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Introductions of exotic species associated with Pacific oyster transfers from France to Ireland.

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SUMMARY

Following the implementation of EC Council Directive 91/67/EEC, the free movement of trade in shellfish commenced in January 1993. This Directive permitted transfers of Pacific oysters, *Crassostrea gigas,* which previous Irish legislation had controlled. Importations from France took place from January 1993. All importations were certified as being free from *Bonamia* and *Martelia* and also free from other species. Samples from consignments revealed the presence of *Mytilicola orientalis, Myicola ostrea, Crepidula fornicata, Ostrea edulis* and *Mytilus edulis.* The biomass of the importations and the frequency of *M. orientalis* and *M. ostrea* in these consignments suggest that they may become established in Irish waters and that there was a risk, albeit small, of introducing pathogens associated with these species in Irish relaying areas. Oysters sourced from Marennes-Oleron had other exotic species present.

INTRODUCTION

Until the end of 1992 Ireland had a policy of banning all mollusc importations except under licence. Transfers from inspected sites in Norway, Great Britain and Guernsey have been permitted. This policy relates to Ireland being an Island and so in a position to exclude pests as well as invertebrate and fish diseases. However some introductions are already known as a result of shellfish transfers, such as *Crepidula fornicata* (Minchin *et al.,* in press - no live populations or specimens of

this species in Ireland are known to exist since 1963), *Calyptraea chinensis* (Minchin *et al.,* 1987) and shell disease of the oyster *Ostrea edulis* (Duggan - internal report, 1963). These introductions together with outbreak of various oyster diseases in Europe led to the strict control of all importations to Ireland, despite which an illegal importation of the oyster *Ostrea edulis* lead to the establishment of *Bonamia ostrea* disease in Cork Harbour, Galway Bay and possibly in Clew Bay. Once the disease was identified, restrictions on the transfer of oysters thoughout Ireland were imposed, movements being permissable only under licence. The disease-free status of Ireland was compromised by *Bonamia* and shellfish exports from Ireland were impeded. The implementation of the EC Directive on trade in shellfish is likely to compromise shellfish cultivation in Ireland further with the eventual establishment of non-native flora and fauna which are likely to interact with Irish marine communities.

Exotic species such as *Crassostrea gigas, Ruditapes semidecussata; Haliotus discus hannai, Haliotus tuberculata,* had all been successfully introduced into Ireland using the ICES Code of Practice so that the introduction of pests, parasites and diseases were avoided. In all cases introductions were made through quarantine. The most recent introduction of the Japanese scallop, *Patinopecten yessoensis* (in 1990) was under tighter controls as the ICES Code of Practice had been updated. Future intended introductions of exotic commercial species will continue to be subject to the full protocol of the current ICES Code of Practice.

METHODS

Oysters imported from France were selected either from oyster bags removed from different parts of the consignment during unloading, or as samples received from growers or from trestles on the shore. Oysters were weighed and measured and the frequency of associated species found in the gut (*Mytilicola orientalis* Mori, 1935 identified using Ho & Kim, 1992), or attached to the gills or within the shell cavity (*Myicola ostreae* Hoshima & Sugiura, 1953 identified using Ho & Kim 1991) or on the shell surface (*Crepidula fornicata* (L.) and *Ostrea edulis* L.). Other associated organisms were also removed. Samples were obtained from different regions within the country to which consignments were known to have been dispatched.

Dinoflagellate cysts were found in sediment within the valves of dead oysters associated with oysters transferred in January 1993 and are discussed elsewhere (O'Mahony, 1993). These had been kept in a cold room for some weeks prior to examination.

RESULTS

The first known importation was to Carlingford on 23 January 1993, of half grown oysters from the Marennes-Oleron region in France. Their condition was very poor, they had translucent flesh, a very reduced digestive gland and many were gaping and had long narrow shells. Subsequent consignments were of marginally better quality. All samples demonstrated varying frequencies of associated exotics (Table 1). The regions where oyster relayings have taken place are shown in Figure 1.

Up to 10 *M. orientalis* were found in the gut of an oyster. When present in numbers these produced a pea-size swelling of the rectum and the female copepods were easily seen through the lining of the gut. Specimens were orange/pink in coloration. Infestation frequencies varied greatly between samples. Those introduced to Carlingford in January had an infestation of 7.3% which had reduced to 2.3% in March in a sample of the same importation; the decline in the frequency corresponded with an increase in oyster mortality over this period. Egg strings were found in samples taken in January and March. This species was found within Pacific oysters from wild settlements in the Oleron and Archachon regions but also from nursery-raised spat, with adult female copepods and attached egg strings being found in oysters from *ca* 1g.

Myicola ostreae was found either adhering to the gills, free on the gills or within the mantle cavity. Where they were found on the cream coloured gills, they were often associated with a small light oval patch, with up to three being taken from a single oyster.

Two *Crepidula fornicata* were found attached to the shells of oysters originating from Marennes-Oleron. These were both males of 6 and 8mm shell length.

The surface of many of the imported oysters had an attached serpulid *Pomatoceros sp.*(Polychaeta). Sediment from within oysters contained specimens of *Terebella lapidaria* (Polychaeta), both previously unreported from Irish waters.

Marine algae associated with oyster importations were not examined.

DISCUSSION

Exotic species are known to spread by the movement of shellfish, in particular with transfers involving oysters. Expansion of the movements of oysters following the EC Council Directive 91/67/EEC which concerns the trade in living aquaculture products, will mean that there will most certainly be an expansion of the ranges of various species of flora and fauna associated with the shellfish transfers. The ICES Code of Practice for the Introduction and Transfers of species considers the transfer, not

only of the organism under transfer, but also of associated species. As the introductions of many shellfish species to continental Europe took place at a time when the ICES Code of Practice had not been fully formed, a number of species that fall into the category of pest or fouling species became established including *M. orientalis* and *Hydroides elegans* in France (His *et al.,* 1978).

Many species survived the transfer from the Pacific to France which would have taken some days, so they are likely to survive the shorter transfer from France to Ireland.

The presence of *Ostrea edulis* and *Mytilus edulis* in consignments is of concern. Although not quantified mussels, *M. edulis,* have appeared in all consignments of half-grown oysters. Both *O. edulis* and *M. edulis* are known vectors of *Martelia refringens* (Tige & Raboun, 1976; Comps *et al.,* 1975). In the case of the protozoan *Bonamia ostreae* the flat oyster, *O. edulis,* is a vector. Pathogens have been identified in Japanese Pacific oysters, from whence the French introductions came. These include a haplosporidian (Friedman, 1991) and a herpes-like virus in Pacific oyster larvae reared in French oyster hatcheries (Nicholas *et al.,* 1992). There is concern that these may spread to oyster culture areas. This recent information questions the use of even hatchery-reared Pacific oysters being suitable for transfer for cultivation within uninfected areas.

M. orientalis was not known in Irish waters until prior to the transfer of Pacific oysters from France in 1993. This parasite is known to cause damage to the lining of the gut of the oyster *C. gigas*, the mucosa being destroyed with penetration into the underlying connective tissue (Sparks, 1962), but Bernard (1969) was not able to show histological damage in his study. Grizel (1985) refers to its ability to cause a reduction in condition index, and in severe cases to cause mortality. His *et al.* (1978), record mortalities of up to 50% in oyster growing areas in France. Chew *et al.,* (1965) noted that infested oysters in the north-east Pacific were not as well conditioned and Odlaug (1946) recorded that infested oysters lost condition more rapidly following spawning. Deslous-Paoli (1981) in his study concludes that the size of the host is important, having found *M. orientalis* in six-month-old Pacific oysters. He claims that in cases where three female specimens appear in a host there is a significant decrease of rates of carbohydrate and glycogen production, presumably infestations greater than this have greater demands on the host.

One method of control proposed by Grizel is the complete prevention of transfer (Grizel, 1985). More recently, recognising that *Mytilicola intestinalis* can cause problems for mussels, he and others (Blateau *et al.,* 1992) have examined treatments to eliminate infestation levels using dichlorvos.

The critical numbers of *M. orientalis* required to establish a population may depend on the local conditions to which the animals have been introduced. Enclosed inlets with poor to moderate tidal flushing are probably more likely to develop local populations. It is considered that Carlingford Lough may be suitable for expansion of this parasitic copepod which is known to infest oysters and mussels and trochid snails. Almost 50 tonnes of oysters with a 3-12% infestation rate have already been relayed in Carlingford. Transfers of nursery-reared spat, are also capable of holding ovigerous female copepods. Eggs of these copepods may develop within smaller oysters once swallowed. It may be necessary to consider filtered supplies of seawater in order to avoid infestation of oysters in hatcheries. Ovigerous females were present in January and February, indicating that in France reproduction may take place all year. In British Columbia Bernard (1969) showed that reproduction takes place from June to late August and that the main population of the copepod was confined to Ladysmith Harbour where the original introductions of Pacific oysters took place. He reports that the larval stages of this species are short and they do not travel far, and interestingly states that oysters and mussels raised above the substrate are not infested. This last statement would not appear to be borne out in the French experience because imported half-grown oysters had previously been cultivated on trestles.

The related species *Mytilicola intestinalis* Steuer is known in Irish waters only from Galway Bay and the coastline of Co Cork (Crowley, 1972), but not from Carlingford Lough (Crowley, 1972) where mussels were again examined in 1993 together with clams and oysters. Korringa (1951) recorded it in Dutch waters as having an adverse effect causing mortality in some cases. Theisen (1987) noted that it has a marked effect on condition in the mussel, *Mytilus edulis* L., but although Davey (1989) found some slight reductions of mussel growth in his studies in Cornwall, England, he concluded that *M. edulis* had no harmful impact on mussels and that the species had features in common with a commensal.

Introductions of Pacific oysters with *M. orientalis* must have consequences for other marine populations. The species is known to occur in various oysters, mussels, clams and trochid and other snails and to-date there have been no quantified studies of its effect on these species. It is known to have taken up new molluscan hosts in British Columbia (Bernard, 1969).

Myicola ostreae is a poecilostome copepod previously known from *C.gigas* in Japan and Korea, and more recently in France following the 1970's direct oyster transfers. The family, Myicolidae are mainly found on the gills of marine bivalve molluscs. This species is also known to occur within *Ostrea edulis* in the Baissin d'Arcachon (His, 1977).

There is sufficient evidence to suggest that the introduction of *Crepidula fornicata* can result in serious modification of trophic relationships within muddy estuaries and bays, areas where oysters and mussels are often cultivated. Successive introductions of consignments containing small and relatively inconspicuous individuals, as found in this study, could lead to the establishment of breeding populations. Since the 1920's (Spicer, 1923) Ireland has been well aware of the possibility of the introduction of *C. fornicata* and measures to prevent its importation were a feature of the licensing system controlling all oyster importations at that time. It does appear that, despite screening, some small populations were transferred to Clew and Kenmare Bays following separate and unsustained importations of oysters (*O. edulis*) for laying, but fortunately these did not survive. Should populations of *C. fornicata* become established there may be significant changes in:

(a) trophic competition,
(b) changes in the texture of the sea bed, and
(c) modification of the benthos.

In France the abundance of this species in certain bays is such that dredging of the sea-bed for their removal is sometimes necessary to enable management of growth of oysters within the same bay (Anon, 1985). In the Granville area of Normandy the population has increased from 150,000t in 1985 to 750,000t in 1992 (Anon, 1993).

Sargassum muticum is widely distributed within oyster growing areas in France. Transfers of germlings of this phaeophyte on oysters are a potential risk with oyster importations. *S. muticum* extended its range to the North-east Pacific at the same time as oyster importations and it is likely that they were transferred with oysters. More recently Critchley & Dijkema (1984) demonstrated a transfer of *S. muticum* on native oysters *Ostrea edulis* from The Solent in England to Yeseke, The Netherlands. This plant can be easily transferred from a small size as has been determined in experiments by Yamauchi (1984). Being a monoecious species a single plant can result in the development of a population, and can become mature within a year. Introductions of this species to Ireland are not only possible but probable with sustained transfers of oysters. According to Scagel (1956) Canadian oyster fishermen have difficulty in observing their stock beneath the extensive stands of *S. muticum*. The plants are buoyant and when attached to oysters can cause them to be transferred elsewhere. Critchley & Dijkema (1984) make an appeal at the end of their paper ... " A call is made for the rigid application of existing quarantine procedures regarding the movement of shellfish and the establishment of an international body (perhaps as part of the European Economic Community) to both administer and enforce these regulations"...

The transfers of shellfish species in the course of trade result in the transfer and establishment of exotic species. The movements of

organisms between different biological provinces can result in unexpected consequences . Examples of this include: the zebra mussel *Dreissena polymorpha* from the Black Sea to The Great Lakes (Snyder, 1992); the invasion of the ctenophore *Mnemiopsis leidyi* from the eastern coast of North America to the Black Sea resulting in modifications of the plankton and elimination of some otherwise profitable fisheries (Harbison, 1993). Movements over small distances can also result in serious consequences as in the case of *Gyrodactylus* transferred from the Baltic Sea to Norway with salmon, *Salmo salar.*

Where little consideration is given to ecological consequences, in the movement of exotic species associated with shellfish movements, serious biological consequences may be expected. The movement of half-grown Pacific oysters from France to Ireland has presently been suspended pending further discussion.

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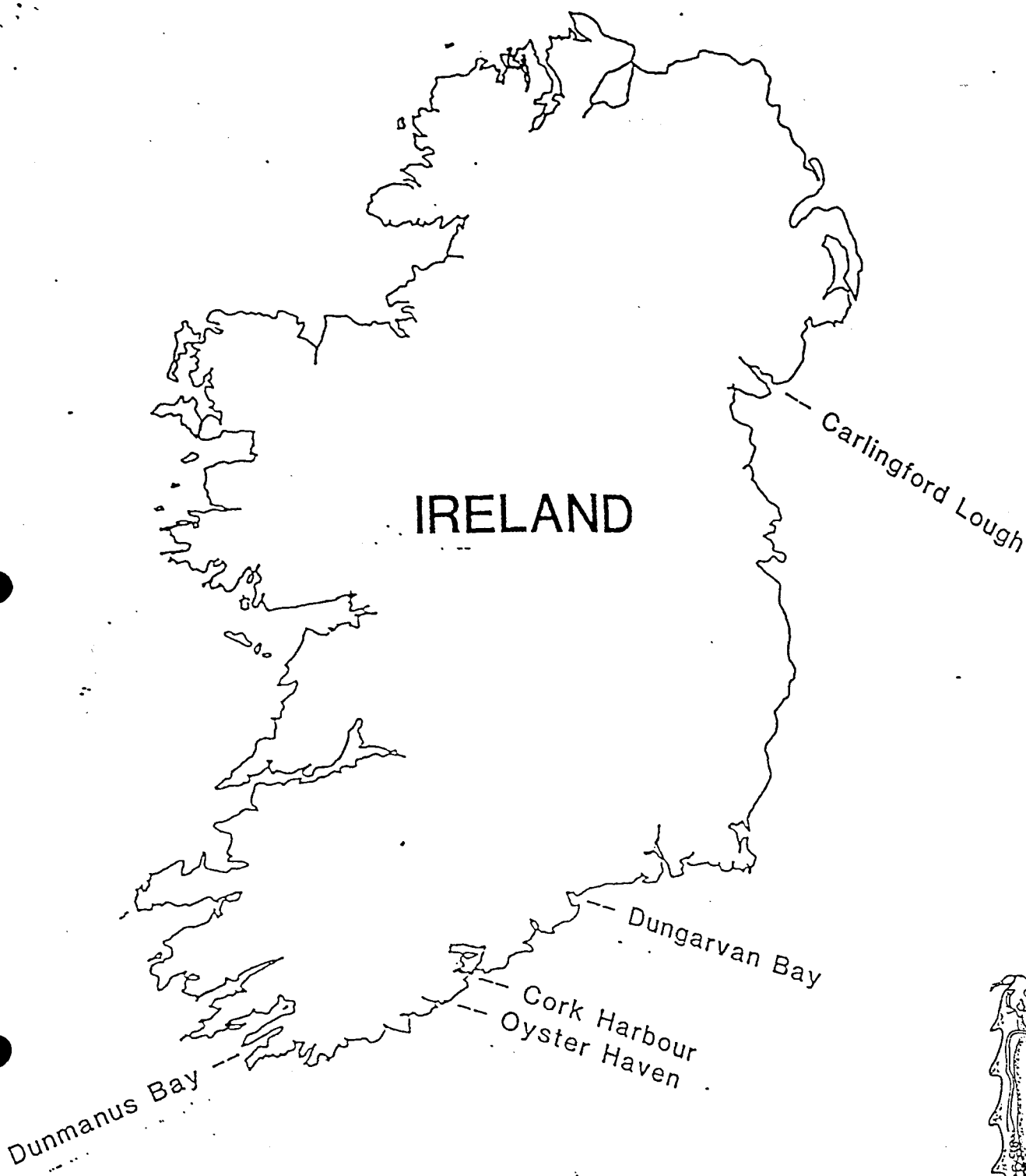
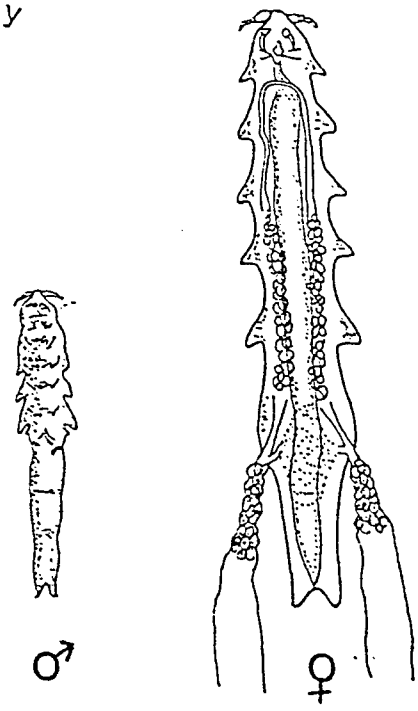
Table 1. Importations of Pacific oyster, *C. gigas*, from France to Ireland during 1993 with associated organisms.
* indicates oysters from a nursery system. + removed from the sea soon after introduction. Oysters from the f first introduction to Carlingford had 2.7% to 5.3% infestation of *M. orientalis* on 10 March 1993, local populations had none.

Import date	Area Relayed	Source	Quantity imported	Examined	Sample size	*Ostrea edulis*	*Crepidula fornicata*	Sample size	% with *M orientalis.*	Number with *M. ostrea*
23-1-93	Carlingford	Marennes	1717kg	yes	113	0	1	86	7.3	present
4-2-93	Carlingford	Marennes	4000kg	no						
5-2-93	Dungarvan	Normandy	3300kg	no						
19-2-93	Dungarvan	Normandy	3300kg	no						
25-2-93	Dungarvan	Marennes	5340kg	yes	308	5	1	67	14.9	5
25-2-93	Cork Harb.+	Marennes	770kg	yes				23	4.3	0
26-2-93	Carlingford	Marennes	9970kg	yes	1721	1	0	82	9.7	?
4-3-93	Dungarvan	Normandy	3300kg	no						
5-3-93	Sample	Arcachon	4kg	yes	80	0	0	80	3.7	3
6-3-93	Dungarvan	Normandy	3300kg	no						
19-3-93	Carlingford	Marennes	15000kg	yes	138	0	0	30	0	0
23-3-93	Sample *	Normandy	2kg	yes	46	0	0	46	30.3	2
25-3-93	Dungarvan	Irish/British	2kg	yes	68	0	0	68	0	0
4-93	Sample	Normandy	2kg	yes	230	0	0	60	6.6	0
4-93	Oysterhaven	Arcachon		yes	60	0	0	40	5	1
3/4-93	Dunmanus	not known		no						
22-4-93	Dungarvan	Normandy	3,000,000 spat (0.5kg)	yes			present			



Areas in which C. gigas from France were relaid.



Mytilicola orientalis

found in C.gigas from Arcachon, Marenne/Oleronn and St. Vaast la Hougue (Normandy).