



MARICULTURE COMMITTEE

by

K. Tiews

1980

BELGIUM

(G. Persoone and F. Redant)

The two pilot-scale installations for mariculture, built at the Belgian coast in 1979 have been started up in 1980.

Research is in progress now to establish the cost-benefit of the operations on the basis of variation of a number of parameters which can be changed within the systems.

The first pilot plant concerns the nursery-rearing of bivalves which is presently a bottle-neck in the controlled farming of molluscs

The Laboratory for Mariculture at the State University of Ghent, which is in charge of the research, jointly with the Institute for Marine Scientific Research (IZWO) is organizing an International Workshop on nursery culturing of bivalve molluscs in the framework of the COST Mariculture Action 46.

The Artemia research is taken care of by the Artemia Reference Center at the Laboratory for Mariculture.

The Artemia pilot-plant at the Belgian coast is focusing on recycling agricultural waste products in protein biomass by intensive culturing of brine shrimp.

The Artemia Reference Center has been editing in 1980 a series of 3 books on "The Brine Shrimp Artemia" containing approximately 100 reviews and papers which cover the major research areas on this particular crustacean used worldwide in fundamental research and in aquaculture.

The European Mariculture Society, the registered office of which is located at the Institute for Marine Scientific Research in Belgium, has launched the "World Conference on Aquaculture and International Aquaculture Trade Show" which will be convened in Venice, Italy in September 1981.

Statistical Information

There was no culture of flat oysters (O. edulis) due to dyke construction in the vicinity of the beds.

CANADA

(J.E. Stewart and R. Driman)

PACIFIC COAST

Shellfish

A commercial spatfall of the Pacific Oyster (Crassostrea gigas), was obtained in Pendrell Sound, the major area of seed collection. Production of oysters for both shucking and sale in shell, declined in 1981, due primarily to a reduction in seeding of beds in recent years.

A small private shellfish hatchery continued to operate in 1980 rearing largely C. gigas. The total amount of seed produced was minor.

The culture of the blue mussel, Mytilus edulis, largely on longlines, is still in the early developmental phase.

A private commercial abalone (Haliotis kamschatkana) operation began production in 1980. The intent is to breed this species and rear it to market size.

Fish

The federal experimental salmon fish farm programme has shown great success. Coho and Chinook 'commercial' rearing in marine cages show consistent survival of 70+ 5% to pan size. Further rearing, to 2kg, results in losses of approximately 50% from diatom (Chaetoceros) blooms, Bacterial Kidney Disease and Furunculosis, but still results in an economic gain.

The resources and facilities used for salmon rearing will be utilized beginning in 1981 for an investigation of the impoundment of herring to establish the potential application of such a technique in the production of roe, an important and economically attractive fisheries product in recent years.

Selective breeding studies utilizing rainbow trout in marine culture show great promise. A domesticated freshwater strain has shown excellent sea growth, exceeding that of salmon, but exhibits high (40%) mortalities at 120g. Survivors will be bred to develop a strain with lower losses. Strains reared from eggs imported from Norway and the U.K. are also being reared in this programme.

A joint federal-provincial (British Columbia) study of the nutritional requirements of rainbow trout in seawater has begun. This incorporates the evaluation of a number of dry and moist diets using a variety of performance criteria and basic studies of nutritional requirements, with the aim of producing practical diets for rainbow trout in seawater using Canadian components.

Atlantic Coast

Marine Plants

Two companies in Nova Scotia, have, for a number of years, carried out pilot studies on the culture of Irish moss (*Chondrus crispus*). One recently terminated its studies whereas the other has expanded operations. In the recent past many biological stumbling blocks were surmounted and progress was being made in growing a cost efficient product. This year the program was set back by a disease. The organism has been identified and steps are being taken to control it within the system.

The fisheries department of the province of Prince Edward Island is continuing growth studies of an unattached form of *Chondrus crispus* in various Island estuaries with the aim of developing an economically viable culture system.

In Newfoundland, an investigation of hatchery techniques for *Saccorhiza* is underway at the Marine Sciences Research Laboratory of Memorial University.

Oyster (*Crassostrea virginica*)

A joint federal/provincial development project in northern New Brunswick continues to show great promise. Its goal is to increase production from private leases by improving existing oyster culture technologies and transferring these to the private sector. Federal input in 1980 included monitoring of oyster larval populations and providing spatfall predictions to industry. This area produces two-thirds of the oysters landed in New Brunswick; over 90 metric tons from leased areas in 1979. From the production history, the potential appears to be at least three times this and based on the area available for oyster culture could theoretically approach fifty times.

Final enhancements were made to the recently completed computer systems for Shellfish Lease Administration, and granting of shellfish leases for off-bottom mussel culture was initiated.

Flat oyster (*Ostrea edulis*)

Interest in growing this species commercially on the Atlantic coast of Nova Scotia is substantial, following experimental and demonstration projects by the provincial government. Hatchery rearing of sufficient seed to supply the initial pilot operations is planned for 1980.

The incidence of shell disease in this species in Nova Scotia has been surveyed. All year classes (1975-1979) were found to be infected, with an overall incidence of 10-20%. However, in the relatively cool waters of this area, no seriously damaging effect was observed. An organism similar to *Ostracoblabe implexa* was isolated from shell lesions and is being maintained in culture. Its morphology, infectivity and physiology are being studied.

Blue Mussel (*Mytilus edulis*)

Commercial mussel culture using longlines is established in Prince Edward Island and Nova Scotia and promising exploratory operations are underway in New Brunswick. A processing and distribution plant is planned for Prince Edward Island. With the establishment of firm market demand a number of new private ventures are in early development phases in the Maritimes and Newfoundland. Appropriate technology, particularly for overwintering in ice, is still a major need and experimental programmes to investigate this and other basic industry-oriented parameters are underway in all areas.

Sea Scallop (*Placopecten magellanicus*)

In Newfoundland, the Provincial Department of Fisheries has continued to support investigations into scallop culture. These included spatfall monitoring in Placentia Bay, Port au Port Bay and Bay of Islands. While spatfall in Garden Cove and Fox Island River reached near-record levels, extremely poor spatfall was recorded in the Bay of Islands.

Growth and survival of juvenile scallops at the new grow-out site of Spencer's Cove were monitored. Survival of 1-year olds was well over 80%, a considerable improvement over that encountered in Garden Cove.

The transfer of culture technology to the private sector has begun. The Port au Port Development Association has started up a resource enhancement project at Fox Island River. Funded largely by the Development Branch of the Provincial Department of Fisheries, the Association has set 2000 spat collectors. Seeding of public grounds will commence in 1982 after accelerated off-bottom growth through the winter of 1981. A private entrepreneur on the south coast of the island has also started up spat collecting operations.

A leasing policy has been developed to facilitate mariculture operations in the province.

Bay Scallop (*Aequipecten irradians*)

The second generation of this species, reared in quarantine from an original import by the Prince Edward Island Department of Fisheries, is being held pending their approval by federal authorities for transfer to Canadian waters.

Growth in both F₁ and F₂ stocks showed considerable improvement over the previous year. In the closed system with severely limited water exchange growth rates comparable to those under natural conditions in the U.S.A. have been observed.

A *chlamydia*-like organism present in the original import from Connecticut has been detected in high numbers in subsequent generations but not in native species held in contact

with them. Similar, but doubtfully identical inclusions have been found in some native species both inshore and offshore. Investigations into the nature and potential threat from this organism and attempts to prevent its passage to subsequent generations are continuing.

Lobster (*Homarus americanus*)

A three year pilot lobster culture study carried out under a federal contract with a private operator in Prince Edward Island will be completed early in 1981. This was designed to develop and test commercially-applicable technology for rearing lobsters from canner to market size using eyestalk ablation and improved diets.

A rearing system has been developed using seawater from a shallow drilled well. Thirty stocks of trays can house 8000 market lobsters individually. The system can operate on a flow through basis or on recirculation, and it has performed well under less than maximum loading, showing acceptable growth performance, disease control and energy efficiency. A number of formulations are under test to develop a feed that is palatable, easy and inexpensive to produce and gives acceptable production characteristics.

During the course of this work it was extended to include culture from egg to market. A number of options for larval culture regimes have been tested. A flow-through system in rectangular tanks using brine shrimp nauplii as feed has shown best results. A stacked tray system is under test for juvenile culture and good progress has been made in feed development.

In federal laboratory studies, lobsters bilaterally eyestalk ablated averaged more than 300g at 13 months. At this age females had well developed ovaries showing a potential for a halving of the normal reproductive cycle in laboratory culture, a phenomenon which could be of great significance in genetics research.

Salmon

There are several areas in the southwestern Bay of Fundy area where climatic conditions are suitable for year-round cage culture of salmonids. In addition to the successful operation which began on Deer Island in 1978, there are new operations on nearby Grand Manan and Campobello Islands. The Deer Island site has suitably warm water (no lower than 0.2°C since 1978) which is not the case in Passamaquoddy Bay and most other mainland locations in the S.W. Bay of Fundy area. The successful operation at Deer Island and the promise shown by the other island operations has sparked interest in further development in the same general area. It is planned that up to 50,000 Atlantic salmon and 30,000 pink salmon smolts will be put in cages in 1981.

In 1980 the Atlantic salmon were smaller than those harvested in 1979. This size difference reflects smolt size which influences size through cage rearing up to harvesting and stock origin which determines incidence of early maturing (grilse) individuals. Salmon of comparable smolt size and of the same stock produced similar sized fish at harvest in 1979 and 1980. Of two stocks reared at Deer Island, one gave negligible (1%) grilse after one sea year while the other stock yielded up to 70% of males and 30% of females as grilse.

Pink salmon were harvested at 2-3 lb after about 14 months of cage rearing. Most individuals were maturing when harvested and would not have been expected to grow any more. These fish were not put in sea cages as early as possible (May-June) but were held in shore-based tanks until August. It is likely that a larger size at harvest would be achieved by putting the pink salmon in sea cages as soon as water reached 10° in early summer. A further trial with pink salmon is planned for 1981.

Sea ranching trials continued in 1980 with the release of 8,000 smolts at the Biological Station at St. Andrews N.B.. A delayed release (mid-July) was used to maximize return. The smolts were reared from returns from an earlier sea ranching trial at the same site. Plans are being developed for a pilot commercial sea ranching trial during the next several years at Grand Manan. This location was chosen because of the lower number of herring weirs in the immediate area and the prospect of fewer smolts and returning adults being taken incidentally in the herring fishery.

A major component of the Salmon Genetics Research Program will involve genetic studies in support of commercial aquaculture. A joint study was begun in 1980 with the SGRP supplying 24,000 smolts of various stocks for rearing on the Deer Island site. Data on survival, growth and maturity are being collected as a basis for selective breeding studies to produce stocks of salmon with appropriate traits for sea ranching. Comparisons of growth and maturity parameters are being made between cage reared and sea ranching individuals representing the same stocks. These studies are also expected to produce genetics data with an application in cage rearing of salmon.

Physiological studies of growth and smolting are being conducted in support of cage rearing and sea ranching. The thyroid hormone, triiodo-L-thyronine, has growth promoting effects and enhances salinity tolerance. This hormone is being used on an experimental basis to improve production of smolts by decreasing the time required and decreasing the cost of production.

Long-term laboratory and field experiments are underway to study possible environmental control of sexual maturation in cage reared Atlantic salmon. It appears that the pattern of maturation in a given salmon stock reared in sea cages differs from that as a result of sea ranching. Experiments are aimed at testing two hypotheses to explain the lower incidence of mature fish in sea cages in comparison with sea ranching. These concern low winter temperatures in sea cage conditions and the effect of diet.

Atlantic Salmon Nutrition

In the Halifax laboratory the effect of changes in dietary protein and lipid levels in practical feed formulas on the performance of Atlantic salmon grown in freshwater at 15°C and 20°C, and in seawater at 15°C, was investigated.

A 16 week feeding trial using 12 dietary treatments (3 levels of protein and 4 levels of lipid) conducted at 15°C demonstrated that the dietary lipid level has a significant effect on protein utilization. Diet containing 16% lipid and 45 and 50% protein showed improved growth, feed conversion and higher nutrient reserves in the body. The effect of high temperature (20°C) on protein and lipid utilization by Atlantic salmon was studied in a 10 week feeding trial. Results show that Atlantic salmon require a low lipid and protein diet at higher temperature due to increased utilization of carbohydrate for energy purposes.

The survival and performance of Atlantic Salmon Smolts fed dry diets (40, 45 and 50% protein and 9, 12.5 and 16% lipid and their combinations), oregon moist diet and purified diet was evaluated under laboratory condition in sea water. Fish fed a pelleted diet containing 16% lipid and 45% protein showed similar growth, flavour and texture properties to those fed oregon moist type diet. Dry feed showed better feed conversion than moist diet.

Rainbow Trout

In Newfoundland commercial production in 1980 was from a brackish embayment. Trials in full seawater showed very low mortality and will be expanded in 1981. A production of 30 MT annually is projected for this operation.

The major producer in the region, growing rainbow trout in cages in the brackish waters of the Bras d'Or Lakes in Cape Breton, Nova Scotia, overwintered commercial quantities of fish which were successfully marketed smoked at a size much larger than the former pan-sized product.

At this site returns of escaped fish are substantial and suggest a potential for sea-ranching as a commercial technique. Fish have been tagged and released to provide data for assessment.

Tuna

As in 1979, the numbers of fish caught in St. Margarets Bay for impoundment and fattening for fall slaughter was below expectations. A weak market in Japan resulted in lowered prices. Unusual numbers of small fish, less than 100 kg were caught, and released and the proportion of females in the impounded animals was observed to be approximately double that previously recorded.

MARICULTURE PRODUCTION 1980 - CANADA

<u>PACIFIC COAST</u>	<u>METRIC TONS</u>	<u>NUMBER</u>	<u>\$US(000's)</u>
Oyster (<u>Crassostrea gigas</u>) Seed on shell (Vertical culture)	-	258 x 10 ⁶	1,047
Market (shucked)	2,007	-	1,020
Market (in shell)	-	357,600	
Mussel (<u>Mytilus edulis</u>)	3.6	-	3.7
Pacific Salmon Species		Not available	

ATLANTIC COAST

*Oyster (<u>Crassostrea virginica</u>)	1,103	-	890
Mussel (<u>Mytilus edulis</u>)	36.3	-	32
Rainbow trout (cages)	83.0	-	260
Atlantic salmon	3.5	-	17
Pink salmon	2.8	-	6
Tuna	29.7	-	110

*Preliminary estimate

DENMARK
(E. Hoffmann)

The experimental work with turbot (Scophthalmus maximus) and pacific oyster (Crassostrea gigas) has continued in 1980 at two small research farms, situated at the power plants, Asnæs, northwest of Copenhagen and Skærbæk in southern Jutland. The oyster production has given very promising results and a production in commercial size is planned for 1980.

The number of culture beds for blue mussel (Mytilus edulis) has increased and the interest for this species is expanding.

In the Limfjord area a raise in the production of the flat oyster (Ostrea edulis) is wanted. The building of a hatchery is under consideration. The total production in the Limfjord in 1980 was only 150.000 individuals.

Production of rainbow trout (Salmo gairdneri) has increased slightly to approximately 300 tons. - Most fishes were between 1 1/2 and 2 1/2 kilos.

Statistical information

	<u>Tonnes</u>	<u>No.(in 100 000)</u>	<u>Value</u> <u>(in 1 000 US.\$)</u>
Flat oyster (<u>O. edulis</u>) from culture beds		150	180*
Rainbow trout in enclosures, less than 0.5 kg each	83		125*
Rainbow trout in enclosures, more than 0.5 kg each	224		650*

*) rough estimates

FINLAND

(P. Tuunainen)

Mariculture in Finland is based on one hand on sea ranching of salmon (Salmo salar), sea-trout (Salmo trutta trutta) and migratory whitefish (Coregonus lavaretus) by introducing smolts of salmonids and 1-summer old whitefish young into the sea. On the other hand it is based on production of rainbow trout (Salmo gairdneri) in net cages and enclosures for human consumption. Mariculture production is continually increasing. This is caused by good domestic markets for rainbow trout and by efforts to increase the volume of sea ranching of the species mentioned above. In 1980 a new fish farm was constructed in connection with Olkiluoto nuclear power plant, western coast of Finland, to produce salmon smolts for introductions into the Baltic Sea.

Except fish farming restoration of salmon and sea-trout rivers is going on and remarkable increases in the numbers of parrs in the restored rapids have been reported. In one of the rivers, Simojoki, flowing into the Gulf of Bothnia constant monitoring program is going on.

Study programs were also carried out to find out the production biological and economic results of the introductions for sea ranching, to improve the quality of reared fish young, to measure the quality by physiological tests and by tagging the fish. Work has also been done to improve the fish feeds, rearing methods and to decrease water pollution caused by larger fish farms.

Statistical information (for 1979 only as figures for 1980 not yet available)

	<u>Tonnes</u>	<u>No. (in 100 000)</u>	<u>Value</u> <u>(in 1 000 US.\$)</u>
Rainbow trout in enclosures, more than 0.5 kg each	794		3 600
Salmon, for introductions, 2 years and older	11	2.78	500
Sea trout, for introductions, 2 summers old and older	40	7.78	1 000
Migratory whitefish, for introductions, 1 summer old	80	81.49	600

FRANCE

INSTITUT Océanographique (J. AUDOUIN et M. GUILLAUME)

Mollusques

Pectinidae (coquilles St Jacques et pétoncles)

Pecten maximus : Les essais de captage se sont poursuivis en Baie de Saint Brieuc, en Rade de Brest et en Bretagne Sud. En raison des mauvaises conditions hydrologiques et de la diminution du stock de géniteurs dans ces différentes zones, les résultats ont toujours été faibles (5 à 40 par collecteur). Des essais d'élevage en éclosérie ont été menés au CNEOX - COB et à la SATMAR. Ils ont fourni une quantité limitée de naissain.

Chlamys varia : La collecte du naissain a été tentée à nouveau en Rade de Brest et en Baie de Quiberon. Des semis à partir du naissain capté en 1979 ont été réalisés et suivis en Rade de Brest (Comité Local des Pêches Maritimes, en collaboration avec l'équipe pêche CNEOX - COB). Des semis ont également été faits dans les Pertuis charentais (I.S.T.P.M. - Comités locaux des Pêches Maritimes).

Veneridae (palourdes)

Les essais d'élevage en sol des palourdes, principalement de la palourde japonaise Ruditapes philippinarum ont été étendus dans le cadre d'un programme national. Ils sont suivis par le CNEOX/COB et par les laboratoires I.S.T.P.M. de La Trinité Sur Mer, Nantes, La Tremblade et Arcachon. A ce jour, les résultats ont été exploités surtout en Charente Maritime grâce à l'action de l'ADACO (Association pour le développement de l'Aquaculture dans le Centre Ouest). Dans cette région, quatre nurseries sont opérationnelles et une cinquantaine d'exploitants se livrant dès à présent à la culture de la palourde. La production commencera à être significative en 1981.

Haliotidae (ormeaux) (CNEOX - COB)

L'éclosérie d'Argenton a désormais pour objectif l'optimisation de ses techniques.

En 1980, la production de juvéniles a été portée à $5\,000/m^2$ de 0 à 6 mois et de 6 à 12 mois à $4\,800/m^2$. De ce fait dans sa forme actuelle l'éclosérie a produit 115 000 animaux d'un an à partir d'une ponte donnée ; comme les installations sont conçues pour ac-

cueillir les produits d'une ponte tous les 6 mois, la capacité théorique de l'unité de production expérimentale d'Argenton peut atteindre 200 000 juvéniles d'un an.

Au titre du grossissement dans la zone intertidale, la mise en place d'habitats artificiels permet d'espérer en 1981 un taux de recapture de 40 % sur des habitats prototypes mis en oeuvre en 1978 et en 1982 de 60 % sur des habitats de types industriels immergés en 1980. Ce dernier taux de recapture devrait assurer la rentabilité de l'élevage.

Ostreidae (huîtres)

Ostrea edulis : La régression de la maladie due à Marteilia refringens est confirmée. Le parasite est toujours présent dans le Golfe du Morbihan, les rivières d'Auray et de Pénérif et dans la Rade de Brest. Dans ce dernier secteur, les huîtres naturelles semblent s'être immunisées. Leur croissance, leur qualité et les mortalités sont normales.

L'épizootie due au nouveau protiste X, nommé Bonamia ostreae, s'est développée dans tous les centres d'élevage bretons. Des mortalités importantes (50 à 80 %) ont été constatées sur les huîtres âgées de 3 ans et 4 ans. Ce parasite a également été décelé sur des huîtres élevées à Arcachon et dans le bassin de Marennes-Oléron.

Mytilicola sp. et Minchinia armoricana ont été signalés.

La production de naissain est évaluée à 450 T. Le stock de 18 mois (huîtres de demi-élevage) à 2 000 T. La production d'huîtres à la consommation s'est située autour de 5 000 T.

Crassostrea gigas

Mytilicola orientalis s'est étendu à de nombreux centres d'élevage situés sur la façade atlantique. Les pourcentages d'huîtres parasitées et les taux d'infestation sont très variables. Ils n'excèdent cependant pas 30 % pour un taux maximal de 5 Mytilicola par huître.

Des études sont réalisées sur le "chambrage" avec production de sel. La carence de certains acides aminés pourrait être à l'origine du phénomène. D'une façon plus générale, la qualité de la coquille (forme et structure), se dégrade dans de nombreuses zones. L'influence du milieu semble prépondérante dans le processus.

La production globale à la consommation (70 000 à 80 000 Tonnes) est en baisse par rapport aux années précédentes (100 000 Tonnes). Cette tendance résulte des mauvais résultats de captage de 1978, en particulier dans le bassin d'Arcachon.

En 1980 des fixations importantes ont été observées dans le bassin de Marennes-Oléron. Le captage à Arcachon ne devrait pas satisfaire la demande de ce bassin. La production en demi-élevage, dans ce dernier est en augmentation par rapport à 1979 ; il atteindrait 350 Tonnes.

Mytilidae (moules)

Mytilus edulis : Les travaux sur les phénomènes d'envasement et sur la recherche de méthodes de "dévasage" sont poursuivis. La craie a été testée avec quelques succès sur une vasière située en amont du bassin d'Arcachon.

La production mytilicole française évolue autour de 50 000 Tonnes, le premier bassin producteur étant celui du Viviers-sur-Mer avec une quantité de 10 000 Tonnes de moules de bouchots. Les méthodes d'évaluation des stocks, propres au bassin de Thau (culture en suspension sous radeau) ont permis d'évaluer la biomasse à 7 000 Tonnes.

Algues

Des recherches sur les possibilités de culture d'Eucheuma spinosum ont été entreprises aux Antilles françaises (I.S.T.P.M.). Deux modules semi-industriels de 2 500 m² chacun ont été installés, l'un en Martinique, l'autre en Guadeloupe. Les résultats obtenus ont été excellents au premier semestre, moins bons par la suite en raison des dégâts occasionnés par le cyclone Allen. Le grand module de Guadeloupe, détruit en Décembre par une cause inconnue a dû être entièrement reconstruit.

Une étude et des essais de culture de l'algue comestible Undaria pinnatifida ont été commencés dans l'étang de Thau. Cette espèce introduite en 1971 lors de l'importation de naissain de Crassostrea gigas a étendu progressivement son aire de répartition sur tout le parc conchylicole de ce secteur.

Crustacés

Homards : La production de post-larves des écloséries a été la suivante en 1980 :

Éclosérie de l'Île d'Yeu (I.S.T.P.M.) : Plus de 180 000 post-larves et 10 000 juvéniles

Éclosérie d'Houat (APASUB) : 100 000 post-larves et 10 000 juvéniles

L'étude comparative de la croissance en captivité du homard européen, du homard américain et des hybrides s'est poursuivie (I.S.T.P.M.). Le comportement des jeunes homards en semi-liberté a été étudié aux Viviers du Perello (APASUB).

■ CREVETTES (*Penaeus* sp.)

Des essais de contrôle de la maturité sexuelle conduits antérieurement sur *Penaeus japonicus* ont été étendus à d'autres espèces : *Penaeus stylirostris* et *Penaeus vannamei*.

Des études à caractère fondamental ont été entreprises sur le rôle de la glande androgène dans les processus de reproduction.

Sur un plan plus appliqué, des recherches ont été entreprises en vue d'améliorer la stabilité de l'aliment, de diminuer le lessivage des éléments nutritifs et d'améliorer les résultats globaux d'élevage par distribution automatique et continue de l'aliment durant la nuit.

Poissons

Loupes, dorades et bars: Une étude de la croissance de ces poissons a été commencée en 1980 en Martinique (I.S.T.P.M.). La courbe de croissance est supérieure à celle constatée en Métropole.

SALMONIDES

Des recherches ont été effectuées sur 4 espèces : *Oncorhynchus kisutch*, *Salmo salar*, *Salmo gairdneri* et *Salmo trutta*, tant pendant l'élevage en eau douce que pendant l'élevage en eau salée.

Sur *Oncorhynchus kisutch*, on a tenté de rechercher si les causes de la mauvaise reproduction de femelles maintenues en captivité en mer étaient d'ordre nutritionnel.

Les résultats définitifs ne sont pas encore connus, mais les performances sont médiocres. En eau douce, toutefois, de bien meilleures pontes ont été obtenues.

Sur *Salmo salar*, une étude des critères physiologiques de la smoltification (Na K ATPase) a montré que les résultats obtenus chez le saumon coho étaient transposables à *Salmo salar*, de même poids.

Chez *Salmo trutta*, deux souches ont été étudiées. L'une ne smoltifie pas, l'autre présente un début de smoltification. Cette dernière supporte bien la vie en mer (même durant l'été) et s'y reproduit bien.

Sur *Salmo gairdneri*, l'étude des meilleures conditions de transfert en mer (taille, époque de l'année) a été poursuivie.

POISSONS MARINS

■ SOLE (*Solea vulgaris*)

Plus de 10.000 juvéniles de 3 mois ont été élevés et utilisés pour des expériences sur l'élevage de transition (3 - 12 mois). Pendant le "sevrage", les meilleurs résultats sont obtenus grâce à l'emploi d'aliments donnant un gel stable dans l'eau. Au delà du sevrage, les meilleurs taux de survie et la croissance la plus rapide ont été observés sur des lots nourris de pâte formée d'un mélange d'aliment complet et de chair de mollusque.

■ TURBOT (*Scophthalmus maximus*)

Durant la phase initiale de l'élevage, deux causes de mortalité ont été mises en évidence : l'une est d'ordre microbien, l'autre d'ordre nutritionnel. En utilisant des rotifères comme "capsules vivantes", et plus spécialement en leur faisant ingérer des antibiotiques et des nutriments, on a pu améliorer très nettement les taux de croissance et de survie à l'âge de 2 mois.

GERMAN DEMOCRATIC REPUBLIC

(W. Loos)

In 1980 mariculture research was continued according to research and development programmes. The activities were concentrated on the following main points:

1. The commercial production of rainbow trout fingerlings in brackish water based on the results of the large-scale experiment in 1979 was initiated. The main data of the large-scale experiment were reached.
2. Concerning rearing fry of rainbow trout in heated brackish water valuable results were obtained from small-scale experiments aiming at shortening of the production cycle. Studies are continued.
3. Rearing work on a rainbow trout stock resistant against diseases in brackish water has been pursued successfully. Measures have been initiated to extend brood stock facilities for further experiments.
4. Large-scale tests on oral immunization of rainbow trout against Vibriosis could not be carried out in full scale. The positive impact of Vibriovaccine was repeated in several laboratory experiments.
5. Studies on adaptibility and tolerance of Hypophthalmichthys molitrix and Aristichthys nobilis x Hypophthalmichthys molitrix to brackish water were finished. Together with the results obtained in 1979 there is now a good basis to evaluate salinity and temperature conditions for rearing of juvenile age groups of above mentioned species. Small-scale experiments on rearing fry in heated brackish water have been continued.
6. Engineering work was concentrated on
 - drafting a pilot-project for utilization of heated brackish water of a power station,
 - studies to promote projects of utilization of coastal waters for mariculture considering the present state of engineering. The resulting short-term programm is aiming at developing effective cage culture technologies under given conditions.

STATISTICAL INFORMATION ON MARICULTURE PRODUCTION - GDR

<u>Species</u>	<u>tonnes</u>
rainbow trout in enclosures	
- less than 0,5 kg each	410
- more than 0,5 kg each	appr. 10
	total 420

FEDERAL REPUBLIC OF GERMANY

(K. Tiews)

Crassostrea gigas:

Indoor experiments on the reproduction and rearing of spat were continued as well as outdoor experiments on the fattening of spat to marketable sizes. The construction of the experimental station Langballigau near Flensburg of the Institut für Küsten- und Binnenfischerei was completed. 25,000 spat were produced.

Container culture experiments on various places along the German North Sea and Baltic coasts were also continued by the Institut für Küsten- und Binnenfischerei.

Growth rates of spat fed on algae (Nannochloris) diets from phytoplankton cultures are studied under different environmental conditions at the Institut für Meereskunde, Kiel. The aim is to find methods for a routine production of seed oysters.

Rainbow trout:

Techniques for sea cage rearing are developed at the Institut für Meereskunde, Kiel as well as feeding strategies with different diets. The stress which intense cage rearing causes to the surrounding natural environment is investigated. A pilot plant for trout production in silos supplied with brackish water from the cooling system of a power plant is accompanied scientifically. The possibility of sea ranching with 4 to 10 weeks old juveniles early weaned to brackish water of 16 ‰ shall be tested.

The gas-physiology and energetics of trout respiration against several environmental factors is studied under the aspects of optimal growth and production rates.

Cage farming experiments:

Cage farming experiments with rainbow trouts were carried out off the coast of Heiligenhafen, of Langballigau and of Eckernförde by the Institut für Küsten- und Binnenfischerei.

Salmon:

Methods for fry production in Germany and sea water cage rearing techniques are under investigation.

Coregonus:

Fry rearing in cages with underwater lights to use the natural zooplankton resource of a lake is tested under quantitative aspects. The 6 months old fry is used for a sea ranching project in a brackish water fjord.

Turbot:

Mass production of fingerlings. The concept is to rear the larvae with high survival rates on a diet of natural plankton for which cultivation methods are worked out. On the base of plankton algae cultures rotifers and copepods, mainly the species Eurytemora affinis are produced. Regarding the latter most biological obstacles have to overcome.

Eel:

Research on eel farming in heated effluents of a conventional power station was continued at the experimental station Emden of the Institut für Küsten- und Binnenfischerei. Also scaling up experiments for the mass rearing of elvers in silos including the optimisation of feeds for these was continued by the same institute in its laboratories in Hamburg.

Fish nutrition:

Work was continued on the development of fish feeds for rainbow trouts in which fishmeal as protein source was substituted by other conventional and unconventional protein sources (Institut für Küsten- und Binnenfischerei). Also the development of eel feeds was continued by the same institute.

Recirculation sea water systems:

The biological station of Helgoland concentrated work on the optimisation of water quality management in brackish water recycling system, investigations on combined biological-chemical water treatment in intensive fish culture units. Also the Institut für Küsten- und Binnenfischerei continued its work on the development of a recirculating sea water system.

Fish pathology:

Work to develop methods with which to describe stress conditions for fish in intensive aquaculture systems was continued at the Institut für Hydrobiologie und Fischereiwissenschaft of the University of Hamburg.

Physiology:

Cryopreservation experiments on long-term storage of sexual products of economically important species were continued at the Biologische Anstalt Helgoland.

Statistics (Federal Republic of Germany)

Species	Tonnes	Approx.No. in 100 000	Value in 1,000 U.S.Dollar
Blue mussels (<u>Mytilus edulis</u>)	11 100	-	2 200
Pacific oyster (<u>Crassostrea gigas</u>) from vertical cultures	2.1	-	7
Pacific oyster (<u>Crassostrea gigas</u>) seed laboratory reared	-	2	11
Rainbow trout in enclosures less than 0.5 kg each	4	-	14
Eel (<u>Anguilla anguilla</u>) not fresh water	8	-	60

ICELAND

(I. Jóhannesson and S. Einarsson)

Experiments with salmon farming in sea water are still taking place in this country. The Fisheries Association has finished their experiments with salmon farming in net pens at Hafnir on Reykjanes and private enterprises have started production there. Experiments with salmon farming in Grindavík (on Reykjanes), where warm sea water from drillhole is pumped into tanks standing on the shore is still going on.

The Fisheries Association has in past years conducted experiments with salmon farming in estuary Lake Lón in North Iceland. These experiments will be continued.

Private enterprise, Tungulax Ltd. and the Norwegian salmon farming company Mowi have entered into co-operation. These companies will carry out trials with salmon farming in the sea and ocean ranching.

A public shareholders, Fiskeldi Ltd. have started their smolt production.

Two more companies Pólarlax Ltd. and Hólarlax Ltd. have also started their smolt production.

NETHERLANDS

(M. Fond)

The private enterprises for commercial culture of Rainbowtrout in seawater are continued, with a reasonable hope for success in 1981.

In the Netherlands Institute for Sea Research on Texel a research project was started in 1980 on the development of a dry food for culture of Sole (Solea solea). The work is carried out as a joint venture of three partners: the Netherlands Institute for Sea Research, the Fishculture department of the Agricultural University Wageningen, and the research department of a private fishfood firm.

NORWAY

(G. Naevdal)

INTRODUCTION

Research on problems related to mariculture is carried out by the following institutions in Norway:

1. Section of Aquaculture, Institute of Marine Research, Directorate of Fisheries, Bergen (including two research stations, Matre and Austevoll)
2. Institute of Vitamin Research, Directorate of Fisheries, Bergen
3. The State Biological Station, Flødevigen, Arendal
4. Research Station for Salmonids, Sunndalsøra and Averøya, Agricultural University of Norway
5. Institute of Fisheries Biology, University of Bergen
6. Institute of Fisheries, University of Tromsø
7. Regional High School, Sogndal

In the following report these institutions are referred to by number. (1) and (4) have continued their long term experiments on salmonids in 1980. The other institutions are mainly concerned with short-term experiments both on salmonids and on new potential species for aquaculture.

RESEARCH PROJECTS

Genetics

Experiments with selective breeding of Atlantic salmon and rainbow trout were continued at (1) and (4). The following sub-projects are included,

- a. Selection program to increase growth rate, (1) and (4), reduce mortality (4) and improve meat quality (4).
- b. Study of phenotypic and genetic parameters in production traits; (1) and (4).
- c. Study on inbreeding depression, (4)
- d. Study of heterosis effect, (4)
- e. Induce polyploid to obtain sterile fish, (4)
- f. Induce gynogenesis (4).

A project concerning antipredator behaviour in Atlantic salmon smolts was started (1). The behaviour of cultivated smolts in relation to potential fish predators (saithe, trout and pollack) was observed in a pond in order to find out possible differences in smolt reactions to predators. Later on will be tried conditioning of smolts to avoid predators in an effort to improve recapture of released smolts.

Physiology and nutrition

Laboratory experiments of nutrition, digestion, growth, metabolism and energy budget of cod have continued (1). Also studies on the effect of smolt size on subsequent growth rate and age at sexual maturation, and changes in the renin-angiotension-system during smoltification in Atlantic salmon have been continued (1). The experiments with feeding of salmonids fry with steroids to obtain sterile or unisexual fish were considerably expanded (1).

Use of Calanus for pigmentation of salmonids was further tried out (1), and so was use of shrimp wastes for salmonid feeding.

Acidified feeds treated with hydrochloric, formic or sulphuric acid were fed to rainbow trout to test the effects on protease activities, growth and feed utilization (2). Silage conservation of fish feed, including shrimp wastes, was also studied by (1) and (4). Studies on protein, fat and carbohydrate in fish food, digestability, feed consumption at different temperatures and of varying fish sizes, and comparisons of wet and dry diets in salt water at low temperatures were carried out by (4).

Experiments on lipid liver degradation due to lack of Vitamin E (1) and studies on egg quality of reared farmed salmonids have been initiated (4).

Use of binders in salmonid feeds (to increase feed efficiency and reduce water pollution) was studied by (2). About 30 different available products were tested for consistency and degree of decomposition in water. Of these, ten was further studied with regard to digestability and effect on growth rate of trout.

Pathology

In 1980 the work (1) on diseases in mariculture has mainly been concentrated on vaccination against vibriosis. Comparative studies on different types of vaccines and vaccination methods were carried out. Spreading of IPN-virus in the marine environment around fish farms was also studied.

Aquaculture technology

Experiments to assess the effectiveness of several antifouling impregnants for net pens and rearing tanks were continued and expanded in 1980 (1).

Storage of live saithe in net pens for subsequent delivering to the fishing industry was studied (1) also in 1980. Especially the effect of handling and throwing were paid attention to this year.

Studies of resirculation of fresh water for smolt production were carried out at (1) and (4). Oxygen consumption and effect of varying oxygene levels as well as effect of super-saturation with nitrogen were studied at (4).

Raising of smolt in net pens in freshwater and use of submerged cages for fish farming in the sea were studied by (1). Treatment of acid water for smolt production was also paid attention to (1).

Rearing of marine fish larvae

Experiments on hatching and rearing marine fish larvae and fry in land situated basins (3), plastic bags in the sea (1) and a closed poll (5) were continued. In plastic bags and the poll cod larvae were reared, while in the land basin rearing of larvae of halibut and turbot was tried. Natural food was used in these experiments.

Other projects

Experiments on commercial culture of mussels, Mytilus edulis, were continued, (1) and (7), and similar experiments on growing oysters and scallops were initiated (1), (6) and (7). Concerning oysters especially possible positive effect on growth rate of raising oysters in the vicinity of fish farms was paid attention to.

At (6) the investigations of the possibility for culture of anadromous Arctic charr, Salvelinus alpinus, both in fresh-water and in sea cages, were continued. These investigations include hatching and first food uptake, osmoregulation and the effect of environmental factors as light and stocking density on growth rate.

STATISTICS

Quantities of salmonids produced are given in the table below. The main mariculture production in Norway still is rainbow trout and Atlantic salmon. The public statistics give no breakdown on production in fresh and salt water, and the production in fresh water is not reported in the inland fisheries statistics. Thus the total production is given in the table below. However, the quantities produced in fresh water is small, and 2-3% of the total production is indicated. Concerning other species, no statistics exist, but small quantities of blue mussels and oysters were produced.

Statistical information

	<u>Tonnes</u>	<u>Value in 1 000 US.\$</u>
Rainbow trout in enclosures, more than 0.5 kg each	3 360	12 782
Salmon in enclosures	4 153	34 982

POLAND

(B. Lubieniecki)

Further studies of rainbow trout farming in cages in brackish water were continued during the year of 1980 with special emphasis to the overcoming and preventing septicemia diseases.

Treatment with sulphonamide was applied.

Injective vaccine against *Vibrio* produced in the German Democratic Republic and hyperosmotic vaccine made in the USA were tested. The first experiments with the tagging of rainbow trout acclimatised in cages during winter time were undertaken.

Statistical information

20 tonnes of rainbow trout, more than 0.5 kg, each were produced.

PORTUGAL

(J.C. de Ataide)

Shrimp Culture

Experiments on *Palaemon serratus* culture have been undertaken. The incubation period of the eggs was followed and determined at different temperatures in order to induce a great number of females to spawn simultaneously for mass rearing purposes.

Mass rearing experiments of the larvae belonging to two different populations of the Portuguese coast, one from the south coast and the other from the northern part of the west coast were started late in 1980 and are to be continued this year. Different concentrations at different food levels are being tried.

Lobster Culture

Experiments on *Nephrops norvegicus* culture have been undertaken. Successive embryonic stages have been submitted to artificial incubation and the period up to hatching was followed. The experiments are to be continued in 1981.

SWEDEN

(B. Holmberg)

According to Swedish Water Law about 2 millions of reared salmon smolts had to be stocked every year in the Baltic to compensate for destroyed natural reproduction. Additionally 600 000 salmon and sea trout smolts have been stocked successfully in coastal waters to enhance the stocks aimed for commercial as well as sportfisheries. Short migrating strains of sea trout have been tested in certain areas. Experimental tests were made to control the effect of smolt size and time of release to increase the survival rate of smolt with the ultimate purpose to increase the yield in the fisheries.

Commercial farming of rainbow trout in fish pens from spring until autumn in coastal areas has increased since last year. Culture of rainbow trout all the year around has been tested by some farms in the Baltic in order to produce fish of bigger size. On the west coast in higher salinities, experiments have been made to overcome the problems to cultivate fish in the critical temperature interval (-0.5 to 1.5°C). Vitriosis was common in the farms located in brackish and seawater.

The commercial farming of blue mussel has increased during the last years on the west coast of Sweden. A production technique with lines and buoys has been adapted to Swedish conditions. The ecological effect of such cultivation on the bottom sediment and surrounding waters are studied.

An investigation about future prospects for aquaculture in Sweden was started 1979 to look into different areas of this field (biology, technology, economy and marketing aspects).

A report in 1980 included proposals for future planning of aquaculture and the need for it in Sweden.

UNITED KINGDOM

SCOTLAND

(A.L.S. Munro)

At present all commercial mariculture activities are located on the west coast of Scotland.

Fin Fish:

Atlantic salmon (Salmo salar) Salmon farming is the biggest mariculture industry in Scotland and is still growing at a significant pace. Five new sea cage sites were recorded in 1980 adding to the 17 already in operation of which 14 have only begun operating in the last 5 years. The tonnage of salmon produced was 598 tons compared to 520 tons last year a somewhat disappointing figure in relation to the other signs of growth. A bacterial disease, furunculosis, was a significant factor contributing to low production in 1980.

The number of salmon smolts placed in sea water was 1 418 000 compared to 834 000 in 1979. From the 1980 smolts it is estimated production of salmon should be 1 700-2 500 tons in 1982 (and from the 1979 smolts 1 000-1 500 tons in 1981) with additional amounts for grilse tonnage to be added.

The technical problems facing salmon farming have been considerable. Significant losses of smolts have occurred in their first sea year (10-40%) from a variety of causes including, predation, storm damage, escape and disease. Maturation as grilse also accounts for approximately 30% of fish after the first sea year. However the industry with help from public funded research is developing solutions to many of its problems.

Rainbow trout (Salmo gairdnerii) Some 6 sea cage sites produced 86 tons of trout in sea or brackish water, a slight drop in production from the previous year.

Sea cage farming is best suited for producing larger than pan sized fish yet a significant market remains to be found for this size of fish. Producing table size fish in seawater given that transfer must be at 70-100 g to achieve good survival in full salinity sites is apparently of limited profitability. Competition for good sea cage sites with salmon farming is another factor depressing growth in this sector.

Eels (Anguilla anguilla) Some 15 tons of eels were produced in seawater using heat from a nuclear power station. This figure should be increased several fold in 1981 based on a greatly increased tank capacity now installed.

Turbot (Scophthalmus maximus) Total production of 15 tons was recorded at two sites using heat from a nuclear power station. Some increase in production is to be achieved from a new pilot scale demonstration unit built by the White Fish Authority. Survival of early juvenile stages still poses problems which limit the growth of production.

Others Experimental quantities of Dover sole (Solea solea) and sea bass (Dicentrarchus labrax) were produced in heated sea water.

Molluscs

Oysters (Crassostrea japonica and Ostrea edulis) Estimated production was 200 000 Japanese and 20 000 native oysters from 9 farms. The growth of the industry has been limited by lack of local demand, the principal outlet for consumption. A single hatchery produces sufficient seed for all local demand with most of its production of both species being sold for export. The long period of growth to market size especially for the native oyster is another factor limiting the industry's growth.

Mussels (Mytilus edulis) Estimated production was 40 tons from 2 farms.

Others Experimental trials to farm scallops (Pecten maximus) and queens (Chlamys opercularis) are in progress with most effort concentrated on methods of catching spat and also finding areas rich in spat.

USA

(A. Longwell and J. Ryther)

I. The U.S. National Program in Aquaculture

The National Aquaculture Act of 1980 established a national policy to promote aquaculture in the United States. Although the National Sea Grant College Program has been supporting aquaculture research since 1968 this new act will provide considerable impetus to expand the scope of aquaculture activities. The current version of the National Aquaculture Plan prepared by the Joint Subcommittee on Aquaculture describes the present status and potential of aquaculture in the U.S., the barriers to its expansion, the actions that can be taken to reduce or eliminate these barriers and addresses the needs to promote the culture of some dozen aquaculture species.

The National Aquaculture Act of 1980, signed by the President on September 26, declared the development of aquaculture in the U.S. to be national policy and called for a coordinated program involving 13 Federal agencies and departments. The Secretaries of Agriculture, Commerce and Interior are assigned primary responsibility for the conduct of the expanded R&D and related programs authorized in the Act. In a Memorandum of Understanding approved by the three Departments in April 1980, the Department of Commerce was assigned responsibility for aquaculture research and development on marine, estuarine and anadromous species. This research is to be conducted or funded by the National Marine Fisheries Service and the Office of Sea Grant (OSG). In addition, OSG is to meet the education, training and advisory service needs of marine aquaculturists.

The Office of Sea Grant currently supports the research and development of most of the academic-based aquaculture in the United States including salmon, marine shrimp, freshwater prawn, American lobster, oysters, and seaweeds.

II. Office of Sea Grant-Supported Academic Research in Mariculture, by species.

Marine shrimp

Research in this area is directed toward control of shrimp maturation and reproduction, nutrition and culture requirements, and control of microbial diseases of marine shrimp (University of California and Texas A&M University). In addition efforts are being made to understand the toxic effects of certain marine blue-green algae on penaeid shrimp (University of Arizona), to improve water stability and nutrient retention by binders in commercial shrimp feed pellets (New Jersey Marine Science Consortium) and to determine the economics of commercial shrimp mariculture (Texas A&M University).

Lobster

The major efforts by the University of California and Massachusetts institutions have been phased out of research and into industrial pilot plant efforts.

Blue crab

A single project involves the identification of nutritional requirements during larval development of blue crabs using microencapsulation techniques (University of Maryland).

Brine shrimp

Research in the two projects here is directed toward regulation of the production of dormant cysts by the brine shrimp (University of California) and defining the nutritional value of selected strains of brine shrimp for culturing finfish and other animals (University of Rhode Island).

Salmon

The salmon projects involved address 1) regulation of disease, particularly furunculosis and bacterial kidney disease (University of Idaho), infectious pancreatic necrosis (University of Maine/New Hampshire), 2) endocrine control of smoltification and its relation to growth rate (University of Minnesota, University of California, and University of Washington), 3) imprinting through odorant recognition (Oregon State University), 4) the relationship of salmonid production to environmental physiology (University of Rhode Island) and salmonid stock development and enhancement, and carrying capability of the near shore environment (University of Washington and Oregon State University), 5) the use of quick freezing in gamete preservation (University of Minnesota), 6) economic analysis of the interrelationship between wild and hatchery salmon (Oregon State University), and 7) predation on released salmon by harbor seals (Oregon State University).

Oyster

A major effort involving growing oysters in a self contained greenhouse system, is a multidisciplinary approach to developing and

demonstrating controlled environment mariculture at the University of Delaware. Other efforts are directed toward 1) understanding the basis of disease resistance in these animals (Virginia Institute of Marine Sciences) and the role of larval American oysters as carriers of oyster diseases (State University of New York), 2) encouraging oyster growers to adopt recent advances in oyster growing technology (Oregon State University), 3) demonstration of hatchery technology and the value of genetics in molluscan culture studies (University of Washington), and 4) development of a marine molluscan cell culture system (University of Maryland).

Clams

Projects in this area of research are directed toward 1) an evaluation of seed clam planting in Long Island (State University of New York), South Carolina (South Carolina Consortium), and Oregon (Oregon State University), and 2) understanding survivorship, bioenergetics, genetics and breeding structure of hard clam populations (South Carolina Consortium, Virginia Institute of Marine Science and University of Georgia).

Abalone

Abalone research efforts are directed toward the use of biochemical engineering and understanding the physiology of fertilization in hybrid formation to improve commercial abalone production (University of California). The University of Washington is conducting studies on the hybridization between the California Red Abalone and the Pinto Abalone.

An experimental abalone enhancement program in the natural environment is being conducted by the University of California.

Scallops

Efforts are underway to artificially control spawning and larval production in the purple-hinge rock scallop for aquaculture purposes (University of California) and to develop a seeding program for bay scallops in Massachusetts (W.H.O.I.)

Seaweeds

A number of efforts in this group are directed toward the cultivation of seaweeds (University of California, University of Hawaii, and University of Washington). Specifically studies address 1) seaweed crustacean polyculture (State University System of Florida), 2) potential of two species of Gracilaria for mariculture in the Mariana Islands and Eucheuma farming in Ponape (University of Hawaii), 3) use of artificial substrates (University of Washington) and OTEC platforms (University of Hawaii) in the culture of seaweeds, and 4) the application of genetic studies to seaweed (Chondrus crispus) production (University of Maine/New Hampshire).

III. National Marine Fisheries Service

Milford Laboratory
Northeast Fisheries Center

Report on Research Conducted Fiscal Year 1981

Spawning and Rearing of Molluscs

Hatchery procedures for producing seed from the bay scallop, Argopecten irradians, and the surf clam, Spisula solidissima, are fairly well-established. During 1980 attention was turned to grow-out strategies. Primarily because of predation, attempts at grow-out in unprotected field situations were generally unsuccessful. However, hatchery-produced seed scallops can reach market size

in 6 months in vertically deployed cylindrical hoop nets about two meters long and one-half meter in diameter. The growth of hatchery-produced surf clams at different densities in cages at a depth of about 20 feet in Long Island Sound was less than that in the laboratory pumped raceway. Surf clam seed hatchery-reared at Milford, transplanted to Virginia and South Carolina, grew considerably there during the winter months, pointing to possibilities for year-round grow-out of such cultures at different latitudes.

Oyster Breeding

A two-way selection experiment for juvenile growth rate of the American oyster, Crassostrea virginica, is in its second generation of selection. In 5 of 7 comparisons of oysters in their first selected generation the fast-growth lines were significantly larger in shell width, length, and area than slow-growth lines. Work continues on close inbreeding of oysters for purposes of test-hybridizing inbred lines. Oysters from Massachusetts and from Texas were hybridized with Long Island Sound oysters in an appraisal of the crossability and performance of numerous intra-specific hybrids under different diet, setting, and temperature regimes.

Nutritional Requirements of Molluscs

Experiments have demonstrated that freeze-dried algae do not provide an adequate food source for larvae and juveniles of the American oyster. However, in the first few days of feeding there was a small increase in larval size, and observations made in epifluorescence indicated that dried algae were present in the stomachs of the larvae. That the algae were consumed by juveniles was clear from the large amounts of pseudofeces formed.

Experiments were conducted with several axenic algal strains to determine the effect of medium enrichments on algal growth in an effort to develop more cost-effective algal growth media. A collection of 94 strains of axenic unicellular marine algae is subcultured periodically on each of three different types of growth media, and several special strains are also maintained. These algal stock cultures are used as inocula for cultures intended for molluscan food in the culture program, and also as a source of material supplied to other investigators on request.

Control of Molluscan Disease

Bacterial pathogens were identified in 6 oyster hatcheries in Long Island, Maine, and Prince Edward Island. Sanitary procedures and ultraviolet disinfection eliminated disease in 4 of the hatcheries. Any advantages of charcoal filtration of the seawater prior to ultraviolet irradiation are being determined. In a monthly sampling program in Long Island Sound 6 of 820 bacterial isolates identified to genus were pathogenic to oyster embryos. Research was completed on the depuration rate of sewage-contaminated scallops. Both ozone gas and chlorine were evaluated in field tests on the scallops. Chlorine was found to cleanse coliform bacteria from living scallops.

A pathogenic pseudomonad has been isolated from moribund oyster larvae. A Vibrio sp. has been found to interfere with oyster development. Cells believed to be involved in disease defense in larval oysters were isolated and identified. One cell type could engulf bacteria in an in vitro cell culture system, and the other attached to bacteria. On exposure of larvae as early as 2 days to a pathogenic Vibrio sp. there was a shift in these two cell types, and an overall increase in their number.

Research Done Under Contract to the Milford (Connecticut) Laboratory

Research on the response of molluscs to yeast exposure is being conducted under contract at the University of Connecticut and at Fairfield University. Work at Fairfield University concerns effects on bivalve larvae. Studies at the University of Connecticut are concerned with the uptake, retention, release, induced depuration, and possible pathogenicity, and effect of ultraviolet irradiation on the natural and artificial introduction of a human pathogenic yeast and a common marine-occurring yeast.

Also under contract, at Yale University, is the measurement of selected by-products of seawater chlorination in New Haven Harbor. Under study are the uptake of such oxidative compounds and effects on oyster larvae in the laboratory, and in the chlorinated effluent of a local waste-water treatment plant.

The University of Connecticut is also investigating the habitat, behavior, and population structure and aquaculture (the latter in cooperation with the Culture Program of the Milford Laboratory) of the bay scallop, Argopecten

irradiations, in selected eastern Connecticut estuaries. The effectiveness of spat collection on suspended artificial substrates is being evaluated.

Contract research at Western Connecticut State College is directed at establishing a continuous cell culture line of the American oyster. Such a culture would be used to propagate disease-causing organisms of the oyster for more sophisticated pathological research on molluscan disease.

U.S.S.R.

(S. A. Studenetsky)

The following are the main results of investigations carried out in 1980:

- 1) Artificial breeding of sea fish and improvement of spawning grounds;
 - 2) Commercial rearing of fish in sea water;
 - 3) Acclimatisation of marine organisms;
 - 4) Cultivation of food invertebrates;
 - 5) Cultivation of commercial algae.
1. PINRO continued experiments for rising the effectiveness of the White Sea herring reproduction with the help of artificial spawning grounds. The dynamics of spawning runs, peculiarities of vegetation, bottom relief and hydrochemical conditions in the areas of natural spawning, the survival of embryo and larvae, the resistance to the influence of extreme environmental factors, food base and feeding of herring larvae were studied. A number of areas suitable for the establishment of artificial spawning grounds were chosen. One of the problems turned out to be the fouling of spawning grounds with diatomous and filamentous algae.
- Investigations of the effect of constant temperatures and salinity on the embryonal growth of Atlantic salmon and sea trout were carried out in the White Sea biological station. Recommendations for the control of temperature and salinity during the incubation of eggs were worked out. Eggs of catfish were received and fertilised there.
2. The Tallinn Branch of BaltNIIRKH carried out experiments on the artificial rearing and cultivation of the young and yearlings of pollan (Coregonus lavaretus). Pollan was cultivated in net cages with the attraction of zooplankton by the electric light at night and additional feeding consisting of granulated food for salmon. It was supposed to grow pollan on lagoon-type farms (fenced bays). Experiments on Coho salmon growing commenced in 1976 were continued. Coho salmon males matured partially at the age of 2+, the bulk of them matured at 3+.

In 1978 rainbow trout (females) were crossed with Atlantic salmon (males). On the average, hybrids grew worse than the parent species, but there were some remarkable individuals among them. The hybrid had probably the higher resistance to vibriosis than Atlantic salmon.

To determine the possibilities to keep trout under the ice or in submerged cages in winter experiments of the influence of the air isolation on trout were made. The isolation from atmospheric air caused changes in the normal activities and might cause death. The severity of pathological changes depended on the initial condition of fish and the duration of the isolation. The changes may be reversible.

Results of growing Atlantic salmon in the White Sea were better than in the Baltic Sea. According to PINRO, the survival rate of fry was 95%; there were no losses in winter. The increase of the weight of yearlings reared in warm water was 50-60 g by spring and 10-13 g in the cold water. Smoltification finished at the age of 10-12 months. Feeding and growth of Atlantic salmon in cages at sea was the most intensive at 8°-18°. Atlantic salmon growth and feeding rates were better than those of rainbow trout and steelhead.

In the Arctic area, Atlantic salmon males matured at the age of 3, females started maturation at 4.

The Baltic Research Institute carried out a series of investigations for the working out of dry granulated food composition for the young and different age groups of salmon. Experimental tests showed high efficiency of these foods.

Results on experiments on the prevention of vibriosis in trout by the vaccine made in the German Democratic Republic were good. Losses among the vaccinated trout were five times less than among the non-vaccinated fish.

In 1978-1979 antifouling compositions for sea cages were worked out. It was shown that during the first season cages were not completely covered by fouling organisms. The influence of the fouling organisms on growth of fish and accumulation of toxins in the organs and tissues were studied.

4. Methods of cultivation of mussels in the Barents Sea and in the White Sea were developed. However, these studies do not yet find practical application.

5. Cultivation of algae in the White Sea. Investigations were aimed at improving the biotechnique of the cultivation of Laminaria in the first stages of development. Investigations showed an important difference in the reaction of White Sea Laminaria saccharina and Far Sea Laminaria to light and temperature.

At present, mariculture in the USSR is in early stages of its development. This is why the mariculture production of fish and other organisms is not yet registered statistically.
