Hilde Jacheve

VENEZIA `81

# Realism in Aquaculture: Achievements, Constraints, Perspectives

## Research Efforts, Developmental Trends and Commercial Realization

# World Conference on Aquaculture and International Aquaculture Trade Show

**The programme will include:**

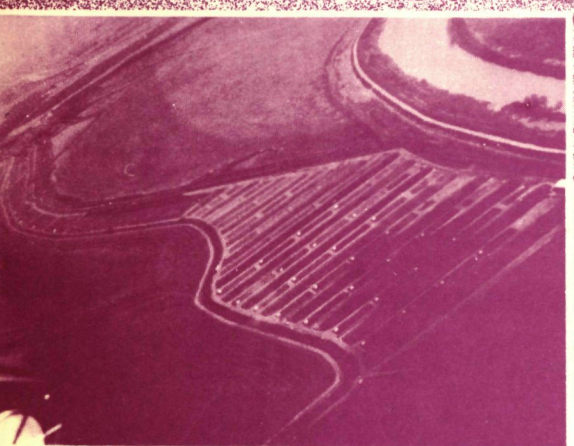
- oral sessions (invited reviews; panel discussions)
- poster sessions (contributed experience papers)
- film session (selected aquaculture films)
- trade show (with special opportunities for publicity and contacts)
- pre- and post-conference tours (United Kingdom, France, Italy)

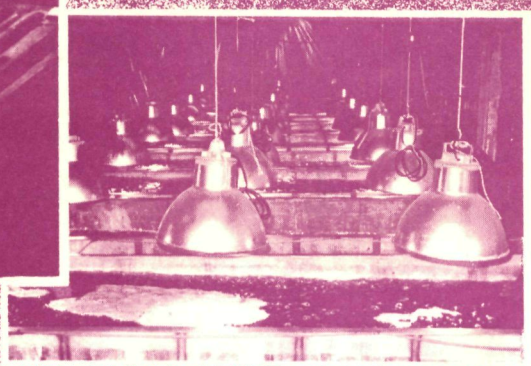
**Topics of the oral sessions:**

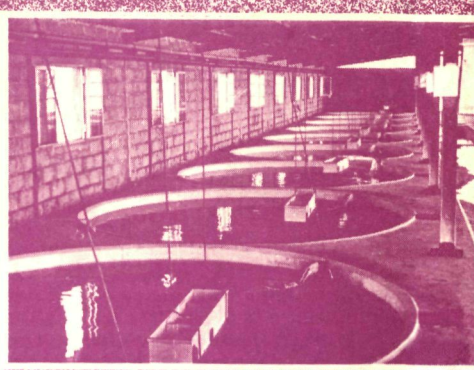
- geographical trends
- biological aspects
- technology
- economic policy
- political implications
- special relationships (ecology and aquaculture, science and industry)

**Organizers:**
European Mariculture Society
World Mariculture Society

Cini Foundation
Venice, Italy
21-25 September 1981







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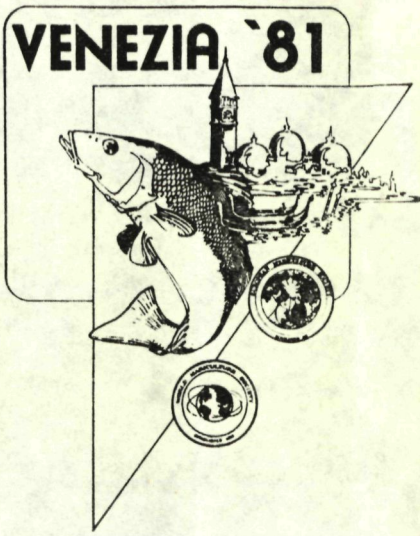


European Mariculture Society  World Mariculture Society

**World Conference on Aquaculture**
**and**
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# CONTRIBUTED PAPERS

# (POSTER SESSION)

**SUMMARIES**

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# FOREWORD

A Poster Session is a form of presentation giving a greater number of contributed papers an equal chance to be considered by the attendance of a conference. It helps to avoid parallel sessions which often compel people interested in two or more different subjects to choose between inconvenient alternatives.

Presenting the results of scientific work or practical experience in form of a poster does not exclude personal discussion between author and conference attendance. On the contrary, it provides excellent opportunities for person - to - person contacts. Explanation and discussion of a poster by the author makes a poster presentation a "session". I invite the participants of the Conference to arrange as many sessions as possible directly with the authors of poster papers.

Martin Bilio
President of the Conference

# S U B J E C T  G U I D E

POSTER 1

## GONAD DEVELOPMENT IN FOOD FISHES IN KUWAIT

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A knowledge of the biology of food fishes, including reproduction is essential for succesful aquaculture. Monthly samples of gonads were collected from *Acanthopagrus latus* ( February 1980 to February 1981 ), *Acanthopagrus cuvieri* and *Pampus argenteus* (September 1979 to September 1980 ), from commercial fish catches taken in Kuwaiti waters. Seasonal and developmental changes of the gonads are classified into eight stages in the female and five stages in the male. Oogenesis and spermatogenesis are each described in five stages of development, from histological sections prepared from gonads. Estimations of potential fecundity in these species were also made.

POSTER 2

## ASPECTS OF FISH PATHOLOGY IN SPAIN, WITH APPLICATION TO OTHER GEOGRAPHIC AREAS

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Diseases are a limiting factor in aquaculture development. Spain has greatly increased its aquaculture production during the last few years. This paper is a comprehensive study of the most important diseases occurring under industrial and laboratory conditions in fresh and saline waters in Spain between 1978 and the first half of 1981.

Parasitic disease (Costiasis and Ichthyopthiriasis), viral diseases (Viral Haemorrhagic Septicemia (VHS), and Infectious Pancreatic Necrosis (IPN)), bacterial diseases (Bacterial Haemorrhagic Septicemia (BHS), gill diseases, bacterial Kidney Diseases (BKD)), metabolic diseases (Liver Fat Degeneration (LFD) and Nephro-calcinosis), and fungal diseases (Saprolegniasis) are described in fresh water fish.

Bacterial diseases (Vibriosis, Flavobacteriosis and gill diseases) and metabolic diseases (systemic granuloma) are described in marine fish.

Preferably the epizootiology and environmental predisposing factors are studied in all these diseases. Spain has an excellent meridional location in Europe and we think that this work may be important for other countries in this region.

POSTER 3

## A PLAN TO MAXIMIZE THE BENEFITS OF SEAWEED FARMING FOR RURAL DEVELOPMENT: A CASE STUDY OF *EUCHEUMA* FARMING IN TAWI-TAWI, PHILIPPINES

E.M. ALIH[1], R.W.A. VOKES[2] & P. EDWARDS[3]

Seaweed farming represents a vital component of integrated rural development strategy to bring about improvement in the quality of life of the rural poor in the coastal settlements of the South China Sea region. Besides offering more work opportunities and making us of the untapped resources available to them, seaweed farming is a highly profitable venture. It serves as a complementary source of income to coastal families without involving disruption of their existing pattern of labor utilization and crop production. In Tawi-Tawi,

Philippines, *Eucheuma*- farming, which serves as a suitable example for seaweed farming development, has contributed to a significant increase in the income and consequently the expenditure of farm households. It has likewise, helped solve unemployment and underemployment which are growing social problems in these coastal areas. The high income from farming has, in a way, kept people from leaving in search of better opportunities elsewhere, particularly Sabah. The profitability of the venture has attracted a number of people from other parts of the country to migrate to Tawi-Tawi. However, not everything is well with the industry. As a result of its unplanned growth, some problems have arisen which threaten its continuous development. Based on the identification and analysis of these bottlenecks, a proposed development plan to stabilize the industry in order that the coastal people can reap the maximum benefits from it on a long-term view is presented.

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POSTER 4

## SEX RATIO AND RATIO OF YELLOW TO SILVER EELS IN FISH REARED UNDER CONTROLLED CONDITIONS

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Glass eels were reared in tanks under controlled conditions for a period of 24 month to market size. About 6000 fish survived until the end of the experiment. Feed consisted of a mixture of treshfish, fishmeal and fishoil, which was offered as a past.

Final sizes and weights obtained were:0.1 % (n=7) of the population reached an average weight of 570.6 g, 22 % (n= 1,300) attained between 90 g and 244 g, 29 % (n=1,720) ranged between 20 g and 90 g, and 49 % between 1 and 20 g.

A random sample, including 24 % of the weight group between 90 and 244 g,was used for sex determination. 92.8 % of this sample were males, 5.8 % females, and 1.4 % unidentified (possibly bisexual). Males averaged 127.6 g in weight (total length: x=40.6 cm), while females attained 160.2 g ( x = 46.4 cm). 70.2 % of this fish were silver eels, only 29.8 % were determined as yellow eels. The shape of the head was visually classified: 78.4 % showed a narrow headform while the rest of 21.6 % exhibited a wide head form.

The fat content was determined in fish of all size groups and showed average values of 29.5 % in fish over 100 g weight (range 113 to 199 g), 28.5 % in fish between 75 and 95 g, and 15.5 % in fish of 17 to 23 g body wet weight.
Mortality reached about 19 % and was mainly due to technical failures.

The quality of th fish for marketing is discussed briefly.

POSTER 5

## PILOT SCALE PRODUCTION OF RAINBOW TROUT IN KIEL FJORD : PRODUCTION OF RAINBOW TROUT IN SILOS - A PILOT SCALE EXPERIMENT

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A commercial trout production plant (system Linde-Moeller; investment about 800,000 DM) with an annual production of 48 tons of rainbow trout is being tested in Kiel Fjord. The system was selected by the owner because it requires only small space.

Fish are grown in eight silos of 20 $m^3$, each supplied with oxygen enriched brackish thermal effluents of a conventional power plant. Growth of rainbow trout in this arrangement seems to be satisfactory (e.g. 1.5-2.0 % of body weight per day in fish of 90 - 120 g ).

In the beginning phase from stocking the fish into silos until the end of the first month, mortality caused by vibriosis war extremely high, up to 30 %. Later, mortality decreased to 2 %.

It is suggested that fish brought inti this complicated culture unit are subject to a considerable amount of stress causing higher susceptibility for diseases. Resulting from the high mortality, the production plant has to cope with losses of 3,000 DM per month.

POSTER 6

## INCREASING PRODUCTIVITY OF HYBRID CARPS BY GYNOGENESIS AND SEX REVERSION

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Hybrids of species of high productivity are one of the most important preconditions for intensive fish culture. In carp culture the viability, fast growth food conversion and quality of meat are the characters which have been used in genetic selection and hybridization programmes. To get sufficient information in our work with the carp landraces of different genotypes, the following genetic methods were applied: kariological and isoenzyme analysis, gynogenesis and sex reversion.

The hybridization of the carp landraces resulted in heterosis in the $F_1$ generation in some of the most important characters. These hybrids show 20 % higher productivity as compared with the parental lines. The degree of heterosis can be significantly enhanced by applying inbred parental lines. Artificial gynogenesis proved to be a rapid and efficient method in producing inbred lines of "long-generation-period" carp. The artificially stripped eggs are fertilized by sperm inactivated with 100 krad of $CO_{60}$ ray. Four minutes after fertilization the eggs were cold-treated at $4^{o}C$ for 1 hour. After this the eggs were re-warmed to $22^{o}C$ and then the well-known Woynarovich method was applied. Female embryos hatch from the diploid zygote formed by the fusion of the maternal haploid chromosome set and the second polar body in the eggs. One generation of gynogenesis corresponds to that of inbreeding effect of ten to twelve generations of sister-brother pairing. The production of the inbred males was performed by the sex reversion of gynogenetic females selected from the paternal lines. By the 30th day of their life we start to feed a diet containing methyltestosteron applied for 40 days.This diet resulted in phenotypic males from a genotypic female population which can be used for hybridization. The productivity of these hybrids was 30 to 40 % higher than that of the original carp landraces.

POSTER 7

## INTENSIVE TANK CULTURE OF TILAPIA IN KENYA

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Tilapia culture in recent years have risen from insignificance to being considered alongside carp and trout as one of the most important cultured fish species. Considerable breakthroughs in culture techniques have been achieved.

This paper describes the pioneer work carried out on intensive tank culture in Kenya. The Bamburi Portland Cement Company, Mombasa, Kenya first utilized tilapia culture as a method to exploit permanent pools in abandoned limestone quarries. Early trials were discouraging. Prolific precocious breeding led to over-crowding and stunted populations. Undaunted by low yields (1.5 t/ha/y), studies continued to utilize alternative techniques such as concrete tank culture units. Water was plentiful, supplied from an underground brackish water lake, and cement was readily available. The following years saw a progression from square, oblong to circular tanks varying in design to suit the biology of the species. Such techniques as sex reversal, through methyltestosterone treatment, all-male hybrid crosses and hand sexing were tested. Reproduction was effectively curbed within the system. Continual improvements to the system lead to an increase in productivity from 50 kg/$m^3$ to over 125 kg/$m^3$ and a previously research orientated unit expanded into a potential 50 t pilot-scale commercial operation.

Self sufficiency in seed production is achieved using breeding arenas supplemented by fry from pond culture, if necessary. Fingerlings are on-grown through two series of raceways before being graded-out at 25-50 g for stocking into production tanks. Near constant water temperature (26 $\pm$ 3$^{o}$C) ensures rapid growth, and fish achieve a marketable size of 250 g, 9 month after hatching. Flow rates maintained at 0.5 to 1.0 l/kg/min supply the necessary oxygen required and maintains a good cleaning efficiency. A pelleted diet, locally formulated, is fed at 1.0-1.5 %/d body weight for fish of 5 to 250 g. It varies in protein content from 25 % to 40 %, the smaller fish receiving the diet with a higher protein level. Feeding six times per day in amounts proportional to the diurnal feeding cycle of fish resulted in a feed conversion efficiency of between 1.5- 2.0:1.

The production units are described, with illustrations of the development of the various husbandry techniques.

POSTER 8

## REPRODUCTIVE CYCLE OF SIX SPECIES OF BIVALVE MOLLUSCS WITH AQUACULTURE POTENTIALITY FROM THE PANAMIC PROVINCE

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Over exploitation of clam stocks has led to a decline in production of this high priced species; therefore it became necessary to establish aquaculture to satisfy the demand.

A source of spat for culture, and the provision of sexually mature adults to induce spawning in the laboratory, require knowledge of the reproductive cycle. At the Fisheries Research Center, La Paz (Mexican Fisheries Department), the ecology and biology of the main commercial species occuring along the coast of the Gulf of California have been studied, all of them from the Panamic Province.

The six species studied show a similar reproductive trend. They do spawn throughout the year, with three or even sometimes more more major spawning peaks,

reaching up to 40 % of the total spawning activity. This phenomenon can be the result of either a constant gametogenic activity or a fast gonad recovery. A high percentage of ripe individuals are found throughout the year. This high reproductive capacity together with the favourable environmental conditions at the Mexican pacific coast that allow constant growth through the year, make these species acceptable for aquaculture.

POSTER 9

## COMPARISON OF GROWTH OF SOLE ( *SOLEA SOLEA* ) IN INTENSIVE REARING WITH MOIST FOOD VERSUS IN EXTENSIVE REARING IN COASTAL POND

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The growth of soles released in a coastal pond at 30 days of age was studied since 1976 and growth curves were obtained. At 1 year of age soles reach 75 g in average.

An experiment was carried out on 90-day-old fish in order to compare soles fed either ground mollusc ( *Cardium* spec.) or two experimental diets made with a mixture of experimental mash and natural foods: "heads" of Norway lobster (*Nephrops norvegicus*) or ground mollusc. Rearing conditions, especially temperatures, were comparable in each lot. The fastest growing fish (5 % of the animals in each trial) reached the following wet weights after 12 month of rearing: pure mollusc diet = 19.4 g ; mash + mollusc diet = 43.5 g; mash + *Nephrops* diet = 8.0 g. In each group the of body weights observed varied considerably (for example 3 to 80 g individual weight in the mash + mollusc trial). In the group fed with a mixed diet of mash and *Nephrops* initial growth was very fast but the final results were poor. Mortality after a few weeks of adaptation to culture conditions became negligible even during winter when water temperatures reached 5°C. The costs of food could be reduced with lower amounts of ground mollusc. With this method an average body weight of about 250 g (i.e. commercial size) could be expected after 30 month of rearing instead of 20 month in extensive culture.

POSTER 10

## PRODUCTION PILOTE D'ALEVINS DE DAURADE, *SPARUS AURATA*

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La disponibilité en alevins de Daurade dorée, *Sparus aurata*, a jusqu'à présent freiné le développement de cette espèce. Sa rapidité de croissance et son marché potentiel important lui assurent cependant une place considérable en Méditerranée. La production de masse par un contrôle de la maturation et de l'obtention des pontes, et par un taux de suvie fiable.

L'obtention des pontes est possible toute l'année, en émissions spontanées ou induites. Dans ce dernier cas, l'injection de 300 UI de HCG/kg de reproducteur suffit à induire la ponte. La maturation est obtenue sous différentes conditions de température et de lumière qui autorisent le décalage de la "saison" de ponte, permettant l'étalement dans le temps des élevages et l'obtention d'animaux prégrossis tôt en saison. Chaque femelle émet environ 500.000 oeufs viables au kilo et ce sur une période qui s'étale actuelldment du 10 Octobre au 15 Juin, soit six mois de plus que la saison naturelle.

Le développement embryonnaire sera présenté: il s'effectue correctement dans une gamme de température de 16° C à 20° C, avec un taux d'éclosion de 80 %. Celle-ci intervient 52 heures après fécondation à 18° C.

L'élevage larvaire est initié à des charges de 50 à 60 larves fraîchement écloses par litre. Il est conduit en cuves de 10 $m^3$, en eau stagnante et faiblement brassée jusqu'au 50ème jour; puis avec un renouvellement de 10 %/ heure maximum. L'apport de levure de boulangerie fraîche à partir du 10ème jour, directement dans le milieu d'élevage et jusqu'au 50ème jour vient en complément de la séquence suivante: Rotifère du jour 5 au jour 30, nauplii d'Artemia salina du jour 20 au jour 40, metanauplii d'Artemia complémentés en huile de foie de morue du jour 30 au jour 50. Au jour 50, les larves sont svrées au poisson broyé, puis au granulé sec. Le taux de survie obtenu en routine à 70 jours,soit après sevrage, est de 1 %.

POSTER 11

## AUALYTICAL TECHNIQUE FOR THE EVALUATION OF TROPHIC SIGNIFICANCE OF NATURAL DETRITUS AS FOOD FOR MULLET

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Characterization of natural organic detritus by measuring carbon and nitrogen, organic and inorganic and use of this technique to obtain information on seasonal evolution of natural detritus in a "valle da pesca" (val di Ca'Pisani, Rovigo,Italy) in which mullet is cultured both extensively and intensively was accomplished: (a) large and shallow water bodies relatively unmanaged, in which mullet es extensively cultured showed a high organic carbon level and a relatively low C/N- ratio. (b) Culture ponds in which mullet is intensively cultured without artificial food supply, exhibit lower organic carbon levels but higher C/N-ratios.

POSTER 12

## HORSE-SHOE CRABS AS AN ATTRACTANT FOR EELS

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During preliminary studies on short-range movements of American yellow eels ( *Anguilla rostrata* ), it was noted that, when possible, local fishermen bait their traps with horse-shoe crabs (*Limulus polyphemus* L.). In experimental traps in fresh water, replacement of alewives by horse-shoe crabs also lead to an important increase in catch. Therefore, the attracting power of these crabs was investigated. The experiment showed that (1) eels do eat horse-shoe crabs, (2) male and female horse-shoe crabs exert the same attraction, with no preference for different parts of the body, (3) catches are higher in traps baited with horse-shoe crabs, (4) horse-shoe crabs had nor effective attracting power on eels in salt-water aquaria, and (5) horse-shoe crabs are inexpensive and easy to catch off the east-American coast. Carcasses of horse-shoe crabs can be obtained from pharmaceutical industries, which use large quantities of *Limulus* for their blood.

Studies are being carried out to identify and , if possible, to synthetize the specific attractant of horse-shoe crab. It is thought that horse-shoe crabs can be used an an attractant in the production of eel feeds and/or as an aggregation element in extensive breeding, especially in Italian "Valle"- culture.

Finally, we would like to introduce a new method for the individual marking of eels by using cold branders with mobile characters. This method has been rejected by many authors. However, we found it easy to apply, easy to read, long-lasting, (over 8 month), and without any complications through infections.

POSTER 13

## NOCTURNAL ACTIVITY OF BIRDS ON SHRIMP MARICULTURE PONDS

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Birds can reduce production of shrimp in mariculture grow-out ponds through predation and competition for feed. This problem has been documented but the rates of predation and competition have not been quantified.

This preliminary study involved weekly nocturnal enumeration of bird populations and observation of nocturnal habits on a series of 18 0.1 ha experimental ponds at the Texas A&M Shrimp Mariculture Facility at Corpus Christi, Texas. Observations were conducted from dusk to dawn during July through October, 1980, using binoculars and US Army Night Vision Goggles model AN/PUS-5A. The observations were conducted every hour for 10-15 minutes. The rate of predation was evaluated every three hours by observation of the number of feeding attempts versus the percent capture over a 10 minute period.

Competition for feed was attributed primarily to gulls (F. Laridae). Active feeding by gulls was restricted to daylight hours, consequently feed loss decreased dramatically when the feed was distributed at dusk or later. The predation of shrimp by birds can be a major problem depending on the facility's proximity to shore and the major flyways. The major predatory species included the herons and egrets (F. Areidae), migratory ducks (F. Anatidae), and to a lesser extent grebes (F. Podicipedidae) and shorebirds (O. Charadiformes).

This study indicates the effect of bird predation and competition can be drastic, with up to 75 % mortality in a pond. Water depth in excess of one meter or a decrease in water clarity does decrease the predation affect of the herons and egrets. Migratory ducks, however, will affect predation to a greater or lesser extent depending on the severity and length of the winters.

No control of the bird population was attempted during this study, thus further studies to quantify the effect on the shrimp population in ponds and methods to control bird predation are warranted.

POSTER 14

## BACTERIAL DEPURATION OF THE MEXICAN SCALLOP, *ARGOPECTEN CIRCULARIS*

W. J. BLOGOSLAWSKI & P. O. MONASTERIO

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Cultivos Marinos de Baja California is a 2-year-old Mexican company which plans to sell artificially cleansed adult scallops, *Argopecten circularis*, to Mexicans and Europeans for human consumption. Wild scallops were collected on palm wood in burlap bags, separated, and placed in grow-out areas near shore or 1 km from shore. The high summer water temperatures (27°C average) and naturally occurring algal food ensure rapid growth to adult size in six months.

The Bay of La Paz is grossly polluted by the secondary treated sewage of 100,000 people. Scallops grow rapidly in this nutrient-rich seawater, and will be marketed raw and eaten whole. It is essential, therefore, that the guts and viscera be free of pathogenic microorganisms. The primary reason for this study was to modify known oyster depuration/cleansing techniques for rapid and complete elimination of bacteria pathogenic to humans in these cultivated scallops.

Seven series of experiments, comparing the effectiveness of ozone vs chlorine depuration in adult *A. circularis*, were performed at the shellfish facilities in La Paz. For each test, thirty adult scallops (6-8 cm) were placed in two 1200-liter fiberglass contacting tanks, which contained either ozonized or chlorine-treated seawater. Ozone was supplied from an 8 gm/hr generator and chlorine was added as commercial grade (5.25 %) sodium hypochlorite. Untreated scallops acting as controls were left in the Bay. Doses of both oxidants were varied from 0.5 t 3.0 ppm in 0.5 ppm increments and scallops were placed in those tanks from 1-3 hours. Totalresidual oxidants were monitored amperometrically. After that time all treated and control scallops were iced and taken by car to the Mexican Federal Marine Fishery Laboratory where total and fecal coliform counts, total plate counts, and taste tests were completed. It was quite difficult to maintain oxidant residuals due to the extreme temperature (+42°C), but experiments did show that both oxidants, chlorine and ozone reduced total plate count 90-94 % and chlorine treatment depurated scallops of coliform in the experimental treatment time

I believe this is the farst experiment to demonstrate effective depuration of thr scallop, *Argopecten circularis*.

POSTER 15

## THE EFFECTS OF MALACHITE GREEN ON CULTURED JUVENILE LOBSTERS

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Survival of the early stages (egg, larva and juvenile) of the American lobster *Homarus americanus* reared under culture conditions, has often been threatened by a variety of fungi and microbial epibionts. While in the past, malachite green has been employed with considerable success to disinfect the egg and larval stages, little attention has been devoted to determining the effectiveness of this agent in treating diseased juvenile lobsters.

A study was conducted with the purpose of defining toxicity levels and optimizing treatment procedures with malachite green. 5th stage lobsters were treated with the biocide each of the following states A-B, $C_4$, $D_0$ and $D_2$-$D_3$. Lobsters in each of these categories were subdivided into samples groups and these were treated for 2-10 minutes with varying concentrations (500 - 1300 ppm) of malachite green. The effects were determined by survival time and normal molting to the sixth stage.

Irrespective of exposure time and concentration, 100 % of the lobsters died in state A-B shortly after treatment. In contrast, 90-100 % of lobsters in state $C_4$ survived and molted normally when immersed in malachite green concentrations of 900-1000 ppm for periods of up to 10 minutes. The effects, however, on lobsters in states $D_0$ and $D_2$-$D_3$ were in general much less uniform. The upper tolerance limits (80 % normal molting to 6th stage) ranged between 500-600 ppm when lobsters were exposed to malachite green for up to 6 minutes. A noticeable drop in survival rate (40-60 %) occurred at concentrations exceeding 700 ppm. This became more pronounced for lobsters in intermolt state $D_0$.

The present work clearly suggests that juvenile lobsters can tolerate malachite green much better than do lobster larvae, l ut that toxicity levels varies according to intermolt state. Lobsters in intermolt state $C_4$ appear to be least

affected and most resistant to potential noxious effects of this agent. One can conclude, that perhaps because of the considerably higher tolerance limits of juvenile lobsters ao compared to other early stages a much broader variety of epibiotic microtial forms could be eliminated without actually inducing damage to the host.

POSTER 16

## INTERACTION OF TEMPERATURE AND FOOD RATIONS ON GROWTH OF SEA BASS (*Dicentrarchus labrax L.*)

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The growth of young sea bass (14 months old at the begining of the experiment) has been studied at temperatures ranging from 13°C to 25°C in relation to rations of 0.5; 1.5; 3.0 and 5.0% wet body weight per day (%W/day), and at a maximum or "excess" ration with a commercial pelleted feed.

It was found that the optimum ration increases linearly with temperature, affecting the optimum specific growth rate which increases exponentially in proportion with Van't Hoff-Arrhenius rule (1.8%W/day at 13°C and about 4.8%W/day at 25°C). The logarithm of the maintenance ration increases linearly with temperature (0.7%W/day at 13°C and about 1.8%W/day at 25°C). Specific growth rate increases approximately in the form of a hyperbolic curve with increasing ration at constant temperature, and changes to a convex parabola with increasing temperature at constant ration. The peak of the parabola represents the optimum point of the specific growth rate and temperature at a particular ration. A certain deviation can be observed at the maximum ration. In general, the optimum temperature is around 22°C and the optimum ration is slightly above 4%W/day.

POSTER 17

## BATCH PRODUCTION OF ADULT ARTEMIA IN $2m^3$ AND $5m^3$ AIR-WATER-LIFT OPERATED RACEWAYS

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Production figures have been increased from 2kg wet dry Artemia/$m^3$ (Bossuyt and Sorgeloos, 1980) to 5kg and more of pre-adult Artemia after 2 weeks culturing at 25°C and 35ppt salinity using micronized ricebran as food.

Although the culture technique is still essentially the same as described earlier, the following minor changes greatly improved the production output:
a) increased naupliar density at start of the culture
b) improved primary treatment with plate separator
c) improved feeding strategies.

POSTER 18

## THE CONTROLLED REPRODUCTION OF THE CARPET-SHELL CLAM (*Venerupis decussata L.*); PRELIMINARY RESULTS

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*Venerupis decussata*, the carpet-shell clam, is of high commercial value and amenable to culture. In order to guarantee a supply of seed clams, research into hatchery methods is required.

Controlled reproductive experiments followed established methods, using temperature to induce maturation of gametes. A study on the local wild population revealed 20°C as suitable for conditioning and 28°C for spawning. The groups of clams undergoing conditioning were comprised of 25 animals and were held in a flow-through system (flow rate 300ml/min) and fed a mixture of microalgae and clam (500ml/d).

Following this procedure the carpet-shell clam was spawned outside of the natural season. The minimum length of the conditioning period was 9 weeks. Out of 10 groups of clams, two produced 2.500.000 and 400.000 larvae respectively. In three only males spawned, and in five no spawning was observed. Excellent survival and growth of larvae were observed at 29°C. The spat were successfully grown to 5mm mean size in a 6m$^3$ tank of stagnant water to wich fertilizer was added to support algal growth. An overall survival of 1.25% was achieved.

Under the stimulus of raised temperature, maturation in *Venerupis decussata* was easily obtained but actual spawning proved to be a difficult step. In the eight groups where spawning was not forthcoming or incomplete, four proved to be in bad condition due to parasitism. It is suggested that some factor other than temperature plays a role in the last stage of gamete maturation.

POSTER 19

## BENEFICIAL USES OF WASTE HEAT: THE Ca,R,P,A, PROJECT

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The utilization of waste heat in agriculture and aquaculture has been studied all over the world in past years. The results obtained will provide the technical and economical informations required for industrial development. In Italy the investigations conducted by ENEL (Italian Electricity Board) were mainly devoted to application of waste heat in aquaculture.

Since 1975 we studied the growth rate of carps and black bull heads reared in floating cages located in the discharge canal of thermoelectric power plant. Carps (*Cyprinus carpio*) reached an average weight of 1.100g in 413 days (density 176kg/m$^3$), Black Bullhead (*Ictalurus melas*) averaged of 150g after 315 days (density 70kg/m$^3$).

Based on these results a large research project is in progress named Ca.R.P.A. (Residual heat for production of aliments) which covers the areas of major interest:
a) the biological exploitation of marine waters; b) the utilization of warm water to control and maintain a fresh water fish farm system within optimum thermal limits and c) the improvement of a agricultural crops.

The project includes the construction of 4 experimental plants both for aquaculture and agriculture and will be implemented in cooperation with

external research laboratories. At present, studies about marine crustacean and fish production are in preparation. Preliminary data related to toxicological aspects are reported.

POSTER 20

## OXYGEN METATOLISM OF FARMED TURBOT (*Scophthalmus maximus L.*): THE INFLUENCE OF FEEDING UPON METATOLIC RATE

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Continuous monitoring of dissolved oxygen in a production tank with turbot over 24 hours, demonstrated considerable fluctuations. Examination of the trace from a chart recorder showed that these fluctuations were of two main types. The first type was a short-term rapid decline initiated by feeding activity; during these periods, oxygen consumption was approximately twice that of resting fish. The second type was a general decline and then incline in dissolved oxygen level over a 24 hours period; this was due to the accumulated affect of the food consumed and the peak rate was approximately 1 1/2times the resting rate. From knowledge of the efficiency of the oxygenation, dissolved oxygen levels, ration size and gross energy, the apparent specific dynamic action of the diet was calculated. The results were compared to laboratory experiments with plaice by other authors.

POSTER 21

## POLYCULTURE OF THE FRESHWATER PRAWN (*Macrobrachium rosenbergii*) WITH TWO COMBINATIONS OF CARPS IN UNFED, MANURED PONDS

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The freshwater prawn (*Macrobrachium rosenbergii*) is normally cultured in tropical ponds, most commonly in monocultures fed high protein, formulated rations. There is little knowledge concerning its culture in such temperate zones as the mid-western USA (Illinois), or its potential for production when in polyculture with carps in static ponds receiving no input but manure.

A study was conducted at Kinmundy, IL, to evaluate (1) the compatibility of prawns with carps, with special attention to their interrelationships with the common carp (*Cyprinus carpio*); and (2) to measure the ability of prawns to utilize the foods available in manured systems. It was theorized that the swine and fish manure, with their associated biota, might provide an adequate and economical food base for prawns. Carps used were the silver (*Hypopthalmichthys molatrix*), bighead (*Aristichthys nobilis*), grass (*Ctenopharyngodon idella*) and common carps.

Four small ponds (0.9 to 0.17ha) were operated at average depths of about 0.8m. Two ponds were stocked with four species of carp (60% silver, 28% common, 10% bighead, and 2% grass carp); in two other ponds common carp were omitted. Total fish densities were 8600ha$^{-1}$ when four carps were stocked, about 6200ha$^{-1}$ when common carp were omitted. Post larval prawns (0.116g) were stocked at densities of 17m$^{-2}$. Swine were housed on the pond dikes so that fresh manure

continuously entered each pond. Swine densities were approximately 60 $ha^{-1}$ of pond area. Two lots of swine were fattened during the experimental period. Loadings of swine manure were calculated.

Growth periods were 162 days for fish, 107 and 121 days for separate stocking of prawns. Gains in biomass by prawns averaged 714 kg/ha in ponds without common carp, 364 kg/ha in ponds containing common carp. Gains in biomass for both fish and prawns were 3619 kg/ha (19.8 kg/ha/d) in ponds with common carp, 2924 kg/ha (18.0 kg/ha/d) in those without common carp. Prawn survival averaged highest (84.5 vs. 72.5 %), but final average weight of prawns was lowest (2.64 g vs 5.86 g) in the presence of common carp. Competition for food was severe between common carp and prawn, but the common carp exerted less influence on survival of small prawns than larger, faster growing prawns.

POSTER 22

## MASSIVE AVAILABILITY OF POSTLARVAL SHRIMP (*PENAEUS VANNAMEI*) FOR AQUACULTURE AT BALUARTE RIVER, MEXICO

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Mexico has a tradition as a shrimp producer, and more than 50,000 hectares are available for the development of shrimp aquaculture. The main factor limiting the progress of both experimental and commercial culture on the coast of Sinaloa, where the Baluarte River is located, is the lack of adequate knowledge on the availability of postlarval *P. vannamei* (P.v.) for aquaculture.

In this paper the total amount of postlarval shrimp present in the one meter superficial layer is estimated during 48 periods of flood tides, distributed in a one year cycle. Three outstanding values were found during October, being 5, 10 and 41 million postlarvae per tidal inflow, and two more in November being 7 and 11 million. In contrast, the absence of postlarvae was recorded in 14 flood tides during the months of April and May. Taking into consideration the average monthly amounts of postlarval shrimp, the highest value was recorded in October, being 12 million, and the lowest, a total absence, in April. The average values follow an ascendent tendency from spring, 462,000, to autumm with 9.6 million. Comparing the averages of the rainy season with those of the dry season, a value of 5 million was found for the first, while only 1.8 million for the second. The highest concentrations were found in the middle third of the inflow period and the lowest concentrations in the last third.

The concentrations an positions of postlarvae during each tidal inflow, were mapped using a computer program designed specificaly for this purpose, and the best place for the maximum possible capture is proposed. The whole set of flood tides is explored and analysed to suggest hypotesis of its general behavior.

The method used to reach these estimations utilizes plankton samples, and the construction of matrices to estimate the density of postlarval shrimp, the volume of water, and the amount of postlarvae. Matrices are done with intervals of 15 meters across the river mouth, and every 30 minutes of the inflow. Current speed and type of water masses are taken into account.

POSTER 23

## ITALIAN FISHFARMERS ASSOCIATION

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The Italian Fishfarmers' Association (API) intend to present information concerning the publicity campaigns which have been carried out by API in 1977, 1978 and 1979/80, to promote the consumption of trout in Italy. Facing an ever increasing production of trout alongside a stagnation in exports, it has been necessary to take action by means of advertising in order to encourage the Italian consumer to buy trout more often.

The three publicity campaigns were entirely financed by the Italian trout producers by vouluntary contribution. The budget used was of 135,000 U.S. S in 1977, 129,000 U.S. S in 1978 and 222,000 U.S. S in 1979/80.The campaigns were effected by all mass media alternatively, with particular attention being given to women's and family magazines. Emphasis was always given to the idea of the "purity" of trout, originating from uncontaminated water, not to mention the marked price competitiveness when compared to other fish of the same category.

The results have been considerable: home consumption has risen from 14,000 t per annum in 1977 to 17,000 t in 1980 while the selling price "ex farm" has remained steady.Production trends (20,500 t in 1980 - the highest in Europe) and the export trends of the last 10 years are documented. Finally, we report on variations of the trade symbols and slogans used in the campaign. A summary of the trade policy which has inspired our promotional strategy is provided.

POSTER 24

## REPRODUCTIVE CYCLE OF SIX SPECIES OF BIVALVE MOLLUSCS WITH AQUACULTURE POTENTIALITY FROM THE PANAMIC PROVINCE

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Over exploitation of clam stocks has led to a decline in production of high price species, therefore it becomes necessary to establish cultures to satisfy the demand. Juveniles as a source of spat for the establishment of cultures, and the provision of sexualy mature adults to induce spawning in the laboratory, require knowledge of the reproductive cycle.

At the Fisheries Research Center, La Paz, Mexican Fisheries Department, the ecology and biology of the main commercial species has been studied, on the Gulf of California, all of them from the Panamic Province.

The six species studied in this paper have a similar reproductive trend. They present spawning through the year, with three or more peaks of more than 40 %. This is the result of either a constant gametogenic activity or a fast gonad recovery. A high percentage of ripe organisms or in gametogenesis were found throughout the year. This high reproductive capacity together with the water stable conditions from the mexican pacific coast that allow a constant growth through the year, make these species favorable for aquaculture.

POSTER 25

## PARASITES AND PARASITOSIS IN FISH CULTURE IN PORTUGAL

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In Portugal, aquaculture is in an incipient state, though in the last years we are witnessing a boom of interes both at official and private levels.

This paper deals with research work covering the period from 1979 up to now and present results of diagnosing parasites in a total of 195 complete dissections of six species both free living and from fish farms: - European eel, *Anguilla anguilla* (49); - mirror carp, *Cyprinus carpio* var. *spicularis* (29); - common grey mullet, *Mugil cephalus* (18); - European plaice, *Pleuronectes platessa* (11); - rainbow trout, *Salmo gairdneri* (42); - common sole, *Solea solea* (46).

A list of protozoans and helminths identified with respective percdntages is given:

(I)Free living fish:

a)European eel (17): *Echinorhynchus clavula* (6.3 %) and *Rhabdochona anguilla* (1.3 %)

b)common grey mullet (18): *Laploporus benedenii* (0.7 %), *Neoechinorhynchus sp.*(16 %) and *Raphidascaris* sp. (4 %)

c)European plaice(11): *Botriocephalus* sp.(larvae)(1.8 %), *Contracaecum aduncum*(0.3%) and *Cryptocotyle lingua* (0.5 %)

d)common sole (46): *Cucullanelus minutus* ( 2.5 %),*Gyrodactylus elegans* (0.3 %), and cestode larvae (3.6 %).

(II) Farmed fish:

a)European eel (32): *Trichodina anguillae* (0.16 %), and *Ichthyophtirius multifiliis* (1.1 %)

b)Rainbow trout (42): *Eimeria truttae* (0.02 %), *Hexamita intestinales* (0.3 %),*Holophrya simplex* (0.02 %), and *Trichodina truttae* (0.05 %).

The results show that wild fish serve as intermediate hosts to helminths, in contrast with fish from farms, which are predominantly affected with protozoans, due mainly to overcrowding and deficient management. It was in these specimens that we found lesions characteristic of protozoans. Though we looked carefully for the *Myxosoma cerebralis*, it was not found in any of the specimens examined.The absence of this parasite in Portugal makes trout culture attractive.

POSTER 26

## INDUCED SPAWNING AND FINGERLING PRODUCTION OF *COLOSSOMA MITREI* (+)

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Experiments on induced spawning of *Colossoma* were conducted at the Laboratory of Fish Culture Section of the Faculdade die Cîencias Agrárias e Veterinárias in 1981. Eight females and seven males of *C. mitrei* were injected with several gonadotropic hormones such as HCG, Tamoxifen (an isomere of clomiphene citrate), carp pituitary crude extract, salmon pituitary crude extract, and SG-G100, salmon pituitary half purified extract through Sephadex G 100. Fish received only two injections. Females injected with salmon pituitarß extracts spawned 8 aud 12 hours after the second injection.

Only eggs of the females treated with SG- G100 were fertilized at a rate of 96.5 %. Eggs were extruded through gentle hand pressure and fertilization was obtained in dry condition in a 2 liter beaker. About 100,000 eggs were obtained

resulting into 70 % hatch about 23 hrs after fertilization. Soon after hatching fry were transfered to small hapas ( 1.0 x 1.2 x 0.4 m) of fine sieve nylon cloth (0.3 mm mesh size), set up in previously fertilized outdoor ponds. Such a device avoided predatory action of bigger cladocera and adults or insect fry and enhanced survival of fry to 80 - 90 % at the 15-20th day of live. Seventy five days after hatching approximately 10,000 fingerlings were caught from four earthern ponds weighing between 2 and 50 g.

(+)With financial support of CNPq (National Research Council)

POSTER 27

## THE EFFECTS OF EDTA (ETHYLENEDINITRO TETRAACETIC ACID) ON THE SURVIVAL AND DEVELOPMENT OF SHRIMP NAUPLII (*PENAEUS STYLIROSTRIS* SIMPSON) AND THE INTERACTIONS OF EDTA WITH THE TOXICITIES OF CADMIUM, CALCIUM, AND PHENOL

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EDTA is used in the intensive culture of penaeid shrimp larvae to increase hatching rates and survival of larvae. To examine the hypothesis that the mode of action of EDTA is to decrease the toxicities of heavy metals by chelation, this study compares the toxicities of cadmium, which is a highly toxic divalent ion, to the toxicities of calcium, which is a normal constituent of seawater, and phenol in both the presence and absence of EDTA. In addition, the toxicity of EDTA at higher concentrations is examined.

The toxicities of EDTA, cadmium, calcium, and phenol are evaluated in terms of the percentage of nauplii surviving after 12 and 24 hours of exposure and in terms of the percentage of nauplii which metamorphose to protozoea. The toxicities of cadmium, calcium, and phenol are also determined in the presence of 10 mg/l (27 $\mu$M) EDTA.

EDTA concentrations above 500 mg/l (1.34 mM) are lethal to nauplii. At 250 mg/l (0.67 mM), EDTA reduces the percentage of nauplii which metamorphose to protozoea but below 125 mg/l (0.34mM) neither survival of nauplii nor metamorphosis to protozoea are affected.

Cadmium, phenol, and calcium are lethal to nauplii after 24 hours of exposure at concentrations of 20 $\mu$M, 7mM, and 400mM respectively. Metamorphosis to protozoea is blocked by concentrations of 1 $\mu$M, 0.9 mM, and 200 mM, respectively. However in the presence of 10 mg/l EDTA, the toxicities of cadmium and calcium are reduced. Cadmium concentrations of 20 $\mu$M do not effect either the survival of nauplii or metamorphosis to protozoea in the presence of EDTA. In calcium concentrations of 50 and 100 mM, the percentage of nauplii that metamorphose to protozoea is increased by the addition of EDTA. The interaction of EDTA and phenol toxicity is not significant.

This study demonstrates that cadmium, EDTA, and phenol are toxic to larval shrimp at low concentrations. On the basis of molarity, cadmium is much more toxic than EDTA, and EDTA is more toxic than phenol. Calcium is toxic at high concentrations but the observed mortality may be due to osmotic stress rather than calcium toxicity. The beneficial effect of EDTA in reducing the toxicity of cadmium and calcium, but not phenol, supports the hypothesis that the reduction is due to chelation of divalent ions by EDTA.

POSTER 28

## EFFECT OF LIGHT INTENSITY ON REPRODUCTION OF *PENAEUS STYLIROSTRIS* AND *P..VANNAMEI*

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In previous studies, modifications in light intensity were suspected of causing variations in reproductive activity of *Penaeus stylirostris*. This 97-day study was conducted to evaluate the effect of light intensity and to identify optimum levels for reproduction of *P. stylirostris* and *P. vannamei*.

Four intensities were established using various levels of fluorescent lighting (bright, 14.7 uE/$m^2$; moderate, 4.4 uE/$m^2$; dim, 0.6 uE/$m^2$; and dark, 0.0 uE/$m^2$) and the fifth consisted of artificial lighting supplement with natural light through a translucent skylight (skylight, 4.7-9.3 uE/$m^2$). Each of the circular 3.7-m diameter maturation tanks was equipped with a recirculating, gravel, bottom filter which removed the effect of turbidity by maintaining high water clarity among all tanks. The 8-month-old *P..stylirostris* (65 g) and the 20-month-old *P. vannamei* (55 g) were stocked at a rate of 5.6/$m^2$ with a 1:1 male to female ratio. Daily photoperiod was maintained at 13 hours of light. The diet consisted of squid, polychaete worms, and shrimp in the ratio 2:1:1. Unilateral eyestalk ablation was performed on half the females. Ovarian maturation, spawning, molting rate, and survival were monitored daily within each tank and growth and gonad size were measured at termination.

Results indicate that *P. stylirostris* matured and spawned more frequently in the skylight and dim treatments (63 and 62 spawns, respectively) than in the moderate, dark, and bright treatments (43, 27, and 20 spawns/tank, respectively). *P. vannamei* matured and spawned more frequently in the skylight, bright, and moderate treatments (12, 12, and 11 spawns/tank, respectively) than in the dim and dark treatments (6 and 4 spawns/tank, respectively).

This study confirms the effect of light intensity on reproduction and indicates a higher optimum light intensity for *P. vannamei* than *P. stylirostris*. The significance of spectral composition was also apparent in the beneficial effect of natural light supplementation on reproduction of both species.

POSTER 29

## AQUACULTURE IN THE VENETIAN REGIONS

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This paper, sponsored by the Council for Agriculture and Forestry of the Venetian Regions, is concerned with the technical and productive characteristics of aquaculture in the Italian regions of Veneto, Friuli Venezia Giulia and Trentino Alto Adige in which fish and molluscs culture have attained the highest development.

Trout production has increased steadily from 12,000 t to 20,400 t per year over the last 10 years, becoming the most important of E.E.C. . Data on the distribution of trout farms are presented together with the technical features of this production field.

Intensive eel farming, developed only in recent years, has attained a yearly production of about 300 t; geographical, technical and productive characteristics of eel culture are examined.

The fish culture in "valli" (inpoundments) occupies a total area of about 18,000 ha with large possibilities for future increases. In fact, "valliculture" is at present extensively performed producing, in good conditions, 100-150 kg of fish per ha and year.

Mollusc farming, almost exclusively mussels, occupies about 50 ha and accounts for a total mussel yield of 25,000 t per year. Geographical distribution of the farms, a comprehensive analysis of data concerned with different aspects of mussel culture, and technical trends to improve production are considered.

POSTER 30

## ONSHORE NURSERY REARING OF BIVALVE MOLLUSCS IN BELGIUM

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Nursery rearing of bivalve molluscs, as the intermediate step between controlled production of larvae in commercial hatcheries and the grow-out of juveniles in the wild, is a practice in mollusc farming which is receiving more and more attention. The goal of mollusc nurseries is to raise cultchless spat of a few mm to a size of 1-2 cm, in a minimum of time, at highest possible density, and with a minimum of costs and risks.

A semi-industrial nursery pilot-plant has been designed and was recently built at the border of the Sluice-Dock in Ostend, Belgium. The system consists of two parts: series of outdoor algal tanks and an indoor nursery based on the upwelling technology (cylinders with a mesh bottom, containing the spat, and through which the culturing medium flows upwards). This pilot-nursery has been conceived as a multifactorial unit, so that the effect of important variables, such as flow rate, stocking density, temperature, feeding rate, etc., can be examined separately or in combination.

In a first series of tests, from November through May 1981, the growth of three bivalve species, *Ostrea edulis*, *Crassostrea gigas*, and *Venerupis semidecussata*, was followed in relation to water temperature and food level (live phytoplankton). The results of this study indicate that during winter, even a very eutrophic water such as that of the Sluice-Dock, does not provide enough microalgae to sustain growth of the bivalve spat, irrespective of the fact whether the water is heated up to a temperature of 12° C or not. Consequently it is necessary to supply additional food (cultured live microscopic algae) to the culturing medium, to a minimal level of 30 cells/µl. Food shortage for 3 month at higher temperature caused no immediate mortality for the seed but induced a stress situation resulting in high mortality rates of the test organisms in subsequent experiments in which all the spat was placed in an optimal combination of temperature and food availability.

Since it is important for a commercial nursery to have shellfish seed ready for the spring sales, overwintering of the spat in the nursery is a must. The ultimate goal of our study is to determine the cost-benefit of two types of nursery operations: the first is based on the storing during winter, at low temperatures, of readily graded juvenile bivalves which have been grown in autumn when the natural food supply was still sufficient; the second consists of growing bivalve spat during winter on an algal diet or inert food in heated seawater by using thermal effluents of a power plant.

POSTER 31

## INTRODUCTION OF THE GHIANT MALAYSIAN PRAWN *MACROBRACHIUM ROSENBERGII* INTO BRACKISH WATER AQUACULTURE

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Introduction of aquatic organisms into water at varying salinities rests to a large extent on the osmoregulatory mechanisms working to maintain a body ionic concentration different from that of the external media.

Adult *Macrobrachium rosenbergii*, is typically observed and cultured in fresh water environments, but is known to withstand relatively wide ranges of salinities. Whereas brackish waters of marine origin are characterized by relatively similar ionic ratios, inland continental brackish water demonstrate considerable ionic anomalies. The present study was initiated to develope a bioassay examining growth potential of *M. rosenbergii* cultivated in varying inland brackish water sources.

Juvenile prawns were grown in water brought from various sources in the Arava desert in Israel, having varying ionic compositions, ratios and salinities. Range of salinities tested were: 24 ‰ (seawater dilution), 16 ‰ (seawater dilution), 15 ‰ (geothermal - 'Yotvetah'), 12 ‰ (geothermal - 'Elat'), 2 ‰ (geothermal- 'Yahel') and 0.75 ‰ (geothermal- 'Mevo-Hama').

The specific activity of the gill enzyme Na-K ATPase, believed to play a key role in osmoregulation, was assayed on prawns adapted to the above media. Our results expressed as the percentage of NA-K- ATPase activity with respect to total membrane ATPase activity was: 79,62, 83, 86, 34 and 38 %, respectively. Metabolic rates (oxygen consumption and ammonia excretion) were highest in media corresponding to high levels of the Na-K ATPase activity, i.e. 0.484 ml $O_2$/gww/hr oxygen consumption; 0.284 µg $NH_3$/gww/hr ammonia excretion, and low in the media corresponding to low levels of Na-K ATPase activity i.e. 0.258 ml $O_2$/gww/hr and 0.120 µg $NH_3$/gww/hr.

A causative correlation was observed between Na-K ATPase activity, metabolic rates and growth, survival and population development. Complete mortality was observed in 15 ‰ and negligable growth in 24 ‰ . Growth rates and population development improved in the sequence: 16 ‰ 12 ‰ 0.75 ‰ 2 ‰.

Our results express that salinity alone per se does not act as the sole limiting factor but in addition, ionic composition and ratio was of even greater consequence. We propose the implementation of this bioassay for the evaluation of brackish water of both coastal and continental origin in *Macrobrachium* aquaculture.

POSTER 32

## THE DEVELOPMENT OF THE POPULATION STRUCTURE, MORPHOTYPIC VARIATION AND SOCIAL INTERACTION IN *MACROBRACHIUM ROSENBERGII* AND ITS EFFECT ON AQUACULTURAL PRODUCTION

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The development of population structure from the post larvae to the adult stages and the differentiation into morphotypes was studied with special emphasis on social interachtions and yield characters.

Post larvae demonstrate a homogenous size distribution which changes, with time, to a positively skewed curve, with some individuals demonstrating a higher growth rate than the average population. At this stage no morphotypic variation is observed and the ratio of males to females is 1:1, equally distributed along the whole size distribution. Both the mean weight and the development of the skewed distribution curve are inversely effected by increasing density. Individual grown prawns demonstrate that the relative growth rate of all individuals is identical. On the other hand, under communal growth some individuals attain higher growth rates, which is highly dependet on the individual's social position (ranking) within the population.

In a mature population, three male morphotypes are identified morphologically: by claw color, mean weight and ratio of claw length to body length; behaviorally: with respect to function fullfilled within the population structure, and physiologically. No apparent morphotypic variation exists in females and their size distribution is generally homogenous. Whereas increased population density does not change the relative position, nor the relative proportions of the three male morphotypes and the females, the skewness of the curve is inversely related to the density.

The relative molting frequency of the various male morphotypes varies according to the social situation, and is correlated with the establishment of a hierachy. The OC male retains the potential of transforming, through molting, into an active dominant BC male while capturing a new territory or replacing an old BC male.

Population structure, morphotypic variation and social interaction are major facters effecting commercial yields. Methods of increasing yield by population manipulation will be discussed.

POSTER 33

## BACTERIAL INFECTIONS IN GILT-HEAD BREAM *SPARUS AURATA* CULTURED IN ELAT

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Acute septicemia following handling operations was a frequent cause of mortality among *Sparus aurata* reared in our facilities. Only a limited number of works have been done on marine bacteria of the Red Sea and none of the isolated strains was studied as fish pathogen.

The biochemical profiles of over 100 bacteria isolated from the blood of 88 dying *Sparus aurata* were recorded in order to determine which strains recurred in septicemic fish and with what frequency.

*Vibrio alginolyticus, Vibrio parahaemolyticus, Vibrio anguillarum* and its related forms were the most frequently isolated species. On the basis of biochemical dissimilarities, strains identified as *Vibrio alginolyticus* were further devided into six types with 26 characteristics in common and six variable. Strains identified as *Vibrio parahaemolyticus* were further devided into four types with 29 characteristics in common and three variable. Strains identified as *V. anguillarum* or closely related species were further divided into five types with 24 characteristics in common and eight variable.

Healthy fish challenged with the three most recurrent strains of *Vibrio alginolyticus* failed however to develop any clinical signs. This may be due either to the lack of primary pathogenicity and the requirement of a physiological stress on the host before bacteria are able to manifest their opportunism, or to the

fact that these bacteria are most virulent when directly transmitted from fish to fish, while when forced to live under artificial conditions in laboratory culture media, their virulence probably decreases.

The role the bacteria play in *Sparus aurata* mortalities is however extremely important judged by the dramatic reduction in losses of fish after handling since routine post-handling treatments with nitrofurans and chloramphenical were introduced.

POSTER 34

## ICHTHYOSPORIDIOSIS IN *MUGIL* SPEC DIAGNOSED IN ASSYMPTOMATIC ANIMALS

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Specimens of *Mugil* spec. with very severe lesions caused by *Ichthyosporidium* in different internal organs have been identified. Such specimens did not show any external symptoms. This observation is of importance when considering pond stocking with *Mugil* caught from the wild. In order to gain knowledge on the extent of the parasitosis of a *Mugil* population which exhibits no external symptoms, different internal organs have been histologically studied (stained by Hatchkiss-McManus and Gridly techniques). The organs that are more precociously present typical lesions in the spleen and the liver. Their examination is presently the most suitable one for identifying the sanitary stage of a mullet population as far as Ichthyosporodiosis is concerned.

POSTER 35

## PRODUCTION, NUTRITIONAL VALUE AND USE OF DUCKWEEDS (LEMNACEAE) IN AQUACULTURE, WASTE MANAGEMENT, AND ANIMAL FEEDS

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The vascular plants known as duckweeds have been the subject of intense interest during the past decade as an aquacultural crop, part of waste management systems, and as a feed supplement for aquatic and terrestrial animal stocks. Yield in high nutrient lagoons in regions with nine month growing season average about 10 metric tons (dry)/hectare, with maximum yields of 12 metric tons projected from 0.1 ha lagoons. Crude protein for duckweeds cultured on animal waste lagoons have ranged from 35 to 45 % of the dry weight and all essential amino acids are present. Lysine is present in sufficient concentration to meet FAO reference standards, but methionine remains below recommended standards. Minerals, fat, fiber, and carbohydrate levels do not appear excessive for animal diets. Successful feeding trials have been conducted with several species of fish, ducks, swine, poultry, and cattle. A review of research indicates this family of plants hold high promise for producing high quality animal and human food world-wide, but the technology for controlled production under full-scale systems is incomplete.

POSTER 36

## PREDICTING OVULATABLE BULLFROGS BY MORPHOMETRY

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The bullfrog (*Rana catesbeiana*) can be ovulated with a combination of bullfrog pituitaries and progesterone, but it is difficult to determine if the female has mature oocytes. In the past it has been necessary to surgically remove a section of the ovary to determine if the oocytes are mature, or to estimate the condition by the plumpness of the female. Neither method is very satisfactory due to complications caused by surgery, and the inexperience of most personnel in estimating the ovary condition by the size of the female.

A study was conducted to develop a morphological index to aid in identifying wild female bullfrogs with a compliment of mature oocytes (Stage V). The index was determined by dividing the widest area of the body in the abdominal region by the interorbital distance at the posterior edge of the eyes measured at the juncture of the lateral fold. An index value 3.0 showed that 87 % of the wild-caught females had mature oocytes (Stage V) and 70 % of those 3.0 ovulated when injected. Only 14 % contained Stage V oocytes if the index was 3.0 and 12 % of them were successfully ovulated. Comparable results were obtained with females under culture.

A great number of females exceeding 400 g had mature oocytes than females less than 400 g. Other factors which affected the accuracy of the technique are discussed.

POSTER 37

## USE OF *SPIRULINA* IN A SHRIMP'S (*PENAEUS JAPONICUS*) DIET

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*Spirulina* is a single-cell alga with good nutritional value. Its efficiency in *Artemia salina* and penaeid shrimp feeds has been shown. In order to study factors responsible for its growth promoting effect, experiments were carried out with *P. japonicus* juveniles. Pelleted diets contained between 0 % and 8 % *Spirulina*. Complete substitution of *Spirulina* by other single-cell ingredients, reduced pigmentation,.and synthetic carotenoids did not give the same results than *Spirulina*; growth performances were always lower though amino acid patterns were quite similar, in diets with no *Spirulina*. Such a difference could be explained by the presence of a "growth factor". To find out factor(s) explaining the growth promoting effect, lipid extract and deffated residue of *Spirulina* were added separatly to experimental diets. From preliminary results, the efficient fraction should be in the deffated residue. A growth promoting effect also is noted with another single-cell protein source, i.e. lactic yeast. This foodstuff might contain the same growth factor. *Spirulina* is an expensive source of protein for shrimp diets; however, a reduction of its production costs could promote its use.

POSTER 38

## CHEMICAL COMPOSITION OF FISHING SCRAPS IN THE FEEDING OF *PENAEUS KERATHURUS*

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A study on the efficiency of fishing scraps for feeding *Penaeus kerathurus* is presented. The chemical composition of the fishing scraps (anchovy, shrimp head, squid, clam, parts of *Mola molae* and a blend of various fish), used alone or in mixture, is correlated to their efficacy and compared to the average chemical composition in wild *P. kerathurus* and those fed a mussel diet as control. The distribution of fatty acids and amino acids in the lipidic and proteic fractions are significant by different and suggest that the closer the chemical composition of the diets is to that of mussel meat and of *Penaeus kerathurus* not subject to alimentary stress, the better the results of the feeding tests.

POSTER 39

## FREE AND PROTEIN-BOUND AMINO ACIDS IN ZOOPLANKTON CONSTITUTING FISH LARVAE DIET

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Several species of freshwater zooplankton, i.e. *Brachionus* sp., *Cyclops* sp., *Daphnia* sp., *Ceriodaphnia* sp., *Eudiaptomus* sp., were analysed for free and protein-bound amino acids. Some species were distinguished into size groups. *Artemia salina* nauplii were also analysed immediately after hatching and subsequently during starvation.

The lowest content of free amino acids was found in rotifers and the highest in III-IV copepodit stage of *Cyclops* sp. In free amino acid fraction, arginine (1.42 % of dry matter), histidine (0.22 %), alanine (0.20 %), glutamic acid (0.15 %) and lysine (0.11 %) were the most abundant. With increasing size of daphnids the per-cent of free arginine in the total amino acid content decreased significantly. Free amino acids content in unfed *Artemia* nauplii was lower than in freshwater zooplankton. Among the most abundant free amino acids were proline (0.55 %) alanine (0.41 %), glycine (0.34 %), and serine (0.37 %). A decrease of most of free amino acids was noted during starvation of nauplii.

Results of total amino acid content in zooplankton are discussed in the context of fish nutritional requirement and possible value of free amino acids for fish larvae is emphasized bearing in mind specific morphological and biochemical unreadiness of larvae to utilize artificial diets.

POSTER 40

## THE POTENTIAL FOR AQUACULTURE DEVELOPMENT IN DENMARK - A PLAN PREPARED FOR THE DANISH COUNCIL OF TECHNOLOGY

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Denmark has for many years been a major producer of rainbow trout in freshwater. The production has increased to a level of 15 - 20,000 t a year. In the seventies and early eighties the production has been limited through environmental constraints. They have caused an increased interest in new production methods and in new species suitable for cultivation. The interest has shown itself through the activities of a number of private companies, organisations and research institutes. However, the Danish Government supported technological development of systems and has decided to make plans for further support of new aquaculture technologies and research activities.

In Denmark, the technological research and development (R/D) is coordinated and supported through the Council of Technology, which is a body established by the Danish Ministry of Industry. In the spring of 1980 the council founded a working group on aquaculture. This working group prepared forecasts for aquaculture production in Denmark and made a plan for R/D activities. The work covered four important areas: (a) Freshwater trout production. In this field the need for waste water treatment and for new production techniques which reduce pollution problems is acknowledged. Seawater trout production. In this field a considerable potential for production may be realized if good construction methods for net cages ere established and the marketing problems are attacked. (c) Cooling water production of trout, eel and turbot. From existing and planned power production facilities a high amount of water is discharged with temperatures well suited for production of a number of species. (d) Recirculated systems for eel and trout seedlings. The water temperatures for optimal growth of eels can in Denmark only be reached by use of recirculated culture systems preferably with input of industrial low grade waste heat.

The production aims for the four above mentioned fields in a 10-year period can be summarized as follows:

| | production (t/year) | value (mio Dkr) |
|---|---|---|
| Trout (freshwater) | 20,000 | 300 |
| Trout (seawater) | 1000 - 5,000 | 25 - 125 |
| Trout, eel (cooling water) | 2,000 - 5,000 | 50 - 125 |
| Eel (recirculated systems) | 2,000 - 3,000 | 80 - 120 |
| Total | 25,000 -33,000 | 455 - 670 |

The R/D efforts needed as background for this production is approximately 10 mio DKr per year.

POSTER 41

## BIOLOGY OF FISH POPULATION IN RELATION TO ENVIRONMENT, CONSERVATION AND DEVELOPMENT

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Investigations have been conducted on survival, growth, reproduction, and scenesence of Indian carp fishes under five main areas of concern: (a) factors affecting survival of post-embryonic Indian carp, (b) factors affecting growth of carp fry , (c) growth rates in ponds, (d) species differences in blood biochemistry under culture conditions, and (e) survival and growth of fish in relation to environmental parameters.

Mortality was calculated for each day during the experiment (randomized block design). Results repeatedly showed that minute quantities of Vitamin B-complex, with or without $B_{12}$, yeast gave highest weight gain and extract of goat manure significantly increased survival.(40 % against 20 % in the controls after 14 days). Survival increased to 42 % using goat-stomach extract (a cheap source of live micro-organisms) and to 78 % with yeast.

An inexpensive pond treatment procedure consisted of the preparation of an extract simply obtained by pressing the juice from the entire stomach content of freshly slaughtered goats and adding some cobalt nitrate. After 11 days this preparation resulted into a survival rate of 65 %, while yeast application alone gave 89 % survival.

The effect of density on survival was also determined. The relationship between percentage survival and initial number of carp could best be described by

the following hyperbolic equation: $Y = \frac{100}{a + bx}$

where Y = % survival = 100 Z/x, Z ≙ number surviving, x = initial number and a and b are constants. From these data the following conclusion may be drawn: (1) the effect of density on survival was most marked during the first weeck of life, (2) treatment with micro-nutrients reduced the effect of density and abolished it by the end of the second week, (3) from the hyperbolic equation it may be inferred that if density is low, about 87 % of the initial number survive without further treatment, while wie micro-nutrients, especially yeast, 98 % would survive.

POSTER 42

## SOME QUALITY CRITERIA FOR THE COMPARISON OF REARING METHODS FOR DECAPOD CRUSTACEA

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Several methodological aspects for rearing decapod larvae were investigated employing the spider crab *Hyas araneus* as an test organism. The sensitivity of several criteria for evaluating the suitability of different rearing methods was tested. The most commonly used criterion, survival rate, was always the least sensitive measure when comparing rearing methods. This is due to high natural variability in the viability of decapod larvae, even if originating from one hatch. Only in very high densities, mortality figures reflect subtle differences between rearing techniques. Unlike survival rate, duration of larval development showed highly significant positive correlations with frequency of water exchange and average ammonia levels. Also other methodological differences (e.g. in larval densities, container design, aeration procedure) could be statistically proved using developmental rate as a measure, especially when individual maintenance was employed. Carbon and nitrogen analysis (by means of a CHN-analyser) revealed even smaller differences of rearing techniques in a shorter time ( at specific larval stages within a few days only). Such analytical techniques require only very small sample sizes ( 200 µg dry weight per determination), and provide reliable statistical data. A criterion which affects rearing costs is working time. Once the required average handling time is determined, the suitability of the rearing method employed in mass culture. Our tests have shown that rearing decapod larvae individually does not only reduce significantly mortality and developmental time, but also stimulates growth and reduces costs in terms of man power units per juvenile produced.

POSTER 43

## LARGE SCALE MICROALGAE PRODUCTION FOR NURSERY REARING OF MARINE BIVALVES

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One of the major bottle-necks in nursery rearing of marine bivalves (the intermediate step between rearing of the larvae in hatcheries, and the grow-out in the natural environment), is production of large quantities of suited microalgae as food. Since natural phytoplankton is sometimes unsuited or insufficient in quantity and since controlled large scale production of monospecific algae is frequently not practical, an alternative approach may be to induce blooms of natural phytoplankton in outdoor enclosures. The key problem is to obtain control over the species composition of the blooms in order to produce algae which are nutritionally suited for bivalve rearing.

A pilot plant for outdoor algae production was designed and built at the Belgian coast, coupled to a semi-industrial nursery for edible shellfish to test out the feasibility at larger scale of the principles outlined above. The micro-algae production unit consists of four tanks of 100 $m^2$ surface, two of which can contain $100^3$ algal suspension (1m depth) and two of 50 $m^3$ content (0.5 m depth). Three of the four tanks are equipped with different systems for mixing (paddle-wheel, air-lift pumps, air bubbling) which can be operated continuously or dis-continuously; the fourth tank is the control unit (no mixing).

The cultures arerrun as chemostats in which seawater is enriched with commercial fertilizers (ammonium sulphate, phosphoric acid, sodium silicate) as nitrogen phosphorus and silicium spurces. Depending on the season, 5 to 80 % of the culture volume can be harvested per day with algal densities ranging from 50,000 to 500,000 cells per ml.

It has already been experienced that by manipulation of operational parameters unsuited or less suited algae such as *Chlorella* and *Phaeodactylum*, could be replaced by more suited species such as *Skeletonema, Nitzschia* or *Thalassiosira.* Factors of major importance in this regard seem to be the temperature stability coupled to the depth of the cultures, the detention time, the addition of silicates, the levels and proportions of nutrients (the N:Si:P ratio) and the intensity and duration of mixing. Various biological and technological problems encountered during year round operation, including algae predation, culture collapsing, water quality, seawater enrichment, fouling and water treatment, are commented on.

POSTER 44

## MASS CULTIVATION OF MARINE FISH FRY FOR INTENSIVE AQUACULTURE IN THAILAND

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Increasing population size has rapidly raised the demand fir high quality protein food but area available for food production remains almost constant. Coastal Mariculture is one possible option for intensified mass production of animal protein. However, grow-units can be operated on a reliable basis only when continuous supply of stocking material can be garantied at all times. In the past three years Aqua-Seeds Research Center (ASREC) has carried out sveral research programmes to develope suitable mass rearing techniques for commercially important marine species.

The poster describes and demonstrates techniques employed and facilities utilized for commercial mass production of fry. The following species are produced on a regular basis: (1) Sea bass (*Lates calcarifer),*(2) Mangrove snappers *Lutjanus argentimaculatus),*(3) Jumbo tiger prawn *( Penaeus monodon),*(4) Mud crab *(Scylla serratus),* (5) Blue crab *(Portunus pelagicus),*(6) cuttle fish *(Sepia pharaonis),* (7) Pearl oyster *(Pinctata maxima),* (8) Giant oyster *(Crassostrea gigas)* and several tropical aquarium fish.

The paper provides figures on culture density and survival rates. Fish fry produced are distributed to mariculturists within the country but also exported to farms in other Asian countries. Transfer of culture technology to the small scale farmer is another activity of ASREC, teaching 16 families in growing fish in near the house operations. Because of the success, 362 families joined the ASREC project in the first half o f 1981.

POSTER 45

## NATURAL SPAWNING IN DIFFERENT MARINE FISH SPECIES IN CAPTIVITY: COMPARISON WITH ARTIFICIAL METHODS OF EGG PRODUCTION

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Natural spawnings have been obtained for several years at the Centre Océanalogique de Bretagne in different species of captive marine fish : turbot *(Scophtalmus maximus)*, sole *(Solea vulgaris)*, sea bream *(Sparus aurata)* and the sea bass *(Dicentrarchus labrax)*. Some recent results concerning natural and shifted spawning seasons are presented. They are compared to those obtained by artificial methods such as hormonal injections or stripping. The advantages and drawbacks of different methods used in laboratories and commercial hatcheries are discussed.

For natural spawnings, egg production and relative fecundities, measured on wild fish gonads, are often similar: for instance, sea bass can produce 200,000 or more eggs per kg fish. The viability of these eggs was more stable, often between 70 and 100 %, compared to that from artificial spawnings.

In cultured species no fertilization success has been experienced at several occasions, especially in turbot. This indicates that certain conditions were not optimal to support natural spawning in captivity with subsequent successful development. It is strongly believed that tank design and stocking density must be adjusted to the species' desire. Providing optimum conditions, millions of fertilized eggs can be collected from the same batch of spawners each year.

POSTER 46

## BEHAVIOUR, DEVELOPMENT AND SURVIVAL OF THE GILT-HEAD LARVA (*SPARUS AURATA*) IN EXTENSIVE BREEDING

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In order to determine the best conditions for breeding gilt head larvae, experiments were made with low initial density (0.5 to 2.0 larvae per liter) in basins of 2,000 to 7,000 liters at a temperature of 16 to 19° C, with a salinity between 32 and 36 % and under continuous light conditions. The water was not aerated and remained completely stagnant during the first 20 days and then was progressively renewed. The initial feeding technique is close to the one used in an extensive breeding. Food organisms are provided by plankton blooms initiated in the tanks and later by additional plankton supply caught in the lagoons. The feeding sequence, first veligers of mussels and/or *Synchaeta triophtalma*, then nauplii, copopodites and finally adults of *Eurytemora velox* resulted in young fish measuring between 12 and 18 mm total length at age of 1 month, and between 20 and 30 mm at the age of 2 month with a final survival rate of 16 and 52 % for larvae having past the prelarval stage.

Morphologically, the animals retain their larval features until they measure over 20 mm and the oil globule disappears only between day 20 and 30. The low density, the absence of aeration, and the important volumes, allowed the animals to express their preferential behaviour patterns. The dispersion of larvae, the swimming distances covered, the prospection of plankton, and the number of attacks per day were observed. The theoretical daily food requirement (prey actually eaten) and the real need of food items (plankton to be distributed in the tanks) are compared. Techniques for continuous distribution of prey, water renewal rates, and a scheme for the supply of *Synchaeta triophtalma* blooms as well as veligers of mussels is proposed.

POSTER 47

## CONDITIONS OF INTENSIVE PRODUCTION OF WHITE SEA BREAM *DIPLODUS SARGUS* ALEVINS

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A technique for intensive production of White Sea Bream alevins is described. The gametes were obtained by pressing on the bellies of dead spawners, caught in trawl nets and supplied at fish auction places. Collection periods, yields of eggs, fecundity, and incubation data are presented. Breeding is carried out initially in tanks of 7 to 10 $m^3$ volume (stagnant water). At a later stage tanks are operated in an open circuit. Feeding was based on live plankton during 2o days, and shifted thereafter to frozen plankton. After 3 month 30 mm long alevins were obtained ( survival rate 18 %; final density 0.1 -0.7 larvae/l). Attempts on early weaning were undertaken between day 10 and 20. Size and quantities of adeaquate plankton species were determined. Nauplii and copepodites as well as adults of *Eurytemora velox* were selected. The behavioural changes and food preferences of this species are reported, abd the early development of agressivity and necrophagy is discussed.

POSTER 48

## HURRICANE SURVIVAL IN AN AQUACULTURE COMPANY

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Increasing growth and development of the warm water aquaculture industry, particularly in coastal areas offering prime physical sites such as those found along the Gulf of Mexico and Northern Carribean brings the increased risk of damage or destruction resulting from hurricanes. In fact, several aquaculture facilities have suffered substantial damage in recent years. In August 1980, CSCI,Inc. was completely destroyed due to storm surge and wind from Hurricane Allen.

This paper discusses in detail CSCI's efforts to anticipate effects of hurricanes, its preparation for an imminent hurricane approach, the physical effects of Hurricane Allen, the types of damage caused by Hurricane Allen, physical recovery and obligatory clean-up, recording and documenting damage for insurance, collecting insurance, applying for disaster assistance programmes, rebuilding under disaster assistance programmes, directing political resources to augment disaster assistance, minimizing losses and taking advantage of starting over. The paper also contains before and after photographic records of storm effects. From hindsight the CSCI staff offers suggestions on how to evaluate potential sites in regard to hurricane risk and how to decrease loss and confusion in the event that such a disaster occurs for those who work in these risk areas.

POSTER 49

## ACUTE TOXICITY OF PROPANIL, ORDRAM, FURADAN AND THEIR COMBINATIONS TO RED SWAMP CRAWFISH (*PROCAMBARUS CLARKI*) IN WATER MEDIUM AND IN AN WATER-SOIL MEDIUM

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In aquaria, juvenile crawfish, 2.0 to 2.6 cm total length were exposed to Propanil, Ordram, Furadan, and to their possible combinations. Four concentrations of each chemical was applied including those used under normal conditions by

farmers and half, double and six times the recommended concentration. Urea and 0-24-24 (N:P:K) were added to each aquarium at a rate of 52 and 74 kg/ha to stimulate fertilization under field condition. In a second set of aquaria, 2 cm of top soil was placed into each aquarium, and the experiment was repeated.

Certain toxicity patterns were observed with various pesticides and their combinations. In most cases a combination of Propanil, Ordram, and Furadan stood out as the most toxic combination to crawfish. Ordram by itself was the least toxic pesticide. Additive effect (synergism) was observed when Furadan was combined with Ordram or Propanil, but antagonism was detected in the combination of Propanil with Ordram. Concentrations of pesticides higher than the recommended rate for use under normal conditions had a significant (P 0.05) lethal effect on crawfish. Soil moderated toxicity of some pesticides and their combinations but not others.

POSTER 50

## GROWTH OF JUVENILES AND POSTLARVAE OF *PENAEUS KERATHURUS* FED AN UNPROCESSED UNSUPPLEMENTED DIET OF FISH MEAT, SHRIMP HEAD AND SQUID

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An unexpensive diet for penaeid shrimp culture composed of chopped and frozen anchovy meat (43 %), shrimp head (33 %) and squid (24 %) without supplementation or binding substances has been tested on juvenile *Penaeus kerathurus* (mean weight 5.57 ± 0.28) during an experimental period of 150 days.

Growth obtained with such a diet was compared to that of a control diet exclusively composed of mussel meat. At the 60th day no significant differences were found between animals fed the experimental and control diet, the mean weight being 11.1 ± 0.45 g and 11.4 ± 0.55 g respectively. At day 90 the animals fed the experimental diet grew more than the controls (mean weight 14.1 ± 0.52 and 12.8 ± 0.65 g respectively). Results were confirmed at day 120 (17.2 ± 0.60 g and 15.7 ± 1.05 g) and at day 150 ( 19.9 ± 0.72 and 17.0 ± 1.13 g).

Since the experimental diet tested was suitable for *P. kerathurus*, a second experiment was programmed in order to evaluate daily optimum amount required for convenient growth from post-larval stage to market size. Daily amounts tested were: 40 %, 60 %, and 100 % body weight. Although this experiment is still in progress, the result obtained so far indicate that growth is affected by daily ration:

| daily ration | mean weight (g) at day | | |
|---|---|---|---|
| | 0 | 60 | 90 |
| 40 % | 0.65 ± 0.07 | 1.25 ± 0.07 | 1.83 ± 0.08 |
| 60 % | 0.65 ± 0.05 | 1.79 ± 0.09 | 2.94 ± 0.14 |
| 100 % | 0.61 ± 0.04 | 2.14 ± 0.08 | 2.92 ± 0.12 |

The results so far obtained on postlarvae are to be considered as preliminary since we believe that longer periods of observation are of fundamental importance when the nutritive value of diets for commercial prawn culture is tested.

POSTER 51

## A METHOD FOR THE SELECTION OF BREEDERS FOR INDUCED REPRODUCTION EXPERIMENTS

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The amount of hormone that should be injected into mature fish to obtain ovulation varies with the stage of oocyte development. Many treatment failures occur due to the lack of precise knowledge of the developmental stage of the ovary.

Thirty-two females of *Prochilodus scrofa* (Prochilodontidae) were selected on the basis of external features (swollen belly, enlarged and reddish genital opening) for hormone treatment. Using a cateter, ova samples were collected from each female, and placed in Gilson solution. Percentage frequency distribution and means of the diameter were elaborated half an hour after fixation. All females received 5 and 10 IU HCG/g, at 12 hours interval, and remained under the same experimental conditions. 24 hours after a second dose, females were sacrified and the ovaries weighted for GSI determination. Three groups of females were recognized according to treatment reaction: (I) Positive reaction to treatment (ovulation) resulting in fertilized eggs wit subsequent development to larvae and fry; (II) Positive reaction to treatment (ovulation) with spawning but no embryonic development; (III) Negative reaction to treatment (no ovulation).

Females of group I showed an unimodal distribution of egg size; a homogeneity of the ova diameter was observed with means ranging between 1088 to 1164 $\mu$m. Group II females showed several modes of egg size distribution, the mean diameter ranging between 1077 and 1196 $\mu$m. Females of group III provided eggs with a more irregular polimodal size distribution, showing a higher frequency at 1055 $\mu$m and a smaller at 900 and 1000 um (means between 974 and 1143 $\mu$m).

POSTER 52

## SUBSIDIES TO THE MUSSEL CULTURE'S DEVELOPMENT IN CABO FRIO REGION, BRAZIL: BIOECOLOGICAL ASPECTS ON *PERNA PERNA* (MYTILIDAE)

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Several ecological aspects related to the mussel *Perna perna* were studied at three different sites in the Cabo Frio region in order to provide the necessary data base for mussel culture development. The vertical range of the mussels' distribution varied between 1.5 m and 7.0 m , depending on site exposure. Within this range, littoral communities are dominated by *Perna perna*, reaching maximum density of about 117.000 individuals/ $m^2$. Throughout the year, these mussel populations are predominantly composed by plantigrades ( 80 %), which experience high mortality rates, probalby due to intraspecific competition and/or predation. Peaks of larval settlement occurred in June-August (winter) and January (summer). Larval settlement intensity is clearly related to local upwelling. In spite of the ecological dominance of *Perna perna*, species diversity of associated fauna is very high. Three parasites have been found: a trematode (Bucephalidae), a polychaete (*Polydora websteri* and a crab (*Pinotheres maculatus*).

*Perna perna* growth was analysed using suspended cages at three different sites. The better growth rate ovserved (0.5 cm / month) was probably due to a domestic sewage discharge. The effects of monthly handling necessary to evaluate the mussels' growth according to the methods employed ( cages and nets suspended on rafts) are discussed.

POSTER 53

## REARING AND ONGROWING OF DOVER SOLE, *SOLEA SOLEA* L., UNDER LABORATORY CONDITIONS

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This study is a first attempt to investigate a pellet formulation suitable to conditions pertaining to Portugal. The criteria employed to evaluate the quality of the pellets used was based on the assumption that food conversion rate and growth rate are the best indicators.

Dover sole larvae were reared at the Marine Farming Unit at Hunterston and sent by the White Fish Authority 120 days after hatching (mean weight = 268.9 mg; mean total length = 31.8 mm). They were distributed between 10 tanks (18 liter volume each), each of them receiving about 150 fish (30 fish/ $m^3$, 943 fish/$m^2$), tanks were connected to an open circuit . The experiment lasted 70 days (water temperature = 20.0 to 21.8° C; salinity = 29.4- 30.4 % ; oxygen levels = 7.3-8.4 mg/l; water flow about 43 l/h).Fish were maintained under continuous low light intensity (15 to 130 lux). The amount of food given daily to each tank varied from 15 to 30 % of the mean live body weight. The pellet formula and its percentage of protein, lipid, water content and ash is outlined in the text. Mortality over the total experimental period was 67.6 %, mainly due to bacterial diseases. The mean growth rate of the population was inferior to that reported by other authors. Daily growht rates ranged between 0.16 to 0.48 mm/d, 0.66 to 15.99 mg/d, and 0.1 to 2.8 per cent per day. The mean food conversion rates were higher than those obtained by most authors and ranged between 4.05 and 20.8, too high to be acceptable for large scale fish culture. The mean specific growth rates ranged from 0.11 to 2.82.

The discrepancy between the mean growth rate and the mean food conversion rates (all of them unsatisfactory) and the good mean daily growth and mean specific growth rates (all of them quite good) may be explained by the high dispersion of sizes and by the diversity of the feeding behaviour observed. The pellet composition is to be reconsidered in order to obtain a smaller fish size dispersion and an overall better growth.

POSTER 54

## CULTURE OF SEA BASS (*DICENTRARCHUS LABRAX* L.) AND OYSTER (*OSTREA EDULIS* L.) IN LIMSKI KANAL, ISTRA, YUGOSLAVIA - A MODEL OF A MARINE PILOT FARM

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Limski Kanal, a bay in the northern part of the Adriatic Sea, is a protected area reserved for marine culture. Hydrographic and biological "base-line" investigations were carried out to serve as a basis for monitoring nad controlling changes which could arise from intensive fish and shellfish culture. The innermost portion of the Limski Kanal, which is under influence of freshwater inflow, displays the greatest fluctuations. In 1979 the temperature ranged between 10.38 and 25.30° C, salinity varied between 11.34 and 37.81 % , and nitrates fluctuated between 105.4 and 2083.2 mg/ $m^3$.

In a part of the Kanal a pilot farm for the culture of fish and shellfish in poly- and monoculture was constructed. Its functioning and viability represent a basis for settint up an intensive culture operation. The farm consists of floating cages for fish and parks for shellfish, constructed as single, double and quadriple exchangeable units. The basic unit is 6 by 6 meters ( 4 x 4 m internal size), constructed from polyethylene floats and filled with expanded polystyrene (0.5 $m^3$) and wooden logs.

Culture of sea bass, and the collection and culture of oysters are carried out on these facilities.The experimental culture of sea bass, from fry hatched in our laboratory, yielded market size fish at age of 22 months (average weight 235 g (1979), 298 g (1980)). Food was mainly trout pellets, of which the consumption was up to 5 % body weight per day in the warmer period. The physico-chemical parameters of the culture environment were monitored regularly.

The oyster seed is collected with 5 meter lon and vertically suspended collectors, made from horizontal stacks of soft polyethylene plaques (18 x 18 cm). In 1980, 200 to 300 one-year-old oysters (56 mm and 25 g) were obtained per meter of collector. The oysters grow to market size (length 81 mm, weight 68 g) within another 6 months, in plastic boxes. The condition index (volumetric method) of the oysters is around 45 % (spring 1981).

POSTER 55

## THE INFLUENCE OF TEMPERATURE ON DAILY FOOD CONSUMPTION, GROWTH AND CONDITION OF YOUNG SOLES (*SOLEA SOLEA* L.)

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Young soles (*Solea solea* L.) were kept at constant temperatures of 10, 14, 18, 22, and 26° C, to estimate food consumption and growth rate. Maximum daily food consumption was estimated over periods of two weeks, by feeding groups of fish daily a weighed excess amount of fresh musselmeat and weighing back food left over the next day. The influence of temperature on maximum daily ration ($D_{max}$) in relation to fish size is illustrated.

In another experiment 14 groups of soles ( each group with 10 fish of about 6-10 cm length) were kept for three months at 14 combinations of seven temperatures and seven daily rations of fresh musselmeat (range 1.3 to 10.7 %W fish/d). The combined effect of temperature and ration on growth and condition of the fish is calculated in a polynomial model and illustrated. A maximum growth rate of 2 cm or 6 g per month was found for 10 cm fish (weight approx. 10 g) at 22°C, with a gross conversion efficiency of about 25 %.

Finally, the decrease in weight of starving soles is compared with the estimated growth at low daily rations of musselmeat, to calculate the influence of temperature (T,°C) on maintenance ration (DM,mg/d) of a 10 cm fish (DM= 6.7, T= 34) and the net conversion efficiency of fresh musselmeat into wet weight of sole (approx. 50%).

POSTER 56

## THE EFFECT OF EDTA HYDRATION ON PRODUCTION OF *ARTEMIA sp* NAUPLII

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Ethylendiaminetetracetic acid (EDTA) has been shown to increase hatching rates in penaeid species. EDTA also increases activation of enzymes associated with hatching of *Artemia* sp. cysts. However, the effect of EDTA on production of *Artemia* sp. nauplii has not been determined. Two tests were run to determine the effects of EDTA during hydration on production: 1) hydration in different concentrations of EDTA followed by chlorox™ decapsulation and 2) chlorox™ decapsulation followed by hydration in different concentrations of EDTA. Production was determined in terms of nauplii per ml after 24 hrs incubation. Use of EDTA during hydration showed no significant effect on production in both tests at all concentrations. Overall production was not increased by hydration subsequent to decapsulation.

POSTER 57

## MOST CONVENIENT SALINITY-TEMPERATURE COMBINATIONS FOR EGG INCUBATION AND FIRST LARVAL DEVELOPMENT OF *SPARUS AURATUS* L. IN THE NORTHERN ADRIATIC

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High mortalities during larval stage encountered in attempts at rearing *Sparus auratus* L. at commercial level, led to a series of experiments on the influence of salinity and temperature on egg incubation and larval survival. For eggs, the salinities tested ranged from 5 to 70 ‰, for larvae from 15 to 45 ‰; experimental temperatures were 18 and 23°C, both allowing fast development of eggs and larvae. In addition to survival, the percentage of normally developed larvae (no dorsal curvature) was considered. Experiments terminated with yolk sac absorption.

Spawning, induced by hormone treatment of breeders, occured at 35 ‰ and 18°C. Transfer of eggs to experimental conditions was effected at the rate of 1‰S and 1°C per hour, beginning at the stage of first cleavages. At 18°C, best hatching (72-92 %) was obtained at salinities ranging from 25 to 50 ‰ and the highest normality values (78-82 %) between 35 and 40 ‰ S. At 23°C, similar optimum ranges were found for hatching as well as for normality. The salinity-temperature combination at which spawning occurred is thus included in the optimum range recorded for egg incubation.

Larvae used for the experiments on larvae survival and normality originated from eggs incubated at 35 ‰ S and 18 °C, i.e. under optimal conditions for egg incubation; gradual transfer to experimental levels was effected just after hatching. At 18°C, as well as at 23°C, best survival (87-97 %) and normality (50-79 %) were both obtained in the salinity range from 15 to 25 ‰. Maintaining a salinity of 35 ‰ , optimal for egg incubation, considerably reduced values of both survival ( 52 and 59 %) and normality (25 and 34 %) were found at both temperatures.

The values of the coefficient of variation ( $C = s/\bar{x}$) calculated for the three replicates of each experiment confirm these results, variability being at minimum within the optimal ranges and reaching considerably higher values outside these ranges. It thus appears that, under the conditions prevailing on the coast of the North Adriatic, good results can be obtained using undiluted seawater for spawning and egg incubation, but not for rearing of the first larval stages, for which seawater salinity should be reduced to at least 25 ‰. The only clear advantage of a higher temperature (23°C compared with 18°C) seems to consist in a further shortening of the period of egg incubation (from 53 to 34 hours) and of yolk sac absorption ( from 90 to 72 hours).

POSTER 58

## POTENTIALITE DES ETANGS COTIERS MEDITERRANEENS POUR L'AQUACULTURE APPROCHE METHODOLOGIQUE APPLIQUEE AUX ETANGS LANGUEDOCIENS ET CORSES, FRANCE

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Le littoral francais méditerranéen apparait comme particulièrement privilégié dans l'hypothèse d'un développement important de l'aquaculture. Nous proposons une méthodologie permettant de planifier le développement aquacole en fonction des potentialités du milieu lagunaire. Il est donc établie une cartographie pondérée des étangs languedóciens (Thau, complex lagunaire palavasien, Mauguio) et corses (Biguglia, Diana, Urbino) mettant en évidence des zones aux potentialités differentes.

Cette analyse a pour objectif de prêsenter une expression rationelle du milieu et de traduire sa diversitê en termes de niveaux d'aptitudes à une gamme d'utilisation variées.

Nous dressons une liste des différents types d'aquaculture et d'espèces envisageables dans le cadre géographique considéré.La classification adoptée tient compte de la complication croissante de l'intervention humaine tant sur le plan biologique que technique et économique:valliculture,élevage semi-intensif en enclos ou lagunes aménagée,élevage intensif en cages flottantes ou bassins à terre,prégrossissement et écloseries, élevage intensif d'organismes fixés (conchyliculture en suspension). Treize espèces pouvant raisonablement faire l'objet d'une aquaculture rentable à plus ou moins long terme ont été retenues.

Les milieux récépteurs sont décrits sur la base de paramètres physicochimiques (sédimentologie, bathymétrie, hydrodynamique, salinité), biologiques (niveaux trophiques et degré d'eutrophisation) et socio économiques (occupation du sol, accès, sources d'énèrgie et possibilités de pompage).

Un tableau à double entrée nous permet, pour chaque couple, d'apprécier l'importance du paramètre considéré pour le type d'aquaculture choisi. A partir de ce tableau nous établissons des cartes visualisant les différents paramètres en fonction des contraintes qu'ils représentent. Quatre cartes sont réalisées par lagune ou complexe lagunaire à partir des données physiques, biologiques, foncières et énèrgétiques.

Enfin la superposition de ces cartes permet de définir les zones aptes à telle ou telle activité aquacole, et ainsi servir de base pour une plnification de l'espace littoral dans le but d'augmenter les chances de réussite de telles expériences.

POSTER 59

## NIGHTTIME AERATION OF CHANNEL CATFISH PONDS

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The efficacy of continuous and nighttime aeration to increase channel catfish (*Ictalurus punctatus*) production at high densities has been demonstrated in recent studies. However, the benefits of aeration from low powerated aerators (< 2kW/ha) to catfish stocked at variable densities has not been investigated.

Channel catfish were stocked in 0.04 and 0.13 ha ponds in March 1980 at rates of 7,500, 15,000, and 22,500 fish per ha. Fish ranged from 8 to 20 cm total length at stocking and were fed a floating pelleted ration (36% protein) daily through November. Ponds received nightly aeration (0200 to 0700 hrs) with 0.25 kW (1.84 kW per ha) floating, fountain-spray aerators from May through October. Two ponds stocked with 7,400 fish per ha received no aeration, and served as controls.

Danw dissolved oxygen (DO) levels consistantly dropped below 2.0 mg/l in all aerated ponds stocked with 15,000 and 22,600 fish per ha July, August,and September. Distressed fish congregated around the aerators during periods of low DO and a partial fish kill resulting from DO depletion occurred in ome aerated pond stocked with 15,000 fish per ha. Additionally, aerators were not effective in maintaining DO above 2.0 mg/l following die-offs of blue-green algae.

Survival in non-aerated ponds was 63 %. Survival in aerated ponds ranged from a low of 68 % in ponds with 22,500 fish per ha to a high of 82 % in ponds with 7,500 fish per ha. Yield of catfish averaged 1,670 kg per ha in the non-aerated treatment and was 2,436, 3,103, and 4,712 kg/ha in aerated ponds stocked with 7,500, 15,000, and 22,500 fish per ha, respectively.

Nightly aeration of ponds with aerators rated at 1.84 kW per ha was not effective in maintaining adequate DO levels at stocking rates equal to or exceeding 15,000 catfish per ha. Larger and/or more efficient aerators are required for high density production of channel catfish.

POSTER 60

## MASS CULTURE OF *BRACHIONUS PLICATILIS* WITH A INTEGRATED SYSTEM OF *TETRASELMIS SUECICA* AND *SACCAROMICES CEREVISIAE*

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Mass culture techniques for *Brachionus plicatilis* are described, integrating traditional feeding with microalgae (*Tetraselmis suecica*) and yeast (*Saccaromices cerevisiae*). Twelfe percent of the rotifers produced are fed with algae and 88 % with yeast. About 76 % of those rotifers fed with yeast are used for feeding fry of aquaculture species.

The culture period for rotifers is subdivided into three stages which last 18 to 20 days : the first stage lasts 5 days and involves cultivation with *Tetraselmis suecica* in a 40 liter polyethylene bag filled with this alga, starting with an average rotifer concentration of about 40 individuals per ml. Final average concentration reaches 300 rotifers per ml. Average daily increase of the rotifer population reaches about 50 to 60 %.

During the second stage of culture, rotifers are utilized to inoculate three cylindrical-conic tanks of 80 liters each (average density 55 rotifers/ ml). The second stage lasts 6 to 7 days, which is the period to feed the rotifers with *Saccaromices* only, at average concentrations of 200 rotifers/ ml. The average daily increase is about 20- 25 %.

During the third stage, 65 % of the rotifers are used for feeding fry. 35 % are used to inoculate three other cylindrical-conic takns (80 l each) with an initial average density of 70 rotifers per ml. Feeding only rotifers with yeast, the population density reaches 150 individuals per ml in 6 to 8 days. The average daily increase in numbers is 10 to 12 %.

The results allow us to reduce operational costs by abput 80 %.

POSTER 61

## SELECTION FOR GROWTH RATE IN ATLANTIC SALMON

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In Norway, production of Atlantic salmon started around 1970. No domesticated fish were available, and the farmers had to use wild brood stock caught in rivers. In 1971, the Research Station for Salmonids started a selection programme for Atlantic salmon. For 4 years brood stock were sampled in 40 rivers. At fertilization several full and half sib families were made from each strain. In each year class about 150 families are tested. The fish were kept under farming conditions during freshwater periods and reared in cages in the sea during 2 years before final selection is made. Large and significant variation between salmon strains were found for most of the traits studied. The variation between families were particularly large for growth rates (distribution of weights of family averages were 3.25-6.50 kg).

The response to selection in growth rate is now available for the first year class. Selected fish averaged 4.29 kg compared with the control which averaged 3.73 kg. This is a difference of 0.54 kg or 15 %. Taking the generation intervall into account, the genetic change per year was 4%. This is in good aagreement with the expectation based on theoretical calculations.

POSTER 62

## INTERTIDAL BIOLOGY AND BIVALVE AQUACULTURE

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Detailed investigations on the intertidal biology of bivalve molluscs may lead to refinements in culture techniques for species which are grown intertidally, and perhaps suggest other species which could be raised in this manner. The present paper reports a series of experiments which sought to delineate the basic growth responses to intertidal exposure of six species of suspension-feeding bivalves: Argopecten irradians, Modiolus modiolus, Ostrea edulis, Mytilus edulis, Crassostrea virginica, and Geukensia demissa.

Batches of field-collected or hatchery-reared juveniles were divided into groups and placed on intertidal racks at various exposure levels from 0 to 60% mean aerial exposure. Parallel experiments were conducted in the laboratory where animals were artificially exposed in a tidal simulator. At the end of each experiment, shell dimensions were measured with dial calipers and the test organisms were shucked for dry weight determinations of both the shell and soft parts. Mean monthly instantaneous growth rates for all parameters measured were calculated and compared. Various morphometric relationships were also calculated and considered statistically.

The ability to grow in the intertidal zone corresponded well to the shore levels naturally occupied by the species studied. Examination of the curves produced by plotting instantaneous growth rate as a function of exposure level well illustrated the superior intertidal performances of the three upper-shore species - M. edulis, C. virginica, and G. demissa - relative to the three lower-shore species. Additionally, the growth curves revealed subtler aspects in the energetic adaptations of upper-shore species to intertidal life, including reduced sensitivity to harsh exposure conditions and an apparent ability to increase nutritional input despite limitations on the time available for feeding. Numerical integration of growth curves allowed quantitative assessments of intertidal growth potential and comparisons among species.

Bivalves grown intertidally tended to have thicker (i.e., heavier) and more globose shells than those grown subtidally. These tendencies did not necessarily correlate with naturally occurring or experimental intertidal level. A trend for higher meat-to-shell ratios in intertidally exposed individuals, on the other hand, did appear to correlate with natural shore position.

This study has provided a method whereby the intertidal growth potential of suspension-feeding bivalves can be assessed. Application of this method will show if, and at what levels, a species can be successfully grown intertidally. Moreover, it has shown that, for species capable of intertidal grow-out, higher meat-to-shell ratios and better shell quality can be expected. These results coupled with those of other studies indicating better keeping quality in intertidally conditioned bivalves warrant the more extensive use of the intertidal zone in bivalve aquaculture.

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POSTER 63

# DESCRIPTION OF A COMMERCIAL TRAY CULTURE FOR OYSTERS
## Operations, Economics, Environment - Baja California, Mexico

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This report describes the physical, economic, and labor factors of an off-bottom oyster (primarily C. gigas) farm in Baja California Sur, Mexico. The farm is located in a shallow estuary adjacent to the fishing community of La Bocana. Operation of the farm is conducted by the Progreso Cooperative under guidance of Panacua, S.A. in the form of a joint-venture.

Because of extensive fouling, strong currents, and numerous predators, the oysters are held in floating, stacked, plastic trays tied to a mooring rope. Oysters are "planted" at 15 mm to 25 mm in size and harvested at 85 mm to 100 mm. Their densities are 1000 to 1500/tray at planting and 80/tray at harvest. The grow-out period ranges from 4.5 to 7 months irrespective of the time of planting. Variations in growth rates and "meat" quality are due primarily to the oysters' intrinsic traits, turbulence, and temperature.

The growing and handling sequence consists of three primary parts: 1) seed growth to 30 mm - 35 mm - one month, occurs in quieter waters and requires frequent handling; 2) growth from 35 mm to 80 mm - 3-4 months, occurs in main channel with less frequent handling; 3) "hardening/fattening" with growth to 85 to 100 mm - 1½-2 months, occurs in very low intertidal area and requires no handling.

The farm has been in operation for 17 months and produces oysters on a continuous basis with plantings occurring monthly and harvests weekly. Seed is obtained in California and sales occur in Mexico and the United States. Operational costs have not stabilized because the farm is growing. However, the approximate U.S. costs/oyster are: seed - 2.0¢; labor - 1.9¢; supervision and administration - 2.0¢; equipment 1.7¢; sales - 1.5¢; materials and other items - 1.0¢; totaling 10.1¢. The average sale price/oyster is 18¢ with the oysters going to the "half-shell" market.

The weekly production is approximately 25,000 oysters and requires 9000 trays and the equivalent of 5 full-time laborers plus supervisory and administrative personnel. Most of the labor requirements are related to tray cleaning and reducing oyster densities as they grow.

We have demonstrated that off-bottom oyster culture in plastic trays can be cost-effective in the appropriate environment. The product is free of fouling organisms and sediment, plus it has good form and taste. Thus, C. gigas has easily penetrated the half-shell market. Accomplishing this required the development of a number of techniques and procedures related to materials handling and oyster biology.

POSTER 64

## PILOT SCALE PRODUCTION OF RAINBOW TROUT IN KIEL FJORD: NETCAGE CULTURE OF RAINBOW TROUT IN BRACKISH WATER - A PILOT SCALE EXPERIMENT

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In comparison to the production plant described in another paper (see Poster No. 5 ) a netcage trout farm was installed in April 1981 in Kiel Fjord at the same locationw whre the silo plant is situated (system Institut für Meereskunde, investment 520,000.- DM). This enterprise uses ten globular submersible netcages. The globes have a diameter of 8.4 m and a useable water volume of 180 $m^3$ each in their upmost position.

The annual capacity of production is about 90 tons. Growth of rainbow trout in this arrangement is satisfactory ( 1.5-2.0 % of body wet weight per day in fish of 45 to 80 g) at a food conversion factor of 0.9 (dry pellets to wet weight gain ).

The mortality lies beween 2 and 4 % during the first month and is decreasing. Production costs including inverstment are estimated to be 4.00 DM per kg until fish will reach a marketable size, indicating the economical feasibility of the enterprise.

POSTER 65

## OPTIMAL LEVEL OF KRILL (*MEGANYCTIPHANES NORVEGICA*) AS THE SOLE PROTEIN SOURCE IN DIETS TO COALFISH (*POLLACHIUS VIRENS*)

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Krill is an important part of almost every higher food chain in the sea. In fish farming, krill may be an excellent feed component in most diets, regarded on taste, pigmentation effect and nutritional quality.

In earlier experiments with use of krill as a protein source in feed to coalfish krill was found to give good growth of the fish.

An experiment was conducted to find an optimal protein level in diets to coalfish with krill as the only protein source in the diet. The results indicated highest growth rate and best protein retention on diets with 24 % protein energy of the total dietary energy.

POSTER 66

## UTILIZATION OF TWO ISOLATED SOYBEAN PROTEINS AS A SUBSTITUTION FOR HERRING MEAL IN DIETS TO RAINBOW TROUT (*SALMO GAIRDNERI*)

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Rainbow trout is adapted to high dietary protein levels of animal origin.

Many experiments have been conducted to replace the fish meal protein with soybean meal, and the results have shown that some part of the fish meal can be substituted.

Isolated soybean protein is the purest soya protein source, and is regarded as a high quality product. Two different isolated soybean proteins have been used as a substitute for herring meal in diets for rainbow trout. With use of Prominw D as a soya protein source, 33 % of the herring meal protein could be substitutet without weight depression in the fed fish. When Soaymin 90 was used as a soya protein source, the experimental results showed that up to 82 % of the dietary protein could come from the vegetable protein source.

The difference between the isolated soybean proteins as a substitution for herring meal can not be clearly explained. But chemical analysis have shown that for Promine D nearly all the methionine exists as methionine sulphoxide. For Soyamine 90, 25 % of the total methionine was oxidized to methionine sulphoxide. No data exist about utilization of methionine sulphoxide as a sulphur containing amino acid in fish; it may be that this difference in the isolated soybean protein cause the difffrent subtitution effect.

POSTER 67

## EFFECT OF FISH SOLUBLES ADDITION IN FISH MEAL ON GROWTH OF RAINBOW TROUT (*SALMO GAIRDNERI*)

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Fish meal is extensively used as a protein source in fish diets. Variations in the chemical composition of fish meal can be made by altering the addition of fish solubles before drying the meal.

Two experiments were conducted to examine the effect of fish solubles addition in fish meal used as a protein source in dry diets for rainbow trout cultivation.

Experiment (I) was made up with three feeds of different dietary composition, run with four groups of 100 trout on each diet. The protein sources examined were as follows:

(a) presscake meal, (b) whole meal and (c) whole meal plus crystallized lysine to the same level as in diet (a).

The experiment was run for 12 weeks with ad libidum feeding three times a a day. The results showed significantly lower ($P<0.01$) weight gain of trout given presscake meal instead of whole meal.

Experiment (II) was also made up with three feeds of different dietary composition, run in triplicates with 100 trout in each aquaria:

(a) presscake meal (b) whole meal and (c) whole meal plus extra addition of fish solubles were examined as protein sources in artificial diets for trout. The experiment was conducted over 16 weeks. The average weight gains were not significantly different between the dietary groups.

In conclusion, fish meal produced with fish solubles can be recommended as a protein source in rainbow trout feeds.

POSTER 68

# Trout and Salmon use $C_1$ or $C_2$ as Vitamin C Sources for Growth

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L-ascorbic acid ($C_1$) is one of the most labile components in fish feeds and determines the shelf life of manufactured and stored finished feeds for fish in trout and salmon aquaculture.

Rainbow trout and coho salmon fed diets deficient in ascorbate develop classical scurvy symptoms after a ten-fold increase in body weight. Lordosis, scoliosis and impaired support collagen synthesis are evident. Scurvy symptoms can be reduced by adding L-ascorbic acid or L-ascorbyl-2-sulfate derivatives ($C_2$) to the diet. Ingested radioactive labelled $C_1$ or $C_2$ is absorbed and appears in dermal and heavy collagen or support cartilage areas in trout and salmon tissues. Depletion studies indicate salmonids at SET can incorporate most of a ten fold continuous dietary requirement intake of ascorbate and can then survive without apparent deficiency signs for an eight-fold body weight increase before scurvy signs appear.

Iso-ascorbic acid at five-fold equivalent $C_1$ dietary requirement can support growth of trout and salmon, but scurvy appears rapidly when the diet is continued and is devoid of ascorbate.

Technical grade calcium L-ascorbyl-2-sulfate($C_2$) supported normal growth and tissue stores of total ascorbate in trout reared for one year with $C_2$ as the sole vitamin C source in the diet.

L-ascorbyl-2-sulfate hydrolase was demonstrated in trout liver tissue, indicating facile conversion of the heat stable $C_2$ stored in the tissues or absorbed from the feed source into physiologically active $C_1$ to supply metabolic needs of salmonids. Techniques to assay for correct amounts of vitamin $C_1$ and/or vitamin $C_2$ in feedstuffs, finished feeds, and in fish tissues have been developed. These assays will enable the fish nutritionist or fish feed technologist to monitor and guarantee adequate ascorbate sources to supply the vitamin C needs of fish in aquaculture.

Tissue storage forms of ascorbate will be presented including probable intermediates and pathways for ascorbate anabolism and catabolism in young fish fed either vitamin $C_1$ or vitamin $C_2$ as the sole C source in the diet.

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POSTER 69

## PRESENT STATUS OF SALMONID CULTURE IN MARINE WATERS ALONG THE COASTS OF FRANCE

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Since the first attempts to rear rainbow trout (*Salmo gairdneri*) in sea water in Brittany (1971), production of marine reared salmonids has developed steadily, passing from a harvest of 100 metric tons in 1978 to 350 tons in 1980 and presumably over 550 tons in 1981. Most of the farms are located on the North West littoral of France (Brittany - Normandy) where 26 projects of various scales are operating in 1981, using various types of enclosures (tidal ponds and cages).

The production cycle, conditioned by environmental factors, consists mainly of a winter rearing cycle with transfer to sea water in October - December and harvest (0.3 to 1.5 kg) before the next summer.

The major part of the production is composed of rainbow trout (over 450 tons) and coho salmon (*Oncorhynchus kisutch*) (around 80 tons). In the meantime, preliminary tests with atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*) and steelhead trout (*Salmo gairdneri*) are being conducted both in laboratory and in several farms.

In spite of environmental conditions, which may be considered as critical in summer for some species, the present situation seems to indicate an important potential development in the near future.

POSTER 70

## *CAUDIVERBERA CAUDIVERBERA* ("BIG CHILEAN FROG") AND ITS DEVELOPMENT

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*Caudiverbera Caudiverbera* is an amphibian of great potential demand in national and international markets for its edible and exquisit flesh. This renewable resource is an endemic species of wide distribution in our country, known as "Big Chilean Frog". The adult reaches a size of approximately 25 cm from nose to anus, and a weight ranging from 250 to 990 g. Its culture, already started in Chile, is easy and unexpensive. The frog was studied in both its natural environment (36°45', 72°25'W) in Concepción, Chile, during spring and summer (1976-1978), and in pools and aquaria reproducing temperature,feeding, light periods and density of the natural habitat. Weight, size, behaviour, feeding and several morphological parameters were recorded daily.

*C. caudiverbera* shows the following developmental stages:
Embrionic stage: from the fertilized egg (0.32 cm) to the hatched embryo (0.90-0.95 cm) unable to feed orally. This stage lasts 9-10 days.
Premetamorphic stage: from the start of oral ingestion (rupture of stomodeal membrane) to the moment in which the larva reaches a length of 14-16 cm and a weight of 40 g. This larva is oval shaped, with a muscular tail and externally invisible limbs. The autopod of the hind limbs might protrude in cases. This stage lasts 7-9 months.
Pro-metamorphic stage: larvaeare 14-16 cm long, with a more voluminous body and a weight of 50-60 g. The behind limbs develop notoriously and exteriorate completely. This stage is 2-3 months long.
Climax stage: it starts when the fore limbs become visible. Deep and progressive

and regressive changes of different organs occur, and the reabsorption of the tail is evident. At the end of this stage, the larva of musculous tail becomes a small untailed frog, with a size of 5-6 cm from nose to anus and a weight of 26 g. Climax lasts about 1 month.
Post-metamorphic stage: the juvenile frog starts a notorious growth reaching a size of 13-15 cm and a body weight of approximately 230-250 g, after 9-11 months.

These observations lead to the conclusion that the development of the "Big Chilean Frog" is of approximately 24 months. After this period a marketable animal of 230-250 g is obtained. Data and observations are being analized to determine the time required to reach maximal size and weight.

POSTER 71

## MORPHOGENESIS AND GROWTH OF THE POST-LARVA OF *PENAEUS KERATHURUS* IN COMPARISON WITH *PENAEUS JAPONICUS*

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Considering the progress in the study of *Penaeus japonicus* and the possibility of the seed production and liberation of this species in the Mediterranean countries, methods of identification, especially in the larval stages. between this species and *Penaeus kerathurus*, which inhabits the Mediterranean Sea are required to distinguish between the native and the very similar species *Penaeus japonicus* . Also a comparison of the growth rates between them is necessary for a future shrimp culture evaluation.

The morphogenesis and growth of post-arvae of *P. kerathurus* were studied in comparison with those of *P. japonicus*. The larvae of these two species were fed for 30 days under similar conditions. On the morphogenesis, the cervical carina of *P. kerathurus*, which differs in length from that of *P. japonicus*, was mainly measured as well as the chela of 3rd pereiopod, 2nd pleopod, and 3rd maxillipede and pereiopod of the post-larvae.

The ratio of total length to length of cervical carina (TL/LCC) of the post-larvae of *P. kerathurus* (total length =5.43 mm) was lower than that of *Penaeus japonicus* . From the substage P13 (average total length 12.37 mm) similar ratios were recorded. At day 30 after hatching, *P. kerathurus* and *P. japonicus* reached a total length of 10.34 mm and 17.57 mm, respectively (weights: 12.46 mg and 45.82 mg on average). The growth rate based on total length from the substage $P_1$ to $P_{12}$ of *P. kerathurus* was 138.9 % and for *P. japonicus* was 222.9 %. The food conversion rates, by feeding mussel meat during 21 days were 30.58 and 7.95, respectively.

Data on growth indicated that the larvae of *P. japonicus* grew more rapidly than those of the other species under similarly controlled environmental conditions.

The ratio TL/LCC seems to provide an easy method for identification of post-larvae as well as the adults of these two species. The results of the growth rates suggest the possibility of culturing *P. japonicus* instead of the native species in the Mediterranean area because of its superior growth.

POSTER 72

## HATCHERY AND NURSERY PROCEDURES FOR THE AFRICAN CATFISH, *CLARIAS LAZERA* (C&V)

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The African catfish, *Clarias lazera* (Cuvier and Valenciennes), is a promissing species for aquaculture. For its successful production a reliable supply of fingerlings is a prerequisite. Hatchery and nursery procedures were therefore developed. A series of experiments were carried out to test and compare different (semi)natural and artificial reproduction methods and to develop reliable reproduction management. For fry rearing, various natural and artificial feeds were investigated, and for fingerling culture an optimal feeding regime was established.

Environmental stimulation of natural reproduction in small ponds resulted in 25 % incidence of spawning, giving a return of about 350 fingerlings per spawn after 4 weeks. The use of DOCA (desoxicorticosterone acetate) to induce natural reproduction gave a complete spawning success, and fingerling returns after 5 to 10 weeks averaged about 1200 $\pm$ 880 ($\pm$SD) per female. Based on the variability of the results this method was considered unreliable. Artificial reproduction using hypophysation with carp pituitary followed by stripping of the females was very successful and resulted in an average of 70 eggs per gram of female body weight. The time period between hypophysation and stripping proved to be critical for hatching success, with optimal values between 75 and 95 % when the females were stripped 21,11 or 7 hours after hypophysation at 20, 25 and 30°C, respectively. It also proved possible to strip the females repeatedly even at weekly intervals. Although the egg yield was decreased, the hatching success was slightly increased as compared to the first hypophysation.

The use of freshly obtained milt t fertilize the eggs, gave about 4 % higher hatching results as compared to the use of sperm that had been stored at 5°C for 24 h. However, 1000x dilution of the milt in a 0.9 NaCl solution prior to use not only increased the hatching rate by about 9 % but also alleviated the effect of storage. This enabled the use of the pituitary and the milt of a single male to first hypophysize a female and subsequently fertilize the eggs.

Yolk sac absorption at a temperature of 30°C took about 2 days. When the free swimming fry were stocked in fry rearing ponds, the average return after 5 to 14 weeks was about 9 $\pm$ 9 % or 2.7 $\pm$ 1.6 ($\pm$ SD) fingerlings/$m^2$ of pond area. For successful artificial rearing of fry, the provision of a natural food (brine shrimp, copepods, daphnids) proved essential up to a weight of 20 mg (day 4) or preferably up to about 100 mg (2 weeks). An average weight of about 1 g (survival 80 %)could then be realized at the age of 4 weeks, using dry feed. Fingerlings of 1 g could be grown to about 12 g (again 80 % survival) in another 4 weeks, feeding trout pellets at 10 % body weight per day and administered at a constant rate both day and night. The procedures mentioned above proved highly reliable and well over 50 % of the eggs obtained resulted in fingerlings that could be used for production. Practical application and adaptation of the methods to tropical field conditions are presently being undertaken in Central Africa.

POSTER 73

## GROWTH AND CONVERSION EFFICIENCIES OF THE AFRICAN CATFISH, *CLARIAS LAZERA* (C&V) IN RELATION TO BODY WEIGHT, TEPMERATURE AND FEEDING LEVEL

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Address see Poster 72

The African catfish, *Clarias lazera* (Cuvier and Valenciennes) is a new species in aquaculture. To substantiate its potential for culture under intensive management conditions, a series of experiments were carried out to study its growth and

conversion efficiencies in relation to body weight, temperature and feeding level.

Fish of about 0.5, 5, 25 and 100 g were fed five different feeding levels from fasting to satiation feeding at 20, 25, 27.5, 30, 32.5, and 35°C. The different trials took place in 150 liter aquaria and lasted for 4 weeks. A sample of fish before and after each trial was analysed for dry matter, protein and energy content. The same analysis were carried out in the trout pellets, that were used as feed. The specific growth rate (% body weight/d) typically increased towards a maximum with increasing feeding levels. The maximum specific growth rate realized by the smallest size group was about 12 % at 30°C. For fish between 100 and 200 g the maximal growth was just over 2 % at 25 to 27.5°C.

The feed conversion on a fresh weight basis was lowest at the optimal feeding levels. The minima varied with the temperature from 0.61 to 0.78 for the small fish and from 0.88 to 3.37 for the largest. At points of maximal specific growth rate, the feed conversion generally increased. Economic considerations must decide the overall optimal feeding levels or the limitations to the culture circumstances. From the biological data it appeared that the culture of *C. lazera* is bestbetween 25 and 30°C. At these temperatures over the size range studies, the overall optimal feeding levels decreased with increasing body weight from about 9 to 1.5 % of the body weight per day. The corresponding feed conversions increased from 0.75 to about 1.1. The conversion efficiencies of dry matter and energy were about 3. The PER (protein efficiency ratio) averaged 2.2 $\pm$ 0.5 ($\pm$ SD) and the average for the PPV (productive protein value) was 0.35 $\pm$ 0.07.

Based on these results a preliminary feeding guide for intensive *C. lazera* culture could be established. In general, the African catfish proved to be a highly efficient feedconvertor and capable of fast growth. It was concluded that at temperatures between 25 and 30°C its use for intensive aquaculture can be recommended.

POSTER 74

## ON THE CULTIVATION OF THE GREEN ALGA *CAULERPA RACEMOSA* IN TROPICAL WATERS AND SOME ASPECTS OF ITS PHYSIOLOGICAL ECOLOGY

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*Caulerpa racemosa* var.*occidentalis*, a benthic siphonaceous green alga has its natural habitat in the sublittoral of tropical shallow water reef areas. In the Philippines, where *Caulerpa* is highly regarded as a vegetable, the algae are cultivated in artificial ponds in the intertidal magrove zone. The culture technology of *Caulerpa* in ponds is described. Besides the comparison of the ecological conditions both in the natural habitat and the culture ponds, the responses of *Caulerpa* to the most important environmental factors have been studied. Unlike in their natural habitat, in the culture ponds *Caulerpa* is subjected to considerable changes of environmental factors such as salinity, temperature, light and pH. The experiments showed that the observed changes of the investigated parameters within the culture ponds usually range within the physiological limits of *Caulerpa*. Under extreme conditions, however, detrimental effects can occur. The possibilities of controlling such factors are discussed.

POSTER 75

## SETTLEMENT AND FIRST GROWTH OF THE MUSSEL, *MYTILUS EDULIS* L., IN THE SOGNEFJORD, WESTERN NORWAY

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The aim of this investigation was to establish some of the conditions for mussel culture in the 200 km long and 1,300 m deep Sognfjord. In the spring and early summer of 1980 some 30 spat collectors were put out in the sea of which 22 were successfully recovered in the autumn. The collectors were distributed along both sides of the fjord to get a general picture of the settlement depth, spat density and the growth the first months after settlement. The collectors consisted of 8 mm green polypropylene ropes achored vertically in about 2o m water depth with a concrete block on the bottom and a plastic buoy on the surface.

In the outer and middle parts of the fjord the upper settlement limit was at or close to the surface, while the lower limit varied from 2-3 m depth in the outer parts and 6-9 m in the middle parts. In the inner parts of the fjord the upper limit dropped to 2-4 m below the surface, while the lower limit was regularly between 9 and 14 m and the maximum recorded 17 m below the surface.The submergence of the upper limit of th spatfall in the inner parts of the fjord is probably caused by the very low salinity which dropped to about 4 ‰ in the summer months in the upper 2-3 m. The very deep extension of the lower limit could not be explained by salinity. High turbidity caused by the freshwater runoff could be of importance.

Spat densities were mostly very high, regularly between 2000 and 7000 per m collector; the maximum recorded was 12,500. This gives the implication that growth on the collectors is not possible without thinning. Spat growth varied considerable. Size distribution curves mostly showed best growth in the middle of the settlement area, with smaller mussels towards upper and lower settlement limit. In places with best growth, mussels not more than 3.5 months old consisted about 50 % (weight) in the size class 20-30 mm and 50 % smaller; and mussels which were maximally 5.5 months old consisted of 33-86 % in the size group 30-40 mm. Only a few individuals were slightly above 40 mm.

From these data, and also from additional data obtained in 1979, it is possible to draw the conclusion that commercial sized mussels (50-60 mm) could be harvested in most parts of the Sognefjord after two summers growth, i.e. 1.5 years.

POSTER 76

## USE OF A SALT WELL-WATER IN THE WINTER GROWTH AND SURVIVAL OF MARINE FISHES: TURBOT, SOLE AND SEA-BASS

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The first tests of fish culture in the new pilot station of the CNEXO on the Atlantic coast saltmarshes showed that thermal variation of seawater is very important (+1°C mini, +25°C maxi in raceways; -1°C mini, +30°C maxi in lagoons). Winter temperatures are lethal for most of the fishes and shrimps.

Since 1980, well-water has been pumped from -5 m. Temperature of this water is constant all year round (+ 14°C), salinity is 36-37 ‰ /l, pH is 6.8 and nutrient concentration is high particularly for total ammonia (4 ppm). To make it acceptable, this well-water has to be oxygenated. The iron precipitate can be removed by filtration and the ammonia by nitrification. This work shows that it is now possible to avoid fish mortality from too cold temperatures in lagoons

and raceways and to have a good growth in winter. Tests were made in well-water simply oxygenated (water 1) and well-water with 90 % ammonia depuration (water 2). It appears that sea bass (*Dichetrarchus labrax*) and sole (*Solea solea*) accept high levels of ammonia present in water 1. Turbot *(Scophthalmus maximus)* is very sensible to iron precipitate which obstruct their gills. A normal growth is obtained for sole, turbot and sea-bass in water 2. The utilization of well-water tanks (water2) in a greenhouse allows to have a wter temperature of 14°C + 4°C with only solar energy. This water is + 5°C to+6°C warmer than seawater formerly used in winter.

POSTER 77

## ILLUMINATED NET CAGES FOR REARING FISH LARVAE

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Many zooplankton species are attracted by light. This phenomenon can be used for rearing fish larvae in cages equipped with underwater lamps. Zooplankton is attracted continuously into cages. Eutrophic lakes are most suitable for this strategy of fry production.

The components of an illuminated net cage unit consists of an anchored pontoon with mounted cross-beams, from which the net cages are suspended, and the electric units are attached. On each side of a 12 m long pontoon 4 net cages (2x2x2 m) can be placed. The cages are made out of tulle (material used to make curtains). The corners are attached to an upper and a lower frame, which maintains the shape of the cages. The size and species of fish to be reared determine the optimal mesh size utilized. Most commonly used are 0.5, 1.0, 1.5 and 3-4 mm meshes. The cages can be opened by zippers for examining and emptying. The unit is anchored about 60 m from shore and powered from land with low voltage (24 V). In each cage a 100 Watt (24 V) electric bulb lamp is suspended freely in the water. Its electrical socket placed in a PVC-housing is made waterproof by an oil seal. To avoid the growth of algae on the cages, they are placed at a depth beneath the double distance of the Secchi-depth. Detritus accumulated in the net material is beaten off twice a week with a plastic carpet beetle.

During the first 2 years of experimental work, 80,000 whitefish (*Coregonus lavaretus* and *C. albula*) up to a lenth of 6-11 cm and a weight of 6-11 g, 35,000 pike (*Esox lucius*), 3-5 cm in length and 0.5-1 g in weight, as well as 4,000 pike-perch (*Lucioperca lucioperca*) up to 3 cm in length were reared in the illuminated net cages. The best survival rates obtained were 39 % for 165 day old whitefish, 42 % for 12 day old fry of pike (3-4 cm in length), and 27 % for 3 week old fry of pike-perch (3 cm in length). Bacterial gill diseases were found to be the primary cause of mortality amoung whitefish and pike-perch.

POSTER 78

## USE OF CHITIN DERIVED MICROBIAL DETRITUS FOR THE MASS CULTURE OF *ARTEMIA*

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The brine shrimp *Artemia salina* has been masscultured in Kuwait for the pre-adult production for feeding the fish larvae. One of the major problems in *Artemia* mass culture is to find a suitable feed which provides nutritional enriched maximum yield within a short period of time without spoiling the water quality. As one of the feed components, chitin derived microbial detritus has been tested to be utilized as a feed during mass culture of *Artemia*.

Shrimp head wastes along with wheat bran and chicken manure were subjected to degradation with the help of bacteria, fungi and yeast. The chitinivorous micro-organisms such as *Serratia marescens*IMR-lel convert the material into a good source of feed containing protein, carbohydrates, lipids, cellulose, etc. The final product has been made into 40 micron particles by seiving through a standard mesh. This was utilized for feeding the *Artemia* from nauplii to the adult stage.

To evaluate the optimum feeding level, experiments were conducted using 5o, 125 and 250 ppm concentration per day. The use of 50 ppm concentration of the microbial detritus proved to give the best results. The culture density was 500 *Artemia* per liter. During the end of the first week 60 to 80 % survival was obtained. The animals matured on the 14th day of the observation period. The following hydrological parameters were observed: salinity 40-48 ppt., temperature 22-27°C, pH= 7.8 - 8.1. It is encouraging to utilize chitin derived microbial detritus as a feed for the brine shrimp because of its economic viability and nutritional quality.

POSTER 79

## TEMPERATURE TOLERANCE AND FINAL PREFFRENCE - RAPID METHODS FOR THE ASSESSMENT OF OPTIMUM GROWTH TEMPERATURES

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It is comparatively easy to determine temperature preference and temperature tolerance limits of fish species, using suitable designed electronic shuttleboxes or temperature gradient apparatus. On the other hand, determination of the optimum temperature for growth is time consuming and involves use of large numbers of fish acclimated to and reared at a wide range of temperatures.

An analysis of published data showed that optimum growth temperature, temperature preference and upper tolerance limits were significantly correlated:

Temp. Pref. (°C) = 1.05 Growth Opt. (°C) - 0.53 ($n = 19 : r = 0.937$)

Upper Tol. (°C) = 0.76 Growth Opt. (°C) + 13.81 ($n = 22 : r = 0.866$)

Therefore temperature tolerance/preferance data could be used as a rapid method for estimation of temperature required to promote maximum growth of fish.

It is suggested that laboratory investigations into temperature tolerance and preferance could also find application in: I) investigation of ontogenetic changes in temperature requirements for growth, II) "screening" of potential culture species, III) site selection of aquaculture stations.

POSTER 80

## BUDGET ANALYSIS OF A SHRIMP HATCHERY UNIT

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Commercially important shrimp species are now being spawned and reared to market size. This study investigated the commercial feasibility of raising shrimp from the naupliar stage through to postlarvae, known as the hatchery phase of shrimp culture. The facility design is based on the National Marine Fisheries Service Shrimp Hatchery in Galveston, Texas. The generalized budget simulation

model for aquacultural facilities recently developed at Texas A & M University was used for the analysis.

Annual budgets for a 10-year planning horizon were estimated, based on a price of $ 10 per 1000 postlarvae, to determine costs, returns and profit. Annual cash flows were generated for a 10 - year planning horizon. Opportunity cost, initial investment costs, and breakeven prices and quantities were also determined. Sensitivity analysis were performed for price and several major cost items.

POSTER 81

## LARVAL REARING OF MILKFISH, *CHANOS CHANOS* (FORSKAL)

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Attempts have been made to rear milkfish larvae to metamorphosis since 1977. Results of a study indicated that better survival rates are obtained if oyster eggs and larvae are offered together with *Brachionus* to the first feeding larvae rather than offering *Brachionus* alone. Since oysters are expensive and difficult to obtain in large quantities in the Philippines, we tried to rear the larvae without using oyster eggs and larvae.

In 1979 and 1980, larvae from artificially fertilized eggs of wild milkfish breeders induced to ovulate in captivity by hypophysation, were teared in 600 l circular fiberglass tanks at ambient temperature (26 - 30$^{0}$C) and at a salinity of 34 ppt. The larvae were stocked at a density of from 1 - 5 larvae / l. *Chlorella virginica* was introduced into the rearing tanks on day 1; *Tetraselmis chuii* and *Brachionus plicatilis*, on day 2. The concentration of *Chlorella* was maintained at 1 - 2 x 10 cells / ml and that of *Tetraselmis*, at 2 - 4 x 10 cells / ml throughout the 21 - days rearing period. The concentration of *Brachionus* was maintained at 20 - 30 organisms / ml from day 2 - 10 and from 10 - 20 organisms / ml thereafter. From day 11 - 21, newly hatched *Artemia* nauplii and the copepodites and adults of the harpacticoid copepod, *Tisbintra elongata*, were introduced to the rearing tanks respectively at a density of 0.5 - 1.0 organisms / ml.

Yolk was completely absorbed in 3 days. At this time, the mouth was opened and the larvae started feeding. High mortality occurred from day 4 - 7; thereafter, mortality was minimal. In 1979 , the survival rates ranged from 4 -17 % (means = 10 %) and a total of 1214 fry were harvested. In 1980, survival rates ranged from 14 - 74 % (mean = 42 %) and a total of 5710 fry were harvested.

In July 1980, one batch of eggs and in May 1981, four batches of eggs spawned naturally by 3.5 - 5 years old captive breeders that sexually matured in floating cages, were collected. Some larvae from these eggs were reared to metamorphosis following the method described above. The survival rates ranged from 20 - 50 %.

Results of our experiments showed that it is not necessary to offer oyster eggs and larvae to first feeding milkfish larvae in order to obtain better growth and higher survival. There are no significant differences in the growth and survival rates of larvae from artificially fertilized and naturally spawned eggs. The short rearing period for milkfish from hatching to metamorphosis makes them suitable for mass production under controlled conditions.

## FISH PRODUCTION IN POLICULTURAL REARING UNDER DIFFERENT POND MANAGEMENT CONDITIONS

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The experiment was set up in six ponds of the same dimensions (9.0 x 5.0 x 1.2 m) at the Fish Culture Section of Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal, São Paulo State, Brazil. Six different treatments were tested, with three different management systems, each of them with 2 stocking densities (1.1 and 2.2 fingerlings / $m^2$). Ponds were stocked with fingerlings of common carp (*Cyprinus carpio communis*), hybrid tilapia obtained through the cross of male *Sarothe rodon hornonum* x female S. *niloticus* and a brazilian catfish (*Rhamdia hilarii*) at a ratio of 2 : 2 : 1.

Management strategies consisted of (a) fertilization only in fish ponds with chicken manure at 6 and 12 ton / ha / year, (b) supplementary feeding with a powder diet containing around 24 % crude protein and (c) a treatment that combined both.

After 6 month fish production was lower in ponds that were fertilized only (1,885.0 and 2,920.0 kg / ha / year). Ponds that received only supplementary feeding produced 5.9 and 6.3 t / ha / year and ponds with both treatments production obtained was 4.6 and 7.3 t / ha / year.

POSTER 83

## NUTRITIONAL ENRICHMENT OF THE MARINE YEAST *CANDIDA SP.* AND THE USE OF SODIUM HYPOCHLORITE DURING MASS PRODUCTION FOR AQUACULTURE PURPOSE

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The marine yeast *Candida sp.* (MFD - Y - St 03) has been mass cultured for feeding zooplankton and shrimp larvae, It was observed that the rotifer *Brachionus plicatilis*, which fed on the ordinary marine yeast, lack some of the essential fatty acids which are required for growth and survival of fish larvae. To solve this problem, in addition to the basic synthetic media for yeast culture, fish oil and Tween 80 were used. The optimum culture conditions for good growth and nutritional enrichment was determined by a series of quantitative and qualitative studies on the preparation of the media for the culture.

Optimum growth rate from marine yeast in total dry weight (g / l) was obtained under the following conditions: agitation speed 400 rpm, aeration volume 10 l / min., temperature 30°C, pH 4.5 and salinity 30 ppt. Various surfactants such as Tween 85, Tween 80 and Span 20 were tested. The use of Tween 80 proved to be the best, resulting in low consumption of sugar and better growth rate. The use of Span 20 failed to give a homogenous mixture and often resulted in precipitation of the cells. The marine yeast thus produced contained the highly unsaturated fatty acids from 18 : 3 onwards.

In addition to nutritional enrichment of the marine yeast, the cost of production was much reduced by use of sodium hypochlorite as a sterilizing agent, instead of antibiotics such as chloramphenicol. The commercial product "Clorox" was used effectively from 10 liter capacity jar fermentor cultures to 1 $m^3$ capacity outdoor cultures, reducing up to 98.8 % the cost spent for sterilizing the culture media.

POSTER 84

## ENVIRONMENTAL CONDITIONING PROCESS FOR ACCELERATING AND CONTROLLING THE DEVELOPMENT OF SALMON SMOLT AND SUBSEQUENT SALT-WATER MATURATION IN PONDS AND CAGES

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Through the technique of blocking the entry of direct or indirect light into a pond over a substantial surface area thereof, as by contacting the water surface with an opaque light shield or cover, that creates immediately thereunder throughout the depth of the pond a dark shadow volume, and circulating natural water appropriately about the shield region,while downwardly illuminating defined uncovered regions of the pond adjacent to the shield to provide illuminated feeding zones that can be viewed by the fish laterally outward from under the shield, the myriad of stress, competition and gonadic development problems inherent in Atlantic salmon fry development have been overcome, and with an accelerated 80 - 90 % smolting result within one year

With appropriate light contol on a 24 - hour basis, if desired, the fish are trained to live in close stacks with densities greater than customarily employed, and with feeding taking place as if in a perpetual continuum of dusk, resulting in remarkably accelerated growth,restraint of gonad development, and the obviating of the nibbling and other damage customarily encountered with precious fish; such that immaculate, uniform size smolt are developed. A measure of control over the time of smolting is enabled through control of the above environmental parameters.

Results obtained in commercial smolt - raising by this "KR" process in the United Kingdom in 1978 - 80 have enable 80 - 90 % smolting of the original fry in natural, unheated river water within one year. Comparison with the 10 % smolt resulting within about one year without the new process, showed that the process smolt were ready for the sea two months earlier. Smolt raised by KR process, moreover, were 75 % longer than the control (14 cm vs. 8 cm). In addition, at least 60 % more smolt of given size range could be raised in a pool than without the process, under similar conditions; for example, 1.1 kg of fish per 64 $cm^3$ in a 3000 $cm^3$ pool, with 38 liters per minute flow, as compared with 0.7 kg.

Starting with 1.65 cm fry in May (1978), 120 g, 22 cm smolt were achieved by August (1979) as compared with normal 40 g, 13 cm smolt without the process.

Initial results in tests performed with the process by the United States Fish- and Wildlife Service at Green Lakes, Maine, included up to about a 50 % growth increase in one large outdoor pond in 10 months over the summer and winter; and continued accelerated growth, up to 35 % over a control group in a four - month period, has now been observed after the smolt have been transferred to salt water pools in which the KR process is continued.

POSTER 85

## THE ELVER-SILO - DESIGN AND MANAGEMENT

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A silo 0.9 m in diameter and 0.5 $m^3$ water volume was used for one year rearing of glass - eels. The upper, cylindrical part held meshwire plates for for housing and feeding, the lower conical part served as a sedimentation chamber for faeces, feed losses and dead fish. A bottom drain served to remove sedimentated material from the system and to fish the eels by emptying the silo

completely. The inflowing water was a mixture of oxygenated water and recircu - lated silo water at a rate of about 1 : 5 (temp. 25 - 26°C). Oversaturation of tape - water was adjusted by the pressure and water level in the oxygenation column to 20 - 50 mg / l. Regulation was done automatically. Tape water and re-circulation water was mixed under pressure before entering the silo. The whole system had a volume of 1.4 $m^3$. Theoretical water exchange is every 5 - 7 hours.

The silo was stocked with 7.5 kg glass eels in May 1980. After two peaks of mortality, the first due to handling stress, the second due to elvers which did not feed, the mortality stabilized below 1 % per month. The growth rate was about 2 %, and the feed conversion was 1.3.

The eels were graded several times by means of meshwire boxes, and after each grading the pregrowers ( 30 %) were kept for further rearing. The total weight of eels in April 1981 was more than 50 kg. Average body weight of these pregrowers was 25g.

In November 1980 the pump basin was stocked with 10 parents of the tropical snail *Ampullarius sp.* which propagated rapidly and was feed on *Sphaerotilus* and bacteria. In April 1981 the total quantity of young snails increased to 3,605 specimens.

Suspended solids deposited in the conical part of the silo and were drained 2 times a day with about 1.5 - 2.0 liters of water each time.The dry matter of this drained concentrate was about 3.5 % of the daily food, with a BOD of 500 - 1,000 mg $O_2$ / l (before feeding) and about 3,000mg $O_2$ / l (during feeding) at daily food quantities of around 800 g dry matter. The inflowing water into the silo showed BOD values between 1.2 and 3 mg / l before and 12 - 20 mg / l during feeding. The corresponding values for the silo - effluent were 2.1 - 4.2 mg $O_2$ / l and 22 - 35 mg $O_2$ / l respectively. Passing the snail basin these values were reduced by about 30 % so that the overflow water (which quantity is equal to the tape water) leaves the system with BOD values between 1.2 and 3.1 mg $O_2$ / l before and 15 - 22 mg $O_2$ during feeding

POSTER 86

## ENVIRONMENTAL IMPLICATION OF TROUT CAGE CULTURE IN RIVERS AND LAKES

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The effect of intensive trout culture in river cages and lake sites on water pollustion was studied. The amounts of nutrients in g, introduced into water per 1 kg of the trout biomass per day were established by the least - squares method; below are stated values of the correlation coefficient - r, were calculated. They were: N in $NH_4$ 0.0405 at r = 0.991, N in $NO_3$ 0.2326 at r = 0.935, $N_{org}$ 0.0401 at r = 0.980, $N_{total}$ 0.3136 at r = 0.997, P in $PO_4$ 0.986 at r = 0.979, and $P_{total}$ 0.997 at r = 0.801. Application of the above factors to calculate the increase in pollution of the water from nutrients enabless the optimization of the trout culture and the simulation of its effects at different hydrological parameters on the rivers and lakes.

The pollution charge of oxidizable organic matter was determined empirically It was 9.22 g $O_2$ per 1 kg of trout biomass per day in the BOD units. Departing from this value a mathematical model was developed for the optimization of trout culture in river cages accounting for the water flow rate in the river and for the admissible BOD value

Acceleration of the lakes eutrophization due to the culture trout in lake sites was shown. The culture was shown inadmissible and therefore liable to prohibition in lakes and dam reservoirs due to excessive deterioration of stan-ding waters.

POSTER 87

## EFFICIENCY OF NITRIFICATION IN TRICKLING FILTERS USING DIFFERENT SUBSTRATES

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The efficiency of ammonia and nitrite oxidation was studied in two trickling filters filled with different plastic media (A = Hydropac® - Folia, Uhde Dortmund, 200 $m^2$ active surface area per $m^3$ volume; B = Bionet - Material, Norddeutsche Seekabelwerke, 260 $m^2$ / $m^3$). Both filters were operated parallel under comparable conditions (hydraulic load: 40.2 $m^3$ / $m^3$ / d = A; 43.4 $m^3$ / $m^3$ / d = B). Ammonia removal efficiency depended on pH value and on initial total ammonia concentration (range investigated: pH = 5.6 - 7.0; total ammonia concentration = 0.15 to 1.8 mg / l; nitrite concentration = 0.08 to 1.85 mg / l). Ammonia removal efficiency was reduced to almost zero at pH values below 5.7. At higher pH levels medium A was less efficient than medium B ( removal efficiency above 50 % at all times at pH values higher than 6.2 compared to 6.8 in medium A). With increasing initial ammonia concentration the removal efficiency decreased drastically in both filters (always below 60 % at concentration higher than 1.0 mg / l) . In generel, nitrite oxidation efficiency followed a similar trend in both filters, indicating a better performance of a trickling filter when using substrate B. Reasons for these observations are discussed.

POSTER 88

## PRODUCTION OF METABOLIC WASTES AND OXYGEN CONSUMPTION BY TILAPIA AND EEL IN A HIGH DENSITY RECIRCULATION SYSTEM

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Metabolic wastes ($NH_4$, $NO_2$, $BOD_5$) produced and oxygen consumed by Tilapia (size groups ranging between 10 and 500 g) and European eel (size groups between 10g and 350g) were determined in circular tanks (diameter 1.0 and 1.5 m, water volume 330 l and 780 l) and rectangular aquaria (40x30x35 cm; water volume 40 liter) at various flow rates (minimum: 7.0 l / min; maximum 36 l / min) and stocking density ( fish water ratio in experimental tanks between 1 : 4 and 1 : 8 kg / l for Tilapia and 18 to 40 kg / $m^2$ tank bottom for eel). The rearing tanks were connected to a brackish water recycling system ( system volume 14 $m^3$; 16 ‰ S; 25°C) which contained a maximum total fish biomass of about 800 to 900 kg (fish water ratio 1 : 17 to 1 : 15 Kg / l).

The results demonstrate that environmental oxygen concentration, feeding status, individual body weight stocking density and daily activity patterns affect the oxygen consumption. Oxygen consumption is maximal during feeding, handling of fish and cleaning the system and increased to more than four times the normal respiration level. A sudden rise in oxygen consumption appeared with the first daylight and increased drastically after feeding, following by a gradual decrease which never returned to pre - feeding levels during daytime. A log - log relationship between oxygen consumption and body weight of fish was demonstrated. Smaller fish required more oxygen per unit body weight and time than larger onces. Tilapia of 14.9 g average weight required on an average 289mg $O_2$ / kg / h, fish of 50.1 g needed 184 mg $O_2$ / kg / h and those of 506 g average weight consumed 59 mg $O_2$ / kg / h. The average oxygen consumption rate of tank-cultured eels were 138 mg $O_2$ / kg / h and 106 mg $O_2$ / kg / h in fish of 45.3 g and 132.1 g average weight.

Ammonia production was dependent on fish size, stocking density, feeding level and daytime (activity patterns). Highest excretion rates occured during and offer the 4th and 5th feeding, during early afternoon and evening hours (i.g. 4 - 5 hours offer last feeding). Data obtained over extended periods ( at an hourly basis over several weeks) indicate the following trends: Prior to feeding Tilapia at average weight of 27 g, 55 - 90 g and 570 g produced, 5.4, 2.0, and 1.1 mg $NH^4$ / kg / h, while maximum values were determined 4 - 5 hours after the last feeding at 25.0, 7.6 and 3.3 mg / kg / h respectively.Ammonia produced by eels attained much higher values after feeding: ( $\bar{x}$ unfed = 1.5 mg $NH_4$ / kg / h, (n = 4); $\bar{x}$ after feeding = 21.6 mg $NH_4$ / kg / h). Nitrit values for the same size groups of fish were: Tilapia unfed = range 0.1 - 2.4 mg $NO_2$ / kg / h; after feeding = 2.4 - 7.7 mg $NO_2$ / kg / h, in fish of 55 to 90 g average weight. Data on BOD production showed similar trends: Tilapia: average weight 41 - 60 g: BOD unfed = 26 - 68 ($\bar{x}$ = 38) mg $O_2$ / kg / h, n = 7; maximum BOD produced after feeding = 50 - 183 mg $O_2$ / kg / h, n = 7; $\bar{x}$ = 114).
The difference between Tilapia and eel is caused by the different feeding strategy. While the daily ration fed to Tilapia is in 4 portions distributed over the day, eels are fed only once a day, receiving the total ration.

In intensive aquaculture systems, variation in metabolic rates affects water quality dramatically. Management strategies are required that include the dynamics of such systems in order to properly counteract the accumulation of metabolites, and to enable the maintainance of acceptable water quality criteria at all times.

POSTER 89

## THE USE OF CULTURED ZOOPLANKTON AS LIVE FOOD FOR TURBOT LARVAE (*SCOPHTHALMUS MAXIMUS L.*)

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In todays mariculture, the demand for living food organisms for larval rearing is mainly covered by rotifers and *Artemia* nauplii. As *Artemia* seem to bear several disadvantages (i.e. size, biochemical composition) our studies were aimed at production of food organisms native to the larvaes environment. An estuarine calanoid copepod (*Eurytemora affinis*) was found to be dominating under the culture conditions in 28 $m^3$ outdoor tanks, supplied with Baltic Sea water (17 ‰ S) and fed with cultured green algae (*Nannochloris spec.*) at average densities of 500,000 cells per ml 2 - 3 weeks after inoculation *Eurytemora* populations reached short peaks of 1000 to 2000 adults and 2000 to 5000 nauplii per liter, followed regularly by a decline in density, when the cultures were run without harvest or water exchange. Within the investigated range of 5 to 25 % a daily replacement of 10 % of the culture volume by seawater or algal medium showed an stabilizing effect on population growth so that constant densities of at least 500 adults and 1000 nauplii per liter could be achieved over several months. When the cultures were harvested by netting without water renewal, a similar positive effect could not be found. At the optimal rate of 10 %, the daily harvest amounts to 250 to 500 mg zooplankton dry weight per $m^3$.

Used as food organisms for two generations of turbot larvae (*Scophthalmus maximus L.*), the suitability and nutritional value of cultured copepods was tested in 1979 and 1980. Trials on comparative feeding on *Artemia* vs. copepods will be carried out in 1981. Successive feeding on nauplii, rotifers (not in 1979) copepodits and adult copepods resulted in healthy larvae with growth rates of up to 32 % weight gain per day and fast larval development, reaching metamorphosis between day 30 ans 36 (15°C) and day 17 and 25 (19°C). Larval survival was

calculated to be 50 % in 1979 and 34 % in 1980, and a good condition enable a weaning without further mortality.

By harvesting only the needed instars ans additional feeding of rotifers, a copepod culture of 28 $m^3$ can nourish a batch of 4000 turbot larvae from hatch to weaning.

POSTER 90

## SEXUAL MATURATION AND SPONTANEOUS SPAWNING OF CAPTIVE MILKFISH IN FLOATING CAGES

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Recent developments in milkfish (*Chanos chanos*) breeding research include succesful induced spawning of wild adults and improved methods of larval rearing. The scarcity of wild spawners, however, stresses the need to develop a captive broodstock. Furthermore, the fry supply for nearly 400,000 hectares of milkfish ponds in Taiwan, Indonesia, and the Philippines still depends on natural source which is uncertain, seasonal, and threatened by coastal pollution.

Milkfish stocked in 1975 - 1977 as juveniles in an enclosed cove at Guimaras Island in central Philippines, were recovered and transferred to 10 m diameter by 3 m deep cages in March 1979. Part of the stock was placed in smaller cages and used in hormone - induced maturation experiments. The fish were fed commercial feed pellets (42 % protein) twice daily at 1.5 % of body weight. Annual ranges of temperature and salinity were 25 - 31°C and 28 - 35 ppt. When negative results from hormone induction experiments implicated handling stress as a causal factor, the monthly changes of cage nets in a 10 m cage with 108 fish was discontinued in March 1980. This group was never subjected to any handling stress eversince. Sampling for gonadal maturation was done at intervals of 6 - 30 days during July - November 1980 from this 10 m cage.

Out of 67 fish (3.5 - 5.5 year old and weighing 2.1 - 4.1 kg) sampled, 26 were maturing, 30 (11 F and 19 M) were mature, and 8 were spent. Most of the mature fish were obtained in July - August. Mature testes weighed 11 - 17 g; mature ovaries, 57 - 308 g. Fecundity was 545,000 - 976,000 eggs. The fish used in hormone induction experiments and transferred to another 10 m diameter cage in August 1980 had maturation in March - May 1981. Most of the mature fish were obtained in April. Spontaneous spawning occurred in both cages - on August 3 and 7, 1980 in the first cage and on May 11 - 15, 1981 in the second cage. The number of collected eggs ranged from 310 to 2700. Fertilization rate was 83 - 98 %; hatching rate was 11 - 75 %. Yearlings and fingerlings are presently being reared at SEAFDEC's Tigbauan station.

The results, obtained for the first time, demonstrate the feasibility of breeding milkfish in captivity to insure future supply of seed stock. Spawning can be controlled by handling stress and occur outside the spawning peak of wild milkfish within the breeding season. Technical problems in egg collection, however, remains to be solved.

POSTER 91



# Investigation into the "Mummification" of the Digestive Gland of the Fresh Water Shrimp *Macrobrachium rosenbergii*

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The digestive glands were the only recognizable remains of the fresh water shrimp *Macrobrachium rosenbergii* found in a culture pond in Hawaii. The glands were found floating on the surface of a pond where the mortality rate exceeded 90%. Subsequent surveys made on three farms in Hawaii for the purpose of determining if the disease condition was an isolated incident revealed the presence of several mummified glands at two of the three farms. To our knowledge this is the first report of this disease condition occuring in any shrimp species.

Since having collected the glands over a year ago they have retained their gross morphological shape without the use of preservatives, while being stored both in water and the ambient air. The resistance of the gland to deterioration is apparently due to their high concentration of saturated fatty acids.

Fatty acid accumulation was thought to be due to loss of lipid metabolation either from the toxic destruction of glandular tissue or the chemical blockage of the enzyme system. Therefore an analyses was conducted on the digestive glands for both heavy metals and pesticides. The heavy metal analyses produced nothing out of the ordinary. However, the analyses for pesticides were positive for the organophosphates, malathion (.49 ppm) and thimet (.29 ppm) from one of the farms and parathion (.06 ppm) and methyl parathion (.03 ppm) from another. The glands containing pesticide showed a significant increase in total lipid content and saturated fatty acids over control glands without pesticide. For the saturated acids palmitic was 58% vs 19%; steric 12% vs 8% and myristic 10% vs 3%. For unsaturated fatty acids the glands containing pesticides were corresponding lower than the controls, approximately 10% vs 60%.

The evidence suggests that malathion and parathion, both known enzyme inhibitors, are the ethiological agents responsible for "mummification" Attempts are presently being made to reproduce the condition through the addition of malathion to the shrimp diet.

POSTER 92

## ARTIFICIAL LAYING OF SPERMATOPHORES ON FEMALES OF THE SHRIMP *PENAEUS JAPONICUS* Bate

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Morphological and anatomical differences in the structure of the thelycum enabled us to recognize two distinct groups within Penaeid prawns, the open thelycum Penaeids and the closed thelycum Penaeids. The mating behavior also differs within these two groups : for open thelycum species, the copulation occurs after ovarian development and just before spawning, at female intermolt stage Do or D'1; for closed thelycum species, the copulation occurs just after the exuviation (intermolt stage A), without relation with the ovarian development; immature females often carry spermatophores.

When rearing Penaeids of both groups in captivity, the experimental environmental conditions may contribute to failure of spermatophore transfer. In such case, the spawning of ripe females leads to unfertilized egg.

Within the open thelycum Penaeids, the artificial transfer of spermatophores has been achieved since july 1979 in french Polynesia on both *Penaeus vannamei* and *P. stylirostris*. One million post - larvae have been already produced, with egg fertilization rate ranging from 0 - 40 % for the former, fom 0 - 90 % for the later (Aquacop, unpublished data).The artificial laying of spermatophores has not yet been recorded for closed thelycum species.

The present study was conducted at the Centre Oceanologique de Bretagne (Brest) on a closed thelycum species reared in captivity for several generations since 1975, *Penaeus japonicus*. Failures in spermatophore natural transfer can happen when the animals become old ( more than 2 years old) or with high biomass ( over 500 g/m$^2$). The identification of ripe males is difficult due to the lack of transparency of the body. The drawing of the spermatophores is achieved by lateral pressure at the fifth pereiopod level. After drawing, the two spermatophores are successively inserted in the thelycum of the female previously lightly anaesthetized by lowering the sea water temperature ( exposure to 10$^{o}$C during 5 minutes). Transfers can be equally conducted on females at different stages of the intermolt cycle. This method has been applied with full success on numerous females of *P. japonicus*. The egg fertilization rate lightly ranged from 80 % and over.

Artificial transfer of spermatophores in Penaeid species could also be a valuable method for genetical inverstigations.

POSTER 93

## INTERNATIONAL STUDY ON *ARTEMIA*. XXIV. STORAGE OF *ARTEMIA*-NAUPLII FROM VARIOUS GEOGRAPHICAL ORIGIN IN THE REFRIGERATOR - POTENTIALS AND LIMITS OF ITS APPLICABILITY IN AQUACULTURE HATCHERIES

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A technique is described for live storage of high densities of instar I *Artemia* nauplii in the refrigerator. For most *Artemia* strains tested naupliar viability is still very high after 48 h storage, and naupliar dry weight has not decreased significantly after 24 h storage. Mysid-juveniles *(Mysidopsis bahia)* and carp larvae (*Cyprinus carpio*) perform equally well on a diet of 24 h (and for the mysid even 48 h) stored nauplii as compared to freshly hatched *Artemia* nauplii.

An automatic system is described for the cyclic distribution of stored *Artemia* nauplii to the cultured species.

POSTER 94

## THE EFFECT OF VARIOUS WATER EXCHANGE RATES ON THE GROWTH OF *DICENTRARCHUS LABRAX L.*, IN RELATION TO THE PHYSICO - CHEMICAL PROPERTIES OF THE CULTURE ENVIRONMENT

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The level of metabolites in intensive fish culture systems may have adverse effects on the cultured organism. The ultimate manifestation may be in mass mortality of the fish, but more subtle problems include slower growth, outbreaks of disease and lower feed conversion efficiency. In freshwater fish, a good deal is known on the concentration of metabolites which can have undesirable effects, but this is not the case with marine fish.

A 90 - day experiment was conducted with Sea bass (40 g average weight). Fish were stocked in three basins of 1.5 m, and were subjected to various levels of water exchange. The growth of the fish and the physico - chemical parameters of the culture water (oxygen, BOD, pH, salinity, nitrate, nitrite, ammonia, phosphate) were monitored.

The fish grew equally well in all three basins, although those with the least water exchange (1.3 times / day) suffered greater mortalities and had a greater food conversion index. The amount of metabolites in the culture water depended on the water exchange rate and temperature, with good correlations for ammonia and phosphate. The levels of metabolites encountered (up to 3 mg / l of ammonia 1.5 mg / l of nitrite) did not appear to adversely affect growth, with pH down to 7.43 units.

These results indicate the level of metabolites which do not adversely affect sea bass, and the amount of water replenishment required for intensive culture installations.

POSTER 95

## FOULING COMMUNITIES IN A MUSSELCULTURE CENTER OF CHILOE, SOUTHERN CHILE

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Fouling studies on rafts and long-line systems at the musselculture Center of Yaldad ($43^{o}08'S$; $73^{o}44'W$) were made from 1978 to 1981. These studies were undertaken: (a) to determine the number of sessile species in artificial communities developed on experimental plates hanging from a seed collector system, and (b) to describe seasonal fouling succession over the year. Two experimental sets using 20 x 20 cm plates were used; one including thick polyethylene horizontal plates hanging grom a partially submerged long-line system, located nearshore and subjected to tide action; the other set was made of asbestos-cement plates which hung vertically from a 16 x 16 m metallic raft at a depth of 1.5 m.

The following general results were: Specific diversity was low in both systems. In the long-line's set, a total of 19 species were controlled, ranging from one species in the first month to 12 species during the whole period. The raft's set

had 13 species controlled. No *Mytilus* domination was observed but there were two important observations: The first corresponded to *Ectocarpus*, a filamentous ephemeral algae that occurs from autumn to the end of spring. The presence of *Ectocarpus* and *Obelia* permitted settlement of mytilid succession of *Diplosoma macdonaldi* (colonial tunicate) developed mainly during spring and summer months. Its folds hung down and were easily cut. On this occassion another agressive ascidian (*Cnemidocarpa robinsoni*) settled on mytilid collectors after being submerged for at least 60 days.

The knowledge of successional events in fouling communities can aid in management control of a musselculture centers such as Yaldad.

POSTER 96

## ARTIFICIAL REPRODUCTION IN *PENAEUS JAPONICUS* BATE ON A BASIS OF COMMERCIAL PRODUCTION OF EGGS AND LARVAE (1)

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*Penaeus japonicus* bate is absent on Italian coasts, but it is considered a very important species for national aquaculture.

To develop shrimp-culture on a commercial basis, a convenient method for producing eggs and larvae of *P. japonicus* was studied. A stock of 140 females, age class 1+ and $F_3$, was operated for unilaterale eyestalk ablation, and they were arranged in three plastic tanks, total surface being 14 $m^2$. Similar conditions of environment and management prevaled including: Sex ratio 1:1, 19.7 specimens/$m^2$, temperature 21±1°C, natural light in winter and photoperiod, twice a day total exchange of sea water, and feeding on mussels. Under sandy bottom six net layers were arranged to avoid stressing spawners. A month after eyestalk ablation, the females were inspected every 7-10 days; spawners were transferred to the spawning tanks. Females with well developed gonads average 22.2 % at every inspection; 70.3 % of the spawners were with spermatophora; others were fecundated artificially by the method of introducing the spermatophora into the thelycum.

In five inspections carried out during a period of 50 days, 2,137,000 eggs were released. A female released 26,000 eggs on the average (maximum 123,000 eggs, minimum 4,000).

The mean rate of fertilized eggs was 63.1 %. It was 73.6 % from naturally fecundated females, and it was 14.9 % from artificially fecundated females.

The mean hatching rate was 40.9 %; and was 50.3 % from spawners naturally fecundated and 6.6 % from spawners artificially fecundated. The total number of viable nauplia was 717,000.

This method will be applied to commercial scale in the ponds for mass production of juveniles in Italy.

(1) Contribution within the scheme of the Applied Research Project: Consolidation, development and conversion of National Aquaculture" subproject "Shrimp-culture" of the National Research Council - Italy.

POSTER 97

# Discrimination of Larval Bivalves in the Plankton: Aquacultural Implications for Predicting Spatfall

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## Summary

An inability to accurately identify bivalve larvae within the plankton has long hampered efforts to reliably predict spatfall for a variety of aquacultural purposes. The vast majority of existing practical barriers to identification of planktonic specimens may be eliminated through routine optical microscopic examination of the hinge apparatus of the larval shell. Various ontogenetic sequences of hinge development from the straight-hinge stage through metamorphosis are photographically illustrated (using scanning electron microscopy) for 18 genera (Mytilus, Perna, Modiolus, Geukensia, Mytilopsis, Ostrea, Crassostrea, Placopecten, Argopecten, Mya, Spisula, Mulinia, Arca, Ensis, Arctica, Xylophaga, Teredora, and Mercenaria) from 11 bivalve superfamilies (Mytilacea, Dreissenacea, Ostreacea, Pectinacea, Myacea, Mactracea, Arcacea, Solenacea, Arcticacea, Pholadacea, and Veneracea). The hinge apparatus (provinculum), by itself, is generally useful for superfamilial separation. In certain specimens, such as larval mytilids, the structure of the provinculum permits unambiguous identification at the familial level. Detailed examination of hinge line structures, when coupled with a consideration of gross shell morphology, often permits generic, or even specific, identification. In those aquacultural operations which rely on natural larval recruitment, careful analysis of the shells of larval bivalves isolated from plankton samples should permit discrimination of the veliger stages of various species, and, hence, provide a means of estimating the timing and intensity of spatfall of those shellfish being cultured.

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POSTER 98

## GENETIC AND ENVIRONMENTAL SOURCES OF GROWTH PATTERN VARIATION IN THE CULTURED FRESHWATER PRAWN, *Macrobrachium rosenbergii*

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We investigated the genetic and environmental sources of variation in heterogeneous individuals ("bull-runt") including growth and sexual dimorphic growth, and economically important production characteristics. Genetic control was estimated by calculating the heritability (genetic variance to total variance) of juvenile size. Two studies , each taking over one year to complete, developed complex methods for full and half-sib analysis and succeeded in producing 50 families. Near simultaneous matings were achieved using prediction molt; larval rearing was done in replicated floating bags and juveniles were reared in individual compartments in water tables. Mean heritability values were low for males (0.086) and high for females (0.26).

We corroborated our genetic findings from results in our second approach which sought to assess the reversibility of runtiness, effects of aggregate and individual rearing, and monosex culture on the size frequency distribution. Our results demonstrated a high prawn compensatory growth capacity - a prawn's size and age have little correlation with its growth capacity and that sexual dimorphism develops in all-male populations.

We concluded heterogeneous individual growth appears to be a non-genetic environmental phenomenon that required induction in free-living aggregate populations of either sex. Moreover, if our results are confirmed in larger animals, the well-known male "bull-runt" phenomenon can be managed as an essentially non-genetic environmental trait induced by intra-populational competition. This management. especially in areas with year-round growing seasons, should involve possible genetic selection of females, stock rotation, and size grading to take advantage of compensatory growth.

POSTER 99

## FURTHER EXPERIENCES ON THE INTENSIVE CULTURING OF SEABREAM ARTIFICIALLY REPRODUCED

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An experiment, for culturing *Sparus aurata* L., whose fry were taken from the Artificial Reproduction Centre of "Italittica" Marsala-Italy, is reported.

We recorded both weight and length increase and survival of seabream put into ponds with a starting density of 100 fry/$m^2$ and a final biomass of 3.6 kg/$m^2$. Growth rate was not regular for the whole period but variations due to climate, especially temperature conditions on the weight increase of the fry. The highest rate of increase, avaraged, about 27 g/month, from June to October, with a temperature fluctuation from 20° up to 26°C.

High summer temperatures increased metabolic activity of the seabream, resulting into higher food consumption. During this period food conversion was 1.5, compared to a conversion ratio of 3.2, during the whole culturing period.

The lower temperature during the winter months, caused a growth reduction (avarage gain about 12 g/month; total length increment 1 cm/month).

The highest mortality was observed during and immediately after transfer of fry from the indoor ponds of the hatchery to the pre-breeding ponds and from this latter into the culturing ponds. In both cases mortality of fry reached 5.5 %. There were only occasion deaths after that. The final survival rate 18 months from the beginning, was about 80 %.

POSTER 100

## ARTIFICIAL BREEDING OF GRASS CARP (*CTENOPHARYNGODON IDELLA* VAL.) IN ITALY

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After 3 year's experiments carried out with methods described by A.G. Konrad (1965), V.K. Vinogradov (1966), K. Kuronuma (1966), W.M. Bailey et al. (1970) and J.E. Bardach (1972) the author developed a technique for grass carp breeding.

As described by R.W. Rottman and J.V. Shireman (1979), induced spawning of grass carp through injections of acetone dried-whole carp pituitary has occurred in indoor tanks without hand stripping of gamets. The circular fiberglass tanks (6 $m^3$ capacity) used were equipped with biofiltrations units, thermostats, and devices for transporting eggs directly to incubators. In May 1980, 6-year-old broodfish, two males and a female, were put in each tank for spawning. The total amount of individuals used was 54. Narcotized females were stimulated with intramuscular injection. Spawning occurred in 14 cases out of 18 for a total of 2,8 million eggs. Various hatchery devices were attempted with unsatisfactory results. Only incubators of the Nucet type provided a high hatching success (59 %).

POSTER 101

## TECHNIQUE OF INDUCING CARP (*CYPRINUS CARPIO* L.) SPAWNING IN CONTROLLED ENVIRONMENT

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Through use of metal tanks (2 x 1 x 0.6 m) equipped with filtration, recirculation and thermostat system, the author has successfully applied a modified technique for carp spawning. Broodfish (three males and a female) lay eggs on spawning bed made of PVC hard net with 2 mm mesh, fixed to the tank bottom. Spawning occurs after hypophysial injections. Spawning beds covered with eggs are transferred to hatching tanks where fry remain for 10 days, fed on zooplankton and commercial feed. This method presents numerous advantages compared to hand stripping and elimination of sticky material. Such advantages are: Reduction of man power; higher hatching rate; less incidence of freaks; higher survival rate at 10 days of age. Four million fry where produced with this system in the 2-year period 1979-80.

POSTER 102

## FEEDING OF SEA-BASS (*DICENTRARCHUS LABRAX*) PROTEIN RATE AND ENERGY LEVEL OF DIET

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Sea-bass (*Dicentrarchus labrax*) of about 75 g initial weight were fed for 3 month dry pelleted diets, the protein level of which varied from 51 to 63 %. For each protein rate, the energy source was either mainly fat (cod liver oil or beef tallow) or carbohydrate (precooked starch).

In each lot, growth was followed by weighing every week individually tagged fishes. At the end of the experiment, body and blood biochemical analyses were made.

The variability of individual responses of the fishes was high in each batch; however, some facts were pointed out.

The diets with high protein level (especially 57 %) allowed the best specific growth rate (0.50 %/d) and feed conversion (dry feed/wet weight gain = 2.0). However, the lower the protein rate, the better the protein efficiency ratio. For a given rate, substituting carbohydrates for lipids improved growth, and more markedly feed conversion, and protein efficiency ratio. Hepato somatic index is inversely related to protein level, and for a given protein level, directly related to the carbohydrate level. No significant differences were noted between different lots for mesenteric fat level (nearing 5 % of live weight)nor for body and blood biochemical data.

POSTER 103

## WEANING OF SOLE (*SOLEA VULGARIS*) USING ARTIFICIAL DIETS

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The adaptation of young sole (*Solea vulgaris*) to non living food (or "weaning") is now one of the problem limiting intensive rearing of this species. Food including no fresh ingredients is accepted with difficulties. In three sets of experiments, several types of weaning diets were compared in 1-month-old soles up to feeding living *Artemia*: (a) frozen ground molluscs, (b) dry pelleted diet stabilised with corn gluten (14 %), including or not different "attractane" matter (ground polychaets and molluscs: 10 % of the diet); (c) wet paste containing 50 % ground molluscs, (d) dry pelleted diet stabilised with sodium algin 15 %.

In every case a check was made when the fishes were 90days old. In spite of large growth variability, several facts were pointed out. As noted before, the presence of attractive matter seems to enhance food intake and consequently growth. Concerning polychaets, the attractant effect only existed in the liquid phase (upper phase after high speed centrifugation). Contrary to previous observations, frozen molluscs and wet paste containing molluscs did not give good results especially for growth. The best results were obtained with a dry artificial diet stabilised with algin. This seems to be due to its high stability in water. Weaning seems to be an important step in the life of fishes, only some of them can go through it with few difficulties.

POSTER 104

## PRODUCTION OF *TILAPIA NILOTICA* FRY BY BREEDERS FED WITH COTTONSEED OIL-CAKE

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An increasing number of fish culturists in Central Africa need of economic mass production of *Tilapia* fry in good conditions. Trials were made to feed breeders with cottonseed oil-cake, which is available in huge quantities in Bangui, at a cost of FCFA 25/kg. (U.S. $ o.1/kg).

Two foods were used: (1) Trials 1-4 meal containing 82 % ground cottonseed oil-cake, 8 % dried blood, 8 % wheat flour and 2 % bicalcic phosphate at total costs of FCFA 32.5/kg. Daily ration was set at 5 % of the estimated weight of fish, one time per day during the 1st and 2nd month, two times per day during the 3rd month.(2) For trials 5-7 = ground cottonseed oil-cake only at 1 kg/are/day. The sex ratio of the breeders was 3 female/1 male. The density of breeders was 150-200 / are for the trials 1-6, 20/are for trial 7. The production is expressed in kg/are for 100 days culture, which is the average time to have fry with a mean weight of 5 g, large enough to have no mortality during handling and transport.

| Trial | Pond area (ares) | Breeders initial density | Duration (days) | Final density females /are | Feeding | Weight food (kg) | Fry production kg/are | Fry production kg/are/an | Food cost /kg |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.3 | 160/are | 87 | 41.2 | composed | 216 | 25.9 | 108.6 | 63.4 |
| 2 | 4.8 | 200 | 99 | 59 | meal | 446 | 31.3 | 115.3 | 96.6 |
| 3 | 4.0 | 200 | 106 | 48 | " | 317 | 0.7 | 2.5 | - |
| 4 | 4.8 | 159 | 108 | 50 | " | 432 | 19.9 | 67.1 | 147.4 |
| 5 | 2.11 | 200 | 109 | 17.5 | cottonseed | 218 | 16.4 | 54.8 | 157.9 |
| 6 | 2.5 | 200 | 110 | 55 | oil-cake | 275 | 39.6 | 131.3 | 69.5 |
| 7 | 8.1 | 20.4 | 136 | 6.9 | id.+4 pigs cottonseed oil-cake | 1088 | 48.2 | 129.4 | 69.7 |

In trial 3 there was an immigration in the pond of *Hemichromis* which ate all the fry. The loss of breeders was mainly due to piscivorous birds and thieves. In trials 4-5 there was some important fissurations of dykes and subsequent loss of fry.

The cottonseed oil-cake give very good resuls, even with a low density of breeders (trial 7) and in so short a duration as 100 days. Trials 1-2-6-7 gave a good economic return (fry was sold at FCFA 150/kg). With the six trials combined, the average cost was FCFA 100/kg and the return was 50 % of the food cost. Trial 3 shows that the ponds must be carefully protected agains the entrance in the ponds of predators like *Hemichromis* which are very voracious, even when of little size.

POSTER 105

## A PRELIMINARY STUDY FOR THE CULTURE OF A FRESH-WATER FISH TRADITIONALLY EXPLOITED AT THE MEXICAN HIGH PLAINS, *CHIROSTOMA JORDANI*, WOOLMAN 1894

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In the Lerma Santiago River system and on the central plateau of Mexico there

is a group of silversides, known locally as "Charal", which has been utilized in a rustic, traditional manner. One of these is the small *Chirostoma jordani*. The fish was studied since 1976 under both natural conditions and in captivity. In nature the species is expierences considerable fluctuations of environmental factors: Temperature = 12 to 27°C; dissolved oxygen = 2.5 to 15 ml/l; conductivity = 75 to 100 ppm; hardness = 85 to 135 ppm; transparency = 200 to 3180 mm; pH = 7. In the Requena Reservoir, production was estimated at almost 34 kg/ha/yr. The authors verified a catch of approximately 0.5 ton obtained from a 4 hectare area within 2 hours. Differences in total length have been observed across populations: 90 mm at Requena to 63 mm at Taxhimay. At Taxhimay the average length was calculated to be 69.3 mm. Seven age groups were detected, also some variation was found in the biological parameters of the species in spring and fall: Condition Factor, from 0.0142 to 0.922; weight-length relationship, from Wt = 0.0185 Lt2.27 to Wt = 476 Lt 1.93; survival, from S = 0.234 to S = 0.328. Fish smaller than 30 mm consumed mostly filamentous algae, volvox and rotifers; the larger sizes ate several species of *Daphnia (D. pulex, D. ambigua, D. laevis)*, the copepod *Diaptomus a.*, and the larvae of insects such as *Chironimus*, other Diptera and Odonata.

The period of sexual maturity extended from May to August. The minimum size for mature specimens was 36 mm, with a maximum of 437 eggs per fish. For the size class from 36 to 47 mm, only between 13 and 70 % of the fish were mature, while of larger fish 75 to 100 % are mature, and the number of eggs produced reached 1870.

In rearing the fish in captivity, all the physical and chemical parameters were kept within the limits prevailing in nature, th exception being pH (5-9.6). At first *Daphnia* were fed; later it was turkey manure. Spawning occurred in May and July 1980, 6 and 8 month in captivity. The eggs were laid in racimes (egg diameter 80 to 90 µ; 12 filaments/egg). Embryonic development lasted 15 to 17 days.

POSTER 106

## EFFECTS OF COMPOUNDED DIETS ON JUVENILE LOBSTER *HOMARUS GAMMARUS* L.: GROWTH, SURVIVAL, PROTEIN, NUCLEIC ACIDS AND DIGESTIVE ENZYMES

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The most efficient formulation of a compounded diet for young lobsters can be determined when measuring the effect of diet composition on growth, moult frequency, survival rate, total protein content, hepatopancreas protein content, RNA,DNA, protease and carbohydrase activity. Seven groups of 100 juvenile lobsters, held individually in the recirculation system of Houat hatchery at 14°C were fed for 120 d. Five pelletized diets containing soy lecithine base (Conklin et al,1980) were tested. Another group was fed alternately every 2 days with frozen *Artemia* and compounded food. Frozen *Artemia* was used as control( 50 % protein).

Growth rates were 74 % in trials with a 30 % protein diet, and 79,74, and 70% in diets containing casein, albumin and gluton (38 % protein)(100%=growht in control). Growth was improved when compounded diet alternated with *Artemia*: 119% of control, best conversion 1:2.4. The best protein conversion efficiency (groupE) was 0.87. Lobsters moulted twice in 120 days. Survival was rather low(except group E and control; survival in both about 85 %).Survival and coulor were imrpoved by adding 0.04% canthaxanthin. Addition of *Spirulina* meal did not improve growth and colour.After 120 days, protein content ranged between 12.7 adn 31.1 mg/ind., DNA content varied between 107 an 673 ug (i.e. 16-22 ug DNA/mg protein).Best growth corresponded to highest protein, RNA and DNA content.Carbohydrase/Protease ratios varied with different diets. Pre-gelatinized starch increased the ratio significantly; changing the nature of carbohydrate source is not beneficial for lobster. An inadequate diet, containing 44 % protein (gluten,casein,albumin and *Spirulina* meal) decreased the wet weight and protein content of hepatopancrease and increased its water content.

A protein mix containing 8 % shrimp meal, which is not an expensive source of marine protein, seems to cover the needs of juvenile lobsters. It leads to high survival and acceptable growht (conversion rate 3.8), which can probably be improved by alternating with natural food.The use of pregelatinized starch increased carbohydrasis synthesis. Maximum protease specific activity was reached for protein levels around 38 %.

POSTER 107

## BIOCHEMICAL ENGINEERING FOR IMPROVED PRODUCTION OF ABALONE AND OTHER VALUABLE MOLLUSCS

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Our research demonstrates that modern methods of biochemical research and development can be used to improve the reliability, yield and economic efficiency of production of several species of abalones and other commercially valuable molluscs. Critical life-cycle stages which thus far have proved amenable to improved control by this biochemical engineering approach include reproduction, larval settlement, metamorphosis and the acceleration of early growth:

1. Analysis of the physiological and biochemical mechanisms which control reproduction in molluscs revealed a prostaglandin-dependent regulation of spawning in abalones and certain other species. Using techniques based upon this finding, we have found that spawning of gravid adults can be induced by the addition of prostaglandins to the surrounding seawater. Even more reliably and inexpensively, spawning can be induced at will by activation of the natural enzymatic synthesis of prostaglandins in gravid animals, in response to added hydrogen peroxide. Peroxide activation of the prostaglandin-dependent spawning reaction has been found widely useful for obtaining synchronous and copius release of fully competent gametes (both eggs and sperm) in a large number of species of abalones, oysters, scallops, clams and other valuable molluscs throughout the world.

2. We have found that the efficient induction of settlement and metamorphosis of abalone larvae normally requires the presence of specific crustose red algae which are uniquely associated with natural recruiting substrates. This requirement can be met by providing competent larvae with the essential algae or with specific proteins purified from these algae, although production of these inducers is both time-consuming and costly. Most conveniently and inexpensively, we find, this natural requirement can be met by providing the larvae with certain unique amino acid constituents normally associated with the inducing proteins. Thus, γ-aminobutyric acid (GABA) can be used simply, safely and inexpensively to induce complete and rapid larval settlement and metamorphosis - with minimal mortality - in a number of commercially important abalone species. This and similar neurotransmitter-related, amino acid-derived compounds are proving comparably effective for the reliable induction of settlement and metamorphosis in a number of other valuable molluscan species.

3. Recent analyses of the natural requirements for rapid early post-larval growth in abalones reveal a mechanism of growth-control which is susceptible to hormonal acceleration. Results of these experiments indicate that the extreme heterogeneity of sizes and growth rates generally observed in the cultivation of abalones (and other molluscs) is not the result of genetic variation, but reflects instead physiological deficiencies in cultivation which may be corrected by external biochemical control. These results also indicate that genetic breeding programs based upon selection for apparently desirable growth-rate properties cannot effectively be started until the physiological and biochemical requirements for optimal growth are fully defined.

This research is supported by the U.S. Dept. of Commerce (NOAA) - University of California Sea Grant Program.

POSTER 108

# PRIMARY PRODUCTION IN INTENSIVE SEA WATER FISH PONDS

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In the present work the interaction between the phytoplankton dynamics, nutrient load and the fish activities has been studied by following simultaneously the physical, chemical and biological parameters in a stocked fish pond as compared to an unstocked control pond. The study was done in two experimental sea water fish ponds situated in Eilat of the Gulf of Eilat (Aqaba). The unstocked control pond, has an area of 203 $m^2$ and a volume of 144 $m^3$. The fish pond has an area of 223 $m^2$ and a volume of 134 $m^2$. The latter was stocked with 600 *Sparus aurata* and 50 *Mugil cephalus*. The average depth of the ponds is 1 m and they were supplied with filtered sea water from a nearby sea water well with a flow rate of 3.5 $m^3\ h^{-1}$.

Primary production was determined in three depths 0.50 cm and 100 cm (bottom) by using the $^{14}C$-assimilation technique. Light penetration was measured troughout the water-column with an underwater quantum sensor every 10 cm. Dissolved oxygen, temperature, pH and alkalinity were measured. Chlorophyll-a, -b, -c concentrations, phytoplankton cell densities and species composition were determined. Dissolved inorganic nutrients ($N\text{-}NH_4$, $N\text{-}NO_2$, $N\text{-}NO_3$, $P\text{-}PO_4$, $Si\text{-}SiO_2$) were determined from the inflow water and pond water. The measurements mentioned were done weekly throughout a yearly cycle.

Both ponds are completely mixed with stable salinity: 41.45 ‰ to 41.81 ‰ during the winter and 41.81 ‰ to 42.18 ‰ during the summer. The temperature in both ponds was identical and varied during the winter (November-April) from 8°C in January to 26°C in April. During the summer (May-October) the temperatures varied from 21°C in October to 29°C in July-August. The pH and alkalinity in the ponds varied from 7.5 to 8.5 and from 2.2 to 2.6 mEqv, respectively. The diurnal cycle of dissolved oxygen ranged from 7 ppm at dawn to 13 ppm at 1400 hours in the control pond and in the fish pond from 3 to 18 ppm. The ambient light regime was 2200 $\mu Em^{-2}\ sec^{-1}$ in the summer and 1300 $\mu Em^{-2}\ sec^{-1}$ in the winter. The percentage light reaching the bottom of control pond varied from 17 % to 78 % and in the fish pond it was 2 to 4 %. These variations can be correlated with the phytoplankton blooms and the turbidity caused by silt stirred by the swimming fish in the fish pond. The average daily primary production was 2 g C $m^{-2}\ day^{-1}$ and 3.5 g C $m^{-2}\ day^{-1}$ in the control and fish ponds, respectively. The standing crop Chlorophyll-a was between 4 and 28 mg Chl-a $m^{-3}$ and 10 to 53 mg Chl-a $m^{-3}$ in the control pond and fish pond, respectively. Both ponds receive the same nutrient load in the inflow (2.7 g at nitrogen $day^{-1}$ and 0.065 g at phosphorus $day^{-1}$ each) and are flushed at a rate of 0.6 $day^{-1}$. Accordingly the apparent growth rates of the phytoplankton varied from 0.62 to 1.7 in the ponds. The fish pond receives an extra nutrient load from the fish food (1.9 g at nitrogen $day^{-1}$ and 0.14 g at phosphorus $day^{-1}$) which is responsible for the higher productivity and standing crop observed this pond. The high N:P ratios (18 to 80) in the inflow water and their periodical fluctuations that correlate with the synchronized pattern of monthly periodicity in phytoplankton blooms show that both systems are phosphorus limited. It is suggested that the tidal pattern in the gulf induces the periodicity of the sea water well water (inflow) N:P ratios and governs the montly cycle of the blooms. The effects of the increasing eutrophication rate in the fish ponds as a cause for observed deterioration in fish growth is discussed together with the organic matter accumulation in the sediments. Preliminary results show that the elimination of observed phosphorus limitation with additional phosphate input results in increased phytoplankton production.

POSTER 109

## A STUDY ON THE MASS MORTALITY OF MUSSELS IN THE LAGUNA VENETA

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In the southern part of the Laguna Veneta, the culture of mussels (*Mytilus edulis = galloprovincialis*) forms an important constituent of the local economy. During the winter of 1980-81 a large proportion of these cultured mussels died. The geographical extent of the epizootic mortality is reported as well as its percentage in relation to depth, to hydrographic features in the Laguna, and to size of mussels.

A digenetic trematode, *Cercaria tenuans* Cole, was identified as the probable causative agent. Sporocysts of *C. tenuans* occur in the mantle tissue of infected mussels and the visceral mass. Free sporocysts were also found in the extrapallial fluid space between the mantle and the shell. Sporocysts containing germballs, apparently viable cercaria, or daughter sporocysts do occur. Other microscopic parasites have been found, but not in appreciable numbers.

The epizootic is discussed with regard to water conditions of this and previous years, including temperature, chlorophyll and inorganic nutrients. Also the likely source of infestation is discussed with reference to previous reports of *C. tenuans* in the vicinity of the Laguna Veneta. Current management procedures for shellfish culture and depuration are described.

POSTER 110

## PRELIMINARY RESULTS ON THE PRODUCTION OF BRINE SHRIMP (*ARTEMIA SALINA*) IN COSTA RICA, CENTRAL AMERICA

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Trials to produce cysts and adults of the brine shrimp in Costa Rica were justified in view of the increasing demand from commercial shrimp farms, of the availability of salt evaporation ponds, of natural conditions suited for its cultivation, and of the necessity of finding new ways for employment of the rural population. Brine shrimp is not indigenous in Costa Rica.

During the dry season (December-May 1980) several evaporation ponds for salt production were inoculated with cysts and freshly hatched nauplii of *Artemia* from the San Francisco Bay strain. Survival of the animals was only quaranteed in the deep (> 1 m depth) brine collection ponds. In the shallow evaporation ponds, during noon time, the water temperature rose to above 40°C, causing mass mortalities. Despite the extreme high salt concentration in the brine collection ponds (up to 240ppt) *Artemia* grew and propagated extraordinarily well. The first cysts could be harvested about 4 weeks after inoculation, and laboratory tests proved a high hatchability. Adult *Artemia* could be collected easily during night by fluorescent light. The high nutrient content of the brine, which originates from mangrove areas, made supplemental feeding unnecessary. The unicellular algae *Chlamydomonas chlamydomonas*, a food source for *Artemia*, developed very well.

The beginning of the rainy season caused unexpected technical problems. Heavy rainfalls created a layer of freshwater above the brine, causing a drastic reduction in ponds water circulation, effecting a lethal increase in water temperature. Due to the daily rainfall,it was impossible to prevent cysts from hydration.

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POSTER 111

## NEW OYSTER ONGROWING CONTAINERS FOR GERMAN MARICULTURE OPERATIONS

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The hydrographic and climatic situation along the German coast requires specially adapted equipment for mariculture enterprises. The containers used in the past for the ongrowing of oysters (*Crassostrea gigas* Thunberg) in shallow sea areas provided results, that gave reason for developing a new type of container which is more economic and proceduces a high quality oyster of uniform shape as well.

Small sized prototype containers based on a galvanized iron construction were built and placed at different sites along the coast. They hold 1,600 oysters each which are reattached with cement on square mesh plastic netting being stapled on oak-wood frames. On these frames which were handled like drawers the oysters had optimal conditions which are believed to be better than on a natural oyster bed. Each oyster had its own space of 7 cm by 8 cm wide and 10 cm high and was not handled until it reached market size. Good water wxchange is provided by the open construction of the container which also gave protection against predators by a complete mesh cover.

POSTER 112

## SELECTION FOR IMPROVED GROWTH RATE IN THE FLAT OYSTER, *OSTREA EDULIS*

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Improvement of aquaculture stocks should be made through the application of selective breeding programs. Although much has been said about this potential there is a paucity of examples that illustrate the gains that can be made in transforming the wild stock now used into domesticated and improved stock.

A selective breeding program with the European oyster, *Ostrea edulis*, has been in progress at Dalhousie University since 1977. First generation selected lines were produced in 1977 and 1978. The selected parents came from the 1975 hatchery year class which was offspring of the original imports to Nova Scotia, considered here as the parental oysters. In both years, the parental oysters were respawned as control lines. Oysters from all lines, individually labelled within a few months of spawning, were stocked in lantern nets and grown in the field. Up to this time, selection has been for growth rate only, as determined by total net weight. The lines have been produced through mass spawning similar to the proceedures used in comercial hatcheries.

An independent comparison of the selected lines to the control lines in both year classes shows progress being made through selection. Over both year classes the selected lines range for 8 to 38 % heavier than the control lines, the average is 24 % heavier. (The control lines average 26.5 g and the selected lines 32.9 g). Progress such as is shown in the first generation of selection suggests that selective breeding can make important improvements in a matter of a few generations.

POSTER 113

# TIME-OF-DAY OF FEEDING AFFECTS SOMATIC AND GONADAL GROWTH IN GOLDFISH

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Although the frequency of meal feeding has received considerable attention in fish culture the specific time-of-day of feeding has not. In mammals, the time-of-day of feeding has been reported to affect appetite, weight gain, and lipogenesis; if fishes react in a similar manner, then time-of-day of feeding could be an important consideration in establishing feeding regimes for cultured species.

In the present study, goldfish Carassius auratus were held in 18 seventy liter aquaria, 16-17 animals per aquarium. Each aquarium was opaque, covered, and provided with a 7 watt light. All aquaria received recirculating water ($10^{o} \pm 1^{o}C$) from a shared reservoir with filter. The fish were subjected to one of six different feeding regimes, three replicate aquaria per feeding regime. All fish received a single ad libitum meal (access to excess food for a 40 min period) at 1500 h daily. However, the 12L:12D photoperiod was staggered so that light onset for the six groups was either 1500, 1900, 2300, 0300, 0700, or 1100 h. Thus, a single daily meal fed at 1500 h had the effect of feeding the fish at one of six different subjective times of day (0, 4, 8, 12, 16, and 20 h after light onset). Fish were anesthetized (MS-222), identifiably marked (fin clipped), weighed and measured (standard length) at the start of the experiment and reweighed and measured after 4 and 8 wk on the feeding regime; the amount of food eaten was recorded daily. There were no significant differences among the six groups for initial weight, length, or condition factor.

Depending on the time-of-day of feeding, there were highly significant differences in daily food consumption, weight gain and condition factor at both the midpoint and end of the study. There were highly significant differences in length gain at the end, but not at the study midpoint. Food conversion efficiency may also differ depending on the feeding schedule as some fish gained significantly more weight but did not eat significantly more food than fish fed at other times of day.

Gonadal state of male fish did not differ significantly among the feeding regimes. However, there was a highly significant difference in female gonad weight. The times-of-day of feeding most conducive to weight gain were not always the most conducive to gonadal growth. When gonad weights are corrected for final body weight (analysis of covariance), the fish fed at the least optimum time for weight gain (16 h after light onset) had the largest gonads.

These laboratory results indicate a significant potential for increasing somatic growth rate in cultured species through judicious selection of the time(s)-of-day of feeding. In addition, because some feeding schedules appear more stimulatory, or inhibitory, to gonadal growth than others, timing meal feeding may afford culturists some measure of reproductive control over their stock.

POSTER 114

## FEEDING OF NILE TILAPIA, *SAROTHERODON NILOTICUS* L.(PISCES, CICHLIDAE), WITH PROTEINS OF ANIMAL AND PLANT ORIGIN

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In aquaculture it is necessary to find the ideal and cheapest food in order to obtain a final product at low cost.

Gain in weight and length of Nile Tilapia, fed with protein of animal and plant origin, at different rations, were compared. Experiments were conducted over 128 days (September 1, 1980 to January 6, 1981) in four tanks (77 cm length, 64 cm width and 48 cm height) with an initial number of 9 tilapias in each tank. Fish were measured and weighed once a month and fed once a day at 10:00 hours (3 % body weight per day, monthly adjusted). Rations for fishes in tank 1 and 2 were made of 50 % fish meal and 50 % soybean flour, while those in tank 3 and 4 were made of bovine blood flour and 50 % caster-oil bran. Water temperature was measured twice a day at 10:00 and 15:00 hours.

Fishes in tanks 1 and 2 provided best results gaining 0.36 g daily in weight and 0.39 mm in length in tank 1 and 0.29 g and 0.32 mm in tank 2, while those in tank 3 (all died 36 days after beginning of experiment) showed weight gain of 0.03 g and 0.11 mm total length increment per day. In tank 4 daily growth was 0.15 g and 0.20 mm.

Mean weight and mean length of fish in tank 1 were 21.6 and 105.7 mm, reaching 68.7 g (gain of 47.1 g) and 155.2 mm ( gain of 50.5 mm) at the end of the experiment. In tank 2 fish grew from 19.9 g and 100.9 mm to 57.2 g and 142.7 mm (gain 37.3 g and 41.8 mm). The corresponding values for tank 3 were: 21.1 g and 103 mm to 22.1 g and 106.9 mm (gain 1.0 g and 3.9 mm). In tank 4 the following results were obtained : initial size 18.5 g and 100.3 mm; final weight 37.3 g (gain of 18.8 g ) and final length 126.4 mm (gain of 26.1 mm).

POSTER 115

## THETHELOHANIOSIS IN THE CRAWFISH *ASTACUS ASTACUS* L.

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In October of 1978, 403 crawfish from the waters of SR Macedonia were examined. Of these, 206 were males, 197 females. Average body weight was 287.8 g. By clinical examination in five males and two females, white muscles were found on the ventral side of the tail. These muscles looked as if they were cooked, and the lesions were of different intensity.

Dissection revealed that the livers of crawfish with lesions in muscles were olive-green. Intestines were partially filled. On the gills, filamentous algae were found. In females, the ovaries were filled with a white content. No lesions in other tissues were observed.

Histopathological investigations allowed identification of *Thelohania contejeani* in muscle tissue.

POSTER 116

## JINKO GYOSHO (ARTIFICIAL REEFS FOR FISHES) IN JAPAN

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The Jinko Gyosho aims to improve coastal fisheries. In 1976, the Fisheries Agency started its new project of Jinko Gyosho with a budget of 70 billion Yen. In this project the structures wer designed to fit the following fishing gear; angling, bottom gillnet, long-line, demersal seine, roundhauls. We also expected to attract the pelagic fishes (tuna, yellowtail, horse mackerel, mackerel) and demersal fishes (red snapper, common rock fish, perch-wolf, leather fish, plaice, other rock fish).

Jinko Gyosho is adopted to water depth between 30 and 150 m. High water depth caused difficulties in arranging structures of large scale blocks, 5 to 10 m in height and 125 to 500 m in length.

The structures for pelagic fish had a height of 5 to 10 m, for demersal fish it was 1.5 to 5 m. A minimum volume of one set of jink gyosho is determind to be 500 m, but the optimum has not yet been clearly determined.

The block of Jinko Gyosho is made of cement concrete, polyethylene concrete, F.R.P., used tires, etc. Jinko Gyosho is composed with large and small scale blocks. The effective area, where commercial fishing is sustained, is estimated at about 300 m for pelagic fish and 100 m for demersal fish, from the structure.

Yearly catch from unit gross volume of the structures ranged between 1.5 and 151.0 kg/m, depending on the site. Catch from fishery grounds with Jinko Gyosho eg CPUE, has been counted from 320 to 5 kg/day/boat (these figures depend on the ratio fishing days over jinko gyosho over total fishing days). Fishing efficiency of the Jinko Gyosho is being investigated at 35 sites with 350 sampling boats.

POSTER 117

## APPLICATION OF COASTAL PONDS FOR MASS-REARING OF MARINE FISH FRY

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Along the Norwegian coast there are hyndreds of ponds with a water volume from a few 10 000 $m^3$ to a few 100 mill. $m^3$. The ponds are characterized by having narrow (less than 20 m) and shallow (less tha 5 m) inlets.

Since 1975, experiments have been carried out in a large out door basin (4,4oo $m^3$) to examine a possible use of these ponds for mass rearing of marine fish fry. These basin experiments indicated a high survival rate for a large number of marine species such as cod, herring, plaice and turbot. No predators are present in the basin. The natural carrying capacity of the system was about 1 fry per $m^3$. Large-scale experiments in a pond were carried out with cod larvae in 1980 and 1981. The pond was closed by dams and the natural population of potential predators, mainly gobies and sticklebacks, were killed with rotenone. The pond containing 50,000 $m^3$ seawater, was supplied with 0.7 mio cod yolk sac larvae in 1980 and 0.5 mio larvae in 1981. The specific growth rate was 10-12 %, and in 1981 a large population reached metamorphosis (12 mm), while in 1980 a dam leakage interrupted the experiment.In the autumn the cod fry will be released in coastal waters and a fraction of the fry will be tagged to enable an evaluation of the release programme. A preliminary tagging experiment indicated that fry reared in such systems are well adapted to live in the open sea.

POSTER 118

## A TECHNICAL SOLUTION TO THE MASSCULTURE OF LARVAL TURBOT (*SCOPHTHALMUS MAXIMUS*) IN A RECIRCULATED SYSTEM

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Several proposals have been prepared to improve survival of newly hatched turbot larvae in massculturing system.

At the Water Quality Institute a 1000 liter recirculating system of eight cylindrical conical rearing tanks have been tested in three 40-days periods to determine the larval rearing capacity. The tanks receiving water through conical bottoms are for the first 14 days after hatching connected to a central 200 liter aeration tank via outlets through exchangeable surface-filters which retain particulate matter. At day 14 this system was connected to a bigger recircultation unit with a biological filter without transfer of the fishes. The larvae were fed on rotifers and *Artemia* nauplii as well as mixed marine algae. Continuous artificial light at 1500-2000 lux was applied at the surface. The algae served dual function, keeping rotifers and *Artemia* at a high nutritional level as well as effectively removing the released ammonia which would otherwise reach critical levels of more than 7 mg $NH_3$-N/l during the first 14 days.

With this system, using a stocking density of 16 larvae per liter, a total survival of 40 % at day 40 has been achieved, giving a production of 6.4 larvae per liter volume of fishwater, or 3000 larvae per $m^2$ surfacearea. These results are reproducible. At day 40 the fishes were transferred to bigger tanks at which time they can be easily weaned onto a dry diet with no further mortality during the weaning period.

This system may well be applicable to massculturing after introduction of dry diets an earlier stage as long as precautions are taken to maintain a good water quality.

POSTER 119

## A LOW COST PROCESS FOR THE CULTIVATION OF *SPIRULINA* IN SEWAGE AT THE RURAL LEVEL

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A low-cost process for cultivation of *Spirulina*, utilizing sewage as a source of nutrients and involving non-expensive recuperation by filtration and simple solar drying, has been developed.

Laboratory experiments under controlled conditions of light (20 watt Grolux lamp) and temperature (30°C) have been carried out in order to determine optimal nutrient concentrations. Growth was estimated by a simultaneous determination of absorbance of the culture, total chlorophyll content, dry weight and protein content. Results have shown that maximum yields are obtained with mixtures containing 1.5 g/l of total alkalinity (carbonates plus bicarbonates expressed as $CaCO_3$ content) and 60 % of raw sewage.

A pilot plant of 200 $m^2$, has been built in which ponds are interconnected by gravity and the use of pumps is not involved, not even for the recuperation process. Cultivation ponds with a retention time of around 7 days are connected to a harvesting pond with a retention time of 2 days. The harvesting pond is fitted with a simple netting device for filtration "in situ". A specially designed solar dryer in which biomass is not directly exposed to the solar light has been utilized.

The low-cost algae biomass produced is expected to have a real social impact in rural areas of developing countries as a supplemental feedstuff.

POSTER 120

## FEEDING *TILAPIA* HYBRIDS WITH THREE AGRICULTURAL BY-PRODUCTS IN NORTHEAST BRAZIL

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Raising hybrid *Tilapia* (*Tilapia hornorum*, male X *T. nilotica*, female) in 350 $m^2$ earthen ponds using three different agricultural by-products as supplemental feed was evaluated after 6, 7 and 8 months of feeding at a ration of 3 % body weight per day. The by-products used were castor bean meal, plam (babacu) meal and cottonseed meal, which contained 33.1, 23.2 and 22.5 % protein, respectively. Castor bean meal produced the highest weight gain (P 0.05) and the highest return per feed cost at each of the three harvest dates. The palm meal and the cottonseed meal ranked 2nd and 3rd in yield and profit. Feeding the fish beyond 6 months, at which time the average weight of the smallest fish was 150 g, was profitable with the castor bean meal treatment but not for the palm or cottonseed meal treatments.

POSTER 121

## *ARTEMIA SALINA* AS PABULUM FOR GROWING PENAEIDS UNDER LABORATORY CONDITIONS[1]

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Growing interest for *Artemia salina* Leach is supported by its high protein content, the relative ease for mass production, and potential biomass not completely utilized existing in saltpans of all over the world.

In Margherita di Savoia (SE Italy) saltwork, during August 1980 adult brine shrimps were caught by means of 500 $\mu$ nylon net, located on the main outflow canal. It was possible to harvest about 500 g per minute. It is reasonable to suppose 100 tons (wet weight) of brine shrimp standing crop at least, in 1000 ha of surface area. *Artemia* was tested for feeding penaeids under laboratory conditions, as sole food and as integrator of a dry selfmade diet. At first, frozen *Artemia* was tested and compared with mussels as penaeid food. The *Artemia* gave the best results at 30 % daily supply of shrimp body (wet weight). Moreover *Artemia* was tested as a balancing component of a dry diet to correct deficiency of amino acids and lacking HUFA.

This mixed diet was enough to give 30 % of the total feeding to achieve promising results considered a good compromise between economics and growth rate of *Penaeus japonicus* Bate. As a consequence it is suggested to plant intensive and/or extensive penaeids culture near saltpans, utilizing brine shrimp biomass as a food source otherwise wasted.

[1]Contribution within the scheme of the Applied Research Project: "Consolidation, development and conversion of National Aquaculture", subproject "shrimp-culture" of the National Research Council - Italy

POSTER 122

## DEVELOPMENT OF A SEMI-CLOSED WATER SYSTEM FOR TROUT BREEDING

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An intensive rearing system was developed for the controlled breeding of cold-water fish under defined environmental conditions.

The system consists of a rearing and a water regeneration unit and has a total water volume of about 10 $m^3$. The rearing unit has 35 single PVC-cylinders with a water volume of 80 liters each. This makes the separated rearing of about 150 rainbow trout (*Salmo gairdneri*) of different origin from fry (about 2 g) up to fingerling size (20-25 g) in each cylinder possible. At the final stage of production a stocking density of about 4.5 kg of fish in each cylinder can be reached. Water inflow of about 10 l/min in the cylinder causes an upstream velocity of about 0.1 cm/sec and a water exchange of seven times per hour, securing sufficient oxygenation and removal of suspended solids and dissolved metabolic products. Water temperature is almost constant (10±2°C) during the production period of about 5 months. After having reached fingerling size, the rainbow trout are cold branded and transferred into silos and ponds for comparative production studies.

Due to the limited fresh water resources at our installation a biological upflow filter for water regeneration and a cascade for water re-oxygenation was included into the system. The addition of only about 10 % freshwater per cycle is necessary to secure a consistent good water quality. The concentration of ammonia, nitrite and nitrate, pH and conductivity were measured weekly, and the COD several times during the experiment. The values of pH (7.2) and of COD (2-6 mg $O_2$/l) remained rather constant; the concentration of ammonia, nitrite and nitrate increased continuously up to 0.7 mg $NH_4^+$/l, 0.6 mg $NO_2^-$/l and 15 mg $NO_3^-$/l.

POSTER 123

## THE EFFECT OF STRESS ON THE STOMACH OF THE EUROPEAN EEL (*ANGUILLA ANGUILLA* L.)

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Social stress is a factor that must be considered when fish in captivity cannot avoid threatening confrontations with dominant members of their own species. This "cage" situation is known to evoke a typical General Adaptation Syndrome manifested by hormonal, physiological, and hematological changes. When our investigations were begun, it was not known whether fish react to stress showing morphological or cytological alterations of their organs, which lead to true diseases of adaptation.

Pairs of eels selected from 26 experimental subjects were isolated in 50-l-aquaria supplied by a warm water circulating system. Battles to determine rank were fought between the eels during the 5 to 10 day experimental period. The subordinate eels proved to be under great stress. The histology and ultrastructure of the stomachs were investigated.

Stressed eels had shrunken stomachs, apparently caused in part by contraction of the musculature. Furthermore, they were translucent and soft. The macroscopic mucous membrane folds flattened out or disappeared. The mucous epithelium atrophies, and during this process, numerous "residual bodies" appear. The degeneration process of the gastric glands included development of vacuoles in the rough ER which formed intra and intercellular cavities. Connective tissue proliferated in the

propria mucosae and replaced the degenerating glandular tissue. The submucosal vessels become extremely narrow.

Just as in the case of mammals, gastrointestinal lesions developed in fish as an adaptation reaction to stress. The atrophy of the gastric mucous membrane certainly leads to a reduction in the immunological barrier against invasion by pathogens, an increased degree of self-digestion, an interference with protein digestion, and thereby a decrease in growth. Stress situations have much more severe consequences for the health of the fish, and therefore for the economic success of an aquaculture operation, than was previously realized.

POSTER 124

## RECENT ADVANCES IN AQUACULTURE OF THE PURPLE-HINGE ROCK SCALLOP

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Aquaculture of the purple-hinge rock scallop requires that spat be produced in a hatchery and reared to advanced juvenile stages before introduction into bay or ocean environments for their cementation and final growth to harvest. Very little is known about the nutrition of juvenile rock scallops. In this study, we tested seven algal diets for groups of small (0.5 cm) and medium sized (1-1.5 cm) juvenile *Hinnites multirugosus*. The uptake of finely divided particulate matter has also been studied to ascertain the possible importance of detritus as a supplemental food source.

During 1980-81, groups of 8-30 juveniles were supplied similar concentrations at 2-day intervals of specific algal diets including a Tahitian strain of *Isochrysis, Isochrysis galbana, Monochrysis lutheri, Tetraselmis suesica, Rhodomonas sp., Gymnodinium splendens, Dunaliella salina* and a 1:1:1 mixture of *Isochrysis sp., T. suesica,* and *D. salina*. Feeding runs were generally of month-long duration. Experiments were conducted in laboratories at the Scripps Institution of Oceanography and the National Marine Fisheries Service, La Jolla, California, USA. Studies to elucidate certain nutritional aspects were accomplished using $C^{14}$ labeled substrate. Kelp (*Macrocystis pyrifera*) was labeled for 24 hours with $Na_2C^{14}O_3$ and fed to abalone (*Haliotis rufescens*) for one week. Radiolabelled abalone feces were recovered, dried, pulverized, and fed to rock scallop juveniles for one week. Total uptake of radiolabel into rock scallop soft body tissue was measured as well as specific activity in various biochemical fractions.

The results of a typical experiment utilizing 15 scallops in duplicate for four weeks at 17-20°C yielded an average shell diameter increase for the 1:1:1 algal mixture of 2.1±0.5 mm (S.D.). *T. suesica* and *Isochrysis sp.* supported growth of 1.6±0.8 mm and 1.1±0.4 mm respectively and *D. salina* supported considerably less growth (0.3±0.1 mm). Similar experiments utilizing 8 scallops for five weeks yielded an average shell diameter for the *Isochrysis sp.* diet of 2.5±1.1 mm. *I. galbana* supported less growth (1.9±0.9 mm) and other algal diets yielded considerably lower growth (0.8±0.6 mm to 1.5±0.6 mm).Radiolabelled abalone feces with a specific activity of 1600 cpm/mg dry weight was accumulated after 48 hours by a juvenile rock scallop at 820 cpm/mg dry weight (soft body tissue) and at 420 and 480 cpm/mg dry weight by two juveniles after one week. After two days specific activity of $C^{14}$ in lipid was 90 dpm/mg dry weight, DNA 90 dpm/mg, RNA 40 dpm/mg, carbohydrate 80 dpm/mg, and first appeared in protein, increased in lipids, and decreased in carbohydrates and free-reducing substances after one week. RNA remained the same.

Among the diets used in this study the mixture appeared superior, although significant growth was seen in juveniles fed *Isochrysis sp.*, *T. suesica*, *I. galbana*, and *Rhodomonas sp.*. The large dinoflagellate, *G. splendens*, was a poor food for juveniles. *M. lutheri*, shown by our earlier work tobe an excellent food for larvae, was a poor food for juvenile rock scallops. It appears that non-living particulate organic matter is ingested and metabolized by juvenile rock scallops. Experiments are in progress to demonstrate utilization of finely divided artificial foods including commercial fish feed.

POSTER 125

## ENGINEERING ASPECTS OF A NEW PROCESS FOR PRODUCING DRY LARVAL FEED

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A new high protein (up to 50 % protein) dry larval diet containing krill or brine shrimp has been developed for a wide range of fish and shellfish species (Gabaudan et al. 1980 and Tucker et al. 1980). The normal binder has been replaced by a fish protein hydrolysate (FPH) that has exceptional binding characteristics and is a 90 % plus functional protein. The FPH process was developed at the University of Washington for utilizing industrial and under-utilized species or fish waste from processing plants (Pigott and Bucove 1976, Heggelund and Pigott 1979, Liu and Pigott 1981). A pilot plant has been designed for continuous production of the drum dried product with a minimum loss of nutritional components. Sketches, photos and engineering drawings describing the design and operation of the plant will be presented. These will be accompanied by an economic analysis showing the advantage of utilizing this process on a commercial basis.

POSTER 126

## AN OXYGENATION APPARATUS

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The apparatus is made up of a centrifugal pump for the force-feed circulation of water and a bottle of oxygen for this gas supply. Two pressure-reducers, controlled by venturipipe, allow a regulation of the oxygen transfer.

The main advantages of this device, compared with direct bubble injections are: First, an optimal utilization of the quantity of available gas, and secondly the avoidance of contact of bubbles on animals' skin.

The regulation of the functioning is easy and can be done by a timer or better by an oxymeter. The field of application of such an installation is wide because it is usable for the dissolving of any gas in a liquid.

POSTER 127

## DEVELOPMENT OF RECIRCULATING HATCHERY AND NURSERY SYSTEMS FOR ATLANTIC SALMON (*SALMO SALAR*) AND EUROPEAN EELS (*ANGUILLA ANGUILLA*)

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Research into the design and performance of closed recirculating systems forms a major component of the work of the Aquaculture Engineering REsearch Group at Heriot-Watt University. Our interest in closed systems began in 1976 with the construction of a number of independent units for the ongrowing of marine flatfish. This paper concerns freshwater systems for Atlantic Salmon (*Salmo salar*) and the European Eel (*Anguilla anguilla*).

The salmon hatchery is designed to allow hatching of eggs and culture of fry to a weight of 5-10 g when they will be transferred to a separate nursery unit for ongrowing to smolts. Two independent multi-tank systems were built each having their own sedimentation and biological treatment units. Additional purification (U.V. sterilisation) and treatment (ion-exchange; carbon adsorption) units were designed as mobile "plug-in" units which could be used for either system as required. The two salmon systems are identical mirror images of one another, and were constructed from p.v.c./glass fibre components. The eggs were hatched in both conventional baskets and in a newly designed trough whilst 1 $m^2$ tanks were used for fry. The fluid prime movers were small mono pumps although other alternatives are being considered. Additional features include temperature control, aeration and a novel system of automatic feeders.

The eel nursery unit is designed to allow elvers collected from the wild to be brought onto feed and culture to a weight of 5-10 g when they are considered large enough for ongrowing. It comprises, a multi-tank system with a sedimentation channel, pump sumps and a centralised water treatment facility employing biological filters. Incorporated into the treatment unit were continuous upward flow ion-exchange and carbon adsorption columns, whilst preliminary work on foam fractionation, ozonation and characterisation of eel wastes has been undertaken. A new outlet screen has been developed for the fish tanks to give an improved self-cleansing capability whilst reducing the interval for screen cleaning. Some of the 1st years crop of elvers have been ongrown beyond 10 g for experimental purposes. Both systems rely completely on the domestic fresh water supply.

POSTER 128

## A COMPARISON OF TWO PENAEID PRAWN BROODSTOCK SYSTEMS - LAND-BASED TANKS AND MARINE PENS

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Due to the disadvantages of seasonality and expense attendant to the procurement of wild spawners, the SEAFDEC Aquaculture Department has shifted to ablated broodstock -- from offshore pens in 1977 and later from maturation tanks- to fill the yearly *Penaues monodon* spawner needs of its prawn hatcheries in Panay Island. Based in the Tigbauan, Iloilo Station the tanks are 12 $m^3$ ferrocement tanks with flowthrough water stocked initially with 3o to 40 males and sampled nightly for gravid females. Located in a protected cove in Batan, Aklan, the pens measure 16 x 16 m with water depth of 3 to 6 m and are stocked with up to 150 females and 150 males each; sampling for gravid females is weekly during the lunar phase.

Maturation rates in the tanks range from 10 to 100 % of females developing to full maturity and spawning after eyestalk ablation. The rate is lower in the pens mainly because weekly examination of the broodstock does now allow complete retrieval of all gravid females. Average fecundity in tanks is 270,000 eggs/ spawning with 36 % hatching rate (n = 213) for ablated wild stock *P. monodon* compared to 204,400 eggs/spawning with 20 % hatching rate (n = 111) for ablated pond stock females. In maturation pens, ablated wild stock *P. monodon* produced an average of 249,000 eggs/ spawning with 56.4 % hatching rate (n = 77).

Weekly mortality rates in the tanks average 9.2 % for females and 5.6 % for males based on 1979-80 data (n = 170 females and 89 males) compared to the pens with 39 % for females, 33 % for males in 1978 (6 pens) and 36 % for females and 29 % for males in 1979 (4 pens). Improved sampling techniques in 198o reduced over-all mortality in pens to approximately 25 %. Higher pen mortality is primarily due to the physical stress during sampling because of the lifting of the net from the water and handling of the animals. Other factors are pollution of the pen bottom by excess feeds leading to disease among broodstock and entry of predators such as eels through holes in the bamboo slats and nets. In contrast, good water quality in tanks is maintained by the flowthrough and daily siphoning of excess foods; although more frequent, sampling for gravid females is less stressful because of the use of an underwater light.

Total construction costs amount to P 10,000/tank and P 15,000/pen. Depreciation is minimal for the ferrocement tanks whereas the pens require yearly repairs and complete replacement after 3 to 5 years. In conclusion, the land-based tank is recommended because of a) lower mortality rates, b) more efficient retrieval of spawners, c) longevity, and d) usefulness for other penaids such as *P. indicus*.

POSTER 129

## POSIBLE NUEVA VARIEDAD DE BOCACHICO, *PROCHILODUS RETICULATUS* VAL. (PISCES, CHARACIDAE) DEL RIO SINÚ. Y SU RELACIÓN CON EL REGIMEN ALIMENTICIO NATURAL Y EN CONFINAMIENTO

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**El presente estudio permite señalar la posibilidad de registrar una nueva variedad de bocachico, Prochilodus reticulatus en el río Sinú. Ya que ésta especie siendo prácticamente de agua dulce, se encontró confinada como un grupo ecológico distinto, en las inmediaciones de la desembocadura del río Sinú, al mar caribe Colombiano.**

**El sitio de captura de los ejemplares fué la bahía de Cispata, lugar que se encuentra ubicado entre los 75°-56'O; y 9°-25'N. Las variaciones de salinidad oscilaron entre 0,5 a 5,0 °/oo, y el oxígeno disuelto entre 5,00-7,40 ppm.**

**El presente trabajo se realizó en base a 20 ejemplares, de los cuales 10 correspondieron al medio natural (Cispata) y 10 a los estanques piscícolas de la Universidad de Córdoba. Se conservaron en formol al 5%, y luego mediante un corte total del esófago y otro al recto y luego de separar los ligamentos mesentéricos, se extrajo en cada caso las vísceras del aparáto digestivo. Con estos organos se -**

realizaron los diferentes estudios morfométricos.El intestino se - corto en segmentos de 5 cm. hasta el ano y cada uno estudiado aisladamente,se efectuo un exámen cualitativo y cuantitativo del contenido gastrointestinal,la masa de fango del estómago se investigó aisladamente de la del intestíno. Para expresar matemáticamente los datos numéricos obtenidos y su relación con las adaptaciones correspondientes,se utilizaron los valores del coeficiente intestinal (RI) y coeficiente celomático (RII).

Los resultados obtenidos nos demuestran que las especies del medio natural mostraron una alimentación compuesta por diatomeas eurihalinas del género Actinoptychus splendens,Bacillaria paxillifer,Biddulphia aurita,B.mobiliensis,B.regia,Chaetoceros compressus, Coscinodiscus gigas,diploneis smithii,Fragillaria sp. Leptocylindrus danicus,Gyrosigma balticum,Grammatophora sp. Nitzschia closterium,Pleurosigma sp. Terpsinoe americana,T.musica y Ciclotella sp.

Mientras que los ejemplares confinados a los estanques piscicolas mostraron un regimen alimenticio compuesto por diatomeas estenohalinas del género Navicula sp. Synedra ulna y S.ulna var,fragilissima,Pinnularia viridis,Nitszchia languida y Diatoma vulgare en una proporción del 80%.

Aunque se tratan de ejemplares de la misma espécie,su comportamiento alimenticio nos puede indicar que se tratan de grupos ecológicos distintos.

POSTER 130

## STATUS OF BRACKISHWATER AQUACULTURE IN THE STATE OF ANDHRA PRADESH : INDIA

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The high potential for Brackishwater (coastal low-lying, intertidal regions) aquaculture has giben rise to very fast and extensive developments in the maritime state of Andhra Pradesh, India during recent years. The coast line is 982 km long and the potential land identified is about 17,000 ha. The 20 - 500 ha extensive farms that have developed are being run by privat companies, societies, fisheries corporation and, the most vital one, that of subsidized farming to the small and marginal farmers. The final category will receive goverment land at 1 ha per person, but the functional unit would be 500 - 1000 ha.

The technilogies that are adopted in the above farms are briefly reviewed: The engineering overview has been given primary importance since ist is a tide-fed system.(Tidal amplitude varies from 0.96 - 2.00 m in a 12 month period, during the spring tides). To supplement the low flows, additional pumping would also be needed. The flow rate during normal spring tide is 12 m per minute. Therefore, the type of excavation is based on the time taken for filling the pond to a depth of 1 to 1.5 m, as per the requirements of monoculture or polyculture.

The culture systems to be adopted are based on the techniques developed in the National Research Institutes of India. The monoculture is of *Penaeus monodon*/ chanos, and mullet; the polyculture is with different combinations of the above species. The seed required for stocking is procured from nature. The nursery

management for *P. monodon* is carried out in cement cisterns at a density of 1250/$m^3$/month with a survival of 80 % while, that of fish is done in earthern ponds at a rate of 40/$m^3$/month with a survival of 98 %. The index of seed abundance in nature is being worked out for each area as the catch-per-man-hour using a standard set of gear viz., hand net, push net, drag net or shootin net. The present seed potential from nature would meet the needs of the existing farms.

The cropping pattern is biannual or triannual with two shor crops in summer and long crop of 6 months in monsoon and winter for *P. monodon*; biannual for *Chanos chanos* and, annual, for grey mullets. The growth pattern of individual species is 20 g/150 mm/3 months for *P. monodon*; 250 g/350/6 months for *C. chanos* and 750 g/360mm/12 months for *Mugil cephalus* and 60 g/130 mm for *L. macrolepis*.

The feeding/fertilization technology is based on seasons, physico-chemical characters of the water and natural feed in ponds. Earlier studies have conclusively proved that both are required for fast growth and greater productions. The feed formula consists of rice bran and fresh meal (1:1); the conversion rate is 2.5:1 (wet weight). The *C. chanos* and *P. monodon* ponds receive bottom fertilization before water filling, for development of lab lab.

The harvest/production capacity to date is 500-600 kg/ha/annum of prawns per two crops and 1000-1200 kg/ha/annum of prawns and fish in polyculture. The rate of returns are also shown.

POSTER 131

## LARGE SCALE CULTURE OF *ARTEMIA SALINA*

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In this work a large scale culture technique for *Artemia salina* is described circular tanks (2.5 m Ø) were used with a capacity of 4,000 litres. An air-water-lift system oxigenates the water and gives a regular distribution of food. The temperature of the medium was kept between 22° and 25° C. A rice bran suspension was fed several times a day through a 500 u filter screen. The suspension was satured in NaCl water. The trials were carried out at different initial concentrations of nauplii: 1/cc, 2/cc, 3/cc. The culture was continued for periods of 6, 9, 12 days. Total biomass production avarage survival was recorded:

| duration of experiments (days) | food concentration (nauplii/cc) | biomass harvested (g) | % survival |
|---|---|---|---|
| 6 | 1 | 1,950 | 96 |
| 6 | 2 | 1,300 | 90 |
| 6 | 3 | 930 | 87 |
| 9 | 1 | 5,000 | 90 |
| 9 | 2 | 5,200 | 73 |
| 9 | 3 | 2,700 | 86 |
| 12 | 1 | 6,9oo | 88 |
| 12 | 2 | 8,700 | 68 |
| 12 | 3 | 5,600 | 74 |

The average increase in weight and length was checked daily in order to determine the growth curve.

POSTER 132

## MOLTING FREQUENCY OF BLUE CRABS, *CALLINECTES SAPIDUS* RATHBUN, CAGED AT THREE DEPTHS IN THE EFFLUENT OF A GALVESTON BAY, TEXAS POWER PLANT

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The effects of heated waters on the survival and molting frequency of caged blue crabs *(Callinectes sapidus* Rathbun) were studied from mid-February through late May 1980 at three water depths in the discharge canal and cooling lake of the Cedar Bayou Generating Station near Baytown, Texas, USA.

Molting rate was 22.5 % in the discharge canal and 22.2 % in the cooling lake. Molting at both sites was observed to occur in the temperature range of 22 to 35° C, with immature females molting more frequently than adult males. Due to low survival and low molting frequency it was concluded that blue crabs are poor candidates for a soft shell crab industry in the discharge canal of the Cedar Bayou Generating Station if raised under the conditions described in this research. However, survival and molting rates were higher during April and most of May in the bottom cage in the discarge canal at other depths and the cooling lake indicating that furhter research is warranted here during months with favorable temperatures.

POSTER 133

## THE RELATIONSHIP OF STOCKING DENSITY TO DISEASE DEVELOPMENT IN MARICULTURE

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Factors important in calculating stocking density for various mariculture systems are given together with examples of recommended levels. The effects of utilizing higher stocking densities on disease incidence are discussed with examples of infectious, metabolic and trauma - related disease. Spread of infection and reinfestation of fish with disease agents is facilitated by the number and proximity of individual fish. This is an especial problem with ectoparasitic disease when "population explosions" readily occur.

An increase in metabolic disease is seen at high stocking levels. This may range from simple oxygen deficiency to disease states caused by a build-up of metabolic wastes. Ammonia, nitrite and suspended solids are particularly damaging at low water exchange rates and have a major chronic effect on the gill, leading to mucus accumulation, epithelial hyperplasia and eventual myxobacterial gill disease and hypoxia. A more direct acute effect may be an alteration in cerebral metabolism. Increased levels of $Co_2$ in the water (in exess of 12 ppm) regularly leads to the development of nephrocalcinosis. This condition is particularly rapid in salt water when urine volume is low and divalent ion concentration is high. Gas bubble disease may arise from attempts to saturate the water with oxygen in heavily stocked systems.

Restocking also commonly leads to traumatic damage from cannibalism or skin damage from ultra violet light effects on the skin due to continual surface exposure of fish. Such lesions are then readily invaded with a variety of otherwise commensal organism such as *Vibrio anguillarum, Flexibacter* spp. and a range of parasitic agents.

At high density, individual food intake also varies and deficiency syndromes commonly develop in weaker fish. This problem also makes treatment for disease variable in effect. High stocking density may also considerably restrict the methods by which treatment may be undertaken e.g. bath treatments may either be too toxic or oxygen availability may become limited and overdosage often occurs. Any factor which reduces oxygen availability i.e. certain treatment compounds, respiration or decay of algal blooms, high temperature are also more likely to be lethal in an intensively stocked system.

In general terms, higher densities in fish culture allow more economic use of facilities but predispose to a variety of disease conditions an rely on a much higher standard of stockmanship.

POSTER 134

## THE AQUACULTURE DATA BASE - A WEALTH OF INFORMATION AVAILABLE TO ALL

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The Aquaculture Data Base was developed to satisfy the need for a centralized source of aquaculture information. By the close of 1981 the Aquaculture Data Base will contain approximately 8,500 aquaculture articles - a wealth of information continually made richer as 100 new documents per month are added.

This Data Base is a part of Lockheed's DIALOG system and may be searched directly from computer terminals throughout the United States, Western Europe and Mexico. A search of the Aquaculture Data Base yields a printout which includes bibliographic information, descriptive terms, and the genus & species of cultured organisms for each relevant article. Assistance in accessing information is available to people throughout the world from National Oceanic and Atmosphere Administration's (NOAA'S), National Oceanographic Data Center (NODC) liaison offices, their Library and Information Services Division, and through the Virginia Institute of Marine Science.

Microfiche copies of many Aquaculture Data Base articles can be provided to anyone requestin them. Contributions of published or unpublished aquaculture articles are always welcome. To contribute articles or to request copies of them, please contact Carol Rideout, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062, USA.

POSTER 135

## PRODUCTION OF ARTEMIA SALINA USING MIXED DIET
## CONSEQUENCES ON REARING OF SEA-BASS LARVAE (DICENTRARCHUS LABRAX)

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Some food additives (DL methionine, choline chloride, glucosamine hydrochloride, cholestrerol, cod liver oil and vitamin premix) were added to single cell protein sources (*Spirulina*, Yeasts) in order to meet the expected nutritional requirements of *Artemia salina*.

In a first time growth rate of *Artemia* was found to be superior with mixed diets than with single cell proteins only. In a second step the effect of the additives on the nutritional value of *Artemia* metanauplii was estimated as food for sea bass larvae. Preliminara results show that use of mixed diets leads to

faster growth of fish larvae; however, these results have to be confirmed by further investigations.

Then the optimum level of each additive in the mixed diet was investigated. In this purpose, a set of experiments in which *Artemia* were fed for their six first days with experimental diets was carried out. For each additive, various proportions in the diets were tested. The minimum level allowing maximum growth of *Artemia salina* was estimated for each nutrient or additive.

POSTER 136

## MARINE ALGAE CULTIVATION

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*Chondrus crispus* has been grown successfully in laboratory seawater tanks on land at the Seaweed Culture Station of the Atlantic Research Laboratory, Sandy Cove, Halifax Country, Nova Scotia (Canada).

The different systems of water circulation were employed: air bubbler, water jet, and mechanically-driven paddles. Goot growth rates were demonstrated from all systems. The paddle system of water circulation, however, is more energy efficient and would be the preferred method to use for commercial-sized tanks.

The effects of nutrient levels, light intensity, and water temperature on the growth of *Chondrus crispus* was studied and evaluated.

More recent studies on the effect of pH control of the seawater on plant groth was made and the results analyzed. It was demonstrated that ist is possible to reduce the flow of fresh seawater to the tanks from 12 changes per day to 0.15 changes per day an maintain the growth rate by controlling the pH with $CO_2$. The economic advantages of pH control would appear to be significant when expansion to commercial-sized systems is contemplated.

POSTER 137

## HEMOGLOBIN ONTOGENESIS IN THE SEA BASS, *DICENTRARCHUS LABRAX* (L.)

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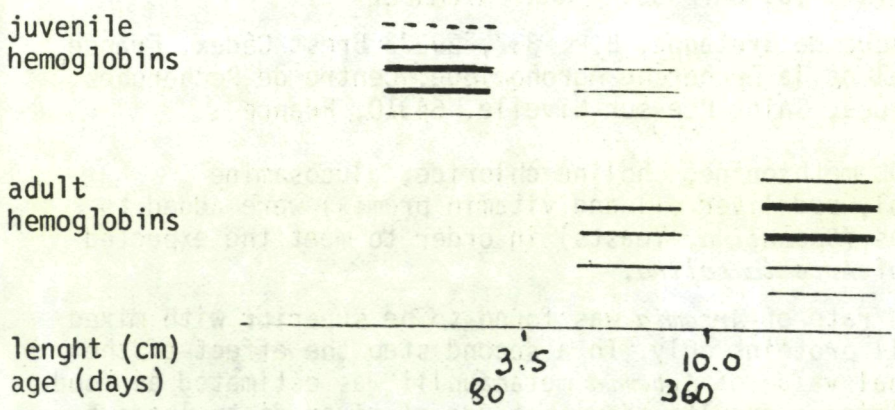
The fry of sea bass undergo a complete change in their multiple hemoglobin pattern, as evidenced by electrophoretic studies:



No hemoglobin polymorphism was observed in the over 100 individuals sampled. In intensive rearing conditions of our samples maintained at the SIRAP aquaculture plant at Pellestrina (Venice), the ontogenetic change occurs in the length range 3.5-10.0 cm, which corresponds to an age span from 80 to 360 days.

Generally the regulation of the protein synthesis is genetically programmed in relation with physiological and environmental factors pypical of the life cycle of the species in nature. The ontongenetic change observed is probably related with a growth crisis connected with the development of the swimbladder. In many fishes some hemoglobin components are thought to serve for gas regulation inside the bladder. Hemoglobin ontogenesis studies can be useful to understand the disorders of gas regulation which often arise in rearing factories at the beginning of swimming bladder formation.

POSTER 138

## SOME IMPORTANT ASPECTS FOR MANGEMENT OF GENUS *CHIROSTOMA* (ATHERINIDAE) IN INLAND WATERS IN MEXICO

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*Chirostoma* is an endemic genus of the mexican ichthyfauna, very appreciated for the quality of its meat and excellent flavor. It has a natural distribution in the inland waters, in the river basin Rio Lerma - Santiago and the Endorrei basin in the states of Michoacan, Guanajuato and Puebla, near of the Meseta Southern Mexicana (Barbou, 1973). Its distribution in more that one-hundred inland waters was successful. In the Bosque's Dam from the state of Michoacan, some fish in the genus *Chirostoma* comprise 20.5 % of the fisheries production.

From catch data for *Chirostoma*, we noted maximum weight an total length of 36.9 g and 17.5 cm; females were larger than males (P 0.05). Correlations between weight and total length of females and males were:

$$\text{weight } 0 = 0.03793 \text{ total length}^{2.3121}$$

$$\text{weight } 0 = 0.01866 \text{ total length}^{2.6087}$$

Females of 9 g had 5000 - 6000 eggs, and those of 37 - 40 g carried up to 44 000. Usually the eggs were layed in the more clean zones on submerged plants in water as deep as 1.5 m from March to June.

This genus is carnivorous feeding of Copepoda, Cladocera and small fish.

POSTER 139

## CONTROLLED REPRODUCTION OF THE SOUTH AMERICAN CATFISH, *RHAMDIA SAPO* (CUV & VAL)

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Several species of South American catfishes of the genus *Rhamdia* are potentially important for warm water aquaculture. Some of the desirable features of *R. sapo* are: exellent flesh quality; resistance to crowding, handling and adverse environmental conditions; ready adaptation to dry feeds and absence of aggressive behabior. They are partial spawners with a rather long reproductive season. Most of the females caught in spring have oocytes at the stage of completed vitelogenesis with germinal vesicles in a non peripheral position. Ripe females with flowing eggs are rarely found. This led to investigations of

reliable techniques for controlled reproduction.

Pituitary suspensions from the readily available characin *Prochilodus platensis* were injected intraperitoneally to females at doses between 3 and 16 mg/kg, at different temperatures. Final maturation and ovulation were checked by ovarian biopsy.

All doses tried effectively induced ovulation. Time between injection and ovulation was clearly dependent on temperature (extreme values are: 27-38 hours at 17.5° C and 14 hours at 27° C). Mating experiments in aquaria were not successful due to overipeness or retention of ovulated oocytes, even when males displayed active courtship behavior. Stripping of both sexes and artificial fertilization by the dry method proved easy and reliable. From 60,000 to 150,000 eggs were obtained from each female. In experiments at 20° C hatching rates were low for oocyted fertilized immediately after ovulation. Eggs have a gelly-like capsule but do not stick together. Incubation times in Chase or Zong yars ranged from 48 hours at 19° C to 27 hours at 23° C. *Artemia* nauplii proved to be the best food tried in larvae rearing experiments.

Descriptions on morphological changes in final stages of oocyte maturation fertilization and embryonic development are given.

POSTER 140

## GAS NORMALIZER

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In aquaculture the term aeration has nearly become a synonym for supplying cultured animals with sufficient oxygen. However, other gases have considerable physiological impact and should not be neglected in intensive aquaculture. Here only two examples:

Taking into consideration, that carbon dioxide is released as oxygen is consumed, the removal of the former is a problem with high stoking densities. In fish there are very distinct physiological effects correlated to carbon dioxide: Bohr effect, Root effect etc..

Concomitant with heating or cooling of the culture water there are changes in the partial pressure of all dissolved gases; oversaturation of oxygen and nitrogen after heating is a well known problem.

During millions of years of evolution, fish adapted to the ambient gas tensions, i.e. normally the partial pressures of gases found in air saturated water, which mostly are equal to the partial pressures of the gases in the atmosphere. Most of the natural waters of cultured species are near this equilibrium point. To simulate such a normal gas environment, should be the aim of artificial rather than selectively altering some of the gases.

The activity of the culturist in this respect should be to support the normal and natural processes. He could increase the area of gas exchange between water and air with mechnical aids rather than introducing new unnatural gas mixtures.

This study introduces two mechanical aids which take into consideration these objectives, therefore named "gas normalizer". They have worked successfully, where simple bubble aeration was not effictive enough. One system makes use of a surplus pump power; the other ist an independant compact unit. The performance and their impact on the culture water ist discussed.

POSTER 141

## STUDIES ON THE TECHNOLOGY OF POLYCULTURAL MARKET-SIZE FISH PRODUCTION IN PONDS

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During years of experimenatal work we established a technology for market-size fish production in polyculture which fits well into Hungarian fish culturing requirements.

Breeding period: 180-200 days (month IV-X); number of days with temperatures higher than 20° C: 80-100 (VI-VIII): minimal average weight of fish: 1000 g; main polyculture species are carps.

Suggested stocking and expected harvesting

| Species | Stocking | | | Harvesting | | | Survival (%) |
|---|---|---|---|---|---|---|---|
| | average weight (g) | Stocking densitiy (n/ha) | (kg/ha) | average weight (g) | yield (n/ha) | (kg/ha) | |
| Carp | 200 | 3300 | 660 | 1200 | 2640 | 3168 | 80 |
| Silver carp | 250 | 1000 | 250 | 1000 | 850 | 850 | 85 |
| Bighead | 300 | 500 | 150 | 1400 | 450 | 630 | 90 |
| Grass carp | 200 | 100 | 20 | 800 | 80 | 64 | 80 |
| Sheat fish | 300 | 100 | 30 | 900 | 80 | 72 | 80 |
| Total | - | 5000 | 1110 | - | 4100 | 4784 | - |

3.0 t wheat, 4.2 t pellet, 800 kg ammonium-nitrate and 250 g triplephosphate per hectare should be supplied to obtain the above yield.

The actual cost (stock-material, feed, chemical fertilizer, wages, amortization, water-charge etc.) was 60 % of the value of produced fish.

The principle of technology: the intensive chemical fertilization significantly increased zooplankton concentration which can be utilized by fish especially in the first stage of development. From July on we shifted to a combined wheat-pellet feed in which the ratio of the pellet was significantly increased thus providing the protein requirement of the fish.

This way we can achieve a yield above 3.5 t/ha using relatively low amount of protein in the feed while the fat content of carps is under 12 %.

POSTER 142

## RESEARCH ON REARING TURBOT (*SCOPHTHALMUS MAXIMUS*) - RESULTS AND PERSPECTIVES

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At the Centre Océanologique de Bretagne, a research programm on turbot rearing has been engaged in for several years. The life cycle is now under control. Up to 10,000 three-month-old juveniles can be produced per spawning season (natural or shifted) in laboratory facilities of about 200 $m^2$.

Attension is now being focused on early life stages. Survival rates of 30 % from hatching up to 3 months are still unsatisfactory. Weaning generally starts with 30-days old larvae, and the gross mortality is 50 % by then. Three month

old juveniles wet weight are around 2-2.5 g. One of our aims is to increase the survival rate from hatching to 3 months from 5 % up to 2+ %.

In Brittany, growing necessarily starts in a nursery: from 2 tp 5 g fish can be transfered outside in summer and from 2 to 20 g at least if fish are transfered outside in autumn. At this stage fish are fed dry pellets containing 53 % crude protein and 12 % crude fat. After 20 g body weight is reached, best results are obtained using a semi-moist food containing at least 20 % trash fish. Pure trah fish also gives good results. The food conversion ratio is about 1 (dry food weight/wet weight fish again). The second limiting factor, after the availability of large quantities of hatchery reared fry at a reasonable cost for a large scale turbot production, is lack of efficient commercial pelleted food.

Early data on turbot growth under intensive conditions are encouraging. Mean temperature range, 7° C in winter and 17° C in summer, allows an average weight of 1 kg at 2 years of age and2 kg (3 kg in the best case) at 3 years of age. A good control of the spawning season is still necessary in order to obtain a good market size in less than 3 years.

POSTER 143

## NITRITE RISK IN AQUACULTURE

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Nitrite can be present at dangerous concentration in aquaculture basins, when incomplete bacterial oxidation of ammonia occurs. Literature shows wide differences for LC 50/96-values among species exposed to nitrite. Toxicity is largely influenced by water chemistry. In particular, chloride has a strong protective effect toward fish exposed to nitrite. Few data are available about the influence of other environmental characteristics such as temperature, pH and other water quality parameters. Subletal nitrite concentrations are suspected to impede growth rate of fish reared through to commercial size. Studies are needed not only on nitrite toxicity but also on sublethal, physiological, and health effects of low level nitrite exposure in order to improve fish production in modern intensive fish farms.

Our studies were conducted to: (1) Evaluate the actual nitrite toxicity threshold marine species selected for aquaculture in Italy, at different development stages; (2) Evaluate temperature influence upon nitrite toxicity; (3) Study specific physiological paramenters influenced by nitrite with the aim to utilize them as early indicators of system performance.

POSTER 144

## PRELIMINARY RESULTS ON GROWTH OF THE SPOTTED RED SHRIMP *(PENAEUS BRASILIENSIS)* IN POLYCULTURE WITH THE MULLET *(MUGIL CUREMA)* IN MARGARITA ISLAND, VENEZUELA[1]

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During 1980, polyculture research was conducted at the Centro de Investigaciones Cientificas, Universidad de Oriente. Spotted red shrimp and mullet were stocked in a circular concrete pond with a double bottom bed and a surface of 7 $m^2$ and in two ponds of 0.05 ha and 0.1 ha. Stocking density in the circular pond was 100 shrimp/$m^2$ plus eight mullet/$m^2$. They were fed on crushed sardines. Stocking densities in the 0.05 and 0.1 ha ponds were 16 shrimp/$m^2$ plus two mullet/$m^2$. In the 0.05 ha pond, the food was: Sardines for shrimp and wheat bran for

mullet. In the 0.1 ha pond the food was sardines, wheat bran; fertilizer (12-24-12) was also applied. Food was given daily at a rate of 10 % of the biomass for each species. Growth and 5 % assumed mortality were taken into account. Water quality was monitored periodically to control high salinity and oxygen depletion of the ponds.

In the circular pond, 700 shrimp were stocked with 0.411 g mean weight (41.4 mm TL). The mean weight after 329 days was 9.795 g (108.95 mm) with 0.968 %, of daily growth rate in weight. In the 0.05 ha pond, 8,000 juveniles were stocked with 0.528 g mean weight (38.5 mm TL). The final mean weight after 269 days was 7.797 g (100,9 mm) with 1.005 % of daily growth rate in weight. In the 0.1 ha pond, 16.000 shrimp were stocked with 0.952 g mean weight (49.6 mm TL) The final mean weight after 147 days was 7.663 g (98.95 mm) with 1.429 % of daily growth rate in weight.

The experimente in the 0.05 an 0.1 ha pond was terminated early, because of mortality produced by bird *(Phallacrocorax sp.)* predation. No analysis of survival food conversion, or yield was possible.

Daily growth rate in the 0.1 ha pond (with fertilization) was the highest, compared with the results of monoculture species in the concrete pond (without double-bottom) during the year 1979. From 1.8 g initial mean weight fish after 377 days reached 19.02 g final mean weight at the daily growth rate of 0.61 %.

[1]Project supported in part by Grant C.I. No 4-20-00122/77, Universidad de Oriente, Venezuela.

POSTER 145

## THE ROLE OF THE GERMAN AGENCY FOR TECHNICAL COOPERATION (GTZ) IN INTERNATIONAL AQUACULTURE DEVELOPEMENT

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Basic Information on the GTZ

GTZ = German Agency for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit GmbH).
The GTZ is an autonomous non-profit organisation under private law, receiving most of its commisssions from the Goverment of the Federal Republic of Germany to carry out its technical cooperation schemes.

The Agency's technical cooperative work covers a variety of activities in the fields of agriculture and forestry, science, technology, education, economics and development of infrastructure. On a considerably smaller scale, the GTZ also privides contributions in the form of financial cooperation (direct funding). The annual GTZ budget is approximately 1 billion DM.

In 1979 the GTZ implemented 409 projects in developing countries with 1238 field experts and associate experts. In addition, 259 projects staffed by 710 experts were being executed by consulting firms commissioned by the GTZ.

The GTZ's policy is largely based on the Federal Ministery for Economic Cooperation'x policy (BMZ), which in turn is oriented towards the basic needs strategy.

Technical (and financial) cooperative activities are developed in different stages, beginning with the project idea and progressing to the project request (submitted by a developing country via the German Embassy to the Federal Foreign Office, the BMZ, the GTZ), the prefeasibility/feasibility study and finally to project implementation.

The GTZ Fisheries Section

Organisation: The Fisheries Section (143) is part of Division 14 (Animal Production, Animal Health and Fisheries) and is thus within Department 1 (Agriculture and Rural Development) of the GTZ.

Some 24 fisheries and aquaculture projects are currently being prepared or implemented including nine aquaculture projects (three of which are still under negotiation). Despite the trend towards an increasing number of aquaculture projects, our experience is still limited.

Aquaculture Research

Cooperative programmes between the GTZ and relevant German institutions as well as multinational donor agencies such as the FAO have already developed and are underway with bilateral agencies and intergovernmental research-oriented institutions such as ICLARM. The GTZ would welcome intensified cooperation activities with other international or national research institutions.

A variety of aquaculture research topics considered of vital importance by the GTZ are listed. Examples are "integrated agriculture-aquaculture farming systems", "technical improvements reducing post-harvest losses", "appropriate techniques in feed formulation and production for aquaculture".

POSTER 146

## DESIGN AND OPERATION OF A LARGE-SCALE, COMMERCIAL PENAEID HATCHERY IN THE PHILIPPINES

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Stocking requirements of nursery and growout ponds being developed by the Salt Industry of the Philippines, Inc. (Saltphil) increase steadily from 0.25 million $P_{10}$-$P_{12}$ postlarvae in January 1981 to a steady-state requirement of 5.0 million postlarvae per month in May 1982. To meet these requirements, a hatchery was designed and constructed; operation began in Dezember 1980.

The design differs from those of other commercial hatcheries in that it follows neither the large tank "Japanese-type" design nor the small tank "Galveston-type" design. The design of the tanks for larval and postlarval rearing has more in common with tanks which were developed at the NOAA Galveston Research Station for the rearing of postlarvae. At the Saltphil hatchery, 30 raceway tanks of 10-mt capacity each were constructed of reinforced hollow block and were plastered to a smooth finish and epoxy-coated. In each tank a single, central, epoxy-coated plywood baffle supports 14 PVC airlifts. A screened internal standpipe permits partial draining and/or flow-through circulation of water during culture. Harvesting is accomplished through an external standpipe which can be lowered into a floor canal.

Filtered, aged seawater is pumped from a two-chambered, roofed reservoir of 600-mt capacity to elevated fiberglass tanks for distribution throughout the hatchery and maturation facilities by gravity. Floatless relays in the elevated tanks acitvate pumping as required. All water and air distribution pipes are PVC and are installed overhead and exposed for convenient traffic flow, hatchery sanitation and for ease of maintenance and repair.

Nauplii from the hatchery's maturation facility are stocked at 30-50 per liter. Two species, indigenous *Penaeus monodon* and introduces *P. stylirostris* are cultured. Zoeae are fed *Chaetoceros sp.* at 60,000-100,000 cells/ml. *Chaetoceros* was isolated lacally and is maintained in pure culture and expanded to 12-liter batch cultures under controlled laboratory conditions. The 12-liter

batches serve as inocula for thirty-six 1,000-liter tank cultures outside the laboratory under a translucent fiberglass roof. Computed volumes of diatoms are pumped daily from these tanks into hatchery tanks containing zoeae.

Mysis are fed newly hatched *Artemia* nauplii hatched in individual batches corresponding to individual hatchery tanks in 20-liter cylindrical plastic containers. Postlarvae are fed a feed prepared from minced fish or clams, eggs, milk powder and yeast. This is supplemented with newly-hatched *Artemia*. Monthly production of postlarvae, which began January 1981, is on schedule to meet stocking requirements.

Details of the design, operating procedures, and management of the facility are discussed, and updated production figures are given.

POSTER 147

## FIELD TRIALS ON THE CULTURE OF THE SHRIMP *PENAEUS JAPONICUS* IN THE SALT PENS OF TRAPANI (SICILY)

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As the economics of salt production in family-scale salt pens of western Sicily are worsening progressively, new utilization is presently envisaged; mariculture seems particulary promising.

Since 1979, S.I.ME. has been performing field trials on culture of *Penaeus japonicus* under these conditions, together with trials on the culture of the bass *Dicentrarchus labrax*.

After 2 years of experiments, the following results have been obtained:

The full life cycle of the shrimp has been performed under natural conditions of the area (temperature 6 to 33 deg. C., salinity 38 to 45‰) including sexual maturation. Larvae rearing has been performed successfully using intensive culture technologies (200 larvae/1) at a scale up to 150,000 post-larvae. Survival rates reached 65 % at the $P_{20}$ stage. The growth rate in extensive conditions (below 5 post-larvae/$m^2$), using tidal flows or effluents of intensive culture of the bass, compared well to the best Japanese results; and young shrimp can be wintered in outdoors ponds.

Hence, ist looks like 2 yearly production cycles can be expected, for shrimp marketed between 15 and 20 g.

POSTER 148

## ANTICIPATED SPAWNING IN PERCH *(PERCA FLUVIATILIS)* BY MEANS OF HORMONAL PREPARATIONS

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The stimulation of perch *(Perca fluviatilis)* to spawn by means of relatively cheap and easily available hormonal preparations can be a useful possibility for breeding improvements.

For this work, 25 adult female perch with an average weight of 125 g were collected from lake Trasimeno on 4 March and transferred to tanks receiving filtrated water directly from the lake. The water was kept at a temperature of $8^{o}$ C, about $3^{o}$ C above that of the lake in the same period. Five days later the the perch were randomly assigned to four treatment groups and one control group with each group consisting of five fish. Fish from each treatment group were

treated three times every second day with intraperitoneal injections of one of the following hormonal preparations: 250 I.U. of HCG (Human Chorionic Gonadotrophin), 250 I.U. of HCG and 1 mg of progesterone, 1 mg of progesterone alone, and 5 ug of syntetic GnRH.

After 20 days, neither the fish in the control group nor those injected with GnRH spawned. Progesterone caused a mild swelling of the abdomen of all the fish 2 or 3 days after the last treatment but did not induce spawning. HCG induced spawning in three fish 2 days after the third injection and in the remaining two, 4 days later. HCG and progesterone induced spawning in only three fish 2 days after the last injection. However, further post-mortem examination of the two fish that did not spawn, confirming their gonadal immaturity (GSI = 0.8 and 1.7 respectively). The ribbons of collected eggs were intact and similar to those obtained from natural spawning. Eggs were fertilized according to the "dry method" with sperm squeezed from mature males and then incubated in Zug bottles. A fertilization rate of about 80 % was recorded.

Also if the experimental design was carried out on a limited number of fish, the effects due to the different hormonal treatments were strikingly consistent and significant. HCG and HCG in combination with progesterone were both effective in inducing spawning with a good syncronization rate, 6 to 8 days after the first injection and at least 20 days in advance to the natural spawning of perch in lake Trasimeno. Progesterone and GnRH were both ineffective in all fish treated.

POSTER 149

## PRELIMINARY REPORT ON HORMONALLY INDUCED SPAWNING OF PIKE *(ESOX LUCIUS)*

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The stimulating effect of different hormonal preparations in order to induce spawning in pike held in captivity was investigated. Unfortunately a persistent frost that hit the region forced a delay in the experiment which began in February only few days before the natural spawning of pike in the lake.

This study was carried out on 20 adult female pike captured from lake Trasimeno between the 3 and 6 February 1981. All females, ranging in weight from 0.4 to 2.0 kg, had reached gonadal maturation. The pike were immediately transferred to tanks receiving filtrated water directly from the lake. The water was kept at a temperature of 9° C.

The fish were randomly assigned to four tratment groups and one control group (five pike). The first group (five animals) receiving 1000 I.U./kg of HCG (Human Corionic Gonadotrophin) injected into the peritoneal cavity three times at 3 day intervals, had not spawned within 20 days. The second group (four fish) was similarly treated with HCG (1000 I.U./kg) and progesterone (10 mg/kg). Two pike spawned 3 days later, while the other two received a subsequent similar injection and then spawned 1 day after. The third group (four fish) was treated with 20 ug/kg of syntetic GnRH (LH/FSH Releasing Hormone) which, however, was ineffective in inducing spawning. The fourth group (two pike) was injected with a homogenate of pituitary obtained from other two pike of similar size and weight. This treatment induced spawning in both animals 3 days later. None of the control group spawned during the experimental period. The eggs obtained were succesfully fertilized using the "dry method" with sperm squeezed from mature males and the incubated in Zug bottles. The fertilized eggs normally hatched after a 10 day period.

Although these preliminary results were obtained from a limited number of fish, they emphasize that HCG alone was not effective in inducing spawning while the HCG and progesterone combination was effective in all treated fish. Also, the pituitary homogenate evidenced good effects. Both the effictive treatments induced a evident synchronized spawning.

POSTER 150

## CULTURE TRIALS WITH ATLANTIC STURGEON, *ACIPENSER OXYRHYNCHUS*, IN THE USA

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The Atlantic sturgeon, *Acipenser oxyrhynchus*, supported major fisheries along the entire Atlantic coast of the United States from colonial days until the late 1800's. Recorded landings, which may include the much smaller shortnose sturgeon, *A. brevirostrum*, peaked about 1890 at 3.3 million kg. Shortly thereafter, the various stae fisheries showed drastic declines or total collapse. This anadromous species, prized for both its flesh and roe "caviar", is highly susceptible to fishing pressure during its spawning migrations. Overexploitation coupled with the construction of dams on major spawning rivers are generally considered responsible for the present day scarity of this once abundant species. Today, commercial activities are centered in South Carolina and North Carolina where the combined annual landings for the past 20 years have averaged about 54,000 kg.

In 1978, a cooperative research program between the South Carolina Wildlife and Marine Resources Department and the United States Fish and Wildlife Service was initiated to begin development of a culture technology for Atlantic sturgeon. The emphasis of this work was to explore the potential for stock rehabilitation programs similar to those demonstrated in Russia. Additionally, information on the adaptability of this species to controlled intensive and extensive aquaculture techniques has been demonstrated, and appropriate transport and holding procedures for these large fish (40-150 kg) developed. Further, we have successfully employed monospecific hypophyseal injections to induce spawning of this species. Egg incubation time varied from 108-126 hours at a mean temperature of 17.5-18.0°C. After yolk sac absorption *A. oxyrhynchus* was weaned on a diet consisting of ground beef liver mixed with salmon mash and supplemented with live *Artemia* nauplii. Hatchery produced juveniles have been tank-reared for up to 131 days and wild-caught juveniles (size range 30-9,800 g) have been reared in ponds for up to 20 months. One large female (68 kg) has also been maintained in a pond for 15 month.

Currently, we feel that there is substantial potential for stocking rehabilitation programs with Atlant-c sturgeon and that this species may also be suitable for traditional aquaculture practices. However, much additional research is needed to assess these potentials. It also appears reasonable that hybridization and selection work with North American sturgeons could begin in the near future, given the current level of interest and cooperative research activities underway in the United States.

POSTER 151

## L-LACTIC ACID ACCUMULATION DURING ACTIVITY STRESS IN *MACROBRACHIUM ROSENBERGII* AND *PENAEUS DUORARUM*

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Stress-induced acidosis can have serious deleterious effects in many aquaculture animals. The primary cause of this acidosis is the anaerobic production of lactic acid in the body tissues during capture, transport or various other handling pro-

cedures. Although this phenomenon is known to occur in fish and other vertebrates, no studies of stress-induced acidosis in aquacultured species of shrimp and prawns are known. This study sought to measure for the first time whole body lactic acid concentrations of resting and active shrimps and prawns.

Marine *Penaeus duorarum* and freshwater *Macrobrachium rosenbergii* between 3.8 and 9.2 g wet weight were allowed to rest in individual containers overnight at 28°C. Half the group of each species were then sacrificed by immersion in liquid nitrogen. The other half were stimulated to exhaustion before immersion in liquid nitrogen. The time to reach exhaustion was recorded. The frozen tissue samples were then deproteinated and homogenized in 8% perchloric acid. Lactic acid was assayed in the supernatants of the centrifuged homogenates.

Lactic acid was found in both resting *M. rosenbergii* and *P. duorarum* (0.091± 0.015 mg lactic acid/g body weight and 0.121± 0.040 mg/g respectively). *Macrobrachium* required , on the average, 1.4 minutes to become exhausted, at the end of which time lactic acid levels has risen 6-fold to 0.610 ± 0.045 mg/g body weight Similarly, *P. duorarum*, after about 0.9 minutes, had increased its whole body lactic acid concentrations over 5-fold to 0.630 ± 0.250 mg/g body weight.

The rapid, 5- to 6-fold increase of lactic acid can have a major effect on the bodily functions of the shrimp. Normally these effects are reversible after a short period of rest. However, this continued stress could leave the animals more susceptable to disease and death. Moreover, the rapid built-up of lactic acid was due presumably to the rapid metabolism of the simple sugar glycogen. Replacing a sugar in the body tissues with an acid may cause a detectable difference in product quality which should be considered during all handling procedures.

POSTER 152

## ESTABLISHING NEW OYSTER AND MUSSEL CULTURE IN A DANISH FJORDSYSTEM OF VANISHING TRADITIONAL FISHING ACTIVITY

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Domestic development in Danish fjordsystems during the last decades has resulted in indreased waste effluents from human activities. This trend has promoted the idea to reestablish the economic activities based on production in the fjordsystem itself.

To fullfill this goal, aquaculture has been introduced, which might create a stable basis for a local industry. The aim of the project is to work out the production of the blue mussel, *Mytilus edulis*, in natural stocks using different culturing methods and devices. The culturing consists of settling on long-line systems, testing different types of ropes as their suitibility during settling and growing. After the first season of growth (before ice covers the fjord) part of the mussels were spread on culturing banks while others were kept on the ropes. Production levels of phytoplankton throughout the year were investigated and results are presented.

Different growing systems with various species/races of oysters, *Crassostrea gigas, C. virginica,* and *Ostrea edulis* are being tested. A new anti-fouling floating wheel for oyster growing is described. Preliminary results on growth rates of *C. gigas* under cold water conditions versus growing oysters using heated effluents from a conventional power plant are presented. Yields of *M. edulis* and *O. edulis* in Denmark are reported for the years 1943 to 1981, indicating the exponential increase in fishery for the blue mussel during the last decade opposed to the low level utilization of growing oysters.

Diagrams of the different growing systems in use ( for instance long-line systems for growth estimations of blue mussels in seven different places of the Isefjord, and a production line system also for blue mussel) will be presented. Data on growth of newly settled spat in comparison to the time of settling were analysed. According to the EEC Directive in shellfish breeding areas, certain water quality restrictions should be considered before turning the Isefjord into a shellfish production area. The project deals with environmental protection in order to describe sources, pathways, and effects of selected pollutants such as Hg, Cd, Cr, Cu and PCB on mankind. Preliminary results on levels of contamination in blue mussels are reported, considering the EEC Directive on quality of sea-water in a shellfish breeding area.

POSTER 153

## PARASITIC INFECTIONS OF CULTURED FISH IN KUWAIT

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Gill parasits induced hazardous effects on all size of fish. Mortality was caused by the hypersecretion of mucus which interfered in the respiratory mechanism. Gill filaments displayed inflammation and haemorrhage. The parasites were *Cryptocaryon irritans*, *Amylodinium* sp., *Polylabris* sp., *Diplectanum* sp., and *Lernanthropus* sp. Skin parasites e.g. *Neobenedeniella* sp. and *Caligus* sp.did not cause mortality but affected growth and produced stress which rendered fish susceptible to secondary bacterial infections. *Caligus* sp. displayed a bimodal peak in seasonal distribution. The parasitism stimulated epidermal proliferation and excessive mucus production.

The fish being cultured at the Mariculture and Fisheries Department are *Epinephelus tauvina*, *Acanthopagrus latus*, *Acanthopagrus cuvieri*, *Siganus oramin*, *Mugil cephalus* and *Tilapia aurea*. Comparison of the susceptibility of infection according to fish species showed *A. latus* and *A. cuvieri* as more prone to parasitism as well as bacterial infections.

Attempts were madeto develop adequate methods of control. A number of chemicals were tested for their efficacy which included Quinine hydrochloride(20 ppm), Malachite green (0.5 ppm), Acriflavin (10 ppm), Formalin (20 ppm), Chloramin T (20 ppm), Methylene blue (3 ppm) and Neguvon (0.25 ppm). Tests were carried out on juvenile fish (average size 10 cm) and broodstock fish (average size 25 cm) in 1 $m^3$ plastic tanks and 90 $m^3$ concrete tanks. Efficacy of the chemicals varied particularly in terms of duration of treatment. Formalin was found most effective and suitable not only for juvenile fish but also for the treatment of broodstock fish in large concrete tanks. Attemperature below 20$^{o}$ C ist showed detrimental effect on mucus coating. In one case of Neguvon, skin abrasion and scale loss were the prominent side effects. Skin parasites (*Neobenedeniella* sp.. and *Caligus* sp.) were easily killed with freshwater bath which was frequently applied at the time of transfer of fish from one tank to another.

POSTER 154

## MALAYSIAN PRAWN CULTURE IN BRACKFISH WATER PONDS IN LOUISIANA

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In accord with increasing demand for culture data of *Macrobrachium rosenbergii* in southeastern United States, the Louisiana Department of Wildlife and Fisheries initiated a series of tests in 1979. These trials, conducted in brack ish water earthen ponds in southwest Louisiana, concerned production without supplemental feeding.

This report summarizes 1980 tests when prawns were cultured for 140 days from postlarvae and fed. Production in ponds receiving Ralston Purina Experimental Marine Ration 25 averaged 410 kg/ha, 620 kg/ha and 510 kg/ha for the respective replicated stocking rates of 2.5/$m^2$, 4.94/$m^2$ and 7.41/$m^2$. Feed conversion factors were 1.0, 1.0 and 1.5. Average prawn size at harvest decreased with increased stocking density and was 21 g, 17 g and 12 g. Prawn harvests per pond ranged from 390 kg/ha to 830 kg/ha.

Post-larvae remaining after the stocking requirements of the feeding study were met permitted additional tests. Stocking rates selected were 1.2/$m^2$, 2.5/$m^2$ and 3.7/$m^2$. Prawns in these ponds received no supplemental feed and we recorded a harvest of 120 kg/ha, 220 kg/ha and 290 kg/ha, respectively. These treatments, the first two of which were not replicated, resembled production obtained in the 1979 study of prawn production on natural forage in brackish ponds at this facility. Average prawn size was 18 g, 15 g and 12 g deminishing with increased densities.

POSTER 155

## MASS CULTIVATION OF HARPACTICOID COPEPODS AS FOOD ORGANISMS IN MARICULTURE

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The availability of living food sources seems to be a key factor for further development of pertinent mariculture projects. The often cited high mortality rates of newly hatched fish larvae can be drastically reduced by offering them a variety of living food organisms of appropriate size and quality. Here, especially larval stages of copepods (nauplii and copepodits) could fill a striking gap.

In 1978 we started experiments for mass cultivation of the harpacticoid Copepod *Tisbe holothuria*. In enclosed flat plexiglass systems, population densities of more than 120 individuals per ml were achieved (Uhlig 1981). In order to avoid deterioration of densely populated media and to establish permanent mass production of different larval stages (nauplii $> 50 < 110$ µm and/or copepodits $> 100$ µm), a special adaptedsemiopened flow-through culture system was developed using floating rings of plexiglass sieves.

A first pilot project was carried out in spring 1981 in cooperation with the IOLR-team at the Marine Biologic Laboratory in Eilat, Israel. Several floating sieves (190-290 um diameter, 5+ um mesh size, immersion depth 10 mm, maintaining a constant water volume of 280 -660 ml seawater) were inoculated with fertilized females ($\approx$ 6 000 each) of *Tisbe holothuriae*, fed with dried granules of *Mytilus* (mantle tissue).

Results: At 23° C ($\pm 1°$) water temperature an average production rate of 9.3 nauplii $♀^{-1}d^{-1}$ was determined within the first six days (total yield per sieve ca. 55 000 nauplii $d^{-1}$). Afterwards the production dropped down to 3.1 nauplii $♀^{-1}d^{-1}$ (Mortality rate of the females about 5 % per day).

By optimizing the initial ciltivation system, production rates of 70 000 nauplii per floating sieve and even more are realistic. Using about 10 sieves, floating in a wide-bodied (at least 2,5 - 3 $m^2$) flow-through seawater tank, up to 1 million nauplii should be produced per day.

Additionally, a yet unidentified, by far larger *Tisbe* species was isolated at the Eilat Station. A series of growth experiments with individual females resulted in basically similar production rates to those found in *Tisbe holothuriae*.

However, according to preliminary studies there is a good chance of getting still higher yields of nauplii when *Tisbe* spec. from Eilat is mass-cultured in the above mentioned floating sieves.

Very preliminary experiments with newly hatched fish larvae of *Sparus aurata* showed that roughly 50 % of the fish larvae had *Tisbe* nauplii in their stomachs, indicating a preference for nauplii as opposed to copepodits.

POSTER 156

## THE ARTIFICIAL PROPAGATION AND CULTURE OF BEAR SHRIMP *PENAEUS SEMISULCATUS* DE HANN IN HONG KONG

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*Penaeus semisulcatus* is a candidate for aquaculture. The peak reproductive period of bear shrimp is May, June, July and even August. The increase in body weight and gonad weight coincided with increase in sea water temperature. This suggested that sexual maturation might be a direct response to increased sea water temperature. In the estimation of fecundity, each mature female shrimp probably carries about 415,000 to 479,000 ova.

In the study of its embryology and larval development, the basic pattern of development in *P. semisulcatus* includes a small yolk egg, a modified spiral cleavage, hatching as a nauplius larva, and a series of larval stages of zoea, mysis and postlarva with intervening moults.

In most cases, the half-spent spawnings led to production of poor eggs, which were characterized by irregular cytoplasmic formation and would finally autolyse. The embryonic development and larval development of *P. semisulcatus* proceeded satisfactorily in slightly alkaline medium (pH ranged from 7.5 - 8.5), and in salinity from 28 - 35 $‰_0$ for egg and nauplius stages, thereafter 25 - 35 $‰_0$ for zoea and mysis stages.

The shrimp exhibited faster increase in body length than body weight in early growth. Later on, after the shrimp had reached a body length of about 7.0 cm, body weight increased more markedly when compared with body length. The daily rate increase of weight was 1.+1 %. The feed efficiency of the formulated shrimp pellets was 31.4 %.

During the nutritional study of *P. semisulcatus*, it was found that the combination of high dietary protein (about 40 %) and low dietary lipid was good for feeding bear shrimp. High increase of biomass of the shrimp fed with clam meat and high quality fish meal demonstrated favorable response of shrimp to these diets. The use of cage culture for culturing bear shrimp was practicable, but not an efficient for culture.

POSTER 157

## CARP CULTURE TECHNOLOGY IN "DOLNA ODRA" POWER STATION COOLING WATER

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This study were aimed at obtaining marketable fish from carp summer fry /$K_V$/ kept for 14 months in power station cooling waters.

A 16 $m^3$ cage was stocked with 16,670 carp summer fry /$K_V$ / individuals of 3.0 g mean individual weight. The cage was stocked on 12 July; on 30 November 10,730 individuals of 90.4 g mean individual weight were caugth. The fish were

fed a specially made pelleted food offered as 10-12 % body weight rations, the food conversion coefficient being 3.78.

The individuals caught were divided into two size groups, 63 and 118 g mean individual weight each, and introduced /1 December/ to separate 30 $m^3$ cages. Six months later /5 June/, a total of 10,430 individuals of 195 and 374 g mean individual weight in each group, respectively, were caught. The fish were fed a pelleted food offered as 2.0 - 4.5 % rations. Food conversion coefficients obtained were 3.84 and 3.88.

The fish were next sorted into four size groups and allocated to separate cages in the following way: 2,015 individuals of 414 g mean individual weight, 1,900 individuals of 368 g, 2,750 individuals of 255 g, and 3,765 individuals of 185 g. The fish were fed a pelleted food offered as a ration of 4.5 %; the food conversion coefficient ranging within 2.43 - 262.

When emptied on 31 August, the cages yielded: 1977 individuals of 1,297 g mean individual weight, 1,863 individuals of 1,189 g, 2.702 individuals of 885 g, and 3,577 individuals of 634 g, making a total of 10,119 individuals weighing 9 438 kg. Until the end of October 11,407 kg of fish were marketed.

The results indicate that cooling waters can be successfully used as a culture milieu to produce marketable carp within 15 months.

POSTER 158

## REARING OF SEA BASS/ DICENTRARCHUS LABRAX/ IN FLOATIN CAGES

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Based on recent developments in the word and particularly in Europe, the rearing of some highly priced marine fish has become commercially justifiable.

Being aware of this fact, at the "Cenmar" the rearing of sea bass in floating cages has been accepted and the following programme separated into three phases developed: (1) 1978-1979= pilot scale rearing in floating cages; (2) 1979 -1982= small scale rearing (10 to 30 t) of sea bass based on fingerlings imported from Italy (SIRAP, Pellestrina); (3) 1982 .. Large scale production of sea bass based on fish hatched at "Cenmar".
The first two phases have already been successfully realized. The third one (construction of the hatchery) should start at the end of 1981.

Used for pilot scale rearing in 1978-1981, 100 to 200 $m^3$ floating cages were placed in Mala Lamjana Bay close to the fishing place Kali, near Zadar. Every spring these cages were stocked with 50 to 70 thousand young fish provided from the hatchery in Pelestrina; their body weight at stocking was 0.3 to 0.5 g. Based on 3 years experiences, the following results can be inferred:

- If in cage culture the size of young fish is around 0.5 g, then the rearing lasts for 17 to 22 months to get commercial size fish of about 300 g per individual.
- In each $m^3$ of cage volume, 8 kg of fish can be produced. This quantity could be increased to 10-15 kg/$m^3$.
- If dry pellets are used, feed conversion is 2.0 to 2.5; survival rate for fish from 0.5 to 300 g body weight was about 50 %.
- Quality of reared fish was excellent; therefore, they were easily marketed and were high in demand, both home and abroad.

POSTER 159

## INTENSIVE CARP REARING IN FARM PONDS IN SOUTHERS GERMANY AND ITS EFFET ON WATER QUALITY

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Conventional carp farming in Central Europe yields 500 to 1500 kg/ha/year, based on natural production, pond fertilization and supplemental feeding. The amount of water required to produce 1 kg fish varies between 20 $m^3$ and 50 $m^3$. This demand of water can be considered as very high when compared with intensive culture systems. Such carp ponds, however, show a high self-purifying capacity providing a relatively stable ecosystem for fish.

Experiments over 3 years in a 1500 $m^2$ pond to intensify production at high stocking densities with controlled feeding, resulted in substantial yield increase (weight gain per ha and year: 2.6 t for $C_1$, 9.1 t for $C_2$, 15.7 t for $C_3$). At the same time, water requirement could be reduced to 4 $m^3$ per kg fish produced. However the stocking densities achieved resulted into a continuously increasing eutrophication effect which expressed itself in mass phytoplankton blooms. This led to considerable diurnal fluctuations in oxygen (0.5 to 20.0 mg $O_2$/1) and total ammonia (0 to 11.0 mg $NH_3$-$NH_4$/1; max. 1.5 mg $NH_3$/1). The high stocking density contributed indirectly to the diurnal fluctuations (fertilization through faeces and lost feed). Its share to the overall $O_2$-depletion at night amounted to less than 25 %. The amplitude of the fluctuation was mainly determind by photosynthetic and respiratory activity of the phytoplankton and by microbiological degradation. With increasing water temperature during summer, increasing feeding rate, continuous fish biomass increment, and decreasing light period per day the danger of total fish stock mortality was greatest in August. Only at maximum photosynthetic activity during day, the total ammonia production in ponds could be counteracted, and sufficient oxygen was produced. Even heavy aeration was not always successful to provide enough oxygen during night. In order to avoid a breakdown of the system, algae and nutrients had to be diluted from time to time by excessive water replacement. Despite the temporary overloading of the pond system, losses in numbers were kept below 6.5 % (normal: 10 %).

Pellets were offered via self-feeding devices. Food uptake was continuously recorded. No diurnal feeding rhythmic could be observed, but feeding activity was entirely dependent on oxygen levels in pond water. Feed conversion efficiencies reached values between 1.96 and 2.48.

POSTER 160

## THE SWIRL CONCENTRATOR - A SUCCESSFUL DEVICE FOR THE REMOVAL OF SOLIDS WITHIN CULTURE UNITS

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The fish farming industry is rapidly increasing, and in some cases severe pollution problems in the receiving waters have been noticed. Compared with other types of wastewater (e.g. domestic wastewater), the concentration of various fractions in wastewater from fish farming is relatively low, but the total quantity of pollutants is high due to the large water consumption in flow-through systems such as for the rainbow trout production. This fact is most important when evaluating suitable treatment methods.

A fish farm producing 50-75 tons a year utilizes approximately 500 litres per second (6,000 gpm). This quantity equals the daily consumption of a population of

170,000 people. Having the price of advanced water treatment in mind it is obvious that methods such as biological treatment, filtration etc. in most cases can be excluded.

At the Water Quality Institute in Denmark a cost-benefit evaluation of different treatment methods has been carried out and according to the results of the noticed evaluation, it is most realistic to deal with gravitational separation, for instance sedimentation.

However, a traditional sedimentation demands a relatively large area, e.g. a basin area at a water consumption of 1200 $m^3$/hour (317.000 gph) would require 500 square metres.

A much less area demanding device is the swirl concentrator. Results of research dealing with a swirl concentrator as a sold removal was successful.

In brief, a swirl concentrator is a circular tank in which the flow is directly tangentially. It achieves clarification of solid-laden liquid flows, not by simple gravimetric separation under quiescent settling conditions, but by introducing secondary motion flows. The result is that the solids fall down to the bottom of the tank. Having an overflow weir at the surface in the centre ensures a clarified outflow. It is now possible to concentrate the solids and discharge them through a foul outlet using only a flow of 1-5 percent of the total.

The removal achieved with a swirl concentrator has from the discharge from circular selfcleansing units (rainbow trout production), been up to 60-80 percent, 30-40 percent for earthen ponds.

Compared with traditional rectangular settling basins, the area used by the swirl concentrator device may be diminished by a factor 8 to 10.

Since no fish farms are all alike in construction, management, production etc., the effluent will differ from fish farm to fish farm. The exact dimensions can, however, be achieved by performing simple batch-sedimentation tests.

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## A NEW SPECIES FOR TROPICAL FISH CULTURE: MATRINCHA *(BRYCON SP.)*

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The worldwide demand for high-quality animal protein makes intensive search for new species attractive , especially in less-developed countries. In order to avoid deliberate introduction and distribution of non-endemic species, a regionally important market-fish "matrincha"(*Brycon sp.*) was tested for its growth-potential in fish ponds at INPA (Instituto Nacional de Pesquisas da Amazonia), Manaus, Am., Brazil.

Two groundwater-ponds (70 $m^2$ an 213 $m^2$) and two dammed sections of a small river (236 $m^2$ and 255 $m^2$) were used as growing units. When stocking these ponds with 1 to 2 fish of 24 g per $m^2$ a production of up to 4 tons of edible fish per ha and year could be achieved (Werder and Saint-Paul, 1980). Within a period of only ten months weight-gains of more than 400 g could be observed and probably matrincha would grow to 500 or 800 g within one year. Food conversion efficiency was 1.5, when feeding pelleted dry-feeds (35 % crude protein) (Saint-Paul and Werder, 1977, Werder 1979, Werder and Saint-Paul, 1978, 1979). Feeding additional cheap food sources, such as wafer-bits, brewery's residues,old bread, and slaughtery-wastes, reduced the feed costs per kg fish produced. Some private culturists decided not to feed pellets at all, but shift to alternative diets.

Conversion rates are not available for this type of feeding. The omnivorous fish grew well on pellet-diets which contained up to 20 % of water-hyacinth meal (Saint-Paul, Werder an Teixeira, 1981).

Matrincha is a very hardy fish and at water-temperatures of higher than 30° C in standing waters, no mortality could be contributed to low oxygen-pressure. The fish survived well even when the concentration fell below 1 $mgO_2/1$. The fish withstands rough handling, shows medium mortality (6 to 30 % per year), produces very tasty meat, and can easily be cultured in small reservoirs and ponds by the local population within the Amazon area on allow-cost investment basis (Werder and Annibal, in print). A 1 ha pond can provide sufficient fish throughout the year for 7 to 8 rural families, each consisting of 6 members.

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## FOOD PREFERENCES OF LARVAE OF *PENAEUS STYLIROSTRIS* TO MARINE DIATOMS, MARINE PHYTOFLAGELLATES, BRINE SHRIMP AND NEMATODES

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Larval substages of protozoea and mysis of *Penaeus stylirostris* were fed four mixed dietary treatments to determine the relative acceptability of: 1) different algal and animal food species, 2) algal versus animal foods, and 3) frozen animal foods versus live animal foods.

Food species tested were the marine diatoms, *Skeletonema costatus* and *Thalassiosira fluviatilis*; the marine phytoflagellates, *Isochrysis galbana* and *Tetraselmis chui*; the brine shrimp, *Artemia sp.* and the nematode, *Panagrellus redivivus*.

Preferences for different food types were exhibited by the various larval substages. The implications of these findings to the shrimp mariculture industry are discussed.