# FUTURE TRENDS OF AQUACULTURE DEVELOPMENT IN EASTERN EUROPE

## Handbook of short communications and national reports

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# FUTURE TRENDS OF AQUACULTURE DEVELOPMENT IN EASTERN EUROPE

Extended abstracts of contributions and national reports on the status of aquaculture in Eastern European countries presented at the International Conference on Aquaculture Development in Eastern Europe
Budapest, Hungary, September 1-5, 1996

Compiled by:

I. Csavas

Layout and processing:

K. Scheire, L. Aspeslagh, and H. Joncheere

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and the
Fish Culture Research Institute

# Preface

This book contains the extended abstracts of contributions and the national reports on the status of aquaculture in Eastern European countries submitted to the International Conference on Aquaculture Development in Eastern Europe in Budapest, Hungary, September 1-5, 1996.

The overall theme of the conference was **future trends of aquaculture development in Eastern Europe.** The conference was jointly organized by the European Aquaculture Society (EAS) and the Fish Culture Research Institute (HAKI).

The first part of this book consists of the extended abstracts that are arranged alphabetically on first author, followed by a section comprising the national reports on the status of aquaculture in several Eastern European countries (annex 1). Abstracts that were received after the publication had been compiled are included in annex 2.

To improve accessibility, a table of contents and author index have been added.

All papers have been printed directly as received from the authors, without additional editing.

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# Extended abstracts

# THE USE OF LOW COST ORGANIC MANURE IN MASS PRODUCING ZOOPLANKTON

P.O. Ajah and S. Holzlöhner
Institute of Oceanography, University of Calabar,
P.M.B. 1115, Calabar, Nigeria

## Introduction

Success in rearing of fish rely on the availability of large quantities of live zooplanktonic organisms. Our objectives were to prove the applicability of locally available and affordable nutrient resources for mass production of zooplankton and to compare the effectiviness of these fertilizers. The aim was also to replace the imported expensive *Artemia* spp. metanauplii with the zooplankton produced as food for catfish (*Heterobranchus longifilis*) larvae.

## Materials and methods

The organic fertilizers consisting of cow dung, goat droppings, poultry droppings, swine manure and bakers yeast (*Saccharomyces cerevisiae*) and the inorganic fertilizer NPK (20:10:10), single super phophate and urea (46% N) were used. The semi-continuous culture system adopted required that 20% of the culture volume be harvested every two days and nutrients replenished using one fourth of the initial dose of fresh nutrient medium. *H. longifilis* larvae at two days old were introduced for 30 days into any of the culture tanks, after establishing constant zooplankton density for five months.

## Results

Results showed that 4.8 kg/ha/day of rotifers were achieved using swine manure, whilst 2.47, 1.32, 1.11 and 0.17 kg/ha/day were gotten using poultry droppings, cow dung, goat droppings and inorganic fertilizers, respectively. Cladocera and Copepoda yielded a biomass ranging from 2.0 to 4.0 kg/ha/7.5 days, respectively, using organic manure.

Table I. Growth and survival of fish larvae per hectare reared using different fertilizers for one year.

| Fertilizer | Larval Standard length (cm) | Survival (%) | Fish Biomass/ ha/year (kg) |
|---|---|---|---|
| Swine manure | 5.3 | 41 | 446.03 |
| Goat droppings | 2.0 | 95 | 331.03 |
| Yeast | 4.0 | 13 | 14.60 |
| Poultry droppings | 9.9 | 3 | 405.15 |
| Inorganic fertilizer | 3.8 | 6 | 76.04 |

## Discussion

The findings of 40,000 rotifers/Cyprinid larva/30 days (Okauchi et al., 1980) and feeding at 80% per fish larval body weight (Fushimi, 1975; Kitajima, 1976; Kitajima et al., 1976), 800,000 and 638,333 catfish larvae of 6 mg initial body weight could be reared in 30 days using rotifers and copepods, respectively. Holzlöhner (1958, unpublished data) and the present work indicated advantages of swine manure over inorganic fertilizers in terms of plankton and benthos biomass as well as better growth and survival of carp (*Cyprinus carpio*) and catfish.

## Conclusion

The final assessment of productivity via growth and survival of fish larvae put swine manure as the best seconded by poultry droppings.

## Reference

Okauchi M., T. Oshino, S. Kitamura, A. Tsujigado and F. Fukusho. 1980. Number of rotifers *Brachionus plicatilis* consumed by a larva and juvenile of porgy, *Acanthopagrus schlageli*. Bulletin National Research Institute of Aquaculture 1:39-45.

# AN EXPERIENCE OF INTRODUCTION OF ORIENTAL RIVER PRAWN *MACROBRACHIUM NIPPONENSE (DE HAAN)* IN COOLING RESERVOIRS OF MODERATE ZONE.

Anatoly Alekhnovich, Sergei Ablov
Institute of Zoology, Academy of Science of Belarus,
Scorina str. 27, 220072 Minsk, Belarus

An ecology of freshwater prawns of genus *Macrobrachium*, Bate acclimatized in a cooling reservoir of electric power station has been studied in long-term experiments. An acclimatisation of subtropical and tropical species of prawns does not restore completely the ecological balance of cooling reservoirs but increases their productivity significantly.

In 1982 1500 heterosexual individuals of subtropical oriental freshwater prawn *Macrobrachium nipponense* have been introduced into the cooling reservoir of Bereza hydroelectric power station (Belarus, Brest province). The species has adapted itself successfully in completely new for it geographical zone at the temperature diapason of 8 to 36°C. The reproductive period of *M.nipponense* in cooling water of Bereza station lasts 5-6 months starting when the water temperature values exceed 20°C and is stopped in autumn after the water temperature comes down lower than 20°C. Due to these circumstances the uncontrolled spreading of M.nipponense in native waters of Belarus is impossible.

A number of prawns in 1985 has been estimated as nearly 2 million individuals. Prawns have been spread through all the area of cooling water including the ponds of the fish-farm and practically all the small drains. In shedding channels its density amouted to 1-5 ind.m$^{-2}$, in some places up to 40 ind.m$^{-2}$, at the cooling reservoir 1-2 ind.m$^{-2}$.

Depending on a year season prawns are distributed differently in the water area. Egg-bearing females accumulate at the maximum depths of the channel (3-5m) while males are dominating at less depths. The new-born juvenales are found in shallow waters under the shelter of water plants. Due to such a distribution the cannibalesm in moulting period is reduced since prawns are surrounded by the individuals of nearly the same size and the juveniles do not compete for food with adults. In autumn the spatial zonation of the population is changing again. All animals are concentrated at maximum depths. At the excess of a number of individuals over the habitat capacity the described sex distribution is breaking up.

The main populational characteristics of *M. nipponense* are shown in the table.

| Age, month | Female lengh,mm | Survi-val,% | Survi-val of eggs, % | Hatch num-ber | Season fecun-dity, eggs | Expected number of descen-dants |
|---|---|---|---|---|---|---|
| 3 | 35 | 0.08* | 20 | 1.5 | 554 | 0.09 |
| 15 | 59 | 0.29 | 44 | 6.0 | 12372 | 15.78 |
| 25 | 69 | 0.12 | 47 | 5.0 | 17265 | 9.74 |

*- the survival is indicated multiplied by the proportion of mature springers

The average annual rates of increment of population number is described by the equation $N_t = N_o e^{0.02t}$, where $N_t$ is a resulting number of the population, $N_o$ is an initial number , t is a time in days.

The role of the acclimatized species a new ecosystem has been estimated after the stabilization of its number. In summer at average temperature 25°C in depth of 1-3 m the biomass of adult prawns amonts to 1,36g.m$^{-2}$. The assimilated energy regarding the somatic, generative and exuvial growth amounted to 95 cal.m$^{-2}$ and pure efficiency of growth -28%. The ration of prawns has been determined as 127 cal.m$^{-2}$. The alive food comprises about 20% of the prawn ration including Chironomus larva, Oligohaeta, small mollusks and the rest is a vegetation, detritus, waste mixed fodder at the cage stocking of fish. The daily assimilated energy of benthos disregarding of prawns comprised 305 cal.m$^{-2}$, the production - 164 cal.m$^{-2}$. Prawns consume 25 cal.m$^{-2}$ of benthos production and the summary energy flow the benthic association comprises 375 cal.m$^{-2}$.

So in the total energy flow of the cooling reservoir the proportion of the introduced species has comprised 25%. Therefore the introduction into cooling waters of freshwater prawns evolutionally adapted to high temperatures significantly increases the cicrculation of the substance and energy in ecosystems and an effectiveness of their exploitation. Oriental freshwater prawn should be recommended for the acclimatization in waste-heat discharge waters of power stations.

# EFFECTS OF SIZE-SELECTION AND TEMPERATURE ON GROWTH IN SEA BASS (*DICENTRARCHUS LABRAX L.)* JUVENILES

L.Bavčević , A.Mihovilović
CENMAR d.d. ,Trg tri bunara 5 ,23000 Zadar, Croatia

## Introduction

This experiment was conducted with sea bass *(Dicentrarchus labrax L.)* juveniles, at different temperatures, in order to get more data about growth dynamics. Obtained results, should make planing of production dynamics in hatchery, much easier.

## Materials and methods

Three size-selection groups 1(large), 2(medium) and 3(small) of the sea bass juveniles, were taken from a regular hatchery production, at the time they reached approximately 45 mm and 800 mg respectively. From each group 300 juveniles were divided to three temperature regimes:19, 21 and 23°C. Each regime consisted of two parallel 50 l aquarium tanks. The experiment was conducted with 50 fish per tank in conditions similar to regular production. Mean length and weight were calculated at the beginning and at the end of the experiment. Only in one of each parallel tanks, total fish length was measured once a week and mean values were calculated. Feeding was ad libitum in order to obtain maximal growth as revealed by Tibaldi (1991).

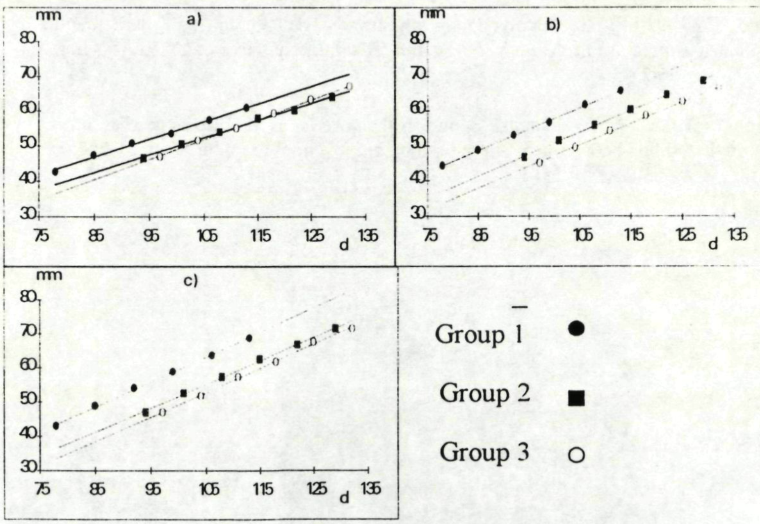


Fig.1- Regression of length growth (mm) on age (day), of sea bass juveniles, at : a)19°C ,b)21°C and c)23°C for three selection-groups.

## Results and discussion

Regression analysis shows that length growth during experiment was linear with high correlation(Fig.1). Comparison of regression coeficents for each temperature reveals at $p<0.01$ that calculated lines are parallel ,except for group 3 at 19°C (Fig.1a).This experiment didn't prove that genetic potential of size selection group is correlated with length growth. Similar results have been obtained by Umino et al.(1994) on *Pagrus major* juveniles.

## Conclusions

Sea bass juveniles' growth rate, is not significantly different between the size selection groups, but it is greatly affected by temperature. It is possible to equalize size of different selection groups using adequate temperature regimes.

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# INTERSPECIFIC ANDROGENESIS - HATCHING OUT GOLDFISH FROM COMMON CARP EGGS

M. Bercsényi[1], I. Magyary[2], B. Urbányi[2], L. Orbán[3] and L. Horváth[2]

[1] Warm Water Fish Hatchery Ltd., Százhalombatta, H-2441 Hungary
[2] University of Agricultural Sciences, H-2103 Gödöllô, Hungary
[3] Agricultural Biotechnology Center, H-2101 Gödöllô, Hungary

## Introduction

Fish are ideal objects for genome manipulation: various forms of these techniques are applied routinely in the daily practice of aquaculture. Androgenesis is a single-parent type of inheritance where by definition the genetic material of the progeny originates exclusively from the male gametes, while the maternal chromosomes are presumed to be totally excluded from the process. In this publication we demonstrate and verify by DNA analysis, that it is possible to perform interspecific androgenesis between two Cyprinid species

## Materials and methods

Viable diploid goldfish (*Carassius auratus*) progenies were produced through androgenesis using the egg of common carp (*Cyprinus carpio*). The ova irradiated with gamma-rays were fertilized with either fresh or cryopreserved sperm. Diploidy was restored by the application of heat shock. Colour and morphological markers were used to prove the male origin of androgenetic progenies (Fig. 1. ).

## Results and discussion

In the best batch 22.9 % of the eggs reached hatching and 8 % survived until 2 weeks. 10 to 30 androgenetic goldfish per male were grown up to sexual maturity in order to use them for further observation and experiments.

## Conclusions

Elaboration of similar methods on some selected major fish groups and establishing frozen gene banks might help in future for restoring extincted species.

**Acknowledgements**

We wish to thank the staffs of Warm Water Fish Hatchery (Százhalombatta). We would like to express our gratitude for funding this research to the Foundation for Science in Hungary of the Hungarian Credit Bank.

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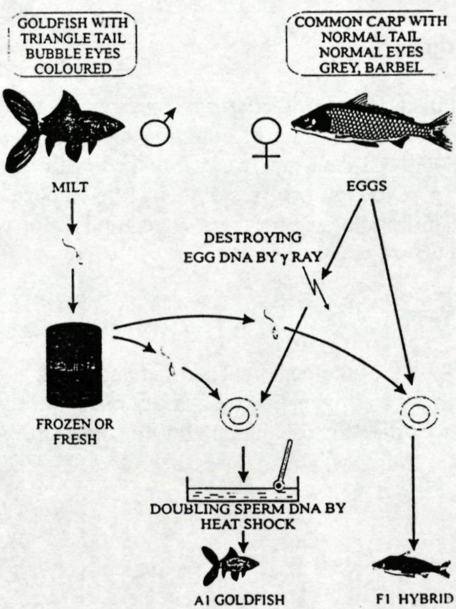
Figure 1

INTERSPECIFIC ANDROGENESIS



# FRESHWATER FISH FARMING IN EASTERN EUROPE

R. Berka

Fish Farmers Association, Pražská 58, 371 38 České Budějovice, Czech Republic

In Eastern Europe, a freshwater fish farming is a traditional part of agriculture industry. In many countries, especially in the present-day Czech Republic and Poland, farming of cyprinid fish species has deep historical roots dating back to the 12th century with a peak in the 15th and 16th century called the Golden Age of fish-pond farming. In some other countries, particularly in the states of the former USSR, freshwater fish pronouncedly contributes to a human animal protein consumption. In Eastern Europe generally, fish farming has an image of very specific and unique field of food production accompanied with a very serious public respect.

The following countries are reviewed in terms of Eastern Europe (from west to east): Czech Republic, Poland, Hungary, Slovakia, Slovenia, Croatia, Romania, Bulgaria, Ukraine, Russia, Byelorussia, Lithuania, Latvia and Estonia. As to the experience in economic and organizational transformation of fish farming sector in the former GDR, this East-German region is taken into account as well.

Regardless the enormous political and economic changes on the territory of Eastern Europe (this term is based rather in the past grouping of countries than the real geographical configuration), the fish farming industry is still not fully denationalized, reshaped and effectively transformed in some of thouse countries. The Czech Republic, Poland, Slovakia and partly Hungary are rather exceptions in this respect; their fish farming sectors are fully privatized and the industry itself is now focussing on hierarchically more pronounced problems, i.e. market development and marketing strategy.

As to some East-European countries, official production and market statistic data are missing and the presented volumes of produced fish are rather expert estimations based on certain knowledge of a status of fish farming in those countries. In the year 1995, about 190 thousand tonnes of farmed freshwater fish was probably produced in Eastern Europe, of which about 100 thousand tonnes in the countries of the former USSR. It is by 30 to 40 % less when compared with the situation in the end of the eighties. The reasons of this drop are discussed (both generally and individually for some individual countries) in the review. Nevertheless, a production potential in all East-European countries is high, and twice higher production volumes (in pond farming) could be reached under improved productivity of work and with only slightly increased inputs.

As in the past, even now the cyprinids are the most widely farmed fish in Eastern Europe. Particularly a carp culture is a dominant sector in fish farming not only due to historical background. Moreover, carp itself (having many advantages from farming point of view) can serve as a well documented example of a domestification of wild animal.

Compared with the generally advanced and well proved methods of fish farming (especially in pond culture), there is no extra experience in fish marketing strategy and policy in all of East-European countries. Freshwater fish is still sold mostly as a live fish and by fish producers themselves. This is not well in accordance with the consumers' needs and it is reflected in a scattered scheme of fish market not fully covering all regions of individual countries (which means, in fact, a regionally strongly non-balanced consumption of fish). In this respect, a situation in some of East-European countries is discussed. Paralelly, marketing, economic and social viewpoints are taken into account as well.

Fish processing is an actual and most serious bottle-neck of freshwater fish industry in all East-European countries. There is no experience in this field and compared with a salmon/trout processing in the Western Europe, the Eastern Europe has about two decades delay in this respect. Nevertheless, structural changes in fish processing are not simple to realize, particularly if these changes have not yet started in the majority of countries of Eastern Europe.

Also a marketing strategy is still a strange word for most of freshwater fish producers in a majority of East-European countries. This refers particularly to promotion where no experience exists due to the past.

Although some export of freshwater fish from East-European countries (especially from those situated near an imaginary border between West and East of Europe) exists, the dominance of fish outlets lays in domestic markets due to a production structure composed mostly from cyprinid fish species. This is why all East-European countries should focus primarily on local markets and supply them with more sophisticated fish semiproducts and products (a parallelism with poultry).

The constraints of more rapid development of fish farming industry in the countries of Eastern Europe represent both objective and subjective reasons. It starts with a delay in privatization and transformation processes in some countries, follows with uncomplexity of legislation, and finishes with underdeveloped domestic markets. Among the subjective reasons, no adequate courage of non-experienced decision makers to deal with new problems of fish market seems to be the most important.

Anyway, there is a good prospect for the East-European fish farming industry. Nevertheless, its pronounced and quick progress (which depends primarily on market development) will need time, money for capital investment and bold people.

## DANISH FRESHWATER FISH FARMS

Marianne Bjerre and Annette Holm Sørensen, Vejle County, Damhaven 12, 7100 Vejle, Denmark.

### Introduction

| | |
|---|---|
| *Number of freshwater fish farms in Denmark:* | *485* |
| *Total feed consumption in Denmark in 1994:* | *34.794 tons* |
| *Total trout production in Denmark in 1994:* | *34.949 tons* |

The counties are the supervising authorities for the fish farms in Denmark.

### Legislation

In 1989 all Danish trout farms became included in the Regulations for Freshwater Fish Farms.

The purpose of the Regulations was to control this industry and, at the same time, to reduce the discharge. The level was fixed according to the objectives for the watercourses. The objectives were, that the watercourses should have a fauna that would by only faintly influenced.

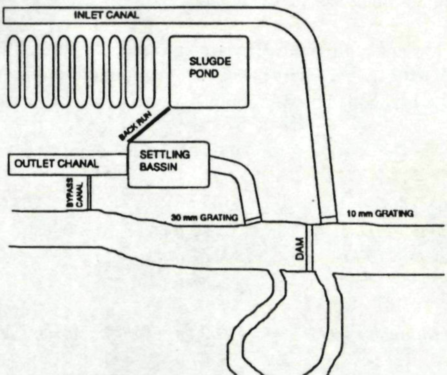



***Fig.** A perfect established fish farm according to danish legislations.*

The Regulations for Freshwater Fish Farms contain demands about the establishment, for instance a minimum demand about establishing a settling basin in front of the recipient. Another demand is that the settling basin must be emptied at least once a month. Canals and ponds must be emptied every 6 weeks. Large quantities of sludge must be removed at once. Sludge shall be lead to a sludge deposit which only must have an outlet to the settling basin.

The speed of the water in the settling basin must not exceed 2.5 cm per second, and the residence time must be at least 25 minutes.

The environmental condition at all fish farms shall be considered again. By 1 January 1998 the fish farmers must require a new approval from the county. If a fish farmer wants a larger feed ration it requires an approval from the county.

Sludge from fish farms that is used in agriculture must comply with the requirements for the limit values of heavy metals. The limit values are stated in the Sludge Regulations. About 50% of the analyses in Vejle County have shown problems by complying with the limit values of cadmium. Thus the sludge must not be used in agriculture.

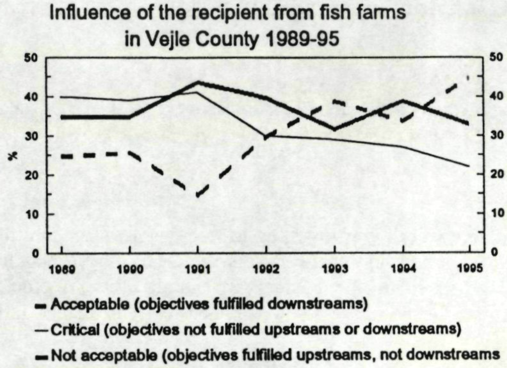
To remove sections of "dead reaches" the Water Supply Act and the Watercourse Act have been changed. In new water catchment approvals 50% of the median minimum flow will be required to the sections of "dead reaches". After the year 2005 the requirements will be 50% of the median minimum flow to the watercourse without any compensation.
By the way, the fish farm can only get an approval for water supply from surface water for 10 years, and from groundwater for 15 years.

So far Vejle County has entered into 9 voluntary agreements with fish farmers about water supply through riffles at the weirs of the fish farm. In the summertime these 9 fish farms supply 5 to 10% of the median minimum flow.

**Consequences in Vejle County from the legislation (by inspections)**

| | |
|---|---|
| *Number of freshwater fish farms:* | *108* |
| *Approved feed consumption, totally:* | *5122 tons* |
| *Total feed consumption in 1995:* | *4637 tons* |
| *Total production in 1995:* | *4781 tons* |
| *Feed quotient in 1995:* | *0.97* |
| *Enforcement of regulations in 1995:* | *109 enjoinings, 3 orders, 9 police reports* |

Even though the regulations about the feed consumption at the fish farms were strengthened the production is still at the same level as in the years before the Regulations for Freshwater Fish Farms were introduced. On the other hand the feed consumption and the discharge have been reduced, and consequently the state of pollution in the watercourses has been improved.




Watercourse estimates from 1995 show that again there is a progress in the number of fish farms where the objectives are fulfilled, both upstreams and downstreams the fish farm. (The objectives are, that the watercourses shall have a fauna that will by only faintly influenced). Apart from a small fall last year the progress has been perceptible since 1991. The reason seems to be an increased environmentally sound operation, such as complying with the terms for emptying the settling basins, etc.

The discharge of organic materials from the fish farms in Vejle County in 1995 corresponds to the discharge of not purified sewage from 22.000 equivalent persons. In comparison it can be mentioned that in the whole county there are 338.000 persons.

**Resource consumption**

The resource consumption for administration and inspection at the 108 fish farms in Vejle County in 1995 were 3.65 men's year and 213.000 Dkr. A man's year corresponds to the work of one persons in one year.

# RISK ANALYSIS - METHOD FOR INCREASING FISH FARMS PROFITABILITY

Assist.eng. Cornel Ceapa, Prof.dr.eng. Mircea Rauta

"Dunarea de Jos" University of Galati, 47 Domneasca Str., RO - 6200, Galati, Romania

## Introduction

All the people who are working or investing in traditional aquaculture field now how risky is such a business and how many factors are competing in obtaining financial benefits. Comparing with some other business we can not insure, in efficient economic conditions, the fish production so the best we can do is to try to assume and to minimise the risks.

However, looking at some other benefits outcoming from an aquaculture business (social benefits, use of existing resources, providing a good quality food for national market etc.) we must persuade in finding the best methods to maximise the fish farms profitability.

## Materials and Methods

The object of the study was represented by an almost bankrupted fish farm (Ciurila from Cluj County, Transylvenia) having loans and penalties to be paid and low market demand for the majority of breaded species (Asian carps).

In such conditions the "do nothing" option is excluded so we tried to find the optimum project alternative and management decisions to increase the profitability.

We were comparing different options of projects using an Excel computer program which is performing a complete financial analysis including cash flow, benefit - cost analysis, balance sheet and finally risk analysis.

As project options we considered the following possibilities:

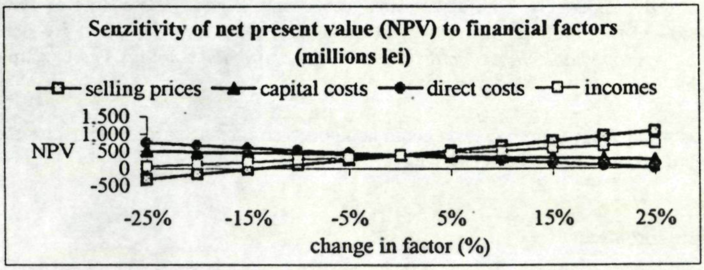
- shifting the breaded species from Asian carps to better quality species (carp, catfish, pike, zander);
- finding supplementary income generating activities as recreative fishing, milling, tourism etc.
- optimising the technological aspects in order to reduce the direct costs;
- using advantageous loans to sustain the rapid implementation of the projects etc.

The risk analysis consists of sensitivity analysis of net present value (NPV) and internal rate of return (IRR) to variations in selling price, capital and direct costs and incomes and also by calculating the switching or crossover values (the percentage change in the variable needed to switch the project from acceptable to unacceptable).

**Results and Discussions**

Comparing different alternatives projects we have chosen the one who is the most profitable, respectively the variant with a NPV of 375 millions lei at a discount rate of 15 % and IRR of 24 %. All the calculations are easy to be done and by sensitivity analysis the management can take the optimum decisions in order to assure the business success.

For example from the following graph can be observed that this business is more sensitive to changes in selling prices and direct costs, comparing with the rest of parameters.




Also we can extract from this graph the switching values for each parameter, fact which is giving to the management team the possibility to be flexible and to take any time the right decisions.

**Conclusions**

By this way we can make maximum use of available information, providing a very efficient and rapid management tool, especially in such variable economic conditions that are in Eastern Europe.

Fish farms managers or investors is necessary to apply risk analysis in any decision taken as a response to general economic and resource situation in order to increase the profitability of a business.

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# THE ASIAN CARPS IN THE LOWER DANUBE

A. Ciolac

"Dunarea de Jos" University of Galati, Fishing and Aquaculture Department
Garii Str., Nr. 63, RO - 6200 Galati, Romania

## Introduction

The Asian carp introduced for fishculture in Romania in 1960-1962 (Manea,1985 ) have escaped accidentally from fish farms into Danube river. These species have introduced and they are reproducing now in the natural conditions. The most frequent species are *Hypophthalmichthys molitrix* (big head), *Aristichthys nobilis* (silver carp), and *Ctenopharingodon idella* (grass carp).

In the last time about these species it could be noticed an increasing of weight into the total capture booked in the Lower Danube.

## Materials and Methods

It have been the statistical data concerning the fish captures in the Lower Danube, the data from our expeditionary research fishing and the information from the professional fisherman.

## Results and Discussions

For the reproduction in natural environment the Asian carps are requiring some important conditions:

- water temperature between 18-22° C;
- the possibility to increase the level of water;
- the speed of water under $3 m.s.^{-1}$ ;
- a degree of water turbulence (solid substances in suspension) almost 1,2 kg $(m^3)^{-1}$ in the reproduction time;

All of these conditions are accomplished in the Lower Danube. In the ex-Soviet Union it has been observed the natural reproduction of these species in the Amu-Daria and Kuban Rivers (Stancioiu and Cristea, 1992).

The increasing rate of *Ctenopharingodon idella* (grass carp) in natural conditions is bigger than one farms. At 9 years old this species have an average 7000g (in farms) and 9000g on the individual (in the river).

The Asian carps under 12000g in the individual weight have the body/fish eggs ratio between 6,14 and 9,2. Into the captures booked in the Lower Danube there are prevailing the individuals from 4 to 8 years old, with a meal - female ratio (M/F) between 1.0-1.5.

The captures of Asian carps have increased from 0,8% in 1970 to 10-16% in 1995, from the all fish captures booked on the Lower Danube.

**Conclusions**

The Asian carps have been introduced in the Lower Danube where they have good conditions for reproductions and growth. This aspect is proved by the good growing rate and by the level of captures.

This is a interesting modality in which some stranger species of fish are capitalising the natural areas insufficient exploited by the local fish species.

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# ECOLOGICALLY SAFE PRODUCTION OF CARP FISH

M. Cirkovic[1], Danica Cirkovic[2],
[1] Agricultural Faculty, 21000 Novi Sad, S.R. Yugoslavia
[2] Fish Farming Cooperative, Mosorin, S.R. Yugoslavia

## Introduction

The sources for filling standard warmwater ponds are flowing waters. However, it is hard to keep the quality of its physical and chemical properties under control. The use of the first layer well-water, (with physical and chemical parametres corresponding to those of drinking-water) owing to its constant qualities, enables us to keep the intensive carp fish production under control. High production level (8-10 t/ha), as well as, desired quality of the meat, are attained by well balanced nutrition, appropriate preparation of the pond bottom and aeration of the water.

## Materials and Methods

Wells from which the water is supplied are excavated at the foot of the Titel Hill (which has alluvial origin and aeolian drift). The first layer well water is affected by percolated waters from the hill, as well as by the water flow of the Tisa river 2 km away. The well is 18 m deep, the filter is 8 m long, the static level is 1 m and the dynamic level is 4 m high. The wells are exploited during the whole period of vegetation by centrifugal pumps having the capacity of 10 l/sec, and the power of 3 kw. Ten wells supply 14 objects covering the area of 10 ha. Aeration of the pond is achieved by the water flow, as well as by aerators AIRE-$O_2$-Aeration Industries International, INC, USA. During the winter, the pond bottom was exposed to low temperatures. A part of the pond bottom soil was transferred to the pond embankment and ploughed twice to the depth of 10 cm by the rotational ploughs and with the addition of 2000 kg $Ca(OH)_2$/ha. Feeding was based on extruded fish feeds (peas, soybeans, wheat, corn) produced by "Sojaprotein"-Becej, with the addition of 20-10% of fish meal. The quantity of the crude protein was 28-24%, while of ether extract it was 10%.

## Results and Discussion

Neither increased organic production, nor lack of oxygen was notced during the period of vegetation. The stocking rate of the yearlings of 85 g was increased by 10 times with losses of 5,8%. In 1995. the total production was 8000 kg/ha. Food expense per 1 kg of the growth was 2 kg. Fat content of the meat was 30% lower than it was the case with carp fish bred in the standard (european) way in half intensive system. Residual materials such as residues of drugs, pesticides, hard metals and radioactive residues, were not detected in the meat.

**Conclusion**

The use of the well-water represent the basic condition for ecologically safe production of carp fish. In addition to the food whose quality meets the requirements of the normatives for healthy food without addition of drugs having residual effects, we attain quality healthy meat in the enviroment with the very low presence of exhaust gases.

**Acknowledgements**

These results represent the part of the research project on the improvement of the fish production, carried out by the Agricultural Faculty of Novi Sad.

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# INTENSIVE RECIRCULATING PRODUCTION SYSTEM IN SEABASS, *DICENTRARCHUS LABRAX L.*

D. Coves and E. Gasset

Station Experimentale d'Aquaculture IFREMER, Laboratoire Merea, chemin de Maguelone, 34250 Palavas-les-flôts, France

## Introduction

Development of marine finfish aquaculture is now restrained in most european countries because of available sites. Conflicts of interest between tourism, urbanization, industry, harbour activities and fisheries are particularly acute along the cost line. Attempts for fish offshore production has been limited by technical constraints, high investisments and difficulties to be correctly insured. Furthermore, around Mediterranean sea, reared marine fish selling price all the more fell because of the recent (1990-95) production increase. At last the environment preservation regulations lead all the farmers to decrease waste, pathogen and chemical discharge.
Faced with that critical situation, land based fish farming in closed system, as a technical alternative, has got strong arguments. In fact the drastic reduction of water needs gives to this rearing system its main advantages. Investors will have possibility to settle their farm in relation to profitable factors instead of water availability and climatic conditions. In the looking for competitiveness closed system offers possibilities by adapting environmental rearing conditions to rid itself of seasonal constraints, to extend species diversification or to fit market demand with required fish quality.
After 10 years of research to define and promote recycling in hatcheries, our laboratory has been dealing with the ongrowing phase since 1992. Today we can propose results from 6 last months operation in closed system in Seabass (150-345g). The aim of this study is to evaluate with high stocking densities (30-140kg/m3) the present status of the recycling technology and rearing tanks we have selected by determining (1) Seabass biological performances relative to environmental parameters proper to recirculated water; (2) Biofilter nitrifying activity; (3) Global efficiency of our recycling device; (4) Parasitism and sexual maturation status compared to a flow-through system.

## Materials and methods

Experiment was conducted in a middle scale (2 tons carrying capacity, 25m3) semiclosed system (10-50h water residence time). The 2 rearing tanks were 10m3 each. Water was recycled through a mechanical filter, U.V. lamps, nitrifying biofilter, CO2 degazing column while pH was controlled by caustic soda (NaOH) supply. Oxygen fish demand was satisfied on a continuous basis by a computerized O2 supply system linked to each tank O2 level recording and integrated with a failure management system.
2 000 and 4 300 150g prereared fish in recirculated water were respectively stocked in tank A and B. They were fed commercial extruded pellets (45% crude proteins and 20%

crude lipids) by self-feeder (24h/24h) coupled with a feeding activity recorder. Temperature (22°C) and photoperiod (16-hL/8-hD) were maintained stable whilst TA-N, NO2-N, NO3-N, total inorganic carbon levels and pH resulted from fish influence and recycling efficiency.
Biological performances were estimated by specific growth rate (SGR), feed conversion ratio (FCR), total ammonia nitrogen excretion (TAN-E). Parasitism and sexual maturation status were compared to those recorded on fish issued from the same hatchery reared population in a flow-through private farm.
The biofilter was described by the bacterial support specificities, the water residence time and flow velocity while the nitrifying activity was characterized by (1) ammonia nitrogen removal per m3 of bacterial support and (2) O2 consumption per ammonia nitrogen removal. Biofiltration results have been recorded during 2 periods of 29 and 37 days for fish weight ranges of 150 to 190g and 290 to 350g respectively.
The whole rearing facility performances were estimated by the water, O2 and NaOH needs by kg of fish production during the 180 days the experiment lasted.

## Main results

During the whole rearing period the environmental parameters have been maintained at satisfactory levels with TAN-N, UIA-N, NO2-N, NO3-N respective (A-B) average concentrations of 1.52-1.87, 0.017-0.015, 0.80-0.75, 17.9-17.5mg/l. Total inorganic carbon level ranged between 80 and 150mg/l while pH mean was 7.3. Stocking densities raised from 30 to 70 and from 65 to 140 kg/m3 in tank A and B for a global FCR of 1.8. No peculiar mortality occured. The recirculated water yields were respectively 120 and 80m3/kg of produced fish biomass.
In our recycling setup 4.5kg NaOH and 5.2$m^3$ seawater per kg of fish were required to produce a total biomass of 1160 kg of 345g (mean) fish. In the private farm fish weight reached only 230g during the same period mainly due to temperature (17°C).
During the 2 investigated periods (P1 and P2) TAN-E ranged between 0.30 and 0.50g/day/kg of fish and between 30 and 40g/day/kg of ingested feed. Biofilter activity allowed an average ammonia nitrogen removal of 204 (P1) and 226 (P2)g per day per cubic meter of bacterial support for a nominal residence time of 7mn (P1) and 5mn (P2) and a flow velocity of 29 (P1) and 38 (P2)m/h.
More, we can assume a closed system protected by sand filtration (10-15 μm) against parasites (Diplectanum aequens) was effective since we never found contaminated individuals when we did in case of unprotected flow-through rearings.
At last stable high temperature combined with long lighting time seemed to affect sexual maturation with only 13% of males fluent against 40% in the other case.

## Conclusion

Considering the results recorded during this study are basic data allowing us to point out critical aspects at a middle scale production setup, solutions will be discussed in order to improve the efficiency of such intensive closed system to make it fully operationnal concerning biological, technical and economical aspects.

# MECHANISED FISHING TECHNOLOGY WITH THE SEINE

Victor Cristea[1], Madalin Panaitescu[1], Constantin Pecheanu[2], Vladimir Titinschneider[2]

[1] "Dunarea de Jos" University of Galati, Fishing and Aquaculture Department, Garii Str., Nr. 63, 6400 Galati, Romania
[2] Fishculture, Fishing and Fish Processing Research and Design Centre of Galati, Romania

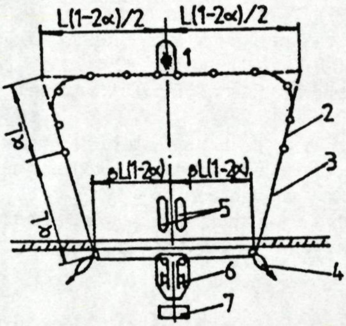
## Introduction

Using of tractioned filter tools for fishing in natural and artificial ecosystems, it's one of the main methods of fishing. High consumption of manual labour and physical effort are recommending partial or full used of mechanised fishing.

On the other hand in cases of basins with inaccessible borders (bad topo-hydrographycal configuration, large deposits of silt, dense vegetation and climbing plants) the fishing with the seines represents the only method for fishing.

## Materials and Methods

The method consist in launching of seine, with a length established before, after it was put in order, from a bank well corroborate and drawing by a multiple winch. Winch have multiples drummers which wrap up two cables.




1 =sack
2 = wings
3 = flexible cable
4 = deviation rolls
5 = boats
6 = winch
7 = action group

Fig. 1. The seine's geometric elements and shape coefficients

Geometric elements and shape coefficients are next:

- L = length of seine;
- $\alpha$ = ratio between length of net segment launched to the deviation role and total length of seine (0,20);
- $\beta$ = ratio between of distance of installed points of deviation roles and the length of seine segment launched parallel with the bank (0,80);
- r = ratio between active length of traction all seine length (1,20 - 1,40);
- $l_c$ = length of traction elements (km).

$$l_c = L [ r + \beta ( 1- 2 \alpha) / 2 ]$$

- F = filtrate surface

$$F = 50 L^2 ( 1- 2\alpha + \beta ) [ (\alpha+ r)^2 -1/4 (1-2\alpha-\beta)^2 ]^{1/2}$$

The main characteristics of the winch are:

- the maxim traction power : 3200daN;
- the peripherical speed at traction: 0,1-0,4ms$^{-1}$;
- oscillation rate of peripherical speed: 0,25;
- the maxim development power: 15kW;
- number of drums: 4;
- drum's diameter: 200mm;
- the total rate of transmission.

## Conclusions

It was observed that useing for traction the flexible cablee are making more easy the filtration of bigger surface, when it was utilised a normal seine length (300m) than it is used another type of cable made of cotton.

Average time for catching fish decrease and get to 60-70min., thanks to hydrostatic installation and power performance of the winch, traction speed being under 20-30m min$^{-1}$ .

Thanks to main technical parameters the seine provide a good capacity of catching.

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# TRENDS OF RESTRUCTURING THE FISH FARMS SYSTEMS IN ROMANIAN AQUACULTURE

Prof.dr.eng. Victor Cristea, Prof.dr.eng. Mircea Rauta, Assist.eng. Cornel Ceapa

"Dunarea de Jos" University of Galati, 47 Domneasca Str., RO - 6200, Galati, Romania

The natural trend manifested after 1989 to decentralise the fisheries economy, together with some organisational and legal problems, determined some lacks of poise that affected all the economy including the visible falling of fish production.

The aquaculture patrimony inherited from socialist economy was mainly formed of large fish ponds (30 - 150 ha., some of them being over 500 ha.), fact which is worsening the possibility to control the production parameters, is limiting the technologies' intensity and is making difficult the privatisation process for such big surfaces.

Also, the land used for building such fish farms was improper for agriculture having a low natural productivity and for this reason the fish production was obtained exclusively by supplementary feeding or by using fertilisers in order to stimulate development of plankton as food for Asian carps. Due of local market demand is going on the shifting process from extensively using of the chines carps to the increasing of the weight of valuable species (carp, predators, sturgeons).

The production systems used in aquaculture are now extensive and half-intensive, using the polyculture in 2 - 3 years production cycle. The majority of fisheries in Romania are organised as commercial stock companies. There are nowadays 36 fisheries commercial companies dealing with the fishculture and fishing and 5 processing companies equipped with freezing and refrigeration capacities.

The necessity to assure the co-ordination of fisheries and to promote the national strategy in the aquaculture field determined setting up of the National Agency for Fishculture, Fishing in the Natural Waters and Fish Stocks Protection within the Ministry of Agriculture and Food.

In order to realise the main objective of any economic activity, maximising the obtained benefits, a national strategy for restructuring, development and privatisation of fisheries sector was proposed by the specialists, from which we emphasise some objectives related with restructuring the fish farm systems:

- increasing the managerial efficiency of the existing fisheries companies by breaking them into the component fish farms or even in smaller parts, which will be easier privatised;

- dimensioning the productions relating to the existing market demand, both from quantity and quality point of view;
- optimising by redesigning each fish farm, concentrating on assuring the optimum correlation between the different types of ponds corresponding to the necessities of cultured species;
- reducing the maximum surfaces of each type of pond in order to increase the economic efficiency of the applied technologies;
- increasing the weight of productive surfaces (up to 85 - 90 %) by applying non-conventional apportionment solutions and using of under-pressure water supply equipment instead of free surface canals;
- optimising the water consumption by regulating the parameters which are influencing this (water depth, infiltration, recirculation intensity etc.);
- providing the fish farms with all the mechanisation equipment, which are increasing the production efficiency;
- introduction of water quality conditioning systems;
- increasing the efficiency of the existing hatcheries and nursering of the larvae in controlled conditions halls;
- using the important surfaces of water reservoirs in cages aquaculture;
- introduction of the recirculating systems for superintensive breeding of fish as an alternative for traditional aquaculture systems;

In conclusion the significant aquaculture potential, estimated at over 200 thousand tones, can not be efficient used without an substantial restructuring of the fish farms according with the national objectives of fisheries sector and the existing resources and conditions.

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# THE EFFECT OF MICROALGA *SKELETONEMA COSTATUM* ON VOLATILE COMPOUNDS CHARACTERIZING THE AROMA OF FRESH MANILA CLAM *(Ruditapes philippinarum)*

M. Demaimay, F. Michel, J.P. Baud (*),

Laboratoire de Biochimie - ENITIAA 44072 Nantes Cedex 03 - France
Station Expérimentale IFREMER, Polder des Champs 85230 Bouin (*) - France

## Introduction

Phytoplankton is the major source of bivalve moluscs and is considered to be the main supplier of the 20-and 22-carbon polyinsatured fatty acids in the marine foods web. Microalga *Skeletonema costatum* which was used for Manila clam breeding, is particulary rich in eicosapentaenoic acid $C_{20}$ : 5 n-3 (Berge 1995). This acid seems to play an important role as the precursor to the aroma in shellfish (Josephson 1991). The aim of this study is to show the effect of *Skeletonema costatum* on the volatile compounds which characterize the fresh Manila clam aroma.

## Material and methods

Farm-raised Manila clams were bred in a basin of seawater. They were fed during 8 months with *Skeletonema costatum* and compared to wild Manila clams with instrumental and sensory analysis. Headspace volatiles from extracts were collected, concentrated on Tenax and analysed with a Tekmar HP system and a HP innowax column. Identification of compounds was based on NBS 75k HP and ENITBIO MS Spectra Data Bases with a combined Gas Chromatography-Spectrum Mass (CG-SM) HP (5971-5890). 19 panelists experimented in the sensory analysis were asked to evaluate Manila clams using a list of descriptive terms. Sensory data profils of Manila clams were statistically processed using the ANOVA test.

## Results

The farm-raised Manila clams have higher dry matter, carbohydrate and glycogen rates than the wild Manila clams (fig. 1). Among the principal common volatile compounds of both studied Manila clams, it was observed that (E,Z)-1,3,5-octatriene is very abundant in farm-raised Manila clams (tab. 1).

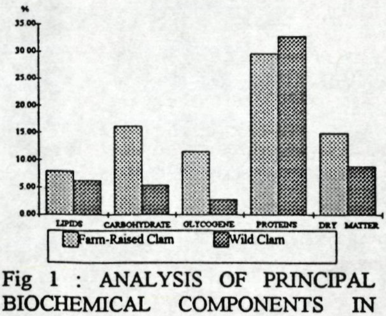


Fig 1 : ANALYSIS OF PRINCIPAL BIOCHEMICAL COMPONENTS IN BOTH FARM-RAISED AND WILD CLAMS.

Tab. 1 : RELATIVE PROPORTIONS OF PRINCIPAL VOLATILE COMPOUNDS COMMUN TO THE BOTH FARM-RAISED AND WILD CLAMS.
(Ratio = Area of the compound/Area of the internal standart)

| VOLATILE COMPOUNDS | WILD CLAM | FARM-RAISED CLAM |
|---|---|---|
| 1-penten-3-ol | 31 | 30 |
| (Z)-2-penten-1-ol | 6 | 7 |
| 1,5-octadien-3-ol | 11 | 7 |
| (E,Z)-1,3,5-octatriene | 9 | 153 |
| 1-octen-3-ol | 10 | 10 |
| 1,3-dichlorobenzene | 5 | 11 |

The sensory analysis shows than farm-raised Manila clams are characterized by its high taste intensity and its sweet flavour ; whereas the wild Manila clams have stronger salt and iodine tastes (fig 2).

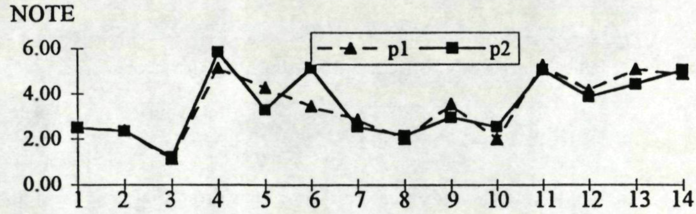


Fig 2 : TASTE PROFILE OF WILD CLAMS (P1) AND FARM-RAISED CLAMS (P2). Descriptive terms : 1 odor intensity, 2 sea water, 3 particulary odor, 4 taste intensity, 5 salt, 6 sweet, 7 bitter, 8 astringent, 9 iodine, 10 after-taste, 11 crisp, 12 elasticity, 13 tough, 14 organoleptic quality.

## Discussion

(E,Z)-1,3,5-octatriene is a volatile compound derived from the polyunsaturated fatty acid pathway. Theoretically, (E,Z)-1,3,5-octatriene can arise from the dehydratation of 1,5-octadien-3-ol (Woolar 1978) or the dehydratation and cleavage of 1,5-undecadien-3-ol (Kajiwara 1982).The high level of polyunsaturated fatty acids, especialy eicosapentaenoic-acid (35% total fatty acid) in *Skeletonema costatum* (Berge 1995) can be the origin of the biosynthesis of (E,Z)-1,3,5-octatriene found in Manila clams. On the other hand, the sensory analysis does not show a difference in the odor of the two Manila clams. Consequently, this compound seems to have a little influence on the odor of the Manila clams. The stronger taste intensity found in the farm-raised clams can be explained by its higher rate of dry matter. Furthermore, its sweeter taste is linked to glycogen.

## Conclusion

*Skeletonema costatum* incites the formation of the volatile compound (E,Z)-1,3,5-octatriene, in Manila clams through polyunsatured fatty acids. This does not have a significant influence on the sensory perceptions of its aroma. *Skeletonema costatum* modifies the chemical composition of the clams and its organoleptic characteristics.

Thanks to technical contribution of C. Bigot ; C. Marzin ; M. Moreau

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# RESEARCH STUDY OF SOME NATURAL FACTORS INFLUENCE ON THE EFFICIENCY OF CARP MEMBRANE DIGESTION

S.N. Egorov, V.F. Zaitsev
Astrakhan State Technical University, Tatischeva 16, Astrakhan, Russia

## Introduction

In accordance with some reserch studies nature factors considerably affect hydrolitic processes taking place in fish intestine (Kuzmina, Nevalyonny, 1986; Nevalyonny, et al., 1991, etc.) Besides that intensificatoin measures performed in ponds whilst commercial fish rearing (pelleted compound feed, pond fertilization, irrigation) also exert certain influence on digestive function. In connection with it the main goal of the study is to research level change of general amililytic activity of mucous layer in the intestine of carp fingerlings Cyprinus carpio (L) during rearing season. Thus we made an attempt to determine the degree of influence of biotic and abiotic invironment factors on the process of membrane hydrolysis of carboghydrate food components in fish intestine.

## Materials and methods

Two ponds with 500 $m^2$ area have been used as experimental ones. Pond N1 absoletly met the require ments of rearing ponds and had stable hydrochemical regime (conditions). Pond N2 on the contrary had essential filtration losses, constant water level fluctuations, considerable overgrowth of plants and disturbance of hydrochemical indices during the season (Table I). Carp was reared on artificial feeds. Four control catches embracing the whole rearing season were performed. Total amilolytic activity was determined in homogenates of carp intestine mucosus layer by Nelson method with modification of A.M. Ugolev and N.N. Iezuitova (1969) in terms of $mkmol*g^{-1}*min^{-1}$.

## Results and discussion

Comparing data recorded on the 24 June, on the 16 July and on the 6 August it is possible to observe similar tendencies of hydrolysis rate changes in carp intestine from ponds N1 and N2 (Table I). On the 27 July increase of enzyme activity was observed in pond N1 while in pond N2 its decrease was identified. At the same time the fact that the level of total amilolytic activity of fish from pond N2 is lower than that of ponds N1 attracted our attention. To our opinion it is connected with considerable instability of indices, characterising ponds N2: hydrochemical, hydrolitic, plant overgrowth, etc. (Table I), that caused growth reduction of fish. The latter stipulated incomplete compound feed utilization by carp (it decreased) and it greatly influenced the degree of total amylolitic activity (27. August).

Table I. Dynamics of studied indices

| Indices | Pond N | Date of catch | | | |
|---|---|---|---|---|---|
| | | 24.06 | 16.07 | 06.08 | 27.08 |
| T°C | 1 | 29.1 | 25.6 | 23.4 | 22.7 |
| | 2 | 29.1 | 24.9 | 24.5 | 22.1 |
| $O_2$, $mg*l^{-1}$ | 1 | 5.9 | 5.6 | 6.0 | 6.3 |
| | 2 | 5.9 | 4.0 | 2.1 | 5.9 |
| pH | 1 | 7.0 | 7.4 | 7.2 | 7.3 |
| | 2 | 7.0 | 7.0 | 6.2 | 7.3 |
| Depth, m | 1 | 1.5 | 1.5 | 1.5 | 1.5 |
| | 2 | 1.5 | 1 | 0.7 | 1.4 |
| Plant ovwergrowth, | 1 | - | 10 | 10 | 15 |
| % from area | 2 | - | 15 | 90 | 15 |
| Total | 1 | 27.25±1.1 | 11.06±1.13 | 23.46±0.94 | 34.23±1.73 |
| amilolytic activity | 2 | 27.25±1.1 | 7.13±0.76 | 19.5±0.93 | 16.77±1.29 |

Analysing the data it should be pointed out that compound feed introduction to carp diet results in habit forming at the functional level, which is expressed in reduction of enzyme activity level. It should also be underlined that in spite of difference of abiotic factors in two ponds on the whole the character of activity level dynamics of studied enzymes is similar during rearing season. Enzymes activity and environmental conditions were not correlated in this period. Probably adaptation of enzymes activity to fluctuations of values of abiotic environmental factors is being implemented for less short periods of time than one season or very likely on some other level.

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# THE FINNISH MEMBERSHIP IN THE EU - NEW CHALLENGES TO COOPERATION IN THE AQUACULTURE INDUSTRY

U. Eskelinen

Finnish Game and Fisheries Research Institute
Laukaa Fisheries Research and Aquaculture
Vilppulantie 415, FIN - 41360 Valkola, Finland

## Introduction

East European countries are increasing their commercial and economic cooperation with Western Europe. Finland, too, has recently experienced a similar integration process. First Finland joined the EEA and, in the beginning of 1995, she became a member of the European Union. This paper describes the changes the integration brought with it in aquaculture and the ways the industry tries to control these changes.

## Aquaculture in Finland

Aquaculture's share of the total value of domestic fish production in Finland is more than 50 %. Small, private companies, app. 700, are the backbone of aquaculture. State-owned farms are responsible for the breeding of endangered species and strains.

Aquaculture produces fish for food and for the management of fishing waters. There are two technologies that are used in the production of both product groups (Table I).

Table I: The structure of Finnish aquaculture

| Production form | Production technologies | Main products | Share of turnover |
|---|---|---|---|
| Food fish | 1. net cages in the Baltic Sea | large rainbow trout | 55% |
| | 2. flow-through farms | large rainbow trout | 20% |
| Juveniles for stocking | 1. intensive (hatcheries) | salmonids | 15% |
| | 2. extensive (natural food ponds) | whitefish and pike-perch | 10% |

## Changes caused by the EU-membership

Before Finland joined the EU the focus of Finnish fishery administration was on the quidance of fishing and the management of fishing waters. Aquaculture played a minor role; the financial aid for the development was directed by several ministries without proper coordination.

After the EU-membership the importance of aquaculture grew because in EU aquaculture is a part of the common fisheries policy. A sectoral plan was drafted for the Southern Finland's fishing industry and the development of aquaculture was one of the priorities. In Northern Finland, which belongs to the objective 6 region, aquaculture is a part of the general plan of the area.

Farmed fish has been a domestic market product in Finland. Exports'share of the production value has been only 10%. Before Finland joined EEA the main product, large rainbow trout, was subject to a 12% export duty in EU countries. Because of the effective protective duties, agricultural produts were expensive in Finland, whereas fish was cheaper than the European average.

EU-membership removed the export duties. In a short term, a more significant change was, however, the fact that the prices of agricultural produts went down and the price of meat grew cheaper in relation to fish.

**The effects of the changes and the ways to control them**

In 1995 Finland's fish market landed in a crisis. The Norwegians salmon overproduction came to the Finnish market, where the competitive position of fish had already been weakened as a result of cheap meat and the value-added tax reform. A situation of oversupply developed in the market and the prices sank below a profitable level. Due to international oversupply, the removal of export duties has not helped to find substituting markets quickly enough.

Even though the reasons for the market disturbance are mostly unrelated to the EU-membership, they must be brought under control by measures approved by the Union. This has made a significant change in the operations on aquaculture's interest group, the Finnish Fish Farmers'Association. Now its main cooperation partners are foreign sister organizations and its important lobbying targets are the officials of customs and EU Commission. Together the organizations have succeeded in making both the national officials and the EU Commission understand the gravity of the situation and some correcting measures have been taken.

The adaption of EU's planning and financing systems has started out without technical difficulties. The problems have been related to the development investments. Due to the weakened profitability of the industry the start of investments with financial participation by EU's structural funds has been slower than expected. Another problem is the regional imbalance caused by different priorities of the national planning authorities. In relation to the volume of the industry, the budget for financial support in objective 6 region is smaller than elsewhere. The situation has been partially compensated.

# ASPECTCS ON PHYTOPLANKTON BIOMASS AND NUTRITIONAL DYNAMIC FACTORS IN THE ACVACULTURE PROCESS CONTROL

**Assoc.Prof.G.Fetecau[1], Ass.Prof.G.Puscasu[1], Biol.M.Fetecau[2]**
**[1] "Dunarea de Jos" University of Galati, Department of Electrotechnics, Electrical Machines and Drives, Domneasca Street, 47, 6200, Romania**
**[2] CCPPPIP, Galati, Romania**

## Introduction

The paper presents the results of some numerical simulation researches, on the phytoplankton biomass dynamics in a fish pond to various inorganic substratum feeding rates as well as on the influence of the nutritional factors on the acvaculture process control.

## The mathematical model of the proces

The mathematical model used for simulating the dynamics of the phytoplankton in the fish pond consist of 26 relation out of which five are partial derivative state equations.The state equations are as follows:

$$\frac{dX(z,t)}{dt} = [\mu(z,t) - K_d(t) - R_a(t)]X(z,t) \quad (1)$$

$$\frac{dC_p(z,t)}{dt} = v_p(z,t) - \mu(z,t)C_p(z,t) \quad (2)$$

$$\frac{dC_N(z,t)}{dt} = v_N(z,t) - \mu(z,t)C_N(z,t) \quad (3)$$

$$\frac{dS_p(z,t)}{dt} = R_a(t)[S_{op}(t) - S_p(t)] - v_p(z,t)X(z,t) \quad (4)$$

$$\frac{dS_N(z,t)}{dt} = R_a(t)[S_{ON}(t) - S_N(t)] - v_N(z,t)X(z,t) \quad (5)$$

where:
X - biomass concentration; $C_P, C_N, S_P, S_N$ - concentrations of intracell and extracell phosphorus and nitrogen; $R_a$ - substratum feeding rate; $K_d$ - autolysis rate; $\mu$ - biomass growth rate; $V_P, V_N$ - specific substratum adsorbtion velocities; $f_1, f_2, f_3$ - functions of day duration, light intensity, respectivelly inter and extracell substratum concetration ($C_P, C_N, S_P, S_N$); z - the depth; t - the current time.

## The simulation results and the dynamics analysis

The system parameters have experimentally determined, considering that the pond is as deep as 2m.
The original condition used for the experiment purpose are: $X_0$=1 [mg/l]; $C_{PO}$= 0.02 [*]; $C_{NO}$=0.1[*] ([*] - [mg/mg eigen wight]); $S_{PO}$=0.6 [mg/l]; $S_{NO}$=1.75 [mg/l]

The control values for the reference situation are:

$$R_a = 0.12 \text{ [day}^{-1}\text{]}; S_{OP}=0.75 \text{ [mg/l]}; S_{ON}=2.5 \text{ [mg/l]}$$

Figures 1 and 2 show the graphic representations of the state variables.

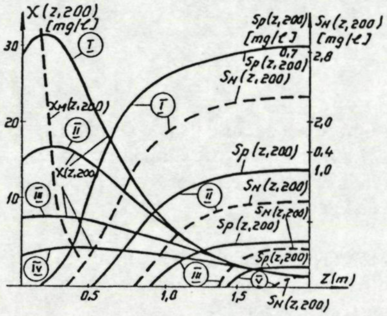

Fig.1

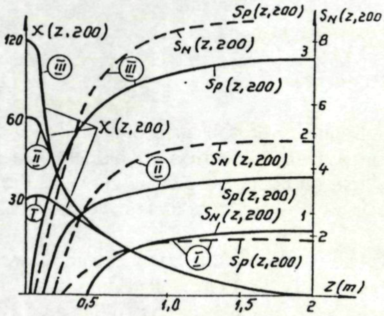

Fig.2

Curves I correspond to the reference situation and curves II, III, IV, V and VI to the situation when the feeding rates are slowed 2, 4 and 8 times and increased 2 and 4 times respectively, with respect to the reference.

## Conclusions

Nutrient feeding is an essential problem in the control on the intense development processes of phytoplankton. It my be obvious that the lower rates feeding leads to insignificant losses of nutrients, accompanied by low biomass productions. On the other hand, the higher rates feeding leads to production increases, but they also cause greater losses.

The conclusion can be drawn than there is an optimum rate of feeding.

Therefore the substratum feeding rates are control values of the acquatic ecosystem.

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[2] **FETECAU,GR.** - Contributii la modelarea si optimizarea automata a proceselor termice si microbiologice cu aplicatii in industria alimentara, Teza de doctorat, Galati, 1992.

# THE DECREASE OF FISHING SURFACE FROM THE FLOOD- PLAIN OF THE LOWER DANUBE AREA

L. Florea

"Dunărea de Jos" University of Galaţi, Aquaculture and Fishing Department, 63, Gării str., 6200 Galaţi, Romania

## Introduction

The Danube river is the most important river of Europe not because its length this river is surpassed by Volga river and also not because traffic intensity, the Rhine river being the first, but because its flow what crosses the continent from west to east through area with a big diversity of naturals and economical conditions.

The last 1075 km of the Danube river, means 38,9 % of its length, representing lower Danube cross the Romanian regions being the most important part, where the river touch the maximum, being very different as against other sectors.

The Danube river and this flood-plain was making a biological unit which in natural conditions have done high bioproductions as outcome of vegetable and animal life from water.The fish productivity of lower Danube river have been depending on the relation between all aquatic and terrestrial ecosystems which founded into flood-plain area.

## The description of state formerly damming

In the lower sector of Danube river the flood-plain have entened especially on left Romanian side, beginning from Calafat. The width of flood plain had importants values lake as: 3-8 Km between Calafat and Călăraşi; 4-30 km between Călăraşi and Ceatalul Ismail; 10-70 km in Danube Delta.

Table I. The main natural units from Danube flood-plain what were important+-s for fishing

| *No.* | *Natural unit name* | *Total surface(ha)* | *Perm.acvatic surface(ha)* | *Surfaces under 5 Hgr (%)* |
|---|---|---|---|---|
| *0* | *1* | *2* | *3* | *4* |
| *1* | *Bistreţ-Cîrna -Nedeia-Jiul* | *20.000* | *8.000* | *50* |
| *2* | *Sărata-Dăbuleni-Potelul-Orlea-Celeiul* | *17.000* | *7.000* | *50* |
| *3* | *Suhaia* | *8.500* | *3.500* | |
| *4* | *Gostin-Pietrele-Greaca-Argeşelul-Dunăre* | *26.000* | | *50* |

| 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| *5* | *Boianu-Sticleanu-Ezerul Călăraşi* | *27.000* | | *60* |
| *6* | *Bugeac-Oltina* | *5.500* | *5.500* | |
| *7* | *Borcea de Jos* | *36.000* | | *60* |
| *8* | *Insula Mare a Brăilei* | *75.000* | | *60* |
| *9* | *Brateşul de Jos* | *12.000* | | *75* |
| *10* | *Jijila-Crapina-Isaccea* | *30.000* | | *50* |

**The description of state posterior damming**

After 1965 there began intensively works for transversal damming which had affected more than 80% of flood plain area and most a quarter of Danube Delta.The lateral damming pull out over 360.000 ha of flood-plain which is now no used that affecting deep the normal acvatic life with consequences over fishing production.

The middle sector of lower Danube was the most affected, in present, from Corabia to Călăraşi, whole flood-plain suited to be cover by water is not used, the two great island between Călăraşi and Brăila, of about 150.000 ha , are now agricultural land.Also, at loss of spawning and feeding places contributed the damming of the flood-plains near the mouths of the tributaries rivers.

**Comparative presentation**

This study make a graphical comparatively presentation (with help of maps and sketch) of the stade before and after damming for the main natural units from danubian flood-plain, where the fishing had an important part.

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# PARASITES AND DISEASES OF CULTURED MOLLUSCS IN THE BLACK SEA: A REVIEW

A.V. Gaevskaja

Institute of Biology of the Southern Seas, Sevastopol, 335011 Ukraine

The world mariculture experience testifies that parasites and commensals can represent the significant hazard for the culture industry. Ukraine's mariculture is currently small scale and its program has concentrated on some species of molluscs and fish. The present work reviews the parasites and diseases of molluscs culturing or perspective for culture in the Black Sea. Original and literary data are used.

At present, two species of bivalves, the mussel (*Mytilus galloprovincialis*) and edible oyster (*Ostrea edulis*) are perspective for culture in the Black Sea. 16 species of parasites and commensals are found in wild mussel and oyster from this sea (Gaevskaja et al., 1990; Gaevskaja, Mordvinova, 1993 ; Zakhaleva, Gubanov, 1985; Kudinsky, Kholodkovskaja, 1990, and others). Some of them can cause diseases in molluscs and consequently be the limiting factors in successful culture of these bivalves. The fungus *Ostracoblabe implexa*, the microsporidia *Steinhausia mytilovum*, the trematodes *Procroeces maculatus*, *Parvatrema duboisi* and *Echinostoma sudanense*, the polychaete *Polydora ciliata* and the sponge *Cliona vastifica* are the most important among them. Pathogenic copepod *Mytilicola intestinalis* is not found in coastal waters of Ukraine.

*O.implexa* infects the oyster and occurs in the north-west part of the Black Sea and along the west shore of Crimea. It causes "shell disease" of oyster. The prevalence of *O.implexa* has been shown to vary markedly with host size, abiotic factors, regions. Sometimes, it can reach 90-100 per cent. Oysters heavily infected with fungus die. *S.mytilovum* parasitizes the female gonad of mussels and is found mainly in the north-west part of the Black Sea. This protozoan may reduce a mussel fecundity, causing complete or partial parasitic castration of mussels.

*P.maculatus* uses the mussel as a first intermediate host, and rarely, as the additional and final ones. It parasitizes the gonad, hepatopancreas, mesosoma, kidneys, mantle, byssal gland, and foot of mussels. This species is distributed everywhere. It may cause "proctoecosis" disease and lead to complete or partial parasitic castration of mussels. Infection indices depends on host size, depth and region. The highest infection intensity was 80 000 sporocysts per mussel.

*P.duboisi* uses the mussel as the additional host and parasitizes the mantle, gonad and gills. It is found along the Black Sea coast. Parasites provocate a reaction of biomineralization and formation of pearls, the numbers of which can reach more than 500. The mussels with a great number of pearls can not be used for food. Last decade the invasion of mussels by this helminth is considerably increased, reaching 100 per cent in some regions. It is known that gymnophallids are capable to invade the man (Ching, 1995), therefore the study of different aspects of biology and ecology of this species has a great significance.

*E.sudanense* uses the mussel as an additional host and parasitizes the foot, mantle and mesosoma of mussels. It is found only in Donuzlav Lake, connected by canal with sea. This helminth may be pathogenic for poultry.

*P.ciliata* and *C.vastifica* live within shell of bivalves. They are found almost everywhere. These commensals cause the formation of different swellings, blisters, caves filled in mud and, rarely, pearls. The mussels with such defects have not a commercial kind.

It is known that a parasite system includes the antagonistic organisms, namely a parasite and its host, and keeps stability under stable environmental conditions. However, mussel populations on mariculture constructions have high density that creates favourable conditions for invasion and reinvasion of mussels by different endocommensals. In such conditions the parasite species being, as a rule, in ecological balance with its host can become pathogenic for it.

The pathology, prevalence, geographical and temporal distribution of each disease organism will be presented.

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# USE OF MATHEMATICAL METHODS FOR EVALUATION OF PARASITOLOGICAL SITUATION IN DIFFERENT REGIONS OF MUSSEL CULTURE

A. Gaevskaja, V.Erokhin, A.Lenin, and A. Solonchenko

Institute of Biology of the Southern Seas, Sevastopol, 335011 Ukraine

## Introduction

The profound parasitological investigations on the mussel, Mytilus galloprovincialis are connected with the development of mussel mariculture in coastal waters of the Black Sea. The present work intends to indicate a possibility of use of mathematical methods for evaluation and prognostication of parasitological situation on mariculture farms.

## Materials and methods

The parasite and commensal faunas of wild and culture mussels were studied during 1989-1993. Materials were collected along the Black Sea coast of Crimea from the Kerch Strait to Cape of Tarkhankut. Standart methods of collection and examintion of bivalves for parasites and commensals were used. Methods of mathematical models and multivariate statistic carried out by Anlrjushenko, Makarov (1984) are used in parasitological study for the first time. Following parameters were accounted: date, duration of existence of mussel construction, total depth of place and depth of sample, temperature, mean and maximum length of mussels, mean quadratic deviation of mussel length, share of mussels infected with either parasite or commensal species in every sample.

## Results and discussion

15 parasite and commensal species were found in wild and cultured mussels (Gaevskaja et al., 1990). Fauna of parasites and commensals of cultured mussels is less diverse and prevalence and intensity of infection are more low. Data on characters of occurrence of the most common parasites and commensals in mussel populations were worked up by methods of mathematic models and multivariate statistic. It is indicated that these methods allow to obtain the adequate evaluation of parasitological situation having relatively small parasitological and hydrobiological samples as well as to prognosticate its development for definite period of time. Our data allow to make a conclusion that the characteristics of infection, prevalence and intensity indices of parasites and commensals and their seasonal changes are closely connected with hydrology and depths of region, characters of soils, water temperature, depth of place of mussel constructions and other oceanological and biological parameters. Results of our investigations were used under the working out of instruction for choice of favourable

regions for mussel culture farms. Principal rules of use of mathematical methods will be presented in our report.

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# ADMINISTRATIVE AND LEGAL CONSTRAINTS TO FISHERY AND AQUACULTURE DEVELOPMENT IN ROMANIA

**Krishan M. George**

**KHF Fisheries Project**
**Bd. Carol Nr. 17, Et. 2, camera 44, O.P. 1 - c.p. 813, sector 1, Bucuresti, Romania**

## 1. Introduction

The British Know How Fund has been active in providing assistance to the Romanian fisheries sector since 1992. This paper outlines the current administrative and legal issues, showing how these are inter-linked and clearly constrain the development of the fishery and aquaculture sector in Romania. The Government of Romania (GoR) has recently taken steps towards addressing these issues and these are outlined. Finally, conclusions are drawn as to the future prospects for the sector and the need for continued political commitment towards the necessary administrative and legislative changes.

## 2. The Problem - A Decline in Sectoral Activities

Official Romanian statistics and studies carried out by the Project over the past 3 years give clear evidence of a decline in the Romanian fisheries sector since 1989. Table 1 indicates the production of freshwater fish in Romania between 1988 and 1995.

In broad terms the decline can be attributed to administrative constraints at a sectoral as well as enterprise level, and certain legal issues which currently prevent a more effective administration of the sector.

**Table 1. Production of Freshwater Fish in Romania - 1988 to 1995 (Mt.)**

| 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|
| 60,000 | 47,122 | 36,433 | 28,539 | - | 32,987 | 31,405 | 23,914 |

## 3. Constraints to Development - Administrative and Legislative Issues Relevant to the Fishery and Aquaculture Sector.

A number of inter-linked factors have been identified as contributing to the decline in economic activity within the fisheries and aquaculture sector.

Administration at a Sectoral Level: The administration of different regions and activities within the fisheries sector is carried out by a number of different organisations. The lack of co-ordination between the various administrators often gives rise to conflicting strategies which constrain the effective development of the sector. The institutional capacity of some of the organisations are limited and are unable to meet the changing needs within the sector.

Administration at an Enterprise Level: The persistence of dysfunctional fishing enterprise structures which remain under State-ownership, and management techniques inappropriate to the emerging market are some factors which have been identified as constraints.

Legislative Issues: There are a number of laws and Governmental Decisions which have been identified as constraints to the development of the sector. On a sectoral level these are related to issues such as land ownership and privatisation. On an enterprise level these are related to issues such as inappropriate fishing regulations, sanitary-veterinary regulations and certain regulations on quality standards.

## 4. Options

In an attempt to reverse the decline in sectoral activities GoR, with the assistance of the KHF Fisheries Project, is in the process of developing a comprehensive portfolio of activities which focus on the key constraints.

Administration at a Sectoral Level: It is intended that the transfer of administrative responsibility to fewer, better co-ordinated organisations with an appropriate institutional capacity will improve policy and strategy development and implementation in order to create a facilitating environment for enterprises within the sector.

Administration at an Enterprise Level: It is intended that the facilitation of functional enterprise structures though a pilot programme of restructuring and privatisation of State-owned fishing enterprises, combined with improving managerial skills, will reduce administrative constraints at an enterprise level.

Legislative Issues: It is intended that the resolution of inappropriate legislation will promote development in the fisheries sector.

## 5. Conclusion.

With a large and relatively sophisticated market the development prospects for the Romanian fisheries and aquaculture sector look promising. The rate of development however, will depend on continued commitment to the necessary administrative and legislative changes.

# PRINCIPLES FOR ACCELERATING FARMING OF CRAYFISH *ASTACUS LEPTODACTYLUS* IN BELARUS

A.P. Golubev and A.M.Bakulin

Institute of Zoology, Academy of Sciences of Belarus, ul. Skoriny 27. Minsk, 220072. Belarus

In the first half of the 20th century crayfish - *Astacus astacus* and A *leptodactylus* were abundant in Belorussian lakes and rivers and an important objects of harvest. At present the crayfish stock in Belarus is sharply decreased. Among the reasons of it there are repeated epizootics of crayfish plague, uncontrolled harvest, increasing anthropogenic water pollution and extensive application of chemicals in agriculture.

The only way to increase significantly the crayfish output in Belarus seems to raise them in specialised crayfish farms. *A.leptodactylus* as a more fast-growing, eurybionthic and anthropogenic pressure resistant species is the most preferable object for farming.

In water bodies of South-Eastern Europe and Turkey *A.leptodactylus* reaches sexual maturity and a marketable size (9-10cm) at the age of 2 years. In Belarus characterised by cooler climate and shorter growing season the appropriate stage is reached of 3-4 years. Therefore full-cycling rearing of crayfish in ground ponds in Belarus is prolonged and rather expensive. At present in Belarus the development of technology of accelerating farming of *A.leptodactylus* is in progress. The technology includes the following successive stages:

1. Winter catching of egg-bearing females in natural water bodies. The optimal size of females is 12-14cm. They have both maximal fecundity (up to 450 eggs in average) and large and (3 mm in diameter) and viable eggs. Smaller-sized females (10-11cm) have lower fecundity (150-200 eggs) and small eggs (1.5mm in diameter). The larvae that hatched from such eggs are very small and weak.
2. Winter incubation of eggs. In water bodies of Belarus the embryonic development of *A.leptodactylus* requires 7-8 months (November-December). Due to low temperature (2-3°C) eggs do not develop in winter - so called embryonic diapause. The following procedure was used for escape from the diapause. Egg-bearing females catched in winter are transferred indoor and kept there for 15 days at 2-3°C. Then they are transferred to the temperature 8-9°C for 45 days. Thereafter females are placed for egg incubation at 18-20°C in special indoor facility. It is a closed recycling thermostatic device with systems of oxygenation, mechanical and biological water refinement and several tanks for females. They can contain up to 600 egg-bearing females. At such temperature embryogenesis lasts 35-45 days at most. The females can care for eggs and aerate them by movements of their pleopods. In such conditions survival of eggs amounts to 80-85%. The system output reaches 50 000 larvae per incubation cycle.
3. Growing up of larvae. Hatching larvae lose contacts with their maternal females after the second moult at the age of 12-15 days. They are 13-15mm in lenght and about 30 mg in weight. At that time females must be removed from the incubation system. Growing up of larvae in the winter period lasts about 2-3 months. The

preferable density of larvae in the tanks - 1000-2000 ind $m^{-2}$. During growing up of larvae special fodder is necessary.
At the end of this period juvenile crayfish reaches an average length of 2,3-3cm and weight of 1,7-2,5g. In natural Belorussian water bodies *A.leptodactylus* juveniles can reach such sizes only by the end of autumn.
Artificial incubation and growing up of larvae allow: to accelerate embryonic development and growth rate of juveniles; to increase survival of juveniles up to 60-80%; to avoid the influence of diseases and predators. It is possible to conduct 2 sets of incubation for the winter-spring period.
4. Growing of juveniles in ponds. Juveniles raised in indoor conditions are stocked in special crayfish ponds in the end of spring-the beginning of summer. These rather large specimen are characterised by much higher viability. They are subjected to predation to much lesser extend. The ponds must be characterised by sufficient amounts of submerged vegetation and zoobenthos biomass. At densities of the crayfish stock lower than 10 ind $m^{-2}$ additional fodder in unnecessary. At the end of the first growing (October-beginning of November) the crayfish become 7-8cm in size. At the end of the second season of pond growing they are able to reach the marketable size. Thus, intensive farming allows to obtain in Belarus commodity output of crayfish for 2 years instead of 3-4 years as in natural water bodies.

# OPTIMIZATION OF COLD SHOCK FOR THE INDUCTION OF TRIPLOIDY IN AFRICAN CATFISH (*CLARIAS GARIEPINUS*)

Gróf,L., Hancz,Cs. and Kiss,L.
PANNON Agricult. Univ. Faculty of Animal Science, 7400 Kaposvár, P.O.Box 16, Hungary

## Introduction

Triploidy causes sterility in both sexes with poorly developed gonads (Henken et al., 1987). This later is favourable in female African catfish because decreases significantly the slaughtering wastes. The aim of the present work was to determine the optimal time and temperature in cold shock induction of the African catfish.

## Materials and methods

The brodstock was reared in 24 °C thermal water and aged 18 months. 50 μg of GnRH was used to induce ovulation. Eggs were stripped after 12 hours from the narcotized females. Sperm was gained from the lacerated testis of killed males, filtered and rinsed with 0,7 % NaCl solution. The ratio of dilution was 1:4. Fertilization was made at 24 °C. After fertilization 1000 eggs were counted for each treatment combination and put into 700 ml pots. Treatments were: starting time of the cold shock after fertilization (1-15 minutes) and temperature (3-4-5 °C). The total duration of the cold shock was 40 minutes according to the methodology of Richter et al. (1985). After the cold shock eggs were incubated in jars functioning in recirculation system at 24 °C (Mac Intosh and Little, 1995). Incubation lasted 36 hours. Treatment effects were evaluated on the number of hatched larvae (see Table I.).

Table I. Effect of the starting time and the temperature of the cold shock for inducing triploidy of the African catfish (number of larvae hatched from 1,000 eggs)

| Temperature | Starting of the cold shock after fertilization (min) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (°C) | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 15 | Control |
| 3 | 47 | 69 | 116 | 96 | 57 | 38 | 17 | 7 | 8 | 714 |
| 4 | 136 | 278 | 372 | 318 | 159 | 92 | 41 | 18 | 8 | 678 |
| 5 | 88 | 171 | 257 | 246 | 119 | 36 | 29 | 9 | 11 | 690 |

## Results and discussion

Hatching results were significantly influenced by the starting time and the temperature of the cold shock as it can be seen in Table I.

**Conclusions**

Optimal temperature of the cold shock for inducing triploidy of the African catfish is 4 °C with 24 °C fertilizing and incubation temperature. Optimal starting time was found to be 4-5 minutes after fertilization with a total duration of 40 minutes.

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Gy. Papp, Zs., Zs. Jeney, M. Saroglia*, G. Jeney, M. Lipták and G.Terova-Saroglia*

**Vitamin C in European catfish (Silurus glanis L.) nutrition**

*Fish Culture Research Institute, Szarvas Hungary*
**Università degli Studi della Basilicata, Dipartimento di Scienze delle Produzioni Animali, Potenza, Italy*

It is well known that vitamin C is essential for most of fish. Several species have been studied earlier but only a few result were available about European catfish (*Silurus glanis* L.). So the aim of this study to demonstrate the role of Vitamin C in the nutrition of this specie.

Experiments with graded levels and/or different forms of vitamin C were carried out with juvenile European catfish. Effects of L-ascorbic acid and ascorbate-2-phosphate esters were studied. Results in different stress situations were observed.

From the study about the vitamin C during the embryonic development and just after hatching, it has been observed that vitamin C concentration in the larvae is in connection with the concentrations of hydroxiamino acids.

According to the growth observation of scurvy symptoms and to saturation of the organs with total vitamin C 10 mg/kg vitamin from each form are the minimum requirement for European catfish. Higher amounts seem to be needed to effort particular stressing conditions. Nitrite induced methaemoglobenia seem to be a good monitoring normal physiological request (~ 100 mg/kg in L-ascorbic acid equivalent).

Uptake of 14C labelled L-ascorbic acid were shown that prefeeding with higher vitamin C level results more rapid turnover time.

Enzyme activities were detected for both most important commercial phosphate form (ascorbate-2-mono and polyphosphate) in the gastro-intestinal tract as well as in liver and kidney. The bioactivity of this vitamin C sources were detected with feeding experiment. Minimum four weeks feeding period was necessary to detect this forms in different organs of digestible tract of fish but phosphates were never found in the brain.

# POTENTIALS OF EXTENSIVE FISH PRODUCTION TECHNOLOGIES IN HUNGARY

Cs. Hancz
PANNON Agricult. Univ. Faculty of Animal Science, 7400 Kaposvár, P.O.Box 16, Hungary

## Introduction

Hungarian fishery is showing clear symptoms of crisis. The decreasing catches on the 140,000 ha of natural waters (including reservoirs) indicate severe ecological and management problems. 20 % of the 23,000 ha fish pond area is out of use mainly because of a general lack of capital characterizing the new private owners (Pintér, 1995). As fish ponds have an important hydrological and ecological role in regional level and are excellent grounds for an environmental friendly production maintaining them in a "culture state" is important in many respects (Pillay, 1992). Extensive technologies (i.e. without feeding and fertilizing) seem to be adequate to realize this objective. Only very general guidelines are available about the sustainable development of fish farming (FAO, 1990), so investigations were carried out to compare the traditional semi-intensive fish production (based on additional feeding and manuring) with the extensive one in terms of yielding and economic viability.

## Materials and methods

Different polyculture systems, based on our previous findings (Hancz et al., 1995), were tested in 5 experimental and 1 control (semi-intensive) ponds with a total area of 45 ha. The ponds belong to the Provincial Association for Nature Conservation (PANC) "Somogy". Survival rates by species, net yields and cost/benefit ratios were calculated. With the help of collected data a model for a 50 ha pond fishery was elaborated to compare and evaluate extensive and semi-intensive technologies.

## Results and discussion

Net yields of experimental polycultures (common carp, grass carp + predatory species) varied between 34 and 362 $kgha^{-1}$ while the traditionally treated pond stocked with common carp and pike yielded 323 $kgha^{-1}$. Extensive rearing is undoubtedly riskier and results less total returns but economically it can be viable as it can be seem on data of Table I.

Table I. Economic modelling of a 50 ha fishery comparing extensive and semi-intensive technology (data in 1,000 HUF calculated with 1995 prices)

| Semi-intensive | Costs | Extensive |
|---|---|---|
| 405 | Equipment (vehicle, nets, tanks, etc.) | 405 |
| 1,200 | Fuel and vehicle maintenance | 750 |
| 2,700 | Wages and related rates and taxes | 1,350 |
| 80 | Renovation | 80 |
| 750 | Transportation | 250 |
| 325 | Others (water fee, accounting, etc.) | 325 |
| 2,335 | Feed, fertilizer, drugs | - |
| 3,855 | Fish stocking | 1,670 |
| 11,650 | Total | 4,830 |
| 14,974 | Returns | 6,730 |
| 3,324 | Result before taxation | 1,900 |
| 0.285 (3,324/11,650) | Income rate | 0.393 (1,90/4,830) |

## Conclusions

Extensive fish production is an environmental friendly and cost - effective alternative for conserving normal pond conditions in Hungary, implementable mainly for small-scale fish farmers and managers of the protected areas.

## Acknowledgements

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# IMPLEMENTATION OF DANISH FISH FARMING IN EASTERN EUROPE

V. Horlyck

Aller Molle A/S, Aller Mollevej 17, DK-6070 Christiansfeld, Denmark.

**Abstract**

Aller Molle A/S is an old mill with more than 75 years experience in producing feed for the agricultural industry and 30 years of experience in fish feed. Having more than 100 years of experience in fish farming in Denmark it is quite obvious, that this know how could be introduced to other countries. As eastern Europe was opened, it was clear, that these countries were of interest. The relative short distance made communication easy. Furthermore fish farming is a well known industry in Eastern Europe.
The idea was to introduce the highly developed Danish fish feed and modern techniques. The very severe environmental legislation has forced Danish fish farming industry to develop extremely fast during the last decade.

The poster will show the way Aller Molle A/S has implemented Danish fish farming products and management's in several countries.
Building up a local network and the necessary support to enhance the fish farm industry.
The most important support is education and establishment of a close network between the local farmers and you.
The poster will elucidate the necessary formalities in respect to the local authorities.
The future development and corporation between west and eastern Europe concerning aquaculture seems promising.

# AQUACULTURE IN TURKEY & FEEDING PROBLEMS

**Belgin Hoşsu, Ali Y. Korkut**

**E.U. Faculty of Fisheries Bornova - Izmir, Turkey**

## Aquaculture in Turkey

Turkey is surrounded by the sea from three sides. Aquaculture has began to improve in Turkey since 1970 .First of all carp culture has began, later trout and lately marine fishes followed this. Fishing capacity according to the geographic regions of Turkey is shown at table first.

Table 1. Fishing rates of Turkey by regional numbers (Tones) (DIE, 1994).

| Name of region | Production (tones) | Rate (%) |
|---|---|---|
| East Black Sea | 300 417 | 61 |
| West Black Sea | 57 601 | 12 |
| Marmara Sea | 39 820 | 8 |
| Aegean Sea | 58 110 | 12 |
| Mediterranean Sea | 35 387 | 7 |

Turkey is 30th in 161 countries, 6th in Europe, 5th in European Economical Assembly, 3th in Mediterranean countries (DPT, 1992).

Improvement of fisheries between 1986 - 1991 has given at table third. According to the table three, sea fishes production of Turkey is decreased and shellfish & molluska production slightly decreased while aquaculture increasing in this period (DPT,1992).

Table 2. Total fisheries production by fishing and aqua culture (tones) (DPT,1992).

| FISHING Years | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|
| Sea fishes | 525.381 | 562.697 | 580.702 | 361.770 | 297.123 | 290.046 |
| Shellfish & molluska | 14.184 | 20.156 | 42.703 | 48.159 | 44.894 | 27.379 |
| Fresh w. fish. | 40.280 | 41.760 | 48.500 | 42.833 | 37.315 | 39.401 |
| Aquaculture | 3.075 | 3.300 | 4.100 | 4.354 | 5.782 | 7.835 |
| Fresh w. fish. | 3.040 | 3.205 | 3.965 | 3.504 | 4.348 | 4.549 |
| Sea fishes | 35 | 95 | 135 | 850 | 1.434 | 3.286 |
| TOTAL | 582.920 | 627.913 | 676.005 | 457.116 | 385.114 | 364.661 |
| Per. Consum. | 8.49kg. | 7.55kg. | 8.73kg. | 6.28kg. | 6.16kg. | 5.38kg. |

## Fish Feed Production in Turkey

First fish feed manufacturing has began in 1986. There are 6 fabrics in 1996 which are mostly located at Aegean and Marmara region. These fabrics are producing fish feeds nearby terrestorial animal feeds. Total fish feed production of Turkey is around 15 000 tones which is given at table 3.

Table 3. Fish feed production of Turkey in 1995.

| Manufacturer | Fish feed production (tones) |
|---|---|
| Bilyemtaş | 2 750 |
| Yatağan | 1 080 |
| Pınar | 7 000 |
| Hakan | 1 200 |
| Abalıoğlu | 2 300 |
| Korkuteli | 740 |
| TOTAL | 15 070 |

These manufacterers are working by peled press system and producing sinking feed. Only one of these manufacturers is has extruder peled system but it's production isn't sufficient yet.

**Conclusion**

Turkey has great aquaculture capacity by it's sea costs and inland water. Since 1970's people are getting interested with aquaculture. The number of fish feed manufacturers are increasing related to this improvement.

Some problems of aquaculturest and manufacturers are;

- Net cage farms are mostly located in bays very close to each other. It may cause contamination of some diseases between farmers.

- Most of the bays are completely full of net cages. There are some complains from some people of Turkey, because of view.

- Some farmers are insufficient on feeding regime.

- Fish feed manufacturers are producing sinking and quick dissolving peled and this cause pollution problems by with bad feeding regime of farmers.

- Most of the ingredients of fish feed are exporting. As a result of this prices of fish feed are high in Turkey.

- Quality of fish feed aren't uniform, because of fish feed production with unsuitable ingredients.

- Fish feed manufacturers are not care about quality of feed according to the kind of species.

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# MONITORING STRESS BEHAVIOR BY COMPUTER VISION

D. Israeli-Weinstein and E. Kimmel
Agricultural Engineering Department, Technion IIT, Haifa 32000, Israel

## Introduction

Detection of stress conditions in fish farming systems is needed in order to reduce production loss. Stress is associated with a variety of conditions such as reduced oxygen level, abrupt variations in temperature, appearance of contaminants or elevated ammonia. When fish are stressed, stress hormones are released; followed by variations in the composition of blood and tissues, and in the ventilation and heart rate; and, later a reduction in the Immunological activity level is observed, which results in a higher susceptibility to diseases and parasites, a decreased growth rate, reduced reproduction and increased mortality. All the stress-induced changes are associated with variations in fish behavior. Any behavioral response that can be continuously monitored and quantified has the potential to be used as a biomarker in the assessment of stress.

## Materials and methods

The behavioral responses of a school of young carp (*Cyprinus carpio* and *Carassius auratus,* 8 to 12 cm length) were monitored using CCD cameras, positioned in front of tanks with transparent sides. Geometrical parameters were derived by processing the projected images grabbed by a computer. Two coordinates of the center of gravity (CX, CZ), and two directional standard deviations (SDX, SDZ) were calculated for the position and distribution of the school. Swimming activity and feeding behavior were characterized by means of a novel parameter - the Projected Mobility Picture (PMP). Stress level was determined by blood glucose (Israeli-Weinstein and Kimmel ).

## Results and discussion

After exposure to ammonia concentration of 0.8ppm, carps responded first by declining to the bottom of the tank and staying there in a crowded school. One day later, the fish school approached the surface, probably due to gill damage that caused respiration malfunctions and practiced "breathing" motions of periodic spreading and contraction. Throughout the experiment, the treated fish exhibited low activity, reduced feeding activity, and reduced variability in time of the center of gravity (Fig.1). This response might be attributed to exhaustion and to a possible attempt to save energy needed to overcome the stress condition. The treated fish had significantly high blood glucose levels. It worth noting that early gathering of fish at the bottom of the tank, was also observed in fish stressed by a frightening disturbance.

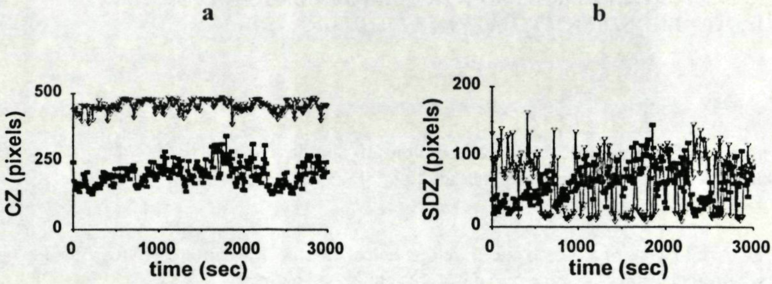


Fig. 1. Variations in time of CZ (a) and SDZ (b) in control (■ ) and fish exposed to ammonia (∇).

In response to hypoxia, where oxygen level was reduced to 1.0ppm, treated fish moved upward, towards the surface (see, e.g., Kramer (1987) for a similar and common response); reduced their activity (similar to, e.g., Metcalfe and Butler (1984)); exhibited spreading and contraction movements of the school, and reduced variability of the center of gravity in the vertical direction.

When exposed to a combined contamination of 0.7ppm cadmium and 0.3ppm lead, carps responded by gathering at the bottom of the tank, and by reducing their swimming and feeding activities (see also Weber et al. (1991).

**Conclusions**

This study might evolve into an automatic stress warning technique for fish farms, based on alterations in the behavior of fish, when stressed. The behavior pattern of carps, when exposed to heavy metals contamination, can be used as biomarkers for these metals.

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# MARICULTURE IN GOVERNMENTAL PROGRAMMES AND REAL ECOLOGO-ECONOMIC SITUATION AT THE UKRAINE

V.N.Ivanov

Department of Mariculture, Institute of Biology of Southern Seas,
2 Nakhimov Ave., 335045 Sevastopol, Ukraine

In the Azov-Black Sea basin the development of marine aquaculture is reasonable actual for theUkraine by some circumstances connected with:

- a sharp decrease in fishery significance of the region. Now the consumption of fish by the Crimea population does not exceed 3 kg per person a year;
- urgency to open new working places in coastal settlements due to structural reconstructions in economy and a prolonged crisis;
- demand for production of medical-prophylactic foodstuffs, natural adsorbents, isotopic and non isotopic carriers for the people suffered from the Tchernobyl accident.
- total ecology deterioration in the Azov and Black Seas.

The Institute of Biology of Southern Seas (IBSS, Sevastopol) coordinates investigations in several mariculture programmes supported by the National Academy of Sciences of the Ukraine (NASU), Governmental Committee on Scientific and Technical Policy (GCSTP), National Agency for Marine Investigations and Technologies (NAMIT). The Programmes invisage to investigate the production potential of coastal waters, to identify and evaluate factors constraining mariculture development, to organize some pilot marifarms cultivating mussels and oysters. Scientific Institutes from Odessa, Sevastopol and Kerch participate in these programmes.Regretful, the above-mentioned NASU, GCSTP and NAMIT Programmes render only an administrative support, but do not plan investments for new marifarms.

Working out scientific bases of a new branch in marine industry for the Ukraine,IBSS scientific departments conduct investigations in several directions:

- Investigations of ecological interactions in marifarm regions. Mussel- and oyster-farms inbuilt in system with natural biocemical relations become a management chain in the ecosystem. A main path to optimize an ecosystem functioning, together with an artificial chain - marifarm, is to set the balancies for water exchange, substance turnover and energy fluxes forming the farm productivity and an ecological status of region.
- Study of natural replication processes, artificial reproduction and developing of biotechnologies for cultivation marine objects at early ontogenesis stages under controlled conditions. Population-genetic investigations with objects perspective for cultivation. Carried out technologies are realized under experimental conditions in laboratories.

- Identifying of an optimal structure for complex mussel-, oyster- and marine fish industry under geographic and economic conditions of the South of the Ukrainie. Development of recommendations to organize favourable social circumstances for marine farmings - prepare prepositions for state bodies, formation of scientific centers, spreading of the experience in mariculture.

By opinion on IBSS scientists, the coastal Black Sea zone ecology may by stabilized and improved if to use mariculture widely. The mariculture business is in good agreement with intensive recreation.

Physico-geographic and climatic conditions of Ukrainian South, experience of E A S member - countries (European Aquaculture Society) allow to assume the great perspectives in mariculture development at Black Sea Shelf.

Institute of Biology of the Southern Seas proceeds fundamental investigations with mariculture objects (fish, molluscs, algae) and is ready to join any commercial programmes directed to organize nurseries, pilot farms, scientific centers in frames of regional and international projects.

# FISH MANAGEMENT IN LARGE ESTONIAN LAKES OF PEIPSI AND VÔRTSJÄRV

A. Kangur and P. Kangur

Institute of Zoology and Botany, Vôrtsjärv Limnological Station
EE2454 Rannu, Estonia. E-mail: andu@lim.tartu.ee

## Characterization of lakes

L. Peipsi (=L. Peipus, L. Chudskoe) is one of the largest inland waterbodies in Europe (area 3550 km$^2$, mean depth 7.1 m, maximum depth 15.3 m). The lake belongs to smelt-bream lakes; due to eutrophication during the last decades it has obtained features of a pikeperch lake. Its fish productivity as well as catches are high (Table I), in this respect L. Peipsi surpasses all large lakes of North Europe. About 2/3 of the area and about 60% of the catch of fish belong to Russia, the rest to Estonia.

Table I. Fisheries characterization of L. Peipsi and L. Vôrtsjärv

| | L. Peipsi | L. Vôrtsjärv |
|---|---|---|
| Fisheries status | smelt-bream-pikeperch | pikeperch-bream |
| Average fish catch (kg/ha/yr.) | 18-20 | 10 |
| Valuable fishes | perch, pikeperch, smelt, bream, pike, vendace, | eel, pikeperch, pike, bream |
| Non-valuable fishes (group III) | roach, ruffe | small bream, roach, ruffe, perch |
| Introduction of fishes | none | glass eels |
| Fish protection measures | closed spring season, legal size for commercial fishes, limitation of the number of fishing gear and minimal mesh size | |
| Main fishing gear | Danish seine, gill nets | large basket traps, gill nets |
| Use of active fishing gear | restricted | forbidden |
| Number of fishermen | > 500 (in Estonian side) | 22 |

L.Vôrtsjärv is a large (270 km$^2$) and shallow (mean depth 2.8 m, maximum depth 6 m) strongly eutrophic waterbody in southern Estonia. According to the fishery typology L. Vôrtsjärv belongs to pikeperch-bream lakes.

## Fisheries arrangement

The fishery in L. Vôrtsjärv is arranged by the Vôrtsjärv Council (set up in 1991; membership: representatives of the county administration, local parishes, fishermen and fish biologists of the Institute of Zoology and Botany). The Vôrtsjärv Council is responsible for the development and protection of the fish stock in the lake. Eel and pikeperch are the most important commercial fishes in L. Vôrtsjärv. The state of the eel population depends on the regular introduction of glass eels into the lake. About 38 million glass eels were introduced into the lake during 1956-1996.

L.Vôrtsjärv was previously regarded as a ruffe lake, because in the 1950s and 1960s the bulk of fish caught here consisted of ruffe, young perch and roach (about 70% of the total catch). The role of pikeperch and pike was small.

Fishes were caught at that time mostly with small meshed active fishing gear (sailing or engine trawls, Danish seine) in the ice-free period and with gill nets in winter. Despite intensive catch, ruffe was very abundant, whereas the role of pikeperch and pike was small. All attempts to reduce the abundance of undesirable fishes by intensive trawling were unsuccessful. On the contrary, active fishing gear killed pikeperch fry.

Owing to the rearrangement of the fishing strategy, rapid replacement of rough fishes by commercial fishes has taken place. In order to increase the stock of valuable fishes, a number of measures were suggested: establishment of the closed spring season and legal size of 40 cm for pikeperch and pike, prohibition of the use of active fishing gear. These measures were efficient: the survival rate of pikeperch fry increased, while the stock and catches of this fish increased rapidly. The number of pike has also grown. The growing pressure of big predatory fishes has led to a sudden fall in the stock of ruffe.

For the arrangement of fisheries in L. Peipsi the Estonian-Russian Peipsi Council was set up in 1974. The main task of this organization was to accord several fisheries measures, among them fishing quota, between the Estonian and Russian sides. Membership of the Peipsi Council: representatives of fisheries firms, fisheries departments and scientific institutes of both sides. This Peipsi Council was responsible for the development and protection of the fish stock in the lake.

The Estonian Peipsi Council was reorganized in 1996, its membership consists of representatives of counties' administrations (governors) who are responsible for the social development of their regions. The real arrangement of fisheries is performed by the Estonian Fisheries Department and by the Estonian Ministry for the Environment. The basis for the arrangement (recommendations etc.) is eloborated by fish biologists of the Institute of Zoology and Botany.

Both the Estonian and Russian local fish markets are restricted by the small purchasing power of the population. There is no common strategy for fisheries management of L. Peipsi. Smelt and vendace as delicate and relatively cheap fishes enjoy high popularity in the Russian local market. Therefore, the Russian side declares that pikeperch is an unwanted fish in the lake that consumes smelt and vendace in large quantities. Pikeperch is caught without a legal size. The Russian foreign fish market is limited too.

Demand for smelt and vendance in the Estonian market is modest; Estonian fish dealers are interested in pikeperch and perch which have a practically unlimited market in foreign countries (Denmark, Sweden, Germany). Pikeperch has become one of the most important valuable game fish in L. Peipsi at present time. The relatively good growth rate and condition of pikeperch in the lake indicates that this waterbody is suitable for this fish. Owing to its high commercial value and vulnerability to fishery, pikeperch is now the most endangered fish species in L. Peipsi.

# CHANGES IN THE CONDITION OF THE BREAM (*ABRAMIS BRAMA* L.) POPULATION FROM L. VÔRTSJÄRV DURING 1964-1994

Peeter Kangur

Dept. Zoology & Hydrobiology, Univ. of Tartu
Vôrtsjärv Limnological Station, EE2454 Rannu, Estonia

## Introduction

Bream is one of the most important valuable commercial fishes in inland waterbeds in the basin of the Baltic Sea. In Estonia, the fish prefers quite large, not very deep eutrophic and hypertophic lakes with moderate water transparency, pH, dichromate oxygen consumption (i.e. the content of organic substances) and fish productivity (Pihu, 1993).
In L. Vôrtsjärv bream, eel and ruffe consume a considerably poor benthic fauna. According to experimental catches benthphagous fishes constituted 71% (bream 35% and ruffe 36% by the number) of fish catches from L. Vôrtsjärv in 1994. The main aim of the paper is to investigate the changes in the condition and growth rate of bream in L. Vôrtsjärv during the period 1964 - 1994.

## Study area

L. Vôrtsjärv (surface area 270 km$^2$, average depth 2.8 m, maximum depth 6 m) is a strongly eutrophic lake. The lake is covered with ice from November till April with an average of 135 days a year. The average water temperature rises up to 17-21°C in July. No permanent stratification occurs in summer. L. Vôrtsjärv belongs to bream-pikeperch lakes. Bream, eel, pikeperch and pike are the main commercial fishes in the lake today.

## Material and methods

The material was collected from the open part of L. Vôrtsjärv during the fishing season (from May till November) of 1994. The fishes were caught with the experimental trawl (mesh size 12 mm in the cod-end). Altogether 12 trawl catches were examined.
The age of the fishes was determined from scales collected in September and October 1994. The growth rate of bream was estimated by growth zones on scales and found from back-calculated lengths (Bagenal & Tesch, 1978) in combination with Petersen's method.
For assessing the condition factor of bream, a total of 208 fishes with a length of 8-43 cm were weighed in autumn 1994. The length and weight of larger fishes (L>30 cm) were measured with the accuracy of 1 cm and 10 g, respectively; the same parameters of smaller fishes, with the accuracy of 5 mm and 5 g. The Fulton's condition factor was calculated (Bagenal & Tesch, 1978). Our calculations combined both sexes.

## Results

Bream has a number of spawning areas in L. Vôrtsjärv. Favourable breeding conditions and relatively high fertility ensure a numerous bream population. Due to scanty food reserves the condition of bream in the 1960s and 1970s was low. Feeding conditions deteriorated after the introduction of glass eels into the lake. With the aim to relieve feeding competition between bream and other benthophagous fishes (eel, ruffe etc.) it was recommended to diminish the population abundance of bream and to catch this fish without any restrictions.

These measures were justified: the growth rate and condition factor of bream in L. Vôrtsjärv have improved in comparison with the 1960s and 1970s (Tables I and II).

Owing to intensive breeding and the absence of natural enemies, the unlimited catch of bream did not prove fatal for its population. Big predators (pikeperch and pike) consume mainly perch, ruffe, roach and smelt in L. Vôrtsjärv.

Table I. Average condition factor and length of bream in experimental catches from L. Vôrtsjärv

| Data | Haberman, 1964 | A. Kangur, 1975 | A. Kangur, 1980 (unpubl.) | P. Kangur, 1994 |
|---|---|---|---|---|
| Condition factor | 1.89 | 1.92 | 2.18 | 2.07 |
| Avg. length (cm) | | 12 | | 16 |

Table II. Growth rate of bream (cm) in L. Vôrtsjärv

| Age group | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Data |
| 6 | 8 | 13 | 18 | 22 | 24 | 28 | 30 | 34 | 37 | 39 | P. Kangur, 1994 |
| 6 | 10 | 14 | 16 | 17 | 19 | 22 | 25 | 28 | 29 | 30 | Ling, 1981 |
| 6 | 9 | 13 | 15 | 19 | 21 | 23 | 25 | 27 | 30 | 31 | A. Kangur, 1975 |
| 5 | 9 | 14 | 17 | 21 | 23 | 26 | 29 | 31 | 33 | 34 | Haberman, 1964 |

The lack of restrictions on bream catches had a positive effect: the proportion of big breams in catches has increased, the growth rate of this fish has accelerated and its condition improved.

The population density of bream should be maintained at a stable level, which can be achieved by limiting its population in future as well.

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# THE INFLUENCE OF DENSITY ON GROWTH OF GIANT TROPICAL PRAWN, *MACROBRACHIUM ROSENBERGII (DE MAN)* UNDER DIFFERENT CULTURE CONDITIONS.

V.F.Kulesh
Institute of Zoology, Academy of Science of Belarus,
Scoriny str. 27, 220072 Minsk, Belarus

The Giant tropical prawn *Macrobrachium rosenbergii (De Man)* takes a dominant position in the world freshwater prawn aquaculture in the contries of tropical and subtropical zone. Long - term experiments at Bereza thermoelectric power station have shown in principle the possibility to cultivate this species in a waste - heat discharge water of moderate zone (Khmeleva,Guiguinyak and Kulesh,1988).

At intensive culture of hydrobionts the great importance is attached to the analysis of density influence on animal growth when metabolites are removed artificially (rearing in tanks of different types) or in pond and cage systems where this process is going on naturally.

In this connection the own and literary data on growth of this species in cages (the native area,Vietnam), in a waste-heat disharge water of power station and in tanks have been analyzed (Alekhnovich and Panyuskin, 1991; Dugan,Hagood and Frakes, 1975; Kulesh and Guiguiniak, 1990; Sandifer and Smith, 1975,1977; Sandifer, Smith, Stokes and Jenkins, 1982; Smith and Sandifer, 1979). For correct comparison of data obtained the age of animals has been taken into account i. e. the rearing period has been timed from the stage of postlarva (the onthogenetic stage when freshwater prawn larvae turn into juveniles at the final 11 th stage of metamorphosis). The data have been analyzed obtained at the optimum temperature (27-28°C) only.

Comparing our own data on growh of giant freshwater prawn in aquariums with literary ones it is possible to conclude that irrespective of the mode of aguaculture (tanks, baths, aquariums, cages) at the optimum temperature (27-28°C) the density proves to be dominant biotic factor determining the growth of prawns.

Nearly at first 50-60 days the density influenced the growth of prawns insignificantly. Then the density influence on growth rates has appeared distinctly. Independently of culture conditions at 70-90 days growth rates in prawns at the stocking density 133 ind/m$^2$ proved to be nearly 3 times lower than at 5 ind/m$^2$. This difference has increased even more to the end of the rearing period.

So the data obtained permit to analize and to calculate quantitatively the density influence on the growth of giant prawn at different rearing modes at a wide density range . To establish the quantitative characteristics of density influence on growth all the data obtained were divided into two groups: the first one with the optimal density of 5-133 ind/m$^2$ and the second one with the density of 200-1617 ind/m$^2$. The growth period has been divided into two stages: the juvenille growth i.e. 50 ±10 days after larva metamorphosis, 100 ± 10 days and 150 ± 10 days and 200 ± 10 days.

As the statistical analysis has shown the growth of giant prawn described by the equation of a linear regression in juveniles up to 50 ± 10 days and by the equation of an exponential function in adults respectively.

The numerical values of (a) and (b) coefficients, coefficients of correlation and statistical characteristics are given in the table.

Table . The parameters of equations the relationship between a growth rate W,g and a stoking density P, ind/m$^2$ in *Macrobrachium rosenbergii* , of a kind: $Y = a + bx$ (1) and $Y = e^{a+bx}$ (2)

| Growth duration, days, ±10 | Density interval, ind/m$^2$ | a | $\delta_a$ | b | $\delta_b$ | $r_{xy}$ | n | NN of equa-tions |
|---|---|---|---|---|---|---|---|---|
| 50 | 5 - 133 | 0.998 | 0.049 | -0.007 | 0.001 | 0.913 | 28 | 3 |
| 100 | 5 - 133 | 1.560 | 0.085 | -0.012 | 0.001 | 0.870 | 30 | 4 |
| 150 | 5 - 133 | 2.593 | 0.103 | -0.012 | 0.001 | 0.860 | 26 | 5 |
| 200 | 5 - 133 | 3.373 | 0.149 | -0.016 | 0.002 | 0.897 | 16 | 6 |

So with the aid of the equations obtained (5-8) it is possible to predict the growth of a giant tropical prawn from postlarval stage up to definitive age in a density range of 15 to 133 ind/m$^2$.

The statistical analysis of data obtained for the second group (the density of 200-1617 ind /m$^2$ ) has shown the absence of any regularies.

# BIOLOGY AND ECOLOGY OF "PEARL-FORMING" TREMATODE *PARVAREMA DUBOISI* IN CONNECTION WITH MUSSELS HATCHERIES FUNCTIONING IN THE BLACK SEA

V.K. Machkevsky

Dept. of Ecol. Parasitology, Inst. of the Biol. of the South. Seas, 2 Nakhimov Av., Sevastopol, Crimea, Ukraine 335011

## Introduction

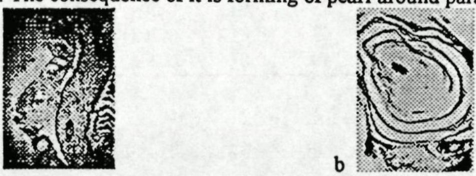
The mediterranean mussel *Mytilus galloprovincialis* forms large settlements in coastal benthic biocenoses in all regions of the Black Sea (Zaika et all, 1991). It is the main object of mariculture here. The musssel endosymbiontic fauna has 16 species. Its more characteristic component is trematode *Parvatema duboisi* (Gymnophallidae). It is widespread species at the coastal zone. The life cycle of P. duboisi includescontains three stages and tree host groups. *M.galloprovincialis* is the additional host of *P. duboisi* (Bartoli, 1974; Machkevsky, 1990). Gymnophallid metacercariae are dengerous for human health.

## Material and methods

The data of this investigation were collected by author during 1991-1995. The parasitological, hydrobiological and histological methods were used. More than 1000 mussels were examined.

## Results and discussion

It was defined that: -Metacercariae of *P. duboisi* provocate host reaction to biomineralization. The consequence of it is forming of pearl around parasite (Fig. 1).



a b

Fig. 1. Metacercariae and pearl in the mantle tissue: a) total view; b) large pearl

This feature of host-parasite relations is very negative factor for mussel in mariculture. The presence of pearls in mussel body decreases food quality of the growing mussels. Not all metacercariae undergo by incapsulation in pearls. Probably the elimination of metacercariae is the consequence of disbalance of host-parasite relations; - Intensity of pearlforming process is proportional to an intensity of metecercariae invasion in hosts. Maximum of pearls in one mussel is 1109; Pearl size correlates with host size. Pearl number depends on depth of host inhabitat; Mussels are invaded by cercariae at erly age (size 3-5mm). Then metacercariae accumulate in mussel and hemipopulation enlarges itself with host growth and reaches 2000-3000; First and additional hosts live jointly. This is the favourable factor for transfer of larvae *P. duboisi* in biocenose;- Final host is the seabirds eating mussels (diving seabirds and gulls) and is the main limitng factor for *P. duboisi* population. Irregular space-time distribution of seabirds along the shore condtions of variability of this parasite number (Fig. 2);

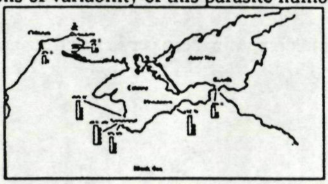


Fig.2. Prevalence (O) and intensity (●) of invasion of mussels by metacercariae P.duboisi in different regions.

-The number of *P.duboisi* populations depends on water pollution. Industrial pollutants inhibit it, but organic pollutants give them growth; - At the Sevastopol region the seabirds overwinter migrations stimulate an increase of prevalence of invasion of mussels by metacercariae up to 100% with maximum of invasion intensity; - Very often mussel mariculturists chose for hatcheries an aquatorium protected from the storm winds and waves. Seabirds also prefer such conditions. Besides, the marifarm constructions create favourable conditions for seabirds: high concentration of hydrobionts - food ojects and substrate for rest.

## Conclusions

Revealed features of parasite-host relationships bitween mussels and metacercariae and *P. duboisi* biology and ecology must be taken into account before organization of mussel hatcheries.

## Acknowlegments

The part of these investigations was supported by ISF Grant U1W000.

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# THE LAGOON OF LESINA: A MODEL SIMULATING ECOLOGICAL PROCESSES

V. Marolla[1]. and V. Hull[2]

[1] Istituto per lo Studio degli Ecosistemi Costieri, Consiglio Nazionale Ricerche, via Pola 4,71010 Lesina, Italy
[2] Laboratorio Centrale di Idrobiologia, Ministero per le Risorse Agricole, Alimentari e Forestali, viale del Caravaggio 107, 00147 Rome, Italy

## Introduction

Ecological processes simulations are very important for ecologists involved in impact studies. Models are powerful tools with evident capability to reduce the high grade of complexity of natural systems. The object of the present work has been to develop an important field experiments database, from which a first qualitative trophic and dynamic model, and then a numeric simulation model of the plankton community of the the lagoon of Lesina were derived. This coastal ecosystem is located in the South-East area of Adriatic Sea; it is one of the largest brackish water bodies of Italy, covering an area of 50 $km^2$. Hydrodynamics is scarse and the only water exchange with the sea is insured through two channels, the Acquarotta Canal and the Schiapparo. The lagoon reaches its maximum depth of 1.3 m in the central area. The bottom is mainly composed by exogenous sand, covered by a layer of endogenus organic mud.

## Materials and methods

During the period from april 1994 to march 1995 a study of ecological dynamic processes has been carried out. Measurements of temperature, salinity, oxygen demand, chlorophyll *a* content, alcalinity, pH and primary productivity were conducted every 3-4 hours for an over 30-40 hours period each month. Additional phyto and zooplankton samples were collected for biomass and floro-faunistic composition determinations. Micro-nutrient samples were also collected to evaluate the evolution of water chemical quality. The experimental data collection were all addressed to the definition of parameters and constants to set up the ecological models.

## Results and discussion

The ecosystem has shown high levels of oxygenation (close to, or over saturation), constant pH values (8.0-8.3) and a very high spatial variability of salinity (between 10.0 and 50.0 $gr.Kg.^{-1}$). The water is particularly rich in nitrates (up to 420.1 $\mu g\text{-}N.l.^{-1}$), ammonia (up to 1106.0 $\mu g.\text{-}N.l^{-1}$) and silicates (up to 1448 $\mu g\text{-}Si.l^{-1}$); this is undoubtedly the cause of the high phytoplankton densities found during the entire period of observation ( up to 5.964.000 $cells.l.^{-1}$).

The results show that the physical, chemical and biological conditions of this lagoon are strongly affected by the season's alternate, and by the efficiency of the two connection with the open sea. The low functionality of the latter, and anthropogenic factors (domestic and agricultural activities pressing on the ecosystem) can be considered the main causes of the few ecological instability conditions that have been storically marked in this lagoon. Phytoplankton population was mainly represented be 5 groups (3 Diatoms, 1 Prorocentrales and unclassified forms of microflagelates). The zooplantkton population was defined by one single species of Copepods (Acartia sp.); anyhow, in the simulations, it has been considered in two different size classes (juvenile and adults) in consideration of their different feedings habits. Macrophytes in the lagoon mainly belong to 5 different species but only one of them (Valonia sp.) has been considered in the modeling processes. Concentration of organic matter in the sediments has been found to be the 6.0%.
The first model that has been developped was qualitative and dynamic of the trophic structure of the plankton community. The modeling methodology has been introduced by Puccia and Levins (1985). The model has shown to be very useful for the definition of ecological stability level of the system. The second model developped was numerical of simulation and is derived from others, built in the last few years by one of the authors (Lagonegro et al., 1992). Most of the information arised from field experiments was included in the numerical model that performs plankton populations growth processes in relation to chemical, physical and meteorological characteristics of the lagoon and the neighbouring.

**Conclusions**

Modeling the ecological processes of the Lagoon of Lesina has shown to be an important tool for a better comprehension the high level of complexity in the system. Results of field data and simulated scenarios have both shown a marked ecological stability of the environment. Even if numerical simulations are not the reality, nevertheless they looks to be important, for the grade of synthesis that they offers, for analysing selected parts of the whole, as well as for understanding where to addrress further investigations.

Copy of the model software and a manual can be obtained from the second author, free of charge, on request.

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## STATUS OF AQUACULTURE IN LATVIA

Andis Mitans
Latvian Fisheries Research Institute, Daugavgrivas 6, LV-1007, Riga, Latvia

Latvia has plenty of potential for aquaculture development. The coastal waters of the national fishing zone in the Baltic sea and the Gulf of Riga are a highly productive area. There are some 3000 lakes and reservoirs with the surface area over 1 ha and 17 rivers with length over 100 km. About 1,5 % of the total surface of the country is covered by freshwater in general suitable for aquaculture as far as the antrophogenical impact on environmental conditions is concerned.

The total area of artificial ponds is about 5000 ha mostly used for farming of the common carp. In the 1980-ies the total yearly production of carp was some 2500 tons. In the same period of years the farming of rainbow trout in the sea and freshwater net cages become a new branch of Latvian aquaculture and in addition the young trout has been used for the ranching in the Gulf of Riga. However over the last years the recent social-economic changes in Latvia and open market politics has led to heavy depression of all commercial fish farming.

At present the fish stock enhancement or ranching by stocking juveniles is the main field of Latvian aquaculture, based on the 8 state owned hatcheries. In 1994-1995 the total release per year averaged 800 000 Baltic salmon and sea trout smolts, 600 000 sea trout fry, 2 600 000 one-summer old pike-perch, bream and vimba, 200 000 pike and 8 600 000 river lamprey larvae.

The salmon smolt rearing for stocking the rivers and the Gulf of Riga coastal waters is the most important sector of the Latvian aquaculture. Only the sea-run salmon has been used and the broodstock fishery takes place in the coastal waters near the river mouth. Incubation and early feeding of fry go on in the hatching trays but rearing of parr and smolt in the plastic tanks. Most of the young salmon become migration smolts of the age 1 year and 20-35 grams in weight. In the Latvian hatcheries mortality of young salmon usually has been low and no M74 syndrome was noticed. The mean rate of salmon recaptured by fishery amounted to 12% and 600 per 1000 released smolts.

The future development of aquaculture in Latvia and especially of the commercial fish farming will depend on financial investment and marketing factors.

# Economical assessment of Hungarian pond fish culture

A. Nábrádi[1], I. Szűcs[1] and L. Stündl[2]

[1] Dept. of Farm Management, Debrecen Agricultural University, Debrecen, Hungary
[2] Dept. of Animal Husbandry and Nutrition, DAU, Debrecen, Hungary

## Introduction

The fish production in Hungary is basically extensive or semi-intensive (3 year cycle) pond culturing. The annual gross revenue of fish production is estimated around 3.5 billion HUF, the gross annual harvest is around 30,000 tonnes, 3/4 of which is the net harvest. The export income of Hungary from fisheries products is 8-9 million USD, at the same time the import is 11 million USD. (Ministry of Agriculture, 1996). In World-level, the per capita supply of fish and fisheries products tends towards a slow but conceptual growth. Presently, the average level of consumption of fisheries products is approximately 13kg/person/year, while this in Hungary is only 2-3kg. The aim is to double this, however from nutritio-physiological point of view the triple amount would be preferable.

In this study the economics of the enterprises dealing with pond-fisheries are studied. In the following questions are investigated in detail:

- average capital requirement and turnover time,
- labour effectivity,
- profitability (yields, revenue, production cost, profit),
- the roles of the fisheries in the future's Hungarian agriculture,
- factors affecting the safety of the production,
- perspectives for the future.

## Materials and methods

The processed data were gained by personal data collection at the enterprises that are well representing the features of the Hungarian fishpond-production. (Since requested, the names of the enterprises are not mentioned.) The scope of data has been supplemented by those provided by National Association of Fish-producers (NAF). Besides conventional economical analyses SWOT- and net present value analysis for the capital investments were also made.

## Results and discussion

In this sector the capital turnover proved to be extremely slow. Examining the establishment of a fishpond from only the investors' point of view (75-85% of the total invested assets are the value of the pond and adjacent establishments) and assessing the production via net present value analysis, the result is that this is not competitive with the bank investments despite the significant state subsidies. In the present economic situation 25-35 and 12-16 hectares of fishpond and arable land for feed production is necessary, respectively in order to realize 1 million HUF profit. Generally speaking, despite the national average yields, in most of the ponds in production the 1-1.1 tonnes/hectare annual yield are obtainable, moreover, in a part of the ponds even the 1.5 t/ha/year yield is not unreal. Unfortunately, due to the difficulties with liquidity and current assets, some technological elements (feeding) were not applied properly in the past few years. The profitability index in the sector found to be 5-25%. The relative yields and stockings - according to the national averages - are shown in Figure 1.

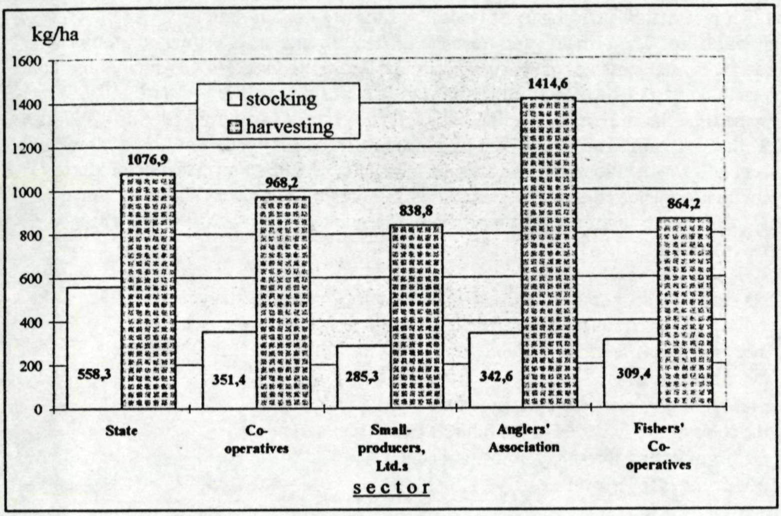


Figure 1.: The relative stock and harvest by sectors (averages of 1992-94)

## Conclusions

The establishment of fisheries and fishponds is important for the social economy but not only from the interest of the production. Moreover, environmental aspects and also those of nature conservation are also to be considered. The establishment of fishponds is one of the most effective ways to „fallow" or to withdraw land from arable production. By doing so, profit can be realised on such soils where arable production is not profitable.

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# FISH MARKETING AND INFORMATION SERVICE FOR EASTERN EUROPEAN COUNTRIES (EASTFISH)

J. Nierentz
FAO, Viale delle Terme di Caracalla, I-00100 Rome, Italy

A new fish marketing and information service to aid Eastern European countries as they test the waters of market economy was born on 1 June. Called EASTFISH, the service is based in Copenhagen and will serve more than 20 countries. It is the first FAO office in Denmark, located in the new United Nations building on Copenhagen harbour.

The Fish Marketing and Information Service for Eastern European Countries, or EASTFISH, will deal with the complex problems of fishing industries in transition, industries that are trying to compete with Western and developing world fisheries. Typical problems the service will try to address include the following:

- A canning factory in one of the Baltic States has just been able to privatize its operation partly but, to compete successfully with other producers from southern Europe in the EU market, it needed to invest in machinery, particularly packaging equipment. How does it prepare a business plan and feasibility study which would be essential to convince financing institutions?

- The oversupply of carp from aquaculture in Hungary, the Czech Republic and Poland caused serious price decreases in national and external markets. Who would advise aquaculture farms on alternatives? How could production be adapted to EU quality regulations?

EASTFISH joins the Network of Fish Marketing Information Services, which also covers the Asia and the Pacific region with INFOFISH (HQ in Kuala Lumpur), Africa with INFOPECHE (HQ in Abidjan), Latin America with INFOPESCA (HQ in Montevideo) and Arab countries with INFOSAMAK (HQ in Bahrain).

The established services concentrate on information and advice on markets and supplies, processing and quality issues. EASTFISH has the additional task of making up for its members' lack of managerial expertise, particularly in the field of business procedures, price and cost calculation and the ability to prepare investment proposals, feasibility studies and business plans according to the requirements of financial institutions.

The Danish Ministry of Agriculture and Fisheries has been a long-time member institution of FAO GLOBEFISH, the unit in the FAO Fisheries Department handling issues of international trade. It became interested in the EASTFISH project and convinced the Danish Parliament to ratify a budget of US$3 480 000 to set up the new service in Copenhagen.

Starting on 1 June 1996, with a preparatory phase of ten months and an additional budget for two years to cover a staff of five professionals and five secretaries and clerks, EASTFISH is supposed to "provide an essential service for achieving market orientation and facilitating the structural adjustment of the fishery sector of Central and Eastern European countries", as the development objective reads.

The work plan of the project includes:

- Setting up National Liaison Offices
- Preparing investment profiles for fish processing industry and aquaculture enterprises
- Compiling a register of companies, traders, institutions, equipment and manufacturers
- Conducting training courses on marketing, quality control, managerial practices and investment profiles
- Promoting the production of value added fishery products
- Distributing marketing information via an electronic data bank

A major effort will be made to negotiate with the member countries the conversion of this FAO-executed project into an independent intergovernmental organization, financed by its member countries and by revenues from sales of services. INFOFISH, INFOPECHE, INFOPESCA and INFOSAMAK have all made successful transitions to independence, while maintaining links through GLOBEFISH.

# Application of a method of molecular biology (RAPD) in fish culture

L. Orbán[1], I. Magyary[2], B. Urbányi[2], Gizella. Tamás[3] and L. Horváth[2]

[1]Institute for Molecular Genetics, Agricultural Bioechnology Center, Gödöllő, POB 411, H-2101 Hungary;
[2]Laboratory of Biotechnology, Institute for Animal Husbandry, University of Agricultural Sciences, Gödöllő, Hungary;
[3]Fry Rearing Fish Farm, Dinnyés, Hungary.

## Introduction

Introduction and parallel application of the modern methods of molecular biology with the classic protocols of fish breeding offers a new route for increasing the productivity of aquaculture.
The knowledge of genetic variation is very important in fisheries management, especially in selectively bred populations. One of the ways of assessing genetic variation is RAPD (Random Amplified Polymorphic DNA; Williams et al., 1990; Welsh and McClelland, 1990), which is a special form of polymerase chain reaction (PCR; Saiki et al., 1985; Mullis and Faloona, 1987). By using one relatively short oligonucleotide primer it is possible to amplify random fragments from the genome of any species and the resulting band pattern could be used for a variety of purposes, including assessing variation.
In the present study we analyzed the breeding stock of the common carp *(Cyprinus carpio)* population of the Fry Rearing Fish Farm (Dinnyés, Hungary) for genetic variation by RAPD.

## Materials and methods

Two hundred and forty one mature common carps were individually labeled by using PIT tags (Biosonics, USA). DNA was isolated from caudal fin clips by Protease K digestion followed by precipitation in ethanol, a simplified version of the method described by Sambrook et al. (1989). DNA concentrations were estimated by comparison with standards following agarose gel electrophoresis.

The final volume of 25 ul of our RAPD reaction contained 10 mM Tris-HCl (pH 9.0), 50 mM KCl, 100 uM for each of the dNTPs (Pharmacia-LKB, Sweden), 10 pmoles oligonucleotide primer (Operon Technologies), 2.5 mM $MgCl_2$, 0.25 U Taq polymerase enzyme (Promega, USA) and 20 ng template DNA. The conditions of amplification were: 2 min. at 85 °C for preamplification denaturation, 30 cycles of 92 °C for 20 sec, 36 °C for 1 min and 72 °C for 1 min 30 sec; then 72 °C for 5 min for final elongation in a DNA Thermal Cycler (Perkin Elmer Cetus, USA). The reaction mixture was then loaded onto a horizontal gel containing 2.0% agarose (Serva, Germany) gel in 0.5 x TBE buffer and electrophoresed for three hours.

**Results and discussion**

Twenty two different RAPD primers (OPE-07, OPE-12 and OPM-01-20) were tested on twenty random DNA samples and two of them: OPM-11 and OPM-14 were selected on the basis of providing the greatest variability of the RAPD patterns produced. All of the 247 DNA samples were then individually amplified by the two selected primers. Common carp breeders were then assigned to different groups on the basis of their RAPD pattern and aimed crosses are planned for the next spawning period to assess the usefulness of the screening. According to our knowledge this is the first time, when the full breeding facility of a fish farm in Central Europe was screened by a molecular biological method.

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# HISTORICAL BACKGROUND, CURRENT STATUS AND FUTURE TRENDS OF AQUACULTURE DEVELOPMENT IN ESTONIA

T. Paaver

Dept. Fish Farming, Estonian Agricultural University, Kreutzwaldi 1, EE2400 Tartu, Estonia

Fish farming in Estonia was established by German landowners in the end of the 19th century, who introduced common carp and rainbow trout. During Soviet period (1944-1991) fish farming developed rapidly since the end of 60-s and reached its peak in 1989 with 1743 tons, which consisted mainly of common carp and large rainbow trout. During this time several large fish farms were built. In the end of the period there were over 40 fish farms in Estonia. Carp was favoured as this was the most important object of fish farming in the USSR. The rainbow trout farming developed also quickly and reached 700-800 ton per year which formed a significant part (1/3 -1/4) of the whole production of trout in Soviet Union. Estonia played especially important role in the production of stocking material of rainbow trout and supply many fish farms in Russia with eyed eggs or fry.

Estonia is a northern country where the vegetation period is short (3-4 months) and thus the water temperature is a limiting factor of fish farming. Heated industrial waters of the electric power plants were successfully used to prolong the growth period. More than half of the aquaculture production of Estonia came from the fish farms on heated industrial effluent waters, the proportion of carp coming from the heated waters reached 85% of the whole production.

Collapse of the socialist system caused decline in fish farming production. It resulted mainly from decline of production by large production units utilizing heated waters from electric power stations. Many collective farms cancelled their activities too. Sales of the fertilized trout eggs and live carp to Russia ceased.

During postsocialist period, the following trends could be followed in the development of aquaculture. All the remaining fish farms (25-30) have been privatisized. The trout farmers switched over to dry feeds imported from Denmark or Finland. The carp farmers applied lower stocking densities in order to make use of the natural food production of the ponds and decreased feeding with the pelleted feeds. As the stocking density was decreased, the production decreased too. However, demand on the carp fingerlings by the owners of small water bodies (farm and garden ponds, small lakes etc.) has increased. The fish farmers have also tried to include several new for Estonia objects of aquaculture (sturgeons, eel, crayfish, charr, grayling). The main trend has been to increase the production of juveniles of native species (salmon, sea trout, brown trout, whitefish, pike, pike perch, tench) for stocking into the natural waters. The fish farmers hoped that government, municipalities, owners of fishing rights and sport fishermen would be interested in financing the production of stocking material. These hopes have not proved to be true.

In 1995, Estonia produced 278 tons of large rainbow trout, 30 tons of common carp and 7 tons of sturgeons for consumption. For stocking into the natural waters 76 thousand juveniles of salmon, 118 th. juveniles of sea trout and 30 th. of brown trout, 63 th. juveniles and 145 th. larvae of common whitefish, 22 th. juveniles of peled whitefish, 7.2 th. juveniles and 5.1 mln. larvae of pike, 120 th. juveniles of pike perch and 25 th. juveniles of tench were produced. There were 15 trout farms, 5 carp farms and one sturgeon farm in Estonia in 1995. 4 hatcheries produced only juveniles for stocking into the natural waters.

Further development of the aquaculture is blocked by limited domestic market (small country and low income of population) and lack of access to foreign markets, especcially in Russia (St. Petersburg) which has been the traditional market for Estonian production. Lack of investments, unfavourable tax system and legislation, small amount of the production, ageing of the facilities and equipment of Soviet origin are playing their role too. The cool climate is limiting the development of carp farming. In the field of trout culture there is strong competition with Finnish production of the same type. As the fish farms are often situated in regions of untouched nature fishing tourism (pond fishing) has certainly large prospectives in Estonia. Lack of investments and high crime rate (steeling of fish from fish ponds is common) have blocked development of this sector until now.

## ORGANIZATION OF THE PRODUCTION

P. Paquotte

IFREMER, Service Economie Maritime, 155 rue J.J. Rousseau, 92138 Issy les Moulineaux Cedex, France

For Eastern European countries which have limited coastlines or which have no longer access to foreign fishing zones in Africa or Asia, aquaculture is a major issue for aquatic products supply. Following the political and economic transformations which have occurred since 1989, the fish farming production has been decreasing in most of countries of the former Eastern bloc. Meanwhile, many enterprises have been restructured and new forms of organizing the production have appeared. The transition from state-owned status to private entrepreneurship is not realised at the same pace in all the countries, but is a general trend. Not only the producers have to adjust to this new economic context, but they have to shift from production-driven to market-driven behaviour. In a context of international competition and short term economic objectives, organisation of the production is a key factor in the aim of sustainable management of aquaculture. Indeed, land and water are natural resources which have to be used with the help of common rules. Moreover, producers organisations may be very helpful to improve the marketing of the products and to make enterprises more competitive, as well on domestic markets as on foreign markets.

# LAKE OF IOANNINA RESTORATION PROGRAMME AND RESULTS

**Pashos I., Natsis L., Kagalou I.**
**Municipal Company of Lake of Ioannina**
**L.Mavili 18, Ioannina, Greece**

**Introduction:**

Lake of Ioannina «Pamvotis» is located in the Northwestern Greece, in the area of Epirus.

According to geological data it's age is estimated about 7.000.000 years old. Some general informations about the lake «Pamvotis» are presented:

- Total area : 22 km²
- Maximum depth : 9 m
- Mean depth : 4.23 m
- Total volume : $90 \times 10^6$ m³

During the past thirty years ecosystem of «Pamvotis» sustained a lot of activities, such as irrigation, deposition of sediments, input of agricultural or domestic sewages e.t.c. causing a serious problem in it's trophic state, with the following characteristics:

- enrichement with nutrients
- increased phytoplankton biomass
- reduced water transparency
- oxygen deficits
- changes in fish fauna

The aim of this study is to present the restoration programme followed by the «Municipal Company of Lake of Ioannina» and the results until now.

**Philosophy of the restoration programme:**

The philosophy of the proposed restoration programme is based on an ecological way of intervention in the lake and includes three stages.

**1est stage**

- «Strengthening» of the food chain by enrichement with special fish-species.
- Removal of the poind-sources of pollution as domestic sewages by the operation of a treatment plant unit, wastes coming from production units, waste solids e.t.c.

**2ed stage**

- Management of the lake area covered by Phragmites sp., in order to restore the natural reproduction fields.
- Step by step removal of sediment.
- Control and limitation of uses and specially of the irrigation.

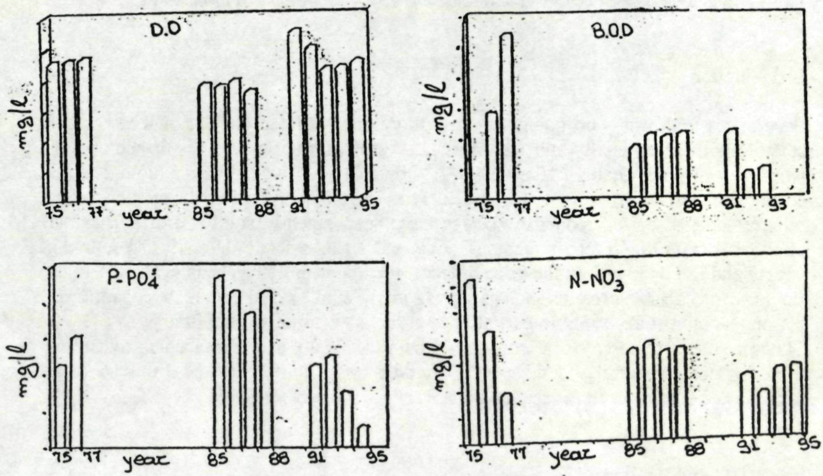
**3ed stage**

- Establishment of an environment educational centre providing informations about the lake ecosystem and generally about the catchement area.

Results:

The restoration programme (1est stage) started up in 1985-86. Next step is going to start in 1997.

In the following diagrams are presented the fluctuation of certain physico-chemical parameters (D.O., B.O.D., P-$PO_4$, N-$NO_3$):




It is obvious the improvement of these parameters especially last years. On the other hand, biological parameters i.e. zooplankton, phytoplankton and benthos species and their variation indicate that «Pamvotis» lake is an eutrophic ecosystem appearing an improvement tendency last years.

Conclusions:

- Lake «Pamvotis» is an eutrophic ecosystem. The main reason for this situation is the «non-friendly» interventions that took place in the past.
- Last years happens an obvious imporovement in it's trophic state, indeed to the restoration programme.
- Our results encourage us to continue this effort until lake «Pamvotis» becomes a healthy ecosystem.

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# FEEDING TEST OF SEA BASS (*DICENTRARCHUS LABRAX* L.) WITH FODDERS CONTAINING VEGETABLE PROTEINS.

Pelosi S., D'Adamo R., Schiavone R., Ferruzzi G.
Istituto Studio Ecosistemi Costieri - CNR - via Pola 4, 71010 Lesina (FG), Italy.
Istituto di Zootecnica Speciale - Facoltà di Agraria - Università di Pisa, Italy.

## Introduction

Several research works on intensive aquaculture have pointed out that if feeds are not suitable both nutritionally and technically, several drawbacks can result such as the worsening of water quality (Amerio, 1990). Obviously, all this has also a biological and economical impact as weight increase in farm-bred food fishes is lower. Nutritional requirements of prized food fish species have been recently studied and particularly aminoacid and protein requirements (Cowey, 1979). In order to diversify the source of supply and finally to reduce the price of feeds, the oppurtunity has been evaluated to use flours with vegetable proteins such as soya (Amerio et al., 1991) copra, rape, sunflower, cotton (Jackson et al., 1982) in partial or total replacement of animal flours.
The aim of this research work is to assess the effect of a partial replacement of animal protein flours, generally found on the market, with flour extracted from soia and decorticated sunflower in the sea bass diet.

## Materials and methods

The trial was carried out in Lesina Lagoon from April to August. 180 sea bass fry aged 14 months were used. They came from an intensive fish farm and were used to receiving artificial feeding. The fry were divided into 3 homogenous groups by age and size and placed in the lagoon for 110 days in 3 basins fenced with a 14 mm. mesh net which had a surface of 2.2 $m^2$ each and allowed a density of 27.3 individuals/ $m^2$ .
During the trial three diets were compared. The experimental diets A and B had the same composition and differed only in the type of vegetable protein flour used in an amount equal to 22.5% of total proteins. Sunflower and soya flours were milled and sifted at 300$\mu$ and micronized to make the blending with other components in the fodder easier and finally pelleted. The three diets were isoproteinic and isocaloric.
The chemical analysis of the fodders was carried out (Martillotti et Col., 1980) and the gross energy was experimentally calculated by calorimetric bomb.
The feeds were administrered twice a day in a ratio of 2% of the live weight of fish and the fodder amount was updated every 20 days. The dailly average increase, the fodder conversion rate and the protein efficiency were also calculated. The main environmental parameters, such as $O^2$, water temperature, pH and salinity were checked daily together with fish mortality. At the beginning of the trial, before the division into groups, 15 individuals were killed and weighted. At the end of the trial, 5 individuals in each group were killed and dried after spinning.
Row protein content, ether extract and ashes were determined in the dried product.

The obtained data were analysed for variance with the squared minimum method. The differences between the extimated means were assessed with Student "t".

**Results and discussion**

During the trial, the chemical and physical parameters of the lagoon had the following mean values: salinity 30.34 mg/V, temperature 22.26 °C, dissolved oxygen 7.09 mg/V and pH 8.13. The stability in water for both experimental diets was good also thanks to the adding of squid flour to the fodder, which so became appetizzed and rich in protein content. Daily weight increases (g/d) all through the trial, were 0.41, 0.46 and 0.52 for diets A, B and C, respectively.
The decorticated sunflower diet showed smaller daily increases as well as a food conversion rate (FCR), a protein efficiency (PER) and biomass increase rate (GR) lower than those recorded with soya diet and commercial fodder, even if no significant difference was noticed. As far as the final length of fish is concerned, statistically significant differences were recorded between individuals fed with traditional fodders and those fed the two other diets ($p<0.05$). The sea bass sacrificed at the end of the trial showed differences in humidity, protein content, ether extract and ashes, but these were not significant. Sea bass fed with sunflower flour, however, showed smaller amounts of ether extract than those fed with other flours.

**Conclusion**

The commercial fodder resulted to be the most appetizzed by sea bass and the best as to production performance compared to diets with decorticated sunflower flour and soya flour used with no pretreatment to improve digestibility, protein and starch bio-availability. The calories of diets A and B were low compared to commercial fodder and definitely could not provide the same production performance. However, from chemical analysis sea bass grown on the two diets with vegetable proteins showed to have less fat in the meat. This feature could be considered as an advantage from the commercial point of view particularly for sea bass grown in intensive farming.

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# STUDIES ON MODELLING OF *SPIRULINA* BIOMASS GROWTH DYNAMICS

**Ass. Prof. G.Puscasu [1], Assoc. Prof.G.Fetecau[1] , Biol. P.Puscasu[2]**
**[1] "Dunărea de Jos" University of Galati, Department of Electrotechnics, Electrical Machines and Drives, Domnească Street, 47, 6200, Romania**
**[2] School nr.1 Galati, Romania**

## Introduction

The obtaining of *Spirulina* in specially arranged "cultivators" also involves the knowledge of *Spirulina* biomass growth dynamics model. By a correct modelling of *Spirulina* biomass dynamics car be observed the influence of the parameters on biomass growth rate. The paper intends to advance a *Spirulina* biomass growth dynamics model and presents the influence of the parameters light intensity and temperature on the obtained biomass.

## Modelling and simulation of *Spirulina* biomass dynamics.

Modelling and simulation of *Spirulina* biomass dynamics is a particular case of the model which describes the quantitative aspects of biomass producing process by photosynthesis proposed by Holmberg, et.al. (1979),

The model is:

$$\frac{dX}{dt} = \mu s_m \cdot f_1(T) \cdot f_2(C)$$
$$\frac{dP}{dt} = ps_m \cdot f_3 \cdot (I) \cdot f_4(T)$$
$$\frac{dC}{dt} = as_1 \frac{dP}{dt} - as_2 \frac{dX}{dt} - as_3 \frac{dR}{dt}$$
$$\frac{dR}{dt} = as_4 \cdot X + as_5 \frac{dX}{dt}$$

where:
$X$- *Spirulina* biomass weight.
$\mu s_m$ - maximum *Spirulina* biomass growth weight rate;
$ps_m$ - maximum assimilated $CO_2$ growth rate;
$f_1(T)$ - function describing the influence of temperature on biomass growth rate ;
$f_2(C)$ - function describing the influence of substrate weight on biomass growth rate ;
$C$ - substrate weight;
$P$ - assimilated $CO_2$ ;
$f_3(I)$ - function describing the influence of light intensity on photosynthesis rate;
$f_4(T)$ - function describing the influence of temperature on photosynthesis rate;
$R$ - respiration;
$I$ - light intensity;
$as_1,...,as_5$ - parameters which depend on utilized alga;

Functions $f_1, f_2, f_3, f_4$ influence the intensity of *Spirulina* biomass growth and the intensity of the assimilated $CO_2$ . The relations which define these functions are given in the paper Puscasu (1996).It is important to be taken into account the influence of temperature and light intensity on *Spirulina* biomass obtaining process.
If the temperature and the light intensity after simulation are T=35°C respectively I=24 klucsi then are obtained the largest values of *Spirulina* biomass. If the temperature moves away from the value T=35°C then the quantity of obtained biomass starts decreasing and the duration of biomass obtaining process starts increasing .If the light intensity starts decreasing under 24 klucsi then only the quantity of obtained biomass decreases. An important result is the dependence between the obtained *Spirulina* biomass after the ending of growth process and the light intensity respectively the temperature.
Fig 1 shows in $R^3$ the dependence between obtained biomass and temperature respectively light intensity .

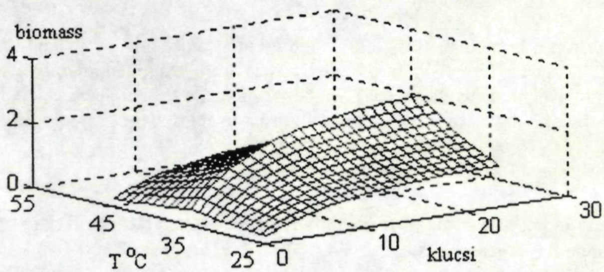


Fig. 1

It can be observed that if the light intensity starts increasing the quantity of the obtained biomass keeps constant.

**Results and discussion**

The obtained results after simulation are tightly correlated with the ones presented in literature ,Raicu et al (1990).The proposed model allows us to study the influence of all values which characterize the *Spirulina* biomass obtaining process. This model can also be used for the internal model control.

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# FUTURE TRENDS IN AQUACULTURE DEVELOPMENT IN ROMANIA

Prof.dr.eng. Mircea Rauta [1]
Dr.eng. Constantin Pecheanu [2]
Assist.eng. Cornel Ceapa [1]

[1] "Dunarea de Jos" University of Galati, 47 Domneasca Str., RO - 6200, Galati, Romania
[2] Fisheries Research Centre of Galati, 2 - 4 Portului Str., RO - 6200, Galati, Romania

The aquaculture in Romania is having a valuable and long experience, gained through a sustainable activity along the time.

Certainly, the main branch in this field is represented especially by fishculture. The other aquatic products (crayfish, frogs, snails etc.) were exploited mainly from the natural waters (rivers, canals, lakes etc.), in the last decades the productions decreasing due of damming and drainage works realised in order to enlarge the agricultural lands.

Fisheries' patrimony of Romania consists nowadays of:

- 300 thousand ha. of natural lakes, including the lakes from Danube Delta.
- 99 thousand ha. of reservoirs.
- 100 thousand ha. of fish farms, from which:
    - 84.5 thousand ha. of commercial fish farms.
    - 15.5 thousand ha. of hatcheries.
- 60 ha. of trout farms;
- 66 thousand km of inland rivers;
- 1 075 km of Danube on Romanian territory ;
- 25 thousand $km^2$ Exclusive Economic Area at the Black Sea.

Of this patrimony the obtained productions were, in the last two decades, over 70 thousand tones fish annually, the maximum being obtained in 1988, respectively 77.3 tones fish.

Adding at this the almost 150 000 tones fished annually by the Romanian long distance fleet this assured a fish consumption of 9-10 kilograms per capita.

In the same period can be emphasised some quantities of crayfish and frogs, captured especially from Danube Delta and rivers meadows, but which are not included in the statistics.

After 1990, beginning with the transition process from centralised to market economy by political, social and economical structural changes it was registered a visible falling of fish production. During the period 1991 - 1993 the inland fish production decreased at about 30 - 32 thousands tones annually, while the activity of Romanian long distance fleet stooped.

In 1994 and 1995 was observed a slightly straightening of the fish production, the production obtained in 1995 being about 38 thousand tones.

Can be noticed the efforts of the fisheries research capacities to shift the inland production from extensively using of the chines carps to the increasing of the weight of valuable species (carp, predators, sturgeons), due of local market demand. The aquaculture is also supporting the restocking programs for natural waters and breeding of endangered species in order to decrease the market pressure on such species.

In Galati and Danube Delta areas there are tryings to develop crayfish and frogs breeding capacities for local market and exports since at the Romanian seaside and lagoons breeding valuable species as shellfish, turbot, grey mullets etc. seems to offer a lot of opportunities.

By setting up the National Agency for Fishculture, Fishing in the Natural Waters and Fish Stocks Protection it was created a proper organisational framework and the closely approval the Fishculture and Fishing Law in the Romanian Parliament will assure the legal framework for developing this economic field.

In the short and medium term strategies for developing the fisheries in Romania are stipulated as main objectives the following:

- stimulation of privatisation process;
- financially supporting of fisheries by subsidised loans and other facilities;
- stimulation of introducing new valuable species;
- stimulation of using modern technologies and equipment;
- supporting the restocking activities of the natural waters;
- stimulation of production and exploitation of other live aquatic resources than the traditional ones;
- supporting the reaching of international standards for quality.

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# ABNORMALITIES OF CULTURED *MYTILUS GALLOPROVINCIALIS* IN THE BLACK SEA

N.K.Revkov and V.K.Machkevsky

Institute of Biology of the Southern Seas, Nakhimov Av.2, Sevastopol, 335011 Ukraine

## Introduction

In 1993 in Kalamitsky Bay (the Black Sea, Western coast of Crimea) on mussel collectors, the mussel *Mytilus galloprovincialis* with sign of "senile growth" (Zolotarev,1989) were met (hereinafter - "defective" mussels). In some shell parts some mussels have periostracum "stitched" to mother-of-pearl layer. The defective mussels densly covered the sites of linear collector of length 3-10m and firmly kept themselves on substratum. Beside them there were normal mussels on continuation of collector. Mean length of defective mussels is 30-40cm, and average age of 1.5 year.

## Materials and methods

The defective and normal mussels were compared on the basis of relative area of gills surface (Sg), relative length of ligament (Kl), relative area of back adductor section (Sr) and extent of byssus trunk development (the relation of byssal trunk diameter in its root part to length of shell):
$Sg=\frac{So}{Sb}$ ; $Sr=\frac{Sm}{Sb}$ ; $Kl=\frac{l}{L}$, where So - area of gill projection in saggital plane, Sm - area of back adductor section in saggital plane, Sb - area of shell projection in saggital plane, l - length of ligament, L - length of shell.

The comparative analysis of body chemical structure of both defective and normal mussels (the last one from adjacent sites of collectors) is executed. Physiological condition of defective mussels was evaluated in natural experiment based on degree of mussels resistents to invasion of *Parvatrema duboisi* Bartoli, 1974 (*Gymnophallidae*) trematode cercariae.

## Results and discussion

The availability both of morphological and functional deviations in defective *M.galloprovincialis* is established. Some (72%) defective mussels had reduced sites of gills near siphonic orifices area. Despite of gill plates reduction, relative area of gill of defective mussels was equal to 0.313. It was close to silt forms of *M.galloprovincialis*, but was more, than this of rocky forms (Zaika et al., 1990). Both the reduction site of gill and shell edge with sign of "senile growth " are in area of siphonic orifices. It permits to speak about inhalant siphon as the main channel for the effect determining the observed changes.

The "weak" back adductor (Sr=0.020) in defective mussels is opposed to good advanced ligament (Kl=0.514). Their development in rocky and silt forms of *M.galloprovincialis* is evaluated correspondingly: Kl - 0.510 and 0.380, Sr - 0.043 and 0.027 (Zaika et al., 1990 ). Relative diameter of byssus trunk of defective mussels (0.026), exceeds this of rocky (0.02) and silt (0.010) forms as well as of normal *M.galloprovincialis* from collectors with various degree of silting (0.012-0.019).

The conditions of inhabitation which caused changes in development of morphological structures, defined an increased physiological immunity of mussels to invasion by *Parvatrema duboisi* trematode cercariae. After 7-th months of exposition mussels were for 100% invaded by cerkaria, but with various degree of intensity. The density of metacercariae hemipopulation in pen with defective *M.galloprovincialis* has appeared 1.9 times lower than at control ones.

In body of defective *M.galloprovincialis*, in comparison with control we also revealed more carbohydrates (the main energy producing material of mussels) and energy-capable lipids. Two-times reduction of RNA and DNA and 20% increase of karotinoid quantity is found. It testifies to an influence of some unfavourable factors. As a result of more intensive process of lipolysis an increase of relative quantity of products of triglicerid desintegration is marked.

Wide scale of displayed deviations from "normal" mussels development makes it difficult to unequivocally interpret the received data. The primary disturbances of mussels condition, causing secondary demonstration of deviation from norm and unequivocal judge about first-reason of changes appear impossible to be allocated. In any case the detection of subpopulation of abnormal *M.galloprovincialis* forms, especially on site of its mass cultivation, is interesting.

**Acknowledgements**

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## MUSSEL CULTURE AND ITS PROSPECT IN THE NORTH-WESTERN RUSSIA (WHITE SEA)

I. A. Sadykhova
Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), 17, V.Krasnoselskaya st., 107140 Moscow, Russia

Cultivation of sea mussel, Mytilus edulis, L in the White Sea is new industry. It has developed in region with depleted inshore fisheries. In 1985 commercial mussel farm was organized by Federal Fisheries Association in the South-Eastern part of Kandalaksha Gulf—Sonostrov, Karelia. Scientific investigations on water quality, prime production, hydrochemistry and hydrodynamic had been carried out by VNIRO. Accordingly to the results 15 cultivate sites in four bays were chosen. The long line system has been used with some adaptation throughout the region. Larvae settlement is very high in the White Sea. Spat attached in July continues to develop and to grow on the same rope collectors. A 3 meter collector should yeld 15-17kg of market sized mussels in 3-4 years, or 20-25kg of geterosized mussels in 2 years (Sadykhova, 1991). The combine production varies from 500 to 700 tones depending on climat conditions.

The harsh winters with long ice period and severe autumn storms are the most serious problems in this region. That's why some biotechnical improvements are constantly made by VNIRO scientists.

The study of the marketing problems shows that cultivated activity should be concentrated on getting mussel raw material for acid hydrolyzate production. This hydrolyzate is in a great demand both as a food supply and some kind of treatment for Chernobyl and other areas with unfavourable ecological conditions. It is found out that mussel hydrolyzate increases the resistance of human organism to various tocsicants and to ultra-violet rays. It was also shown (Bichurina, 1995) that its medicin derivate — VYRAMID has very strong antivirusus activity (influenza virusus of 3 common types, gerpes virus and some others). Recently it was proved that VYRAMID induces gamma interferon formation in human blood.

Now mariculture department of VNIRO starts to collaborate with technological Association EKOS (St.Peterburg) in the field of mussel processing plant creating for wasteless production of medicine hydrolyzate.

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# POND FISHFARMING : A TOOL FOR RURAL MANAGEMENT AND DEVELOPMENT

O. Schlumberger[1], N. Cadic[1], M. Sagliocco[1], J.P.Proteau[1], and J. Y. Allard[2],

[1] Freshwater Aquaculture and Fisheries Division, CEMAGREF, BP 5095, 34033 Montpellier, France
[2] IDEE engeneering service, 98 rue du Dr. Barraud, 33000 Bordeaux, France

## Introduction

Semi-intensive and intensive pond-fishfarming has developped in some regions of France. The objectives are to improve the global income of land-owners or farmers and maintain a socio-economical web in depopulated rural areas.

## Semi-intensive production

Initialy, in 1986-87, public funds were obtained to assess the potential for fishfarming after the rehabilitation of the ponds in the Aquitaine Region. Then, the structures were improved (construction of access roads, external fishing-ditches,...), technical and scientific assistance was provided by the CEMAGREF for pond management (water chemistry and plankton controls, fertilization, fish production). Market studies showed that there was a good opportunity to produce species having a high market price to supply the needs of the local Fish Anglers Associations for restocking purposes.
As the demand for common carp (*C. carpio*) is low, original combinations of fish species have been tested and developped in relation with the typology of the ponds : roach (*R. rutilus*) + tench (*T. tinca*) associated with pike (*E. lucius*) or pike-perch (*S. lucioperca*), respectively in shallow or deeper ponds. In case of sandy bottom, the tench is replaced by the gudgeon (*G. gobio*). Experiments are under way to include the black-bass (*Micropterus salmoides*) or the crayfish (*Astacus leptodactylus*) in new polyculture schemes. The fertilization of the ponds is standardized and from 50-80kg/ha, the production is usually now between 400 and 500kg/ha/year (CARA-CEMAGREF, 1992), the value of the fish being a more important factor than the yield (net income : 1 000-2 000US$/ha/year, the construction costs being allready redeemed ; Giraud et al. 1996). The production from the 220 ponds is collected to a central station where the fish are stocked and sold. Markets for consumption are now prospected.

## Intensive production

Research work made by the CEMAGREF (1988-90) on the artificial propagation and on-growing of the european catfish (Wels ; *S. glanis*) demonstrated the interest of this species for intensive production in ponds (Proteau and Thollot, 1988). Simultaneously, market studies showed that this fish could be of interest for the agro-industry owing to the quality of the meat. Two Regional Directorates of Agriculture decided to promote the intensive production of this fish to re-activate the traditional local pond production, traditionally based on common carp. In these Regions, a research and demonstration

aquaculture station was built, and extensionists helped the new producers. Financial support was obtained from the french Ministry of Agriculture and the European Union.
Investments were made by the agro-industry and feed-manufacturers to integrate the whole activity, including hatcheries, on-growing fishfarms, slaughtering and filetting plants.
New production methods have been developped either in ponds, similar to the cat-fish (*I. punctatus*) production ponds in the USA, or in intensive structures with recirculation of water after lagooning (Martin, 1994). Such growing systems save water and have no polluting effluent. Two sites use geothermal water at 25-27°C.
For maket-size fish (1-2kg), the production cycle in ponds is 3 growing seasons (water temperature higher than 15°C for 150 days/season). This could be shortened to 2 seasons when out-of-season artificial breeding techniques will be transfered in 1996 to the private hatcheries by the CEMAGREF scientists.
In 1995, about 30 fishfarms produced 310t of European Catfish in France

## Conclusion

Traditional fishponds can be valorized through « new » productions and localy compete economically with other agricultural products. Some prerequisites must be associated for a successfull operation : markets, political will, technical and scientific assistance, implication of the concerned fishfarmers and coordination of their activities.

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# CONSTRUCTION PRINCIPLES OF RECIRCULATING AQUACULTURE SYSTEMS

C. Schuster and H. Stelz
Institute of Anatomy, Physiology and Hygiene of Domestic Animals, Department of Animal Hygiene, University of Bonn, Katzenburgweg 7-9, D-53115 Bonn, Germany

## Introduction

There are two different, initial stages to design a recirculating aquaculture system:
i. Will it used for special scientific investigations or
ii. will it used in a commercial way.

Table I. First basicley considerations of system design

| **I. using in a scientific way** | | **II. using in a commercial way** |
|---|---|---|
| to reduce the amount of make up water | | to intensify the exploitation of production factor water |
| ➔rearing fish independent of locational factors | | ➔to produce warm water species |
| • to have fish available | | • product value |
| • growing studies | | • production costs |
| • digestibility studies | | production reliability |
| • infection studies | | costs of energy |
| • studies with radioactive marked substances etc. | | available knowledge about recirculating systems etc. |
| ➔to design biotic and abiotic factors for special aquatic environmentals | | ➔asaisonal reproduction |
| • stress studies | | • using different light/ temperature conditions |
| • immunological studies etc | | • to get a special hygienic status ect |
| **evaluation of research** | **investment overheads** | **calculated profit** |

## Basis of construction

Normally, recirculating aquaculture systems are inhousing systems because its water is a nutrient solution for alga and an ideal culture medium for disease-causing agents. Environmental demands of the choosen fish species in combination with the calculation intensity of stocking and feeding as well as the composition of the fishfood are the basis of further decisions (Pfeffer, 1993; Schuster, 1994).

Table II. Conception of decisions (examples)

**quality/quantity of system water** **quality/quantity of make up water**

↓

→ stocking density/feeding intensity/feed composition

→ maximum/minimum concentration of excreted substances in fish ponds

• quality/quantity of outlet water

↓

→ unsolubled substances

• organic, suspended solids

sedimentation/flotation/filtration

utilisation: fertilizer/denitrification

treatment: aerobic COD reduction

→ solubled substances

• gas (effects of respiration: $CO_2$ and $O_2$)

aeriation systems

$CO_2$ stripping

$O_2$ accumulation

• nitrogen compounds (products of utilisation: $NH_4$/$NH_3$)

nitrification systems

$NO_3$ accumulation

$H^+$ accumulation

stabilisation of pH-value has to be

reduction of $NO_3$ concentration has to be

with the amount of make up water

with the amount of buffer

with denitrification

denitrification systems

using intern and extern organic carbon

**quality/quantity of system water**

## Conclusion

This construction concept is one important part of a general aquaculture management system. Other elements are:

i. the hygienic strategies (Schmitz-Schlang, 1992)

ii. the reliability on the system's performance

iii. and - marketing (for commercial systems) (Bächtiger, 1988).

## References

are available by the authors

# APPLICATION OF IMMUNOSTIMULANTS IN PROPHYLACTIC AND THERAPY FISH DISEASES -ECOLOGICAL AND ECONOMICAL ASPECTS

A.K. Siwicki[1], D.P. Anderson[2] and M. Studnicka [3]
[1] Fish Pathology and Immunology Research Lab. IFI, 05-500 Piaseczno, Poland
[2] Salmon Bay Biologics and Consulting, Seattle, WA 98107, USA
[3] Department Biology and Toxicology, Catholic University Lublin, Poland

## Introduction

The application of immunostimulants in fish culture for prevention of diseases is a promising new and important development. In general, immunomodulants comprise a group of biological and synthetic compounds that enhance the nonspecific defense mechanisms and specific immune response in fish. Immunostimulants heighten the cellular and humoral defense mechanisms in fish, which induces a generalized protection. This protection may be particularly important for fish that are raised in or released to environments where the species or serotypes of pathogens are unknown and immunization by specific vaccines may be futile. Also substances for treating fish diseases include antibiotics, drugs and chemicals such as those used for sterilizing fish-holding ponds. While each therapeutant is at least partially effective in the treatment of a particular disease, problems arise with accumulation of these substances in the environment as well as the emergence of resistant pathogenic strains when using antibiotics. In the past, the immunological approach to preventing infectious diseases has been by vaccination against specific pathogens. But sometimes, the vaccines are not economically effectiveness. Fish depend more heavily on nonspecific cellular and humoral defense mechanisms than do mammals. This is especially true for short-lived fish living in cool or cold waters because the development of a specific immune response is temperature dependent. Similar to mammalian models, several drugs and natural products have been shown to be effective in stimulating cellular and humoral defense mechanisms in fish (Siwicki et al. 1994).

In the several studies we evaluated twelve new immunostimulants which were chosen primarily because they are derived from substances that are closely related to natural products. The effects of this drugs on the nonspecific cellular and humoral defense mechanisms and specific immune responses were studies after application by intraperitoneal injection, immersion and *per os*. Also the fish were then challenged by bath or intraperitoneal injection exposures to pathogens (bacteria or virus), and mortality patterns were observed and documented.

## Materials and methods

**Fish.** Rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), sea trout (*Salmo trutta*), carp (*Cyprinus carpio*) and european catfish (*Silurus glanis*), stock hatchery fish, weighing 50 to 200 g, from a disease-free population were used in experiments of this study.

**Immunostimulants and vaccine**. In the experiments the following immunostimulants were tested: levamisol, glucans, chitosan, Evetsel, FinnStim, *Saccharomyces cerevisiae* yeast, *Candida utilis* yeast, *Propionibacterium acnes*, nitrogranulogen, ceromangan, isoprinosine and dimerized lysozyme (KLP-602). For study the specific immune response, the O-antigens *Yersinia ruckeri* and *Aeromonas salmonicida* and Yersivac were used.

**Immunological assays and challenge tests.** The following assays were run: leucocyte numbers, phagocytic ability of neutrophils, phagocytic index, respiratory burst activity of PMN and MN cells, potential killing activity of phagocytes, myeloperoxidase production of PMN and MN cells, lysozyme activity, CRP and ceruloplasmine levels in serum, antibody secreting cells, and plasma immunoglobulin levels. A disease challenge test using *Aeromonas salmonicida* and Infectious Pancreatic Necrosis virus were conducted. The fish were given single intraperitoneal injection or were immersed for 1 min in a dilution of suspension of a bacteria cells, and were given single intraperitoneal injection of a IPN virus in medium. Mortalities were tabulated and collected and the presence of pathogen was confirmed by isolation from the kidneys of fish.

## Results and discussion

The results of these experiments demonstrate that immunostimulants applicated by injection, immersion or in diets stimulated nonspecific cellular and humoral defense mechanisms and specific immune response. The single injection, immersion induced short-term protection against bacterial and viral diseases (Anderson and Siwicki, 1994). Cumulative mortality were lower (30-40%) in fish fed the dietary treatments containing immunostimulants (Siwicki et al. 1994). Dietary intake of immunostimulants by fish for the prevention of diseases has definite advantages in large-scale fish culture. In fish farm and hatcheries containing millions of young fish, individual injections are very expensive. Immersion, bathing and shower techniques are very effective in fingerling, but also costly and involve handling, causing stress. Incorporating an immunostimulant in the feed may be the best way of presenting it to fish.

To the best of our knowledge, this is the first time fish given immunostimulants in feed or immersion have been tested for changes nonspecific defense mechanisms and the changes in these mechanisms correlated with protection against diseases. The fact that we can use specific nutritional supplementation to manipulate the immune response over and above simply providing sufficient vitamins, proteins, and calories in the diet opens a whole new vista for immuno-nutrition collaborative research.

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# THE DYNAMICS OF THE ROACH'S (*RUTILUS RUTILUS CARPATHOROSSICUS* VLADICOV 1930) NUTRITION FROM THE RAZELM ECOSYSTEM

Stancioiu S., V. Caruntu, I. Metaxa

Fishing and Aquaculture Department, "Dunarea de Jos" University, Str. Garii, nr. 61-63, 6200-Galati, Romania

## Introduction

The Razelm Ecosystem underwent changes because man activities that influenced the hydrochemical conditions of the Razelm Ecosystem with implication on ichthyofauna structure and diet.

The roach (*Rutilus rutilus carpathorossicus* Vladicov 1930) is one of the species who are important from industrial fishing point of view in Razelm Ecosystem. For this reason we tried to find out what is her diet in the last two years when the ecological conditions from the Razelm Ecosystem kept on change.

## Materials and methods

To assess the dynamics of the roach (*Rutilus rutilus carpathorossicus* Vladicov 1930) nutrition from the Razelm Ecosystem we studied 43 exemplary that were fishing each month between May and September in the last two years. We extracted the gut and analysed from quantitative and qualitative point of view the content of the gut at all exemplary fished. The study we made for each age and sex of the fish. For assess we based on frequency of the each organism that we found on the binocular and than on the microscope. We made and used a frequency scale with 5 frequency levels.

Also we analysed the plankton and bentos that were harvest in the same time and from the same places with fishes for correlate the nourishing components from the fish gut and the other from the natural environment.

## Results and discussion

First, in each month the fish were group on age and sex classes to have in view the possible differences of the nutrition dynamics for each age and sex. The results show that in the roach's gut stood out in finding frequency order the following organisms: molluscs (*Gasteropoda, Lamellibranchiata*), crustaceans (*Copepoda*), algae, crustaceans (*Cladocera*).

In all vegetative season we observed in the roach gut the constant presence of the molluscs, crustaceans (*Copepoda*) and algae. Also we found out a small difference between nutrition of different ages. Thus, the young exemplars (1-2 years old) used in their diet mainly the crustaceans (*Copepoda* and *Cladocera*) and the adults (3-5 years old) used in their diet mainly the molluscs (these found out in the roach gut in percentage until 95%).

**Conclusions**

Roaches from Razelm Ecosystem, in the last tow years, seem to have mainly a preference in their nutrition dynamics for molluscs (*Gasteropoda, Lamellibranchiata*). Also we found out that the roaches use very well the bentonical organisms and the organisms on the aquatic vegetation and the dynamic of the roach's nutrition depends on age, sex physiological moment, the existence of the nourishing organisms in the roach's environment.

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# TECHNOLOGICAL ASPECTS RELATED TO BREEDING CYPRINIDS IN THE FIRST SUMMER

Stancioiu Soare, Metaxa Isabelle, Panaitescu Madalin

"Dunarea de Jos" University of Galati, Fishing and Aquaculture Department
Garii Str., Nr. 63, RO - 6200 Galati, Romania

## Introduction

The scientific research and the productive practice show that for rearing fish species in polyculture system, in the first year, we can achieve highest productions on some surfaces, only if there is a correlation between fishing material density, the adequate breeding conditions and the supplementary feeding.

Because in the first vegetative period, at the beginning stages of rearing (first summer), many species are using the same food (natural food, especially phytoplancton) and on the other hand between them it is a permanent competition, it must be a presume proportion for the species breaded in polyculture system. The species must be chosen so that this proportion do not have a significant influence for the growing rate in this period.

## Materials and Methods

In the experiment we used a fishpond with the surface of 25 hectares, which was populated in polyculture system with cyprinids. There were studied the trophyc components used by the carp, grass carp and big head during the vegetative time.

The pond was stocked with fingerlings obtained by natural and artificial reproduction. In order to do a comparison between trophic elements growing in fishpond and the elements occurred in fish alimentation, in the same time we made analyses of planctonic samples.

Qualitative and quantitative analyses were made for both intestine content and plankton samples, concerning the following objectives:

- natural food consumption;
- fodder's consumption;
- the competition at the artificial and natural food;
- length and weight rearing rate of fish during the vegetative period;
- survival parameters at the end of breading period.

**Results and Discussions**

After the analyses of food consumption for all three species there were obtained the following results:

- for carp were identified 45 planctonic taxons from which 37 phytoplanctonics (82,2 %) and 8 zooplanctonics taxons (17,3 %), among these existing some differences by the point of view of number of individuals and meeting frequency during the rearing period; in the analysed samples was also found fodder;
- for grass carp the number of planctonic taxons was 37, from which 33 phyto-planctonics (89,2 %) and 4 zooplanctonics taxons (10,2 %). The number of taxons decreased from first to last sample (from 35 to 15 taxons). Macrophyte vegetation components (remainders) and artificial food represented the main content of intestinal tractus for the grass carp;
- for big head was established the existence of 46 planctonic taxons with domination of phytoplanctonics (44 taxons - 95.6 %) and 2 zooplanctonics taxons (4,4 %) with a lower frequencies. Also there were found artificial food and organic matter in low quantities and with reduced frequency.

Concerning all three species it was observed that:

- ♦ there is an appreciable competition in the phytoplanctonic consume, especially in first stage of breeding;
- ♦ it was not observed any competition concerning the use of zooplanctonic organisms, the carp being the lonely species in which spectrum dominated those organisms both as frequency and as number;
- ♦ it was observed an active competition for artificial food between carp and grass carp during the rearing period;
- ♦ it was found more macrophyte vegetation (remainders) in the digestive tractus of the grass carp comparing with the carp, without an effective competition, and concerning the organic matter the situation was the opposite.

**Conclusions**

By the present research it was established the trophic regime (natural and artificial food), for fish species breaded in polyculture system and the dynamics and frequency of taxons in food during the rearing period.

It was also determined the growing rate during the vegetative period and the ways to improve the breeding parameters.

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# START-UP AND MANAGEMENT OF BIOLOGICAL FILTRATION IN A CLOSED MARINE RECIRCULATING AQUACULTURE SYSTEM

H. Stelz and C. Schuster
Institute of Anatomy, Physiology and Hygiene of Domestic Animals, Department of Animal Hygiene, University of Bonn, Katzenburgweg 7-9, D-53115 Bonn, Germany

## Introduction

The reuse of water in recirculating aquaculture systems is mostly based upon biological purification. First step is the oxidation of the $NH_3$ excreted by fish via $NO_2^-$ to $NO_3^-$ (nitrification), and the second step embraces the reduction of $NO_3^-$ to gaseous nitrogen compounds (denitrification) to stabilize $NO_3^-$-content and pH-value of the rearing-water. Biological filtration has to be activated before the system is stocked In saltwater, the conditioning-period is at least 5 weeks up to several months until nitrification shows a sufficient performance.
The aim of this study was the examination of the effectiveness of different techniques of conditioning bio-filters and the management of the system to maintain the required water quality.

## Material and Methods

Saltwater (salinity 30-35‰) was produced by adding artificial sea-salt (Dohse-Aquaristik) to tap water. Rainbow trout (*Oncorhynchus mykiss*) served as reference animal.

## Start-up of Biological Filtration

On principle, three different techniques are used to start-up nitrification:
<u>I. Self-settling:</u>
The presence of $NH_3/NH_4$ in the system water leads to an increase of this ubiquitous nitrifying bacteria until a sufficient filtration perfomance is achieved. Using this technique, the conditioning period in marine systems is 35 up to 280 days (Forster, 1974; Hirayama, 1974; Bower and Turner, 1981; Nijhoff and Bovendeur, 1990).
<u>II. Inoculation:</u>
This technique includes all kinds of adding nitrifying bacteria to new systems. The using of commercial additives (Bower and Turner, 1981) or sludge of the wadden sea (Nägel, 1976) didn't decrease the time required to start-up nitrification. Best results ( 4 days) were achieved by seeding with filter media from established systems (Bower and Turner, 1981).
<u>III. Adaption of freshwater nitrifying bacteria to saltwater:</u>
<u>IIIa stepwise:</u> This method was confirmed by Rosenthal and Otte (1979) and Nijhoff and Bovendeur (1990), increasing salinity in 2‰/d up to 8‰ or in 3.5‰/d up to 17‰, respectively.

IIIb in a single step: This technique is discussed contradictory. Kawai (1964) as well as Bower and Turner (1981) dispute it, Nijhoff and Bovendeur (1990) recommend it to accelerate the conditioning period.

## Results

In own experiments (Stelz et al., 1995) the method of stepwise adaption of freshwater bacteria to saltwater was cancelled, because a salinity of 12‰ or 28‰, respectively, led to an inhibition of nitrification. According to Nijhoff and Bovendeur (1990), the salinity change in a single step showed best results. After 5 days the perfomance of the nitrification unit was the same as before in freshwater.

## Management of Biological Filtration in Saltwater

Some aspects have to be regarded to maintain performance of filtration:
Conditioning nitrification and denitrification simultaneously by adding $NH_4HCO_3$ and $CH_3COH$ to the system water is advantageous:
- start-up period is decreased
- mechanical filtration of suspended solids by the biomass in the denitrification unit
- reduced risk of fluctuating pH-values and $NO_2$- accumulation caused by uncontrolled denitrification.

pH-value of the system water should range above 7; below 7 there is a risk of inhibited nitrification and increased water losses caused by foam.

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# THE USE OF ACCESS DATABASE AS A TOOL FOR PLANNING IN AQUACULTURE AND FISHERIES

Cristian Stoicescu[1] and Alan Bourne[2]

[1] KHF Fisheries Project , Bd. Carol I, sector 1, Bucharest - Romania
Address for correspondence: Fish Culture Research Station Nucet - 0230 Nucet - Romania
[2] Natural Resources Institute, Central Avenue, Chatham Maritime, Chatham ME4 4TB, U.K.

## Introduction

The Romanian fish farming sector comprises about 300 fish farms, grouped in 38 state owned fisheries companies. The total pond area is about 100 000 hectares. Most of the fish farms were designed and built after 1965, to replace the natural lakes, ponds and wetlands from the lower Danube valley, which had been drained and transformed into agricultural fields in 1950-1965. In the last 6 years the fish production dropped drastically, as a result of the general economic climate, technical and managerial limitations.

One of the main problems in sector planning and management in Romania is the lack of management information at all levels. Although the former central structures of the fisheries sector collected files concerning the fish farms, most of this information is not readily available or is not reliable (especially the production figures and the cost/revenue data). The continuous decline of fish production after 1989 made obvious the fact that the present structures are not functional any more in the new economic environment. Restructuring became one of the main goals of the Ministry of Agriculture. Thus, the need for collecting up to date information on fish farms and fisheries companies came into focus.

## Methods and time table

The survey was designed by British consultants and Romanian specialists, during a three week period; major changes and improvements were made, so that by the end of the initial stage the questionnaires were ready field tested. In the period May-September 1995, 143 fish farms were visited by the five survey teams. The survey team members were 12 Romanian fisheries specialists, some of whom were farm managers or had had this experience in the past. A three week period was used to refine questionnaire forms proposed by the British specialists.The survey database was designed on the basis of the questionnaire forms, using the Microsoft ACCESS® software. ACCESS® was selected because it is a powerful, user friendly database management system, providing tools for rapid establishment of ready to use databases. The facilities provided make the use, updating and data reporting easy. The data or queries can be exported to EXCEL®, so that the data analysis is accessible. Compared to a custom database, an ACCESS®database is much easier to use. Last, but not least , the availability and the cost of the software make it very accessible to the user.

### The Fishfarm Database

The database is a relational one, more complicated than a simple "clients-sales" database, because of the great number of tables and fields. The number of records is limited, the basic unit being the fish farm (the main primary key is the Farm ID). The main table in the database is named "Farms", comprising general information on each fish farm. The main input form is similar to the questionnaire form used at the interviews, this making the input and checking of data easier.

### Results and discussion

The survey could be considered an important step forward, considering the fact that 143 fish farms were visited in a relatively short time. Although during the field survey some of the initial questions proved to be inappropriate or impossible to answer at the farm level, an important amount of information was collected for each fish farm, including farm managers opinions on different technical or economical aspects and their options on restructuring. The professional background of survey team members (fisheries specialists) proved to be essential for the survey. Data analysis was carried out, in order to outline some general and regional patterns and to provide an initial background for discussion. The analysis lead also to further changes in the questionnaire forms and the database itself, in order to increase the efficiency and accuracy of data collecting. These changes and the experience gained by the interviewing teams will reduce the time needed to complete the second part of the survey (the summer 1996).

### Conclusions

The fish farm database and the data analysis are available to ministry officials and to professional organisations in the sector. As restructuring and/or privatisation is approached, the database will be used as one of the information sources. The methods and the database can be easily adapted to the capture fisheries. One of the main benefits of this survey is the experience gained by the participating Romanian specialists.

**Note:** The use of any software product is not intended to imply any endorsement by the Know How Fund.

# RESEARCH AND EDUCATION IN CROATIAN FRESHWATER AQUACULTURE

Tomislav Treer, Ivica Anicic, Roman Safner, Andrea Kolak

Department of fisheries, beekeeping and special zoology, Faculty of Agriculture, University of Zagreb, Svetošimunska 25, 10 000 Zagreb, Croatia

## Introduction

The situation in Croatian freshwater aquaculture follows the one in Central Europe. In few years the production dropped down to only 40% (Table I). The war, which affected great part of the country, was only one of the reasons. The others include difficulties in economic transition, the loss of the market in former country and other countries. There were also significant losses of fish due to the cormorants (*Phalacrocorax carbo*). The technology on carp farms turned almost entirely to the extensive way. Very low imputs resulted in low production that could support only small number of employees. Consequently, those facts reflected upon research as well as on education.

Table I: Production of freshwater fish and the area of fish-farms in Croatia (according to Croatian Department of Statistics)

| Year | Production (tonnes) | Index | Carp farms (ha) | Trout farms (m2) |
|---|---|---|---|---|
| 1990 | 14 919 | 100.0 | 12 234 | 32 508 |
| 1991 | 8 840 | 59.3 | 8 540 | 24 860 |
| 1992 | 9 187 | 61.6 | 10 212 | 7 066 |
| 1993 | 8 184 | 54.9 | 12 811 | 36 143 |
| 1994 | 7 340 | 49.2 | 12 742 | 27 893 |
| 1995 | 6 044 | 40.5 | 12 713 | 26 093 |

## Research and education

The present situation in freshwater aquaculture influenced the change in the course of the research. The environmental aspects of aquaculture have been regularly investigated for years, but their significance is now even more stressed. The possibility of processed carps being sold seems promising and part of research is concentrated on that with particular stress on various aspects of carp dressing percentage of several important cultured carp populations. These populations are also compared within population genetic aspect. Some genetic engineering research is also being done, particularly on salmonids (Teskeredzic et al. 1993). Partly replacing common carps with other, more valuable fish species could be helpful, too. The use of growth promoters in food for such fish species is being considered in Croatia recently (Anicic et al. 1995). Also, the nutrition values of fish meet is being more stressed than before. The problems of fish farms transition point out the importance of socioeconomic aspects, too, although not much has been done in this field so far.

Fishery education in Croatian freshwater aquaculture has a long tradition. Nowadays, Fisheries as a subject is tought at the Agricultural faculties of Zagreb and Osijek, as part of the study for B.Sc. degree in agriculture. It includes both, aquaculture and management of open waters. There is also a special study of marine fisheries in Split, while Fish pathology is a subject at the Veterinary faculty also in Zagreb. Faculty of Agriculture in Zagreb offers postgraduate studies in fisheries - both for master and doctoral degree. Master degree is organized during two years of study held by many fishery experts from Croatia and several from abroad. Only a small number of people studies fishery science in Croatia and this type of education is done through consultations and practical work in scientific institutes.

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# THE PROTECTION AND THE EXPLOITATION OF FISH FAUNA FROM UPPER SECTOR OF ROMANIAN DANUBE RIVER

G. Vasilescu and L. Florea

"Dunărea de Jos" University of Galaţi, Aquaculture and Fishing Department, 63 Gării str., 6200 Galaţi, Romania

## Introduction

The lower sector of the Danube river, which crosses and delimits the Romanian land for 1075 Km, had from oldest period and has also in present the most richest ichtiofauna (from the qualitativ and quantitative point of view ) from the whole hidrografic basin. This fish fauna has a high economic and scientific importance.

During the years importantes changes happened to ecological and bioeconamical aspects of lower Danube river ecosystems because of the modifications done by natural evolution on one side but especially, in the last period, on another side.

The building and the making in function of the hydroelectric barrages: Iron Gate I (1970) and Iron Gate II (1984) transformed a tronson of the Danube river (km 843- km 1075) from a running ecosystem (river) in two barrages -lakes ecosystems (lake-river) where is created sthagnophilies conditions, differences to rheophilies conditions that has been before the damming.

## Materials and methods

- The study of references about fish fauna of the Danube river;
- The analysis of some hydrological, meteorological and fisheries dates about the upper sector of Romanian Danube river;
- Experimental fishing and the informations from fishing men from this region;

The direct observations on field during the whole year but especially in the spawning period of fish whit economic value.

## Results and discussion

In not damming conditions in upper sector of Romanian Danube river, have been presented all fish species from lower Danube river, the majority of fish species being typically rheophilic, some species had no rheophilic tendency being generative phytophilic species, a few species have been characteristic stagnophilic and a few species have been anadromus migratory from Blak Sea.

In present, the barrage Iron Gate II (km 863) is the final point of migration of species *Huso huso, Acipenser guldenstadti, Acipenser stellatus* and *Alosa pontica*.In barrages lakes created on Romanian Danube river are yet presented all species of fish with high economic value, but in less quantity than before river damming.

The permanent variations of water level in barrages lakes, in short periods of times, done by energetic used, make that many of fish eggs spawn on recently flooding plants by economic value fish species remain out of water and die, that contribute really to diminish the fish stock.

In the barrages lakes there is a continual regress of rheophilic fish species, in the same time with increase of stagnophilics or indifferent species.In this places rose the asiatic species lake as: *Hypophthalmichthys molitrix, Ctenopharyngodon idella, Aristichthys nobilis*.Antropic impact has negative effects upon fish fauna of Danube river.

**Conclusions**

- All activity at the Danube river must take into consideration the fisheries need.
- The river must be protected against all sources of pollutions.
- Fish capture must be correlated with natural productivity of ecosystem.
- To establish a permanent prohibitive zone aval of barrages ( along 10 km) to protect species which have upstream swimming tendency.
- To respect strictly the reglementations of Fishfarm and Fishing Lows : the delimitation, the organisation and the protection of spawning grounds for phytophilic species; the correlation of prohibitive period for fishing with climatic condition favourable to natural reproduction; to respect the minimal dimensions for length of fish and food fishing tools; to help the fish fingers when the water level decrease in isolated pool; to fight against poachers; etc.
- To improve the valuable fish stock by achieving fish material in nursery special built, for people the river.(*Cyprinus carpio, Acipenser ruthenus, Silurus glanis, Stizostedion lucioperca, Abramis brama).*
- In special condition to stop entire the fishing in some zones or for some species, during a fixed period of time for the rehabilitation of fish stock.
- Romania must permanently collaborate with danubian countries for establishing some common measures for fishing and for protection of fish stock.

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# THE CURRENT STATUS OF THE ROMANIAN FISH FARMING INDUSTRY - USE OF AN INVENTORY SURVEY AND DATABASE.

Ian Watson*

Natural Resources Institute, Central Avenue, Chatham Maritime, Chatham, KENT ME4 4TB, United Kingdom.
* Address for correspondence: KHF Fisheries Project, Et.2, Camera 44, B-dul Carol I nr.17, Sector 1, Bucuresti, ROMANIA

## Introduction

While Romania has a long tradition in freshwater fisheries, large scale fish farming is a relatively recent development, most farms having been constructed in the 1960's and 1970's. Production is based on carp polyculture, and is either extensive or semi-intensive. Production is based on fertilisation, together with supplementary feeding. There are 38 state owned societies engaged in fish farming.

The British Government's Know How Fund has been supporting restructuring and privatisation. It became necessary to collect information on the industry in order to know exactly what the sector comprised, what state its infrastructure was in, to know what was being produced and to identify potential constraints to industry development. Existing information was either of unproven reliability or was incomplete. Therefore, an inventory of the industry was commissioned. This is described elsewhere in these proceedings (Stoicescu and Bourne).

## Production statistics

Statistics for Romania have traditionally counted all fish on farm in the autumn as production. Therefore apparent production is substantially greater than the production of marketable fish. The current estimate of total production of freshwater fish in Romania for 1995 is 24 400 tonnes of which 16 400 tonnes were table fish. Out of this, 11 700 tonnes of total production and 6 900 tonnes of table fish production came from fish farms. The dominant species is silver carp (*Hypophthalmichthys molitrix*) which accounts for about 40% of total production and about 60% of farm production. The survey indicated that the majority of fish farmers wish to change their production to reduce the silver carp to 20-40% of production, increasing the production of more valuable common carp (*Cyprinus carpio*).

The survey showed that total production statistics can be misleading in a number of ways. The gross productive area of fish farming societies in Romania is approximately 216 000 ha, and total production in 1995 was 27 400 tonnes, suggesting a yield of only 120kg $ha^{-1}$. However, this figures is misleading since a large area of fish farm is actually enhanced natural fisheries. A true fish farm production of 11 500 from 21 000ha gives a more reasonable yield of 540kg $ha^{-1}$ . Even this is low, and completion of the database is expected to reveal a true fish farm yields in the range 1 000-1 500kg $ha^{-1}$ usually quoted by farm managers.

**Infrastructure**

The survey assessed the physical infrastructure of fish farms. Problems are being experienced with many farms due to inadequate maintenance prior to 1990, and the lack of money to be able to effect repairs subsequently. The most common problems encountered are dams and bunds in urgent need of repair and ponds which are difficult to manage due to engineering problems. Typically, these would have been the result of financial constraints during pond construction which led to overlarge ponds being built, or ponds which could not be fully drained for harvesting.

Water quality was generally assessed as being good, although water supply was often found to be a constraint to operation as the volume can be inadequate at critical times of the year when the ponds are filled.

**Problem areas**

The section of the fish farming industry most affected by changes since 1989, is fry and fingerling production. Internal pricing policy within the fish farming societies has led to the value of fry and fingerling production being under their real market value with consequent loss of income to fry and fingerling producers. They are often listed as having made losses and complained of a lack of investment. This is a vital section of the industry, and if it were to fall into disrepair, this could pose a serious constraint to the development of the industry.

The industry has low profitability, although this is currently an artificial situation due to the characteristics of state ownership which results in a substantial proportion of gross margin being retained by the state. Some farms had very high pumping costs, where pumping is necessary for both filling and emptying ponds. The future viability of such farms is questionable.

**Future development**

Most of the farm managers interviewed during the survey expressed a wish to change the industry. Many wished to change the production profile towards fish species which are more profitable and with higher consumer demand. Views expressed on the future ownership of the industry were more varied, but with the majority favouring some form of leasing or concession agreement with the farm as the basic production unit. The technical problems faced by some farms may prevent profitable operation and alternative activity, such as recreational fishing or water sports could be considered.

# AN ASSESSMENT OF THE FEASIBILITY OF ISO-OSMOTIC MARINE FISH CULTURE

Norman Y. S. Woo

Department of Biology, The Chinese University of Hong Kong, Shatin, Hong Kong.

## Introduction

Adverse environmental conditions limit the potential for marine fish culture in Hong Kong. Growth of fish cultured in conventional float cages is often sub-optimal. A land-based re-circulating seawater system would provide a vigorously controlled environment and therefore creates the possibility of optimizing conditions for growth and reproduction. A closed system design requires only minimal water exchange and is ideally suited for experiments involving the assessment of salinity on growth. Such a system has been in operation in The Chinese University of Hong Kong since 1988 (Woo et al., 1988; Woo and Kelly, 1995). Theoretically, fish expends considerable amounts of energy for hypo-osmoregulation in seawater as well as for hyper-osmoregulation in a dilute environment. In an iso-osmotic environment, no ionic and osmotic movements exist and any savings in the energy devoted to osmoregulation can theoretically be chanelled to benefit other functions such as growth. The objectives of the present experiments are to assess the beneficial effects of iso-osmotic salinity on growth, if any, and the accompanying metabolic alterations in four teleost species.

## Materials and methods

The re-circulation system consisted of a grow-out tank (22 000 l) and a sedimentation tank (82 000 l). Seawater was pumped from the sedimentation tank to a sand pre-filter. Outflow from the pre-filter was directed over biological filters and then allowed to drain by gravity into the grow-out tank. The flow rate through the entire system was 15 000 $l.h^{-1}$. To complete the circuit, water was drained by gravity into the sedimentation tank via an underground conduit. The entire system was constructed inside an indoor laboratory to simulate "factory" conditions. The following species were tested for possible growth enhancement at iso-osmotic salinity: sea bass (*Lates calcarifer*), sea bream (*Sparus sarba*), pompano (*Trachinotus ovatus*), and tilapia (*Oreochromis niloticus*). Fish were stocked at an initial density of 2.5-3 $g.l^{-1}$ into different tanks at different salinities (7, 12 or 33 ppt). Fish were fed daily on a ration of artificial pellets made from fish meal containing 70% protein (3% body weight.$d^{-1}$). The final protein content of the pellet diet was 52%. Growth was monitored by weighing the fish at 20-day intervals for a period of 150-200 days. Specific growth rates, food conversion efficiencies, oxygen consumption and ammonia excretion rates were monitored. Fish were sampled at termination and tissue samples (liver and muscle) were monitored for changes in biochemical contents and enzyme activities.

## Results and discussion

Growth rate and protein efficiency ratio of sea bass, sea bream, pompano and tilapia cultured at 12 ppt were consistently higher than those cultured at 7 or 33 ppt. In the sea bream, growth enhancement at iso-osmotic salinity was accompanied by reduction in oxygen consumption, ammonia excretion rate, liver lipid levels and hepatic glucose-6-phosphatase activity. However, hepatic hexokinase activity was stimulated at 15 ppt. These data suggest that growth enhancement at iso-osmotic salinity may result from (1) reduction of metabolic cost of osmoregulation, a point which has been pointed out by various workers (Febry and Lutz, 1987) and (2) re-organisation of metabolism, which would allow protein sparing in favour of a shift towards preferential utilisation of carbohydrate and lipid. Working with other fish species, other workers have demonstrated that iso-osmotic adaptation had either no effect (McCormick et al., 1989) or had stimulatory effect on growth (Alliot et al., 1983). Our results confirmed a definite growth enhancement effect of iso-osmotic salinity in the sea bass, sea bream, pompano and tilapia.

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# Annex 1
# National reports

# THE STATE OF AQUACULTURE IN BELARUS

Alexander P. Golubev and Victor F. Kulesh

Institute of Zoology, Academy of Sciences of Belarus,

220072 Minsk, Belarus

## Introduction

Belarus (formerly one of the USSR republics, at present - independent state) is situated in the centre of Europe on the watershed of the river basins of the Baltic and Black seas. Belarus has no entrance to seashore but is very rich in freshwater resources. The total runoff of the rivers over the territory of Belarus equals 58 $km^3$ for a year of average water content.There are up to 20.8 thousand rivers with total length of 90.6 thousand km, more than 10 thousand lakes with total area of 2000 $km^2$, many artificial reservoirs, ponds, channels etc. As to the quality , the waters are considred to be moderate polluted.

In combination with the favourable climate characterised by relatively mild winter and rather warm summer it creates the good opportunities for the aquaculture. Nevertheless, at present aquaculture in Belarus is restricted mainly by rearing of freshwater fishes in artificial ponds and reservoirs. The aquaculture of invertebrates in Belarus is practically absent.

## Freshwater aquaculture production

### Fishery

The natural water resources for fishery in Belarus consist of 1074 lakes, 115 water reservoirs with the total area of 116 thousand hectares and 2813 km of rivers and channels. The 14 state fishery enterprises are functioning in Belarus. They are exploiting 177 lakes with the total area of 70.8 thousand ha, 8 reservoirs with total area of 6.2 thousand ha and 1494 km of rivers. The lake Beloye (490 ha) and the Dnieper- Braghin reservoir (968 ha) are exploited in a semi-intensive regime of fishery - with periodical restocking of fish fry.

In 1990 the natural waters yielded 1986.3 tons of commercial fish. The total fish catch in 1994 has amounted to 918.6 tons, in 1995- 852.1 tons. The catch in lakes amounted to 77.2% of the total value, in rivers - 17.2%, in reservoirs - 8.6% , in waters with semi-intensive fishery - 2%. The quantitative data on catches of some fish species in the last years are given in Tables I, II. Lowering of catches in 1995-1995 can be explained an unsatisfactory organization of fishing due to economical crisis and incomplete use of resources. The average fish productivity of exploited water bodies in 1990 was equal to 15.1kg $ha^{-1}$, with 15.1kg $ha^{-1}$ in lakes and 29.5kg $ha^{-1}$ in water reservoirs. The fish productivity of rivers was as high as 125.9kg $km^{-1}$. The data for previous years are given in Table III.

**Fish farming**

There are 27 state fish-farms in Belarus with total pond area of 21 thousand ha. The total fish output of these farms in 1995 amounted to 7000 t. The carp *(Cyprinus carpio)* is the main object of fish farming in Belarus. In small quantities the Prussian carp*(Carassius carassius)*, the pike (*Esox lucius*) and rainbow trout (*Salmo irideus)* are rearing up. In fish-farms using discharge waters of power stations some heat-loving species such as *Ctenopharyngodon idella, Hypophthalmichthys militrix, Aristichthys nobilis, Ictalurus punctatus* are breeding.

Table.I. The catch of fish in harvesting waters of Belarus (1994, tons)

| Fish species | Total | Rivers | Lakes | Reservoirs |
|---|---|---|---|---|
| *Abramis brama* | 190.3 | 52.3 | 116,9 | 21.1 |
| *Angiulla anguilla* | 22.6 | 9.8 | 12.8 | - |
| *Aristichthys nobilis* | 0.6 | - | 0.6 | - |
| *Coregonus albula* | 2.3 | - | 2.3 | - |
| *C. lavaretus* | 0.7 | - | 0.7 | - |
| *Cyprinus carpio* | 17.0 | 0.3 | 10.2 | 6.5 |
| *Esox lucius* | 50.1 | 21.3 | 20.2 | 8.6 |
| *Perca fluviatilis* | 24.5 | 1.2 | 23.0 | 0.3 |
| | 323.8 | 51.4 | 268.3 | 4.1 |
| *Rutilus rutilus* | | | | |
| *Silurus glanis* | 6.8 | 0.1 | 0.1 | 6.6 |
| *Stizostedion lucioperca* | 7.7 | 1.2 | 5.1 | 1.4 |

Table. II. The catch of fish in harvesting waters of Belarus (1995, tons)

| Fish species | Total | Rivers | Lakes | Reservoirs |
|---|---|---|---|---|
| *Abramis brama* | 176.0 | 36.7 | 127.5 | 11.8 |
| *Angiulla anguilla* | 17.1 | 7.1 | 10.0 | - |
| *Aristichthys nobilis* | 3.7 | - | 3.7 | - |
| *Coregonus albula* | 1.2 | - | 1.2 | - |
| *C. lavaretus* | 3.3 | - | 3.3 | - |
| *Cyprinus carpio* | 30.0 | 0.1 | 21.5 | 8.4 |
| *Esox lucius* | 37.2 | 9.5 | 20.6 | 7.1 |
| *Perca fluviatilis* | 32.5 | 0.4 | 31.7 | 0.4 |
| *Rutilus rutilus* | 247.9 | 27.7 | 217.7 | 2.5 |
| *Silurus glanis* | 0.2 | - | 0.05 | 0.15 |
| *Stizostedion lucioperca* | 8.1 | 1.9 | 4.2 | 2.0 |

Table III. The perennial dynamics of fish harvest from natural water bodies and fish production of fish-farms in Belarus (thousand tons)

| Water body | 1951-1955 | 1956-1960 | 1961-1965 | 1966-1970 | 1971-1975 | 1976-1980 | 1981-1985 |
|---|---|---|---|---|---|---|---|
| Natural water bodies: | 3.19 | 2.97 | 2.59 | 2.27 | 2.23 | 2.03 | 2.25 |
| rivers | 0.50 | 0.52 | 0.73 | 0.63 | 0.66 | 0.63 | 0.68 |
| lakes | 2.69 | 2.45 | 1.86 | 1.64 | 1.57 | 1.40 | 1.47 |
| Fish-farm ponds | 1.06 | 1.80 | 2.75 | 4.93 | 8.21 | 6.44 | 11.77 |

**Crayfish harvest**

There are two crayfish species in Belarus - *Astacus astacus* and *A.leptodactylus.* The native species *A.astacus* formerly was found everywhere in the country being most common and abundant species. The alien species *A.leptodactulys* has entered the territory of Belarulns in the second half of XIX century. In the first half of 20th century these species were abundant in Belorussian lakes and rivers and an important objects of harvest. In 30-40-ties the annual crayfish catch (mainly *A.astacus)* reached up to 40 tones. Most of them was imported in West European countries. In 1950 - 1954 crayfish harvest didn't exceed 22 - 28 tons, in 1961-1964 - 8 - 29 tons.

In 70-ties the crayfish stock in Belarus was sharply decreased. Unfortunately, crayfish, in first turn, *A.astacus,* disappeared in many water bodies. Since 1982 *A.astacus* has been entered on the Red Data Book of Belarus.

Among the reasons of such a situation there are repeated epizootics of crayfish plague in Belarus and neighbouring countries, uncontrolled harvest, increasing anthropogenic water pollution, aggravation of water environment state as a result of melioration and extensive application of chemicals in agriculture. At present some significant organized crayfish harvest in Belarus is absent. The only data available for *A.leptodactylus* are - 280kg in 1994 and 1012 kg in 1995. The data of individual fishermen catch are unknown.

The only way to increase significantly the crayfish output in Belarus seems to raise them in specialised crayfish farms. *A.leptodactylus* as a fast-growing, eurybionthic and anthropogenic pressure resistant species is the most preferable object for farming. In natural water bodies of Belarus *A.leptodactylus* reaches the sexual maturity and marketable size (8 - 9cm) at the age of 3- 4 years. At present in Belarus the development of technology of accelerated farming of this species is in progress. It includes the winter incubation of crayfish eggs in special thermostatic system at 18-20°C and following growing up of larvae during 1,5-2 months in indoor conditions at the same temperature. It allows to stock juveniles of 2,5-3 cm to farm ponds in spring or early summer. These specimen are able to reach the marketable size for 2 years instead of 3-4 years in natural water bodies.

**Prawn farming potentialities**

At 1982 the oriental freshwater prawn *Macrobrachium nipponense* has been acclimatizated successfully in the cooling reservoir of Bereza electric power station (south-west of Belarus). In this reservoir it exists within the temperature range 8-36°C. At present this species has became the dominant in zoobenthos associations playing an important role if feeding of marketable fish. The fishermen use this prawn as a fishing bait and sometimes for eating.

The growth and reproductive potential of the giant tropical prawn *Macrobrachium rosenbergii* in the same water body have been studied. The yield of prawns reared in ponds and cages on the shedding channel of the station (temperature up to 36°C) amounted to 1000 kg $ha^{-1}$ per year.

Obviously these prawn species may be potential objects for harvest and aquaculture on waste-heat waters of electric power stations in Belarus.

**Marketing of national products in Eastern and Western Europe**

At present due to high cost for energy, fish fodder, equipment, machinery and consumable materials the fish aquaculture in Belarus is extremely expensive. The prices for pond fish in Belarus are compatible with world ones. Wide-scale export on the national aquaculture products in foreign states is absent. Crayfish harvest at several lakes with the high population density may be rather profitable if delivered at appropriate prices in luxury restaurants. Some private business enterprises deliver small amounts of *A.leptodactylus* in Germany and some other western countries. Unfortunately, the reliable data are not available.

**Research and education status**

The aquaculture researches in Belarus are carrying out in Belarussian Research Institute of Fishery, Institute of Zoology of the Academy of Sciences of Belarus, Belarussian Agricultural Academy, other scientific and educational institutions. Special attention is paid to improvement of methods of fish aquaculture, fish breeding, etc. The up-to-date distribution and state of crayfish stock in Belarus are determined.

The aquaculture specialists are training at the biology departments of universities and some other higher education institutions in Belarus.

**Legal aspects of aquaculture and marketing.**

The national legislation strictly regulates the fishery and crayfish harvest in Belarus and quality of aquaculture products delivered for sale. Buelorussian State Committee on Fishery controls the observance of the fishing regulations. Nevertheless the fish poaching caused by complicated economical situation in Belarus has become the serious social problem.

At present all the laws related to the environmental regulation and practices and the mechanisms for their inforcement are being revised in the Republic of Belarus.

**Organization of the production**

The guidance fishery regulation in Belarus is carrying out by Belorussian State Committee of Fishery. The aquaculture and fish industry in Belarus is based on state fish-farm and enterprises. Last time some private enterprises are trying to organize small farms for growing up of fish (mainly rainbow trout) and for licence crayfish harvest in natural water bodies.

**Conclusion**

Belarus has a good potential for aquaculture development but it is realizing only in a small extend. At present in fish aquaculture extensive and semi-intensive technologies are used. The fish growing up is carrying out mainly in ground ponds. In future the transition to the intensive technologies for fish and crustacean aquaculture is possible. A special attention should be paid to protection and reproduction of valuable fish and invertebrates species (crayfish, freshwater pearl-mussels) in natural conditions and renaturalization of species entered on the Red Data Book in other water bodies. However these measures may be realized in conditions of improvement of total economic situation in the country.

# STATUS AND OVERVIEW OF AQUACULTURE IN CROATIA

Ivan Katavic

Institute of Oceanography and Fisheries, Split, Croatia

## 1. INTRODUCTION

Fish culture in the Croatian has a long history. It began more than 110 years ago with the culture of carp fish species. Even prior to carp, shellfish culture - oysters and mussels was practiced in sheltered locations all along the coast.

Croatians have historically valued their aquatic natural resources, not only as a source of food, but also as a source of recreation. So, some hatcheries became involved in fish production for stocking sport fish in man-made reservoirs or to replenish and maintain depleted stocks in natural bodies of water. Until the 1980's, all cultured fishes were freshwater, both warmwater and coldwater species. Only recently, beginning in the mid-1980s has there been an increase in marine fish production. The aquaculture production, fresh water species in particular has been adversely affected by the recent war due to the loss of traditional markets, the lack of new investment, some disease problems, etc. This paper reviews the development of fish culture industry in the Croatia, its current status, the annual production of aquaculture products, and perspectives in the near future.

## 2. COMMERCIAL PRODUCTION STATISTICS

Dominant species in Croatian freshwater farms has been common carp (*Cyprinus carpio*) in polyculture with some "secondary", both herbivorous and predatory fish species. Cold freshwater is used to produce rainbow trout. Marine fish farms produce 70% of the high valued sea bass (*Dicentrarchus labrax*), while the remaining part is gilthead sea bream (*Sparus aurata*) with other sparids. Both oysters (*Ostrea edulis*) and mussels (*Mytilus galloprovincialis*) are grown on hanging culture all along the coast. There used to be some production of coho salmon (*Oncorhynchus kisutch*) and rainbow trout (*Oncorhynchus mykiss*) in marine waters.

Total fish and shellfish production in the Croatia today is estimated to be around 11000 tons (Table I).

Table I. Production of fish and shellfish in Croatia in 1995.

| Category | Tons |
|---|---|
| **Freshwater fish** | **7750** |
| Warmwater species | 7350 |
| Rainbow trout | 400 |
| **Marine fish** | **1600** |
| Bass | 1200 |
| Bream | 350 |
| Others | 50 |
| **Shellfish** | **1650** |
| Mussels | 1500 |
| Oysters | 150(equal to 1 milion pieces) |
| **TOTAL** | **11 000** |

2.1. FRESHWATER CULTURE

2.1.1. Carp and otehr warm water fishes

Pond culture of warmwater fishes in the Croatia began in the second half of 1800s. Some currently operating farms were constructed more than hundred years ago, and the newest are about fifteen years old. Pond culture of warmwater fishes was already well established by the end of World War I. However, there were no appreciable improvement in surface area being used between 1918 and 1955, although the productivity per unit surface area doubled (Table II).

Table II. Evolution of warmwater pond production by Croatian farms from 1918 to 1994

| **Year** | 1918 | 1955 | 1980 | 1990 | 1994 |
|---|---|---|---|---|---|
| **Total farming area (ha)** | 4500 | 4044 | 12 647 | 12 327 | 10 623 |
| **Production (tons)** | 1 140 | 2 305 | 17 180 | 15 650 | 7 341 |
| **Yield (kg/ha)** | 253 | 570 | 1 354 | 1 220 | 691 |

The most important species has always been the common carp with scaleless varieties now being used almost exclusively. Smaller quantities of predatory fishes such as European catfish (*Silurus glanis*), pike perch (*Stizostedion lucioperca*) and the pike fish (*Esox lucius*) are also grown. The herbivorous group of fishes, such as grass carp

(*Ctenopharyngodon idella*), bighead (*Hypophythalmichthys nobilis*) and silver carp (*Hypophthalmichthys molitrix*) were introduced in the sixties. However, market resistance to the introduced fish species has always limited their production.

There are currently 19 warmwater companies in Croatia, farming a total area of around 11000 ha ponds. Following the war and the loss of traditional markets in Serbia and in Bosnia and Hercegovina, annual production has fallen drastically from around 17 000 to 7 000 tons. In 1996 the production is expected to continue to decrease.

In the last few years carp ponds are routinely managed with only 660kg/ha, that is the yield achieved 40 years ago. Output per employee-year is now from 10 to 15 tons, but was formerly much higher when fish production was less constrained by marketing difficulties.

Common carp has always represented more than 80% of the warmwater production. Participation of herbivorous fishes has decreased in the last decade from 12% to 6% in favor of predator fish from 1.3% to 9.5% With greater participation of those high quality species in polyculture with common carp, there would be better economic benefits and easier access to investment credit in the future

Production technology, methods and equipment being used in nineteen Croatian carp farms are fully equal to those in other European countries. Virtually, all fry production in the country is now done in seven hatcheries. Growing ponds are up to about two hundred hectares. Growth of carp to a market size of 1-3kg requires two to three years. Fish are fed with wheat followed by corn. The feeding coefficient is from 3.0 to 3.4kg.

2.1.2. Trout

There are eight trout farming companies growing rainbow trout to market size in fresh water. Total trout production has fallen from around 1 000 tons before the war to about 400 tons today.

Portion-size trout is considered 250 to 300g. Production of portion size trout from the eggs normally takes 14 to 20 months depending on the water temperature, quality and quantity of feeding and genetic factors. The wholesale prices of trout in Croatia varies between 6 and 7DM/kg for large orders and 8 to 9DM/kg for small ones. Feed conversions of 1.7-2.0 are reported, and feed makes up to 50% of total production cost. Average output is about 8 tons per employee-year.

Experiments to rear anadromous salmonids in some isolated locations along the middle and south Adratic have been made since 1980's. Commercial trials of both salmon and sea-reared trout have so far been met with very limited success. At its peak during the late eighties, production has reached about 200 tons per year. This has now fallen back to a very low level. While winter seawater temperatures in the Adriatic are ideal for growth of salmonids, production is limited by high summer sea water temperature. However, some sites can be found on the northern Croatian coast in which both summer temperatures and salinities are reduced to suitable levels by continuous inflows of cold fresh water. It seems that a sudden drop in production of salmonids is due to the war situation and marketing problems, rather than to production technology.

### 2.1.3. Sports fisheries

Sport fishing in fresh water is a popular hobby for Croatians, and attracts some tourist business from abroad. There are about 230 sports fishermen associations, with a total membership of around 35,000. Before the war, the number of registered associations was 270, exceeding 70,000 sports fishermen. The associations provide detailed plans produced by professionally-qualified consultants that includes management procedures for the areas concerned. The plan includes estimates of the fish species and stocks to be present, amount of fish to be harvested, and proposal for restocking natural waters.For sports purposes, normally only rod and line is allowed.

## 2.2. MARINE AQUACULTURE

Several different marine organisms are cultured in Croatia including both fish and shellfish, of which the latter are all bivalve species. The list below includes not only species where the culture method is well known and all aspects of the life cycles are controlled, but also experimentally cultured organisms where the methods are not fully known or proven in a practical way.

| | | |
|---|---|---|
| **Fish species** | Sea Bass | *Dicentrarchus labrax* |
| | Gilthead Sea Bream | *Sparus aurata* |
| | Othe Sparids | *Diplodus puntazzo* |
| | | *Diplodus sargus* |
| | | *Dentex dentex* |
| | | *Pagrus pagrus* |
| | | *Pagrus (Chrysophris) major* |
| | | *Pagelus bogavareo* |
| | | *Pagelus acarne* |
| | Yelowtail | *Seriola dumerilii* |
| | Mullet | *Mugil sp. (cephalus, ramada, chelo, auratus)* |
| **Invertebrate species** | Mussel | *Mytilus galloprovincialis* |
| | Oyster | *Ostrea edulis* |
| | Carpet shells | *Chamelea gallina (=Venus gallina)* |

2.2.1. Fish species

Research on culture of high valued marine fish began in the mid seventies while commercial production started in the early eighties. The challenge was the very high prices attainable for these species in Italy and the possibility to supply local market, particularly during the tourist season. The dominant farmed fish in the Croatian mariculture are sea bass and gilthead sea bream. The life cycle for these species has been well studied and can be fully controlled. The technologies used are modern, up to date, and virtually the same as these employed in the other European countries. Hatcheries are lend based for maximum control over all the activities. However, this industry is not yet self sufficient. Pelleted feed is imported and most small growers also import their fingerlings from Italy and France.

In addition to three large companies producing today about 1100 tons market sized fish, there are about 20 small producers with estimated output of about 500 tons per year. Total production from Croatian marine fish farms is estimated to be around 1,600 tons annually, almost 70% of which is sea bass.

All marine fish species are cultured in cages, but design, size and mooring arrangements of cages are variable according to the exposure of the site and personal preference of the investors. In sheltered coastal areas where meteorological conditions are not very severe, cages can be of light construction with a relatively weak mooring system. The major problem in this area is the from reduced water quality from two sources, both anthropogenic and self pollution. Offshore areas, being a less exploited environment with fewer conflicts and less risks from coastal and self pollution, seems very promising for expansion of mariculture industry. However, the mooring system and cages need to be sufficiently strong to withstand much higher forces exerted by wind and waves. A compromise between the two described approaches might be a semi-offshore technique, suitable in the exposed coastal areas, where the conditions are such that disadvantages of both areas are minimized whilst maximizing the advantages.

2.2.2. Shellfish

There are now about 70 farmers producing an estimated total of around 1 500 tons of mussels and about 1 million oysters per year. Even though the production potential for shellfish is great, the production will be limited by the size of the local market until permision to export is obtained.

Traditional shellfish farming technologies were improved by introducing more intensive ones in the 1980s (floating long lines). Mussels and oysters are grown on vertical structures suspended from lines floating on the sea surface. Carpet shells are grown out in sandy bottom areas. Total production does not exceeding 20 tons per year. Hatcheries for spat production of these bivalve are not economically viable because it is cheaper and easier to collect spat from natuaral habitats.

## 3. MARKETING

Among the numerous problems the aquaculture sector is faced with, i.e. shortage of capital, lack of government support, low productivity etc., the market problem is a crucial one. Following the war, loss of the traditional markets in the other republics affected the freshwater fish industry very drastically, especially those involved in supplying the cheaper warmwater species. Some producers are penetrating EU markets for live fish in Italy and Germany, but the prices drop down from around 3DM/kg to 1.7-2DM/kg, hardly exceeding production costs. Prices on the local market are higher, but the market is small and mainly oriented toward the interior part of the country. Rainbow trout cannot compete with the large industries of other European producers, and it is limited on the home market only.

Due to large increases in supply from fish farmers in the Mediterranean, prices for sea bass and sea bream on the export market have fallen drastically. The export of Croatian fin fish had almost exclusive orientation towards the Italian market. Prices were cut down in half. In less than five years it went from 28DM/kg in 1991 to 11 DM/kg in 1994 (Table III).

Table III. Evolution of the export prices to Italy for the sea bass extra class from 1991 to 1996.

| Year | Export price in Lit. | Ratio DM:Lit | DM equivalent | Index |
|---|---|---|---|---|
| **1991** (September) | 21 000 | 748 | 28 07 | 100 |
| **1992** (October) | 16 500 | 935 | 17 65 | 62 |
| **1993** (October) | 12 500 | 966 | 12 94 | 46 |
| **1994** (January) | 11 500 | 976 | 11 78 | 42 |
| **1995** (March) | 13 000 | 830 | 11 78 | 40 |
| **1996** (July) | 15 000 | 998 | 14 97 | 53 |

Demand in the North European States also exists but for limited quantities through specialized importers. At the same time, the potentiality of the domestic market has decreased due to the collapse of the tourist industry that also hit marine aquaculture in particular. Shellfish cannot be exported to the Europe because EU quality control regulations have not yet been met. The rules require scientific monitoring of shellfish production sites to ensure that no toxic algae are present Monitoring of culturing sites is now being done showing no dangerous plankton organisms. However, it must be continued for a while unless all administrative procedures are completed to clear the farms to export to Europe.

Another problem this sector is facing with is 15% of the import taxes that is charged on Croatian fish entering the European market. As a matter of fact the duty is paid by the European buyer, but clearly Croatian suppliers are forced to reduce their prices by the same amount to remain competitive. Recently, more attention is being given to develop the home market, which is more profitable. However, this is again closely connected to tourism which is now recovering.

## 4. LEGAL ASPECT

General laws concerning the protection of the environment, water quality and living resources are not specific to aquaculture. As with any industry, aquaculture is covered by a number of regulations applying to it directly or indirectly. These regulations are implemented through permits or licenses generally based on the use of space and water.

Regulations in fish culture are administered by the Ministry of Agriculture and Forestry. Application for a fish farm license should include informations concerning suitability of the site, the methods and techniques to be employed, the species and biomass to be produced and the suitability of the applicants regarding their qualifications and experience. Water must be used in an efficient manner compatible with the water management policy and general interests of the community. Only the construction of buildings directly related to the fish farming activities are allowed. Depending on the project size this permit may be subject to an impact study procedure. Special requirements may also be set by the permit as result of an impact study in order to maintain a rational balance between aquaculture development and environmental protection. In Croatia, concession granted for 12 years or shorter is issued by the local government (Zupanija). The Ministry of Agriculture is responsible for the aquaculture permits which last up to 33 years, while Parliament will be granting concession above 33 years.

The coastal zone management plan in Croatia prepared in 1989 considered marine aquaculture as one legitimate activity in the coastal area along with the development of tourism, national reserves, industry, military use etc. However, due to inappropriate zoning and aggressive actions undertaken by certain sectors (i.e. marinas, human settlements etc.) many excellent areas for mariculture are definitely lost. Since Croatia possesses an abundance of sites suitable for mariculture, it is believed that a shortage of usable sites will not be a major limiting factor in the further mariculture development. As for freshwater fish farms, new sites are more limited, but since existing farms are operating at less than half their capacity, it is unlikely to be a main obstacle in the near future.

Croatia has an Act of Fish Disease similar to those in other European countries. Permission is needed to import eggs and fish. Imported stocks are required to be quarantined and tested after arrival in Croatia.

## 5. ORGANIZATIONAL ASPECT

At the governmental level, Department of Fisheries in the Ministry of Agriculture is responsible for fisheries and fish culture in both sea and freshwaters. There are no voluntary fish farmer associations, but all commercial companies are required to join the Croatian Chamber of Commerce in the same way as commercial fishermen. Within the Fisheries sub-sector, there exist a separate group covering marine and freshwater aquaculture. The purpose of the Chamber is to act like a trades union for its members, representing their interests to the government and to other industries.

All aquaculture enterprises are either privately owned or are in the process of privatization. As in most other sectors of Croatian economy, unrealistic valuations made difficulties in finding interested parties willing to buy the larger companies. If "privatized", this transition resulted in a lack of capital investment to improve the business. Namely, 50% of shares are held by the State Privatization Fund and the balance is offered to workers employed by the company. Most of the shares are bought on credit without contributing liquid funds. Even, that small percentage of money paid for privatized shares does not go to the company but to the treasury. The working capital is still remainins a problem, while at the same time loans are costing above 20% in a country with zero inflation rate. This is one reason that most of the farms are lacking investment in new equipment. The modernization of hatcheries and labor saving machinery are badly needed. Croatian fish farmers should cooperate and work together, particularly if they want to promote sales of their products abroad, but also at home. They should try to establish an individual image of their product based on the highest quality criterias as it was achieved by salmon producers in Norway and Scotland.

All types of aquaculture production use more labor than is objectively needed. Organization of production need to be improved which will lead to a higher productivity per employee-year. Although the ownership has changed, the ways of thinking/working not yet changed enough. Productivity can also be improved from progressively increased growth rates of the fish as a consequences of improved feeding, genetic and other technical improvement. Substantial foreign interest for mariculture is shown by Italian, French and Spanish investors. Shareholding in two marine farms are already actualized. This has generally been welcomed by the industry, as it provides new capital, knowledge and contact in the European mariculture system.

## 6. RESEARCH AND EDUCATION

Research in freshwater culture is oriented towards technical problems such as fish feed development and the genetic improvement of farmed fish as well as assessment of fish diseases.

Major research issues in marine aquaculture are:
-diversification of mariculture products by studying and selecting new species to be cultured; this also includes genetic studies oriented towards the production of hybrids, triploids and monosex populations;

- environmental aspect of mariculture by including inventory of the coastal areas suitable for various mariculture technologies, impact of mariculture on the environment and monitoring of fish and shellfish culturing areas;

- fish pathology oriented towards prevention, diagnosis and control.

The involvement of the Fisheries Department of the Ministry of Agriculture and Forestry as advising researcher in existing institutes and universities is not satisfactory. So, the research is not always strictly focused on practical problems. It is expected that in the near future this Department will play a key role in organizing needed interactions between the industry and science. The first step to make this function is to organize and develop a method for collecting the statistical data from different sources in fish culture sector and integrating this data into international networking activities such as the System of Information of Aquaculture in the Mediterranean (SIPAM).

Professional staff of the scientific institutions are providing advice to fish farmers if requested, but there is no official extension service or formal training. Most of the larger fish farms have contracts with qualified organizations or experts for regular visits to the farms to conduct routine environmental and health monitoring on stocks.

## 7. CONCLUSIONS

Fish culture in Croatia is expected to expand, and much of that expansion will be for marine species. Development within the next 5-10 years will likely be more dramatic than development during the past decade. The local demand for both fish and shellfish are expected to increase as the tourism of the Croatia continues to grow. Future mariculture expansion is expected from an increase in the number of farms producing marine fish and shellfish. Assuming the tourist industry recovers to its previous size, it is expected that home sales could absorb most of the bass and bream production at profitable prices. Technically, shellfish farming also has an excelent potential on the Croatian coast after it satisfies EU import requirements. Freshwater culture will also expand, but mainly trough intensification of production from existing facilities, by diversifying production into new, higher value species such as catfish, and improving the quality of the fish produced.

# CZECH REPUBLIC: NATIONAL REPORT ON FISH FARMING INDUSTRY

R. Berka, J. Filistein

Fish Farmers Association, Pražská 58, 371 38 České Budějovice, Czech Republic

## Introduction

As an inland country, the Czech Republic is interested in fish farming and production of fish is an integral part of agriculture. After 40 years of absolute nationalization, former state fish farms were transformed into limited and joint–stock companies or private farms (this privatization was closed before 1995). This has been a complicated process due to many constraints linked to the past, including shortage of capital, not well advanced style of work in some sectors, and particularly underdeveloped market.

To assist progress, the Fish Farmers Association as a professional organization of fish farmers and processors was established in 1991. Today, the Association has 46 members representing a dominant part of fish farming and processing industry (from total fish production, about 83 % is covered by members of Association). Fish Farmers Association is also a member of other all–national agriculture and food bodies – e.g. Agriculture Chamber of the Czech Republic, Union of Poultry Producers, Food Industry Association etc.

## Freshwater fish production

In the Czech Republic, fish ponds are dominating as fish farming basis. Other production units and facilities (trout farms, units producing fish in heated effluents, net cages, indoor facilities etc.) have no pronounced commercial importance and do not affect a final production figures.

From total 51 000 hectares of ponds, about 33 000 hectares are operated by members of Fish Farmers Association. South Bohemia (close to the Austrian borders) is the most important fish farming region where more than 70 % of total pond area is situated. Here, in this region, the largest Czech fish–pond farm (Fish Farm of Třeboň) operates managing more than 7 000 hectares of ponds. A long–term development of market fish production is shown in Table I.

Table I. Market fish production on the territory of the present–day Czech Republic (in 1000 t)

| 1950 | 1960 | 1970 | 1980 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 7 | 10 | 13 | 19 | 17.5 | 19.5 | 16.6 | 18.5 | 18.5 |

Carp as a traditional fish (produced mostly in a market size of 2 kg and more) is a dominant species, supplemented with other fish species (Chinese carps, whitefish sp., tench, some predatory fishes) produced mostly in polyculture with carp. Trout has no extra position due to both limited sources of high–quality water and a competition of imported trout. Apart from carp, whitefish and grass carp have a very good sound in domestic market. A species composition of produced fish is presented in Table II.

Table II. Species composition of market fish in the last five years (in %)

| species | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|
| carp | 88.1 | 88.5 | 87.8 | 87.5 | 87.8 |
| rainbow trout | 3.8 | 3.7 | 3.1 | 3.0 | 3.2 |
| tench | 1.6 | 1.4 | 1.5 | 1.5 | 1.7 |
| whitefish sp. | 1.4 | 1.0 | 0.9 | 0.8 | 0.5 |
| grass carp | 0.8 | 1.0 | 1.0 | 1.5 | 1.3 |
| silver carp / bighead | 2.9 | 2.8 | 3.1 | 3.0 | 2.4 |
| pike | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 |
| pike–perch | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| European catfish | 0.2 | 0.1 | 0.2 | 0.3 | 0.2 |
| Nile tilapia | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 |
| others | 0.8 | 1.0 | 1.7 | 1.5 | 2.1 |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Ponds are to be classified into four categories according to a degree of farming intensity. The first category represents fish ponds (usually multipurpose) extensively farmed without additional feeding the fish with a production level up to 0.3 $t.ha^{-1}$ of fish. The fourth category represents fish ponds with intensive feeding of fish and production over 1.6 $t.ha^{-1}$. The culture technique is well advanced in fish pond farming and balanced between an intensity possibilities, production economy and ecological conditions.

In general, intensity of pond farming is not directed towards maximizing production by means of intensive feeding the fish with pelleted feeds. In this sense, it is rather to speak about a semi–intensification in the Czech fish–pond farming which is primarily focussed on maintaining the high quality of carp flesh (as a result of proved farming technique giving into balance a utilization of natural food /zooplankton, benthos/ as a source of animal protein and a supplemental feeding the carp with cereals as a source of energy). This system of farming is fully in accordance with other conditions (economic /feed conversion of 1.6 on average/, ecological) and allows to keep a reasonable price of carp in a market.

Apart from pond farms and several trout farms, there are few culture facilities utilizing the heated effluents for production of warm–water fish (Nile tilapie, sturgeon, African catfish). Nevertheless, these facilities have not extraordinary effect on overall fish production.

An integral part of fish production is a fish processing. Up to now, most of fish is still sold as a live fish. This has a deep traditional roots (live carp in Christmas and/or Easter seasons). The proportion of processed fish (mainly chilled/frozen halves, steaks and fillets of carp and grass carp, smoked carp, smoked whitefish and smoked silver carp/bighead) is still very low and doesn't reflect the changes in life style and consumption habits. Fish processing is exclusively in hands of fish producers. The quantitative development in fish processing volumes is documented in Table III. The data referrs mainly to chilled/ frozen fish and basic semi–products.

Table III. Volumes of processed fish (in 1000 t of live weight)

| 1985 | 1988 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|
| 2.5 | 2.9 | 3.8 | 2.2 | 2.3 | 1.5 | 1.6 | 1.7 |

The decrease of fish processing volumes in the last five years has several reasons. First of all, it is a consequence of food market prices liberalization in 1991 followed by increased export of Czech live fish. It is believed this is only a temporary feature and, together with improving the economic climate in the country, balancing the prices between export and domestic markets, improving a local market and modificating a life style, the proportion of processed fish will gradually increase again.

Anyhow, a fish–processing sector is a bottle–neck of the fish farming industry. Non–adequate acceptance of processed fish in local market due to price competition of both marine fish and poultry, underdeveloped outlet channels and shortage of capital investment stay in the background of a low volume of processed fish, nevertheless it also exists a very subjective lack of courage to deal with this problem. A low profit margin may also be one of the reasons.

**Marketing**

In the past, fish were sold mostly by a fish producers. There was no interest of big state food organizations to deal with fish as a by–product of a food market. This situation was reflected in a scattered scheme of market not fully covering the country. Dependence on live fish was another aspect hampering the development of a market. And the overall problem of freshwater fish market was particularly based in fact the market was completely in state hands with no personal private motivation. The state fish farms aimed their activity to fish farming only. Marketing was a field out of interest and in this non–realistic aspect the fish farms followed the global false socialistic policy claiming the production is the primary viewpoint instead of market.

Nevertheless, the Christmas and Easter are still the two dominant seasons in local fish market. These two periods represent about 75 % of total domestic annual consumption.

Fish export is an important economic feature of the Czech fish farming industry. Its development in presented in Table IV. The export has increased due to both high quality of Czech fish and their very reasonable price. Beginning 1993, the export volume has been under influence of division of former Czechoslovakia; the Slovak market very depending on Czech fish became an export market. As to 1995, about 7700 tonnes of live fish and 300 tonnes of fish semiproducts and/or products were exported, of this about 6400 tonnes of carp.

Table IV. Export of fish (in 1000 t)

| 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|
| 2.7 | 4.6 | 5.6 | 9.3 | 7.5 | 8.0 |

Import of freshwater fish to the Czech Republic is negligible. It consists mostly from a portion–size trout (live, whole frozen, smoked fillets). No carp is imported at all. In 1995, about 250 tonnes of freshwater fish was imported altogether.

In the Czech Republic, fish consumption (including marine fish) is about 5.5 kg per person and year, of this freshwater fish represents about 1.0 kg. A marked decrease in consumption in the period 1991–1994 is now approximatelly balanced with standard figures from the end of eighties and the beginning of nineties. Consumption of freshwater fish is territorially very unbalanced, the highest is in the capital and in the South Bohemia. A market potential is high, nevertheless it needs a sophisticated marketing strategy including a very intensive promotion. Presently, there are no sufficient funds inside a fish farming industry itself to cover the costs connected with these problems.

**Research and education status**

Fisheries research (in broad spectrum from very practical problems to rather theoretical aspects) is principally realized through the Research Institute of Fish Culture and Hydrobiology at Vodňany which has joined the South–Bohemian University beginning this year.

Fisheries education has three levels. The skilled workers are educated in a three–year cycle at the Fisheries School at Třeboň, the technicians are educated in a four–year study at the Fisheries High School at Vodňany, and a university level of education is realized at the Czech Agriculture Universities, particularly at the Mendel University of Brno with a specialized fisheries chair.

**Legal aspects of fish production**

Fish farming is realized under the valid laws of the Czech Republic. At present, most of

Czech standards in fish production are adapted to the future status of Czech Republic as a member of the European Union.

In 1995, Fish Farmers Association was significantly engaged in a preparation of proposals of new Water Law and Fisheries Law which should be negotiated in parliament in 1996.

**Conclusions**

Under new economic conditions of the Czech Republic, fish farming is considered as a perspective field of agriculture activity. In pond–fish culture, the production methods are well developed and, in general, 1000 to 1500 $kg.ha^{-1}$ of market fish on average can be gained in ponds with only supplemental feeding the fish with cereals. The production capacity and amount of produced fish will be sufficient to cover both export and domestic market (even when consumption of pond fish will increase by 100 %).

In a long–term perspective, increase of pond–fish production can be expected. Although new small family farms will probably appear, their production will not seriously affect the total figures.

No dramatic changes in fish production can be expected in 1996. In this year, analysis of prospective potential of the Czech fish farming industry for the next decenium (particularly from point of view of market) will be also finished. Nevertheless, a short–term progressive development cannot be expected primarily due to both shortage of funds in fish farming industry and underdeveloped market.

# HUNGARY: NATIONAL REPORT ON FISH FARMING INDUSTRY

L. Varadi

Fish Culture Research Institute, P.O.Box 47, H-5541 Szarvas, Hungary

## Introduction

Hungary is a landlocked country in Central Europe with an area of 93,000 square km. The climate is typical continental climate with four distinct seasons. The fish growing season is about 150 days, when the temperature of the surface waters is above 16 C°. The average water temperature during the growing season is around 20 C°. During the fairly long winter time from November until March, the surface waters usually are freezing, and sometimes the fish needs special care. The annual precipitation is 800 mm, but most of the rain falls out of the growing season. About 140,000 ha natural water area and 20,000 ha man made fish ponds are the major resources for fish production in Hungary. Due to the special hydrogeographic conditions, more than 90 percent of the rivers have their source in the mountains of the surrounding countries, and this situation creates difficulties in the water management sometimes that has an effect on the fisheries and aquaculture as well. The geothermal water resources should also be mentioned as potential water resources for fish production. 81 freshwater fish species can be found in the natural waters in Hungary. 68 species are native in this region, while 13 species have been introduced mostly from Asia. There are 29 protected species in Hungary.

The history of fisheries in Hungary goes back to the 16th and 17th centuries when fish production in all river basins and wetlands were common. However, with the introduction of animal husbandry and the intensification of agricultural methods for crops, much of the lands were drained and most of the rivers were "channelized" by flood protection dikes. In order to compensate the decreasing captures from natural waters, extensive fish pond construction programme was started at the turn of this century. The first fish farms in Hungary were established in the 1890's, according to German and Bohemian standards, and the first "selected" carp varieties were obtained also from these countries. The total fish pond area was about 9,200 ha in 1938. As a result of a new fish pond construction programme after the Second World War, the total fish pond area reached 22,000 ha by 1975.

As joint efforts between farmers and scientists, remarkable results have been gained in the development of fish pond technologies in Hungary, with special regards to the fertilisation of fish ponds, reproduction biology and artificial propagation, and integrated fish-cum-duck production. Some of the Hungarian methods have gained world-wide acceptance in carp producing countries, and have been used all over the world.

**Freshwater fish production**

The fish production sector is a small, but special sub-sector of the agriculture. About 4,000 people are involved in fisheries and aquaculture currently, that is less than 0.5 percent of the total labour force. The total value of fish production was about 23 million USD in 1992, that remains below two percent of the total agricultural production. Fish doesn't play an important role in the diet of the people. The fish consumption per capita is less than 3 kg/year. Fish, however, has a special, traditional role during certain holidays, first of all during Christmas time. Aquaculture and fisheries are important elements in the cooperative management of aquatic resources in Hungary. Various fish pond technologies have been developed, that are based on the treatment and recycling of organic wastes. It is also worth to mention, that Hungarian experts have been actively involved in aquaculture development projects in developing countries.

As a consequence of the political and economical changes in Hungary, the fish production sector has been restructured and most of the farms have been privatised. During this transition period, the volume of fish production has declined (Figure 1)

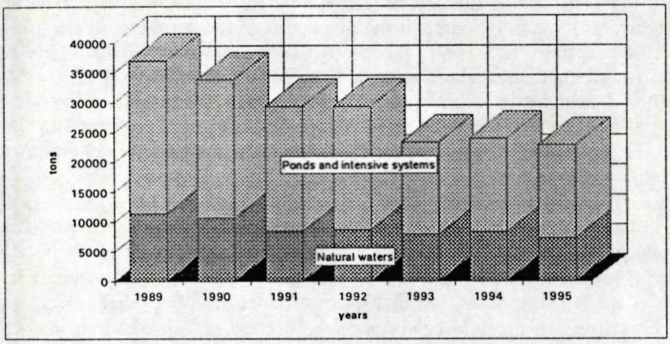



Figure 1. Total fish production in Hungary (1989 - 1995)

Undoubtedly, the changes and uncertainties in ownership were the main reasons of the drop in production, however the water shortage in the past years and the price increase of input materials also contributed to the decrease of fish production.

Water scarcity is a great challenge in Hungary that fish farmers have to face with. The internal renewable freshwater resources of a country ( that is the difference between the precipitation and evaporation, expressed in cubic kilometres of water per year, but it can also be expressed in terms of cubic meter per capita/year), is 591 $m^3$/cap/year in Hungary. Less than 1,000 $m^3$/cap/year internal renewable water resource is considered to indicate water scarcity. Hungary is among those twenty countries of the world where water is a scarce resource. Hungary is also heavily depending on river flows from other countries, since more than 90 percent of the rivers have their source in the mountains of the surrounding countries. Hungary is among those thirteen countries of the world that receive over 75 percent of their available water supplies from river flows of upstream neighbours. The water scarcity is the main reason why conflicts have been increasing between the water suppliers and water users, and among the different competitive users. In some areas the cost of water can reach 20,000 - 30,000 HUF/ha ( 130 - 200 USD/ha). However, when the production is expressed as a function of the renewable water resources, the exploitation of the fisheries potential is rather high in Hungary.

Common carp dominant polyculture production in large size fish farms ( up to 5,000 hectares ), that were operated by large co-operatives and state farms under the centrally planned economy have been general pattern in fish production in the past forty-five years in Hungary. Traditional pond production technologies have been applied in pond fish farms, with slight differences in intensity level. As a result of the restructuring of the fish production sector, the rather uniform management practice in pond fish farms has been changed, and the new managers are adjusting the production technology to the local biological, physical and socio-economical conditions and market realities. In some areas, where the conditions (first of all water supply) are favourable, intensive pond production is carried out, while at some other areas fish ponds are used for extensive production with low stocking density, without or with low level supplementary feeding. Some of the fish ponds have more diversified use, including angling, eco-tourism, bird sanctuary as well. Based on the availability of geothermal water resources in Hungary, and the good export possibilities of some high value species, numerous new entrepreneurs started intensive fish production in tanks and in small ponds supplied with geothermal water. The most important cultivated species is common carp, that comprises 74 percent of the total fish production as shown in Figure 2.

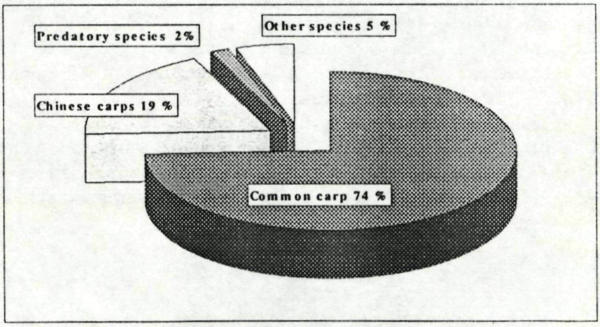



Figure 2. Fish production by main species in Hungary in 1994

The species composition of the fish production in ponds and intensive systems is shown in Table I. Unfortunately no reliable statistical system is available presently in Hungary, therefore caution is needed when the data of Table I are analysed. The table for example doesn't show the production data of one of the major fish farms with 2,000 ha fish pond area, and the production of several newly established or upgraded intensive farms, where African catfish is produced.

Table I. Fish production in ponds and intensive systems by species in 1994
(The data include the production of all age groups)

| Fish species | Production in tons |
|---|---|
| Common carp *(Cyprinus carpio)* | 11,659 |
| Silver carp *(Hypophthalmichthys molitrix)* | 2,112 |
| Grass carp *(Ctenopharyngodon idella)* | 671 |
| Bighead carp *(Aristichthys nobilis)* | 205 |
| Tench *(Tinca tinca)* | 5 |
| Catfish *(Silurus glanis and Clarias gariepinus)* | 179 |
| Pike perch *(Stizostedion lucioperca)* | 52 |
| Pike *(Esox lucius)* | 21 |
| Trout *(Oncorhynchus mykiss)* | 11 |
| Other high value species | 9 |
| Crucian carp *(Carassius auratus)* | 655 |
| Other low value species | 71 |
| Total | 15,650 |

The ratio of common carp has been increased in the past years, and the share of the predatory species in the total production has also been higher. The large quantity of the harvested low value species indicates the potential in the further increase of the production of predatory species. The production of the herbivorous species, especially silver carp, has been declining. The total fish production was 22,866 t in 1995. 68 % of which (15,552 t) came from ponds and intensive systems, while 32 % (7,314 t) from natural waters and reservoirs. The net yield in pond fish farm was 563 kg/ha, that is less with about 12 % than in the previous year.

7,314 t catch has been reported from about 140,000 ha natural waters and reservoirs in 1995. There is an increasing importance of sport fisheries on natural waters. The catch of the 330,000 anglers comprises about 20 percent of the market size fish production in Hungary.

**Marketing**

In the centrally planned economy trade was regulated administratively rather than by the market. The producers were dependent on the various state owned trading companies that were in a monopolistic position having exclusive export-import licence. Although foreign trade has been "liberalized" in the early eighties, business contacts and knowledge on this field remained the privilege of a fairly small number of experts. After being directed or guided by the state, most of the producers have not been prepared for the new challenges, they lack marketing skills, business and market information. The new law on "Market Regime" helps to regulate the market and to secure free and fair competition for all participants on the market. According to this new law, so called "Product Councils" have been organized with the participation of the producers and traders. One branch of the product councils is the Fish Council, that suggests limit prices, contingents, export-ban periods etc.

The domestic market is rather limited in Hungary. The fish consumption per capita is around 2.5 kg/year, and it seems to be quite stable throughout the past ten years. The producers in Hungary should also count with a higher competition with other imported fish products and also with alternative food products. While there is a rather stable but limited market for live fish, the development of processing is a key factor in the development of the fish production in the future. The structure of the fish consumption indicates the trends for the favour of processed products. Between 1993 and 1995, the consumption of live fish decreased by 13 percent, while the consumption of frozen and canned fish products increased by 32 and 142 percent respectively. It should be noted however, that the consumption of processed fish products is only about 1 kg/cap/year.

The income from export was about 5.9 million USD in 1995. About 37 percent of this income came from eel production in Lake Balaton, however, there is a campaign recently to eliminate this fish from the lake. The volume of carp export was 1,188 t in 1995, while that of Chinese carps was 369 t.

**Research and education**

Agricultural education and training is undertaken by a number of institutions including three agricultural universities in Hungary. Although no special fisheries engineering diploma can be provided at these universities, opportunities exist for students to specialized in fisheries, and there are also state scholarships to study fisheries engineering abroad. Vocational training and education is limited due to the relatively small demand by the sub-sector, and courses and post graduate education are held intermittently. There is one special school in Hungary for the training of skilled fishermen. The regular 3-year course caters for 20-25 students annually, but post graduate master-fishermen courses are also held occasionally according to the demand.

There is a solid research and development background in aquaculture and fisheries in Hungary. Special methods in the propagation and pond production of common carp that were elaborated by Hungarian scientists are widely applied world-wide. The core institution for research and development is the Fish Culture Research Institute at Szarvas, that is an internationally acknowledged center in this field. In spite of the serious cutback in financing research during the past three years, the institute could preserve and even develop the valuable research capacities as a result of an internal restructuring programme.

No special extension service is available for fisheries and aquaculture. However, those institutions that are involved in research and development on this field, are providing assistances and services through various channels. The Association of Fish Producers also assists the technology transfer providing linkage between farmers and research institutions, organizing meetings and training programmes.

## Legal aspects

Although the need for a new fisheries act has been discussed as early as 1988, the Decree No. 30 of 1977 is still in force. This declares that the right to fish is under State control except for a few small ponds in private lands. However the State transfer this right to appropriate users. According to the Decree, only State owned companies, agricultural and fisheries cooperatives, and the Hungarian National Angler's Union has the right to get fishing rights on natural waters and reservoirs. Since January 1993 this restriction has been removed and all companies, organisations and private entrepreneurs have equal right to apply for the fisheries right of a water area owned by the State. This has led to a slow restructuring in the utilization of inland waters for fisheries and aquaculture. The regulations regarding the licensing system for recreational fishing has also been changed. Before 1993, anglers had to apply for licences from the Hungarian National Angler's Union, and they also needed a permission from the user of a particular water body. Under the new regulation, State licences are issued by the Ministry of Agriculture, and the income from fishing licences goes to a Fisheries Fund, that is used for the development of the aquatic habitat, stocking, environmental protection, research and education.

A draft of a new Fisheries Act has been elaborated jointly by the Ministry of Agriculture, the Hungarian Fish Farmer's Association, and the Hungarian National Angler's Union, and it is expected that the Act will be passed in 1996. According to the new Fisheries Act, the fishing rights of those "closed" water bodies that are located on a private land, belongs to the owner of the land. Larger "open" water bodies and rivers will remain state property, therefore the fishing rights that have been given to some users before, remain valid further on. In the new Act there is a section for regulations regarding the protection of the fish and its habitat.

## Conclusions

The difficulties of the transition period into market economy combining with other difficulties related to the increasing competition for water resources and adverse weather conditions, created recession in fish production in the past years. The fish production sector should meet the requirements of an emerging more diversified market that requires continuous supply of high quality products, and the new regulations of the European Community requires special measures for producers and processors. The evolution of the Hungarian agriculture, and that of the fish production has inevitably become market driven. Based on long tradition in fish culture in Hungary, and a solid knowledge and experience on this field, and also on the entrepreneurial spirit of the farmers, the fish production sector will overcome those problems that are emerging and intensifying during the transition period into market economy, and the Hungarian fish production sector will be an integral part of the European fisheries and aquaculture community in the not too distant future.

# FISHERIES IN LITHUANIA

A. Rusakevičius[1], L. Janėnas[1], L. Jakštienė[2], E. Milerienė[1]

[1]Fisheries Department of the Ministry of Agriculture of the Republic of Lithuania
[2]Laboratory of State Pisciculture Centre

The Lithuanian coastline is very short, only about 99 km long, so Lithuanian economical zone is the smalest of all the Baltic countries. It includes open Baltic Sea and one-fourth part of the Curonian Lagoon with area of 41 300 ha. The economical zone is not yet fixet until this time, but it will be after negotiations between Lithuania and its closest neighbuors Latvia, Russia and Sweden.
Atthough being small the Lithuanian economical zone is one of the most fish-rich areas in the north-eastern part of the Baltic with big herring, sprat and cod stocks as well as with migratory and fresh water fish species.
The Lithuanian fishery and aquaculture are an important branches of the Lithuanian economy.
For the reason of economical crisis and loss of fishing rights in traditional areas the total catches of the Lithuanian fleet in the Open Seas and the Baltic Sea have fallen down. In the Baltic Sea fishing areas the Lithuanian total catches have been reduced from 18 till 12.4 thousand tons. Total catches in the inland waters of Lithuania (Curonian Lagoon, lakes, water reservoirs, rivers and pond farms) in 1995 year were 26 33 tons.

## Organization of the Lithuanian fishing industry

The overall responsibility for fisheries policy lies with the Ministry of Agriculture. The most important role is played by the Deep-Sea fishery operating in international waters of all parts of the Atlantic Ocean. The Baltic Sea delivers about 5.5-6.0%.
The development of the private sector was started in 1992.
Part of Lithuanian fishery, fish processing plants, institutions, organizations, hacheries belong to the Ministry of Agriculture, Fisheries Department regulation sphere. The Fisheries Department has two divisions - the Division of Deep Sea Fisheries and the Division of Inland Fisheries. The office of the Department is in Vilnius. The Department is run by the Secretary of the Ministry of Agriculture - Director of Fisheries Department. The chiefs of the both Divisions of the Department are Deputies of the Director of the Department too. In the Department are employed 13 specialists.
Representation of Lithuania in the International Organizations and Commissions, establishing and permanent maintenance of International

fisheries relations with foreign countries, management of Lithuanian Deep-Sea Fishing Fleet activities in the International waters and executive zones of foreign countries is the prerogative of Fisheries Department.
Specialists of the Department also work with very many problems and questions, connected to fishery regulation inside the Lithuania.
Management of Fishery Resources and Licensing in the Lithuanian Fishery Zone in the Baltic Sea and inland waters is conduced by two Departments - the Fish Resources Department of the Ministry of Environmental Protection and the Fisheries Department of the Ministry of Agriculture.

**Marine fishery**

LARGE - SCALE FISHERY

Lithuanian large - scale fish industry is concentrated in Klaipėda. Here, in the ice - free fishing and commercial port all fishing, transport and auxillary fleet which consist of more than 130 vessels 60 of them have posibilities to fish in open Oceans. Approximately 90% of total catches of Lithuanian fishing fleet is cought in the open Atlantic fishing areas and executive economical zones of foreign countries such as: Mauritania, Senegal, Guinea - Conacry, Guinea - Bissau, Sierra - Lione, Canada, Faroe Islands and others. Till the end of 1991 the Lithuanian fishing fleet works in zones of foreign countries according to bilateral agreements entered by the USSR. Since 1 January 1992 Lithuania has lost its rights.
The Klaipėda State Transport Fleet Company has 15 vessels.
The main plant of fish processing is JSC "Fish Cannery", located in Klaipėda. In the largest towns of Lithuania such as Vilnius, Kaunas, Šiauliai, Klaipėda, Panevėžys, Kėdainiai there are fish processing plants and trading companies of local importance. Total capacity of fish processing plants on the coast - 12 000 tons of fresh, frozen, salted, smoked fish including over 15 million conditional cans of various canned fish per year.
The greatest part of fresh, frozen and canned fish and other sea products are exported to the former Soviet Union market as well as to the Poland and Chech Republic.
In Klaipėda there are the following large - scale fishery plants and institutions too: two Ship Repairing plants, the "Baltija" Shipyard, Klaipėda Package JSC "Progresas", JSC Fleet Engineering Centre, Fishery Joint - Stock Company "Baltija", Klaipėda Marine College, Fisheries Research Laboratory and other organizations.

BALTIC SEA FISHERY

The largest fishery Joint Stock Company "Baltija" exercise active fishing of herring, sprat, cod, salmon, flounder and other fishes in the Lithuanian fishery zone in the Baltic Sea. In 1992 year this Company had 40 trawlers. Now

remained only 19 trawlers. Others were privatized, but still are working in the same field. Total catches of Company in 1995 year were 8 000 tons. This the occupations of company are fishing, fish processing, repairing of the vessels, production of fishing tackle, selling of the fish products. Three refrigerator trawlers are specialized on freezing of sprat and herring in the Sea. 940 workers are employed. Canning factory of JSC "Baltija" have capasity to produce 3 million cans of sprat in oil, 1 million cans sprat paste and 1 600 tons smoked herring annualy. The factory is supplied with refrigerator with the capasity of 1 500 tons.
Also there are some private fishery enterprises, such as Joint Stock Company "Pajūrio žuvis" (3 various vessels) and Joint Stock Company "Neringos žuvis" (6 vessels). There are two associations, which unite private fishermans. The first - Association of Fishery Enterprises Klaipėda office - has 23 owners of fishing vessels. The second - "Pajūrio kraštas" - units about 120 owners of fishing boats fishing in the coastal zone.

**Inland fishery**

The Republic of Lithuania has 4 000 lakes with an area of 93 850 ha, one - fourth of the Curonian Lagoon with an area of 41 300 ha, some not large water reservoirs and rivers. Commercial fishery is widely spread in the Curonian Lagoon, in the majority Lithuanian lakes, reservoirs and rivers (partly). The total fishing areas of inland waters is approximately 82 000 ha. Whereof 161 lakes and reservoirs (26 500 ha) are used for the development of the intensive fishery.
In 1995 in the lakes and rivers of Lithuania approximately 114 tons and in the reservoirs 61 tons of fish were caught. The valuable fishes such as: bream, pike, pike-perch, vendace, eel, carp, crucian, sheatfish (silurus), burbot, whitefish make only 35-45% of the total quantity of fishes caught in the lakes. The main part of total catch in the lakes is perch, roach and other not valuable species.
One of the basic reasons of the demishing of the resources of valuable fishes was ecological situation, because in the Soviet period Lithuanian industry and agriculture were using low level technologies.
Fish breeding and lakes restocking programmes were developed not enough, technical and biological reclamation measures of the lakes were almost forgotten. We do not have enough hatcheries, fish breeding ponds, basins for stock material farming. The main object for stocking of the lakes are pike and vendace. Total stocks in 1995 were 40 166 thousand fishes. The lakes of Lithuania were not stocked by glass eel for a long period already because of the lack of hard currency. But in 1995 we stocked 319 thousand glass eel. The normal demand of glass eel is 4.5 million pieces per year.
In the Curonian Lagoon in 1995 year were almost 90 private enterprises catching fish. The main fishes for catch are bream and pike-perch, perch.
At present the ecological situation in the Curonian Lagoon is very difficult - the delta is overgrowing with grass, it is getting muddy and all this is partly

preventing fish migration, feeding and spawning conditions. Particularly the Curonian Lagoon is suffering from the bad cleaned waste waters. As a result of all this the structure of species caught in earlier one of the most productive Lagoons in Europe went worse.
The data of Lithuanian total catches in the Curonian Lagoon in 1990 were 2 323 tones, 1991 - 1 465t, 1992 - 1 385t, 1995 - 744t (from them bream 358 tons, roach -243 tons, pike-perch - 38 tons).

**Aquaculture**

The works of fish breeding for stocking of natural waters in practical or commercial scale in Lithuania began at the end of the last century. At that time hatchery "Vokė" was built at the suburbs of Vilnius. It has been a hundred years and is successfully working now. This hatchery and about 400 hatcheries and fish farms in some countries were designed by famous in all Europe pisciculturist M.Girdvainis.
In the post war period in Lithuania some hatcheries were built: "Ignalina", "Simnas", - for white fish breeding, "Rusnė" - for salmon and vimba breeding, "Žeimena" - for salmon, trout, pike, whitefishes breeding and "Laukysta" - for trout and carp breeding.
At present the following species are used for stocking natural waters: carp, trout, whitefishes, vendace, pike, pikeperch, salmon and sea trout. In 1995 40 million young fishes of different age were released to the inland waters.
Stocking of natural waters is carried only by state owned hatcheries, but also by pond fishery farms. They form a great part of stocking material of carp, whitefish and pike which is used for stocking lakes.
A lot of spawning feds for vimba and other fishes brood stock were cleaned and new ones were built in the rivers of Lithuania.
We have many problems concerning investigation and estimation of resources of Baltic salmon, sea trout,brook trout and other valuable species and effectivness of their natural spawning in the rivers of Lithuania. Today we doing these works on a largest scale, because about 20 years ago these works, including the artificial breeding of Baltic salmon, sea trout and vimba were stopped without any reasons by the Soviet time inland fishery leaders. Now these important works were renewed.
In order to protect the decrease of resources of salmonid species and to quarantee their optimal level in the fishery zone of Lithuania, in the nearest future we must reconstruct old Lithuanian hatcheries according to the latest technological demands.
As far back as 30 years ago the Lithuanian export of wide - claw crayfish has been the fourth highest in Europe. The crayfish plague in the subsequent years decreased the crayfish stock considerably, and their export was suspended. Nowadays the attempts are made to restore their stock. For this in Simnas hatchery was found a base for crayfish stocking.

**Pond fishery**

According to the data of 1995, there were 20 Joint Stock Companies, LTD firms and enterprises, which were growing fish in Lithuanian Republic. General areas of ponds covers 9 725.04 ha. The privatization was accomplished (carried out) according to the law of Property Privatization of Lithuanian Republic. Production of aquaculture is regulated by the law of the Earth (1994 year, No.1-446), the law of the Earth Rent (1992 year, No.1-354), the law of the Environmental Pollution and the resolutions of Lithuanian Government.
2 776 tones of alive carp were saled in 1993 year. In the second years amount of realized carp decreased - it was 1 784 tones in 1994 and 1 608 tones in 1995 year. The profit last year was 0.175 mln USD. It reduced about 0.75 mln USD in comparison with 1993 year. The main production of the ponds is alive carp. The realization was about 90% . Besides the carp we grow and sale peled, pike, pike-perch, gold fish. Approximately 70-80% of saled carp is scaly and about 20-30% is mirror carp. The average weight of the carp for sale is 800-1500g.
During the last years the growing (cultivation) of the carps became more extensive.
Corn is used more and more as food for the carps, because it is 3 times cheaper than combined food.
Therefore the productivity of ponds decreased from 700 to 500-600 $kg.ha.^{-1}$.
During the last three years the greatest productivity of first year carp in ponds in joint ventures "Bartžuvė" 809 $kg.ha.^{-1}$ and "Vasaknos" 775 $kg.ha.^{-1}$, second year carp in Raseiniai 1 020 $kg.ha.^{-1}$ and "Bartžuvė" 984 $kg.ha.^{-1}$ and commercial carp in "Bartžuvė" - 1 067 $kg.ha.^{-1}$, "Šventjonis" - 1 073 $kg.ha.^{-1}$.
The similar situation is in growing stock material. The Lithuanian pond farms have 6 sections for the incubation, which are able to satisfy the needs of all farms with larvae. But still about 20% of the larvae farms get from the natural spawning. All selecting works are concentrated in the selective farm of Šilavotas.
The systematic works for the breeding of carps in Lithuania are carried out since 1972. For this purpose to Šilavotas - specialised ponds section, the following species of the carps were imported: Lithuanian Bubių (B), Western Ukraine (U) and German (V).
During the long term studies (research works) new hybrids have been evaluated, the recommendation for the spawning of the trade carps and reproduction of stock carps (thoroughbred carps) have been prepared as well as the future plans for carps selection have been forseen.
The best productivity characteristics have showed German, Ukraine (VxU) and the triple hybrid (UxBV) carps. The vitality index of hybrids is 25% higher, the growth rapidity is 30-40% higher, the output is 50% higher, than of those pure Lithuanian, Ukraine or German carps.
In 1988 the selection works with European carps and carps with the blood of A Grass carp, S Wild carp have started in Silavotas. The good results we got in the selection of hybrids with the Lithuanian and Para carps (Russia). At present

time there are hybrids with 12,5% blood of A Grass carp S Wild carp and some kinds of hybrids with 6,25% A Grass carp S Wild carp blood in Šilavotas. In former times the brood stock carps selected in Lithuania have been realised in Russia, Ukraine, Belarus, Latvia, Kazakhstan, Uzbekistan, Armenia.
The industrial capacity of pond fishery farms in 1990 were 6 000 tones of alive carp for trade. Now the growing of the carps decreased three times, because of the market problems. But we think, that amount of exported carp will increase this year (last year we exported only 100 tones of alive carp, were in 1993 it was exported 708 tones of ones), because of supposed abolishment of customs duty for alive fish in some countries. At the present time we grow mainly the mirror carps and other fish species as: pike, peled.
All works with aquaculture are carried out by the Fisheries Department, witch is subordinated to the Ministry of Agriculture. The Fisheries Department executes the state regulation in the field of fisheries directly. All Joint Stock Companies, LTD and farms are under the direct subordination to the Local Authorities of Regions.
In 1994 was formed state Pisciculture Centre. This Centre planned an intensification for Republican ponds and lakes farms and Joint Stock Companies. The most attention is attached to hydrochemical, hydrobiological, biochemical and ichthyopatological researches and broadening of biotechnological control, witch carries out Laboratory of State Pisciculture Cetntre.

**Ichtiological research**

In 1993 fishery resources in the Baltic Sea and in inland waters were investigated by specialists of the newly founded Fishery Research Laboratory of the Lithuanian Inatitute of Agrarian Economics, which obtained a new research ship "Darius", and of the Institute of Ecology of the Science Academy of Lithuania to the orders of Fisheries Department of the Ministry of Agriculture of the Republic of Lithuania. Based on state financed agreements, the main trends of research were as follows:
-investigation of fish resources in the Lithuanian economical zone of the Baltic Sea, in the Curonian Lagoon and the Lower Nemunas;
-investigation of by-passing and vanishing fish resources and preparation of means for their preservation and augmentation;
-epizootic state of pond fishery, means to fight fish deseases and crayfish breeding technology.

# ACTUAL PROBLEMS, ACHIEVEMENTS AND PERSPECTIVES OF AQUACULTURE IN MOLDOVA

I. Toderash[1], E. Zubcova[1], M.Usatai[2], V. Lobcenco[3], A.Toderash[4], L. Curcenco[3], V. Nauc[1]

[1] Moldovian State University
[2] Institute of Zoology of the National Academy of Sciences
[3] Scientific station of fishery
[4] Institute of Microbiology

## Introduction

Moldovian Academy of Sciences is a leader in the elaboration of the scientific basis for aquaculture. The Institute's scientists contributed a great deal to the development of such directions as aquaculture on the basis of natural reservoirs-coolers of power plants, on the basis of small reservoirs and pond farms, and on the basis of industrial fish farms.

## Freshwater aquaculture production

During a long period of time, the Institute's ichthyologists are monitoring the population reproductive capacities and ecology of reproduction of commercially valuable and rare species of fish in rivers and reservoirs of Moldova. On its basis methodological recommendations were elaborated for stocks reproduction and protection of *Styzostideon lucioperca, Vimba vimba, Barbus sp., Abramis brama, Rutilus rutilus* and other fish species in the Dniester river, in Kuchjurghan reservoir and many others. Also the eco-industrial method of phytophylic fish reproduction and new technological elements and appliances for its insuring were elaborated (Authorised certificates No704565, No1556609).

Moldova is rich not only in big reservoirs, but also in a multitude of small rivers, were cascades of ponds and small reservoirs were built. Ichtiological, hydrobiological and hydrochemical researches allowed to give a scientifically based system of aquaculture in reservoirs used for irrigation, which provides a receive of additional fish production due to rational natural foodstuff.

A significant part in the Institute's research the problems of biotechnics of industrial reproduction and growing of different species of fish and other hydrobionts perfectioning play.

On the basis of long-term experiments, methods of industrial reproduction of aborigine species (*Styzostideon lucioperca, Vimba vimba, Abramis brama, Cyprinus carpio, Tinca tinca* and others) and introduced ones (Chinese carps, catfish and other) were elaborated.

The recommendations on preparation and use of *Carassius auratus* and three-year-old carp hypophysis for stimulation of fertilisation of producers of commercially valuable fish species. Also a new method of keeping of the fish spawn and larvae (Authorised certificate No841624) and a whole series of appliances for spawn incubation and larvae growing of Cyprinidae and Ictaluridae fish (Authorised certificate No644425, No793529, No 815779, No 1033099, No1060158). In the field of CHPP waste water use, the biotechnique of carp and catfish larvae production on warm waters in early periods were modificated.

Of great interest are the scientific researches of fish stress during the process of their industrial reproduction was spared. As a result, new biotechnical elements were introduced into the method of artificial reproduction of the Far East Chinese carps, which allows to decrease significantly its stressogenity and to prevent the damaging consequences of stress (Authorised certificates No1056975, No1111712, No1124900, No1210756).

For the practical realisation of the hypostressogenic biotechniques of artificial reproduction, the basic principles of the industrial fishery complex formation were modified, and also a range of new constructive elements was elaborated, which increase significantly the effectiveness of the process of fish reproduction (Authorised certificate No1194341).

The technologies of foodstuff hydrobionts cultivation and growing on them fish larvae in temperature conditions close to natural ones, but with a larvae density 400 times greater than the one in ponds were also perfectioned at the Institute of Zoology. A range of new appliances for larvae, juveniles and commercialised fish growing in industrial conditions were elaborated (Authorised certificates No886868, No925272, No1127135).

Some potential benefits derived from the preservation of fish gametes can be obtained using the cryobiologic approach to the artificial reproduction: (1) Gametes of desired species could be shipped from hatchery to hatchery in dependence on the demands of individual spawning seasons. Furthermore, the risk of spreading infection diseases would be greatly reduced by using frozen gametes instead of live fish; (2) The number of males normally kept as broodstock fish from season to season could be reduced or, possibly, eliminated entirely at some facilities; (3) If one sex ripens in advance of the other, there would be assurance of having mature gametes of both sexes on at the proper time.

A work on evaluation of a group of compounds, effective as cryoprotectors with the definition of cryoprotective media formula for common carp (*Cyprinus carpio*) sperm was undertaken in collaboration with Laboratory of Cryobiology of Institute of Physiology (Moldovan Academy of Sciences). The performance of sperm quality before and after pretreatment, freezing and thawing being highly effected by series factors such as temperature maintenance before pretreatment, the extender formula, the cryoprotective agents, freezing facilities, the protocol, cryopreservation conditions, the thawing method and the postthawing application, the role of these factors was analysed. At the same time, a study on evaluation of the degree and nature of injuries, issued as a result cryopreservation (study of proteins and lipids; aminoacids composition before and after cryopreservation) was undertaken. The development of reliable techniques of fish sperm cryopreservation with the control over endangered species and the protection of their pool of genes by means of gene bank creation is to be investigated.

**Marine aquaculture production**

Collaborators of Institute of Zoology participate directly at the acclimatization of Mugil so-iuy Basilewsky and elaboration of the technique for its artificial reproduction. During this year the Odessa Fish Reproduction farm already supplies markets of Odessa with at least one tonne a day of Mugil so-iuy grown at the farm.

Due to the fact that recently the fresh water salinisation is observed in the Black sea region, this fish species comes into its own because this fish grows good in waters with 1-33% salinity.

Collaborators of the Institute obtained over 2 million individuals of Mugil so-iuy (average weight 25-30gm) which were introduced to the Poliev bay of Hagibey lagoon, at the Fish reproduction farm in Odessa region (the Ukraine) in 1995. The juveniles went through wintering successfully and feel comfortably in this water body. In the May of 1996 their average weight was about 100gm.

Meantime the artificial reproduction technique should be adjusted. Research workers of the Institute have some achievements in this field.

The Institute's experts carry out work on introduction and acclimatisation of shrimp species inhabiting fresh and brackish waters.

**Aquaculture**

Aquaculture in its classical meaning is the water organisms' reproduction and growth under controlled and semicontrolled conditions. The present information is a part of a wide range of problems being solved by Moldovan fisheries, and it contains only the fish reproduction in artificial conditions, cage growing, *Acipenseridae* species and catfish growing under semiintensive conditions, invertebrates growing and reproduction.
The fish growing in artificial conditions in Moldova commenced in the sixties, and actually includes over 20 species (*Coregonus sp., Cyprinus carpi*, four species of Chinese carps, *Styzostideon lucioperca, Abramis brama, Rutilus rutilus, Vimba vimba, Sparus auratus, Acipenser baeri, Acipenser stellatus, Acipenser ruthenus, Husa husa x Acipenser ruthenus, Acipenser guldenstadti, Polyodon sp.,* three species of buffalo and other species).

The fish cage growing in warm waters of Moldovan CHPP, which reservoir-cooler is

Kuchjurghan, was initiated in 1968. On the basis of received data, the conclusions were made on the possibility of the reservoir's water use for industrial fisheries and a receive of 190 kg. cm.-1 productivity at a density of carp caging equal to 300-400 specimen cm-1. The expenditure of the balanced food on the nutrient substances content accounts for 1.5-2 kg.kg of weight growth-1.

At the joint growing of *Cyprinus carpio* with Chinese carps, the latter is contributing to an additional production of 20-35 kg.cm-1. The optimal overweight of one-year-old fish when caging is 40-50 grams. The feed is 6-8 times a day during a light day, with a two hours break. In such a case the productivity accounts for 95%.

The advantage of autumn caging of standard weight fish of the same age is already proved. The method of supporting diet is giving an overgrowth and decreases the rate of wastes to 1-2 due to traumation.

Positive results were received when autofeeding was used.

In dependence on the surface used for caging, the global volume of fish in cages in Kuchurghan reaches 100-120 tonnes a growing season (May-October).

The catfish, carp "Fresinet", carp of German strains and Acipenseridae species' adaptive capacity in the reservoir-cooler was determined.

The influence of temperature on the effectiveness of the artificially prepared food use by carp in the practical absence of natural food was estimated.

It is already determined that carps grown in warm waters are in a better position as compared to the pond ones in the terms of food quality because of a higher content of dry substances, proteins and fat.

The work on trading production growth in cages placed in natural conditions of Goyan bay of the Dubasssary reservoir was made since 1987. Fish productivity in carp's monoculture accounted for 60-80kg cm-1 and in polyculture with Chinese carps it increased by 15-20kg.cm-1. The global volume of production in the limited use of the reservoir could reach 80-100tonnes.

The *Acipenseridae* species growing in semicontrolled conditions was made on *Acipenseridae* section of NIRHS in fisheries plant of Pridnestrovsk in 1974. The first object was *Husa husa* x *Acipenser ruthenus* introduced from Rostov, with a weight of three grams young fish. Later this species was introduced in young and spawn form from *Acipenseridae* farm of Volga.

*Acipenser baeri* was introduced for the first time in 1975. In 1983 it started to be grown in the *Acipenseridae* section of NIRHS. In the same time there were works done for reproduction and growing of Dniester population of *Acipenser ruthenus*. Since 1994

*Acipenser guldenstadte* and *Acipenser stellatus* caught in Duna started to be reproduced and grown. Since 1988 the object for reproduction and growth is becoming *Poleodon sp.* For all Acipenseridae species mentioned above, the technologies of their reproduction and growth were elaborated.

The growing of these species of fish was made in the experimental frame: *Husa husa* x *Acipenser ruthenus* was grown in industrial volumes of over 1tonne a year.

The catfish was introduced in Moldova in 1976. In the conditions of Cahul fishery farm the female school of these species fish was formed, and technologies for their growth and reproduction in conditions of natural temperature regime and cages on the waste warm water of Moldovan CHPP, including the biotechnics of pre-spawning keeping of fertile catfish in ponds with plastic covering, receiving of larvae by aquarium method and juveniles growing in trays and ponds in natural regimes of the IV zones of fisheries, growth of one-year and two-years juveniles in trays on warm water, profylaxis and treatment of catfish illnesses, preparation of ponds.

During the investigation process in the recent years, within the Institute of Zoology of the Moldovan Academy of Sciences a study of the technological scheme perfectioning of several species of *Protozoa*, *Rotatoria* and *Cladocera* cultivation was made. The aim of this study was to use them as starting food for the first 10-12 days of the postembrional development of fish alevins. This problem solving had a principal significance for perfectioning of the reproduction technology of economically precious fish species.

As a result of investigations in this field, the following was specified:
- the reproduction capacity in the cultivation conditions of the most prospective species of hydrobionts from the groups mentioned before;
- the optimal consistence of the nutrient medium in the cultivation;
- the optimal graphic of their introduction into cultivators;
- the optimisation of the preparatory scheme of preparation of pure cultures of hydrobionts;
- the optimal conditions of the environment's temperature in the cultivators were established;
- the optimal terms of daily extraction of hydrobionts' biomass from the cultivators;

and other.

The results of these studies were approved after the successful pass of the semi-industrial control.

**Shrimp**

As a result of the co-operation between collaborators of Institutes of Zoology from the Academies of Sciences of Belorussia and Moldova, the Japanese thermophyle freshwater shrimp was successfully introduced and acclimatisated in the reservoir-cooler of

Moldovan CHP plant Kuchurghan in 1996, for the fish foodstuff enrichment. The favourable abiotic and trophic conditions of the reservoir contributed to the fast formation of the local population, higher indices of linear-weight growth and reproduction compared to the populations from other reservoirs in the limits of the range(Vladimirov, Toderash, 1989; Vladimirov, 1994).

The biotechnique of fresh water mysides in floating capron cages was elaborated, which allows obtaining up to 15 thousand individuals of shrimps per square meter at the water temperature of 21-23°C and the initial density of fertile females in the limits of 60-90 specimen per square meter. The young shrimps are introduced into the fishery reservoir for fish foodstuff enrichment (Vladimirov, Toderash, 1983).

Recently Institute of Zoology Institute of Microbiology and the Botany Department of Moldovan State University carry out joint researches with the goal to achieve induced synthesis, production of biologically active substances from such microorganisms as *Spirulina pratensis*, *Nostoc linckia* and algae *Dunaliella salina* and *Porphyridium cruentum* and their application with the elements of advanced techniques in aquaculture.

# FRESHWATER AND MARINE AQUACULTURE IN POLAND

J.A. Szczerbowski
Inland Fisheries Institute, ul. M.Oczapowskiego 10, 10-719 Olsztyn - Kortowo, Poland

## Introduction

Total area of inland waters in Poland is about 7 000km$^2$, of this about 2 000km$^2$ is represented by river and dam reservoirs, 600km$^2$ by ponds, 3 000km$^2$ by lakes and 1 000km$^2$ by other waters (channels, marshes etc). As regards water resources per capita, Poland occupies 20th position in Europe (Leopold, Szczerbowski 1995). The Polish Fishery Zone in the Baltic occupies 8.5% of the entire Sea area, i.e. 32 500km$^2$ (Szczerbowski, Draganik 1994). These should be augmented by the brackish waters of the Lagoon of Vistula and the Lagoon of Szczecin of which 320km$^2$ and 514km$^2$ respectively belong to Poland.

Most rivers are heavily polluted. In 1978-1983, of the total length of Polish rivers (16 238km), only 1 107km (6.8%) were classified as meeting the criteria for the first class water quality. Lakes, occupying 92 720ha (30.3% of the total lake surface), are the recipients of sewage. Out of 131 larger dam reservoirs, 30 cannot be used for recreation and fishery, 16 of them are heavy polluted. The increase of the pollution was also observed in waters of Baltic Sea.

## Freshwater aquaculture production

Total fish production in the last 10 years from commercial inland fishery amounted on the average to 30 000t annually with the significant tendency of grow (Fig. 1). Unreported recreation catches from rivers and lakes accessible for anglers are estimated also at about 30 000t (Leopold, Bnińska 1987). Fish production from pond culture amounted about 23 000t, in this 20 000t were fish sold for direct consumption (carp - 17 000, trout 3 000t), the rest was used as the stocking material (Szczerbowski, Leopold, Bnińska 1988; Szczerbowski 1995).

The commercial fish landings from lakes amounted to 7 000t. It makes that the total fish yield obtained from lakes ranges from 60 to 80kg/ha. Increasing fish catches in the lakes reflect the effects of lake management - stocking with regard to vendace, whitefish, eel, and higher lake productivity due to eutrophication process (roach, bream) (Fig. 2). Predator populations show a decreasing trend along with lake eutrophication. This is well depicted for pike and perch respectively.

Polish lake waters are also under heavy pressure from recreational fishing. This results in considerable disturbances of the lake littoral and, consequently, has a negative effect upon the species inhabiting this zone. Landings of the typical littoral species also tend to decrease (tench and carassius). Catches of valuable cyprinids (bream and roach) show a decisively increasing trend, typical for lakes advanced in eutrophication process.

Fig. 1. Yield and production fishes in Poland (Szczerbowski 1996)

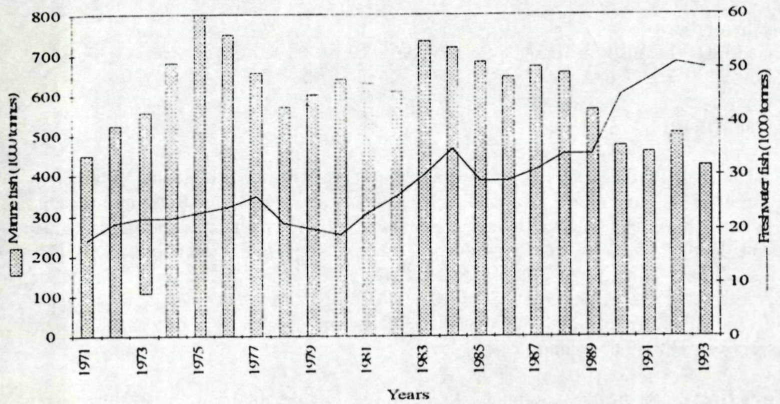
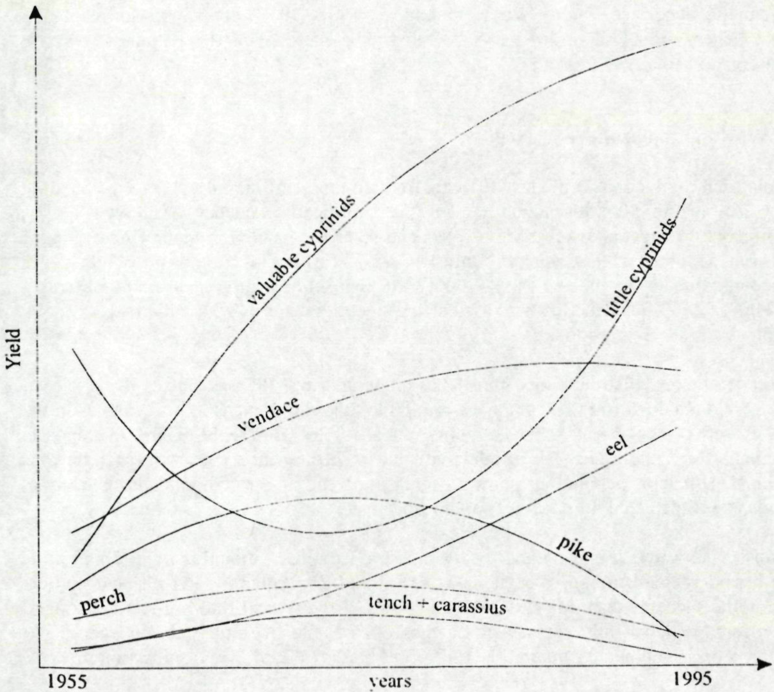



Fig. 2. Trends of lake fishes yield in Poland (Leopold. Szczerbowski 1995



The recorded fish landings from rivers and dam reservoirs amounted to about 700t. Recreational catches have been estimated at about 10 000t. It is accepted that total fish yield from the Polish rivers ranges from 50 to 120kg.ha$^{-1}$ depending on the region and river class. In case of river fishery, special attention should be paid to salmonid fishes. They are represented by salmon (*Salmo salar*), sea trout (*Salmo trutta*). Salmon is under total protection in inland waters, so its fishing is forbidden. Catches of this fish are made only in the sea. Commercial catches of salmon ranged from 22-78t in 1980-1984, 162-137t in 1985 and 1986 respectively. Sea trout is caught by the fishery cooperatives and by anglers in rivers, and by sea fishermen at the sea, where the catches amount to about 100-200t annually.

The result of pilot studies allowed to estimate that the river catches effected by the Polish anglers are predominated by roach (35%), followed by pike (18%), bream (11%) and perch (10%).

## Marine fishery

Thirty years ago the Baltic Sea was rated among area of with low productivity. In the middle of the 80s the total annual biomass removed from the Baltic reached almost one million tonnes. The Polish Fishery Zone that occupies 8.5% of the Baltic area (385 000km$^2$) yielded over 200 000t of fish. These should be increased by 8 000t of fish taken annually from the Lagoon of Vistula and the Lagoon of Szczecin. The bulk of the Polish catches taken from the Baltic waters was composed of three species: cod, herring and sprat. Cod and sprat are more abundant in the eastern part of the Zone, whereas the richest fishing grounds for herring are located in the central and western part of the Zone.

Polish catches in the Baltic Sea diminished by more than half in the period 1980-1991. In 1980 and 1982 they exceeded 200 000t. Since 1984 a steady catch reduction is being observed. In 1990 the catches were about 110 000t, and in 1991-1995 - about 100 000t. In contrast to many previous years, the national quotas for three main Baltic species had not been utilized in full within the three subsequent years, i.e. 1989-1991. In 1991, for instance, the quota for cod was used only in 74%, for herring - in 51%, and for sprat - in 54% (Szczerbowski, Draganik 1994).

Therefore, the decline in the cod catches was caused first of all by natural factors (hydrological conditions) and secondly by an excessive fishing effort.

## Marketing of national products in Eastern and Western Europe

It was estimated that in 1991-1995 there were about 300 000t of fish on the Polish market, in this 265 000t of sea fish and 35 000t of freshwater fish. Hence, fish consumption was not high, about 7kg/year/capita (tab. 1).

Usually, pre-prepared fresh fish are difficult to obtain on the market. Partly processed fish (marinated, salted, smoked, frozen) are, however, generally available. Fish consumption in Poland is also indirectly affected by fish import. In 1993 about 3 000t of carp and about 155 000t of sea fish were imported from East Europe. Fish exportation to West European countries was 2 100t of trout, 1 200t of lake fish, and some 155 000t of sea fish.

Table 1. Fish marketing in Poland (1000t per year in 1985-1995) (Kosko 1995)

| Table fishes | Production | Export | Import | Consumption | kg/capita |
|---|---|---|---|---|---|
| Carp | 20 | - | 5 | 25 | 0.6 |
| Trout | 4 | 2 | - | 2 | 0.03 |
| Lake fishes | 6 | 1 | 1 | 6 | 0.1 |
| Together | 30 | 3 | 6 | 33 | 0.7 |
| Marine fishes | 250 | 200 | 150 | 233 | 6.5 |
| Total | 280 | 203 | 156 | 266 | 7.2 |

## Legal aspects of aquaculture and marketing

The most important legislation which regulates all inland fisheries in Poland is the Inland Fisheries Act of 18 April 1985 (Dz.U. 1985 nr. 21, poz. 91). It is related to the Water Law (Dz.U. 1974, nr. 38, poz. 230) which states that all open waters belong to the State, except waters located within private land (Szczerbowski 1995). Fish and other aquatic organisms are living assets which can be exploited only after having obtained a legal permit for the fishery use of waters, sport catches being the only exception to this rule.

The Inland Fisheries Act determines the conditions for fish culture, breeding and exploitationn. It defines also the basic terms: culture is defined as the activity aimed at maintaining and enhancing fish production, breeding as the activity which also comprises selection in order to maintain or improve fish quality. Those having the right to carry out the fisheries management are obliged to proceed in a rational manner, i.e. to fully utilize the productive potential of the water. The permit for the fishery use of water is given for the whole fishery region to one user only. In waters specially suitable for fish culture or fish breeding areas may be established, in which most of the protective regulations are not valid. Protective zones may also be established within a fishery region, for example places of fry development, fish wintering, fish migrations or spawning ground etc.

The Inland Fisheries Act is valid together with the Legislation of the Minister of Agriculture, Forestry and Food Economy (Dz.U. 1985, nr. 33, poz. 151). It states protective sizes, standards for the fishing gear, mesh sizes and protective seasons. At present the Fisheries Act is to be updated taking into consideration new social and economic conditions.

## Organization of the production

In 1995 a new legislation was passed on agricultural property. At that moment there were 62 state fishery enterprises on lakes and state fish farms on ponds (Nowicki 1995). Since then number of private enterprises is steadily increasing. Natural waters belonging to the State are gradually leased to private companies and users, which at present use over 75% of inland waters utilized for fishery purposes. Some waters are administered by the State Research Institutes, non-agricultural branches (e.g. Ministry of National Education, the Polish Academy of Sciences and Government). The Polish Anglers Association disponed of about 500ha of fish ponds, 90 000ha of lakes and 88 000ha of rivers and dam reservoirs. The majority of ponds belonging to this Association is used for producing stocking material (80%), while open waters are used for sport fishing. The Association has 800 thousand members.

Sea fishery is almost totally carried out by private fishermen. The remaining state enterprises are gradually being transformed into private companies.

**Status of research and education**

Research in the field of inland fisheries is carried out by the organizations subordinate to the Ministry of Education, most of all by the Inland Fisheries Institute in Olsztyn and, to a lesser extent, the Polish Academy of Sciences. The Inland Fisheries Institute is supervised by the Ministry of Agriculture and Food Economy (Szczerbowski and all. 1995). The Institute is engaged in research and studies on the biological principles and methods of intensifying fish production, fish breeding, acclimatization of new species, fishing techniques, and economics of inland fisheries. It is also engaged in training the scientific staff, disseminating the knowledge, and extension services.

Vocational education relating to inland fisheries is carried out by the fishery schools in Sieraków, Giżycko and Kock. The schools also have their own fish farms. A higher level Technical Fishery School is located in Sieraków as well. Education at the academic level is carried out at the Faculty of Water Protection and Inland Fisheries at the University of Agriculture and Technology in Olsztyn. An academic degree in fisheries can also be obtained at most agricultural universities in Poland, and most of all at the Faculty of Sea Fishery and Food Technology at the Academy of Agriculture in Szczecin.

**Conclusions (future trends)**

The development in the Polish inland fisheries is similar to that observed in many countries situated in the same climatic zone. The traditional methods currently employed in the Polish pond fishery provide little possibility for an increase in fish production. Nevertheless, there is still a room for improvement among others by the use of waters used for cooling in the electric and heat-generating plants. Moreover, if the existing farms were modernized, equipped with oxygenerators, and the fish fed with feeds containing high protein concentration, there would be a possibility to increase their current production two to threefold. This requires that they would operated in the recirculation water systems which, if besed on water from power plants should be purified before. The above mentioned approach seems to be the most practical one in the current circumstances to meet an increasing demand for fresh fish and fish products. Inland fisheries operating in lakes and rivers could maintain the current level of market supply with such sought for species as whitefish, vendace, pike, eel if the exploited waters were duly stocked with larvae or fry of those species. Stocking of some more eutrophicated lakes with tench and carp is indispensable. Moreover, the management criteria require removing of some species considered as a weed fish, which are strong competitors of the valuable species in lakes and rivers. This refers to stickleback, bleak, roach, white bream and in some type of lakes - also bream. Fish rearing in cages might be allowed on condition that the output water is of the same quality as that inflowing to the farm.

Development in the Polish sea fishery is limited by the international law ruling the fishing activities in the waters extending over the continental shelf. It seems that the Polish deep-sea fishery has reached its peak level and will decrease steadily. The Baltic fishery is limited to a very productive Fishery Zone, but the living resources supporting the fishery in the Zone are sensitive to changes in the environment triggered by pollution and pressure from the fishery.

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# AQUACULTURE STATUS IN ROMANIA
**- national report -**

Prof. dr. eng. Mircea Rauta[1], Eng. Nicolae Dimulescu [2], Dr.eng. Constantin Pecheanu [3], Assist. eng. Cornel Ceapa [1]

[1] "Dunarea de Jos" University of Galati, Romania.
[2] "Rompescaria" Employers Association, Bucharest, Romania.
[3] Fisheries Research Center of Galati, Romania.

## Introduction

Fisheries' potential of Romania was and has been well established as one of the most important from Europe, considerably contributing to ensure the safety and food health of the population, during all historical stages covered.

At the beginning of the XX-th Century fisheries' potential of Romania was about 1.5 millions hectars, from which over 90 % were represented by Danube holm and delta. The first decades of this Century coincided with starting the dyking of Danube holm with a view to obtain new agricultural land. In such a way, up to 1933, 59 000 hectares were dyked, but starting with 1960 it was passed to the total dyking of the Danube holm, action that was quite close to be done.

As a result of this, fish production considerably decreased fact that determined the state bodies to encourage fishculture development by building new fish farms.

Fisheries' patrimony of Romania consists actually of:

- 300 000 ha. of natural lakes, including the lakes from Danube Delta.
- 99 000 ha. of reservoirs.
- 100 000 ha. of fish farms, from which:
  - 84 500 ha. of commercial fish farms.
  - 15 500 ha. of hatcheries.
- 60 ha. of trout farms;
- 66 000 km of inland rivers;
- 1 075 km of Danube on Romanian territory ;
- 25 000 km$^2$ Exclusive Economic Area at the Black Sea

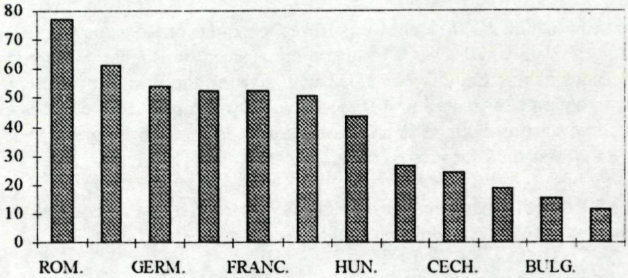
**Freshwater Aquaculture Production**

Seizing the existing patrimony the fish production obtained by fishing and aquaculture continuously increased.

If at the end of the second decade the annual fish yield was 32 000 tones, in the ninth the fish yield placed Romania on the first place in Europe (excepting the former Soviet Union).

In the paper "Fishery Statistics - Catches and Landings" vol. 74/1992, edited by FAO the major inland fish catches are published, during 1983 - 1992 (Fig. 1).

Fig. 1. The Major Captures - Inland Waters by European Countries for the Period 1983 - 1992 (Thousand Tonnes)




Adding the almost 150 000 tones fished annually by the Romanian long distance fleet, the total fish production of Romania was about 230 000 tones per year, which is conducive to an amount of 9-10 kilograms fish per capita.

The beginning of the tenth decade of our century is representing a cross-road for the Romanian fishing and fishculture. The transition process toward the market economy, political, social and economical structural changes that are going on, determined some lacks of poise that affected all the economy including the visible falling of fish production.

From 77 300 tones which was the fish production in 1988 this one comes to 32 000 tones in 1993. There are complex and multiple causes that are conducive to this regress, those causes being linked to the over-exploitation of the aquatic resources in the past

20 years, aggressive water pollution, changes induced in the local populations by introducing and supporting of the Asian carps unlike by the population, the existing legislative emptiness that is stimulating the exploitation untidiness and is facilitating the poaching as well as the lack of financial resources of the production units.

The last years showed a slightly straightening of the fish production. If in 1994 was registered a production of 34 000 tones of fish, in 1995 those rose at 37 930 tones, from which:

- 34 501 tones in inland waters;
- 3 429 tones in marine waters.

We should notice that by aquaculture 25 832 tones of fish were obtained.

The species weight in the marketable production is: carp - 14%, Asian carps - 53% and other species - 33%.

**Marine aquaculture production**

Even the national fisheries patrimony is including quiet a large surface (25 000 km$^2$) represented by the Exclusive Economic Area of the Black Sea and on the other hand there is a considerable demand, both on local and external market for the suitable species for marine aquaculture (shellfish, turbot, grey mullets, shrimp, etc.), there are not production units in this field.

However, small quantities of some of above mentioned species are fished from the natural waters and used for export or sold on local market.

The done researches (especially at the Marine Research Institute of Constanta) showed the great potential of marine aquaculture in the Black Sea, being achieved reproduction and breeding technologies for the majority of the above enumerated species.

**Marketing of National Products in Eastern and Western Europe**

If in 1989 the export per import balance for fresh, chilled or frozen fish was positive (Table 1), in 1995 is increasing the deficit to import's advantage.

| Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|---|---|
| Exports | 8 614 | 0 | 96 | 2 436 | 93 | 0 | 117 |
| Imports | 4 684 | 17 660 | 1 767 | 544 | 7 548 | 12 806 | 21 927 |

Table 1 Fish exports and imports in Romania, during 1989 - 1995.

This deficit can be explained on the one hand by the raised demand for fish and fish products on the local market, demand that can not be met by internal and long distance yield, at list in actual conditions.

Also, must be considered that the fish is a traditional food of Romanians, especially in some regions of the country (Moldova, Oltenia, Dobrogea, Muntenia).

The herring and mackerel had the largest weight within the imports (97%), having a low price but implicit a low quality, fact that can be explained by decreasing the buying capacity of the population.

The export's diminution is due of complementary action of multiple factor as: insufficient development of marketing informational system, lack of participation from the government in encouraging the exports, straitened circumstances of the fisheries companies, life fish transportation system insufficient developed.

The most exported species and fish products were: sturgeons, caviar, pike perch, pike, Danube shad, etc., the partner countries being: France, Holland, Austria, United Kingdom, Moldavian Republic, etc.

Analysing the exports and respectively imports we can point out the existing opportunities for increasing and diversifying the aquaculture production, opportunities that can be capitalised especially as a result of the reorganising of fisheries in Romania process which is going on now.

**Research and Education Status**

The scientifically assistance for the activities in aquaculture is assured by the four existing research institutes, well staffed with specialists who are continuously supporting the production.

The main aquacultural research fields are concerning: genetics and improvement of cultural species, improvement of reproduction and rearing technologies for valuable species, nutrition, mechanisation of the processes, introduction of new valuable species, using of intensive (in cages) and super-intensive breeding systems.

Training of the specialists is assured though the Faculty of Food Industry Aquaculture and Fishing within the "Dunarea the Jos" University of Galati by five years long undergraduate courses, postgraduate courses, master's and doctor's degree.

The various specialities teachers from this faculty also are carrying on scientific research in the field, usually in co-operation with the above mentioned fisheries research institutes.

**Legal Aspects of Aquaculture and Marketing**

The existing legal framework that is going to be adjusted at the actual requirements, is representing one of the causes of aquaculture and fishing staying behind in the last years. As a result, the specialists from production, research and education field elaborated a protect of Fishculture and Fishing Law, project which was advised by the Ministry of Agriculture and Food and is going to be approved in the Romanian Parliament.

Simultaneously were and are on the way to be approved laws which are more or less tangential with fisheries' field as: Environmental Law, Danube Delta Biosphere Nature Reserve Law, Waters Law, Land Law, etc.

The enforcement of the laws in the field will be done by the Fisheries Inspection, organisation that is on the way to be set up within the Ministry of Agriculture and Food.

**Organisation of the Production**

The majority of fisheries in Romania are organised as commercial stock companies. There are 36 fisheries commercial companies dealing with the fishculture and fishing and also three of the research institutes which includes production capacities.

The production systems used in aquaculture are now extensive and half-intensive, using the polyculture in 2 - 3 years production cycle.

Is going on the shifting process from extensively using of the chines carps to the increasing of the weight of valuable species (carp, predators, sturgeons), due of local market demand.

The existing fish farms are usually formed of large fish ponds (30 - 150 ha., some of them being over 500 ha.), fact which is worsening the possibility to control the production parameters and is limiting the technologies' intensity.

In the nearest future is foreseen to be set up the National Agency for Fishculture, Fishing in the Natural Waters and Fish Stocks Protection directly subordinated to the Minister of Agriculture and Food, organisation that will assure the co-ordination of fisheries and will promote the national strategy in the aquaculture field.

Concerning the property type is foreseen the stimulation of privatisation process of the fish farms by long term granting.

**Conclusions**

Fisheries' patrimony of Romania and the existing conditions on the local and external market are offering many opportunities for aquaculture development.

Fisheries' field reorganising by setting up the National Agency for Fishculture, Fishing in the Natural Waters and Fish Stocks Protection, setting up of the Fisheries Inspection and the approval the Fishculture and Fishing Law are significant factors for recovering of fisheries in Romania.

The short and medium term strategies, proposed by the specialists, are concerning as main measures the following:

- stimulation of privatisation process;
- financially supporting of fisheries by subsidised loans and other facilities;
- stimulation of introducing new valuable species;
- stimulation of using modern technologies and equipment;
- supporting the restocking activities of the natural waters;
- stimulation of production and exploitation of other live aquatic resources than the traditional ones;
- supporting the reaching of international standards for quality.

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* * * Fishery Statistics - Catchers and Landings vol. 74/1992, edited by FAO.

# AQUACULTURE IN RUSSIA

I.A.Barannikova[1] and Y.P. Mamontov[2],

[1] Saint-Petersburg University and Central Laboratory on Reproduction of Fish Resources of the Fishery Committee of the Russian Federation, 24/52, Prof. Popov Street, Saint-Petersburg, 197022, Russia.

[2] Fish Industry Company of the Russian Federation (Rosrybkhoz), 18-a, Ermolaevsky Pereulok, Moscow, 103001, Russia and Fish Industry Association, 12, Rozdestvensky Boulevard, Moscow, 103031, Russia.

## Introduction

Russia is one of the leading fish industry states. Until recently a considerable part of the world fish and sea-food catch belonged to this country. It was achieved mainly due to fishing in the world ocean.

Lately the situation has substantially changed. The volume of catch of majority of marketable fish has reached its maximum and resources of many of them drastically decreased. The reduction in sea fish catch is being aggravated at the same time by the progressive pollution of seas and oceans, especially in shelf zone - the most valuable in respect of fishery.

That is why Russia, as well as other countries, is switching in an increased scale to the development of aquaculture - fish breeding and commercial cultivation of hydrobionts in controlled conditions.

The aquaculture in Russia has its own historical roots and a reliable basis. In the course of decades there were developed technologies to breed commercial fish in ponds, industrial and pasture conditions for inner fresh water reservoirs in Russia. Another sphere of aquaculture being developed in our country is mariculture. These spheres of aquaculture are ensured by the well arranged system of reproduction of fish resources.

The main figures of aquaculture production in the former USSR and in Russia are shown in Table 1.

**Table 1. Production of aquaculture in the USSR and in Russia (in tons)**

| Aquaculture main objects | USA | | | Russia | | | |
|---|---|---|---|---|---|---|---|
| | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 |
| Carp | 325530 | 319782 | 341117 | 70295 | 58370 | 49420 | 33400 |
| Tolstolobic | 65000 | 70364 | 77109 | 31261 | 30723 | 15870 | 17800 |
| White amur | 1092 | 2669 | 1873 | 500 | 520 | 440 | 480 |
| Sturgeon | 150 | 68 | 74 | 7 | 28 | 400 | 460 |
| Salmon | 1310 | 2342 | 2533 | 500 | 420 | 1630 | 1100 |
| White fish | 6500 | 3456 | 3508 | 630 | 489 | 800 | 2000 |
| Mullet | 100 | 40 | 40 | - | 10 | 20 | 100 |
| Flat fish | - | 20 | 71 | - | - | - | 50 |
| Cancroid | - | - | - | 1 | 1 | 1 | 20 |
| Mussel | 70 | 35 | 1390 | 350 | 650 | 898 | 975 |
| Sea-scallop | 40 | 124 | 153 | 150 | 155 | 1001 | 100 |
| Total: | 269792 | 398890 | 427868 | 103694 | 91366 | 74949 | 56885 |

In the year of 1994 there were also produced 2500 tons of seaweeds; in 1995 - 6560 tons. The figures in the Table 1 show a substantial decline in aquaculture production after the year of 1991. It has been caused not only by the disintegration of the USSR but mostly by the fact that some changes of priorities are taking place nowadays both in main spheres of aquaculture and in the choice of cultivated objects.

In the new economic conditions the disparity of prices for fish and forage, energy and other resources forces to drop the breeding of carp and to introduce the breeding of more valuable (in respect of food stuff and price) fish - sturgeon, salmon etc. At the same time there being prepared the transfer to a large-scale introduction of methods of pasture fish breeding on the basis of utilization of various species of fish. Taking into account the fact that Russia possesses huge area of inner water resources (lakes - 20 million hectares, fresh water reservoirs - 4,5 million hectares, multiple purpose reservoirs - 1 million hectares, rivers - 0,45 million kms, ponds for commercial fish breeding - 0,125 million hectares) the possibilities to increase the production of fish reach not less then 1 million tons, first of all in the production of fresh water aquaculture.

If one adds to the above-said the possibilities of breeding sea-fish, cancroids, shell-fish, seaweeds by methods of mariculture the potential of aquaculture in Russia becomes evident as a whole.

## Fresh water aquaculture

Fresh water aquaculture, being developed on the basis of multiannual experience in reproduction and cultivation of hydrobionts, at the present stage of its development in Russia has certain advantages in comparison with other brands of agricultural production, in particular with stock-raising. These advantages are related to reproduction specifics, volume of forage used for breeding, more effective utilization of pond's area etc. (Y.P.Mamontov, 1990).

Three basic freshwater aquacultural methods are being developed successfully: pond-based, industrial-based, and so called "pasture-based" operations.

Until recently, pond-based commercial fish farming was the most widespread method, accounting for 85 percent of all fish raised in fish farms. But output from pond-based fish farms has dropped from 259,000 tons in the 1980s to a mere 60,000 tons today. Pond-based farming now concentrates on low-cost techniques for raising carp and herbivorous fish, although some facilities are switching to more lucrative species (i.e., sturgeon). Not all of these fish will be consumed; some will be used to stock revers and other natural waters.

Industrial-based farming utilizes heated waste water from power plants. The utilization of such thermal energy is a serious economic, environmental, and social problem for any developed country.

With the changing economic conditions, pasture-based farming is becoming the most important of the three techniques. The basic idea behind this method is to achieve the most efficient possible utilization of the resources available by stocking an area with a carefully selected mix of species, each filling a different ecological niche.

Rosrybkhoz has worked out a program to develop commercial sturgeon farming, calling it "Sturgeon-2000". The plan is already showing results: in 1995, over 1 million sturgeon fry were produced, a 50 percent increase over 1994. Thus all the elements necessary for the 1996 sturgeon production target to be reached are at hand.

The spheres of fresh water aquaculture mentioned above can mutually supplement each other while methods of their implementation and elements of separate technologies can be applied in various combinations.

## Marine aquaculture

The objects of marine aquaculture are transitional fish, sturgeon and salmon. The scale of their breeding is rather voluminous.

For example in 1984-1985 90 million sturgeon, stellate sturgeon and beluga fry were released to Azov and Caspian seas. The release of salmon fry is close to 500 million pieces; 400 million out of them come to the Far Eastern seas. This type of fish breeding means that only part of fish life cycle is spent in fish-farms. However after fattening in the seas the quantity of returning fish, especially in the case with Pacific salmon, is rather high. Nowadays the breeding of hunchback salmon ensures the return of almost 25.000 tons of fish.

The commercial production of salmon family fish is arranged in sea-farms (White sea, Barentz sea, in the near future 1000 tons of trout and hunchback salmon). The breeding of grey-head salmon will be arranged in the Black sea with the use of special fish-wells. There are also going works to breed and fatten sea fish. In Russian southern seas the main objects are flat fish and mullet family. As a result of release of flatfish-kalkan fry to Black sea in preceding years it is planned to harvest 20 tons of this fish. There was developed the bio-technology for breeding of grey mullet and golden mullet; annual production for a number of last years reaches 20 tons in Azov-Black sea basin.

The Far Eastern mullet (Mugil so-ing Basilevscy) was successfully acclimatized from the Sea of Japan to Azov-Black sea basin. Also there was worked out the technology of artificial cultivation and we witnessed the development of self-reproducing stock; in the year of 1995 we harvested 500 tons of mullet; in 1996 we expect to produce one thousand tons. This kind of fish is rather prospective for farm cultivation. A mullet-farm has already been established.

The object of mariculture in the North is the fish of the cod family. In the year of 1993 cod was bred to maturity in the ponds in the sea bays of the northern parts of Cole Peninsula. The perspectiveness of this work has been proved and it is planned to get 10 tons of commercial cod.

There was worked out the technology of cod breeding up to maturity with the use of hormonal stimulation and with fry breeding. However these experiments up to now have not received necessary development due to the lack of proper cultivation base.

Out of invertebrate species the most substantial works are carried out with shell-fish. The objects of breeding are mussel Mytilus edulis L. in White and Black seas, mussel Mytilus galloprovincialis, oyster Ostrea edulis and Far Eastern sea-scallop Mizuhopecten yessoensis in the Sea of Japan.

There has been proved the possibility of mussel mariculture in Arctic seas. In the White sea the cultivation of mussel is done in suspended hutches. The growth of shell-fish in such conditions exceeds in 5-6 times its growth in natural conditions. This technology is fully worked out. Out of mussel there received food products as well as mussel hydrolisat - mecical prophylactic preparation with anti-virus activity and immune strengthening reactions.

To be used for medical purposes the preparation can be cultivated within 1,5-2 years. The harvest is 200 tons of raw mussel from one hectare of mariculture area. In Kandalaksha bay of the White sea there are more than 33 hectares of mussel plantations (Research on mussel mariculture, 1993).

In the Black sea mussel is being successfully cultivated in the sea-shore areas of Krasnodar Region. Main obstacles are constituted by the necessity of creation of adequate facilities to process raw mussels. The cultivation of sea-scallop and mussel in the Far East is being done in a number of farms, in particular in the bay of Minonosok (Sea of Japan); the area of this farm is 26 hectares. While cultivating shell-fish in various climatic zones

it is necessary to take into account the possibility of pollution of water areas used and to foresee measures to prevent it.
An important object of marine aquaculture are seaweeds. The plantations up to now are still insignificant area wise. The bulk of the product is received from the Sea of Japan. In the year of 1994 there were harvested 2500 tons of seaweeds. At the existing farms in the Sea of Japan it is planned to produce 6550 tons of raw seaweeds. An experimental-industrial farm in the White sea is being operated where sugar laminaria is being grown. In the near future it is planned to harvest 60 tons of the product. There has been worked out scientific-practical aspects of seaweeds cultivation (Vozjanskaya, Kamnev, 1993).

## Reproduction of fish resources

The aquaculture is not limited to the production of food-stuff only. For many years an artificial reproduction ensures the re-stock of natural resources of fish as well as the breeding in controlled conditions.
The works on artificial reproduction of fish resources are done by fish breeding enterprises of the Rosrybkhos, of the State Committee for Fishery (Roskomrybolovstvo) and joint enterprises. In the year of 1995 the reproduction enterprises in Russia produced and released to the natural environment 7350 million pieces of small fry, including 435,5 million pieces of salmon, 83,5 million pieces of sturgeon etc. The most part of this fry was produced by the Rosrybkhoz enterprises, namely 4,9 million pieces.

## Forage and forage production

Russia possesses wide opportunities to harvest natural forage, in particular canceroid Artemia salina. Its new deposits have been discovered in Siberia (not less than 1000 tons). There are possibilities to establish joint enterprises for harvesting and processing of this valuable bio-forage. The possibilities of harvesting and production of dry gammarus are estimated at several thousand tons.
Three combined forage enterprises are in operation nowadays (Rostov-on-Don, Belgorod, Krasnodar Region). They produce artificial starting and processed forage of various recipes.

## Marketing of aquaculture products

The organisation of marketing is being done on the basis of direct contracts with customers and through brokers, as well as by producers of aquaculture themselves. The improvement of aquaculture products marketing is facilitated by the arrangement of large international exhibitions in Russia ("Inrybprom", "Aquaresource" etc.) where large-scale contracts are concluded for the supple of hydrobionts.

**Research and training**

In various regions of Russia several institutions are functioning in the sphere of fresh water and marine aquaculture.
Eight of these scientific research institutions specialise in fresh water aquaculture and five - in mariculture.
Besides, the problems of aquaculture are dealt with in a number of academic and university centers.
Three high institutions and four special advanced schools train specialists in the sphere of practical aquaculture and research.
Highly trained specialists in aquaculture are being prepared in a number of universities (Moscow, Saint-Petersburg, Tomsk etc.).

**Legal aspects of aquaculture**

The activities in development of aquaculture must be based on a proper legal basis. This is the purpose of the "Code for Fishery and Aquaculture" which has been worked out and submitted for consideration to the State Duma (Parliament) of the Russian Federation. To develop this document several down stream instructions are being prepared.
In accordance with the Order by the Government of the Russian Federation a very important action is being undertaken, namely the licensing of activities connected with the cultivation of hydrobionts in aquaculture farms (marine, lake and fish-ponds) in natural water reservoirs, as well as connected with the reproduction of fish resources and scientific-research works.

**Organisation of production**

The development of aquaculture is ensured by enterprises and establishments of various forms of ownership which exist in the system of the Ministry of Food and Agricultural Production of Russia (Rosrybkhos), and of the State Committee for Fishery.
The main role in the production of fresh water aquaculture belongs to Rosrybkhos (Table 2).

**Table 2. Aquaculture Production by Various Establishments**

| Name of Establishment | Fish Production (thousand tons) | Share % | Production of small fry (mln. pieces) | Share % |
|---|---|---|---|---|
| Rosrybkhos | 46.5 | 81.4 | 4900 | 66.7 |
| Roskomrybolovstvo | 1.4 | 2.4 | 2400 | 32.6 |
| Agricultural collective farms | 4.1 | 7.2 | - | - |
| Farmers | 2.9 | 5.0 | - | - |
| Joint Enterprises | 0.6 | 1.1 | - | - |
| Rosokhotrybolov-sojus | 0.3 | 0.6 | 50 | 0.7 |
| Rosrybkolkhoz group | 1.1 | 1.9 | - | - |
| Other enterprises | 0.2 | 0.4 | - | - |
| Total: | 57.1 | 100 | 7350 | 100 |

## Conclusion

There are wide opportunities for development of aquaculture in Russia. On most of cultivated objects there exist highly advanced bio-technologies. The most expedient objects of aquaculture are valuable species of sturgeon and salmon family fish which ensure high profit and also herbivorous fish which allow to receive products based on natural resources.

Investments are needed for establishment of commercial sturgeon farms, mariculture enterprises, for joint procurement and processing of bio-forage.

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# Annex 2
# Last minute entries

# HOW TO PLAN YOUR EASTERN EUROPEAN AQUACULTURE VENTURE - OBTAINING FINANCE FROM WESTERN EUROPE AND THE USA

G.A. Howard
Greg A. Howard & Associates, Aquaculture Business Planning & Finance
Sport-y-Gwynt, Llandegfan, Anglesey, North Wales, United Kingdom
LL59 5YD Fax: (+44-1248) 715 055

## Introduction

The likelihood of starting and maintaining a strong and profitable aquaculture venture is significantly enhanced following the preparation of a due-diligent business plan. A good business plan does not guarantee success; however, studies have shown that without one, potential pitfalls may surprise the unsuspecting would-be entrepreneur. More significantly, the potential investor will not part with funds without first seeing that the founders have thoroughly prepared themselves for the challenging and most certainly arduous task ahead, that of forming and managing a business. There is general knowledge that foreign investment of both capital and know-how are essential if many companies are to survive and become competitive in world markets. Many companies are actively seeking foreign partners to gain competitive advantage. As part of the early business planning process, such details as the laws, regulations, protections, restrictions and incentives relevant to the country of operation should be fully explored. The focus of this presentation is the essential factors required to create and negotiate a business plan that will acquire financial backing together with the legal implications required to conduct Eastern European business with foreign investment. Included will be a discussion regarding the following:

- Content and layout
- Negotiation techniques
- Legal regulations and
- Legislative guarantees

## Content and layout

The four main sections required in a well-balanced business plan include: the management team, market, production and financials. A careful investor will be looking first and foremost for both a sound management team and good market potential. Also, clues for being market- and not product-driven will be a distinct advantage. Investors the world-over expect the business plan to be presented in a particular format, with for example an early, comprehensive executive summary and perhaps a glossary if relevant. It is also useful to include a general legal clause or "an investor's note" which limits the entrepreneurs liability. Additionally, specific (and especially over-optimistic) projections promising a given return on investment (ROI) should be avoided. Such definite language in forecasting the ROI should be replaced with tentative language.

**Negotiation techniques**

Once a thorough business plan has been prepared, then it is essential that the would-be entrepreneur develop appropriate negotiation skills to create a "win-win" partnership.

**Legal regulations**

The laws vary between countries. For example, in Hungary there are more than twelve legal regulations which have removed barriers to make joint ventures more attractive for both Hungarians and Investors. Under these laws a foreign party may invest in Hungary in three ways.

**Legislative guarantees**

In countries such as Hungary, the Czech Republic and Estonia (to name three) there are legislative guarantees that further protect both the foreign investor and the local enterprise.

# APPLICATION OF IMMUNOSTIMULANTS IN AQUACULTURE: A PERSPECTIVE FOR SUSTAINABLE FISH HEALTH MANAGEMENT.

G. Jeney*, Z. Jeney*, and D.P. Anderson**
* Fish Culture Research Institute. Szarvas, HAKI. H-5541 Hungary
**Salmon Bay Biologicals. 2805 NW Golden Dr. Seattle, WA 98117-2628

A good quality water, well balanced food, and good farming practice are the basic preconditions for a good health status in fish culture. To reduce the lose due to the diseases several methods for prevention and treatment are applying by fish culturists. Antibiotics and chemotheraupeutics are used extensively to avoid an acute infection, but this practice represents a hazard to the environment and some pathogens become resistant to some antibiotics due to their overuse or misuse. They do not completely eliminate a pathogen resulting in recrudescence of disease, and their residues may accumulate in the fish flesh and the environment. Vaccination of fish provide protection for a specific disease,. Vaccines are protective at the time when the fish is most susceptible, are easily administered, and safe, but no efficient vaccine exists yet against a number of commercially important diseases in fish culture.

A number of different biological and synthetic compounds have been found to enhance the non-specific system in fish, and shown to increase barrier of infection against a series of pathogens simultaneously, both specific and opportunistic ones. Levamisole, a well known antihelmintic, ISK, a polypetide extracted from fish, qurternary ammonium compounds, killed mycobacteria, muramyl dipeptide and other synthetic peptides havee been reported to increase the resistance of rainbow trout against several bacterial pathogens.

One of the most promising areas of development for strengthening the defenses of fish is through administering glucans as adjuvants or immunostimulants. Various background reports from work drawn from mammalian research have shown that b-1-3 glucans are immunostimulatory. On the other hand objectives of immunostimulation in fish include not only promoting a greater and more effective immune response to infectious agents, but also overcoming the immunosuppressive effects of stress. Glucocorticoids are secreted in response to stress and are known to increase susceptibility of fish to diseases.

The present paper will report on the use of some immunostimulants (ISK, Levamisole and Qaurternary Ammonium Compound) as adjuvants in *Aeromonas salmonicida* vaccine. Results of experiments from oraly administered glucans to some warmwater fish species (European catfish, sturgeon) will be presented. The experimental data from stress experiment show that feeding of glucan in low dose several weeks before transportation helped to prevent negative effects of stress. Glucans can be used to increase general resistance of farmed fish substantially.

# AN ASSESSMENT OF THE ECOLOGICAL EFFECT OF A CROATIAN MARINE CAGE FARM

**I. Katavic**

Institute of Oceanography and Fisheries, Split, Croatia

## Introduction

Intensive culture of fish in sea cages may generate considerable amounts of organic waste in the form of uneaten food and feces (Gowen and Bradbury, 1987). Excessive nutrient loading may lead to several of the eutrophication effects (Weston, 1990; Gowen and Ezzi, 1992; Ackefors and Enell, 1994).

The study was conducted in the Mala Lamljana bay, in the island of Ugljan in the central coastal region of Croatia, where a large sea bass cage farm was established in the spring of 1983. The bay is about 1.8km long and 0.7km wide. It is well protected, the shores are quite deep, and water exchange is very good. Substrata are a typical of transportation bottoms. The depth in the central part ranges between 15 and 20m, and exceeding 30m, at the communication with the open sea. The estimated water volume is around 25 million cubic meters.

Over the last 10 years, this farm has been producing around 200 tons of fish per year, while shellfish production never exceed 50 tons. Based on the daily farm records, 626 tons of the pelleted feed was used in a single year with feed conversion 2.35. Calculated nutrient load (Persson, 1988) from such a fish farm is 25 666kg N, and 4 319kg P. When these values are divided by the fish biomass being fed (266 tons) it gives 96.5kg N, and 11kg P per ton of the fish produced.

With the exception of few short-term surveys and unpublished reports, there have been no studies of the effects of effluent from fish-cage farms in Croatian waters. The aim of this preliminary investigation was to collect basic biological and hidrological data in order to assess whether such a long-term operation of a relatively large fish farm affects the local environment, and if so, to what extent.

## Material and methods

Data on fish production and on the type and amount of the feed used were provided by the farm. Water samples for the nutrient components were collected once per months at two locations; one was at the cage site, while the second one was of the control station 1 km from the last cage. Measurements of temperature, salinity (optical refractometer) and oxygen (oxygen-probe) were made at the same stations as for nutrients, but at daily intervals. Water samples for estimation of chlorophyll - related phytoplankton biomass were taken monthly from selected stations and depths, from May to July 1995. The standard fluorescence method with an acidification step (Tett and Wallis, 1978) was used to estimate the concentration of chlorophyll and pheopigments. The methodology employed in benthic surveys involved traditional ecological methods, three line transects and sampling by using scuba diving.

**Results and comments**

It can be said that sediment was not excessivelly enriched by organic matter beneath the fish cages. Within 100m of the floating cages, the organic content of the surface sediment along a transect was slightly reduced, from 3.58% to 2.63%, while at 300m from the cages it was 2.40% It is likely that organic matter released on a transportation bottom dispersed over a larger area so that the effect is smaller than expected.

Relationships between feed supply, nutrient concentration, and eutrophication effects were analyzed. In summary, it may be stated that increased feed doses to the fish in the cages from June to September correlate best with the concentration of phosphate in both the surface and deeper waters when reaching the average value from 0.3 to 0.5 mg/l. Increased summer concentrations of phosphate at the control station indicate that the reach of phosphate spreading exceeds 1km from the point sources, and that control station is also in a zone which is affected.

In contrast to phosphate, there were no correlations between nutrient supply and concentrations of nitrate and nitrite in the water column. The mean values do not exceed 0.05 mg/l for mitrate or 0.01mg/l for nitrite. Surface and bottom water concentration are not significantly different, and no differences with control station were found. It seems that, as for these parameters, the assimilative capacity of the ecosystem still maintains its balance with such quantities of nutrient discharged.

With respect to the primary productivity there were no indications of increase in the phytoplankton biomass. From May to July chlorophyll fluctuated between 0.30 mg/m$^3$ and 0.95mg/m$^3$, respectively. Composition of the phytoplankton communities is still diverse. However, most of the summer chlorophyll was contributed by diatoms among which 90% are *Skeletonema costatum* and *Chaetoceros compressus*. The remaining 10% are dinoflagellates dominated by several species of *Ceratium*.

Oxygen levels fluctuated throughout the year, and there appeared to be seasonal variations with a decrease in dissolved oxygen from June on, reaching a minimum in September.Changes in the oxygen budget of the water body in the cages, as compared to the surrounding waters, are significant only in the 5m of the surface layer during the summer.

Average saturation from June to October is around 80%, but without undesirable consequences for fish in the cages. A more serious problem associated with summer high water temperatures was noted in the morning, when occasionally oxygen saturation may drop bellow 70%. This appeares to be the case during July, August and September when over the night oxygen is rapidly taken up by the fish, while exchange of the water is reduced. Horizontally, decrease of the oxygen levels is restricted to 10m from the cages.

The results of studies of macrobenthic communities undertaken on three transects during June 1996 show quite rich and diverse benthic flora and fauna. The total number of benthic algae was 128 plus one phanerogamic species. However, with respect to its type, composition, structure and distribution, the benthic flora is clearly affected by the fish farm.

Chlorophyta usually dominated the biomass, and the number of species, while Phaeophyta were in regression. Beneath the cages and around their edge, the bottom flora is very scarce. In the surrounding water, flora was well developed and diverse, with domination of the nitrophilic species (*Ulva rigida, Enteromorpha intestinalis, E.compressa, Dictyopteris polypodioides, Dictyota dichotoma var.intricata* and

*Gigartina acicularis*), indicating significant changes that hapened in the benthic vegetation structure. Well developed *Posidonia oceanica* beds have disappeared below the cages.
Benthic macrofauna was represented by 84 species. Mollusca was predominant in the number of species (39.3%), followed Arthropoda (14.3%), Annelida (11.9%), Tunicata (8.3%), Echinodermata (7.1), Cnidaria (7.1%) and Porifera (6%). Tentaculata, Echiurida and Sipunculida accuounted for only 6% of the total. Echinoidea (sea urchins), Holothuroidea (sea cucumbers), and some ascidians species (Thaliacea) dominated both biomass and abundance at all three transects. A number of studies have shown that changes in the community structure of the benthic macrofauna may result from both direct input of organic matter to sea bed , and enhanced primary production. The onset of changes in the ecology of the bottom macrofauna is suggested to be used as an indicator of the more widespread effects of hypernutrification (Gowen and Ezzi, 1992).
A rich ichtyofauna was visualy observed throughout the sampling period. Abundant shoals of commercial-size grey mullets (*Liza aurata*) dominate in the upper layers, between cages. Biomass was estimated at up to 10 tons, and it seems to be a species that makes the best use of the uneaten food available. From the bottom feeders, the striped sea bream *Lithognathus mormyrus* was the most abundant species. Occasionally it was possible to note, *Bops salpa*, and *Diplodus sp.*, but also non sparids such as *Mullus, Trachurus, Sardina, Engraulis, Seriola l and Lichia sp.*
Fish recruitment is thought to occur near the farm, were small *Pagelus erithrinus, Diplodus puntazzo* and *Diplodus annularis*were atracted by the rich food supply.
In conclusion, it is to be expected that the site with such a high nutrient loading will be more severely affected by fish farming. However, it can be said that, based on both biological and hydrological parameters, the studied area does not show signs of significant eutrofication. Most probably, this is result of the bottom morphology and exchange of the water between the bay and its adjacent sea (flushing rate) that is higher than the potential of the nutrient to accumulate and cause a stronger biological response.

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# AQUACULTURE RESEARCH IN EASTERN EUROPE AND EDUCATIONAL ASPECTS

L. Varadi
Fish Culture Research Institute
P.O. Box 47, H-5541 Szarvas, Hungary

## Introduction

As a result of the recent political and economical changes in Eastern Europe, the institutional systems, including that of research and education, have also been changed, and are still changing. In the turbulent political and economical environment of the changes, research and educational aspects haven't always get priority during the implementation of reform programmes, and no effective measures have been taken in order to protect the tremendous value that has been accumulated in these fields, and at the same time to restructure the rather big and rigid institutional system. There are considerable differences from country to country, according to the stage of development, the rate of the changes, and the role of aquaculture and fisheries in the economy of the country etc., however an attempt will be made to summarise some general findings, and draw general conclusions.

## Research

In the centrally planned economy, research and development activities were under close control of the state, and the R & D programmes were planned and financed according to "central" decisions. The institutional system has been established and structured accordingly. The mandate of these institutes were mainly to provide scientific basis for the increase of the volume and efficiency of the production. Their activity was closely connected to the specific needs of a sector or sub-sector, and financing was based on the redistribution of the state incomes of a particular sector according to "central decisions". No doubt, that tremendous amount of intellectual value has been accumulated, and valuable scientific results have been gained in these centres, that contributed significantly to the development of fish production in Eastern Europe. International collaboration was very limited, however there was regular exchange of information in the frame of the COMECON, and some bilateral R & D programmes. The research and education sphere however was rather isolated on international scale, and only some FAO projects can be mentioned as notable exceptions. There was however a relatively stabile (although low level) financing and also existential stability in the research sphere.

Unfortunately, one of the big losers of the changes over from centrally planned economy to market economy is science, development and innovation in many Eastern European countries. In many countries research issues have been completely overshadowed by other issues, political and social tensions, the old institutional system stopped to work and the new was not available yet, and financing has also been dramatically reduced. These circumstances, together with the view, that market conditions will solve the problems in the research sphere, resulted in critical situation in many Eastern European countries. In Hungary for example, the R & D expenditures decreased below 0.7 % of the GDP, while this is 1.5-3.0 % in developed countries. Although, the withdrawal of the state from direct research management and financing in developed countries is an obvious tendency, it is a great danger, and would be great loss (also on international scale) if the state left alone the vulnerable scientific sphere in the recent turbulent political and economical environment in Eastern Europe. If there is any area where these countries need international assistance, the research and development are definitely among these areas.

In spite of the serious problems regarding the operation of the institutional system, there are positive changes in the content and trends of research programmes, thanks to the recent openness, individual initiatives and international assistance in these countries. Research for sustainable development is becoming dominant in aquaculture and fisheries research, in which multidisciplinarity and system approaches are applied more commonly. In a recent EIFAC meeting in Rome (Consultation on Management Strategies for European Inland Fisheries and Aquaculture for the 21st Century), the following areas were identified as research priorities in Eastern Europe: marketing studies; impact of intensive culture on the environment; fish diseases and their prevention; fishery use of protected waters; development of new, value added products; possibilities of increasing diversity of fish produced through aquaculture. Unfortunately, the access to international research funds is very limited for Eastern European countries. There is a great interest to collaborate both in the West and especially in the East, however these initiatives should get more international assistance in the future.

**Education**

Education has got high priority in Eastern European countries in the past, and in the field of aquaculture a three-level educational system has been developed for skilled workers, technicians and engineers. Due to the changes and the consequent economical problems in Eastern Europe, the government support of the schools and universities has been reduced, and some of these training and educational centres are in great trouble now. Besides structural and financial problems, the teaching curriculum should also be developed in order to meet the changing requirements. There has been a high level teaching in classical disciplines, however some new concepts like sustainability, integrated resource management, socio-economic and marketing aspects, etc. are still weak elements of the teaching curriculum. There is a definite need for the development of international cooperation among universities, and the TEMPUS program is a good example on this field, however the share of the Eastern European universities in European collaborative programmes has not been satisfactory yet.

**Conclusions**

Major structural and conceptual changes are needed in research and education in Eastern Europe, therefore the restructuring of the institutional system in this field will take longer time than expected. Governments are trying to preserve the tremendous intellectual values that have been accumulated in this field, however research and educational aspects are very often overshadowed by political and economical issues. More international assistance is needed to mobilise the universal values that are available in the Eastern European institutions for the benefit of the people in the united Europe.

# AQUACULTURE STATUS IN BULGARIA - NATIONAL REPORT

Sonya Zlatanova and Nikolay Kissiov

State Fisheries Inspectorate,
Ministry of Agriculture and Food Industry
99 Kn. Boris Str., 1000 Sofia, Bulgaria

## Introduction

Before commencing to discuss the general status for aquaculture development in this country, it is worth mentioning that in 1996 a century since the foundation of the Bulgarian freshwater fish culture will be celebrated. A general view on the fisheries status in Bulgaria will be just briefly mentioned, too.

The shelf are of Bulgaria (the Black Sea) amounts to 11963 km², the length of the coastal line 378 km and population appr. 9 mln (1990). Until the establishment of the oceanic fishing fleet in 1964, the marine fisheries production of Bulgaria was completely obtained from the fishing activities in the Black Sea and did not exceed 5000 t (4502 t in 1964). Since then, with the rapid expansion of distant water operations, the fish production notably increased and in 1976 the ocean catches reached 150,000 t. In 1976 the Black Sea catches are at the range of 9941 t. In 1978 the Bulgarian ocean catches drop to 100,000 t. With the modernization of the Black Sea fishing fleet the average catch in the 1980s reached 12081 t (17194 t in 1981).

At the beginning of the transition period in 1989, the management of the Bulgarian fisheries was carried out by the State Fisheries Board "Ribno Stopanstvo" (Bourgas) and the R& D Complex "Freshwater Fish Culture" (Plovdiv). In 1991 all enterprises of the ex-"Ribno Stopanstvo" became self-financing companies (including the Fisheries Institute in Bourgas, now IRP-25 Co). The Freshwater Fish Culture Institute (Plovdiv) and the Fish Resources Institute (Varna) remained in the system of the Bulgarian Academy of Agricultural Sciences.

In 1991 the state stopped giving any subsidies for fisheries, including aquaculture activities.

## Freshwater fish culture production

Bulgaria has a comparatively large area of inland water resources: appr. 70,000 ha, 30,000 ha of dam-lakes (artificial water bodies) and 6,000 ha of natural lakes are suitable for fish production and recreational fisheries. The area of the specialized fish farms (man-made earthen fish ponds) is currently 3,700 ha. Obviously the potential for freshwater fish production in the country is quite high, but now considerably underutilized.

The large scale dams of over 500 ha water surface represent 62 % of the total dam area of the country. The medium size (200-500 ha) give 10%, and the small size dams (up to 200 ha) - 28%. For intensive fish farming appr. 38% (11,500 ha) of the dams could be used. Almost all Bulgarian dam-lakes are suitable for stocking with fish and used for commercial and/or recreational fishing.

The ex-state cooperative farms had over 2,200 small-size dams which in the 1980s were giving appr. 6,000 - 7,000 t of cultivated fish (marketable size) annually. At the same time, some dams produced a large quantity of stocking material used by the cooperative farms and by the state fish farms as well.

At the end of the 1970s the annual production of cultivated fish ranged between 8-9,000 t while in the 1980s - between 12-16,000 t/year. The maximum fish production was achieved in 1982 - 16,900 t. In 1989, the beginning of the political change, Bulgaria produced appr. 16,000 t of freshwater fish comprising 12,000 t of common carp. 1,200 t of rainbow trout and the remainder - Chinese carp species. Those figures include the production in the state and cooperative sector; the latter presenting appr. 30%.

Within the systems of the Ministry of Agriculture the 23 specialized fish farm enterprises (comprising more than 80 fish farm units) were transformed in 1991 into state-owned sole proprietor limited liability companies. Each enterprise included 1-10 fish farm units. Until now only 3 of the fish farm enterprises have been privatized - in general privatization in fish farming seems to be very slow. A few fish farm units have been privatized as parts of whole fish farm enterprises - 7 units up to now. Four enterprises bankrupted.

1995 seems to be the year of the recovery of the freshwater fish culture production (4000 t annual harvest; referring to a report, presented at a meeting of the Ministry of Agriculture and Food Industry, May 1996). An increase of 200 t was being underlined Then, referring to the sharp decrease in the freshwater fish culture production after 1990, 1995 seems to be the best year for the freshwater fish culture after 1990: 1,500 t were being produced by the private sector.

It should be underlined that after the collapse of the centrally controlled system, the government stopped subsidizing fish production and marketing. The state fish farms were left to cope with unstable and costly feed supplies, water, electricity and high administrative costs, without guaranteed marketing channels. As a result, already mentioned above, financial bankruptcy of the state-owned fish dams increased. Most farms have ceased or diminished production and are open to buyers. The slow privatization procedure, the lack of capital and high interest rates for bank credits, however, are the major obstacles for investments. In fact a significant area of inland water resources, the potential for freshwater fish production in the country, remain underutilized in the context of the inconsequent aquaculture state policy, out-of-date equipment, shortage (resp. high prices) of stocking material, unreliable water supply for a number of fish farms, lack of ownership documents etc.

It is being expected that the newly established Agricultural Fund will promote the renovation of the privatized fish farms. It is also expected that during the enforcement of privatization broodstock production and maintenance will remain the responsibility of the Government, under the management of the research institutions and stations, while the larvae and fingerlings productions will be transferred to the private sector.

**Mariculture production**

The mariculture research in the country began in the 1970s, and today a highly mechanized mussel culture has been developed along the Bulgarian Black Sea coast. The production has remained at the level of 100 -150 t/annually. Also R&D activities of the Pomorie Mariculture Experimental Station (mullets, shrimp, flounder) were giving promising results. In general, Bulgarian mariculture is still pending more attention and investments in the context of the coastal area management. The latter seems to be not only a national, regional or local issue as quite a lot of international concern is being addressed to the expanding coastal activities (including exploration and exploitation for oil and gas). Certainly much not only national but also international economic information is needed to develop any big mariculture initiative while trying to minimize the risk (environmental and economic).

In any respect, the interest in expanding mussel culture along the coast is obvious related also to the increasing number of stationary fixed fish nets (traps) where mussel culture appears as an accompanying activity both to fishing and tourism.

An interest is being shown in developing turbot culture as well.

The expectations regarding the Black Sea Environmental Programme remain in force as deeper attention could be paid not only to monitoring but also to the recovery and rehabilitation of the Black Sea living resources through aquaculture.

**Marketing of national products in Eastern and Western Europe**

This is one of the crucial issues in developing aquaculture in the present unstable socio-economic situation in the country. Since 1989 the national currency (1 lev) has become almost 200 times cheaper than 1 US $. The inflation rate for the first half of 1996 is 120%.

Both state and private fish farmers need marketing knowledge not only to develop profitable fish culture production but also in the new socio-economic realities. The state trade channels of the previous regime have been terminated or changed. There appeared an "intermediate" level of speculating sellers who let the emerging fish producers sell their fish production at very low prices. In some cases fish reaches the market at a price

4-5 times more expensive than it was sold at the farm. At present the state is not able to diminish the speculation in this respect.

Most of the trout produced is exported to Western Europe while carps - to Greece, Macedonia and Serbia.

A new fisheries/aquaculture policy is needed related to promoting viable fish production and marketing which will offer fresh (not frozen!) fish to the national market and to the developing touristic industry of Bulgaria. Utilizing at the same time underexploited aquatic basins and already accomplished expertise in producing fish in this country.

**Research and education status**

**- Research**

Fisheries and aquaculture research is being undertaken at different institutes which at the moment are seriously under-funded by the state. Even in 1991 the ex-Fisheries Institute, Bourgas, was transformed as IRP-25 Co. Ltd. with minimized research activity (mariculture research almost depleted).

The Freshwater Fish Culture Institute (Academy of Agricultural Sciences) in Plovdiv is responsible for strategic research in freshwater aquaculture. The Institute has a hatchery where the Chines carps were first introduced and reproduced in the country. The production of carp fry, fingerlings and market size fish (exported to Greece and Macedonia) gives additional funding to the research activities of the Institute.

Marine biology, environmental and fisheries research is being carried out at the Institute of Fish Resources (Academy of Agricultural Sciences) and Institute of Oceanography (Bulgarian Academy of Sciences), both in Varna. Their financial problems and deficiency of equipment requires harmonization of efforts and no overlapping in research.

The Central Veterinary Research Institute (Academy of Agricultural Sciences), Sofia, is responsible for the research on fish diseases, parasitology, bacteriology and virology.

The Department of Hydrobiology at the Institute of Zoology (Bulgarian Academy of Sciences), Sofia, carries out ichthiological research.

**- Education**

The Secondary Technical School of Marine and Ocean Fishing (Bourgas) has a speciality ichthiology and aquaculture (freshwater and marine).

The Department of Hydrobiology, Ichthiology and Fish Culture at the Biological Faculty of the University of Sofia is involved in both teaching and research on aquatic biology, ichthiology, fisheries/fish culture. The 2-year specialization covers 15-20 students annually while the research activity of the Department is mostly financed by the National Research Fund of the Ministry of Education, Science and Technologies.

At the University of Zootechnics and Veterinary Medicine, Stara Zagora, the Department of Special Animals is being involved in a specialized programme on fish culture/fisheries. Three-credit courses on Fish Culture/Aquaculture are offered in the fourth year of the degree, and a five-credit course on Fish Culture in the fifth year. The fourth-year course in Fish Culture is offered to students in other specializations. Approximately 100 students take this course each year.

The initiative of the University in Stara Zagora for the establishment of agriculture extension service including aquaculture extension could be enriched with the capacity and expertise of the Freshwater Fish Culture Institute (Plovdiv) for technical advice, testing and analysis required.

**Legal aspects**

- The Fish Husbandry Act 1982 is the principal enactment governing industrial fishing, sports fishing, fish farming and related issues in Bulgaria. The Act envisaged an implementing regulation to give effect to many of its provisions but no such regulation has ever been enacted.
  Many of the bodies referred to in the original Fish Husbandry Act 1982 have undergone subsequent organizational changes and have been renamed. In the 1990s some secondary fisheries legislation is being elaborated and implemented, to reflect the new realities in exploitation and monitoring of the fisheries resources in inland waters and on the shelf area of the Bulgarian Black Sea coast.

- The new forms of ownership and related activities urgently need new fisheries/aquaculture legislation in the complicated context both of privatisation and precautionary approach; the embarrassed socio-economic situation in the country and the need for harmonized efforts in aquatic resources/fisheries - aquaculture management.

- At present FAO TCP 4451A "Rehabilitation of Inland Aquaculture" is being implemented in Bulgaria where the strongest component is the legal one. One of the expected output of the project is the elaboration of new fisheries legislation.

- The Environmental Protection Act 1991, the Concession Act 1996, the land legislation, the draft Water Law are some of the legal tools related also to development of aquaculture in this country. Harmonization is being needed not only in their elaboration but also in their enactment, enforcement and control of the fisheries/aquaculture activities while introducing and applying the precautionary approach at present.

**Conclusions**

In the most complicated situation in Bulgaria today it is very difficult to make any prognosis related to the fisheries/aquaculture development in this country. Though the country will be dependent on importation of fish, efforts will continue on all levels to develop viable aquaculture both in inland waters and along the Black Sea coast.

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