



SHILAT



AQUACULTURE DEVELOPMENT IN SISTAN-BALUCHESTAN 2005 - 2008

*Project financed by Italian Cooperation
Italian Ministry of Foreign Affairs*

TECHNICAL REPORT

ARTIFICIAL REPRODUCTION OF *SCHIZOTHORAX ZARUDNYI*

METHODOLOGICAL APPROACH

Zabol/Zahedan March-July 2006

*Executed by CIRSPE, Italy
ROME, OCTOBER 2006*

Aquaculture Development in Sistan-Baluchestan 2005-2008

Project financed by
Italian Ministry of Foreign Affairs

Italian Cooperation
(General Directorate Development Cooperation)

UNDP
United Nation Development Programme

SHILAT
Iranian Fisheries Organisation

CIRSPE
Italian Research and Study Centre for the Fishery

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METHODOLOGICAL APPROACH
(Task 1)

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SHILAT-IRANIAN FISHERY ORGANISATION

AQUACULTURE DEVELOPMENT IN SISTAN BALUCHESTAN
(2005 – 2008)

PROJECT EXECUTED BY CIRSPE – ITALY

Project brief description:

The objective of the project is to reduce poverty and social imbalance while raising the income level of the local populations and communities in the *Province of Sistan-Baluchestan through the reinforcement and dissemination of aquaculture activities*. The project's main target is to strengthen and expand aquaculture activities in two areas in the Sistan Baluchestan Province, in terms of production, technology, economic results, in order to increase the socio-economic level of target groups and the local communities involved. The project is expected to have significant impact on the living standards of target groups, as well as indirect socio-economic benefits for the local communities, and also generate a model for provincial level replication. The specific objectives, therefore, are: i) Identification of valid production strategies for aquaculture in Sistan-Baluchestan; ii) Identification of appropriate technologies for both the different contexts (fresh water and sea water); iii) The Expansion of the base production and the diversification of the product; iv) Institutional capacity building and professional growth on the part of the Shilat Iranian Fisheries Organisation. The project comprises 3 main components: technical assistance and supply of technology and equipment

FOREWORD

This document is the Technical Report on *Schizothorax zarudnyi* artificial reproduction and concerns the technical activities carried out in Zahak hatchery, Zabol from March to July 2006.

This component is part of the Project Task 1; the carried out activities are connected to the SHILAT exigency to concentrate the effort to the native species of the Hamun lake *Schizothorax zarudnyi*, for lakes/reservoirs stocking.

The productive activities were scheduled from March to July 2006. CIRSPE signed an agreement with an Iranian private company (AFTM) detailing some technical service such as reported in the contract CIRSPE/AFTM.

CIRSPE/AFTM have organised the activity of artificial reproduction of the Hamun lake native species with the target to identify the methodological approach, giving importance from both scientific and pilot point of views.

The productive activities have been planned considering the necessity to increase the knowledge on species biology for the re-stocking in lakes of Zabol area.

Concerning the project budget and Task 1 implementation, CIRSPE and SHILAT agreed to reduce the financial resources reserved to the “international consultant” and to reallocate the money to support SHILAT in the Zahak hatchery management (CIRSPE/AFTM agreement).

In any case, it is important to remark that the new Ministry of Agriculture and SHILAT organization process has to take into account from a financial and a budget point of view, the needs for the management of Zahak hatchery, in terms of local technical staff, local workers, spare parts, equipment installation and maintenance.

Rome 1st October 2006

Roberto Ugolini
Project Manager

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ABSTRACT

This document is the Technical Report on the activities carried out in Zahak hatchery (Zahedan/Zabol) for the artificial reproduction of Hamun native species *Schizothorax zarudnyi*.

In June 2003 the Italian Ministry of Foreign Affairs has approved to finance the project "Aquaculture Development in Sistan Baluchestan" (act n.49; 24/6/2003; N. aid 6945.01.3) and the United Nations Development Programme ("UNDP") has agreed to co-operate in its implementation. On 25th of February 2004 the Italian Ministry of Foreign Affairs and UNDP signed the contract that includes the three following components: technical assistance, training, and equipment.

The objective of the project is to increase the income level of the local populations and communities in the Province of Sistan-Baluchestan through the reinforcement and dissemination of aquaculture activities. Improving the capacity of the public service necessary for new responsibilities and assignments tied to a great dissemination of operations, with the training of personnel, especially in management and technical activities. SHILAT expressed the need to concentrate technical effort on the native species of the Hamun lake *Schizothorax zarudnyi*. The lake has been one of the most important wet zones in the middle East, protected on the base of the International Conference of Ramsar. Before the drought, the productivity of the Hamun lake system was unrivalled in South Central Asia, with an annual production of 3.500 mt of fish and 1.7 millions of cattle, goats and sheep living around the lake there was ample income for the people in the area to sustain themselves, as well as supplying the majority of the protein requirements for the region.

The intention of the project (Task 1) is to define 2 strategies regarding the freshwater sector (for instance repopulation of water bodies and production of fingerlings for the private sector) and 2 technological packages for fish hatchery.

The productive activities were scheduled from March to July 2006. CIRSPE signed an agreement with an Iranian private company (AFTM) detailing some technical service. CIRSPE/AFTM have organised the activity of artificial reproduction for the species with the target to identify the methodological approach, giving to this activity importance from both scientific and pilot point of views, to increase the knowledge on the biology for the re-stocking in the lakes around the Zabol area. The executed activities in Zahak hatchery concerned hatchery management, maintenance of equipment related to breeding, fish biology and production, on job training.

From a productive point of view, the pilot activity in Zabol hatchery achieved the result of identifying the methodology useful for artificial reproduction of *S. zarudnyi*. However, the species is not probably suitable for aquaculture on a small scale, considering that the growth rate is slower than other freshwater species such as Indian carp and trout. In the rural contest (such as Zahedan/Zabol/Kash) farmers need to rear species that can achieve the market size in less than one year, considering the farms cash flow needs.

On the other hand, the species is very important from an ecological point of view in terms of biodiversity and fishery. The approach must be oriented towards artificial reproduction and repopulation of water bodies.

It is also important to underline the other aim for which Zahak hatchery can be managed: the production of aquaculture suitable fingerlings for private farmers. In the area there are about 600 small scale farms for trout and carp fattening run on a family level, that shows a production limitation connected to the fluctuating availability of seed fingerlings, this situation prevents these family enterprises from properly planning their activities. Zahak hatchery must produce at least about 600.000 fingerlings of 3-5 gr. to provide the private sector so to give it the chance to produce every year.

EXECUTIVE SUMMARY

Introduction

1. The Italian Government intention is to contribute to the peace process in the Middle East area and, for this reason, it is promoting development projects and investing in local human resources in the area, supporting the civil society and economic productive processes.
2. In June 2000 the General Department of Development Cooperation of the Italian Ministry of Foreign Affairs and the Iranian Ministry of Foreign Affairs signed a “Meeting Memorandum” in which the parties expressed the intention to finance cooperation activities in the Province of Sistan Baluchestan.
3. In June 2003 the Italian Ministry of Foreign Affairs has approved to finance the project “Aquaculture Development in Sistan Baluchestan” (act n.49; 24/6/2003; N. aid 6945.01.3). The United Nations Development Programme (“UNDP”) has agreed to cooperate in the implementation of the project. On 25th February 2004 The Italian Government/Ministry of Foreign Affairs and UNDP signed the contract for the project implementation that includes the following components: technical assistance, training, and equipment.
4. The project’s main target is to strengthen and expand aquaculture activities in two areas in the Sistan Baluchestan Province, in terms of production, technology and economic results. The project is expected to have significant impact on the living standards of target groups, as well as indirect socio-economic benefits for the local communities, and also generate a model for provincial level replication.
5. In the rural context of Zahedan, fish rearing is practiced in the internal zones, where there are many rural small scale farms, which play a very important social, cultural and economic role. The project intends to develop 2 strategies for the freshwater sector and 2 technological packages for fish hatchery.
6. At the same time it is crucial to improve the capacity of the Public Service which is necessary for the new responsibilities and assignments which will arise from the increasing of the production. That will be achieved through the diffusion of techniques, the training of personnel, especially concerning management and technical activities. This is also important for the reinforcement of the extension service, with the undertaking of a clear-cut effort to disseminate the technologies set during the project activities.
7. The specific objectives can be identified as follows.
 - Identification of valid production strategies for aquaculture in Sistan-Baluchestan;
 - Identification of appropriate technologies for both the different contexts (fresh water and sea water);
 - Expansion of the base production and the diversification of the product;

- Institutional capacity building and professional growth of the Shilat- Iranian Fisheries Organization.
8. In the area of Zabol, Lake Hamun has been one of the most important wet zones of the Middle East, from an ecological point of view. It is protected on the basis of the International Conference of Ramsar. Before the drought, the productivity of the lake Hamun system, was unrivalled in South Central Asia, with an annual production of 3.500 mt of fish and 1.7 millions of cattle, goats and sheep living around the lake. There was ample income for the people in the area to sustain themselves, as well as supplying the majority of the protein requirements for the region.
 9. SHILAT and CIRSPE considered the need to develop aquaculture and fishery and they agreed to put emphasis on the native species *Schizothorax zarudnyi* for lakes/reservoirs stocking. The productive activities were scheduled from March to July 2006. CIRSPE signed an agreement with an Iranian private company (AFTM) providing technical service as reported in the CIRSPE/AFTM contract.

Zahak hatchery

10. The hatchery is located near the town of Zabol, on the banks of the Chahnimeh reservoirs, which were established in 1993. The total farm surface is about 100 ha but, presently, only app. 16.0 ha. water area is in use. Ponds vary from 0.3 to 1.0 ha in size. The farm receives water from the abovementioned reservoir.
11. SHILAT manages the center, implementing activities orientated towards reproduction of Chinese carps (grass carp, *Ctenopharyngodon idella*, silver carp, *Hypophthalmichthys molitrix*, big head, *Arichthys nobilis* and common carp, *Cyprinus carpio*). These species were introduced in this farm in 1998. Seed production of the abovementioned species started in 2003.
12. Chahnimeh reservoirs occupy an area of 4.700 ha and 680 million cubic meter capacity. They are composed of three sub sectors 1(21 km²), 2(9 km²), and 3(17 km²) connected together by a system of channels. There is no continuous source of water supply into the reservoirs. The main source of water is Hirmand River which, unfortunately, is often dry.

The species

13. *Schizothorax zarudnyi* (English name: Snow Trout, Persian name: Hamun mahi & local name: white fish pronounced sefidak) is one of the most important & highly valued carp. From a systematic point of view, the species is part of the subfamily Schizothoracinae (family of Cyprinid).
14. This group is endemic to the central plateau of Asia and is the most typical representative of the ichthyofauna of the region. The genus *Schizothorax* is included in the Primitive Schizothoracinae group. According to some systematic specialists, 39 species and sub-species can be included in the genus that is the largest genus of the subfamily.

Schizothorax zarudnyi is endemic of Sistan and Afghanistan and it is common in Hirmand river and, in Hamoon Lake before dry period, both in Iran and Afghanistan area.

15. Mature specimens migrates during April- May from rivers and lakes to cold and well oxygenated waters (Streams and their tributaries) to breed in shallow pools within boulders, sand and gravel.
16. The breeders after laying eggs migrate back to rivers and lakes leaving their young ones behind. The fertilized eggs are adhesive in nature and normally stick to sand, gravel or other substrate so that they are saved from being washed away by strong currents, floods etc.
17. During the breeding season the species exhibit definite secondary sexual characters- the females are characterized by possessing soft, enlarged and distended belly while males develop prominent nuptial tubercles on the snout coupled with roughness of the body, evident just before spawning season and disappear shortly after the spawning. Males normally mature about a month earlier than females under almost identical ecological condition

Methodology

18. Successful fingerling producers select high quality brood fish and then take care of them properly. This helps insure high quality and many young. Determining the sex of fish is an important step in knowing whether one has a pair. Once males and females have been distinguished, a suitable pair or spawning group should be chosen. There is important trait to seek in choosing the parent fish. Male broods are easily identifiable. When pressing ventral, white fluid comes out. The genital papillae are slender pointed and genital aperture is narrow.
19. Recognizing females is not always very sure, but a good female has a genital papilla blunt, aperture is wide & bulging. Abdomen is soft in touch. The broods are very susceptible to stress. Such brood may not respond to hormone or may breed partially affecting the quality of gametes. Care was taken to transport brood from pond to hatchery in a tank filled with water and oxygen was also flowed in tank.
20. Females that have eggs in a proper stage of maturity should be injected for a successful induced spawning. Any delay in injecting the brood fish greatly diminishes the chance for a successful spawning.
21. While injecting the fish, every effort must be made to minimize stress and injury. OVAPRIM (Each ml contains SGnRHa20µg + Domperidone 10 mg, manufactured by Biomeda MTC Animal Health, Ontario, Canada) is a very effective hormone inducing Indian Carps, by intramuscular injection. Doses: knockout & split doses of hormone were tried. Hormone dose was double to female brood than male. Males were always in oozing condition. The first experiment on 17.03.06 did not achieve any results. In fact, after 18 hours of hormone administration, eggs were catered and the observed eggs were not in an optimum stage of maturity.

22. The second experiment on 27.03.06 produced fertilized eggs. A total 1.4 ml/kg body wt. hormone to female brood in a span of 68 hours was administered. Between 12-24 hours fishes were stripped. The best result for the ovulation period was obtained stripping fish with an interval of 24.00 hours. Eggs were released free and fertilization was over 90%. Waiting/ovulation period: 12-24 hours. Hatching time: 108/130 hours (90-108 day/°C). Yolk absorption: 18-25 hours (15-21 day/°C). Water average temperature 20°C. It was observed that late hatching hour's have 10-15% deformed larvae.
23. The eggs were stripped in dry basin. The male fish was wipe off properly so that water was not allowed in the egg basin. The male fish was stripped and milt was dropped on eggs. Thereafter, 2-3 minutes mixed gently with the bird feather. Then sprinkle urea solution (5g urea/1 lit of water) and mixed. Then eggs were washed with solution 2-3 times for an interval of 5 minutes. The eggs are adhesive but unlike common carp. These fertilized eggs were washed later with urea solution (20 g urea/lit + 5g salt/lit of water). Two washings with this solution for 5 minutes were found enough to free the eggs.
24. There is an optimum temperature required for each developmental life stage and water temperatures should be maintained with minimal fluctuations, preferably no more than $\pm 1^\circ\text{C}$ from optimal.
25. After hatching, about 6000 larvae were collected & put to hapa, fixed in a breeding tank for further rearing. These larvae for the first three days were fed with starter feed (egg yolk 1:1 milk powder& tiny zooplankton). Then they started to accept plankton feed readily. Rearing went on until the 8th day when they attained 11.0 mm in length. At this stage they were termed as advance hatchlings. A pond of 0.12 ha (40x30m) was dewatered and limed of 250kg/ha. The silt was made upside down and kept drying for two days. Later, it was filled with freshwater; the initial dose of urea (150kg/ha) and single super phosphate 50 kg/ha) was applied. Later 3200 advanced hatchlings (11.0 mm in length) were stocked for further rearing.
26. On 13th of August the staff involved in the project carried out a sampling in the pond. The results showed that the *Schizothorax* fingerlings reached the average weight of 5,5 gr and average length of 95 mm. After this samples, CIRSPE has delivered the fingerlings to SHILAT following an official letter, according to the contract and the agreed planning.

Results

27. The technical results obtained in the pilot experience show that male above 600 g and female above 900 g were found more suitable for breeding and the fish develops gonad after fish attains weight higher than 400 gm. The egg size recorded is mm 1.542 ± 0.05 and the Fecundity range 24.300-37.640, fish weight was 0.8 to 1.1 kg respectively. So it is possible to consider 32.600 eggs/kg fishes.
28. Operative water temperature must be from 14 to 22 °C with an optimum rate for reproduction between 18-20.
29. CIRSPE/AFTM have organised the activity of artificial reproduction of the lake Hamun native species with the target to identify the methodological approach to be transferred to

the SHILAT technicians giving to this activity importance both from scientific and pilot point of views. The productive activities have been planned considering the necessity to increase the knowledge on species biology for the re-stocking in lakes of Zabol area.

Discussion/conclusions

30. The project intention is to draw 2 strategies for the freshwater sector and 2 technological packages for fish hatchery. Strategies: repopulation of water bodies and fingerlings production for private sector. Technological packages: artificial reproduction of *S. zarudnyi* and pre-fattening of fries/fingerlings.
31. Concerning the productive aspect, pilot activity in Zabol hatchery achieved the result to identify the methodology useful for the artificial reproduction of *S. zarudnyi*. Just to give some practical indications, the survival rate can be about 20% from fertilized eggs to the larvae stage that is possible to transfer in the pond. The survival from the eggs to is about 10% for fingerlings of 11 mm lengths. For example, it is evident that to produce 100.000 fingerlings of *S. zarudnyi* it is necessary to have a brood stock of about 33-35 kg of females. The water temperature must be 18-22 °C and it is advisable to use hormone OVAPRIM.

Recommendations

32. SHILAT and CIRSPE/AFTM agreed to organise the activity of artificial reproduction of the lake Hamun native species with the target to identify the proper methodology. The species is probably not suitable for aquaculture on small scale, considering that is growing more slowly than other freshwater species such as Indian carp and trout. In the rural contest (such as Zahedan/Zabol/Kash) farmers need to rear species that can achieve the market size in less than one year, considering the farms cash flow exigencies.
33. On the other hand, the species is very important from an ecological point of view in terms of biodiversity and also for the fishery. The approach must be oriented to artificial reproduction and repopulation of water bodies.
34. The original idea of repopulate the lake Hamun is unfortunately affected by the conflict on Hirmand river water management, between Iran and Afghanistan. However, this conflict must be solved considering the importance of lake Hamun wet zone both in Iran and Afghanistan. Apart from that Chahnimeh reservoir with 4.700 ha can represent a important income for the local fishermen so to justify the repopulation of it with *Schizothorax* fry.
35. In this case it is convenient to produce pre-fattening fingerlings of about 3-5 gr., instead of releasing larvae or fry in the reservoir. The fingerlings approach should have the result to increase the survival rate. The condition for this productive activities is to improve the facilities and the management of Zahak hatchery, as SHILAT declared to do.
36. It is also important to underline the other aim for which Zahak hatchery can be managed: the production of aquaculture suitable fingerlings for private farmers. Zahak hatchery

could produce at least about 600.000 fingerlings 3-5 gr. sized to provide the private sector enabling it to produce every year.

37. Finally, the consolidation of the extension service in the Province is also important and crucial for private sector and it is strictly connected to the professional growth of the Shilat/Fishing Department. It is crucial to improve the capacity of the Public Service which is necessary for the new responsibilities and assignments which will arise from the increasing of the production. That will be achieved through the diffusion of techniques, the training of personnel, especially concerning management and technical activities.

1. INTRODUCTION

The Italian Government wants to reinforce political and economic relations with the Islamic Republic of Iran, considering the reciprocal interest in the exploitation of Iran's raw materials and in exporting Italian technology, industrial products and consumer goods.

Apart from that Italy has always considered the importance of Iran in the Middle East context such as a crucial regional Country.

The Italian Government intends to contribute to the peace process in the Middle East area and, for this reason, it is promoting development project and investing in local human resources in the area, supporting the civil society and economic productive processes.

1.1. Project background

On June 2000 the General Department of Development Cooperation of the Italian Ministry of Foreign Affairs and the Iranian Ministry of Foreign Affairs signed a "Meeting Memorandum" in which the Italian party expressed its intention to finance cooperation activities in the Province of Sistan Baluchestan.

The Province of Sistan Baluchestan is the poorest in the Republic of Iran (UNDP, 1999 "National Human Development Report"). The Province borders with Afghanistan and with Pakistan and plays a strategic role for the central Government.

The topics relevant to the cooperation program were studied in depth during technical missions carried out by the General Department of Cooperation Development, of the Italian Ministry of Foreign Affairs. Upon examination, priority was given to the development of aquaculture, for the interesting prospects of sector development, both in marine and fresh water.

The Technical Unit of the Italian General Department of Development Cooperation (DGCS) studied in depth the cooperation opportunities, during many technical missions carried out in 2002 and 2003.

In June 2003 the Italian Ministry of Foreign Affairs has approved to finance the project "Aquaculture Development in Sistan Baluchestan" (act n.49; 24/6/2003; N. aid 6945.01.3). The United Nations Development Programme ("UNDP") has agreed to co-operate in the implementation of the project.

The modality of cost-sharing agreement has been chosen to allocate the project budget in the beneficiary Country; this system gives to the financer adequate visibility, together with direct participation and control of the different performance phases with the structure managing the project.

On the 25th of February 2004 The Italian Government/Ministry of Foreign Affairs and UNDP signed the contract for the project implementation that includes the three following components: technical assistance, training, and equipment.

The objective of the project is to increase the income level of the local populations and communities in the Province of Sistan-Baluchestan through the reinforcement and dissemination of aquaculture activities.

The project's main target is to strengthen and expand aquaculture activities in two areas in the Sistan Baluchestan Province, in terms of production, technology, economic results, in order to increase the socio-economic level of target groups and the local communities involved.

The project is expected to have significant impact on the living standards of target groups, as well as indirect socio-economic benefits for the local communities, and also generate a model for the replication on a provincial level.

The target groups of the project (i.e. the beneficiaries that will be directly positively affected by the project at the Project Purpose level) are:

- Ministry of agriculture/SHILAT (Central and Province level);
- SHILAT technicians for the project training activities;
- Private sector involved directly in the project activities.

Shilat/Fishery Directorate, above all, is one of the beneficiaries/stakeholder that, participating directly to project management, can achieve a high level of professionalism.

The Final beneficiaries of the project are the actors of the aquaculture private sector, like farmers, and that intend to be operative in aquaculture sector in the Sistan-Baluchestan Province.

Ministry of Agriculture/SHILAT and the Bank system are also final beneficiaries of the activity and results of the project, considering the objective to develop and consolidate the private sector in the context of Province.

1.2. Local context

In the rural context of Zahedan, fish rearing is practiced in the internal zones, where there are many rural small scale farms, playing a very important social, cultural and economic role.

The preliminary analysis executed during 2002 and 2003 showed that this rural sector presents macroscopic limitations in terms of technology, service and marketplace.

However, the central system continues to invest on structures and equipment, trying to solve the problems of growth and consolidation that can essentially be traced to the technical-cultural isolation which the Country has experienced over the last decade.

The aim of the project is to expand and reinforce aquaculture activities both in terms of production/technology and economic results and to raise the socio-economic level of the groups and populations involved.

This target can be achieved with the identification of valid production strategies for aquaculture in the Province and the identification of appropriate technologies for the different contexts.

The project intends to draw 2 strategies for the freshwater sector (for instance repopulation of water bodies and production of fingerlings for the private sector) and 2 technological packages for fish hatchery.

1.3. Objectives

The specific objectives of the project can be identified as follows:

- Identification of valid production strategies for aquaculture in Sistan-Baluchestan;
- Identification of appropriate technologies for both the contexts (fresh water and sea water);
- Expansion of the base production and diversification of the product;
- Institutional capacity building and professional growth of the Shilat-Iranian Fisheries Organization.

The project consists of:

- production initiatives both in the public facilities of the SHILAT (Zabol/Zahak hatchery) and in the private farms (Chabahar/Gowater), with the results to be transferred to the private beneficiaries;
- training addressed to the technicians of the SHILAT/the Ministry of Agriculture, with forecast fall-out on the private operations, given that the individuals trained are employed in the extension service;
- supply of technology and items useful to the project pilot activities to demonstrate the worth of the new production strategies and, finally, testing and proposing innovative technical packages and, at the same time, appropriate to the context.

1.4. Task 1

In the area of Zabol, the lake Hamun has been one of the most important wet zone of Middle East, from an ecological point of view and protected on the basis of the International Conference of Ramsar. Before the drought, fishery in the lake was very profitable for local population.

The productivity of the lake Hamun system was unrivalled in South Central Asia, with an annual production of 3.500 mt of fish and 1.7 millions of cattle, goats and sheep living around the lake. There was ample income for the people in the area to sustain themselves, as well as supplying the majority of the protein requirements for the region.

A long dispute between Iran and Afghanistan caused lack of water for the all system of Hamun lake and Helmand river.

The rivers are controlled in Afghanistan by a system of dams, principally Garishk, Kajaki, Daula and Boghra, constructed in the 1940s with US assistance, deep inside Afghanistan.

Under an agreement between the two Countries (signed in 1973) Afghanistan agreed to let at least 26 cubic meter of water/sec. flow from the dams to Iran. But in 1999 the Taliban closed the dams completely and the lake dried.

On 2005 the Governments signed a new agreement and a technical mission carried out on August 2005 verified the presence of water estimating a lake surface of about 400.000 ha (considering the two portion in Iran and Afghanistan), on the basis of the information by SHILAT.

SHILAT and CIRSPE agreed to consider this new situation and the exigency to develop aquaculture and fishery component strictly connected to the fishery management of the lake, giving emphasis to the native species *Schizothorax zarudnyi* for lakes/reservoirs stocking.

The productive activities were scheduled from March to July 2006. CIRSPE signed an agreement with an Iranian private company (AFTM) detailing some technical service as reported in the contract CIRSPE/AFTM.

CIRSPE/AFTM have organised the activity of artificial reproduction of the Hamun lake native species with the target to identify the methodological approach, giving to this activity importance both from scientific and pilot point of views.

The productive activities have been planned considering the necessity to increase the knowledge on species biology for the re-stocking in lakes of Zabol area.

The new SHILAT organization process presents some financial and budget constrains. This is evident and crucial above all for the management and maintenance of Zahak hatchery. It is very important to have a good management in the farms (technical staff, workers, spare parts, equipment installation and maintenance).

In other words, CIRSPE and SHILAT agree to reduce the budget reserved to the “international consultant” and to reallocate the money to support SHILAT in Zahak hatchery management.

2. ZAHAK HATCHERY

2.1. Location

The hatchery is located near the town of Zabol, at the bank of Chahnimeh reservoirs and it was established in 1993. The total farm surface is about 100 ha area but, presently, app. 16.0 ha. water area is in use.

Ponds vary 0.3 to 1.0 ha in size. Farm receives water from the abovementioned reservoir.

2.2 Technical activities

SHILAT directly manages the centre, implementing activities oriented to reproduction of Chinese carps (grass carp, *Ctnopharyngodon idella*, silver carp, *Hypophthalmichthys molitrix*, big head, *Arichthys nobilis* and common carp, *Cyprinus carpio*).

These species were introduced in this farm during 1998. Seed production of the above species started in 2003.

SHILAT management is the following:

- Production of Chinese carp seed;
- Distribution of seed to farmers and stocking in reservoirs;
- Conducting training and workshop at the farm;
- Research.

2.3. Infrastructure

There is a water pump station at the reservoir site, from where water is drawn to the farm ponds and hatchery complex.

Chahnimeh reservoirs have 4.700 ha area and 680 million cubic meter capacity. It is made of three sub sectors 1(21 km²), 2(9 km²), and 3(17 km²) linked together by channels. There is no continuous source of water supply into the reservoirs. Its main source of water is the Hirmand River coming from Afghanistan.

Chahnime Reservoirs are the only source of water for the cities of Zabol, Zahak, and Zahedan which have to use that both for the agriculture and aquaculture activities.

The hatchery complex has the following facilities:

- Chinese type breeding tanks: 2 nos.
- hatching units: 30 nos.
- Vertical jar hatching units: 40 nos.
- Brood conditioning tanks: 4 nos. (L 2.8, B 1.2 m, H 1.2m)
- Heating system: To maintain desired water temperature in hatching units when required.

Other rearing infrastructure includes:

- Brood /culture earthen ponds: A total of 8.0 ha have earthen ponds vary from 0.3 to 1.0 ha.
- Fry rearing tanks: Four rearing tanks having inlets outlet facilities
- Raceways: Four raceways (each L 6.8m, B 1.8m, and H 0.5m) are for spawn rearing.

2.5. Technical staff

SHILAT technical staff includes:

- Head of Zahak hatchery
- Head of Fishery Research Station
- Technician in research lab. One no.
- Supporting staffs 6 nos.
- Auxiliary staff such as electrician and pump operator etc.

2.6. Research laboratory

The laboratory is still under re-organization but it is well equipped. Some routine observations on physico- chemical parameters are done.

3. THE SPECIES *Schizothorax zarudny*

3.1. Identification

Schizothorax zarudnyi (English name: Snow Trout, Persian name: Hamun mahi & local name: white fish that pronounces as sefidak) is one of important & priced carp.

From a systematic point of view, the species is part of the subfamily Schizothoracinae (family of Cyprinid).

This group is endemic to the central plateau of Asia and is the most typical representatives of the ichthyofauna of the region. According to the degree of specialization of the barbells, scales and pharyngeal teeth the Schizothoracinae are divided into 3 grades (Zi-Ming, Yi Feng, 2001):

- Primitive Schizothoracinae;
- Specialized Schizothoracinae;
- Highly specialized Schizothoracinae.

The genus *Schizothorax* is included in the Primitive Schizothoracinae group. According to systematic experts, 39 species and sub-species can be included in the genus that is the largest genus of the subfamily.

Schizothorax zarudnyi is endemic of Sistan and Afghanistan and it is common in the Hirmand river and, in the Lake Hamun before dry period, both in Iran and Afghanistan.

The fish has taken a shelter to Chahnimeh reservoirs. Propagation of the said species in nature has been drastically effected. Recruitment is not to the level of maintaining its population. The fish catch has shown declined trend.

SHILAT, according to the Government sector priorities, is taking up a priority to save this species before it gets extinct from natural water bodies.

Morphology: Body is cylindrical, dorsally blackish and lateral side is pale yellow in colour. Biometric details are: Depth 5.3-20.2% of SL, Dorsal spines (total): 4 - 4; Dorsal soft rays (total): 8; Anal spines: 2; Anal soft rays: 5. Pharyngeal teeth: 5.3.2-2.3.5.

3.2. Biology

Mature specimens migrates during April- May from rivers and lakes to cold and well oxygenated waters (Streams and their tributaries) to breed in shallow pools within boulders, sand and gravel.

The breeders after laying eggs migrate back to rivers and lakes leaving their young ones behind.

The fertilized eggs are adhesive in nature and normally stick to sand, gravel or other substrate so that they are saved from being washed away by strong currents, floods etc.

During the breeding season the species exhibit definite secondary sexual characters. Females are characterized by possessing soft, enlarged and distended belly whiles, while males develop prominent nuptial tubercles on the snout coupled with roughness of the body.

The roughness of the body and the tubercles becomes evident just before spawning season and disappear shortly after the spawning. Males normally mature about a month earlier than females under almost identical ecological condition

3.3. Fecundity

The fecundity of *Schizothorax spp.* is reported by different authors as follows:

Species	Fish length (mm)	Fecundity range	References
<i>S.niger</i>	195-252	1,810-5608	Malhotra, 1965
	135-365	810-11458	Joyti & Malhotra, 1972
<i>S.longipinnis</i>	210-430	5748-34221	Sunder, 1986
<i>S. richardsonii</i>	216-331	2600-16605	Das & Koul, 1965
	241-331	2598-27312	Mir, 1979

Gonadosomatic index is taken as a measure of sexual maturity and is one of the important tool to assess the degree of ripeness of the ovary. The values of monthly GSI as worked out on *Schizothorax* are as follows.

S. niger, Dal lake Kashmir. (Malhotra, 1965) monthly GSI recorded are as follows.

Jan	7.85	July	1.53
Feb	9.00	August	1.77
March	10.55	Sept	3.85
April	8.80	Oct	5.24
May	7.26	Nov	8.20
June	2.13	Dec	10.85

3.3. Spawning behavior

Schizothorax spp. (except for *S. niger*) undergo spawning migration in the small adjoining tributaries of main lakes and rivers in Kashmir and lay their eggs under stones, gravel and debris with moderate current.

Malhotra, 1966 reported that the probable factors influencing the spawning of *S. niger* in Dal lake, Kashmir are the temperature followed by light having no dependence on rainfall or flood.

Shreshta and Khanna (1979) suggested that the spawning season of *S. richardsonii* from Nepal waters depends upon suitable extroceptive factors, e.g. Photoperiod, temperature, pH flood etc.

The spawning season of various *Schizothorax* species has been reported as follows.

Species	Locality	Peak breeding duration	Authors
<i>S. niger</i>	Kashmir	March-April	Vass et al. 1979
<i>S. curvifrons</i>	Kashmir	May – June	Sunder & Subla, 1984b
<i>S. longipinnis</i>	Kashmir	May-June	Sunder, 1981
<i>S. richardsonii</i> H. P.		March, May-June & Oct- November	Jhingran & Sehgal 1978.

3.4. Artificial reproduction

A preliminary work for the culture of *Schizothorax* species has been conducted at Srinagar (Raina et al., 1985a, b, and 1986). Different species of *Schizothorax* were bred artificially by stripping method.

The rate of fertilization varied between 70-90%. The incubation period for *S. niger*, *S. micropogon*, *S. curvifrons*, *S. exocinus* and *S. richardsonii* ranged between 192-360 hours and cumulative survival from egg to swim-up fry stage was 25-55%.

Eggs incubated in running water conditions (barring *S. niger*) gave better survival rate (40-55%) when compared to stagnant water conditions (25-30%).

A specially designed incubator (Sunder et al., 1980) was also fabricated to accommodate 12,000-15,000 eggs arranged in tiers. The fry produced ranged between 8-11 mm in total length and an average weight of 0.5 g. The fry after stocking in ponds were fed on artificial diets of both plant and animal origin. In about a rearing period of 60 days, the fry attained a length range of 35-60 mm and weight range of 200-400 mg. The rate of survival from early fry to advanced fry ranged between 60-75%.

The advanced fry of *S. esocinus* are reared for about six months and during this culture period the fish increased to a length of 90-125 mm and weight of 2-5 g. the survival rate during this period varied between 75-80%.

A team of Uremia Fisheries Research Station studied artificial reproduction in 1999. They remarked that the maximum GSI was 7.9-9.6 in March and April with 14-18°C. The minimum was in May. Variation in GSI values shows that reproduction has annual cycles which begins in May and ends in April. A significant increase of oocyte diameter and GSI were observed from October. The species is a total spawner and showing a synchronous ovary.

4. METHODOLOGY

4.1. Breeders

Successful fingerling producers select high quality brood fish and then care of them properly. This helps insure high quality and numerous young.

Determining the sex of fish is an important step in knowing whether one has a pair. Once males and females have been distinguished, a suitable pair or spawning group should be chosen. There is an important trait to seek in choosing the parent fish. Male broods are easily identifiable. On pressing ventral white fluid come out. The genital papillae are slender pointed and genital aperture is narrow.

It is not always sure to recognize a female, but a good one has a genital papilla blunt, aperture is wide & bulging. Abdomen is soft in touch.

Example of gonad somatic Index of females & males fish

S. No	Sex	Wt. of fish (gr)	Wt. of gonad (gr)	Length of Coelomic cavity(mm)	Length R/L gonad	GSI	Remarks
1	F	700	34.7	188	160/158	4.95	Eggs yellow in colour
2	M	700	47.5	180	172/175	6.78	Creamy colour, milting
3	M	500	21.2	178	164/164	4.24	Creamy colour, not milting
4	M	750	55.3	185	174/166	7.37	Creamy colour, milting

$$\text{Gonad somatic Index (GSI)} = (\text{Wt. of Gonad/Wt.of body}) \times 100$$

4.3. Transportation

Fish transport under crowded condition can rapidly become stressed due to physical injury, oxygen deficiency, deteriorating water quality, rapid change in water temperature and osmotic imbalance.

The broods are very susceptible to stress. Such brood may not respond to hormone or may breed partially affecting the quality of gametes. Care was taken to transport brood from pond to hatchery in a tank filled with water and oxygen was also flowed in tank.

4.4. Weighting

Both male & female were weighted. So as an accurate hormone dose can be administered. At most care was taken to avoid stress during weighting.

4.5. Hormone treatments

Females that have eggs in a proper stage of maturity should be injected for successful induced spawning. Any delay in injecting the brood fish greatly diminishes the chance for a successful spawning.

While injecting the fish, every effort must be made to minimize stress and injury. Brood fish are captured and gently restrained in a beg net for injections. Avoid squeezing or forcefully holding the fish. It is unnecessary to anesthetize the fish. The fish struggle less if a cloth is placed over its head.

OVAPRIM (Each ml contains SGnRHa20 μ g + Domperidone 10 mg, manufactured by Biomeda MTC Animal Health, Ontario, Canada). This is one of the most effective hormones for inducing Indian Carps. Intramuscular injection was given.

Doses: knockout & split doses of hormone were tried. Hormone dose was double to female brood than male.

4.5.1. Breeding Expt. No. 1:

-Date of experiment: 17.03.06

-Source of brood: pond

-Water temp.: 14-18 °C

-Type of hormone: OVAPRIM

Dose: 0.4 ml to female/kg body Wt. of fish. 0.15-0.2 ml/kg body Wt. of body to male. Males & females were injected at a time.

S.No.	Wt. in kg/length of brood (mm)		Time of Injection(hrs)	Breeding response
	Male	female		
1	0.70/360	1.20/430	13.20	Negative
2	1.00/440	0.70/385	13.20	Negative
3	0.80/380	1.40/440	13.20	Negative
4	0.60/365	-	-	-

Males were in oozing condition. Hormone did not have any affect on female. After 18 hours of hormone administration, eggs were catered and observed eggs were not in optimum stage of maturity.

Probably brood pond environment was not suitable. It was full with filamentous algae & terrestrial weed. Under such stressed environment probably gonads did not come up to final stage of maturity. To overcome the said filamentous algae & terrestrial weeds were removed from pond. Freshwater was added to pond & allowed the brood in this improved environment over a week. Thereafter, only brood was netted out for subsequent breeding.

4.5.2. Breeding Expt. No. 2

- Date of experiment: 27.03.06
- Source of brood: pond
- Water temp. : 18-22 °C
- Type of hormone: OVAPRIM
- Dose: knockout single dose & split doses were tried.

A. Single knockout dose 0.5 ml/kg body wt. to female & 0.2 ml/kg wt. to male at a time were administered.

S.No.	Wt. in kg/length of brood (mm)		Remarks
	male	female	
1	0.60/370	0.80/360	All male milt thinned out & milting profusely. In this set of experiment female dose of hormone was increased to 0.5 ml/kg. The female were checked after 29 hrs. None of the female responded to hormone.
2	0.70/380	0.90/400	
3	0.80/400	1.00/410	
4	0.70/390	0.90/405	
5	0.60/365	0.60/355	

B. Split doses of hormone to female & single dose to male at 0.2 ml/kg body wt at the time of second dose to female.

S. No	Wt. in kg/length of brood (mm)		Time of administration of hormone				Fecundity
	Male	female	1 st 27.03.06 12:30	2 nd 28.03.06 8:30	3 rd 29.03.06 8:00	4 th 30.03.06 8:00	
1	0.60/385	0.90/390	0.2ml	0.4ml	0.4ml	-	Few eggs released
2	0.65/393	1.00/400	0.2ml	0.4ml	0.4ml	0.4ml	Did not respond
3	0.70/405	0.90/390	0.2ml	0.4ml	0.4ml	0.4ml	27565, 5-10% fertilization
4	0.75/378	1.20/420	0.2ml	0.4ml	0.4ml	0.4ml	34230, over 90% fertilization

A total 1.4 ml/kg body wt. hormone to female brood in a span of 68 hours was administered. Between 12-24 hours fishes were stripped. The best result ovulation period was obtained fish stripped at an interval of 24.00 hours. Eggs releasing was free and fertilization was over 90%.

Waiting/ovulation period: 12-24 hours.

Hatching time: 108/130 hours (90-108 day/°C)

Yolk absorption: 18-25 hours (15-21 day/°C)

Water average temperature 20°C

It was observed that late hatching have 10-15% deformed larvae.

4.6. Fertilization of eggs

The eggs were stripped in dry basin. The male fish was wipe off properly so as water was not allowed in the egg basin. The male fish was stripped and milt was dropped on eggs. Thereafter, 2-3 minutes mixed gently with the bird feather. Then sprinkle urea solution (5g urea/1 lit of water) and mix. Then eggs were washed with solution 2-3 times at an interval of 5.0 minutes.

The eggs are adhesive but unlike common carp. These fertilized eggs were later washed with a urea solution (20 g urea/lit + 5g salt/lit of water). Two wash with this solution for 5 minutes were found enough to free the eggs.

4.7. Hatching units (vertical jar of 8 lit capacity)

Considering that eggs and fry have high oxygen requirements, maintain oxygen levels at a minimum of six parts per million (ppm). Water pH must be between 6.5 and 8.5 for best results. Risk of disease is less if there is continuous flow of water with the above quality.

Incubation temperature has a direct effect on the timing of embryonic development and thus determines hatch time and rate. Fish development and hatching is delayed at low temperatures, and accelerated at high temperatures. Incubating temperatures are also known to modify the behavior of larvae and determine certain morphological characteristics.

There is an optimum temperature required for each developmental life stage. Water temperatures should be maintained with minimal fluctuations, preferably no more than $\pm 1^{\circ}\text{C}$ (2°F) from optimal. Poor embryo gives low hatching success, reduced growth rates, larval deformities results in low survival in the rearing system.

Vertical jar hatchery is based on upward flow of water. The newly hatched larvae move out along with water current. There are three components of hatching unit:

- a) **Over head tank** : The desired quality water through filter is drawn from reservoir to the tank. From here water is flowed to hatching units.
- b) **Vertical jars**: Preferably jar size may vary from 6 to 8 liters capacity. These jars are fitted on an iron frame. Water to these jars is supplied from below and flows out to the common channel. The water of channel falls to spawn collection unit. Water flow in jar depends on species of fish.
- c) **Spawning unit**: The size of the spawning depends on the number of jars connected to the unit. An excess water flows out retaining the larvae. Water is also showered to the unit to maintain oxygen level. The larvae remain in the unit until yolk is absorbed.

In one jar about 12,000 eggs were released for incubation. During incubation, a constant water flow is essential in order to prevent accumulation of waste products and allowing gas exchange between the egg and the surrounding water. Constant motion also appears to be necessary for successfully hatching some species of fish. Proper water flow also reduces mechanical abrasion. Water outflow was maintained at 1.5-1.7 lit/minute.

With this outflow eggs do not move out from jar & remain rolling inside. Embryo developed very well in jars. After hatching the larvae could not move out to spawn collection unit. Even water outflow was increased. Ultimately the larvae start dying in the unit. It was observed that these larvae do not have upward movement thus unable to move to spawn unit.

At this stage developing embryos were removed from jars and spread on a 1mm mesh size cloth fixed and below fine mesh nylon cloth was tied. These cloth containers were put in a plastic basin. Where water was provided from the bottom & overflowed through outlets. Thus water was continuously overflowed to developing embryos.

After hatching it was observed that hatchlings trickle down to outer cloth. From this cloth container about 6,000 larvae were collected & put to hapa fixed in a breeding tank for further rearing. Majority of hatchlings lost in the jar hatching units & handling at this critical age of larvae. Newly hatched larvae are elongated cylindrical & yolk is bulb like at anterior end and become narrow towards posterior end.

4.9. Rearing

4.9.1. Indoor rearing of larvae

Because of their size and permeability, larvae are susceptible to many types of organic or inorganic materials dissolved or suspended in the water. These may include gases, minerals, metals, and particulate matter from rocks, soil, plants and animals. It is essential to know the water quality standards for larvae of the fish species.

General water quality standards used in fish culture can be used as a reference point for hatchery water. These standards are available in aquaculture textbooks. Disinfection with malachite green was a method to keep a check on secondary infection. .

0-days hatchlings after yolk absorption were not strong enough to be released in earthen pond. Necessarily, these larvae need more care. Rearing of these continued for 7 days in hapa.

These larvae for the first three days were fed with starter feed (egg yolk 1:1 milk powder& tiny zooplankton). Then they start accepting plankton feed readily.

Fifth day onwards it was observed that hatchlings are very active and move about in the entire water column to feed upon plankton. Rearing was continued till 8th day when they attained 11.0 mm in length. At this stage they are termed as advance hatchlings.

Count, size of eggs and length of hatchlings.

S.No	Parameters	STEDV
1	Count of ovarian eggs/ml	283.6 +- 9.5
2	Count of fully swollen fertilized eggs/ml	235.4 +- 7.89
3	Size of ovarian eggs(mm)	1.542 +- 0.05
4	Size of fully swollen fertilized eggs(mm)	2.54 ± 0.19
5	Size of newly hatched larvae(mm)	4.9 ± 0.74
6	Size of yolk(mm)	2.76 ± 0.23
7	Size of 5 days old hatchlings(mm)	8.28 ± 0.08
8	Size of 8 days old hatchlings(mm)	11.0 ± 0.35

During the course of indoor rearing the mild flow of water in tank was maintained. System was also disinfected by adding 2 ppm solution of malachite green everyday to check on fungal infection.

4.9.2. Pond rearing

A pond of 0.12 ha (40x30m) was dewatered and limed of 250kg/ha. The silt was made upside down and kept dried for two days.

Later, filled with freshwater the initial dose of urea (150kg/ha) and single super phosphate 50 kg/ha) was applied. Later 3.200 advanced hatchlings (11.0 mm in length) were stocked for further rearing.

Besides natural feed, supplementary carp feed was also supplied daily to hatchlings. As the stocking rate is very low there was no calculation of feed / kg biomass of fry in pond.

On 13th of August the staff involved in the project carried out a samples in the pond. The results showed that the *Schizothorax* fingerlings reached the average weight of 5,5 gr and average length of 95 mm.

The fingerlings showed the parasites *lernea* (that decrease growth rate strongly), but this parasite is conventional in Chahnimeh reservoirs on body of *Schizothorax*.

After this samples, CIRSPE delivered the fingerlings to SHILAT by an official letter, according to the contract and the agreed planning.

5. RESULTS

The technical results obtained in the pilot experience shows that male above 600 g and female above 900 g were found more suitable for breeding and the fish develops gonad after fish attains weight more than 400 gm.

The egg size recorded is of mm 1.542 ± 0.05 and the Fecundity ranged 24.300-37.640 of fish weight was 0.8 to 1.1 kg respectively. So it is possible to consider of 32.600 eggs/kg fishes.

In synthesis:

- The fish develops gonad after fish attains weight more than 400 gm.
- Gonad somatic Index of males & females were recorded (following table)
- The male gonads were found occupy the coelomic cavity to the end. .
- The female gonads were found fully occupying coelomic cavity.
- The eggs were yellow in colour.
- Egg size was recorded 1.542 ± 0.05 .mm.
- Ovarian eggs were loose & uniform in size.
- Ovarian eggs count was 283.6 ± 9.5 /ml.
- Fecundity ranged 24300-37640 of fish weight was 0.8 to 1.1 kg respectively.
- Prospective male above 600 g and female above 900 g were found more suitable for breeding.
- Operative water temperature must be from 14 to 22 °C with an optimum rate for reproduction from 18-20.

CIRSPE/AFTM have organised the activity of artificial reproduction of the lake Hamun native species with the target to identify the methodological approach to be transferred to the SHILAT technicians giving to this activity importance both from scientific and pilot point of views.

The productive activities have been planned considering the necessity to increase the knowledge on species biology for the re-stocking in lakes of Zabol area. The executed activities in Zahak hatchery have been the following:

- Management: Organization and control of the personnel in ZAHAK hatchery; The employed staff was the following:
 - 1 Technical manager selected by CIRSPE;
 - 5 graduate trainers for on job training activity, introduced by SHILAT;
 - 2 expert technicians on *Schizothorax* reproduction, introduced by SHILAT;
 - 5 workers for the daily farm management.
- Maintenance of the equipments related to the breeding;
- Fish Biology and production
 - a) *Schizothorax* Brood stock management
 - b) Propagation procedure (hormones type and dosage) (eggs quality control)
 - c) Nursery management
 - d) Water parameters
 - e) Feeding management
- On job training

6. DISCUSSION AND CONCLUSION

The project financed by the Italian Government wants to expand and reinforce aquaculture activities both in terms of production/technology and economic results for raising the socio-economic level of the groups and populations involved.

This target can be achieved with the identification of valid production strategies for aquaculture in Sistan-Baluchestan and identification of technologies appropriate to the context.

The project aims at drawing 2 strategies for the freshwater sector and 2 technological packages for fish hatchery.

Strategies

- Repopulation of water bodies
- Fingerlings production for private sector

Technological packages

- Artificial reproduction of *S. zarudnyi*.
- Pre-fattening of fries/fingerlings

From a productive aspect, the pilot activity in Zabol hatchery achieved the result to identify the methodology useful for artificial reproduction of *S. zarudnyi*.

Just to give some practical indications, the survival rate can be about 20% from fertilized eggs for obtaining larvae which can be transferred in the pond and finally the survival from the eggs is about 10% for fingerlings of 11 mm lengths.

For example, it is evident that to produce 100.000 fingerlings of *S. zarudnyi* it is necessary to have a brood stock of about 33-35 kg of female.

The water temperature must be 18-22 °C and it is advisable to use hormone OVAPRIM.

A total 1.4 ml/kg body wt. hormone to female brood is suggested, and stripping must be done between 12-24 hours.

The best result ovulation period was obtained fish stripped at an interval of 24.00 hours. Eggs releasin was free and fertilization was over 90%.

The waiting/ovulation period that has to be considered is 12-24 hours, the hatching time 108/130 hours and the yolk absorption 18-25 hours.

7. RECOMMENDATIONS

SHILAT expressed the need to concentrate the effort to the native species of the Hamun lake *Schizothorax zarudnyi*.

CIRSPE/AFTM have organised the activity of artificial reproduction of the Hamun lake native species with the target to identify the proper methodology.

The species is not probably suitable for aquaculture at small scale, considering that is growing more slowly than other freshwater species such as Indian carp and trout. In the rural contest (such as Zahedan/Zabol/Kash) farmers need to rear species that can achieve the market size in less than one year, considering the farms cash flow exigencies.

On the other hand, the species is very important from an ecological point of view in terms of biodiversity and also for the fishery. The approach must be oriented to artificial reproduction and repopulation of water bodies.

The original idea of repopulating the Hamun lake is unfortunately affected by the conflict on Hirmand river water management, between Iran and Afghanistan.

This lake has been one of the most important wet zone of middle East, from ecological point of view and protected on the base of International Conference of Ramsar.

Before the sickness and the dry period, fishery in the lake was very profitable for local population. A long dispute between Iran and Afghanistan caused lack of water for the all system of Hamun lake and Helmand river for many years.

The rivers are controlled in Afghanistan by a system of dams, principally Garishk, Kajaki, Daula and Boghra, built in the 1940s with US assistance, deep inside Afghanistan. Under agreement between the two Countries (signed on 1973) Afghanistan agreed to let at least 26 cubic metre of water/sec. flow from the dams to Iran. But in 1999 the Taliban closed the dams completely and the lake dried. On 2005 the Governments signed a new agreement. A project technical mission carried out on the month of August 2005 controlled the presence of water estimating a lake surface of about 400.000 ha (considering the two portion in Iran and Afghanistan), on the basis of the information's by SHILAT.

The productivity of the Hamun lake system was unrivalled in South Central Asia, with an annual production of 3.500 mt of fish and 1.7 millions of cattle, goats and sheep living around the lake there was ample income for the people in the area to sustain themselves, as well as supplying the majority of the protein requirements for the region. SHILAT request to CIRSPE to consider this new situation and the exigency to develop aquaculture and fishery component strictly connected to the fishery management of the lake.

After many years of drought (Dams in Afghanistan and a long dry period) on 2005 about 400.000/500.000 ha of water were present on the boundaries between Iran and Afghanistan. On 2006 the lake is again dry due the conflict with Taliban's in the area.

However this conflict must be solved considering the importance of Hamun lake wet zone both in Iran and Afghanistan areas. Apart from that Chahnimeh reservoir with 4.700 ha can represent a important income for the local fishermen so to justified to repopulate it with *Schizothorax* fry.

In this case it is convenient to produce pre-fattening fingerlings of about 3-5 gr., instead of leaving larvae or fry in the reservoir.

The fingerlings approach can have the result to increase the survival rate. The condition for this productive activities is to improve the facilities and the management of Zahak hatchery, such as SHILAT declared to do.

It is also important to underline the other aim for which Zahak hatchery can be managed: the production of aquaculture suitable fingerlings for private farmers.

In fact in the area there are about 600 small scale farms for the fattening of trout and carp run on a family level that show a production limitation that can be traced to the fluctuating availability of seed fingerlings, an annual uncertainty that prevents these family enterprises from properly planning their activities.

The new SHILAT organisation process presents some financial and budget constrains. This is evident and crucial above all for the management and maintenance of Zahak hatchery. It is very important to have a good management in the farms (technical staff, workers, spare parts, equipment installation and maintenance).

Zahak hatchery could produce at least about 600.000 fingerlings of 3-5 gr. to be given to the private sector the guarantee to produce every year.

Finally, the consolidation of the extension service in the Province is also important and crucial for private sector and it is strictly connected to the professional growth of the Shilat/Fishing Department.

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ANNEXES

On job training

The project intends to improve the capacity of the public service necessary for the new responsibilities and assignments tied to a great dissemination of operations, with the training of personnel, especially in management and technical activities.

At the same time it is crucial to improve the capacity of the public service necessary for the new responsibilities and assignments tied to a great dissemination of operations, with the training of personnel, especially in management and technical activities. This is also important for the reinforcement of the extension service, with the undertaking of a clear-cut effort to disseminate the technologies prepared during the project activities.

Training can have the result of reinforcement of the extension service, with the undertaking of a clear-cut effort to disseminate the technologies prepared during the project activities.

Within the context of the technical activities related to artificial reproduction of *Schizothorax zarudnyi*, CIRSPE has planned an “on job training” such as described in the signed contract CIRSPE/AFTM, approved by SHILAT.

In the project area of Zabol, the team members have been selected in collaboration with SHILAT Zabol office and its indications. All the members of the team selected is unemployed Fishery Graduates. It was aimed to impart practical and theoretical training so as they will have sufficient knowledge. They have an opportunity to get a job and confidence for self-employment.

The team members had a low knowledge of English language. That posed a little problem to communicate the subject matter. Teaching on the subject was repeated till got the satisfactory feedback. At the end of the week we planned a workshop .Teaching material was translated in local language. Application of aquaculture techniques were taught in detail. More stress was given in propagation of *Schizothorax* being the main job assigned to the team.

Theory aspects

Basic principles of culture and propagation were taught .The topics were covered as follows.

- Design and construction of fish farm and hatchery
The freshwater fish and prawn are the most suitable species for cultivation in tropical and subtropical climates.
To delineate suitable cropping pattern and managements measures for obtaining optimum sustainable fish production in different climatic regions, selection of suitable site and proper layout of the fish farm are prerequisites.
Layout of the farm mainly depends on the topography and shape of the area which significantly reduces the cost of the construction and ensures a smooth and trouble free service of the various facilities and structures allowing the proper management of production activities.

The pond shape and size mainly depends on the purpose of its use, whether it is for nursery, rearing, grow out or for any other culture system to be employed and also upon the topography of the area.

While designing the drainage channel, proper attention is required, so that used culture water does not find its way back into the farm ponds. The selection of suitable site for establishment of a carp hatchery complex would mainly depend upon the water supply, the soil condition, the topography and the economical aspect of the hatchery. A hatchery complex should have the following units.

- The brood stock unit for rearing and management of carp brood stocks
- The main hatchery unit for spawn production
- The nursery unit for raising fry from stocked spawn(4-5 mm to 25 to 30 mm)
- The rearing unit for raising fry to fingerling (50 mm and above)
- The packing and marketing unit

- Biological productivity of culture ponds

Physico-chemical parameters, benthic and plankton biomass of water in culture ponds are prerequisites to know the fertility status of pond. Appropriate dose of manure is very important.

Over dose or low dose, both will effect the fish production.

Qualitative analysis of plankton and benthic is essential to decide the type of fish and rate of stocking in pond

- Study on fishery biology of fish

Fishery biology knowledge about a fish is essential to understand its propagation and culture practices. The following parameters are essential to study.

- Age and growth of fish in a growing environment
- Maturity status of a fish in an environment where it is cultured
- Age at first maturity depends on temperature and rearing practices in a specific environment
- Feed and feeding habit need to be known both qualitatively and quantitatively at various stages of life cycle (spawn, fry ,adult and brood)
- Natural habitat, breeding and fecundity etc.

- Pond preparation

It is prerequisite before stocking .It should be free from unwanted fishes and Organisms, which may share space and food. This may effect the production.

Dewatering, drying, liming and manuring are the steps for preparation of pond. Cleaning of marginal submerged terrestrial weeds as they provide shelter frog and birds they feed upon fry and fingerlings. Besides weeds also takeaway nutrients of which make the water unproductive

- Breeding of *Schizothorax*

Selection is done based on morphological changes occur during breeding season. Males start **oozing** about a month before breeding season. Female abdomen is bulging and soft in touch. The genital papilla is blunt and aperture boundary becomes fleshy and reddish in colour. Receptivity (condition of mature eggs in situ) period of this fish is 15 to 20 days.

Above 18 degree centigrade water temperature fish loose condition very fast. Egg quality can also be assed through catered eggs.

These are immersed in a solution (1part of glacial acetic acid and 3 part of ethanol by volume).

After about five minutes germinal (GV) is seen. An eccentric position of GV is an indicator of good quality of eggs.

Management stress factors are very important, especially mature brood fish are more susceptible Stress are likely to occur during netting. Transport and handling for injection etc. Under such physiological stresses the release of hormone get disturbed.

The brood may respond partially or may not respond.

Many inducing hormones such as Ovaprim, ovatide and Wova FH are available in the market. All these hormones have the same chemical composition (SGn RHa 20 micro- g + Domperidone10 mg/ml). Ovaprim was found effective for induction *Schizothorax*. Female and male gametes were stripped in a dry basin. Avoid any mixing urine, faecal matter and water etc.

Mix gently with bird feather about a minute and thereafter sprinkle urea solution to complete the fertilization process.

Fish spermatozoa remain immotile in its own seminal fluid.

They activate when they come in touch with water. After activation self life of spermatozoa only few seconds.

The eggs of this fish become sticky when they come in touch in water. It is necessary to degum the eggs before releasing in hatching unit.

Stocking size is important before stocking in earthen ponds for good survival. Age of 0- day hatchling (after yolk absorption) may not be fit to stock in earthen pond. At this age hatchlings are unable to move in water column.

- Cryopreservation spermatozoa and their utilization for up gradation hatchery brood stock
Generally in most of the hatcheries the targeted seed is produced over the years from a very few individuals and the process of breeding continues leading to inbreeding. Further after sale the left over seed remains for raising the adults for future brood.
Even periodical replacement of stock with wild stock is hardly followed due to practical problems.
By using cryomilt out breeding can be carried out to maintain viability of stocks, using wild germplasm of stock with genetic variation.
- Brood raising programme:
Yearlings are to be collected from an extensive culture system or from different natural sources.
Select the healthy fast growing young once for brood raising programme. Use formulated diet for better gonadal growth.
Avoid over crowding and intensive carp culture practice in brood raising programme which may invite physiological stress to fish.
Avoid the yearling collection from waste water, industrial affluent and sewage culture system.
Maintain year wise/ pond wise stock register; fishes can be reared separately; while of same year breeding can be avoided which will decrease inbreeding level. Along with genetic aspects, environment and feed management should also be given proper emphasis so that the expression of genes will be proper

- Application of genetics in aquaculture:
Intensive and extensive fish technologies are based mainly on species ratio manipulations and certain management measures; they may have their limitations as any other technology. Moreover, intensive culture practices involve relatively heavy inputs of feeds and fertilizers which besides adding to the cost of production, may likely interfere with the ecological balance of the culture medium in the long run, if there is any further increase in these inputs aimed, at higher production.
So, for any further increasing in the production, with relatively lower cost of production and its sustainability, it is compulsory to exploit the genetic potentials of the candidate species and to develop genetically improved varieties that can produce quality seed with higher survival and better growth, greater resistance to disease and adverse environmental conditions.
This may bring down the cost of production and also reduce the culture /grow period considerably due to fast growth.
- Activities at the Zabol University :
Delivered a lecture on "Propagation of *Schizothorax zarudnyi*" to the Fishery Graduate students of Zabol University, Zabol.
During the course visit of research labs, discussions were held with researchers of respective groups in the labs.
A meeting was held with Dr. Ali Noori Chancellor of the University.

Practical activities

The covered topics are the followings.

- Pond preparation and management
Physico-chemical parameters control, fertilization and manure.
Qualitative analysis of plankton and benthic.
- Breeding of *Schizothorax*
Breeder's selection, sex examination. Water temperature role. Eggs maturity examination. Stress control and reduction. Hormone treatments (Ovaprim). Stripping in dry basin. Disease control. Sperm and eggs mixing. Urea solution to complete the fertilization process. Eggs incubation, larvae rearing, fry rearing and pond stocking.

Each trainee has submitted an individual report as follows.

Trainees reports

Breeding of *Schizothorax Zarudnyi* in Zahak hatchery

By Hadi Shahraki

Introduction

Schizothorax is a valuable fish in Hamun wetland and distribution.

This fish identified by Annandale, 1920 mainly. According to Annandale, this fish belongs to central Asiatic and Helmand upstream. Probably it belongs to ancient fishes and its origin is in Amodariato river system.

Schizothorax is a popular fish in Sistan that needs developing programs for culture and breeding. Thus UNDP planned for *schizothorax* breeding in Zahak hatchery.

Activities

Brood selection

For brood providing there is only one natural source that is chahnimeh reservoirs .Prospective broods were caught by gillnet from Chahnimeh reservoir. They were transported from brood pond to hatchery in oxygenated water tanks.

Broods in pond selected by sex differentiations.

Breeding tanks and equipments were disinfected by malachite green to avoid any secondary infection.

Injection of hormone

For the injection we used OVAPRIM hormone that is a Canadian hormone. First set of experiment was taken on 16.Mar.2006. Dose of hormone was 0.4 and 0.2 ml/kg body for female and male respectively. Time of injection was at 8 hours intervals. Two times for males and 4 times for females. .

Some hours after hormone administration, black spots on fish body appeared. . Vent of the female bulged and become reddish pink in colour.

Sperms and ovulated eggs mixed in plastic basin with a feather.

For removing of adhesive in egg they were washed by urea, salt and water for 10 – 20 minutes. After fertilization, developing embryos were released in vertical incubation jars. Hatching commenced after 96 hours of fertilization. Larvae are thin elongated with heavy yolk. These larvae were not able to move out from jars to larvae collection unit. At this stage developing embryos and larvae were removed to surface flow water hatching unit.. . The designed incubator for hatching was successful. Hatchery water temperature ranged from 17.5 to 19 degree during hatching of embryos. Time of hatching was recorded 110 to 140 hours. .

Indoor culture

Larvae maintained in concrete pond for one week. Pond cleaning from insects, disinfection with malachite green was done every day.. Tiny plankton feeding was given there times: morning, noon and evening.

After stocking of larvae in ponds all physico–chemical factors (including temperature, pH, Oxygen, hardness, salinity) were recorded. Earthen pond was prepared and manured following standard managements practices. Larvae feed by common carp feed.

Work report of Reza Nasehi Boomadi from Mar 2006 to Jul 2006

PROPOGATION OF *SCHIZOTORAX ZARUDNYI*

Government of Iran had taken up priority to save this species before it gets extinct from natural water bodies. The program is funded by the Italian Ministry of Foreign Affairs to develop a package & practices for propagation of said species on commercial scale.

During March fishes were collected from fishing site in the Chahnimeh reservoir. Males were seen in oozing condition. No female brood was available in catches.

We study on the maturity status of brood and it was observed that when fish attains 400 gr. wt. starts developing gonads. Fully mature male and female gonadic somatic index six and seven respectively was recorded.

Rearing pond of 0.3 ha was prepared before hand for raising fry to fingerling. Pond was dried up and remains exposed to sun for 2-3 days. We treated the pond bottom with lime at 300kg/ha and latter water was filled by filtering. Pond was fertilized with organic and inorganic manure. Fish were stocked in pond and were fed with common carp feed @ 5 to 10% of body wt. daily of the biomass.

Injection of hormone to brood

We used Ovaprim as inducing hormone for induction. It was found effective to induce *Schizothorax* fish. Male were given at 2.0 to 2.5ml/kg body wt. of fish at time of second dose to female. While female were given a total 1.4 ml/kg body wt. of fish to 4 times at specific time. After hormone injection female brood turn dark. Dry stripping is followed. Eggs were stripped in a dry basin and males were stripped on eggs. Mix both the products gently by bird feather, following sprinkle urea solution (5gm. urea/lit. of water) to active the spermatozoa to complete the process of fertilization. In this solution we gave two wash at an interval of five to ten minutes. Embryos were incubated flow through system. Hatching completed between 108 to 130 hours.

Rearing

For the first 8 days the hatching were reared indoor hatchery. At this age attain 11.0 mm length and they were able to move about in entire water column feeding upon plankton.

First 3 days were fed on starter feed (1:1 boiled egg yolk and milk powder equally by weight) concentrate + tiny zooplankton. Latter continue to feed on tiny zooplankton.

After 14 days fishes were stocked in one pond of 0.7ha. Before stocking pond was prepared. The fry were fed regularly with carp feed. The feed supply was done at a fixed time and place (in two places) in the pond. We observed that *Schizothorax* fry accept carp feed. Pond was fertilized with organic and inorganic fertilizers and monitored biological productivity of pond by assessing plankton population. Water and air temperatures were recorded every day. During this period air temp was between 24 to 39 degree centigrade and water temp was between 21 to 28 degree centigrade. DO and pH were recorded every week. During this period DO was 4.5 to 8.6 and pH was 8.1 to 8.4. Water level in pond was maintained 1.5 to 2 m in the entire period of culture.

During the period Zahak fish market was visited. *Schizothorax* adults (200-400gm) were seen. Some fish were cut open and their gonads on examination were found that gonads were in

preparatory phase. We translated the reading material to Persian language.
We have been taught on various aspects on propagation of *Schizothorax*.

Work report of Fazlollah Khammari from Mar 2006 to Jul 2006

PROPOGATION OF *SCHIZOTORAX ZARUDNYI*

Introduction

Schizothorax zarudnyi is one of the important & most priced carp. It is native of the Hamun Lake. Now it has dispersed in central Asia, Afghanistan and Libya. Due to prolong draught lake dried up and disappeared between 1999- 2001, only in 2005 fish re-entered to lake. The fish took a shelter to chahnimeh reservoirs.

Population of the said species in nature has been drastically effected. Recruitment is not to the level of maintaining its population. The fish catch showed declined trend. Government of Iran has taken up priority to save this species before it gets extinct from natural water bodies.

Breeding period

In the vicinity of Zahak, from 15th March to April appears to be an optimum period. During this period desired water temperature prevails between 18 to 24 degrees centigrade. Under higher temperature fish undergo resorption very fast.

Stage of work

During March fish were collected from fishing site in the chahnimeh reservoir. Males were seen in oozing condition. No female brood was available in catches. We study on the maturity status of brood, and we found when fish attains 400 gr. wt. starts developing gonads. Male brood gonad somatic index recorded six while mature female gonad somatic index was above seven. Broods were fed @ 2to3% of body weight of fish daily.

Injection of hormone to brood and hatching

Ovaprim (SGnRHa20+domperidone 10 mg/ml) is one of the very effective hormone for inducing carps. It has also been found effective to induce *Schizothorax* fish. Male were given @2.0 to2.5ml/kg body wt. of fish at time of second dose to female. While female were given a total 1.4 ml/kg body wt. of fish splited in to 4 times at specific time. After hormone injection female brood turn dark. Genital aperture become red and bulges out. With little pressure to vent side to abdomen the eggs comes out freely. If eggs are in clumps wait for about 2 to 3 hours. Dry stripping is followed. Eggs are stripped in a dry basin and males gametes are stripped on eggs. Mix both the products gently by bird feather, following sprinkle urea solution (5gm. urea/lit. of water) to active the spermatozoa to complete the process of fertilization. In this solution give two wash at an interval of five minutes. Embryos were incubated in flow through system. Hatching completed between 108 to 130 hours. For first 8 days the larvae were reared indoor hatching cisterns for 15 days. At this age larvae attained 11.0 mm length and able to move about in entire water column feeding upon plankton.

Rearing

First 3 days larvae were fed on starter feed (1:1 boiled egg yolk and milk powder equally by weight) concentrate + tiny zooplankton. Latter continue to feed on tiny zooplankton.

After 14 days fish were stocked in one pond of 0.7ha. Before stocking, we prepared the pond. The fry were fed regularly with carp feed. The feed supply was done at a fixed time and place. (in two place)in a pond. We observed that *Schizothorax* fry accept carp feed. Pond was fertilized with organic and inorganic fertilizers and monitored biological productivity of pond by assessing plankton population. Water and air temperature were recorded every day in during this period air temp was between 24 to 39degree centigrade and water temp was between 21 to 28 degree

centigrade. DO and pH were recorded every week. During this period DO was 4.5 to 8.6 and pH was 8.1 to 8.4. Water level in pond was maintained 1.5 to 2 m during the entire period of culture. During the period under report Zahak fish market was visited. *Schizothorax* adults (200-400gm) were seen. Some fish were purchased and their gonads on examination were found in prepatory phase.

We translated the reading material to Persian language.

By: Ali Poudineh

I worked in the *Schizothorax* propagation project. These are titles of my activities:

Breeding period

Because of the best condition for *Schizothorax* breeding on March and April, we collected and selected suitable broods from one earthen pond in Zahak hatchery. These broods were caught from Chahnimeh reservoirs between August to October. There were some problems in that pond. Pond was full of weeds that have negative effect on broods. Further brood catch was very difficult because depth of water was very much and water draining needs long time.

After catching of broods, they selected by Dr. Gupta and transported to the hatchery. Male broods were in oozing condition. Selected male and female broods were kept in hapa fixed in cistern.

After three to four hours broods were injected with ovaprim hormone. This is a very effective hormone in inducing carps. It has also been found effective to induce *Schizothorax* fish. Dose of injection was 0.2 ml for males and 0.4 ml for females three to four times at six to eight hours.

Physico-chemical parameters are very important for successful breeding. These were recorded as 4.5 to 7.2 ml/lit DO, 8.2 to 8.4 pH, 14-18°C water temperature.. We injected broods in three to four times. One female has good response. We got 6200 larvae from one brood and released them in pond when these were 11 mm in length. Good weight of brood is more than 1 kg. Broods that are below of 400 gr are not suitable.

One importance aspect in *Schizothorax* breeding is incubation unit. Because units that are used for carps are not suitable for *Schizothorax* hatching. We changed incubation unit to horizontal situation. This shape helps eggs to hatch and larvae could be collected better. The duration of the hatching is 96 to 130 hours that is more than common carp.

Feeding

For the first three days larvae were fed on starter feed. Subsequently fed on tiny filtered plankton collected from pond.

Stocking

Larvae 11 ml in length were released in the pond. Pond prepared by draining, liming and drying. Fertilizer was cow manure. We use 200 kg of cow manure. We also removed all weeds from the bottom and sides of pond. After stocking physical and chemical factors were monitored regularly. Depth of water in pond was maintained 1.5 to 2 meter. PH was 7.8 to 8.5 and water temperature ranged 18 to 22 degree centigrade.

Work report of Naser Mahmoodi

(Mar 2006 – Jul. 2006)

PROPOGATION OF *SCHIZOTORAX ZARUDNYI*

Schizothorax is a hydrothermal fish of Cyprinidea family, and in this family, it has great similarity to salmonidea fishes. This fish is native of Sistan zone and its settlement was in Hamun Lake, but this lake became dry because of the drought in the field. Now, we can see this fish only in Chah-nimeh reservoirs.

Government of Iran had taken up priority to save this species before it gets vanished from natural water bodies. The program is funded by Italian Government to develop a packages & practices for propagation of seed species on commercial scale.

This project was taken up in Zahak research station by Dr. S. D. Gupta and his assistants. They became successful to reproduction of this fish.

First we fishing brood fishes from Chah-nimeh, and released them in brood pond of size 2000-3000 m². After all the studies we found that the best brood, must has weight of 400 gr or more. We took the best broods to the hatchery.

We used Ovaprim hormone to stimulate and develop the gonads of fishes. For male brood we used 2 ml per their body Wt. and for female broods this value was 1.4 ml. We had 3 time injection for female broods and 1 time for male broods. Usually, 12-24 hours after injection, brood fishes were ready to ovulate. We can see change in the color of brood fishes, that female fishes became dark. Also we see some change in the anal of brood fishes.

We noticed that fecundation for these fishes were dry. In the step one, we take eggs from female broods and collect them in a dry tray. To overcome stick of eggs we use urea solution (5 mg in one liter). In second step, mixture of 5 mg urea plus one table spoon salt in 1 liter of water. Next, for completion of fecundation, we add sperms to eggs and mix them by a bird's feather. After fecundation, we released fertile eggs in incubator. Hatching will complete in approximately 103-108 hours.

We released larva in a net among a tank, which this tank is in hatchery. In the first 3 days, larva eats elementary feeding in solution case (yellow plus one table spoon milk powder). After this time, they eat phytoplankton achieved from other ponds, which was filtered by a net.

After 8 days, they can move all over the water and eat phytoplankton by self. At this age they have length of 11 mm. After 14 days, we transport them to one pond of 1200 m² size.

Before transportation, we had to do something: first we must, dry the pond and expose it to the sun for 3 days. Second, we used 25 kg lime for the disinfection of pond. Feeding in this pond will carry out by larva's ready foods. 3 or 4 days after releasing, we used animal dung for increase in productivity. (2000 kg / hec).

Moreover, we have to prevent the growth of weedy plants. Because, these weedy plant can effect in water physical parameters. Hence, we measure parameters, such as DO, pH, Water temperature and weather temperature.

Water and air temperatures were recorded every day during this period. Air temperature was Between 24 to 39 and water temperature was Between 21 to 28. DO and pH were recorded every week. During this period DO was 4.4 to 8.7 and pH was 7.9 to 8.3.

We must notice to the formation and manner of larva, such as change in their color, appetite for feeding, and their natural movements. All of these symptoms must seem and studied because we must be sure about larva care and water quality.

We translated the reading material to Persian language.

Moreover we visited Zahak fish market and we purchased some fishes and assessed their gonads.

Suggestions:

- Assessment of feeding in natural for these species.
 - Making incubator proportional with larva manner.
 - Availably of broods with best quality.
-

Physiochemical parameters ZAHAK HATCHERY (*SCHIZOTHORAX* POND)

Date	Water temp	Air temp	DO (mg/lit)	pH	Parameters have been recorded (between 9:00 to 10:00 AM)
23.5.06	23.5	36			Water filling was continuing
24.5.06	24	36.5			Water filling was continuing, Windy
25.5.06	24	38	5.8	8.1	Windy
26.5.06					Holiday
27.5.06	24.5	37.5			-
28.5.06	25	39			-
29.5.06	28	41			-
30.5.6	25	37			-
31.5.06	21	31.6			Windy
1.6.06	20	29	5.3	8.2	Windy
2.6.06					Holiday
3.6.06	25	36			-
4.6.06					Holiday
5.6.06					Holiday
6.6.06	24	38			Windy
7.6.06	23	38.5			Windy
8.6.06	25	36	6.8	8.3	Windy
9.6.06					Holiday
10.6.06	24	31			Windy
11.6.06	24	31			Windy
12.6.06	23	35			Windy
13.6.06	24	37.5			Windy
14.6.06	24	35			-
15.6.06	23.5	33	7.2	8.6	-
16.6.06					Holiday
17.6.06	25	33.5			Windy
18.6.06	26	32			Windy
19.6.06	25.5	36			-
20.6.06	27	35.5			-
21.6.06	28	36			-
22.6.06	28	37	7.1	8.5	-
23.6.06					Holiday
24.6.06	27	35			Windy
25.6.06	27	35.5			Windy
26.6.06	27	36			-
27.6.06	28	37			-
28.6.06	28	38			-
29.6.06	27	36	7.2	8.5	Windy
30.6.06					Holiday
31.6.06	27	36			-

Sistan Baluchestan synthetic picture

With an area of 187,502 sq. km, this province is composed of two regions of Sistan, covering 15,717, and Baluchistan 171,785 sq. km, and located at longitude of 58.50 to 63.21 and at latitude of 25.3 to 31.27. This province borders with Afghanistan and Pakistan with the length of 1200 km. The Malek Siah mount, at 40 km to Zahedan city, is the common border of Iran, Afghanistan and Pakistan. This province is the neighbor of Khorasan province in the north, Afghanistan in north and east, Pakistan in east, Oman Sea in south (about 270 km water border), Kerman and Hormozgan provinces in west. According to the last political divisions, this province includes 32 townships, 30 cities and 94 villages. The townships of the province are Zahedan, Zabol, Zahak, Khash, Iranshahr, Sarbaz, Saravan, Konarak, Nikshahr and Chabahar.

Population

The province population in 1996 was 1,722,579 and in 2000, it was estimated 1,984,191.

Climate

Khash has a good climate in the province because it's higher than other townships and is neighbor to Taftan, highest peak of the Baluchistan, in the north. Besides Khash, Chabahar has vernal climate because of being nearness to the tropic of the equator area. Temperature changes in different seasons are a little and summers are unnoticeable and falls are the same, too. The trees are forever green during the year.

Khash and Chabahar have good climate and the most beautiful areas in this province. Iranshahr, Zabol and Bahookalat areas have desert climate, Zahedan has semi desert condition and mountainous area of Bamposht in the south of Saravan and along that towards the east of Bashagerd mounts, it has mild semi-desert climate. With consideration of influence on the province climate because of Indian seasonal conditions, especially from October to April, when most of the tourist poles are reduced because of the cold weather, Sistan & Baluchistan entertains tourists and Baluchestan entertains tourists and interested people with nice weather.

Hydrological and Environmental Situation of Sistan

The Helmand River originates from the western edge of the Hindu Kush Mountains of central Afghanistan approximately 50 km of the west of Kabul. The upper slopes of these mountains have a severe climate for much time of a year, with glaciers which exist on the uppermost, northern facing peaks. Below 4000m, the mountains are initially free of vegetation, followed in descending altitude by pastures and steppes, small-scale agricultural activities.

The mountainous upper reaches of the Helmand river basin (together with its tributaries) cover most of Vardak, Ghazni, Oruzgan and Zabol provinces. The middle reaches cover Kandahar and Helmand provinces, with their small mountains, foothills, and gently-sloped agricultural areas. The main tributaries are the Ghazni, Musa Qala and Arghandab rivers.

All major tributaries join the Helmand River upstream of the city of Lashkar Gah in Helmand Province; then the river slowly meanders for over 400km across the desert in Nimrooz province and to the Iranian border. Just after passing the village of Char Bujak near the Iranian border, the Helmand River divides into two branches.

Sistan branch flows directly into I. R. Iran and into the Hamun-e Helmand. The northern branch, Parian, passes Zaranj city, and forms the border with I. R. Iran for approximately 20km, before turning back into Afghanistan and flowing into the Hamun-e Puzak.

The total length of the main Helmand River is 1,188 km and the total drainage area is 166,000 km. The total potential of annual flow of the Helmand River and its tributaries is estimated 7.5

billion m³. Flow measurements have been carried out from the late of 1940 up to 1978, and the peak record flow during this time was 1,582 m³/s in May 1967.

The majority of water flow in the Helmand originates as precipitation in the upper reaches - falling mostly as winter snow. Hence the level of the river rises with the onset of snowmelt, from spring onwards, and peaks in early summer. Apart from these upper reaches, the river catchment area is semi-arid, arid or very arid.

A series of diversion and storage schemes have been constructed on the Helmand River, mostly in the 20th century. The large schemes include the Kajaki dam constructed in 1952 (1.7 billion m³), Arghandab (or Dahla) Dam (479 million m³) and the Helmand Irrigation schemes¹ (irrigating 99,400 hectares).

When they were constructed, the principal objects of these schemes were flood control, irrigation, and hydro-power. In addition to these large schemes, many small-scale schemes exist at all points in the river basin (except the upper reaches). These include: irrigation of natural springs; karez (man-made underground canals) for collecting/distributing ground-water; small and deep-wells, both hand and motor driver; up to 60 mobile pumping stations; and small diversions from main rivers or main irrigation canals to household or village irrigation plots. Almost all irrigated agriculture takes place close to the main river course in the river valley.

Other rivers flowing into the Sistan Basin include the Farah, Harut, Gulistan, Khash and Kajrud². The drainage areas and flows of these rivers are shown in Table 1. These rivers lie to the north-west of the Helmand. As with the Helmand, all the rivers in Table 1 originate in central mountainous Afghanistan and so they have a similar seasonal distribution of flows as the Helmand. They also experience similar levels of withdrawals in their middle reaches, although there is no information on large-scale formal diversion or storage schemes.

Flows and drainage area of main rivers flowing into Sistan basin (taken from FAO, 1997)

River	Mean Potential Annual Flow (million m ³)	Drainage Area (km ²)
Helmand	7,500	166,000
Farah	1,250	27,800
Harut	210	23,800
Gulistan	40	9,100
Khash	170	10,500
Kajrud	60	20,800
Total	9,230	258,000

With regards to the Helmand River (for which the most information is available), the cumulative effect of all the withdrawals, particularly the Kajaki Dam and the Helmand irrigation systems, has been a great reduction in the flow of the lower reaches through Nimroz province. The river is now mostly dry for long periods in much of this province. This has greatly increased drought vulnerability in the province. In addition, in dry years, water reaching Iran is channeled from the Sistan branch to the Chahnimeh storage system.

As a consequence of the upstream withdrawals and diversions, the Helmand River is no longer a principal source of water for Hamun-e Puzak. The Khash River is now the major source. In fact,

¹This consists of 3 schemes, the Saraj, Boghra and Darweshan.

²Under natural conditions, the flow in the Helmand River is 4-5 times greater than the combined flow of the other rivers mentioned (FAO, 1997a).

During dry years, no water flows from the Helmand into any of the three lakes (such as during the sustained drought from 1998-2002). During times of drought, the last areas to remain wet are the Chahnimeh reservoirs, the Godzareh depression and, sometimes, the Afghani part of Hamun-e Puzak.

The Sistan Basin stretches across the border of I. R. Iran and Afghanistan. The Sistan Basin is a very arid region with rainfall below 50mm/year and potential evaporation rates over 4,000mm per year. It consists of three freshwater, inland, permanent lakes; the deltas of several major permanent rivers feeding into the lakes, and; the wetlands and land between and immediately surrounding the lakes. Of the three lakes, Hamun-e Puzak lies mostly in Afghanistan, Hamun-e Saberi lies on both sides of the border, and Hamun-e Helmand lies in I. R. Iran (see Annexes 1b 1c).

Under normal circumstances, the three lakes cover approximately 216,000 hectares (Puzak is 50,000 hectares, Saberi approximately 101,000ha and Helmand 65,000ha). The lakes are very shallow (on average 2-3 m deep) and, as they lie in a flat area, their surface area varies greatly as a function of the incoming water. During great floods the three may join up to become one vast lake. The main lakes are surrounded by permanent and seasonal wetlands, including vast and rich marshes, reedbeds and salt marshes.

In general water flows through rivers and underground canals from H. Puzak to H. Saberi to H. Helmand. In addition, H. Saberi receives water directly from the Farah river, and H. Helmand receives water directly from the Sistan branch of the Helmand River. Excess water flows from H. Saberi through a seasonal river to the Godzareh depression in Afghanistan. This depression is thought to be highly saline.

The Sistan Basin is a unique example of a complex wetland ecosystem within a desert area. The wetlands play a substantial hydrological and ecological role in the natural functioning of a major river. The wetlands are also an extremely important staging and wintering area for migratory waterfowl, as well as an important breeding area for many waterbirds, and are home to a large diversity of mammals, aquatic species and flora.

Due to low precipitation, the wetlands were largely dry during the period 1998-2002. However, in the lower reaches of the river courses, the rivers continued to flow seasonally, and small springs swell and run permanently over short distances. Even in times of intense drought, these areas provide healthy examples of the natural ecosystem, as well as gene banks for the region.

The lakes have a history of drying up and then recovering. The maps, based on a time series of satellite images, show that the lakes became almost completely dry between 1976 and 1987, only to completely recover by 1988, and then be dry again by 2001.

Biodiversity in the Sistan Basin

Water diversions in I. R. Iran implemented during the 20th century have contributed to the degradation of H. Saberi and H. Helmand. They have lost much of their original characteristics. However, H. Puzak has retained much of its original qualities, and it is representative of how the entire Sistan basin would have been in past times. The richest parts of H. Puzak lie in Afghanistan, for which unfortunately there are very few reliable recent records.

Bird Life International (1994) lists 8 globally threatened winter visitors in the Sistan Basin, including *Pelecanus crispus*, *Oxyura leucocephala*, and *Aquila heliaca*. Breeding species previously recorded in the area include: *Phoenicopterus ruber*, *Anser anser*, *Cygnus olor*, *Netta rufina*, *Picus squamatus flavirostris*, and *caprimulgus mahrattensis*. For example, in total, Bird Life International (1994) list 20 wintering and breeding bird species for which over 1% of the global population has been recorded in the Basin. In terms of wintering birds, in 1976 over 500,000 wildfowl were counted on Hamun-e Puzak alone, in what was considered to be a very poor year.

Information on aquatic species in the Basin is limited, although it is thought to host a unique and rich diversity. The dominant flora species in the area are *Phragmites australis*, *Typha* sp., *Carex* sp., and *Tamarix* sp. The vast *Phragmites* reedbeds are considered particularly unique.

There are various species in Hamun Lake and Helmand River. In 1998, 15,000 tons of warmwater fishes caught by fishermen. Fisheries products value was 30 million USD. Now number of fishermen is 3000 person (On the other hand 3000 families).

There are also two important native fishes (*schizothorax zarudnyi* & *schizocypris altidorsalis*).

They are endemic, thus they have an ecological value for Hamun Wetland. Prolong drought caused a decrease in stocks of these fishes. The high value price of *schizothorax* fish in local market and reduction in the stock, leads to artificial propagation of this species. The project focused mainly on *schizothorax* and the technique of propagation.

Activities pictures

