts at control. Attached plants can now be found between Brighton and Plymouth. The weed causes problems on beaches and in harbors; the overall effect on fisheries remains difficult to gauge. Fishing boats, like other fairly small vessels, have reported some interference with navigation in badly affected areas, and the weed could be a mechanical nuisance on trawling or dredging grounds. On the other hand, Sargassum appeared to support a rich fauna, and young fish and crustacea were reported to be abundant in weed-affected areas. Catches of adult fish were also reported to have been high in Sargassum stands, presumably due to the increased shelter provided.

With regard to control, a special dredge was developed for use near beaches and in harbors; research is continuing on possible chemical and biological control methods. Herbicides have not been found to be effective, due to poor penetration of the highly-sulphated Sargassum cell walls. Hand gathering has been abandoned as ineffectual.

4.2 Pacific Salmon

An entire evening session on April 2 was devoted to discussion of the introduction of Pacific salmon (genus Oncorhynchus) into the North Atlantic and adjacent seas. Among the significant points made were the following:

(a) The USSR has introduced Pacific pink salmon (Oncorhynchus gorbuscha) into waters of the Kola Peninsula. The fish have survived, but success of the introduced population depends on annual planting of eggs, presumably because of the hard winters. Pink salmon from these introductions have been definitely established in northern Norway, where they have been found as much as 300 km upriver.

(b) Atlantic salmon rearing is expanding steadily in western Europe, with Scotland and Norway in the lead.

(c) For ocean ranching purposes, pink and chum salmon seem preferable since they move to sea soon after hatching, whereas coho remain for a long period in fresh water and probably would compete with Atlantic salmon for food. Generally, the environmental requirements of cohos are similar to those of Atlantic salmon.

(d) Atlantic salmon runs should be enhanced. Enhancement could take the form of reduced pollution of rivers, increased hatchery production, and changes in regulations concerning catches.

(e) A detailed, long-term study is needed in areas where both Atlantic and Pacific salmon now exist together. Of particular importance are food habit studies, to determine the nature of competition. An equally important but more difficult aspect is the food competition in salt water -- particularly since pink and chum salmon seem to be opportunistic feeders.

(f) A summary paper "Introduction of Pacific salmon to Europe" was introduced by Dr. Munro of Scotland, and is appended to this report (Appendix 10.3).

4.3 Crassostrea gigas

Following the massive mortalities of Crassostrea angulata in the late 1960's and early 1970's, oyster production in France dropped to 18,000 tons. It was necessary to import massive quantities of C. gigas from Japan and British Columbia for the French oyster industry to survive. From 1971-1976, 15,000 tons of C. gigas seed (2/3 from Japan, the rest from Canada) were imported, and 500 tons of adults were imported from British Columbia. Greatest imports occurred in 1972/73, with virtually none being required for the last two years, due to natural and hatchery production in France.

The introduction can be regarded as successful overall, though some problems have been encountered. C. gigas has a higher respiration rate than C. angulata and poor growth was encountered when growers laid C. gigas at the same densities used for C. angulata. There is also a problem with shell growth in some areas, mainly where culture was intensive, though it is thought that overcrowding was not completely to blame. C. gigas appears to have rather specific hydrographic requirements for successful spawning and larval settlement. Some areas are therefore not suitable for C. gigas cultivation and in many others spatfall is irregular. The introduction was as tightly controlled as possible, though obviously the quantities involved made the implementation of control measures difficult. All seed was treated with freshwater (and sometimes formalin) twice -- once in the country of origin and once on arrival in France. This measure appeared successful in preventing the introduction of the flatworm Pseudostylochus. However, a number of other associated species have been introduced, including an annelid (Hydroides), several balanoids, algae (Undaria and Sargassum) and a parasitic copepod Mytilicola orientalis. The latter caused localized mortalities in the Arcachon area in 1977. No mortalities due to epizootics have been observed, though a virus had been found in C. gigas.

4.4 Macrocystis pyrifera

In 1973, France imported spores of Macrocystis from the U.S.A. and Chile for culture under laboratory conditions. The sporelings were put into the open sea near Roscoff in February on cement substrates. By September, a size of 13 meters had been attained, when the plants were removed before reproduction could take place. A series of observations was then made in the U.S.A. and Chile and a proposal was put to ICES in 1974 regarding further experimental introductions to the sea. This was rejected following strong objections by a number of member countries and all plans were dropped. Another project has now been prepared for an introduction to a sandy bay in south Brittany; the French hope that the absence of any rocks would prevent the possible spread of Macrocystis spores. This plan has not been approved by the French Department of the Environment, whose permission is required before the experiment can proceed. If the go-ahead is given, the ICES Introductions Working Group will be informed before any action is taken, so that the proposal can be fully discussed by the Group and their invited experts. It is assumed that a new law would be required to forbid the transfer of Macrocystis to other parts of the French coastline before the experiment could take place. It was suggested that an ICES inspection team should be formed to undertake the monitoring of any experimental introduction, in the event that the project is approved by the Introductions Working Group.

5.0 GENETIC CONSIDERATIONS

Following the presentation of the case histories, consideration was given to a paper by Gary F. Newkirk on "Genetic Considerations for the Introduction of Non-indigenous Species". Considerable discussion took place on the requirement for the maintenance of genetic variability in introduced stocks, balanced against the increased dangers of introducing pests and diseases by introducing large number of exotic stocks. An inherent problem appeared to be balancing large imports against necessary quarantine limitations. Dr. Newkirk's summary statement is appended (Appendix 10.4).

6.0 INTRODUCTIONS QUESTIONNAIRE

The original introductions questionnaire developed and approved by ICES in 1973 was then examined to see if it was still adequate with regard to obtaining up-to-date information from member countries. It was decided that only a few minor modifications were required, such as adding definitions. These were made, and the modified form is attached as Appendix 10.5.

It was also decided that the modified questionnaire should be distributed to all member countries via the Secretary General of ICES, with a request that the introductions information required should be returned to the Working Group chairman by January 1980; an updated report (similar to Cooperative Research Report No. 32) could then be prepared by the time of the 1980 statutory meeting.

7.0 CODE OF PRACTICE

Some attention was then paid to the Introductions Code of Practice. It was decided that a preamble should be added, the wording of which would be taken from the recommended procedure outlined in Cooperative Research Report No. 32, pp. 41-42. This would read: "Member countries contemplating any new introduction should be requested to present to the Working Group, at an early stage, information on the species and objectives, with such information on its habitat, epifauna, associated organisms, etc., as is available. The Working Group should then consider the possible outcome of the introduction and offer advice on the acceptability of the choice".

Other minor changes in wording were suggested, and a revised draft prepared for the joint working group meeting (Introductions and Pathology).

The chairman pointed out that there was a pressing need to develop detailed standard protocols governing all introductions, including such areas as quarantine facilities, certification of inspectors, inspection procedures, etc., but that these would logically follow approval of the revised Code of Practice by the Council. He also pointed out the need for a full and detailed review of the entire matter of introductions of marine species, possibly in the form of a special meeting in 1981.

8.0 JOINT SESSION WITH MARINE PATHOLOGY WORKING GROUP, APRIL 4, 1979, CONCERNING PATHOLOGICAL ASPECTS OF INTRODUCED SPECIES

The joint session was opened by general introduction of participants and review of material covered by the Introductions Working Group in the previous two days. Much of the discussion centered on disease aspects of oyster and salmon introductions.

8.1 Pathological aspects of C. gigas introductions

According to French representatives, importation of Crassostrea gigas really commenced on a large-scale in 1971. There was no C. gigas present in 1968 when Marteilia disease first occurred in the Abers. Stages of the protozoan pathogen Marteilia refringens have been found in Crassostrea gigas on the French coast, but the French think that C. gigas is only an occasional host, since only early stages are seen. The speculation was also made that the extensive oyster mortalities in the 1920's may have been caused by Marteilia, although no evidence exists.

Concerning the introduced Pacific parasitic copepod Mytilicola orientalis, the parasite has been found for the past two years in C. gigas from the French coast at Arcachon, and last year was also found on the south coast of Brittany. In Arcachon, because of the high densities of oysters, large numbers of parasites occur (up to 40 per oyster) and some mortalities were reported. No M. orientalis has been reported from U.K., Netherlands, Ireland, or Portugal.

M. orientalis has been observed in hatchery oysters (C. gigas) from the west coast of United States, and is a relatively non-specific parasite, capable of infecting C. gigas, C. virginica, O. edulis, O. lurida, Mya arenaria, Macoma balthica, and Mytilus edulis.

Concerning other diseases of C. gigas, the United States reported on "Denman Island" disease, which occurs on the west coast of Canada, and may be caused by a microsporidan protozoan. This disease has features similar to that of gill disease in C. angulata, but is not the same disease. Additionally, an irido-virus disease of C. gigas larvae has been reported in one west coast hatchery. The disease attacks the velum and the virus may be similar to one described in France from C. angulata (the size is different, however, with the U. S. virus at 228 n.m. vs 335 in France).

Other parasites have been found in C. gigas from Korea. An intracellular organism similar to Marteilia occurs in ova, and a Minchinia has also been found. With the difficulty of obtaining adequate seed at a reasonable price from Japan, the United States has been exploring other possible seed sources (particularly Korea and Taiwan). Because of concern about additional disease introductions, it has been recommended that seed from no new countries be introduced, and that only the traditional exporting areas of Japan be used. There is continuing industry pressure for other seed sources, however.

8.2 Pacific salmon introductions

Increasing demand for salmon flesh has led to increased Atlantic salmon (S. salar) farming in Scotland, Norway, and to some extent in Ireland and Spain. Pacific salmon (members of the genus Oncorhynchus) have been considered as an alternative. In U.S.A., five species of Oncorhynchus are being examined for farming at the Northwest Fisheries Center, National Marine Fisheries Service, and a small industry already exists for one, the coho salmon (Oncorhynchus kisutch). The U.K. is also looking at coho, but all Oncorhynchus species may be candidates. There have been a number of imports of eggs from the west coast of America to Europe, and some juveniles to France. No brood stock has been established as yet, so trials rely on continuing imports.

The ICES Code of Practice recommends use of eggs of fish for introductions. This has largely taken place, but few quarantine arrangements exist for hatched juveniles.

The French were the first to import coho to Europe. Two diseases -- vibriosis and bacterial kidney disease -- have been important. Kidney disease did not appear during first two years following import, and there is no evidence that it was imported with eggs. Young fish were exported to Spain and then reimported to France; bacterial kidney disease then appeared in the reintroductions in 1970. The disease was observed in all installations

where coho were held. Immunization has been tried but has been unsuccessful. At the present time, French coho production is 40-50 tons. It is now obligatory to treat with erythromycin. Rainbow trout are very sensitive to kidney disease, and Atlantic salmon are also sensitive.

Concerning vibriosis, no infections were seen in French coho up to 1978. Then the disease appeared but did not cause severe mortalities. The Vibrio strain isolated consistently is similar to strain 775 from the United States west coast. Vibriosis is probably endemic.

The general conclusion about coho disease was that there was little evidence that new diseases had been introduced (with the possible exception of kidney disease) and no evidence of transmission to Atlantic salmon stocks. However, since eggs are imported, diseases to be concerned about are kidney disease, infectious hematopoietic necrosis (IHN), and viral erythrocytic necrosis (VEN).

Concerning pink salmon (O. gorbuscha) introductions, those introduced by USSR on the Kola peninsula have established now in northern Norwegian waters, and are spawning; the Soviets appear not to have looked at diseases, and they continue to release about 5 million eggs per year. Pink salmon appear to be very susceptible to local vibriosis, and IPN virus was found in pinks in 1978, with levels higher than in Atlantic salmon. The pinks were derived from eggs taken from salmon released by the Soviets and migrating up northern Norwegian rivers.

The Canadians carried out major egg transplantations of pink salmon from the west to the east coast in the 1960's, but they have not yielded good returns, and pinks appear not really established in Newfoundland waters, though there is some spawning. There is some cage culture now and probably some escapes.

8.3 Joint consideration of the ICES Code of Practice

The joint working groups considered the revised Code of Practice (Appendix 10.6). Most of the discussion centered around the recommendation that only first generation progeny of introduced species should be introduced into open waters. Despite difficulties involved, the general conclusion was that it was a necessary recommendation.

It was pointed out that the Code of Practice consisted of recommended procedures, and that advice should be sought about proposed introductions from both working groups.

It was also pointed out that where rainbow trout and salmon are concerned, the disease status of brood fish must be known before acceptance of treated eggs. If brood stock is not certified disease free, then the progeny must be maintained in quarantine.

9.0 RECOMMENDATIONS

The following recommendations are proposed by the Working Group for consideration by the Mariculture Committee, the Shellfish Committee, and the Anadromous and Catadromous Fish Committee.

9.1 The Council should consider the adoption of the revised Code of Practice as approved by the joint working group meeting of Introductions of Non-indigenous Species and Marine Pathology, held in Conwy, April 4, 1979.

9.2 The Council should encourage the conduct of feasibility and environmental impact studies for all species of Oncorhynchus prior to any further introductions into North Atlantic waters and adjacent seas.

9.3 Member nations should be encouraged to consider regulations providing control and inspection of marine species considered for introduction. At present, little standardization exists, and some nations exert no control.

9.4 The European Economic Community (EEC) should be encouraged to consider the degree of control that its member nations should exert with respect to introductions.

9.5 Member nations should be encouraged to develop national or regional quarantine and inspection facilities for introduced marine species.

9.6 For those species that are part of current commercial practice member countries should encourage establishment of brood stocks certified free of specified pathogens.

9.7 Member nations should complete the questionnaire titled "Statement of the present situation in relation to the introduction of non-indigenous marine organisms", as described and reproduced in Cooperative Research Report No. 32, prior to February 1980.

9.8 Member countries should establish mechanisms for informing ICES and all member countries about exports or imports of species destined for introduction.

9.9 Legislation and regulations of all member countries regarding introductions should be documented by ICES and developed into a summary report. Included would be considerations of the following: Inspection and quarantine procedures, certification, training of inspectors, and intra-national transfers.

9.10 Consideration should be given by ICES to the genetic implications of the introduction of non-indigenous species, particularly the maintenance of genetic diversity during the establishment and proliferation of the stock.

9.11 In cases where little is known about a species proposed for introduction a member nation considering an introduction should send a biologist to the country of origin for an in-depth study of the ecology of the proposed introduced species.

9.12 Because of the significance of the international ramifications of the subject matter dealt with by the Working Group on Introductions, every member nation is strongly urged to ensure appropriate representation at every meeting of the Working Group.

9.13 Because of the immediacy of problems related to introduced marine species, the next meeting of the Introductions Working Group should take place from April 22-25, 1980 at Nantes, France.

APPENDIX 10.1 TERMS OF REFERENCE FOR THE WORKING GROUP ON INTRODUCTION OF NON-INDIGENOUS SPECIES

At the 1978 Statutory Meeting, the Council agreed that the Working Group on the Introduction of Non-indigenous Marine Organisms should be reconvened with Dr. C. J. Sindermann as Convenor.

The relevant resolution (C.Res.1978/2:28) reads:

"It was decided that: the Working Group on the Introduction of Non-indigenous Marine Organisms should be reconvened with Dr. C. J. Sindermann as the Convenor. The recent plans on intended introductions should be assessed. The Group should also comment on the proposals made by the Working Group on Pathology of Marine Organisms to amend the present Code of Practice to reduce the risks of adverse effects arising from the introduction of non-indigenous marine species, adopted by the Council on 10 October 1973. The Group should meet at Conwy ..... immediately prior to the Working Group on Pathology so that one joint session of the Group is possible".

From an earlier Council Resolution (1971/2:7) the function of the Working Group was described as follows:

(a) collate and disseminate information received regarding existing and proposed introduction of non-indigenous marine organisms, and

(b) take responsibility for advising the Council on all questions relating to the introduction of new species and for suggesting and modifying agreed procedures covering them, with the aim of establishing an accepted International Code of Practice.

The Working Group should include in their consideration the movement of species between member countries as well as new introductions from outside the ICES area.

APPENDIX 10.2

INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

Working Group on Introduction of Non-Indigenous Species

Fisheries Laboratory, Conwy, North Wales
April 2-4, 1979

Proposed Agenda

April 2; 9:00 am to 6:00 pm	Convene; Introductions Consideration of Agenda Brief (10 minute) national summaries of the status of introductions and plans for future introductions Consideration of recent reviews by Rosenthal and Mann Case history reviews of the present status and results of recent introductions: 1. *Sargassum muticum* 2. *Crassostrea gigas* 3. *Anguilla rostrata* 4. Other Formation of subgroups to consider these specific cases
April 3; 9:00 am to 6:00 pm	Meeting of subgroups (AM) Reports (10 min) of subgroups immediately after lunch Reexamination of Code of Practice adopted by ICES in 1973 with view toward expansion of guidelines for procedures to be followed
April 4; 9:00 am to Lunch	Joint meeting with Pathology Working Group to consider disease aspects of introductions
April 4; Lunch to 5:00 pm	Separate meetings of Working Groups Discussion of Working Group report, and preparation of draft report Adjourn

APPENDIX 10.3

ICES Working Party on the Introduction of Non-indigenous marine organisms
- April 1979

Introduction of Pacific salmon to Europe

by

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Aberdeen, Scotland

Introductions of Pacific salmon species to Europe re-started from 1956 onwards with Russian releases of pink salmon in the Kola peninsula. Interest in the mariculture possibilities of the Pacific salmon in the 1970s has resulted in importations of coho and pink salmon to several countries. Few, if any, details have been released of the criteria by which the importations were judged "safe" or "of acceptable" risk. Concern about these transfers centres on dangers to the abundance of native salmonids through interspecific competition and the introduction of disease agents. With accelerating interest in Europe in introductions of Pacific salmon it is appropriate that the re-established ICES Working Party should consider the subject to determine if there is evidence to warrant concern and further action.

Current Status

Pink salmon (Onchorhynchus gorbuscha). The Russian introductions of pink salmon to the Kola peninsula (adjacent to northern Norway) are by far the most significant in terms of numbers introduced and measurement of the consequence. The sources of the introductions were eggs from the Soviet Far East ranging in number from 4-36 million in any year. The Russians claim to have established a fishery based solely on culture releases because the natural conditions of the Kola peninsula are too severe to allow the survival of eggs in most years (Grinyuk et al. 1978). Culture is now based on stripping returning migrants rather than introductions from other areas.

There are Norwegian reports of pink salmon ascending northern Norwegian rivers (Berg 1961) where Atlantic salmon also run but the consequences of the migrations for both species remain unreported. Pinks have also been caught off the coasts of Scotland (DAFS 1962 and Williamson 1974), Iceland and southern Norway.

Norwegian researchers are working with pink salmon derived from the Kola stocks to assess their potential for mariculture (Gjedrem and Gunnes 1978). Several thousands of fish are held in sea water pens at an experimental site until maturity. In the Baltic, off the coast of Estonia (O. Leino, personal communication) there are also mariculture trials with pink salmon possibly of Kola origin.

Neither the Norwegians nor the Russian workers have made any comment about new diseases of fish in the areas where pink salmon have been held nor, have they commented on a significant disease problem in pink salmon stocks.

Coho salmon (Oncorhynchus kisutch). The French Government sponsored programme to determine the suitability of coho for mariculture has resulted in systematic importations of eggs since 1971 from American west coast sources mainly to the Brittany area (Harache and Novotny, 1976). There have been some private importations as well, some of which were deliberately released into rivers running into the English Channel. The consequences of these releases are under observation by official agencies. The mariculture potential of the coho has not been clearly established in these experiments making the future of further importations uncertain. The reasons for this are interrelated namely, freshwater is limited and more profitably used for trout culture because the suitability and survival of the coho in seawater is poor. The causes are early maturity and two diseases, vibriosis and bacterial kidney disease. Vibriosis is a serious problem when coho are cultured in their own coastal waters. The origin of vibriosis in France is probably of local origin. The origins of bacterial kidney disease are obscure. The bacterium has been reported in Scotland in Atlantic salmon (Smith 1964), but not in France before. The bacterium is very common in Pacific salmon in North America. Whether the pathogen in France was imported with eggs (as it is claimed can happen) cannot be established.

In Spain there are continuing imports of American west coast coho eggs exclusively for commercial pen culture. Although there are problems of poor survival in seawater the causes remain obscure.

Italy has had numerous imports of many millions of coho eggs exclusively for commercial freshwater rearing. The resistance of coho to viral haemorrhagic septicaemia (VHS) has been one attraction for Italian farmers. The commercial success of these imports is in serious doubt. However, a source of Mediterranean seawater for overwinter culture or, a source of deeper cooler Mediterranean water for all the year culture might easily change the commercial prospects.

In the UK there has been one importation of 20 000 eggs in 1976 by a commercial company from a Canadian west coast river source. The eggs and the fish hatching from them have been kept in strict quarantine all their lives with periodic testing for known pathogens. Because of the expense of quarantine where rigid separation from other stocks and sterilisation of the water effluent are government requirements the fish have been progressively culled to 300 at this time. They are expected to spawn this year providing a disease free source of coho stocks.

Conclusions:-

1. Current introductions are of coho and pink salmon.
2. Introductions have been exclusively of eggs.
3. The reasons for the introductions are for mariculture and to assist the establishment of culture based fisheries.
4. Pink salmon have not established natural runs in the Kola peninsula. Insufficient evidence is available on the fate of coho and pink salmon in other areas to which they have strayed or in which they have been cultured.
5. Bacterial kidney disease of coho salmon is the only identified disease which might have been introduced with egg imports but even here there is insufficient proof of the origin of the KD bacterium.
6. The role of Governments in consciously deciding to allow these imports or to use the control measures which most can exercise is not established.

Consequences of Pacific salmon introductions

1. Establishment of a non-indigenous species.

As a result of deliberate or accidental release the introduced species may establish and maintain itself. Because such a consequence may be irreversible introductions should be carefully considered. Establishment raises the prospect of interaction with native fish and considerable fears that there will be a reduction in the abundance of one or more native species.

In Europe, Atlantic salmon are often considered at greatest risk but salmonids in general and other fish species might be affected similarly. The major interactions are likely to be competition for food, special habitats and spawning grounds and through predation and alteration of the habitat or spawning ground. Such effects are most likely to occur and be observed in the freshwater phase. The reasons why a species does not establish itself are complex and little understood. One theory favours establishment if interactions with native species are small or limited and in essence predicts success if there is an unfilled or inefficiently filled niche. Where interactions occur most situations, but by no means all, will favour the native species because it is considered to be adapted to and has competed for that environment over many generations. Unfortunately even in small geographical areas, such as the British Isles, there are many diverse freshwater environments which offer differing opportunities eg in the degree to which native species have been selected as fit for their current distribution (Wheeler, 1977).

In this context it is interesting to note that if the rainbow trout (Salmo gairdneri) a native of the Pacific west coast were a candidate for culture in Europe today a large number of interactions would be predicted

between Atlantic salmon and brown and sea trout (Salmo trutta). Introductions would almost certainly cause alarm yet this species is cultured on a massive scale and released extensively for sport fishery purposes. However the species ability to reproduce at the expense of native fish, salmonids in particular, would appear to be so limited that we can safely conclude it poses no significant threat.

The introduction of pink and coho salmon to the north west Atlantic into Atlantic salmon habitats has continued for some years (Berg 1975) but their genuine establishment is still in doubt.

Escape of fish from mariculture regimes is common but culturists tend to deny that numbers of escaping fish are sufficient to cause significant ecological effects. If the population of a single sea pen escaped several thousand fish might be involved, perhaps near spawning condition, and possibly "programmed" to ascend an adjacent river! Such an event, possibly repeated in successive years, might establish an introduced species by overwhelming small native fish populations.

If a Pacific salmon species were established either by natural reproduction or by the assistance of culture, commercial exploitation would follow. The scale of exploitation, if big enough and depending on the methods used, may result in Atlantic salmon and sea trout as bycatches. There are potential dangers here, both for the abundance of native species and for traditional exploitation industries. Legislative controls to regulate fishing activity may offer the best solution to such problems.

Potential species for introduction should be ranked as to whether they may become established and then according to estimates of their interaction ratings with native species. Exceptional preference for study should be given to species with low ratings. Of the 5 North American Pacific salmon the pink and the chum will be low ranked species with behaviour at spawning as the major area for concern. Those species with a high rating (and in this respect the coho, chinook and sockeye, are predicted to have several potential interaction areas with Atlantic salmon) should not be introduced at all unless evidence is available to show that the introduction is most unlikely to become established or that the feared areas of interaction can be discounted.

2. Disease Factors.

Introduction of fish or eggs may carry pathogens some of which are not endemic in European waters eg infectious haemorrhagic necrosis virus (IHNV) and Ceratomyxa shasta or, they may carry more virulent varients

of native pathogens (an unproven example may the KD bacterium). Eggs are much less likely to carry such a range of pathogens as fish and have the added advantage that the outside of the egg may be exposed to disinfectants. Most, if not all, eggs of Pacific salmon are currently derived from wild stocks whose disease status is uncertain. None of the elaborate testing schemes for farmed fish devised and recommended by the FAO/OIE Intergovernmental Consultation (1977) eg .the Coded Pathogen Free (CPF) status of farmed brood fish, can be used for the supply of eggs. Salmonid eggs can carry pathogens inside them eg infectious pancreatic necrosis virus (IPN) and possibly the KD bacterium. In addition the effectiveness of disinfectants may never be absolute.

It is concluded that if Pacific salmon are to be introduced then only their eggs should be imported. In the absence of CPF Pacific salmon hatcheries in North America a safe solution is to establish the eggs and the fish from them in quarantine then to proceed from there to establishing European brood stocks of Pacific salmon. Continued recourse to annual imports of many millions of eggs from wild sources in North America is a recipe to introduce non-indigenous and other pathogens.

Pressures for Introductions of Pacific salmon

At present the major motivation to increase European production levels of salmon flesh is for commercial gain. National objectives (which are secondary) are to reduce imports of salmon and to increase yields of food from the sea.

In this century Atlantic salmon has been a luxury product due to its scarcity enforced by the low production of the fishery. However in the last two decades a considerable degree of substitution by frozen Pacific salmon from North America has occurred without consumer reaction or notice. The increasing production of farmed Atlantic salmon is expected to reverse substitution. Additionally there is a separate and long established market for tinned Pacific salmon which is substantially bigger than the current market for fresh and frozen salmon flesh. There is therefore in Europe a big, and because of increasing consumer purchasing power, increasing demand for salmon flesh.

The fishery for Atlantic salmon based largely in the British Isles and Scandinavia depends on the number of smolts produced in freshwater. Perhaps 10-15% of all salmon flesh eaten in Europe comes from this fishery. Research has shown that river production of smolts can be improved, possibly

quite significantly, but the legal and economic climate for this is not ideal. Culture and release of smolts would also boost the fishery but it is expensive, an unproven economic success and also beset by legal problems. Sweden is the only country practising this technique on a significant scale with Atlantic salmon and special factors prevail there.

The recently developed Atlantic salmon farming industry, again based mainly in the British Isles and Scandinavia, currently produces an amount similar to the fishery but unlike the static fishery production its contribution is predicted to increase several fold in the next decade. Other European countries have not developed Atlantic salmon farming probably because of the lack of adequate quality freshwater, and sheltered sea pen sites. However, because of the establishment of low technology Atlantic salmon farming in Spain and possible technological advances, eg recirculation freshwater systems, land-based culture using pumped seawater, this situation may change.

It is concluded that there are strong commercial pressures for the farming of any salmon species for which there is a possible rearing process. The introductions of coho to Europe, the only one of the Pacific species for which a commercial process was available, illustrates this. However attention should be focussed on salmon species which have significantly different cultural requirements to Atlantic salmon because they may appeal to those countries, or areas of countries, which are currently at a natural disadvantage in the Atlantic salmon culture business. The limited freshwater requirements of the pink and chum make them good candidates for consideration.

There would be considerable interest in establishing a fishery for one of the Pacific species amongst local fishing interests in the areas chosen. Initially such a fishery would require culture assistance or it may have to be a continuous operation such as the Russian experience with pink salmon. The extensive freshwater phase of the juvenile coho, sockeye and chinook makes them unattractive for introduction. However, the pink and chum with their short freshwater phase are attractive and deserve attention.

Conclusions

1. Increasing public consumption and as a consequence commercial demand for supplies of salmon flesh may be expected to result in continuing pressures for the introduction of one or more Pacific salmon species for mariculture and/or the establishment of new fisheries.
2. Member countries are not yet fully conscious of this pressure and therefore have not worked out policies or indeed assembled adequate information to meet requests for introductions or to control them.

Recommendations

1. The Working Party should seek ICES to discourage all further introductions of coho, sockeye and chinook salmon for the present.
2. The Working Party should establish a group or groups on pink and chum salmon introductions to:-
   a. examine their possible establishment and subsequent effects on native salmonids
   b. assess their potential for mariculture
   c. assess their potential to establish a fishery or culture assisted fishery.

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APPENDIX 10.4

Genetic Considerations for the Introduction of Non-indigenous Species

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Almost any manipulation of a species is likely to have genetic consequences. Whenever animals or plants are moved from one environment to another there is the possibility that the selection pressures acting on the species will be altered and produce genetic changes. In addition, the artificial propagation of a species can very easily lead to a restriction of the gene pool. Such manipulation is certainly involved in the introduction of a non-indigenous species, especially if there is a generation or two propagated under quarantine conditions. The genetic change that could be produced will have serious consequences during the subsequent culture of the species.

The most serious problem is that a founding population might be created with reduced genetic variation. This may occur as a result of a restricted number of adults being introduced or as a result of sampling during quarantine. Reduced genetic variation will limit the species' adaptability to the new environment and hamper progress if the species is subject to a selective breeding program. Non-indigenous species are likely candidates for intensive culture and it is under such circumstances that the production of genetically improved strains will be of most value. It is not unreasonable to expect genetic improvement on the order of 10-20% per generation. However, such genetic gains can only be made if there is sufficient genetic variability in the founding stock.

It is recommended that:

1) Large samples should be imported.

A reasonably large sample of genes should be taken from the native populations. In almost all cases there will be very little information on the genetic structure of the species. Consequently, one must try to maximize the genetic variability in the imported stock by taking as many individuals as possible. These may be divided into different, noncontemporaneous importations. The stocks should be derived from natural populations as the genetic variability of hatchery stocks will very likely be lower than the natural populations. Whenever possible samples should be taken from different populations as this will provide a further means of increasing genetic variation.

2) Subsequent breeding should be done with carefully controlled crosses.

Once a certain level of genetic variation is acquired it must be maintained. Once genes are lost from the non-indigenous population they can not be replaced except by subsequent introductions. (Mutations are so rare as to be of negligable effect.) Controlled crosses are a must. A conscious effort should be made to preserve the maximum genetic variation by using a mating scheme that will insure the maximum transfer of genes from one generation to the next. Species with a very high fecundity present a particular problem in that it takes so few adults to produce an immense number of offspring.

3) After the stock is released from quarantine it should be integrated into a selective breeding program.

Having made the effort to maintain genetic variability through the introduction stage this variability should be exploited to produce stocks which are genetically improved and adapted to the local environment. Artificial selection can be much more efficient than natural selection. In fact, natural selection may well be pressing for adaptations which are not necessarily the most desireable for man's needs. Great gains are to be had through selective breeding, gains which will be well worth the effort spent to produce them.

APPENDIX 10.5

QUESTIONNAIRE

Statement of the present situation in relation to the transfer and introduction of marine organisms*

For completeness each record should if possible include the source and site of introduction, dates or periods, quantities and full references to published descriptions. For species introduced as a regular practice over many years, only a general statement is required.

I. Statement of relevant laws in member country.

II. Statement of other procedures governing decisions on introductions, e.g., committee recommendations.

III. List of deliberately introduced animal or plant species, including a statement of the result, introduced for the following purposes:

(a) Establishment of new reproducing populations.
(b) Growth and fattening.
(c) Live storage prior to sale, including eels.
(d) Improvement of food supplies for other species.
(e) Research purposes, excluding hatcheries (see VI below).
(f) Intended for the control of other pests.
(g) Intended to alter the environment.
(h) For recreational purposes.
(i) For other reasons, and only where relevant, e.g., zoos, aquaria adjacent to the sea, with particular reference to animals known to harbour parasites, e.g., dolphins, seals.

* Note: As an aid in completing this report, transfers (or transplants) are defined as deliberate or accidental movements of species within a hydrographic mass but across jurisdictional boundaries, while introductions are defined as deliberate or accidental movements of species between hydrographic masses and across jurisdictional boundaries. Marine refers to any aquatic organism that does not spend its entire life cycle in fresh water.

IV. List of species introduced accidentally with III(a) to (i) above, with a statement of the effects, specifying particularly

(a) any beneficial effects, e.g., if subsequently utilized;

(b) harmful effects

(i) establishment of predators
(ii) establishment of parasites
(iii) introduction of disease agents
) indicating whether the deliberately introduced species and/or other species are affected

(iv) establishment of competitors
(v) other modifications of the ecosystem or environment

V. List of species introduced by mechanisms other than in III (above), with a statement of the effects.

(a) Completely accidentally, and including specifically instances where survival has been facilitated by special environmental conditions, e.g., in heated effluents from power stations.

(i) Attached to the hulls of ships
(ii) In ballast tanks of ships
(iii) Atqached to floating wood or other drifting objects
(iv) Escaped from aquaria, zoos, etc.
(v) By some other means including natural invasion

(b) Through man-made or natural changes in environmental conditions in areas linking water masses (as for example in the Suez Canal).

VI. List any species introduced for the purpose of hatchery rearing, the progeny of which

(a) have not subsequently been planted outside the hatchery;
(b) habe been relaid in small quantities under controlled experimental conditions;
(c) have been supplied in larger quantities to the industry or some other organization.

Give the site of the hatchery, areas to which transplanted and, where possible, dates and an approximate indication of quantities. State what treatment is given to the effluent from any hatchery housing exotic species, and give particulars of any "escapes".

VII. Is your country contemplating any further introductions of new species?

VIII. List any shellfish, fish or algae exported live for consumption to named countries and give an approximate indication of quantities. (If exported as a regular practice, species and countries but not dates and quantities are required).

IX. Record any live species, with dates, supplied by your country for introduction into any other named country in the world, for any of the purposes listed under headings III(a)-(i) and VI above. (For species supplied as a regular practice, species and countries but not dates and quantities are required).

APPENDIX 10.6

REVISED CODE OF PRACTICE TO REDUCE THE RISKS OF ADVERSE EFFECTS ARISING FROM INTRODUCTION OF MARINE SPECIES*

I. Recommended procedure for all species prior to reaching a decision regarding new introductions (this does not apply to introductions or transfers which are part of current commercial practice).

(a) Member countries contemplating any new introduction should be requested to present to the Council at an early stage information on the species, stage in the life cycle, area of origin, proposed place of introduction and objectives, with such information on its habitat, epifauna, associated organisms, etc., as is available. The Council should then consider the possible outcome of the introduction, and offer advice on the acceptability of the choice.

(b) Appropriate authorities of the importing country should examine each "candidate for admission" in its natural environment, to assess the justification for the introduction, its relationship with other members of the ecosystem and the role played by parasites and diseases.

(c) The probable effects of introduction into the new area should be assessed carefully, including examination of the effects of any previous introductions of this or similar species in other areas.

(d) Results of (b) and (c) should be communicated to the Council for evaluation and comment.

II. If the decision is taken to proceed with the introduction, the following action is recommended:

(a) A brood stock should be established in an approved quarantine situation. The first generation progeny of the introduced species can be transplanted to the natural environment if no diseases or parasites become evident, but not the original import. The quarantine period will be used to provide opportunity for observation for disease and parasites. In the case of fish, brood stock should be developed from stocks imported as eggs or juveniles, to allow sufficient time for observation in quarantine.

*Note: A marine species is defined as any aquatic species that does not spend its entire life cycle in fresh water.

(b) All effluents from hatcheries or establishments used for quarantine purposes should be sterilized in an approved manner.

(c) A continuing study should be made of the introduced species in its new environment, and progress reports submitted to the International Council for the Exploration of the Sea.

III. Regulatory agencies of all member countries are encouraged to use the strongest possible measures to prevent unauthorized or unapproved introductions.

IV. Recommended procedure for introductions or transfers which are part of current commercial practice.

(a) Periodic inspection (including microscopic examination) by the receiving country of material for prior mass transplantation to confirm freedom from introducible pests and diseases. If inspection reveals any undesirable development, importation must be immediately discontinued. Findings and remedial actions should be reported to the International Council for the Exploration of the Sea.

(b) Inspection and control of each consignment on arrival.

(c) Quarantining or disinfection where appropriate.

(d) Establishment of brood stocks certified free of specified pathogens.

It is appreciated that countries will have different attitudes to the selection of the place of inspection and control of the consignment, either in the country of origin or in the country of receipt.