

This Report not to be cited without prior reference to the Council*

INTERNATIONAL COUNCIL FOR
THE EXPLORATION OF THE SEA

C.M. 1985/F:60:Appendix VIII
Mariculture Committee

SPECIAL REPORT

of the

Working Group on Introductions and Transfers of Marine Organisms

on

THE INTRODUCTION AND CULTIVATION OF THE BROWN ALGA UNDARIA ON THE ATLANTIC COAST OF FRANCE

Göteborg, Sweden

May 28 - June 1, 1985

This document is a report of a Working Group of the International Council for the Exploration of the Sea and does not necessarily represent the view of the Council. Therefore, it should not be quoted without consultation with the General Secretary.

* General Secretary
ICES
Palægade 2-4
DK-1261 Copenhagen K
DENMARK

THE INTRODUCTION AND CULTIVATION OF THE BROWN ALGA UNDARIA
ON THE ATLANTIC COAST OF FRANCE

Background

The brown alga, or seaweed, Undaria pinnatifida (Harvey) Suringar, known in its native Japan, where it is highly valued as food, as "wakame", is a member of the Order Laminariales of the Phylum Phaeophyta. Undaria pinnatifida occurs naturally in Japan along with two other species of Undaria (Saito, 1975), and it has been intentionally introduced to Korea and China for mariculture purposes (Perez et al., 1981). Undaria grows to depths of 13 - 15 m in Asia (Perez et al., 1981 [Appendix a]; IFREMER, 1985, p. 2 [Appendix-e-i]), "on rocks and reefs...in places facing the open sea or within bays near the open sea, along nearly the whole warm current coasts of Japan" (Saito, 1975). Under good growing conditions on the Brittany coast of France it may reach a length of 3 m (Perez et al., 1984, p. 14).

In February 1971, an oyster culture grower discovered Undaria pinnatifida growing in the warm, shallow waters of Thau Lagoon (l'etang de Thau) on the Mediterranean coast of France (Perez et al., 1981). The evidence suggests that Undaria was accidentally introduced to France as spores or young plants attached to shells of the Japanese oyster Crassostrea gigas, imported at the time from Japan to re-establish the French oyster industry (Perez et al., 1981; IFREMER, 1985). A variety of marine invertebrates were also transported to France by the same means (Gruet et al., 1976). Since 1971, Undaria has been found only in the Thau Lagoon or immediately nearby on the breakwaters at the port of Sete (Table 1). Its failure to rapidly spread is characteristic of the Laminariales (IFREMER, 1985, p. 1), and, in the specific case of Undaria, drifting pieces of the algae that

Table 1.

CHRONOLOGY OF UNDARIA IN FRANCE

Date	Event	Reference
February 1971	<u>Undaria</u> discovered growing in Thau Lagoon (l'étang de Thau), Gulf of Lions, Mediterranean coast	Perez et al., 1981, p.
1981	<u>Undaria</u> discovered growing outside of Thau Lagoon, on the breakwaters of the Port of Sete	Perez et al., 1984, p.
late September, 1983	Experiments with <u>Undaria</u> culture begun in Brittany: * <u>Island of Groix</u> * <u>Island of Ouessant</u> [Ushant] * <u>St. Malo</u> , on Rance estuary	Perez et al., 1984
1984	Experiments continued at above localities, and also at: * <u>Roscoff</u>	Perez et al., 1984, p. IFREMER, 1985, p. 3, lines 32-33
1985	Experiments continued at the above islands ("iles du Ponant" region), and also: * <u>near Paimpol</u>	IFREMER, 1985, p. 5; H. Grizel, ICES Working Group Meeting, 29 May 1985, Göteborg (oral presentation)

might be carried out of the lagoon into the Gulf of Lions (Golfe de Lion) do not carry spores, since the spores are located on the anchored basal portion of the plant which remains attached to the substrate (IFREMER, 1985).

In late September 1983 the Institut Scientifique et Technique des Peches Maritimes (ISTPM) placed sporophytes (plantules) of Undaria cultured in the laboratory on ropes into the sea at three sites on the Atlantic coast of France in Brittany, for experimental cultivation purposes (Perez et al., 1984 [Appendix b]):

- (1) on the south shore of Brittany, at the Island of Groix, west of the port of St. Nicolas, in a moderately exposed habitat, but with a strong current,
- (2) on the west shore of Brittany, on the Island of Ouessant (Ushant), in a region very exposed to the southwest wind,
- (3) on the north shore of Brittany, on the mainland at St. Malo, on the Rance Estuary, in a site protected from the wind

The results of these experiments, with growth data reported through March 1984, are presented by Perez et al. (1984). Table 1 (herein) summarizes these experiments and those that followed at the same and additional localities in 1984 and 1985.

WORKING GROUP MEETING -- 1984

In March 1984, Dr. A. Preston, ICES delegate for England and Wales, requested that the ICES Working Group (WG) on Introductions and Transfers of Marine Organisms seek information that would clarify the Undaria experiments on the French coast. In May 1984, the WG considered this request at a meeting at the Fisheries Laboratory in Halifax, Canada. The WG heard presentations from Dr. H. Grizel of IFREMER (then ISTPM) and from Dr. J. S. Craigie, of the

National Research Council of Canada, on the French experiments, and on the distribution and life cycle of Undaria, respectively. The results of this discussion and conclusions reached at that time were presented in the WG Report for 1984 (C.M. 1984/F:35, pp. 33-37, including a figure on the life cycle of Undaria) [Appendix c herein]. In summary, at this meeting, the WG:

- * noted discrepancies in the reported temperature requirements for reproduction of Undaria in France and in Japan
- * requested an assessment of the possibility of loss due to storms of cultured Undaria, and thus transport out of the experimental sites
- * requested details of the experiments and plans for the future
- * expressed regret that ICES was not informed "at an early stage" about these experiments

WORKING GROUP MEETING -- 1985

Two reports were submitted in 1984 - 1985 to the Working Group through the auspices of the General Secretary and of Dr. J. E. Stewart, Chairman, Mariculture Committee:

- (1) "Observations on the experiments with Undaria pinnatifida on the north west coast of France", by Dr. G. T. Boalch, Marine Biological Association of the United Kingdom, 5 November 1984, 4 pp. [Appendix d herein]

and, at the request of ICES, in response to the Boalch report,

- (2) "Introduction sur les cotes francaises de l'algue Undaria pinnatifida: Evaluation des risques d'extension (et) Mise en valeur d'une nouvelle ressource", by IFREMER (Institut francais de recherche pour l'exploitation de la mer), 5 April 1985, 5 pp. [Appendix e_i and Appendix e_{ii} (= English translation provided through auspices of Dr. A. Munro, Department of Agriculture and Fisheries for Scotland, Aberdeen)]

The WG was formally requested by the General Secretary and by the Mariculture Committee Chairman to consider these documents and to:

- (1) "undertake, through deliberations of this Working Group, an analysis of the risks imposed by introduction of Undaria to the Atlantic Coast of Europe, using the reports and materials referred to above and such other materials, reports and experts as the Working Group deems necessary,"

and

- (2) "file a separate report related only to the Undaria introduction giving background documentation, the risk analysis in light of ICES guidelines, conclusions and recommendations for consideration at the 1985 Statutory Meeting of ICES".

To this end, the WG met in a special session on 29 May 1985 at the National Board of Fisheries Offices, Göteborg, Sweden, to consider the Undaria matter.

In attendance were:

G. E. Turner	--	Canada
R. S. Eisner	--	Canada
V. Jacobsen	--	Denmark
P. Tuunainen	--	Finland
H. Grizel	--	France
H. Rosenthal	--	Federal Republic of Germany
D. McCarthy	--	Ireland
S. de Groot	--	Netherlands
E. Egidius	--	Norway
H. Quiroga	--	Spain
B. Dybern	--	Sweden
A. Munro	--	U.K.
D. Solomon	--	U.K.
C. Sindermann	--	U.S.A. (Chairman)
J. Carlton	--	U.S.A. (Rapporteur)
R. Welcomme	--	F.A.O.

In addition, two invited phycologists were present:

Dr. G. Boalch	--	Marine Biological Laboratory, Plymouth, U.K.
Dr. I. Wallentinus	--	University of Göteborg, Sweden

At this time, Dr. Boalch presented a second document to the WG for consideration (Appendix f).

Proceedings of the Meeting

H. Grizel first presented a detailed report on the French Undaria experiments (Appendices a, b, c; Table 1, herein). In assessing the risk and likelihood of Undaria becoming established and spreading on the Atlantic coast of France, the following major points were emphasized:

- (1) Extensive plantings (and the great majority) of Japanese oysters (Crassostrea gigas) from Japan have been made on the Atlantic coast of France, on many occasions over the last 15 years, but Undaria has never established itself there,
- (2) Transfers of flat oysters (Ostrea edulis) from l'etang de Thau to the Atlantic coast, from Brittany to Spain, have been made regularly over the years, but Undaria has never established itself there,
- (3) The temperatures for gametophyte maturation are too low on the Atlantic coast: it is necessary for water temperatures to be maintained at 22° to 24° C for about ten days; maximum temperatures at the experimental sites do not exceed 18° C. The interaction and importance of adequate light availability and penetration are very important here in determining the role of temperature,
- (4) In two years of experiments with Undaria (1983 and 1984) at the sites in Brittany noted above, Undaria did not reproduce,
- (5) The spores (zygotes) of Undaria cannot survive under heavy competition for substrate space with native species of brown algae (Ectocarpus, Sachoriza, Laminaria); these latter species monopolize the substrate and outcompete the Undaria. Cultivation experiments are successful only if plantules (sporophytes) 2 to 4 mm long are used, giving Undaria a "lead" over the other species. Thus, even if Undaria could reproduce, it is unlikely that naturally settled spores would or could grow.
- (6) Floating and drifting pieces of Undaria do not carry spores. Spores are located only at the basal holdfast of the algae, which is very resistant and solidly attached to the substrate,
- (7) Experiments are carried out solely with plantules (sporophytes) produced in nurseries under axenic conditions; thus, it is with only F₂ and later generations that these experiments are undertaken.

(7) [continued]

No diseases or parasites have been noted in any of these experimental nursery cultures.

Dr. Grizel also reviewed certain aspects of the history and biology of oyster culture and movements on the Atlantic and Mediterranean coasts of France.

In response to Dr. Grizel's presentation, Dr. Boalch made the following major points:

- (1) Literature reports [Appendix d, herein, and Appendix f, pp. 2-3] from Japan, and personal communications Dr. Boalch has received from Chinese phycologists, indicate that the reproductive and gametophyte maturation temperatures are much broader than those noted by IFREMER. Data from Asia indicate that Undaria will reproduce at the temperatures at the experimental sites on the French Atlantic coast.
- (2) Given (a) that Undaria grows on the French Atlantic coast to much larger sizes than either in the l'etang de Thau or in Asia, (b) that its growth rates are much different in Brittany, and (c) that Sargassum muticum also differs strikingly in various characteristics between the Asian and European populations, it is therefore difficult to predict how Undaria will "behave" reproductively or physiologically on the Atlantic coast. Introduced populations of a species may change their biology, ecology, and physiology, and so full predictions about these species are very difficult to make.
- (3) Greatly increased intensity and quantities of Undaria cultured on the Atlantic coast of France, may result in its successful establishment there, despite the arguments by IFREMER that this would not be possible. Experiments with Undaria in the sea on the northwest coast of France "gives the possibility" of Undaria spreading to the English Channel and to the Atlantic coast of Spain.

Following the presentations by Dr. Grizel and Boalch, WG members presented comments from their national phycological experts, as follows:

Canada: Dr. G. Robin South, Memorial University of Newfoundland

Denmark: Dr. T. Christensen, Københavns Universitet, Institut for Sporeplan

F.R.G.: Dr. K. Lüning, Biologische Anstalt Helgoland
Ireland: Dr. M. D. Guiry, University College, Galway
Netherlands: Dr. C. den Hartog, Katholieke Universiteit
Sweden: Dr. I. Wallentinus, University of Göteborg

These comments included:

- (1) concern for possible escape of Undaria from cultivation and spreading to other areas,
- (2) noting certain of the temperature arguments given by Dr. Boalch, above,
- (3) expressing great concern over such introductions, these being "unacceptable", "without adequate assurance," and a "potential danger" (among other similar comments),
- (4) the importance of adequate regulations to prevent uncontrolled introduction of exotic species

After the presentations, and after the departure of Drs. Boalch and Wallentinus, the WG discussed the Undaria experiments at great length for several hours. Considerable discussion focused upon:

- (1) all of the points presented by Drs. Grizel and Boalch, above
- (2) the question of competition between Undaria and native algae, and the difficulties of assessing this with the present data at hand. Differences exist in space and time, and with juvenile:adult and adult:adult interactions. Dr. Grizel noted that the possibilities of competition are limited, however, as the Undaria are harvested in winter, and they die back in summer. Dr. Grizel also noted the inherent difficulties of studying competition solely in the laboratory
- (3) the role of Undaria, Sargassum, and other algae, as a "nursery" habitat for various commercial and noncommercial fish and shellfish species, and the significance of this

- (4) the potential market of Undaria in France and elsewhere
- (5) the theoretical and practical methods of risk analysis and risk assessment, and the "scales" of risk

ANALYSIS OF RISKS IMPOSED BY INTRODUCTION OF UNDARIA TO THE ATLANTIC COAST OF FRANCE IN LIGHT OF ICES GUIDELINES; AND CONCLUSIONS AND RECOMMENDATIONS FOR CONSIDERATION AT THE 1985 STATUTORY MEETING OF ICES

Response of Working Group

The Working Group:

- (1) concluded that the significant gaps in the data available, including the continued discrepancies in the reported temperature requirements for Undaria to reproduce on the French (and other European) Atlantic coasts, made a complete risk assessment and analysis by the WG to be impossible at this time. Nevertheless, the WG concluded that:
 - (a) although large numbers of oysters from Japan and from l'Etang de Thau (Undaria occurring in both places) have been placed on the Atlantic coast of France without the appearance of Undaria there, and although French scientists have been unable to get Undaria to either reproduce on the Atlantic coast (= successful zygote (spore) settlement arising from adult plants placed in the ocean) or to grow out (up) on the Atlantic coast from the zygote stage placed in the ocean (due it is believed to overgrowth by native algal species), if extensive culture of Undaria were to be carried out (undertaken) on the Atlantic coast, the eventual escape and dispersal (dissemination) of Undaria would be probable and establishment (reproduction and continued spread) in the wild would be likely,

and that,

 - (b) although speculations are available by experts on the potential (possibilities and probabilities) for competition between Undaria and native species of algae (including displacement, replacement, and/or other levels of interaction) and for how Undaria could effect native fauna, too little is known to make a sound, objective, and substantive statement of the ecological and/or other risks if Undaria were to establish, propagate, and spread on the Eastern Atlantic European coast,
- and that,
- (c) disease risks are minimal, as the French scientists restrict their experimental activities to axenic F₁ (and later) cultures, wherein no diseases or parasites have been found, and to the parental stock in l'Etang de Thau, where no diseases or parasites have been found,

and

- (2) found and noted again that the introduction of Undaria to the Atlantic coast was not brought to the attention of ICES before the introduction took place (see: C.M. 1984/F:35, p. 37),

and,

- (3) noted that French scientists have followed those sections of the Code and Guidelines that call for (a) experimental data on the biology, ecology, physiology, and competitive abilities of the species in question to be developed, (b) the species be examined and studied in the country of origin (where it is native), (c) only F_1 , and later, generations, free of diseases, be planted in the natural environment, and (d) awareness of, and intention to undertake, risk assessment; "...et de procéder à toutes observations complémentaire sur les risques de prolifération incontrôlée" [and making all additional observations needed relative to the risk of uncontrolled proliferation] (IFREMER, 1985, p. 4, last line),

and thus,

- (4) based upon all of these considerations and conclusions, and noting that French scientists are continuing a pilot scale program of experiments in the open sea, urges that any commercial (industrial) expansion of the program be held in abeyance, and efforts at containment of the existing introductions be carried out, until a full, detailed, and extensive study be submitted to ICES on the risks imposed if Undaria were to become established on the Atlantic coast; such a study should include but not be limited to the following questions raised by the WG:
- (a) the likelihood of reproduction throughout Western Europe, and the resolution of the differences between those temperature requirements reported for reproduction and gametophyte maturation by IFREMER in the report of 18 April 1985, and the requirements reported by other workers, and why such differences exist,
 - (b) the likelihood of the escape of Undaria from the culture sites, including the likelihood of the loss of entire substrates (such as ropes), during storms, substrates that would carry the entire plant, including spore-bearing basal parts; such an assessment should thus include a full description of the experimental site, and the hydrographic conditions at the site and surrounding waters,
 - (c) the likelihood that not all Undaria could be harvested prior to their becoming reproductive and the release of zygotes (spores) occurring,
 - (d) the likelihood of the nature of potential ecological effects and interactions with native species of algae and invertebrates (such as herbivores, or species that might use Undaria beds for a nursery area), over a wide range of spatial and seasonal conditions, and,
 - (e) a full listing of the risks and benefits in the introduction of Undaria, and a program in which and by which the risks are to be prevented or minimized,

(5) that such a study be communicated to the Council for evaluation and comment, through its Working Group on Introductions and Transfers of Marine Organisms, for advice on whether to proceed with the introduction of Undaria, and what actions should be taken and the directions in which to proceed,

and,

(6) that, in the meantime, also, the WG will recommend to the Council that an expert be asked to prepare a detailed analysis, addressing the above questions as best as possible, but also based upon all available literature, and based upon contacts with other experts, such an analysis to be available before the next WG meeting.

Literature Cited

IFREMER

1985. Introduction sur les cotes francaises de l'algue Undaria pinnatifida: Evaluation des risques d'extension (et) Mise en valeur d'une nouvelle ressource. IFREMER DRV/AQ No.009, 5 pp.

Gruet, Y., M. Heral, and J.-M. Robert

1976. Premiers observations sur l'introduction de la faune associee au naissain d'huitres japonaises Crassostrea gigas (Thunberg), importe sur la cote Atlantique Francaise. Cah. Biol. Mar., 17: 173-184.

Perez, R., J.Y. Lee and C. Juge

1981. Observations sur la biologie de l'algue japonaise Undaria pinnatifida (Harvey) Suringar introduite accidentellement dans l'etang de Thau. Science et Peche, No. 315, 12 pp.

Perez, R., R. Kaas, and O. Barbaroux

1984. Culture experimentale de l'algue Undaria pinnatifida sur les cotes de France. Science et Peche, No. 343, 15 pp.

Saito, Y.

1975. Undaria, pp. 304 - 320, in: J. Tokida and H. Hirose, eds., Advance of Phycology in Japan. Dr. W. Junk b.v. Publishers, The Hague.

APPENDICES

- a. Perez, R., J. Y. Lee and C. Juge, 1981.
Observations sur la biologie de l'algue japonaise Undaria pinnatifida (Harvey) Suringar introduite accidentellement dans l'etang de Thau. Science et Peche, No. 315, 12 pp.
- b. Perez, R., R. Kaas, and O. Barbaroux, 1984.
Culture experimentale de l'algue Undaria pinnatifida sur les cotes de France. Science et Peche, No. 343, 15 pp.
- c. Report of the Working Group on Introductions and Transfers of Marine Organisms, Halifax, Canada, 17 - 19 May 1984.
C.M. 1984/F: 35

Comments: The Cultivation of the Brown alga Undaria on the Atlantic coast of France [pp. 33-37]
- d. Boalch, G. T. 1984. (15 November)
"Observations on the experiments with Undaria pinnatifida on the north west coast of France"
- e. [i]
IFREMER. 1985. (5 April)
Introduction sur les cotes francaises de l'algue Undaria pinnatifida: Evaluation des risques d'extension (et) Mise en valeur d'une nouvelle ressource. IFREMER DRV/AQ No. 009, 5 pp.
- [ii]
IFREMER, 1985.
Introduction of the alga Undaria pinnatifida to the coasts of France: Evaluation of risks of its spreading (and) Development of a new resource. IFREMER DRV/AQ No. 009.
- f. Boalch, G. T. 1985 (17 May)
"ICES Special Meeting: Working Group on Introductions and Transfers of Marine Organisms" [further comments on Undaria introduction]