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Exploration of the Sea

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Administrative Report

MARICULTURE COMMITTEE
by

Dag Møller
1982

BELGIUM

No report received

CANADA

(J.E. Stewart)

Pacific Coast

Shellfish

Oyster (Crassostrea gigas) production, two thirds of which is cultured, declined to around 1400 mt in 1982. The commercial hatchery for oysters described last year has continued to produce eyed larvae successfully with several farmers using these as the production source.

Experimental work with Manila clams (Tapes philippinarum) is continuing and trials are being carried out to determine whether Manila clams can be grown simultaneously on the same grounds with oysters. The results appear promising. Trials with the scallop, Patinopecten caurinus are continuing as are those with the Abalone (Haliotis sp.).

Finfish

About 12 permits have been issued for salmon farming with several of the farms showing signs of success. Around 180 mt was produced in 1982 consisting mainly of coho. Attemps are being made in the Ocean Falls, B.C. area, to culture Black Cod (Anaplopoma fimbria).

About 200 mt of herring (Clupea harengus) was held in cages for about two months (January-March 1982) with excellent results. The quality of the roe produced at the end of that period was equal to or better than that produced from fish captured in the gillnet fishery.

Atlantic Coast

Newfoundland

Technology transfer and provision of scientific advice to a scallop enhancement project in Port au Port Bay continued. Scallop spat collected from natural spawning are now in the second phase (accelerated off-bottom intermediate culture) of the enhancement program.

Maritime Provinces

Commercial culture of the Blue Mussel (Mytilus edulis) continued in Prince Edward Island and Nova Scotia resulting in a production of over 170 mt.

Development work on the culture of the European flat oyster (Ostrea edulis) has continued. A cooperative with six members is working with government scientists and Dalhousie University on resource aspects including nutrition studies; genetics; technological aspects and limited production runs. Attempts are being made to expand the seed supply.

Lobster nutritional research showed that when crab protein was used as the sole source of protein, the amount of protein required was reduced substantially; i.e., crab protein was required at the 30% level (diet dry wt) versus 40-50% when casein was used. In addition, it was shown that growth and survivial was not impaired when lobsters were fed diets containing up to 80 ppm cadmium for three months.

An Indirect Fluorescent Antibody Technique for more rapid and sensitive determination of the disease Gaffkemia was tested and shown to be a marked improvement in time and specificity.

Work on improved lobster holding continued in 1982 and will be carried on through 1983 with reports expected to be available in 1984.

Finfish

In salmon genetics work, over 500 adult salmon returned in 1982 from releases of smolt from the North American Salmon Research Center in 1980 and 1981. This is the largest return since the first release of smolts in 1976. These fish (489 grilse and 67 large salmon) have spawned, yielding in excess of a million eggs. Photoperiod manipulation and hormone implantation effectively accelerated ovulation time. Many females, however, which received the LH-RH implantation produced eggs that could not be fertilized. This was not a problem with females ovulating early due to artificially shortened photoperiods.

The commercial culture of Atlantic salmon is continuing and increasing in size. Approximately 50 mt were produced in 1982. Production is expected to increase considerably in 1983. A major impediment to the growth of the industry has been the limited supply of smolts. Steps taken during 1982 will result in a marked increase in the smolt supply from government sources and particularly in the private sector. Disease was not an important impediment in culture operations in 1982.

Studies on Bacterial Kidney Disease, Furunculosis, Enteric Redmouth Disease and Gaffkemia continued during 1982. A Vibriosis vaccine produced by a Canadian commercial firm was licensed and offered for sale.

ANNUAL MARICULTURE PRODUCTION - CANADA

(1982 PRODUCTION EXCEPT WHERE NOTED)

	PRODUCTION		VALUE
ATLANTIC COAST	METRIC TONS	NUMBERS	(US$, 000)
American Oyster (Crassostrea virginica)	not available		
European Flat Oyster (Ostrea edulis)		1,000	0.5
Blue Mussel (Mytilus edulis)	173.6		122.6
Giant Scallop (Placopecten magellanicus)		(market)10,000 (seed)16,000	3.2
Atlantic salmon (Salmo salar)	48.0		402.1
Rainbow trout (Salmo gairdneri)	104.5		323
Bluefin Tuna (Thunnus thynnus)	68.3		985
PACIFIC COAST			
Pacific Oyster (Crassostrea gigas)	1,400 (in shell)		1,000 approx.
Blue Mussel (Mytilus edulis)	not available		
Salmon (Oncorynchus sp.)	(1981)176.3		777.7
Rainbow Trout (Salmo gairdneri)	(1981) 85.1		375.1

DENMARK

(E. Hoffmann)

During the last five years marine aquaculture has developed rapidly in Denmark. Today the following species are used in mariculture either in laboratory scale or in commercial farms (underlined): Rainbow trout *(Salmo gairdneri)*, turbot *(Scophthalmus maximus)*, eel *(Anguilla anguilla)*, lobster *(Homarus vulgaris)*, the European flat oyster *(Ostrea edulis)*, pacific oyster *(Crassostrea gigas)* and blue mussel *(Mytilus edulis)*.

The production of rainbow trout in marine waters is of more recent date. The yearly production in 1981 was 405 tonnes with a rise to about 500 tonnes in 1982. The production can be divided into two groups according to fish size: (1) 200-500 g and (2) 800-3500 g. The production in group (1) in 1981 was 115 tonnes and in group (2) 290 tonnes. The most marketable size is 1500 g to 2000 g. The trouts are transferred from freshwater farms to the marine farms in April and the total production period is now eight to nine months. Due to ice and bad weather conditions a production is not possible during the wintertime. The size of the transferred fish range from 100 g to 600 g depending of what final weight the fishfarmer wants of the fish. Normally a total growth to about four to five times the initial weight is expected. The stocking rates varies between 10 kg to 40 kg per cubic meter. The food is standard dry pellets used in Danish freshwater trout farms and the feeding is mostly done by hand.

The European flat oyster has been extensively cultivated in the Limfjord area for about one hundred years. In the beginning of the century the production was based on natural spawning and the small oysters were collected by hand and

placed in oyster beds. This method is still in use but normally a yearly supply imported from France, Scotland or United States are the main part of the production. Production has varied between 100000 and 4 million individuals per year with the lowest values in recent years. The production in 1982 was only 50.000 individuals. A hatchery is planned and the use of wooden cages has given promising results. Further development with this technique is expected to increase production in the near future.

DISEASES

In Danish mariculture the bacteria *Vibrio anguillarum* and *Aeromonas salmonicida* have caused severe mortality among rainbow trout *(Vibriosis* and *Furunculosis)*. The treatment of these diseases has normally been performed by the use of chemotherapeutica. An alternative has been to develop methods for immune prophylaxis. Vaccinations against *Vibriosis* have been performed both on a laboratory scale and in commercial fish farms. Three application techniques have been used: Injection, hyperosmotic infiltration and spray.

Spray vaccination was performed with a commercial high pressure cleaning machine (KEW 700). The fish were caught with a net about 6 kg at a time, and placed in a box while receiving a shower of vaccine for 8-10 seconds. They were returned to the pond immediately after.

The vaccinations had a marked protective effect and no inhibition was demonstrated in plurivalent vaccines. In a marine fish farm with several serotypes included in the natural challenge a tetravalent vaccine gave a better protection than a divalent vaccine.

Research

During the last two years hatching and rearing of turbot *(Scophthalmus maximus)* has been carried out on a laboratory scale. Fertilized eggs have been brought to Denmark from

British and Scottish farms. Today small turbot are found in two experimental fish farms both using heated effluent from power plants. An expansion in the production of juvenile turbot is planned. The weaning of turbot larvae from live food to artificial pellets has been successfully accomplished. Micropellets at a size of 100-200μ are given to the larvae at a size where they normally start eating *Artemia*.

Culture beds and rope culture of blue mussel *(Mytilus edulis)* have developed in recent years in different areas of Denmark, but up till now the production in these new units cannot be estimated.

The Pacific oyster *(Crassostrea gigas)* was introduced in Denmark in 1978. The seed came from the German laboratory in Langballigau (in the Baltic). In 1979 the seed were imported from Scotland. The oysters were placed in the water area Lillebælt between Jutland and the island Funen. The salinity at the bottom in this area varies between 15 ppt and 20 ppt. The seed were also placed in a land based experimental fish farm using heated effluents from a power plant and moreover in shallow water at sea in wooden cages. The growth rates have been high with a growth to about 8-10 cm after a 2-year period at which size the oyster can be marketed. A production of 1 million *Crassostrea* per year is planned.

In the spring 1981 the Council of Technology supported the building of an experimental fish farm of commercial size with 2.5 million Dkr. (300000 US dollars). The fish farm is situated at the Ensted power plant in the fjord of Åbenrå. The total economical support will be 8 million Dkr. (1 million US dollars) for a 5-year period.

In the Ensted Fish Farm a commercial production system, based on the experiments carried out at the test laboratory, will be operated. The production of rainbow trout will be about 10 tons in the first year, raising to 50-80 tons per year later. Also commerciel production of eels and turbot is expected.

Statistics (Denmark)

Species	Tonnes	Approx.no in 100.000	Value in 1000 US dollars
Flat Oyster (from culture beds)		0.5	50
Rainbow trout in enclosures	500		2300

Note: All figures are preliminary

FINLAND

(P. Tuunainen and K. Westman)

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. As a new species for marine net cage culture the Baltic salmon (Salmo salar) is gaining more and more interest and small-scale experiments in this field are going on.

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 Bothnian Bay 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 rearing methods and to decrease water pollution caused by larger fish farms.

For the UDN of the Baltic salmon stated in the middle of 1970s still limitations in transfers of fish between the sea and freshwater area as well as between the inland watercourses exist.

Especially in rainbow trout culture in the sea area the vibriosis disease still causes considerable harms and better vaccines against it are being developed.

For food fish production of salmon in net cages and other marine farms comparative rearing experiments between different stocks have been carried out. These experiments include also rearing in warm effluents of nuclear power plants.

The quality of reared salmon smolts has gained more and more interest and therefore physiological studies on the quality of wild and reared salmon smolts as well as the criteria for reared smolts have become as an object of interest. These studies have been connected with tagging experiments with the Carlin tag as well as with the nose tagging.

In connection with the COST 46 of the EC project on the factors increasing the survival rate of salmon smolts in the sea has been carried out in the area of the Bothnian Bay. Results of this project will be published in 1983.

Because year after year a greater share of the input of salmon smolts into the Baltic Sea is based on the reared smolts and because there are very clear indications of the influence of fishery into the genetics of fish stocks also studies on the genetics of the wild and reared salmon stocks have been intensified.

OUTLINE FOR STATISTICAL INFORMATION ON MARICULTURE PRODUCTION

Mariculture production 1981 (figures for 1982 not yet available)

Country: Finland

Species	in metric tons	approx.number in 100 000	value in 1 000 US $
Rainbow trout in enclosures more than 0.5 kg each	2 211	-	9,000
Salmon smolts for introductions, 1 year and older	-	9.18	1 400
Other salmonids (specify): Sea-trout for introductions 1-summer old and older	-	8.09	1 000
Others (please specify): Migratory whitefish for introductions 1-summer old	-	64.59	470

Fishculture in Finland in 1981

KALANVIljELYLAITOSTEN LUKUMÄÄRÄ ANTAL FISKODLINGS-ANSTALTER NUMBER OF FISH FARMS AND HATCHERIES	Merilaitokset[1] Anläggningar i havet Brackish water cage farms	Sisävesilaitokset[1] Anläggningar i sött vatten Fresh water farms and hatcheries	Luonnonravintolammikkoyritykset Naturdammsföretag Natural rearing pond breeders	Yhteensä Inalles Total
	85	253	200	538

KALANVIljELYLAITOSTEN TUOTANTOTILAT FISKODLINGSANSTALTERNAS PRODUKTIONSUTRYMME PRODUCTION CAPACITY OF FARMS AND HATCHERIES	Haudontakapasiteetti Kläckningskapacitet Incubation capacity		Kasvatustilat Uppfodningsutrymme Rearing space				
	Suppilohaudonta Kläckning i glas Glass incubation Matilitraa Liter rom Egg liters	Asettihaudonta Backkläckning Tray incubation	Keinoaltaita Konstgjorda bassänger Artificial tanks	Maa-altaita Jorddammar Earth ponds	Verkkoaltaita ja -aitauksia Nätkassar och -inhägnader Net cages and enclosures merialue havsområde sea area	 sisävesialue sötvattensområde freshwater area	luonnonravintolammikoita naturdammsdammar natural rearing ponds
	10 796	10 127	N 2 014 1000 m³ 23	1 757 938	611 170	149 93	647 ha 5 269
Laitoksia – Anstalter – Farms and hatcheries	55	54	60	218	85	28	200

KALANVIljELYLAITOSTEN[2] RUOKAKALANTUOTANTO FISKODLINGSANSTALTERNAS MATFISKPRODUKTION FOOD FISH PRODUCTION OF FISH FARMS	Merilaitokset Anläggningar i havet Brackish water cage farms	Sisävesilaitokset Anläggningar i sött vatten Fresh water farms	Yhteensä Inalles Total	Tuotannon arvo Mmk Produktionens värde M Fmk Value of production M Fmk
	Tuotanto – Produktion – Production 1000 kg[3]			
	2 211	3 172	5 383	116,8
Laitoksia – Anstalter – Farms	85	157	242	

1) Samaan omistajan eri laitokset laskettu omiksi yksiköikseen. — Samma ägares olika anläggningar räknade som olika enheter. — Same owner's separate farms counted as separate entities.

2) Tuotannosta kirjoitettu yli 99 % kuha. Jäännös taimenta. — Av produktionen över 99,9 % regnbågslax. Resten öring. — Over 99,9 % of production rainbow trout. The rest brown trout.

3) Tuotanto-arvot perkaamatonta painoa. Perattuna ilmoitetun tuotannon muuttamisessa perkaamattomaksi käytetty teurastusprosenttia 85. — Produktionssiffrorna som orensad fisk. Vid omräkning av den som rensad angivna produktionen till orensad har använts slaktviktsprocenten 85. — Production in kg ungutted fish. When gutted production was reported, it was converted to ungutted production by dividing with 0.85.

4) Lohi-, taimen- ja meritaimenpoikasia, on osalta syömäänoppineita, vapaasti uivia poikasia. — Beträffande lax, öring och röding, yngel som börjat äta och som simmar fritt. — Salmonids free-swimming fries.

5) Hauen osalta ed.kesäisiä, muutaman viikon ikäisiä poikasia. — Beträffande gäddan nykläckta, några veckor gamla yngel. — Pikes a few weeks old fry/fingerlings.

ISTUTUKSIIN KÄYTETTY TUOTANTO 1981 PRODUKTION FÖR UTSÄTTNING 1981 PRODUCTION TO STOCKINGS 1981	Vastakuoriutuneet nykiäkte newly hatched	1-kesäiset 1-somriga 1 summer old	1-vuotiaat 1-åriga 1 year old	2 kesäiset 2-somriga 2 summers old	2 vuotiaat 2-åriga 2 years old	3 kesäiset 3 somriga 3 summers old	3-vuotiaat 3-åriga 3 years old	vanhemmat äldre older	Yhteensä (ei sis vastakuoriutuneita) Totalt (excl newly hatched)
Istutukset 1000 kpl – Utsättningar 1000 st – Stockings 1000 fish									
Pohjasiika – Sik – Whitefish Coregonus pidschian (Gmelin)	114	2 823	31	–	31	–	–	–	2 885
Vaellussiika – Sik – Whitefish Coregonus lavaretus (L.) s.str.	105 981	6 459	–	–	–	–	–	–	6 459
Järvisiika – Sik – Whitefish Coregonus oxyrhynchus (L).	1 560	–	–	–	–	–	–	–	–
Planktonsiika – Sik – Whitefish Coregonus muksun (Pallas)	5 871	13 213	66	6	–	2	–	2	13 287
Peledsiika – Sik – Whitefish Coregonus peled (Gmelin) s. Berg	4 848	3 217	937	20	–	–	–	0	4 174
Siika, laji tuntem. – Sik, art okänd Whitefish, unidentif. – Coregonus sp.	780	2 548	–	–	–	–	–	–	2 548
Muikku – Sikloja – Vendace Coregonus albula (L.)	1 420	–	–	–	–	–	–	–	–
Lohi – Lax – Atlantic salmon Salmo salar L.	–	–	260	2	629	3	26	0	918
Järvilohi – Insjölax – Landlocked salmon Salmo salar m. sebago Girard	20	10	88	41	35	17	3	0	194
Meritaimen – Havsöring – Sea trout Salmo trutta (m. trutta) L.	222	9	51	71	676	–	2	0	809
Järvitaimen – Insjö-öring – Brown trout Salmo trutta m. lacustris L.	1 287	102	42	180	1 059	112	63	0	1 558
Purotaimen – Backöring – Brown trout, non-migratory – Salmo trutta m. fario L.	465	1	–	–	19	–	–	–	19
Kirjolohi – Regnbågsforell – Rainbow trout Salmo gairdneri Richardson	130	52	80	3	10	–	–	–	145
Nieriä – Röding – Char Salvelinus alpinus (L.)	902	–	3	–	6	–	–	0	9
Puronieriä – Backröding – Brook trout Salvelinus fontinalis (Mitchill)	–	–	–	–	2	–	5	–	
Harmaanieriä – Kanadaröding – Lake trout Salvelinus namaycush (Walbaum)	–	–	–	–	37	–	68	–	105
Harjus – Harr – Grayling Thymallus thymallus (L.)	556	364	2	–	–	–	–	–	366
Hauki – Gädda – Pike Esox lucius L.	20 426	1 237	–	–	–	–	–	–	1 237
Lahna – Braxen – Bream Abramis brama (L.)	–	40	–	–	–	–	–	2	42
Karppi – Karp – Carp Cyprinus carpio L.	–	–	18	2	2	0	–	–	20
Säyne – Id – Id Leuciscus idus (L.)	100	10	–	–	–	–	–	–	10
Kuha – Gös – Pike-perch Stizostedion lucioperca (L.)	250	117	–	–	–	–	–	–	119
Rapu – Flodkräfta – Grayfish Astacus astacus L.	–	–	2	0	0	–	–	–	2
Täplärapu – Signalkräfta – American crayfish – Pasifastacus leniusculus (Dana).	–	0	–	–	–	–	–	–	0

FRANCE

(J. Guillaume and M. Grizel)

1 - POISSONS ANADROMES ET MARINS

Des travaux empiriques visant à obtenir des oeufs de saumon coho (*Oncorhynchus kisutch*) à partir de reproducteurs gardés durant toute leur vie en eau douce ont été couronnés de succès : les pontes ont été de bonne qualité et le nombre d'alevins s'élève à plusieurs dizaines de milliers.

Tandis que les premiers essais de pacage marin (sea ranching) se poursuivaient sur un site expérimental breton avec *Salmo salar* et *S. trutta*, les tout premiers retours de saumon atlantique étaient enregistrés.

En matière d'élevage intensif des salmonidés en mer, il faut surtout signaler les essais visant à élucider les causes de la mortalité estivale des truites arc-en-ciel et des saumons. L'influence de la maturité sexuelle n'a pu être démontrée ; des séquelles de la nécrose pancréatique infection (NPI = IPN) pourraient constituer un facteur aggravant.

Le turbot (*Scophtalmus maximus*) a bénéficié d'efforts de recherche accrus. Les méthodes d'élevage et d'alimentation des larves à l'aide de proies enrichies en nutriments, de sevrage et d'alimentation à l'aide de nourriture contenant des attractants ont été perfectionnées.

Transposées à une écloserie pilote, elles ont permis l'obtention de 45 000 juvéniles ; le taux de survie à 90 jours a, dans la plupart des cas, dépassé 10 %.

Les méthodes ont également été adaptées à la sole (*Solea solea*) où elles permettent de gros progrès pendant le "sevrage".

Pendant la période de croissance (de 3 mois jusqu'à la vente) plusieurs types d'aliments artificiels ont été comparés ; ils donnent de bons résultats chez le turbot.

CRUSTACES

Le rôle du rapport lysine/arginine a été étudié chez la crevette impériale *Penaeus japonicus*. Mais chez cette espèce, c'est surtout le lessivage des nutriments et la technologie de fabrication des granulés (permettant de réduire ce lessivage) qui a retenu l'attention des chercheurs et permis des progrès substantiels.

STATISTIQUES

Les productions françaises sur la Côte Manche Atlantique ont été les suivantes :

- Saumon Coho	70 t
- Truite Arc en Ciel	400 t
- Turbot	10 t

Autres espèces : négligeable.

- Mollusques, Crustacés

Mollusques :

Pectinidés :

Pecten maximus

Le captage à grande échelle de naissain de coquille Saint Jacques est momentanément arrêté en Baie de Saint Brieuc. Une veille scientifique est cependant maintenue pour obtenir des informations sur le prérecrutement.

Des semis ont été réalisés en Baie de Saint Brieuc, en Rade de Brest et en Baie de Morlaix à partir de naissain originaire d'Irlande et de naissain d'écloserie (CNEXO/COB - ferme aquacole du Tinduff et SATMAR). Cette voie sera privilégiée en Rade de Brest au cours des prochaines années.

Chlamys varia

Les travaux de recherche se poursuivent en Baie de Quiberon, tandis que la production se développe en Rade de Brest. Des semis de plusieurs millions d'individus ont été réalisés et les premiers résultats devraient être obtenus en 1983.

Vénéridés :

L'élevage de la palourde (R. philippinarum) se développe sur les côtes de la Manche et de l'Atlantique. Diverses techniques sont utilisées selon la nature des zones d'élevage (parcs ostréicoles, claires à huîtres). Les techniques de prégrossissement en Bretagne, en Vendée et en Charente se sont vulgarisées permettant aux conchyliculteurs de disposer d'un produit moins onéreux.

Une machine a été mise au point pour la pêche de la palourde sur l'estran, par contre les divers essais réalisés en claire n'ont pas encore permis de déboucher sur un appareil opérationnel.

Ostréidés :

Huître plate

Ostrea edulis

La maladie due à Marteilia refringens sévit toujours dans plusieurs centres bretons.

La culture de l'huître plate est très ralentie du fait du développement de l'épizootie causée par Bonamia ostreae. Un plan de sauvegarde, basé sur l'éradication des foyers infectieux, l'interdiction de transfert et la culture de naissain dans des zones indemnes, a été mis en place.

La production de naissain sera très faible, peu de collecteurs ayant été mis à l'eau (700 000).

De nouveaux collecteurs et procédés de captage ont été testés.

Huître creuse

Crassostrea gigas

Des expériences réalisées in situ et au laboratoire ont mis en évidence le rôle perturbant des dérivés organostanniques, contenus dans les peintures antisalissures, pour la formation de la coquille. La relation avec la proximité de zones portuaires est très significative.

Des études entre la qualité du milieu et la biomasse d'un bassin sont poursuivies dans le bassin de Marennes Oléron et dans l'étang de Thau.

Mytilidés :

Moules

Mytilus edulis et M. galloprovincialis

Des essais de cultures en longues lignes, en milieu ouvert, sont en cours dans plusieurs centres de Bretagne et en Mer Méditerranée.

Crustacés :

Homarus gammarus

Les opérations de repeuplement des zones côtières ont porté sur l'immersion de post-larves et de juvéniles produits en écloserie. La production de l'Ecloserie de l'Ile d'Yeu s'est élevée à 100 000 post-larves (stade VI) et 10 000 juvéniles d'un an.

Les immersions ont été les suivantes :

- 65 000 post-larves et 7 720 juvéniles en provenance de l'Ecloserie de l'Ile d'Yeu,
- 98 000 post-larves (stade IV et V) et 8 400 juvéniles en provenance de l'Ecloserie d'Houat (APASUB),
- 102 000 post-larves (stade V) en provenance de l'Ecloserie de l'Ile de Sein.

GERMAN DEMOCRATIC REPUBLIC

(W. Loos)

In 1982 the following activities were carried out in the field of mariculture research.

1. Biological and technological experiments on rearing rainbow trout and carp species in heated brackish water were continued on larger scale.
   A pilot plant for utilization of heated brackish water is under construction now.
2. Comparative studies on different types of vaccines and immunization methods against Vibriosis and on bacterial diseases were carried on. In the case of rainbow trout the method of bath immunization showed successful results.
3. In coastal waters large scale cage farming experiments on circular cages and adequate technological equipment (feeding, control and harvesting) provided promising technical and economic results.
   Commercial employment will be initiated in 1983.

STATISTICAL INFORMATION ON MARICULTUR PRODUCTION - GDR

Species		tonnes
Rainbow trout in enclosures	total	505

FEDERAL REPUBLIC OF GERMANY

(K. Tiews)

Crassostrea gigas:

Indoor experiments on the reproduction and rearing of spat were continued as well a outdoor experiments on the fattening of spat to marketable sizes.

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

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

Salmonid fish:

Studies on the development of techniques for marine intensive culture were continued at the Institut für Meereskunde, Kiel.

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

Recirculation sea water systems:

The Biologische Anstalt Helgoland concentrated its efforts also in 1982 on studies related to the performance of recirculation systems in brackish water. Three compartments were specifically investigated. (1) Trickling filter performance at various loddings, (2) treatment efficiency of a newly designed contacting tower of the ozonation by-pass system and (3) water mixing and exchange rates of circular fish tanks (silos) in relation to inlet and outlet design as well as stocking density.

The Central Station of the Biologische Anstalt Helgoland started 3 newly designed recirculation systems within its new building. The total capacity of these systems varies between 10 and 20 m^3. They are multicycle systems which allow a largely independent control of system compartment.

Turbot:

Mass production of fingerlings was continued at the Institut für Meereskunde, Kiel. 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 culture 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 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. Immune biological studies on rainbow trouts were started at the Institut für Meereskunde, Kiel.

Statistics: (Federal Republic of Germany)

	Tonnes	Approx. No. in 100 000	Value in 1,000 U.S. Dollar
Blue mussels (Mytilus edulis)	17 000	-	1 692
Pacific oyster (Crassostrea gigas) from vertical cultures	10	-	60
Eel (Anguilla anguilla) not fresh water	12	-	110

ICELAND

(S. Einarsson and I. Johannsson)

In Iceland there are operating 5 large salmon hatcheries, as well as several smaller ones. The total production capacity of the hatcheries is 1.2-1.6 million smolts, plus approximately 2-3 million fry. Three years ago the total production capacity was only 2-3 hundred thousand smolts.

In past years experiments in ocean ranching have been carried out by private enterprises and by the state. These experiments give good hopes, but as yet there has not been a real break-through in this field. However, experiments by private parties conducted on the West Coast of Iceland (Lárós in Snæfellsnes) have been successful and returns have reached 12-15 percent.

In the past years smolts and fry have been released into the rivers and lakes in order to increase salmon fishery. The total annual catch in Iceland has reached appromimately 240 tons. The total catch of char and trout is also about 240 tons annually. There has been very little effort made in culturing trout and char fry. Very limited experiments have taken place in culture of other fish species.

Fiskifélag Íslands (The Fisheries Association of Iceland) have had the lead in farming salmon in cages in the sea. These experiments show that conditions are generally poor on the Icelandic shores. However, there are a few promising places, one of which is Lake Lón in the district Kelduhverfi on the North East Coast. Fiskifélag Íslands have carried out experiments with cage farming in this district for some years.

In continuation of the observations carried out by the Fisheries Association of Iceland, the fish farming concern ISNO Ltd. (established by Tungulax and the Norwegian firm MOWI), are now operating an experimental fish farm, which is the largest in it's field in our country.

IRELAND

(J. Doyle)

A modest expansion in mariculture operations occurred in 1982.

Fin Fish

Atlantic salmon (Salmo salar)

Production in 1982 from four units was 111 tonnes compared to 32 tonnes in 1981. The bulk of the production was grilse. Average size was 1.7 kg with maximum size of 3 kg being obtained.

Production continued to be limited by a shortage of good quality smolts and early maturation. Because of the acute shortage of smolts an importation of Norwegian smolts from known salmon parentage have been permitted under strictly controlled quarantine conditions. Growth rates of smolts derived from Norwegian ova imported in 1981 compared very favourably with domestic stock.

Furunculosis was not a major problem in 1982. A technique for controlling latent furunculosis in smolts by injection with a recently developed antibiotic prior to transfer was tested with promising results.

Vibriosis was the most serious bacterial problem encountered in salmon with outbreaks in two units. At one site losses of 20% of brood stock were reported but at the other site serious losses were prevented by timely use of antibiotics.

Rainbow trout (Salmo gairdnerii)

Production from 8 units was 210 tonnes and remains static. Two units ceased to operate during the year. Serious losses again occurred at a number of farms following a period of exceptionally warm weather with temperatures up to 24°C being recorded. Heavy infestations with Trichodina were associated with these losses. Salmon brood stock and smolts in adjacent cages were not affected. Nephrocalcinosis also caused losses and Proliferative Kidney Disease (PKD) was also detected in trout in the sea.

The economics of farming trout in the sea were being reviewed at the end of the year.

Molluscs

Production of oysters O.edulis was 58 tonnes, of C.gigas 49 tonnes. Shortage of hatchery spat continues to be a major constraint in the expansion of oyster farming.

Production of Mussels (M.edulis) was 400 tonnes by longline and raft culture while extensive culture techniques produced 3324 tonnes.

Ten new pilot projects were established during the year.

Escallops (Pecten maximus) farming is confined mainly to spat collection and re-laying in on-growing sites and has not yet reached commercial production.

One million spat from Mulroy Bay were exported to France and Spain during the year.

Research

Eight organizations are engaged in research projects on mariculture related topics.

1. Fisheries Research Centre, Abbotstown, Castleknock, Co. Dublin
Research on diseases diagnosis and control (J. McArdle)
Mollusc culture techniques, predator control studies (Duggan, Minchin, Crowley)
Aspects of nutrition of salmonids and environmental effects of salmonid cage culture (J. Doyle).

Investigations of incidence sub effects of plankton blooms on farmed fish (M. Parker).

2. Beirtreach Teoranta (D. O'Callaghan)
Mollusc hatchery techniques, raft and cage engineering.

3. Shellfish Research Laboratory Carna (Dr. J. Mercer)
Mollusc hatchery techniques, diatom culture

4. University College Galway

Zoology Department (Professor N. Wilkins)
Genetic studies of molluscs and salmonids.
Microbiology Department (Dr. P. Smith)
Studies on incidence and control of furunculosis

5. University College Cork

Zoology Department (Professor M. Mulcahy)
Study of renal diseases in farmed salmonids

6. Salmon Research Trust (Dr. D. Piggins)
Biochemical genetics, nutrition and disease control of salmonids

7. Electricity Supply Board (N. Roycroft/B. Whelan)
Research and development of salmon and eel farming, investigation of methods of control of sexual maturation.

8. National Board for Science and Technology (O. Sweeney)
Responsible for co-ordination of research and funding of research projects.

NETHERLANDS

No report received

NORWAY

(G. Nævdal)

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 Nutrition, 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
8. National Veterinary Institute and Veterinary College, Oslo
9. Norwegian Herring Oil and Meal Industry Research Institute, Bergen.
10. Norwegian Institute for Water Research (NIVA).

In the following report these institutions are referred to by number. The greater part of the institutions are concerned with short-term experiments on salmonids and on new potential species for aquaculture. Long term experiments are conducted at (1) and (4).

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 programs to increase growth rate, (1) and (4); reduce mortality (4); improve meat quality (4) and increase age at maturity, (1) and (4). At Sunndalsøra and Averøya about 300 families of Atlantic salmon and rainbow trout are tested in each year class in the selection program.
b. Study of phenotypic and genetic parameters in production traits, (1) and (4)
c. Study of inbreeding depression, (4)
d. Study of heterosis effect, (4)
e. Induce polyploidy to obtain a triploid steril fish, (4)
f. Induce gynogenesis, (4)
g. Study genetic variation in stress measured by cortisol level (4)
h. Study genetic variation in flesh pigmentation, (1).

Behaviour

Studies on antipredator behaviour in Atlantic salmon smolt was continued. (1). The behaviour of cultivated smolt in relation to potential fish predators (cod, saithe, rainbow trout and others) was observed in a tank in order to reveal differences in smolt reacting to predators. Conditioning of smolt to avoid predators will be tried in an effort to improve recapture rate of released smolt.

Tracking of smolt migration in the sea was conducted with the aims of comparing wild and raised smolt, and study the migration of the fish in relation to the hydrography in the migration area.

Physiology and nutrition

Laboratory experiments on nutrition, digestion, growth, metabolism and energy budget of cod were continued (1). Experiments on sex reversal on salmonids by feeding the fry with steroids were continued in a small scale (1).
Use of shrimp wastes for salmonid feeding was further tried out (1) and also experiments with comparison of different carotenoids were continued (4).

Feed 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 long term effect, health and meat quality, was studied by (4).

Studies on protein, fat and carbohydrate level in fish food, digestibility, feed consumption at different temperatures and of varying fish size, and comparisons of wet and dry diets in salt water at low temperatures were carried out by (4) and (1). Also effects of different "new" feed ingredients were examined at (4).

Studies on factors responsible for varying egg quality of reared salmonids were continued by (1), (2) and (4). Particularly, investigations concerning the effect of vitamin C supplementation to brood stock diets on reproduction in salmonids were carried out by (2).
Use of binders in salmon feeds (to increase feed efficiency and reduce water pollution) was studied by (2) and (4).
Also effects of dietary copper on rainbow trout was investigated by (2).
In collaboration between (2) and (9) effect of stabilized krillmeal in the diet of Atlantic salmon on fillet pigmentation and influence of different heat loaded fishmeals in the diets of Atlantic salmon on digestibility and growth were studied.

Pathology

Work on vaccination and vaccines against vibriosis was continued by (1) and (6). Different disease problems at fish farms have been looked into. Special attention are still given to the cold-water vibriosis or Hitra-disease at (1).
Studies on spreading of IPN-virus from known carriers in fish farms to the marine environment was continued (1).
At (8) the following projects were conducted:

a. Vaccination experiments against vibriosis and infection with Aeromonas salmonicida var. achromogenes
b. Registration of IPN in Norwegian Fish Farms and wild populations
c. Infection with Ichthyobodo necator in sea water
d. Methodology development for detection of recidues of drugs in fish
e. Epidemiological, clinical, hematological and treatment studies in connection with hemorrhagic syndrom (Hitra disease)
f. Cataract in fish
g. Survival of fish pathogens in ensilaged fish (in cooperation with (4)).

Aquaculture technology

Experiments to assess the effectiveness of several antifouling impregnants for net pens were continued and increased in 1982. Also storage of live saithe in net pens for subsequent delivering in 1982 (1). Systems for resirculation of fresh water for smolt production were further studied and improved by (1) and (4). Treatment of acid water for smolt production was also paid attention to (1). Oxygen consumption and effect of varying oxygen levels and supersaturation with nitrogen were studied at (4).

Raising of smolt in net pens in fresh water and use of submerged cages for fish farming in the sea were studied by (1) and (5).

At (10) the following research programmes were initiated:

- Development of advanced fishfarming plants with special attention to water quality, energy conservation and water demand.
- Research on aquaculture systems for waste water treatment including technical design, selection of species, inoculation, harvesting etc.
- Encouraging extensive fishfarming in the 3.world as part of the national development aid.
- Integrated research (social, natural and technological) on optimal localization of fishfarming plants. This project is part of a larger research programme on utilization of the coastal zone.

Rearing of marine fish larvae

The program on mass-rearing of cod fry in an enclosed pond, initiated in 1980, was continued in 1982 (1). The pond was treated with rotenon to exterminate predators on the cod larvae and fry. The larvae were released at the yolk-sac stage and collected during summer (6-10 cm). A tagging and release program on cod fry was initiated. Also the program on rearing of cod fry in plastic

bags in the sea was continued (1), and a program for composing an artificial or semi-natural feed for cod larvae was initiated (1).
Rearing experiments with halibut larvae was continued (1).
Ripe fish were caught with gill nets on the spawning grounds.
During Autumn a brood stock of halibut has been established near Bergen.
Experiments with hatching and rearing marine fish larvae and fry was also continued by (3) in a land situated basin.

Other projects

Experiments on commercial culture of blue mussels were continued, (1) and (7). Similar experiments on culture of oysters and scallops were continued in a small scale (1), (6) and (7). Also the investigations of the possibility for culture of Arctic char were continued (6).
Technology for raising lobsters in large scale is being tried out by a private firm.

STATISTICS

The main mariculture production in Norway 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. The total production therefore is given in the following table:

Species	In metric tons
Rainbow trout in enclosures	4 690
Salmon in enclosures	10 266

However, the quantities produced in fresh water are small, and less than 5% of the total production is indicated. Concerning other species, no statistics excist, but small quantities of blue mussel and oysters were produced.

POLAND

No report received

PORTUGAL

(M.J. Figueiredo and J.M. Saldanha Lopes)

SHRIMP CULTURE

1. Palaemon serratus

This culture was continued in 1982, in fiber glass tanks using new devices of recirculated Sea Water Systems. Four defferent types were tried, which were specifically designed for carrying out the different phases of the culture. Special attention was paid on the relation surface/volume, as an important factor acting on growth and survival of the species.

The suitability for larval rearing of some Portuguese strains of Artemia salina, was tested against S.Francisco - California Strain, in small volumes.

2. Penaeus Kerathurus

A special recirculating system device, particularly designed for controling photoperiod and temperature, was set up for experimental work on induced maturation of gonads and spawning, in captivity.

The animals were caught in the wild, late in 1982, as juveniles and were progressively adapted to the captive conditions of the laboratory.

FISH CULTURE

1. Sparus aurata

Histological studies of adult's gonads were undertaken in order to obtain information for future experiments on induced spawning, in captivity.

Comparative experiments on food conversion rates were carried out in intensive and extensive systems, using in both cases, the same kind of Pellet, previously tested in the laboratory.

Studies on the ongrowing of fingerlings, captured in the "Ria de Faro" (Portuguese South Coast) were carried out in fiber glass tanks, in semi-closed sea water systems - the animals were fed natural food, mostly cockles and clams.

SCOTLAND

(A.L.S. Munro)

PRODUCTION - FINFISH

Salmo gairdneri Scotland produced 1918 tonnes of trout in 1982 of which 133 tonnes were produced at 5 seawater cage sites. The rest of trout production was in freshwater.

Salmo salar Total UK output of Atlantic salmon all of which is produced on the west coast of Scotland was 2152 tonnes. The production was made up of 595 tonnes of grilse and 1557 tonnes of salmon. Some 1.7 million smolts were placed in seawater. Of 46 commercial sea sites, 41 used cages and 5 used pumped seawater.

Anguilla anguilla One commercial farming using heated pumped seawater from a power station has a significant production of eels.

Scophthalmus maximus Two small scale commercial units are rearing turbot, one using pumped heated seawater and the other using sea cages for on-growing juveniles.

PRODUCTION - MOLLUSCS

There are no statistics for mollusc production. A few hundred tonnes of oysters, mainly Crassostrea gigas, and mussels (Mytilus edulis) are produced.

RESEARCH

Marine Laboratory, Aberdeen. This Laboratory has programmes of research on several diseases of fish, on maturity control in salmon and trout and on developing methods of scallop culture. Disease diagnosis is also conducted for both the Ministry and fish farmers.

Torry Research Station, Aberdeen. A limited programme is concerned with quality aspects of farmed fish including spoilage, gaping, storage, smoking and taste.

Institute of Marine Biochemistry, Aberdeen. At present nutritional balance studies are concerned with dietary needs for protein, and amino acids, lipids, polyunsaturated fatty acids and antioxidents as well as mineral requirements. Resear on marine flatfish includes the rearing of Dover sole larvae as well as feeding behaviour and control by chemosensory mechanisms.

Dunstaffnage Marine Research Laboratory, Oban. Research is conducted on a recall reading system for trout, methods of using fishery wastes for feedstuffs, the quality of ova, fish dermatology, relationships between algae and aquaculture and oxygen budg for fish cages. Advice is given on physical environmental conditions and investigati conducted on phytoplankton induced fish kills.

Sea Fisheries Authority, Ardtoe, Argyll. Research on scallops and queens centres on sprat collection, sorting of sprat and different methods and conditions for on-growin Turbot rearing is concerned with the hatchery production of juveniles for on-growing trials in cages. The Authority also provide engineering and economics services for t aquaculture industry.

Institute of Aquaculture, Stirling University, Stirling. Programmes of research are conducted on fish diseases and several aspects of the biology of salmonids, and marine and tropical fish of importance to aquaculture. A disease diagnostic service is available for farmers.

Biology and Engineering Departments, Heriot Watt University, Edinburgh. Research includes study of the processes and systems necessary for recirculation of water in fish farms, the design of sea cage systems and the development of systems of scallop culture.

SPAIN

No report received

SWEDEN

(H. Ackefors)

Aquaculture intended for fisheries management (conservation) is of great importance in Sweden. Aquaculture aimed at directing human consumption is still of minor importance, although the number of operations are increasing.

Fisheries management (conservation)

About 10 species of fish are cultivated under the auspices of fisheries conservation in Sweden. The commercial fishery favours the promotion of mainly salmon, trout and eel. Other species, such as rainbow trout, trout, brook trout, char and grayling are important for sport fishing in fresh waters. Thanks to the many compensatory cultivations of salmon there is a relatively large salmon population in the Baltic.

In 1982, stocking of fish in brackish or marine waters amounted to about 3 million specimens.

Species	The Baltic Number x 10^6	Swedish west coast Number x 10^6
Salmon (Salmo salar)	1,9	0,1
Trout (Salmo trutta)	0,7	0,01
Eel (Anguilla anguilla)	0,1	-

The main part of the salmon and trout smolts intended for stocking in the Baltic were raised in compensatory operations according to the decisions made by the Swedish Water Right Court to compensate for destroyed natural production in rivers. Additional smolts, as well as eel, have been stocked successfully in coastal waters to enhance the stocks.

Aquaculture farming in commercial operations

The numbers of operations have increased very much since the end of 1970's. In total there are about 300 cultivations with rainbow trout (Salmo gairdneri). A little less than 50% are situated in brackish or marine waters. The number of blue mussel operations (Mytilus edulis) in marine waters on the Swedish west coast are about 60. In 1982, the production of rainbow trout was probably close to 3000 tons. The production of blue mussel was about the same, although the harvest was less than 2000 tons. Experiments with salmon farming in net pens in the Baltic area, as well as on the west coast, are continued. Two commercial operations are located in the Bothnian Sea.

A company is building an experimental/commercial operation on the west coast to raise various species by using supplementary waste heat. Other companies are also planning to utilize waste heat.

During the years 1981-1982 the Swedish Steering Committee on aquaculture and its working groups have analysed the possibility of building up an aquaculture industry in Sweden. The final report summarizes the background, analyses and proposals of the different groups which briefly can be divided into four main areas: economy/marketing, administration/organization, research and education.

U.S.A.

(A. Longwell and J.H. Ruther)

In recent years efforts have been made to collect aquaculture literature in computerized files, and also publish directories of information sources. Access to these sources can either be direct or through the U.S. Mariculture Committee members. These sources, citations to a few descriptions of national programs, and cumulative listings of references to works not yet published in primary journals are given below.

Aquaculture Data Base (previously National Aquaculture Information System). Collection of documents including practical manuals, short articles of interest, technical and scientific reports, books, journal articles - published and unpublished - international. Since 1980 part of the Lockheed DIALOG system of computer searchable databases. Located at Virginica Institute of Marine Science, Gloucester Point, VA 23062. Supported by the National Marine Fisheries Service.

Sea Grant 1982. Sea Grant Aquaculture Plan 1983-1987. Prepared by the Aquaculture Committee of the Council of Sea Grant Directors, B. Crowder, Ed., 48 pp. Marine Information Service, Sea Grant College Program, Texas A and M University, College Station, Texas 77843.

Sea Grant 1982. New Sea Grant Publications and Extension Publications. Listed in Sea Grant Today, Vol. 12, No. 6, Nov.-Dec. 1982. Includes aquaculture listings.

Sea Grant 1982. Annual Reports, Aquaculture. Obtainable from Extension Division of the Virginia Polytechnic Institute and State University. Blacksburg, VA 24061.

National Aquaculture Library, United States Department of Aquaculture, 1982. Directory of Aquaculture Information Resources: Includes basic literature sources - abstracting and indexing aids, directories or summaries of significance, and selected primary periodicals; description of information sources by state; subject index of information resources section; list of state cooperative extension services, fisheries/aquaculture specialists, USDA and contact person for fisheries/aquaculture. 52 pp. National Agricultural Library, Beltsville, Maryland 20705.

United States Department of Agriculture. Aquaculture, Research. 1983. A Directory of USDA and state projects in CRIS. Miscellaneous Publications 1432. Current Research Information System, National Agriculture Library Building, Beltsville, Maryland 20705.

National Agricultural Library, United States Department of Agriculture. In Press. Aquaculture bibliography drawn from AGRICOLA (Agricultural On-Line Access). Contains 1.5 million citations from 1970 to present of which 2500 are aquaculture citations. Added to monthly, and a major portion of the record is published monthly with the Bibliography of Agriculture.

University Programs Supported by the Office of Sea Grant, Department of Commerce, as of 1982.(Listing of programs only. Information on any of these can be obtained directly from the respective universities along with names of researchers, or through Mariculture Committee members.).

The U.S. Department of Commerce Office of Sea Grant is now the only federal agency in the United States that provides research support to universities and non-government laboratories in mariculture to any significant extent. In 1982, that organization provided partial support for 106 projects in the general field of aquaculture. Of these, 72 involved the cultivation of marine species including 14 crustacean projects (9 penaeid shrimp), 18 mollusc projects (8 oysters), 27 fin fish projects (19 Pacific Salmon), and 11 seaweed culture projects.

Other Sea Grant Aquaculture support included cultivation of fresh water species (i.e. in the Great Lakes Region) and projects involving policy, economics, and general advisory activities, none of which were oriented toward technological aspects of mariculture.

Sea Grant Mariculture projects in progress in 1982 are listed by category below:

I. Crustacea

1. Hawaiian Prawn Aquaculture Experimental Research Project
   University of Hawaii

2. Analysis of Potential Organic and Inorganic Toxicants in Hawaiin Shrimp and Prawn Aquaculture
   University of Hawaii

3. Feeds and Supplements for Optimum Prawn Pond Production
   University of Hawaii

4. Aquacultural Engineering for Prawn Farming
   University of Hawaii

5. Penaeid Shrimp Pond Production: Polyculture and Two Crops per Year
   Texas A & M University

6. Economics of Commercial Shrimp Mariculture
   Texas A & M University

7. Penaeid Shrimp Maturation and Reproduction: Nutrition and Culture Requirements
   Texas A & M University

8. Microbial Diseases of Shrimp
   Texas A & M University

9. Electrophoretic Variation and its Usefulness in the Aquaculture of Penaeid Shrimp
   University of Houston

I. Crustacea continued

10. Development of Techniques for in Vitro Fertilization of Decapod Crustaceans
South Carolina Marine Resources Center

11. Evaluation of a Closed Recirculating System for the Production of Soft-Shelled Blue Crabs
Louisiana State University

12. Control of Egg Drop in the Lobster
University of California, Davis

13. Development of Procedures for Artificial Insemination and Sperm Storage in Lobsters
University of California, Riverside

14. Variation in Intracellular pH and its effect on Hatchability of the Brine Shrimp Artemia Salina
University of California, Davis

II. Molluscs

1. Oyster Hatchery and Genetic Study
University of Washington

2. Oyster Larval Death-Algal Abiosis
University of Washington

3. The Use of Eyed Larvae as an Oyster Seed Source
Oregon State University

4. Artifical Food for Oyster Larvae
Virginia Institute of Marine Science

5. Utilization of Brewery Wastes for Oyster Mariculture
Virginia Institute of Marine Science

6. Nutrition of Crassostrea Virginica
University of Delaware

7. Population Dynamics of the Mangrove Oyster, Crassostrea Rhizophorae
University of Puerto Rico

8. Influence of Suspended Particulates and Salinity on the Energy Budget of the Oyster Crassostrea Virginica
University of Maryland

9. Nursery Culture of Juvenile Mollusks: Comparative Analysis of Experimental and Conventional Systems for Mercenaria mercenaria
South Carolina Marine Resources Center

10. Genetics of Growth and Reproduction in the Hard Clam Mercenaria mercenaria
George Mason University

II. Molluscs continued

11. Assessment of Supplemental Feeds for Cost Reduction in Growing Hard Clam, Mercenaria Mercenaria, Seed
Virginia Institute of Marine Science

12. Artificial Control of Gametogenesis, Spawning, and Larval Production in the Purple-Hinged Rock Scallop
San Diego State University

13. Biochemical Engineering for Improved Production of Commercially Valuable Marine Shellfish
University of California, Santa Barbara

14. The Effects of Environmental Factors on the Ability of Chemical Cues to Trigger Settlement and Metamorphoses of Bivalve Larvae
Humboldt State University

15. Molluscan Culture Studies
University of Washington

16. Molluscan Hatchery Technology
Oregon State University

17. Culture of Marine Bivalves: Nutritional Role of Dissolved Organic Solutes
University of California, Irvine

18. The Application of Lipid Specific Staining in the Culture of Bivalve Molluscs
Woods Hole Oceanographic Institution

III. Fin Fishes

1. Endocrine Control of Smoltification and Reproduction in Salmonids
University of Washington

2. Optimizing Chum Salmon Culture Techniques
University of Washington

3. Diet Development for Marine Pen-Cultured Coho Salmon Broodstock
University of Washington

4. Coho Salmon Stock Development for Marine Pen-Culture
University of Washington

5. Physical Training as an Enhancement Strategy for Salmon
University of Washington

6. Analysis of Salmon Production Practices
Oregon State University

7. Survival and Nutritional Requirements of Salmonids in Transition from Freshwater to a Marine Environment
Oregon State University

III. Fin Fishes continued

8. Reproductive Physiology and Induced Maturation of Salmon Brood Stock
Oregon State University

9. Endocrine Control of Salmonid Development and Seawater Adaptation
University of California, Berkeley

10. Incubation Technology
University of Alaska, Fairbanks

11. Genetic Evaluation of a Chum Salmon Transplant
University of Alaska, Fairbanks

12. Study to Abolish the Carrier States of Furunculosis and Bacterial Kidney Disease in Anadromous Pacific Salmon
University of Idaho

13. Biochemistry of Fat Depletion During Salmonid Smolt Transformation
Humboldt State University

14. The Relationship of Growth Rate Changes to Smoltification of Chinook Salmon
University of Minnesota

15. The Role of Size and Age in Determining Osmoregulatory Ability in Sea Run Brook Trout
Woods Hole Oceanographic Institution

16. OTEC Coldwater Fish Culture
University of Hawaii - Hawaii Institute of Marine Biology

17. Development of Techniques to Optimize Production of Juvenile Striped Bass Hybrids
University of North Carolina

18. Nutritional Requirements of the American Eel
East Carolina University

19. Development and Demonstration of Finfish Mariculture in South Carolina
South Carolina Marine Resources Center

20. The Nutritional and Economic Consequences of Mallad Browing Reaction in Fish Feed
University of Rhode Island

21. Design and Fabrication of Microcapsules for Fish Larvae Feed
Massachusetts Institute of Technology

22. Life History Studies on Red Drum (Sciaenops Ocellata) and Red Snapper (Lutjanus Campechanus)
University of Texas Marine Science Institute

IV. Seaweeds

1. Vegetative Propagation of Commercially Important Benthic Algae
   University of California, Santa Barbara

2. Physiological Aspects of Prophyra Perforata Mariculture: The Effect of Desiccation on Photosynthesis and on the Control of Epiphytes
   - Stanford University

3. Technology Transfer of Eucheuma Farming Information to Ponape
   University of Hawaii

4. OTEC-Aquaculture Macroalgae Experiments
   University of Hawaii - Hawaii Institute of Marine Biology

5. The Potential of Two Species of Gracilaria (Rhodophyta) for Mariculture in the Mariana Islands
   University of Guam

6. Aquaculture of Seaweeds on Artifical Substrates
   Washington Department of Natural Resources

7. Improved Seed Stock and Net Seeding for Seaweed Aquaculture
   University of Washington

8. Development of a Northern New England Seaweed Institute
   University of Maine

9. Experimental Manipulation of Sulfate in Agar-Producing Seaweed
   University of New Hampshire

10. Marine Algae in Production of Fermentation Alcohol and in Wastewater Recovery
    Mississippi State University

11. Marine Alage in the Production of Fuel/Chemical Feedstocks in Wastewater Recovery
    Jackson State University

V. Miscellaneous

1. Aquatic Animal Production
   University of California, Davis

2. Bacterial Chemosynthesis for Aquaculture
   Woods Hole Oceanographic Institution

University Programs Supported by the Department of Agriculture
Current and Recently Completed

CULTURE

Oysters

Further studies were conducted on the economic intense culture of the oyster in hatcheries in Oregon (W.P. Breese, Oregon State University, Crovallis). Hatchery techniques developed there for the Miyagi variety of Crassostrea gigas are being applied now to Kumamoto oysters, gaper, cockle, and razor clams and to the sea mussel. C. rivularis has been accepted by some growers in the area and eyed larvae and seed are being produced in two commercial hatcheries.

A study underway at Clemson University, Clemson, South Carolina, is examining the feasibility of proposed mariculture of clams in South Carolina (A.G. Eversole).

Penaeid shrimp

A program at Texas A and M University, Corpus Christi, seeks to obtain basic and applied knowledge essential to the development of the penaeid shrimp mariculture as a successful industry - reproduction in captivity, development of satisfactory prepared feeds, and improvement of shrimp production from intensive and extensive culture (A. Lawrence).

Freshwater prawn

Improved production and management systems of Macrobrachium culture in Texas were sought at Texas A and M University, College Station. Field studies of freshwater shrimp were conducted in hopes of a better understanding of their nutritional and environmental requirements (R.W. Brick).

Rather broad-based studies of Macrobrachium culture have continued at the University of Hawaii, Honolulu (S. Malecha and B. Law). These include development of improved feed and pond management strategies.

Pacific salmon

In an ongoing study at Oregon State University, Corvallis, the relationship between incubation density and fry quality in shallow gravel incubators is being examined. Some analyses have already been completed. Application of results depends on the relative importance of biological vs economic optimization - 3000-4000 eggs/ft 2 favors high quality fry production while 7000 eggs/ft 2 minimized the cost of producing each fry.(J.E. Lannan).

NUTRITION

Lobster

Minimal cost lobster rations were formulated and evaluated at the University of Maine at Orono (R.C. Bayer). These were made with brewer's yeast, fish meal, kelp, alfafa and wheat flour. The basal diet was supplemented with vitamin A.

Salmonids

At Oregon State University, Corvallis, the fundamental nutrition of hatchery salmonids was studied, and the Oregon Moist Pellet further developed and improved (D.L. Crawford and D.K. Law). Corn and soybean oil supplements were replaced with fish oil providing superior dietary fatty acids. A University of Wisconsin, Madison, study was aimed at determining the quantitative amino acid requirements of rainbow trout, and at the feasibility of employing anabolic substances (C.H. Amundson and T.B. Kayes). At the University of Rhode Island, Kingston, diets for trout and salmon have also been developed and in some cases commercial rations made available (K.L. Simpson and T.C. Lee).

Diets for both the fresh and saltwater rearing phases of salmon culture are being investigated at the University of New Hampshire, Durham (R.G. Strout).

DISEASE

Oysters

The role of larval American oysters (Crassostrea virginica) as carriers of oyster disease was researched at Cornell University, Ithaca (R. Elston and L. Leibovitz). At Texas A and M University, College Station, the level and

seasonal distribution of Vibrio parahaemolyticus were determined in freshly harvested shellfish, and the effect of processing and handling on these levels (C. Vanderzant).

Continuing studies at Rutgers University, New Brunswick, New Jersey (H.H. Haskin) indicate that the oyster disease MSX which first appeared in Delaware Bay in 1957, has been continuously present since then. Its prevalence and intensity have fluctuated in cyclic fashion with three periods of low prevalence. Survival of the Delaware Bay oyster industry depends on the availability at reasonable cost of a moderately disease-resistant seed from upper Bay natural beds. Experience shows that a grower can expect to lose, on the long-term average, approximately 40% of his oysters to disease in the first year following planting.

Salmonids and Other Finfish

A Histopathology Laboratory offering diagnostic services to aquaculture projects was set up at the University of Rhode Island, Kingston (R.E. Wolke). Research is underway there to improve diagnostic methods for fish and mollusca (P.W. Chang, V.J. Yates and R.E. Wolke).

Recent research at Oregon State University, Corvallis, concerned the IHN attenuated water borne serial vaccine. Feasibility studies for development of either a bacterium or vaccine for the causative agent of bacteria kidney disease in salmonids were also conducted examining isolates for serological differences and immunologic responses of the fish (J.L. Fryer).

The early events in bacterial kidney disease in rainbow trout - a route of entry, site or sites of multiplication and dissemination through the body - were researched at Cornell University, Ithaca (J.C. Carlisle).

The life cycle of Myxosoma cerebralis, the causative agent of whirling disease in salmonids, was investigated at the University of Nevada, Reno (R.L. Taylor). An enzyme-like immunosorbent assay (ELISA) test was developed for the serological identification of infected fish.

Atlantic salmon were found to be as susceptible as coho salmon to Maine- New Hampshire strains of Vibrio anguillarium in transmission through either injection or exposure in water (R.G. Strout, University of New Hampshire, Durham).

Piscine erythrocytic necorsis virus was the subject of studies on both the east and west coasts (Univeristy of Maine, Orono, B.L. Nicholson; Oregon State University, Corvallis, J.L. Fryer).

An ongoing study at the University of Georgia, Athens, seeks to determine the nature of the immune response of fish to ciliary antigens, and the duration of immunity induced by heterologous immunization by various routes of administration (catfish, D.L. Dawe and J.B. Gratzek).

GENETICS

Oysters

At high MSX prevalence levels in Delaware Bay in 1980, laboratory-bred stocks of resistant oysters experienced mortality rated 20 - 50% those of native wild stocks which also have developed, through natural selection, some degree of disease resistance (H.H. Haskin, Rutgers University, New Brunswick, New Jersey).

Freshwater Prawn

At the University of Guam, Agana, Guam, there is an ongoing attempt to effect an interspecies hybridization of Macrobrachium (D.E. Matlock).

Salmonids

The genetic basis of electrophoretically variable enzymes in brook, brown, rainbow and lake trout and their hybrids is the subject of past and continuing research at Pennsylvania State University, University Park (J.E. Wright) aimed at understanding the evaluation of trout genomes. Extensive cytogenetic analyses are performed including chromosome banding and meiotic studies of both spermatocytes and oocytes, the first such in-depth analyses accomplished on an aquacultured fish species.

In an ongoing breeding and genetic study at the University of California (Davis) significant non-genetic sources of variation were found to influence growth rate in rainbow trout - spawn date, tank, density, stress, water temperature and rate of sexual maturation (G.A.E. Gall). However, growth to one year was found to be heritable. Rainbow trout and golden trout crosses produced viable second generation progeny. Also standard electrophoretic and histochemical techniques are being used

to identify protein and enzyme polymorphisms in wild trout populations.

Mosaic polyploids were produced in brook trout by cold shock (University of Rhode Island, Kingston, L.T. Smith). These appeared to grow at a faster rate than non-polyploids, but no sterility was noted.

Catfish

Quantitative data on the growth rates of different strains of channel catfish, and their performance on different dietary formulations were recently collected at Kansas State University, Manhattan (J.R. Kelley, Jr., C. Deyoe, and B.E. Klaassen).

At Auburn University, Auburn, Alabama, realized heritability for body weight in a wild strain of channel catfish was found to be sufficient to yield an 11% increase in growth through one generation of selection. Generally, intra-specific crossability did not differ, but only crossbred individuals hybridized with blue catfish. Genotype x environment interactions were significant when the environmental variable was stocking density (R.O. Smitherman).

A bi-directional selection program for body weight and size uniformity at the Georgia Coastal Plan Experiment Station, Tifton, increased body weight in one generation about 22%, and total length about 9% at 40 weeks of age. The rates of decline in the downward direction were about 19% and 4% respectively. One generation of inbreeding in channel catfish resulted in about 7% and 6% growth depression at 16 and 40 weeks of age , respectively (K. Bondari, T.K. Hill, and J.W. Andrews, Jr.).

The genetic variability in mortality rate at a low level of dissolved oxygen was recently examined for some geographic strains and families of catfish (Louisiana State University, Baton Rouge, researcher J.W. Avault).

Striped Bass

At North Carolina State University, Raleigh, the potential of striped bass x white bass, and striped bass x white perch hybrids was evaluated for use in aquaculture (J.H. Kerby, M.T. Huish, and K.R. Keller).

Water Quality, Closed and Recirculating Culture Systems

At the University of Rhode Island, Kingston, practical methods were sought for removal of metabolites from fish culture water that render it unsuitable for use, and for treatment of fish culture water to meet existing and projected standards for its discharge (T.L. Meade). Solids removal is one of the more difficult unit processes involved in water reuse systems in salmonid culture.

Filtration in closed cycle fish culture using biological systems is the subject of ongoing research at the University of Maryland, College Park (F.W. Wheaton, T.B. Lawson, and E.P. Karlander).

At Auburn University, Auburn, Alabama, a closed system for the culture of fish, shellfish and aquatic plants was evaluated. Maximum production of channel catfish and Tilapia was calculated (R. Allison). The operational characteristics of a solar heated greenhouse, thermal storage, and heat recovery facility for a recirculating fish culture system are now being determined.

Cyrogenesis

Procedures used with success for cryogenic preservation of sperm from cold water fish are being screened for potential use with warm water fish, North Carolina State University, Raleigh (J.H. Kerbey). Another object of research there is to improve freezing techniques for striped bass sperm, and to develop methods for preserving large volumes of semen for use under hatchery conditions.

Economics

The economics of a pilot aquaculture system utilizing water re-use was analyzed for salmonid aquaculture in New England (University of Rhode Island, Kingston, J.M. Gates).

Data for an aquaculture budget generator were obtained by the University of Massachusetts (Amherst) through a survey of shellfish aquaculturists in New England and by the economic-engineering analysis of three synthetic model plants. The

economic-engineering analysis indicated that it was possible to produce 85 mm oysters at 1979 costs which ranged from $18.50 to $34.50 per bushel. Price received in 1979 for high-quality half-shell oysters was $33.75 per bushel. A bioeconomic simulator was prepared for lobster mariculture based on culture experiences at the University of California, Davis (researchers P.G. Allen, D.A. Storey, and J.M. Conrad).

Northeast Fisheries Center
Milford, Connecticut Laboratory
National Marine Fisheries Service

Shellfish Culture

The suitability of Japanese style lantern nets for the grow-out of bay scallops to market size has been explored. At densities of up to 750 scallops/m^2, market size was achieved in a single growing season in Long Island Sound. Total adductor muscle yields from nets increased with increasing densities up to 1500/m^2 where yields peaked at 5 kg/net (E. Rhodes). Scallops in a shallow (2-4 m) location and in laboratory raceways grew equally well.

Some progress has been made in growing surf and hard clams in wire mesh cages at densities of 500/m^2, partially buried in the seabed, and in boxes of sand raised off the bottom (R. Goldberg).

Algal Cultures for Shellfish Food

Stock cultures of 100 strains of estuarine unicellular algae are maintained in the laboratory collection and seed cultures made available to researchers and hatcheries on request (R. Ukeles). New species are added to the collection from time to time. Recently, the following algae were evaluated as food for larval, juvenile and adult oysters: Tetraselmis maculata, Dicrateria inornata, Carteria chunii, chlorophyte species NOR-G, and Pavlova gyrans.

The usefulness of two earlier developed reduced-nutrient media relative to a standard media was determined in respect to growth of the several algae, the total protein content per alga cell, and nutritional value to juvenile oysters of algae so cultured.

Shellfish Disease

Considerable effort has been expended in isolating bacteria and practicing disease control in conjunction with commercial hatcheries (W. Blogoslawski). Also, about 3% of a few hundred bacteria isolated from oyster shells on natural beds in Long Island Sound were proved pathogneic to oyster larvae in laboratory tests.

Sea scallop (Placopecten) sera were examined and shown to contain primarily chemical factors which cause agglutination of bacteria. However, a portion (roughly 30%) of the agglutination of a pathogenic Vibrio sp. was caused by an absorbable molecule in the serum. This agglutinin showed some degree of specificity since it did not attach to Bacillus cereus (a terrestrial organism) (R. Robohm).

A minimal synthetic medium was derived which supported growth of a pathogenic Vibrio sp. but not production of its toxin. Presently, attempts are being made to determine the essential nutrients for production of the toxin. Partial purification of a toxin produced by a Pseudomonas sp. has been carried out (C. Brown).

Shellfish Breeding and Genetics

The second generation of American oysters selected for fast and for slow growth in a bi-directional selection experiment (the third hatchery-bred generation) failed to provide sufficient gametes in the spring of '82 to produce a subsequent generation for selection. It is expected though that this will be accomplished this spring. Performance was measured in '82, and these data provide a basis for determining continued favorable response to selection for faster growth, its degree, continuity, and limits (E. Losee, S. Stiles, A. Longwell and S.Dudley).

The effect of high pressure on the segregation and other behavior of the meiotic chromosome groups in spawned and fertilized oysters eggs is being examined with respect to its likely application in obtaining haploid and/or polyploid oysters for various purposes (S. Stiles and J. Choromanski).

Aquaculture

Production Figures

In 1980, U.S. aquaculture production (below) exceeded 200 million pounds. At the farmer level, the crop was worth $168 million. Here is the breakdown by species:

SPECIES	PRODUCTION (millions of pounds) Reported	Estimated	VALUE (millions of dollars)
Catfish	76.7	80-90	53.6
Trout	48.0	55-60	37.5
Crawfish	27.5	30	23.5
Oysters	23.0	23	37.1
Salmon	7.6	10	3.4
Clams	3.9	3.9	10.4
Shrimp	0.3	0.3	1.2
Other	---	0.5-1.5	0.9
TOTALS	187	202.7-218.7	167.6

Notes: Meat weight is given for molluscs, but live weight for other species. Estimated production is to account for production in non-survey states or for species not listed. Values were estimated in some cases.

Source: National Food Review, U.S. Aquaculture as a Food Source: Its Status and Potential. Michael Stellmacher. U.S. Department of Agriculture. Economic Research Service, NFR-17, P-11, Winter 1982.

Statistics continued

In December 1980, the National Marine Fishery Service (NMFS) commissioned a private research and consulting firm to determine the size of the shellfish aquaculture industry in the ten coastal states from Maine to Virginia. The purpose of the survey was to compile aquaculture statistics for calendar year 1979. Here are some of the major findings:

1. Pollution and disease have put some farms out of business.
2. Aquaculture production of shellfish was valued at more than $16 million in 1979.
3. There were 257 shellfish farms in the region (more than expected).
4. From Virginia to New Jersey, most farms cultured the American oyster (Crassostrea virginica) on leased land.
5. From New Jersey to Maine, the industry used a greater number of species and more advanced technology.
6. Yield and value of harvest per acre were substantially higher from New Jersey to Maine.
7. Throughout the ten-state region, archaic and cumbersome state leasing laws make shellfish farming difficult. In Delaware, Maryland, and Virginia, existing statutes and regulations force farmers to circumvent the law to make a profit.
8. Throughout the region there is a detectable undercurrent of animosity between commercial fishermen and shellfish farmers. Organized, numerous and politically aware, fishermen jealously guard their rights to the water column and bottom. They are able to defeat or dilute programs that are favorable to aquaculture.
9. From New Jersey to Virginia, farmers resist new methods and techniques. Reluctance to use hatchery-produced seed and resistance to off-bottom culturing methods typify this attitude.

The same firm was commissioned to compile statistics for 1980. Here are some of the findings from that survey:

1. The industry is fragmented, with less than 260 farms.
2. New Jersey has 61 farms; Virginia 58; and Maryland, 51.
3. The American oyster (Crassostrea virginica) was the predominant species cultured in the ten states.

4. The total value for all species harvested was around $20 million.

5. Over 90% of the acreage used by the shellfish aquaculture industry was on leased land.

6. Lease restrictions in the states of Delaware, Maryland, and Virginia have forced several shellfish aquaculturists out of business.

7. During 1979 and 1980, the industry employed less than 1,300 people. Manpower projections through 1982 indicate a four to seven percent increase for new employees, generally classified as laborers.

Information: Mr. Anthony Bocelle, Technical Advisor and Contract Officer, Region III, NMFS, 14 Elm Street, Gloucester, MA 01939; and Randall Flint, Profiles Research and Consulting Group (PRCG), P.O. Box 2358, Vernon, CT 06066.

Sources: 1. A Survey of Private Commercial Marine Aquaculture in the Northeast. Prepared for the NMFS by PRCG. Arpil 1981. 2. Survey (1980) of Aquaculture: Private Marine Shellfish Industry: Ten State Area. Prepared for the NMFS by PRCG. (no date)

U.S.S.R.

(S.A. Studenetsky)

In 1982 mariculture investigations in the European USSR were conducted in the following fields:

- cultivation of sea and diadromous fishes;
- commercial cultivation of fish in sea water;
- cultivation of invertebrates and algae;

Works aimed at rising reproduction effeciency of White Sea herring with the help of artificial spawning grounds were continued. Though the hatching rate of larvae was high, these works showed that studies should continue in two directions. In the first place, the final installation of spawning grounds should be regulated in such a way that it should prevent herring from laying eggs on the spawning ground (net) several times and in dense clutches which causes abnormal development of eggs in them. In the second place, it should be prevented that other hydrobionts deposit on the layed eggs on the spawning grounds, as far as dense concentrations of hydrobionts may interfere with the development of embryoes.

For the cultivation of mullet in the closed water circulation system optimum temperature and salinity range of embryoes and larvae was found.

The hatching rate of normal embryoes of grey mullet was the highest under the temperature of 22-24°C. This temperature may be considered as the optimum one for the emryo development of this species.

To rise the productivity of fish cultivated in sea cages long-term selection in a number of generations and intraspecific breeding are under way to create new breeds of sturgeons and salmons.

In 1982 special attention was paid to studies of three generations of bester of the second crossing. Selection works were aimed at the reestablishment of genetic balance broken as the result of interaction of parent genoms contrasting by many signs. Significant variations in the viability and occurrences of abnormalities of embryonic mitosises in the progeny of spawners of the second crossing, the existence of normal individuals from the genetic point of view makes selection studies promising.

Granulated food for the young (Baltic salmon, rainbow trout) with different content of animal and vegetable protein was improved in the process of growing salmons.

In the White Sea waters ferment preparations were added to food of the cultivated coho salmon with the increase of growth rate of 8-30%.

Experiments on growing mussels Mytilus were commenced off the south-eastern coast of the Crimea. Mussels reached the market size (5 cm) within 12-13 months; meat content made 17%. Mussels reached maximum length (6-7 cm) after 15-16 months of cultivation.

In the White Sea waters a plantation for the cultivation of Laminaria saccharina within 2 year cycle was developed.

In the Baltic Sea artificial reefs were installed to increase and restore red alga stocks (Furcellaria).

The biotechniques of the cultivation of two microalga species Dunaliella tertiolecta and Chlorella sp.marina used as food in the cultivation of sea fishes and invertebrates (rotifers and artemia) was elaborated. Accumulation and running regimes of the cultivation under artificial light and in the open air in farms were worked out. Algae were cultivated in closed thermostat systems with different types of liquid consumption depending on the object used.

The productivity of algae in the open air made 25-30 g/m^2 per day, specific speed made 0.8-1.2 times per day, effeciency coefficient of sun power utilization - 4-6%.

Experiments on the introduction of Monochrysis lutheri in mass cultivation were carried out. Light-absorbing abilitity of cells, spectral characteristics of the suspension, lag-phase duration for the culture, physic-chemical parameters were determined. The desirable initial density equaled to 500 million cells per ml. In case of accumulation regime and the lightness of 200 w/m^2 the density of the suspension made 8-10 milliard per ml within a week of cultivation.

The study of biological backgrounds for mass cultivation of brackish water rotifers Brachionus plicatilis in farms (in the open air without a thermostat) was continued. The relationship of the population condition and salinity was revealed.