No.

Report on the Cooperation for the High Dam Lake Fishery Management Center of the Arab Republic of Egypt

January, 1989

Japan International Cooperation Agency

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Preface

This year is the eighth year since we began to dispatch experts from our country after the completion of the High Dam Lake Fishery Management center in 1981 under Japan's grant aid cooperation.

This report sums up the course of technical guidance to the Center staff during these 8 years and the results, as well as future guidelines.

The cooperation extended to the Center will continue on the present scale until next year and we hope the Center will become a prominent fresh-water fishery management center in the Middle and Near East, and the Africa region through the completion of this technical transfer under grant aid cooperation as summed up in this report.

January 1989

Japan International Cooperation Agency
Director
Hiroaki Tamamitsu

Foreword

The Fishery Management Center was established in Aswan City of the Arab Republic of Egypt in 1982 with Japanese grant aid for fishery maintenance and management, and to increase fish resources of the High Dam Lake. This booklet is an intermediate report on the progress of technical cooperation in the Fishery Management Center since its start and the results thereof.

In the establishment of the Management Center, Dr. Minoru Nomura (now president) of the Tokyo University of Fisheries has participated from the start of the study of the general development plan for the south part of Egypt and through the construction phase and then worked in the Center's development as the person responsible for the university experts after completion of the construction. This responsibility was transferred to me in 1986. The faculty of the Tokyo University of Fisheries have continued to render technical cooperation to the management center as short-term experts up to the present time. We experts have approached our work with the following basic posture on technical cooperation: Even if we transfer Japanese high-level fishery techniques, it is not certain that there will soon be appreciable results, since such techniques can be assimilated only after adjusting to the circumstances, customs, etc., of the recipient country. Thereby our posture is to develop an understanding of the culture, climate, social circumstances, etc., of the recipient country. Hence we have been careful to develop a step by step approach suiting Egyptian social conditions, technique levels, etc., and not just transfer Japanese fishery resource management techniques as they are used in Japan. For example: regarding the introduction of outboard engines, we encouraged the Egyptians to wait for the results of a preliminary appraisal because the sudden introduction of new technology can result in resource overfishing; and as to the desire for introduction of the newest measurement instruments, we rather recommended use of a type of instrument that can be repaired locally in the case of some trouble. In addition, each of our experts has been mindful that his job is to work together to solve problems, not just to occupy a teaching position and to give advice. Almost all Egyptians are Muslims and their culture is different from that of Japan. Despite such a cultural gap, mutual understanding deepened through the long period of interchange so that we could advise our counterparts from the strength of a good relationship. Because this booklet is an intermediate report, I regret that it lacks uniformity among the authors' writings, but this is due to the real differences among the specialty branches, and I wish to offer a general technical transfer completion report.

Lastly, I would like to express my appreciation to each of those concerned who helped in the promotion of this cooperation plan.

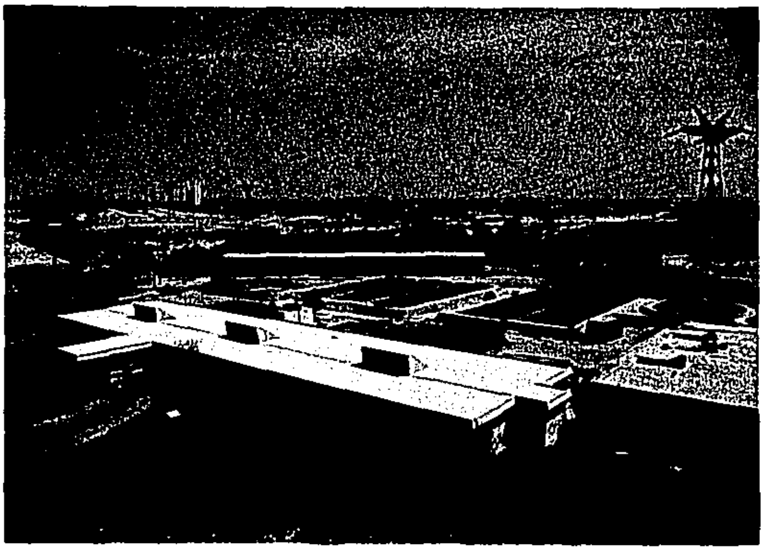
January, 1989

Dr. Atsushi Koike
Tokyo University of Fisheries

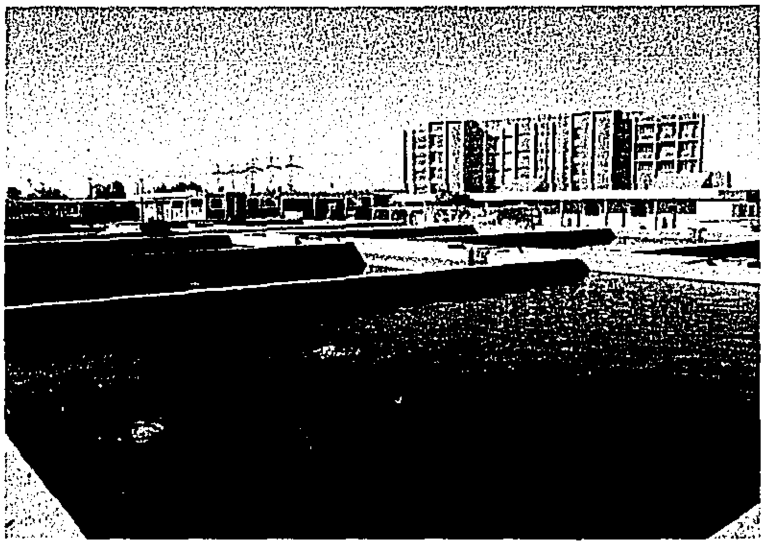
Authors:

Dr. Atsushi Koike (General Management & Fishery Resources Management)
Dr. Kohei Kihara (General Management & Environment)
Dr. Nobuo Hirayama (Fishery Resources Management)
Dr. Fumio Takashima (Aquaculture)
Dr. Kiyoshi Sakai (Aquaculture)
Dr. Masaaki Murano (Environment)
Dr. Yusho Aruga (Environment)
Dr. Teru Ioriya (Environment)
Dr. Masaru Maeda (Environment)

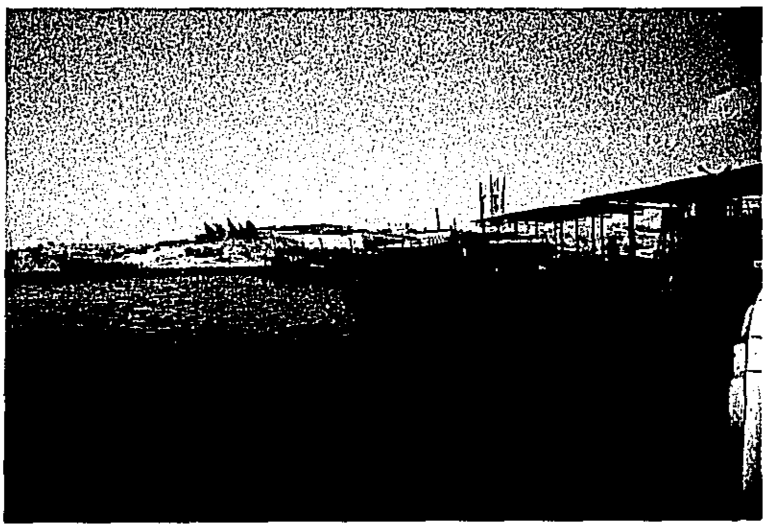
(All are faculty of the Tokyo University of Fisheries)



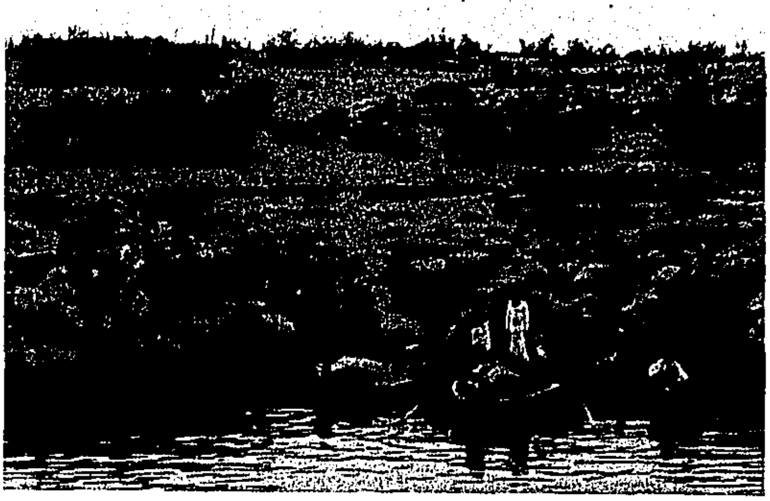
High Dam Lake Fishery Management Center (FMC)



FMC experiment ponds
(backside bldg. is the High Dam Lake Development Authority)

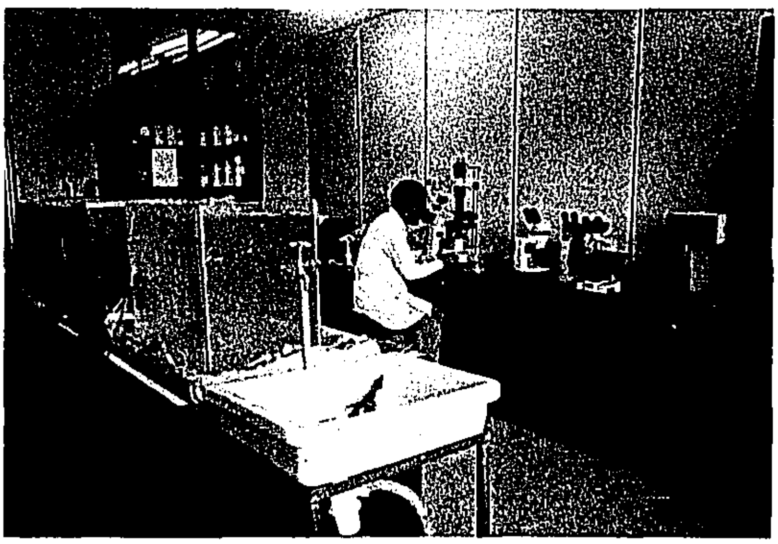


High Dam Lake and Aswan fishery port



Fishing boats and a camp for fishermen

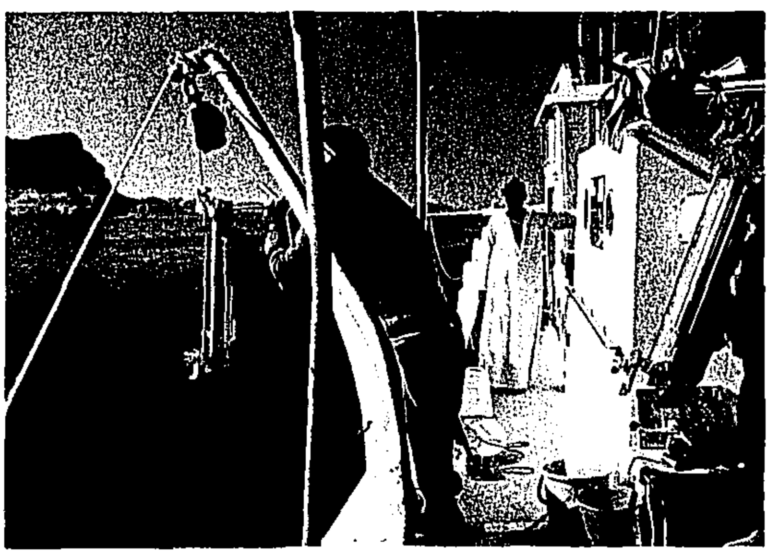
Gill net fishing boat at work in the lake



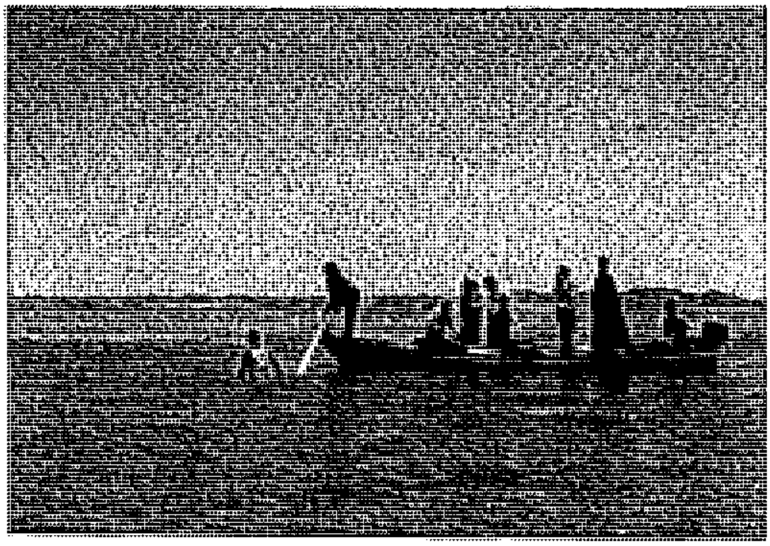
A fish carrier boat

Fish selling . Aswan City

Research boat *El Sadaka*



Environmental research by *El Sadaka*



Survey of fish resources

Fish farming experiment with net cages

Fishermen workshop operated by staff of FMC

Contents

I. History of Cooperation on the High Dam Lake Fishery Management Center

1. Background

The population of Egypt rises at a rate of 2.4% per year and the staple food supply suffers insufficiencies. The Egyptian government has shown great enthusiasm for fish culture project development and fishery development in regions such as the Mediterranean Sea, Red Sea, lakes in the northern delta region, and the High Dam Lake in order to increase fish production with the purpose of stabilizing a self-sufficient food system.

A master plan concerning the development of the southern region of Egypt including the region around High Dam Lake was drawn up in 1977 and project based cooperation was requested of Japan by the Egyptian government.

In response to this request a preliminary research team was dispatched in May - June 1978. Then research teams were dispatched twice to draw up a general development plan for the region around the High Dam Lake: once in January - March and once in June - August 1979. These teams were each comprised of experts on regional planning, agriculture, fisheries, mining, manufacturing, transportation, sightseeing, water resources, city planning, finance, etc.

From the results of this research, Egypt judged that fisheries showed the most promise based on the fact that fishing is already practiced in the High Dam Lake and the high potential there for protein resource production. Our fisheries team conducted simultaneous site research of the High Dam Lake fishery, fish culture, and fish catch freshness maintenance, etc. The following points were clarified from the results.

Though annual fish production in 1968 was barely 2,700 tons, it increased steadily thereafter due to the increase in the number of fishing boats and the increase in the size of carrier boats so that production in 1980 was 30,000 tons. But the High Dam Lake

Development Authority (HDLDA), which is a government office in charge of the administration of the High Dam Lake, is very worried about fishery resource exhaustion from overfishing. Such concerns may be raised as the remarkable decrease of *Tilapia nilotica* which is a main fish species, and the decrease in the production of tiger fish which live in the open sea.

In order to maintain and to increase the fishery resources of this lake in the future, it is first necessary that the amount of fishery resources of this lake, the maximum sustainable production amount, etc., be estimated and, together with the introducing of various optimum fish resource management system, etc., based on this, a fish stocking project be urgently undertaken.

The High Dam Lake Development Authority is well aware of this necessity, but the situation is that there are no basic data which are necessary for sustaining and managing of fish resources to formulate this policy and no fry production. Seeing this situation, the research team proposed the establishment of the High Dam Lake Fishery Management Center as a mother institution for this project promotion in its last report document*.

2. Contents of request for cooperation

The Egyptian government, after due deliberation, reached the conclusion that establishment of the High Dam Lake Fishery Management Center (FMC) is urgent as an institution for sustaining and increasing the fish resources of the High Dam Lake, based on the proposal as mentioned above. Consequently, upon receiving the Egyptian request, a JICA research team was dispatched again in 1980 to confirm the contents of the request by the Egyptian government for the Center's establishment and to draw up the Center's basic design.

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* Integrated Regional Development Plan of the High Dam Lake Area, 1979, 453pp, Japan International Cooperation Agency

After that, the Center's construction under Japanese grant aid was determined according to Japan-Egypt intergovernmental discussions, and buildings/equipment were completed in December 1981. In addition, a research boat 9.4 ton and machinery/materials were also granted.

In the spring of 1981, the Egyptian government made an urgent request to the Japanese government for the dispatch of experts to advise the Center on its operations in order to maximize the Center's function after completion and to train personnel for the Center's staff.

According to this request, a preliminary research team to give advice concerning the management and operation of the fishery center after its completion and the dispatch of experts for the training of personnel was dispatched with Dr. Minoru Nomura of the Tokyo University of Fisheries as its head in August 1981. This research team held consultations about cooperation for the Center's research system and researcher selection, the dispatch of experts, acceptance of researchers as training-personnel, and necessary machinery and materials based on the request of the High Dam Lake Development Authority which wanted to fully operate the Center immediately after its completion.

The Center proposes to perform the applied research work and data collection necessary for fish resources management and the promotion of the stocking of useful fish species in order to achieve stabilization of native fish resources through ongoing maintenance and to increase High Dam Lake fish resources. It also proposes to contribute to the welfare and prosperity of fishermen and to carry out training at the same time through: 1) survey of fishing operations 2) survey of fish catches 3) fishery management 4) resource analyses 5) stocking and fish propagation 6) welfare and extension for fishermen 7) ecological research 8) environmental research.

The High Dam Lake Development Authority asked for the dispatch of 7 experts per year from 1981. The request was specifically for 2 experts to help with item 5 mentioned above and 1 expert each for items 2, 3, 4, 7 and 8. In response to this the research team decided to dispatch a total of 4 experts during December 1981 - January 1982 and to dispatch 6 experts per year during the 3 years beginning from 1982, dividing each year into 2 - 3 terms with each dispatch period being 1 - 1.5 months.

3. Assigned institution and its system

(1) Designation

Fishery Management Center (hereinafter sometimes called FMC)

(2) Location

Located 15 km south of Aswan City, at the north end of High Dam Lake (Figure 1)

(3) Purpose of establishment of the center

The objective is to carry out the applied studies and experiments necessary for fishery management and the promotion of useful fish breeds for the Center's stocking project in order to achieve fish resources stabilization through permanent maintenance and increasing of the High Dam Lake fish resources, improvement of fishermen's welfare and prosperity, and extension work.

(4) Structure scale

Site area	13,000 m^2
Research administration bldg.	800 m^2
Wet laboratory	600 m^2
Experimentation ponds	28 facets 2,084 m^2

(though originally having been 12 ponds with a total of 990 m^2, now there are 10 ponds of 150 m^2 large ponds, 4 middle ponds of 64 m^2, 12 ponds of 10 m^2 small ponds, and 2 ponds of 200 m^2 circular ponds as of 1988; all facilities except research administration bldgs. were constructed by the Egyptian side.)

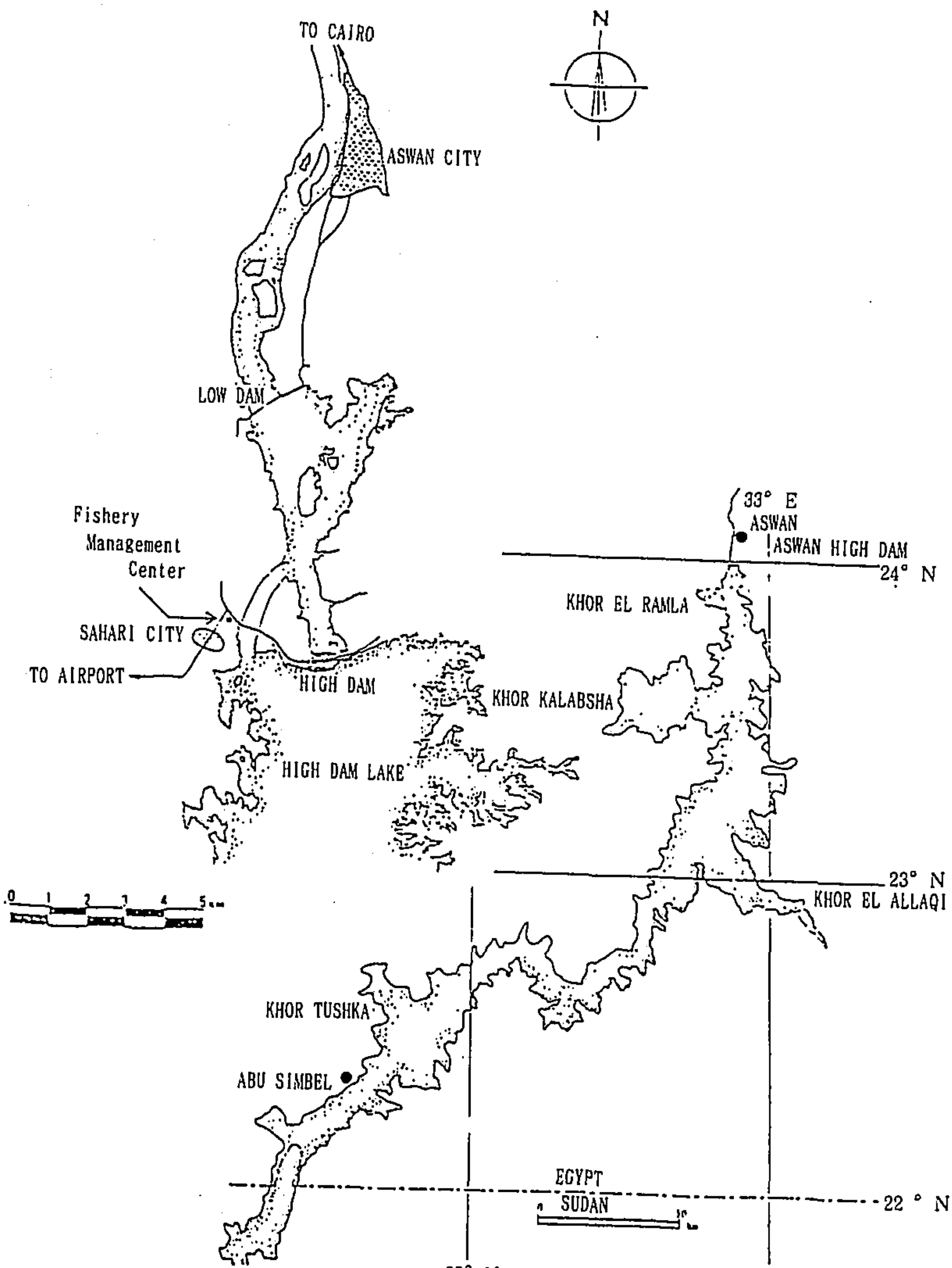


Figure 1. High Dam Lake and Fishery Management Center

FMC bldg. stationing is shown in Figure 2:

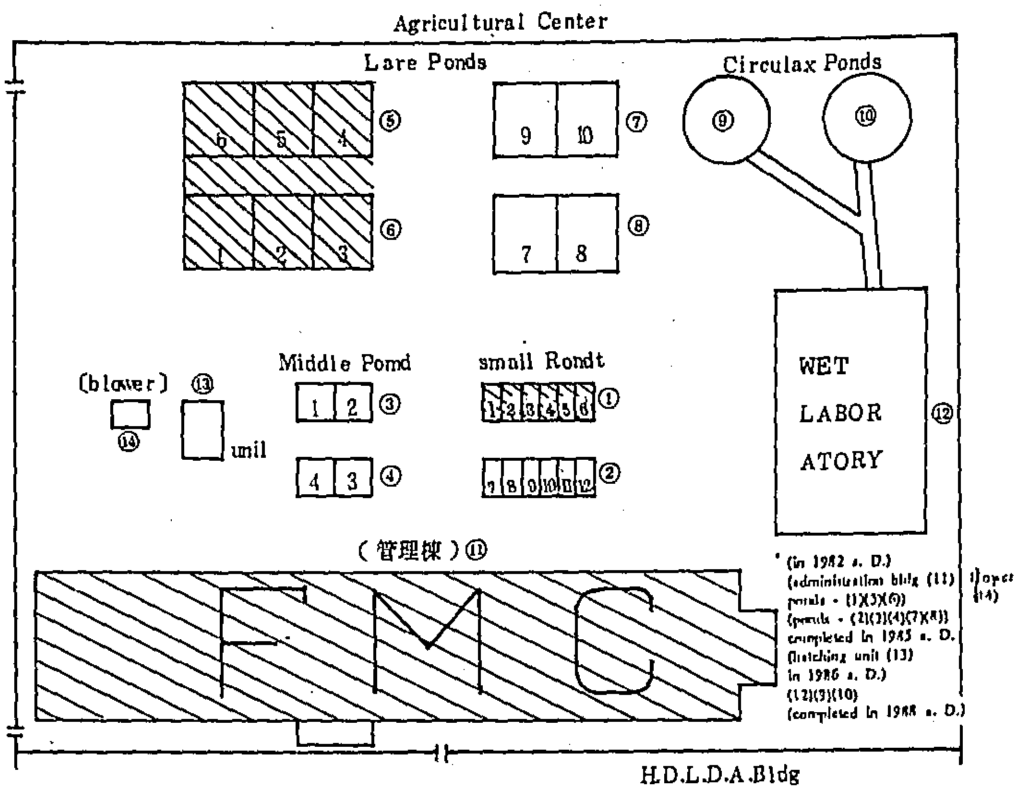


Figure 2. Bldg. and pond arrangement as of 1988
(Hatching units are from the time of FMC's establishment)

(5) System

As for governmental administration, FMC is under the jurisdiction of the High Dam Lake Development Authority of the Egyptian Ministry of Reconstruction, Housing, and New Community.

4. Form of cooperation

Faculty of the Tokyo University of Fisheries including Dr. M. Nomura have served as short-term specialists since FMC's establishment in December 1981 and have provided advice to FMC research personnel concerning FMC's operation.

5. Specialists and their respective periods of work

The first dispatching of experts was December 1981 - January 1982 when 6 faculty members were sent as short-term specialists. After that, short-term dispatching of experts has been continuing with 2 - 3 experts sent each time with each dispatch period being 1 - 1.5 months so that the total number is 6 experts per year.

The number long-term experts dispatched since December 1983 was increased by one from 1987. These experts have been providing advice to FMC's researchers.

The record of experts dispatched year by year is as follows:

1) Expert Dispatch

Dr. Minoru Nomura, Dr. Atsushi Koike (both are from the Tokyo University of Fisheries as are all experts mentioned hereinafter unless specially noted), and Mr. Yoshinobu Kitao, a junior official at the Planning Liaison Section of the UNESCO (United Nations' Educational Scientific Cultural Organization) International Division, Art/Science International Bureau, Literary Affairs Department, Japanese government: August 4 - 23, 1982 for advice and cooperation concerning FMC's formation and operation, and for preliminary investigation regarding the acceptance of research personnel.

2) Advising at the High Dam Lake Fishery Management Center

December 15, 1981 - January 24, 1982:

Aquaculture Department and general topics: Dr. Minoru Nomura

Fishery Resources Management Department: Dr. Atsushi Koike, Dr. Nobuo Hirayama, Dr. Etsuyuki Hamada and Mr. Kyusuke Itoh

Environment Department: Dr. Kohei Kihara

April 13 - May 9, 1982:

Aquaculture Department: Drs. Minoru Nomura and Fumio

Takashima

August 10 - September 13, 1982:

Fishery Resources Management Department: Drs. Atsushi Koike and Shoichi Takeuchi

Environment Department: Drs. Teru Ioriya and Kohei Kihara

April 26 - May 30, 1983:

Aquaculture Department: Drs. Fumio Takashima and Takeshi Watanabe

July 10 - August 18, 1983:

Aquaculture Department: Dr. Minoru Nomura

Fishery Resources Management Department: Dr. Atsushi Koike

December 16, 1983 - January 14, 1984:

Aquaculture Department: Dr. Minoru Nomura

Fishery Resources Management Department: Dr. Nobuo Hirayama

Environment Department: Drs. Yusho Aruga, Masaru Maeda, and Kohei Kihara, and as a long-term expert Mr. Masanori Kawaguchi (International Marine Production Technique Development Co., Ltd.) with a service term of 2 years.

May 28 - June 24, 1985:

Aquaculture Department : Dr. Kiyoshi Sakai

December 17, 1985 - January 23, 1986:

Fishery Resources Management Department: Dr. Kaname Satoh

Environment Department: Dr. Teru Ioriya

April 22 - May 22, 1986:

Environment Department: Dr. Kohei Kihara

Aquaculture Department: Dr. Kiyoshi Sakai

August 12 - September 5, 1986:

Fishery Resources Management Department: Drs. Atsushi Koike and Nobuo Hirayama

Environment Department: Dr. Yusho Aruga

December 19, 1986 - January 16, 1987:

Environment Department: Drs. Masaaki Murano and Kohei Kihara

Aquaculture Department: Dr. Kiyoshi Sakai

and as a long-term expert, Mr. Hiroyuki Chagi

(International Marine Production Technique Development Co., Ltd.)

with a service term of 2 years.

April 10 - May 8, 1987:

Aquaculture Department: Dr. Fumio Takashima

Environment Department: Dr. Yusho Aruga

August 12 - September 8, 1987:

Fishery Resources Management Department: Drs. Atsushi Koike and Nobuo Hirayama

Aquaculture Department: Dr. Fumio Takashima

Environment Department: Dr. Kohei Kihara

December 25, 1987 - January 21, 1988:

Fishery Resources Management Department: Dr. Atsushi Koike

Aquaculture Department: Dr. Kiyoshi Sakai

Long-term expert, Mr. Shinichi Mitsugi

May 18 - June 17, 1988:

Aquaculture Department: Dr. Kiyoshi Sakai

June 29 - August 9, 1988:

Environment Department: Dr. Kohei Kihara

August 1 - August 30, 1988:

Fishery Resources Management Department: Drs. Nobuo Hirayama and Kazumi Sakuramoto

Environment Department: Dr. Masaru Maeda

February - March 1989:

Aquaculture Department: Dr. Kiyoshi Sakai

6. Acceptance of training program participants

The acceptance of training program participants was decided at the Tokyo University of Fisheries from 1982. This acceptance of trainees was performed based on a general judgement of FMC's activities and each teacher's circumstances. As part of the study to be done in Japan, observation at related Japanese national fisheries research institutes, various provincial fisheries experimental stations and other important facilities, as well as practical training with research & training vessels of the Tokyo University of Fisheries were included. Selected trainees for each year are as follows. Their official titles at FMC are in parentheses.

Morad Zakki Agaibi (researcher): October 24, 1982 - March 25, 1983 to study about fishery resources

Botoros Zaki Shinoda (researcher): October 24, 1982 - March 25, 1983 to study about aquaculture

Mohamed Tawfic (researcher): November 1, 1983 - January 27, 1984 to study about fishery resources

Ahamed Mohamed Yosef (research boat captain): April 16 - May 16, 1984 to study fishing boat operations

Ahmed Abdel Rahman (researcher): April 10 - October 8, 1984 to study environmental issues

Hussein Amar Adam (researcher): April 16 - November 21, 1986 to study about fishery resources

Rokaya Hussein Goma (researcher): May 22 - November 21, 1986 to study environmental issues

Mohamed Mahamod El Shahat (general director): June 14 - July 8, 1987 to study environmental issues

Olfat Anwar Habib (researcher): January 20th - September 28, 1988 to study environmental issues

Magdi Nagibu Abdel Shahid (researcher): July 27, 1988 - January 29, 1989 to study stocking and fish propagation

II. Cooperation Plan

1. Background

Background of Nile fishery

Fishing in the Nile river basin goes back to several thousand years before Christ. The fishing techniques used can be considered, based on shipbuilding techniques, the types of fishing gear including nets, etc., to have reached near perfection by 2000 B.C., as seen from the reliefs remaining on ancient walls or pictures on papyrus. But the present state of fishing techniques in Egypt after the last four thousand years can hardly be said to have improved over the ancient techniques and the level is still low notwithstanding the fact that new materials for use in fishing gear and new shipbuilding techniques have been introduced.

Fishing gear and fishing methods

Almost all fishing methods presently utilized in this area depend on manpower and none of them are mechanized. The following table summarizes these. As for the manufacture of fishing gear, some local fishermen are able to manufacture their own fishing nets and implements from net webbing materials.

Table 1. Fishing gear and fishing methods used in High Dam Lake

Name of fishing method	Name of fishing gear	
	English name	Local name
gill net fishing	trammel net	duk
gill net fishing	bottom gill net	kobok
gill net fishing	floating gill net	sakarota
long line fishing	long line	sinnar

Fishermen

The exact number of fishermen is hard to know, although statistics on the number of fishermen have been compiled from 1966 when the High Dam construction began, inferring from past data from various fields. The number is now about 3,200 persons, showing a gradual decrease from the peak of 4,000 persons in 1978. Composition according to age groups is not so clearly known but is characterized by 2 strata which can be called a young stratum and a middle-high age stratum. The young statum here includes 10 - 15 year olds who seem to be part timers working during summer school vacation. Respective fishermen are classified into those belonging to an association or public corporation and private boat owners. Public corporations and associations in present actual operation are as in the following table. Each fisherman is attached to his designated work area (which is locally called a camp) and dwells at his respective camp for three to six months.

Table 2. Fishing work by associations and public corporations as of 1987 (researched by FMC)

Name of association or public corporation	Number of camps	Number of fishing boats	Number of fishermen
Misr Aswan Co., Ltd.	36	117	199
Aswan Sons' Fishermen's Union	44	191	341
Mother Corporation Co.	343	979	2298
Nubian Corporation Co.	31	83	193
El Takamol Corporation Co.	17	35	71
Sum	471	1405	3102

Almost all the fishermen are workers from the towns of Quena, Soho, etc., of upper Egypt and there are no fisherman domiciled around the lake. The education level of the fishermen is generally low.

Fishing boats

Fishing boats can be largely classified into 2 kinds: the cylindrical bottom type and the flat bottom type. The former of these types is comparatively large and can accommodate several fishermen. Among these boats are many made from steel. Almost all of them have outboard engines, and are usually used in the lake's south fishery area. On the other hand, flat bottom type boats are usually small, carry only 2 - 3 fishermen, and are often powered by hand. There is also a fish catch carrier boat in addition to these fishing boats, which goes round the camps under its respective jurisdiction, collecting the fish catch from each fisherman.

Fish catch

Fish catches are classified into fresh fish and salted fish. Among these, salted fish is an Egyptian traditional food, and the utilized fish species is limited to a fish with the local name kalb-samak. The quantity of this salted fish is not more than 10% of the total, but this fish is one of the most important fish in this lake so it is costly. This fish is usually taken with the floating gill net, *sakarota*. Next, among fresh fish, the main fish is *tilapia*, which is locally called *bolti* and of which there are 2 subspecies: *Tilapia nilotica* and *Tilapia galilaea*. Among these, *T. nilotica* is the most important fish species among this lake's fish resources because it grows rapidly and is delicious. This fish accounts for 80 - 90% of the annual catch, when combining together the 2 subspecies of *tilapia*. Important fish species in this lake are as shown in Table 3.

Table 3. Commercially important fish species in High Dam Lake

Fish family name	Scientific name	Local name
Mormyridae	*Mormyrus kannume*	Boweza, Anooma
Characinidae	*Mormyrus caschive*	Boweza, Anooma
	Alestes murse	Sardina
	Alestes dentex	Raya, Omaya
	Alestes taremose	Raya, Omaya
	Hydrocynus forskalii	Kalb-samak
Cyprinidae	*Barbus bynni*	Benni
	Labeo niloticus	Lebeis (Lebis) abyad
	Labeo horie	Lebeis (Lebis) aswad
	Labeo horie	Lebeis (Lebis) aswead
Clariidae	*Heterobranchus bidorasalis*	Hout, Kharmout
	Heterobranchus longifilis	Hout, Kharmout
	Clarias anguilaris	Hout, Kharmout
	Clarias lazera	Hout, Kharmout
Schilbeidae	*Eutropius niloticus*	Shilba
	Schilbe mystus	Shilba
	Schilbe. uranoscopus	Shilba-Arabi
Bagridae	*Bagrus bayad*	Bayad
	Bagrus docmac	Docmac
Synodontidae	*Synodontis spp.*	Schall
Cichlidae	*Tilapia nilotica*	Bolti
	Tilapia galilaea	Bolti
Centropomidae	*Lates niloticus*	Samoos, Ishr-Bayad

2. Strategy

Japanese short-term experts have specifically advised FMC researchers in the data-collecting methods and research methods necessary for performing the investigations/experiments/research concerning High Dam Lake's fishery resources maintenance/increase. Experts made manuals showing the process of each type of work method, made tables to record the research/investigation results for each experiment, and also provided on-site advice concerning the research method following such manuals, the data recording method, etc.

Though the FMC researchers are all university graduates, there is no college of fishery science and technology in Egypt universities, and most of the researchers are science college zoology/botany department graduates or oceanography department graduates. So their knowledge of fisheries can be considered almost nil. Considerable time was expected to be needed for technical transfer considering this situation.

Because Aswan City is located in a region near the national border with Sudan, it is considered as a boundary area by Egyptians (Figure 3). Though there were cases where some people from the north of Egypt who graduated from Cairo University or Alexandria University became FMC researchers, some of these researchers transferred to Cairo or other northern region offices in a short time period. For this reason there often occurred the situation, especially in the 2 - 3 years after FMC was first set up, where the transfer of researchers occurred at a point when technical transfer had somewhat progressed and so advice had to be given again from the beginning for newly employed researchers. But after that, the researchers have generally settled down in their work and there are no more researcher transfers to other organizations.

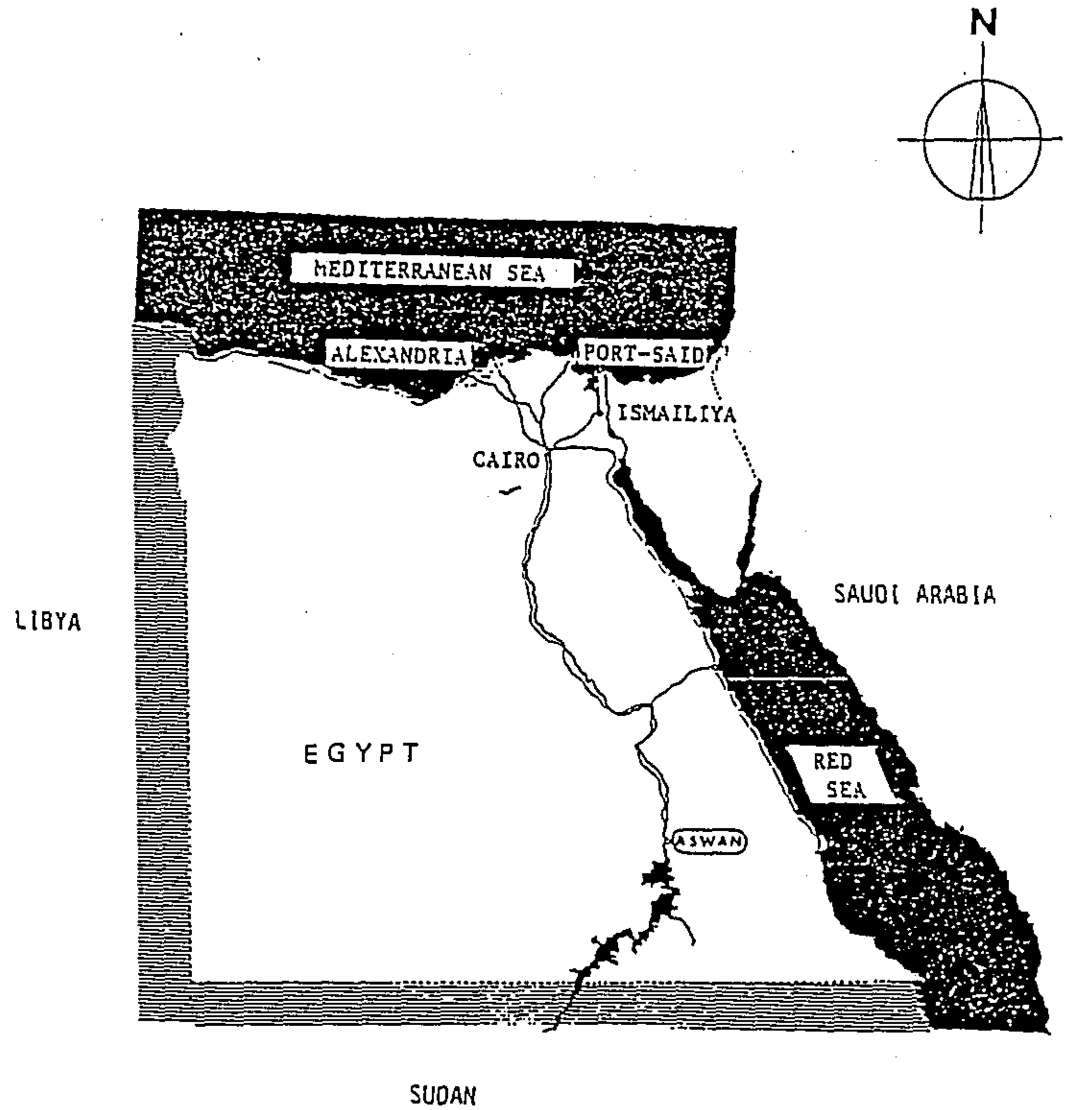


Figure 3. Location of Aswan city and the High Dam Lake.

FMC is located 15 km from Aswan City, and the means of transportation for FMC researchers is limited to the High Dam Lake Development Authority bus service alone. The researchers must use this bus service to return home, except in cases of special experiments, etc., at day's end. Hence inevitably work operations in the late afternoon are not done efficiently.

For the above reasons, work done amounts to less than half of that in Japan, hence technical transfer has required a long time period. Our first time expert dispatch was in 1981 and after that has been continuing at the rate of 6 experts per year as described above.

FMC system reconsideration was requested by the General Director of FMC in 1982, so the status of technical transfer to researchers was discussed and the General Director was advised to integrate the system into 3 departments for professionals excluding the business offices. The present system is as follows:

General Director

Office of General Affairs

Duties: The general administration work, library management

Department of Fishery Resources Management

Duties: Fish resources analyses, fish resources management, fish biology research, fishermen's welfare and technical extension

Department of Environment

Duties: physical/chemical/biological environmental analyses, ecosystem investigation/research, fish resources environmental analyses, fishermen's welfare and extension

Department of Aquaculture

Duties: Fish stocking and propagation techniques development, fish nutrition research, fishermen's welfare and technical extension

Administration office for research boat and instruments

Duties: research boat running and maintenance of instruments

Fish Hatchery Center (scheduled to belong directly to the High Dam Lake Development Authority separate from FMC after 2 - 3 years)

Duties: fish stocking, fishermen's welfare and technical extension

From the beginning the short-term experts have carried out their cooperative work estimating to finish technical transfer by March of 1988. But a request for cooperation extension was presented by Egypt in 1986. The reasons presented were: the FMC researchers had not yet been brought up to the level of first-rate researchers; decrease of the High Dam Lake water level had been severe during recent years and shrinkage of fishing ground due to lowering of water level, etc., and FMC researchers could not yet devise new measures related to resource management policy, fish stocking, etc. Egypt also expressed the strong hope for FMC to take the position of a prominent freshwater fishery management center in Africa in the future and to teach trainees from various African nations. The request to prolong the plan for 5 years until 1993 was submitted based on this reasoning.

The experts conferred with the Japanese government to formulate a concrete work plan as in Table 4 to prolong the plan for 3 more years based on this request. After that cooperation was rendered according to this revised plan.

3. Plan

1) Department of Fishery Resources Management

As for High Dam Lake fishery development, the following objectives were set before FMC's establishment, after detailed discussions between the preliminary research team dispatched from Japan and the High Dam Lake Development Authority.

(1) Development of an effective method of fishery resources management

Table 4. Activity plan of the Fishery Management Center

Program	Period: Jan. 1986	Jan. 1987	Jan. 1988	Jan. 1989	Jan. 1990	Jan. 1991
I. Training Training regarding methods of analysis of collected data and preparation of reports	———	———	———	———	- - -	- - -
II. Surveys, Study and Analysis						
1) Collection of data and conducting of surveys as routine work a) Landed fish survey b) Echo sounding survey c) Camp survey d) Collection of catch data from FCS, etc. e) Plankton survey and water analysis at Khor El Ramla and main channel (including sediment collection, and water movement and weather observations)	———	———	———	———	———	———
2) Study on changing of fishing gear and methods	———	———	———	———	———	- - -
3) Study on seasonal changes of stomach contents in various sizes of <u>Sarotherodon niloticus</u>	———	———	———	———	———	———
4) Survey on spawning ground of <u>S. niloticus</u>; location and environmental condition		———	- - -	-		
5) Study on seasonal changes of habitat and migration of <u>S. niloticus</u>						
a) Preliminary	- - -	———	———			
b) Full-scale			———	———	———	- - -
6) Study on growth of <u>S. niloticus</u> in the Lake						
a) Preliminary	———	———	- - -	-		
b) Full-scale			———	———	———	- - -

Program	Jan. 1986	Jan. 1987	Jan. 1988	Jan. 1989	Jan. 1990	Jan. 1991
7) Study on effects of release of *S. niloticus* fry to a certain fishing ground fishing ground						
a) Preliminary	———	———	——			
b) Full-scale			——	———	———	———
8) Study on cause of decrease of catch ratio of *S. niloticus*	———	———	- - - -			
9) Tag experiment	———	———	———	———	———	———
10) Production of one million tilapia fry and their release		- - - -	———	———	———	———
11) Introduction and rearing of silver carp.	———	———	- - - -			
12) Trial egg-taking from silver carp	———	———	———	- - - -	- - - -	
13) Trial net cage cultur of silver carp near main channel area without supplementary food	- - - -	- - - -	———	———	———	
14) Experiment on estimation of number of tilapia fry produced in large pond	———	———	- - - -			
15) Mass culture of plankton as initial food for fry.	- - - -	———	———	———	———	———
16) Experiment on artificial food for tilapia fry	———	———	———	———	- - - -	- - - -
17) Survey of fishery resources and environment by experimental fishing and hydrographic and atmospheric measurements						
a) Khor Kalabsha				———		
b) Khor Allaqi					———	
c) Khor Tushka						———

Program	Period					
	Jan. 1986	Jan. 1987	Jan. 1988	Jan. 1989	Jan. 1990	Jan. 1991
18) Seasonal variation of dissolved oxygen, water temperature, pH, transparency, etc., in the Lake (analysis of collected data)	———	———	———	———	———	———
19) Seasonal and regional variations of nutrient salts and other items						
a) Total-N, total-P and COD(Cr)	- - -	———	———	———	———	———
b) Reactive-P, NO_3, NO_2 and H_2S	- - -	———	———	———	———	———
c) SS and ignition loss	- - -	———	———	———	———	———
20) In- and outflow of nutrient salts (N, P) in the Lake		———	———	———	———	———
21) Analysis of relationships among nutrient salts, plankton and fish catch (Analysis of collected data)	———	———	———	———	———	———
22) Quantitative and qualitative analysis of seasonal variations of plankton distribution in the Lake (Analysis of collected data)	———	———	———	———	———	———
23) Estimation of primary productivity in the Lake	- - -	———	———	———	———	———
III. Facility						
1) Construction of wet laboratory for rearing new species in FMC	———	- - -				
2) Construction of (a) facilities for production of one million tilapia fry and (b) natural nursery ponds for acclimatization of new species	——— (a)	——— (a)	- - - (a)			
	——— (b)	- - - (b)	- - - (b)			

(2) Determination of available fish resources and maximum sustainable production quantity

(3) Fishing method and fishing gear improvement

(4) Improvement of fish catch transportation method on the lake, etc.

It is regarded that (1) is the main purpose of FMC's establishment and (2) ∿ (4) respectively are steps by the Fishery Resources Department to achieve this main purpose, so the aim of this department in 1982 was to organize its system and foster researchers. Detailed items were prepared as the first stage.

Investigation of fishery situation

a) Camp research
   i) composition of fishermen and degree of fishery proficiency
   ii) investigation of fishing gear used
   iii) work operation methods and fishing-ground utilization research
   iv) investigation of problems encountered by fishermen

b) Fishery statistics
   i) fish catch statistics (classified by fish species, regions, and months)
   ii) fishing boat statistics
   iii) fishery statistics (number of fishermen, amount of fishing gear, etc.)
   iv) water level change statistics

c) Biological research on fish catch
To perform the following biological research classified by fish species and months based on random sampling at the fish landing site (all catches are landed at the damside fish port

on this lake):

i) fish body length and body weight measurement
ii) fish maturity measurement
iii) fish sex ratio research
iv) fish scale collecting for age determination
v) fish species phase research

d) Carrier boat research
   i) navigation status
   ii) investigation of fish condition during transportation and condition within fish hold of fishing boat

Method of data analyses

Experts teach the individual arrangement method for each type of collected data, how to analyze the arranged data, and for what purpose the results, can be used. They also teach what relationship as a whole the respective results have so as to be useful for fishery production management.

Concrete policy establishment for fishery resources management

Having diagnosed the fishery situation and resources by the above-mentioned "analysis technique", we determine what action (management policy) shall be taken based on diagnosis results.

In 1982, the FMC Fishery Recourses Department's research system was established as in the following table based on the above plan.

Table 5. Fishery Resource Management Department's research system

Name of functional field	Name of division in department	Research/investigation domain and role
Fishery resources management	Fishery operation analysis	To determine the actual fishery situation and draw out the present fishery problem points
	Fishery resources analysis	To look at fishery trends from statistical data or from fishing-site information and to establish the parameters necessary for resource estimation,forecast to determine the appropriate fishing level
	Fishery biology	To gather biological information about the main types of fish caught so as to survey internal variation among the total resources and to use this as material for resource analysis

Because each division in the department deals with interrelated matters, it is important to have a cooperative work system. So it is necessary to always exchange information.

2) Department of Environment

Advice was given regarding physical/biological/chemical aspects based on the plan shown in Table 4 and taking the following items as main subjects: (1) the environmental influences affecting the ecosystem of the lake and the biological process of fish species, and the importance of these influences and their relation to FMC activity, (2) various environmental factor survey methods, (3) survey instrument handling methods, (4) survey data processing and basic analysis methods of data, (5) relation between environmental change and fish resources, (6) method of summarization of results, (7) report document and dissertation preparation methods, (8) operation and maintenance of research boats.

3) Department of Aquaculture

It was purposed to maintain/increase the High Dam Lake fish resources at FMC. The following three activities were selected: (1) *tilapia* fry mass production and releasing, (2) utilization of open water area of High Dam Lake, (3) aquaculture of fish species whose catch amount has decreased.

(In response to this, the following 8 items of a technical cooperation plan were carried out in the Aquaculture Department.

1. *Tilapia oreochromis niloticus fry* production technique in 1983 - 1985.
2. Mass cultivation technique for zooplankton as early stage food source in 1984 - 1986.
3. Production technique for One million *tilapic oreochromis niloticus,* fingerlings in 1988.
4. Silver carp parent fish cultivation and artificial spawning technique at FMC in 1984 - 1987.
5. Non-artificial food cultivation technique for silver carp in stagnant pond in 1986 - 1988.
6. Non-artificial food culture technique in net cage for silver carp for evaluation of adaptability for releasing in waters in 1986 - 1988.
7. Artificial spawning technique of useful fish species whose catch has decreased in 1983 - 1988.
8. Artificial food preparation technique in 1983.

III. Activities and Results

1. Management of the Center

1) Organization system

At the start of the plan, there were 8 mutually independent sections: (1) fishery production, (2) fish catch amount research, (3) fishery management, (4) resource analysis, (5) fish fry and fish propagation, (6) fishermen's welfare and training, (7) ecological research, and (8) environmental research. These were set up based on the overall plan concept and each individual research station and laboratory was established and personnel, and (researchers, assistants, technicians) were assigned. In addition, offices of general affairs and boat administration (with 2 research boats, 2 carrier boats, and several fishing boats) were organized.

This system structure was effective for each employee to understand his own job well but it also gave rise to the problem of researcher sectionalism which hinders smooth implementation of integrated analyses/discussions relating to the various specialities which are important in resource management. Hence FMC was advised in September 1982 that in order to solve this problem it would be best to integrate into (1) a Department of Fishery Resource Management (unifying the above-mentioned sections (1), (2), and (4)), (2) a Department of Aquaculture, and (3) a Department of Environment (unifying the above-mentioned sections (7), (8)).

After that some researchers were ordered to transfer to other organizations related to the High Dam Lake Development Authority as part of the system structure change, and the as part of the system structure changed in August 1987 to the new one with the above 3 departments and an office of general affairs and an administration office for research boats. And as for the hatching facility which was set up by the High Dam Lake Development Authority in 1986, this facility was set to be aligned with FMC as a structural component of the same rank as the Center sections until the facility is completed and can function on its own (2 - 3 years).

2) Management

Advice was given concerning the following matters to effectively operate FMC and to achieve smooth performance of its activities.

Stress was placed on goal clarification, harmonious mutual understanding, clarification of rights and responsibilities, a system of cooperation, evaluation impartialization, task distribution optimization, activity control function, importance of communication in idea coordination, idea correspondence, opinion exchange, mutual reliance, etc., as items concerning the establishment mission, activities, and function of the Fishery Management Center.

Also stressed was the importance of setting goals, realistic, adaptable and rational planning (overall planning and sectional planning), appropriate activity allotment, confirmation and control of the details of performed activities, activity improvement, cultivation of professional knowledge and integral insight, etc., to the smooth implementation of the FMC activities.

The following meetings were suggested in order to realize the above points:

(1) Staff meeting (general meeting attended by all personnel in charge of research, office work, engineering, and boats): once or more per month.

(2) Department meeting (attended by researchers and assistants): once or more per month
(3) Director general and experts meeting: 3 days a week
(4) Activity planning meeting (director and representatives from each department): once a month
(5) Morning meeting (attended by all employees): every morning
(6) Morning meeting of each department (attended by researchers and assistants): every morning
(7) Meeting for fishing condition forecast (attended by departments of fishery resource management and environment): once a month
(8) Planning liaison meeting (attended by outside institutions related to fishery): twice a year
(9) Seminar (by all researchers): once or more per month

Among these meetings, employee meetings and seminars have been held before, and employee morning meetings have been held every morning without exception since the summer of 1988 and have been useful in harmonizing of activities.

3) Budget

FMC operational expenses are furnished through the High Dam Lake Development Authority from the Headquarter Ministry. The budget in 1981 (the year of FMC's establishment) was LE45,000 (LE: Egyptian pound, 1LE ≒ ¥70). The Fishery Management Center undertook a 5 year plan whose main purpose was silver carp fry propagation and releasing based on Japanese advice (Reference data No. 13). The budget total of the 5 year plan, starting from 1987, whose allocation was determined by the Finance Treasury Ministry, is LE12,700,000 (¥889,000,000) among which LE2,240,000 was apportioned in 1987. In addition, so far FMC has put LE4,000,000 into the hatching facility construction, US$30,000 into hatching equipment importation, and LE30,000 into fish culture.

4) External activities

Fishermen training related to technique improvement/ propagation has been carried out for persons engaged in fishery as an important FMC activity. The researchers reportedly had no difficulty understanding the research results of their respective specialty fields and gave technical advice about problem points at the research study workshop held on September 3, 1987. About 50 persons engaged in fishing, leaders of fishermen's cooperatives, etc., attended that workshop meeting and actively exchanged opinions. The following points were of interest to fishermen: (1) fish school movements accompanying the water level decline, (2) comparison from economic viewpoint of setting a closed season for fishing and artificial hatching, (3) fish catch transportation method improvement and possibility of fish carrier boat grant, (4) problem of new species introduction, etc. Similar workshop meetings have been held once or twice a year.

5) Recommendations submitted

(1) Preliminary report on High Dam Lake fishery development. Minoru Nomura, January 1984 (Reference data No. 1)
(2) Recommendation concerning a cooperative study by FMC staff and foreign scholars. Atsushi Koike. April 1986 (Reference data No. 2)
(3) Reply to questions from FMC director. Atsushi Koike, Nobuo Hirayama, Fumio Takashima, and Kohei Kihara, August 1987 (Reference data No. 3)
(4) Recommendation concerning the FMC future plan. Atsushi Koike, September 1987 (Reference data No. 4)

(5) Reply to questions from FMC director, Atsushi Koike, Nobuo Hirayama, Fumio Takashima and Kohei Kihara, September 1987 (Reference data No. 5)

2. Department of Fishery Resources Management

1) Counterparts

Though the selection of staff for this section was expected to be difficult because there are few fishery colleges in Egypt, the following three were employed at FMC (Fishery Management Center) from the beginning.

(1) Mohamed Aly, oceanography, Oceanography College, Alexandria University, for fishery analysis section
(2) Morad Zakki, zoology, Science College, Ashoot University, for resource analysis section
(3) Hussein Adam, zoology, Science College, Aswan University, for fishery biology section

Because the fishery (marine production) related knowledge of these men (except for Mr. Mohamed Aly of the fishery analysis section) was limited, as can be seen from their specialities, they should start their training from fishery science fundamentals. Moreover, although the fishery analysis section researcher seemed promising as a future FMC staff member, he resigned after about a half year of his office tenure due to such things as the living environment at Aswan City, etc. This was a great loss both for FMC and for the Japanese experts. Since then, this section has lacked the necessary personnel and its work has been performed concurrently with their own activities by the researchers of the other 2 sections (i.e., Morad/Hussein.) Each of these men has trained for half a year at Tokyo University of Fisheries to learn fish resource analysis and fishery science: Morad Zakki (training period: October 1982 - March 1983); Hussein Adam (training period: April - October 1984).

2) Recommendations and advice

Because fishery resources research differs depending on the particular fishing pattern or target fish species, guidelines for fishery research are needed. And basic field research requires integrated/interdisciplinary knowledge of biology, mathematics, fishery science, etc. But it is impractical from the viewpoint of time to wait to begin research activity until mastering all these sciences. So it is advisable to proceed in the following manner, with the idea that the shortest route to implementing such research is to directly get hands-on experience in the fishery industry.

(1) to observe the actual fishery business and to participate in fishery work
(2) to deal directly with fish and understand the living creature's history and various biological/natural/conditions
(3) to always be prepared to get fishery information directly from fishery operators and fishermen

Based on this approach to research guidelines, the following survey items (Table 6) in several fields were selected.

The above survey items are for conducting a continuous survey, which has been done so far but with partial exceptions.

There are also experiments which are performed as a result of the above survey items. These are experiments for which a necessity arose in the course of the above survey process. Since these experiments also correspond to the researchers' desire for high technology learning in the research survey stage, they have been allowed to perform them after an experimentation plan was formed. The following (Table 7) shows the experiment items.

Table 6. Items for research

Survey item	Relevant survey items and contents	Survey frequency
Landed fish survey	1) Fish body length/weight, 2) fish species, 3) maturity, 4) fish scale sampling, 5) otolith collection, 6) stomach contents, 7) sex ratio, 8) fish scale inspection	Twice a week
Echo survey	Counting fish with the fish finder image; fixed line observation (at 5 stations)	Once a month
Camp survey	1) Number of fishermen in camp, 2) employed fishing implements and fishing boats, 3) work operation method, 4) discarded fish number	All year round
Catching experiment	To set fixed lines to periodically survey fish species caught, net spread status, etc.	Twice a month
Survey of discarded fish	To survey the quantity of fish unable to be sold because of bad storage	Once a month
Survey of fish resources and environment	To participate in fishery work with fishermen to survey the fish caught and the real situation for fishermen	Twice a year

Table 7. Research experiments having been performed

Experiment	Experiment objective/contents
Experiment for releasing tagged fish	Experimental method of resource estimation, fish migration route estimation, fish growth measurement
Mesh selection test	This experiment becomes basic data for selecting an adequate mesh size for gill nets, mesh regulations for resource control, etc.
Parallel net experiment	Survey of the stock density, fishing gear efficiency, and fish behavior
Fishing efficiency experiment	This experiment is to determine the thinning out strength of gill nets which becomes fishing regulation data for resource control
Experiment for counting fry	This experiment is to accurately count the number of fry in the breeding pond.
Beach seine experiment	This experiment is for new fishing method introduction and stock density estimation.

In each respective field experiment, unexpected situations may occur, mistakes may arise due to the experimenter's inexperience, etc., so it often occurs that he cannot achieve the initial objective. Especially in experiments on fishing operations, because it is necessary to repeat the experiments over and over again, researchers are allowed to perform them only after being made sufficiently cognizant of the possible problems.

3) Recommendations submitted

(1) About fish catch amount, Nobuo Hirayama. September 1986 (Reference data Recommendation No. 6)

(2) About fish catch regulation, Nobuo Hirayama, Akio Maeda, and Kazumi Sakuramoto. August 1988 (Reference data Recommendation No. 7)

Table 8. Trend of annual fishing yields and employed boats (1966 - 1987)

year	Boat	Increase (%)	man	Landings (ton)	Increase (%)	Tilapia (ton)	(%)	Lates Niloticus (ton)	(%)	Bagrus (ton)	(%)	Labeo Niloticus (ton)	(%)	others (ton)	(%)
1966	200	0.00		761.90	0.00	278.60	36.57	5.80	0.76	25.10	3.29	134.80	17.69	308.60	40.50
1967	350	75.00		1414.70	85.68	471.10	33.30	27.50	1.94	69.30	4.90	309.80	21.90	537.00	37.96
1968	500	42.86		2484.50	75.62	713.10	28.70	71.90	2.89	59.60	2.40	700.60	28.20	939.30	37.81
1969	599	19.80		4676.90	88.24	1978.30	42.30	289.30	6.19	112.20	2.40	954.00	20.40	1343.10	28.72
1970	816	36.23	1800	5677.40	21.39	2384.50	42.00	451.40	7.95	176.00	3.10	817.50	14.40	1848.00	32.55
1971	1039	27.33		6820.20	20.13	3157.80	46.30	517.40	7.59	245.50	3.60	934.40	13.70	1965.10	28.81
1972	1135	9.24		8343.80	22.34	4146.90	49.70	451.30	5.41	258.70	3.10	826.00	9.90	2660.90	31.89
1973	1440	26.87	3300	10692.50	28.15	7179.00	67.14	394.70	3.69	162.00	1.52	212.00	1.98	2744.80	25.67
1974	(1540)	(6.94)		12256.70	14.63	7244.00	59.10	490.00	4.00	127.00	1.04	83.00	0.68	4312.70	35.19
1975	(1630)	(5.84)		14636.00	19.41	9660.00	66.00	525.00	3.59	121.00	0.83	4.00	0.03	4326.00	29.56
1976	(1680)	(3.07)		15697.00	7.25	10519.00	67.01	446.00	2.84	75.00	0.48		0.00	4657.00	29.67
1977	(1690)	(0.60)		18500.00	17.86	11200.00	60.54	564.00	3.05	66.00	0.36	362.00	1.96	6304.00	34.08
1978	1700	(0.59)	4000	22575.00	22.03	(16931.2)	(75.0)		0.00		0.00		0.00		0.00
1979	1613	-5.12		27021.40	19.70	22347.80	82.70	371.80	1.38	45.10	0.17	331.90	1.23	3863.00	14.30
1980	(1570)	(-2.67)		30231.60	11.88	25440.90	84.15	433.80	1.43	31.60	0.10	376.00	1.24	3949.30	13.06
1981	(1500)	(-4.46)		34205.60	13.15	30527.00	89.25	399.00	1.17	21.30	0.06	433.00	1.27	2825.30	8.26
1982	(1450)	(-3.33)		28666.70	-16.19	23712.00	82.72	274.00	0.96	11.00	0.04	308.00	1.07	4361.70	15.22
1983	1388	(-4.28)	3159	31283.30	9.13	28220.00	90.21	256.84	0.82	6.20	0.02	200.20	0.64	2524.60	8.07
1984	(1385)	(-0.22)		24630.90	-21.27	22862.80	92.82	134.90	0.55	4.90	0.02	218.30	0.89	1309.90	5.32
1985	(1382)	(-0.22)		24974.60	1.40	23276.30	93.20	129.90	0.52	2.50	0.01	159.80	0.64	1403.50	5.62
1986	(1379)	(-0.22)		16588.90	-33.58	14930.00	90.00		0.00		0.00		0.00		0.00
1987	1379	(0.00)	3141	16814.74	1.36	14548.15	86.52	307.30	1.83	1.56	0.01	443.66	2.64	1544.25	9.18

* Values in parentheses are estimates.

4) Outcome

Based on the suggested research plan, the following outcome has so far been attained through the various data collections and various experiments or surveys performed by FMC researchers.

(1) Outcome obtained through the fish catch statistics

The field fish catch statistics had been previously summarized based on the daily fish landing quantity chits submitted by Misr Aswan Co. which is located at the landing site, but the data arrangement and storage method were very poor so the data before FMC's establishment were unintegrated and incomplete. The fish catch statistics are the most important data for understanding the true fishery resources conditions and forecasting them. According to this viewpoint, the FMC Fishery Resource Section negotiated with the authorities concerned so that it could take charge of the summarization/arrangement of raw data concerning fish catch amounts and consequently has taken charge of more accurate data collection since its inauguration. Table 8 shows the number of working fishing boats, total fish catch amounts, and the fish catch amounts as classified by fish species year by year. In this table, detailed data before 1981 are lacking.

Research guidance was provided concerning the following matters based on such data.

i) The catch yield forecast in High Dam Lake

The catch yield depends on the following three basic elements: the intensity of fishing efforts (extent of fishery activities, e.g., the number of fishermen, number of boats, and the fishing operation frequency), the fishing technique level (fishing gear structure, fishing method, fishermen's technical maturity), and the stock level (resource amount or environmental conditions). Among these three elements, the fishing effort intensity and the fishing technique level can be directly grasped by investigation, but there are many unknown factors as for stock level. And in cases such as this lake where the water level (Figure 4) varies throughout the year and also year to year, resource estimation is very difficult.

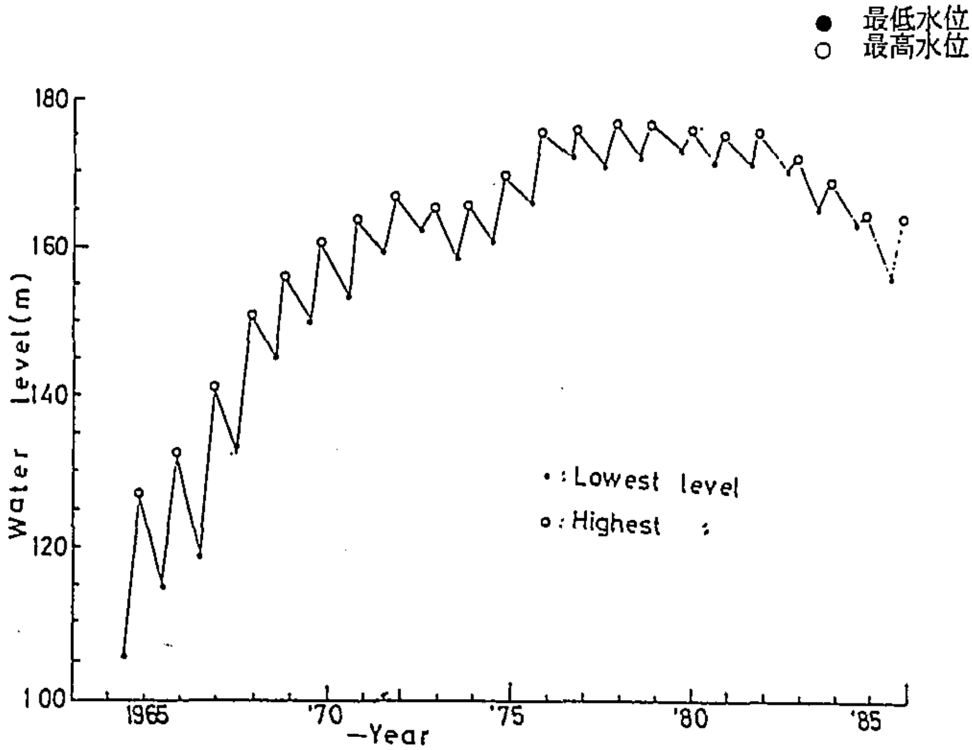


Figure 4. Annual variation of water level

How fish catch amounts vary for High Dam Lake is very important data for establishing a fishery control policy at this lake. To compute this data, firstly catches were forecasted upon the following assumptions with the limited fishery information available: a) the fishery scale, technique level, and resource level will continue their present increase trend; b) lake water level will maintain a maximum value of 180 m. A logistic curve is useful when forecasting things that are in a process of growth.
The following equation can be used.

$$Y(t) = Y(\infty) \ (1 + e^{-at+b})^{-1} \qquad (1)$$

In the Eq. Y(t) is taken as the fish catch amount for the year t and $Y(\infty)$ as the maximum limit for fish catch amount. Here a is a constant determining the fishery development strength and b is a constant related to initial value of catch yield. As for the above assumption b), the water level increase around 1980 was unstable so when we use fish catch amount data up to 1978 and calculate the respective constants to substitute them in the equation, the following Eq. (2) results:

$$Y_{(t)} = 8.0 \times 10^4 \ [1+30\exp\{-0.21(t-1966)\}]^{-1} (\text{ton}) \qquad (2)$$

Using this result, it was forecasted that this lake's fish catch amount will vary as shown by the dotted line in Figure 5.

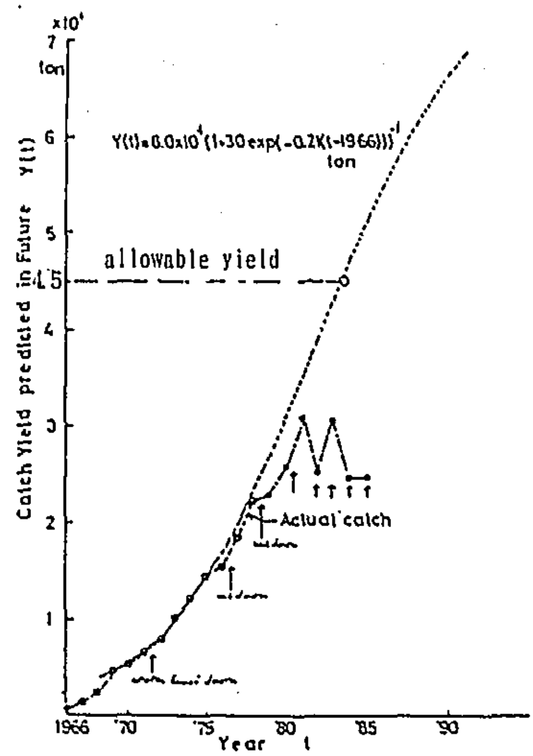


Figure 5. Annual variation of fish catch amount and catch yield predicted.

From the result of this equation the optimum fish catch level was set as 1/2 Y(∞) ∿ 2/3 Y(∞) = 40,000 ∿ 45,000 t from the point in time when the water level becomes stable at 180 m.

ii) Variation in fish catch amounts month by month

Figure 6 shows how fish catch amounts vary through the year according to recent data from 1980 ∿ 1985. The month by month fish catch amount variation is great as may be seen. But this variation is fairly regular. Table 8 shows the monthly fish catch amount percentage ratio variation through the year. March through April is a thriving season and 30% of the yearly fish catch is caught is these 2 months. There are 2 reasons why such a thriving season exists. One

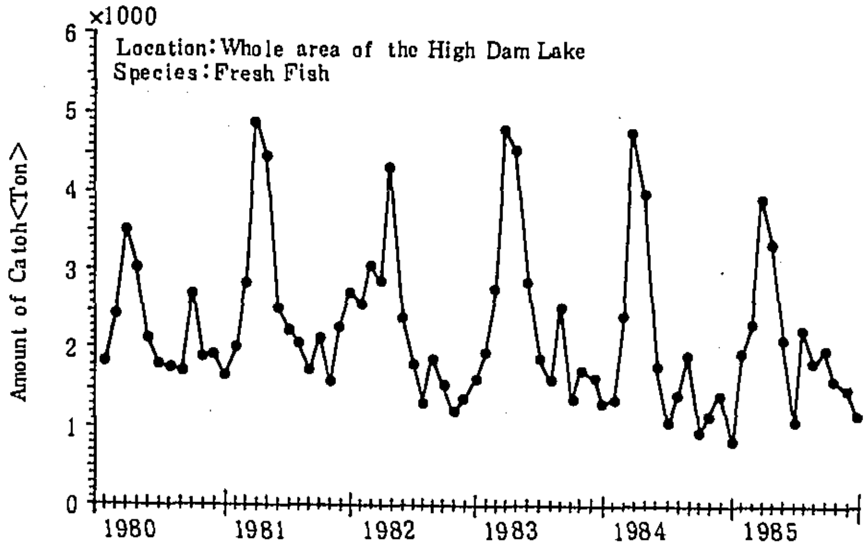


Figure 6. Fish catch variation by months (1980 - 1985)

Table 9. Percentages of monthly production of fresh fish (*tilapia* being the main fish species) of High Dam Lake (1980 - 1985)

	Year						
Month	1980 (%)	1981 (%)	1982 (%)	1983 (%)	1984 (%)	1985 (%)	MEAN (%)
Jan.	6.98	6.20	9.83	6.75	5.85	7.75	7.42
Feb.	9.24	9.08	11.72	9.42	10.50	9.16	9.85
Mar.	13.33	15.62	11.04	16.55	20.62	15.69	15.48
Apr.	11.55	14.25	16.58	15.57	17.19	13.28	14.73
May	8.09	7.99	9.38	9.77	7.81	8.62	8.61
Jun.	6.76	7.08	7.09	6.46	4.54	4.21	6.02
Jul.	6.74	6.59	5.08	5.50	6.23	8.97	6.52
Aug.	6.47	5.53	7.26	9.15	8.33	7.48	7.37
Sept.	10.20	6.84	5.95	4.71	4.13	7.86	6.62
Oct.	7.13	5.00	4.59	5.99	4.97	6.28	5.66
Nov.	7.35	7.21	5.19	5.58	6.14	6.00	6.25
Dec.	6.16	8.61	6.23	4.55	3.69	4.70	5.66
%	100.00	100.00	100.00	100.00	100.00	100.00	100.00

is related to the spawning season of *tilapia*, the main fish caught; the other is the increasing fishing effort intensity. Later these 2 matters will be further discussed based on the data.

iii) The variation of fishing effort intensity month by month

Fishing effort intensity is the most difficult item to quantify in fishery statistics collection. Though the number of fishing operations would be useful data to measure the intensity of fishing efforts, and this data could be gathered by asking fishermen, etc., the local situation does not permit it, so the information was gotten by the following method.

The fishing operations on this lake are conducted only at night when the fish catch carrier boat cruises to each camp, except for that in the lake's northern zone Stn.I, because there are no fish preservation facilities in the fishermen's camps, so the number of fishing operations can be considered as proportional to the number of carrier boat cruises.

The following table shows the number of monthly cruises and fish hauls at each fishing zone in 1983 and 1984. From this we can understand that in March - April the number of cruises is large and fish hauls are also large. And if we examine the fish hauls per cruise (CPUE), the modes are in February, March, or April. This shows that February, March, and April constitute the peak fishing season relative to other months. This trend is also seen at the lake's North Ramla, Kalabsha, and Allaqui fishing zones.

Table 10. Carrier boat operations and fish catch amounts at the lake's south fishing zone (Korosko, Tushka, Abusimbel)

	1983			1984		
Month	Catch (ton)	No. of cruises	CPUE	Catch (ton)	No. or cruises	CPUE
Jan.	856.5	54	15.86	725.8	61	11.89
Feb.	1142.9	66	17.31	1389.1	89	15.60
Mar.	2126.5	115	18.49	2129.0	115	18.51
Apr.	1668.5	97	17.20	1502.1	98	15.33
May	1160.8	93	12.48	749.2	83	9.03
Jun.	772.4	78	9.90	692.6	75	9.23
Jul.	838.8	72	8.58	603.3	53	11.38
Aug.	1033.6	83	12.45	954.9	88	10.85
Sept.	626.0	67	9.34	30.7	6	5.10
Oct.	797.3	69	11.56	472.9	63	7.50
Nov.	766.9	75	10.23	586.6	50	11.73
Dec.	641.9	65	9.88	341.9	31	11.03
	12432.1	934	13.31	10178.1	812	12.53

iv) Discarded fish and the monthly variation

Fish preservation on the carrier boat has been a problem. Precise numerical values of the quantity of fish discarded due to spoilage and its ratio to the total catch, etc., have not been obtained. Generally, there are 2 points at which fish may be discarded, one of which is when the carrier boat leaves the fishing boat in the fishing ground, the other of which is when the carried fish is landed from the carrier boat at the fishing port. Though the former case has not been sufficiently investigated, landing site investigation results through 1983 are shown in Table 11. A special monthly trend is not seen. What can be said is that fish are discarded at the ratio of about 1.3 - 1.5% of the total catch and the yearly average turns out to be 250 - 300 tons of spoiled fish per 20,000 tons of fish caught. So it can be seen that fish catch preservation in the fish storage of the carrier boat is an important subject.

Table 11. Discarded fish and the monthly variation

	1983				1984				1985			
Month	fresh (kg)	spoil (kg)	total (kg)	%	fresh (kg)	spoil (kg)	total (kg)	%	fresh (kg)	spoil (kg)	total (kg)	%
Jan.	1025456	2020	1027476	1.11	1413560	6160	1419720	0.43	1955097	27700	1982797	1.40
Feb.	2008547	40140	2048687	1.41	2501614	39050	2540664	1.54	2314180	3666	2317846	0.16
Mar.	4911866	116145	5028011	2.31	4879283	80160	4959443	1.62	3960860	28155	3989015	0.71
Apr.	4816059	74545	4890604	1.52	4149216	39700	4188916	0.95	3352550	31601	3384151	0.93
May	3133436	39417	3172853	1.24	2016170	16175	2032345	0.80	2064900	42332	2107232	2.01
Jun.	2293205	71835	2365040	3.04	1094093	4820	1098913	0.45	1062080	29334	1091414	2.69
Jul.	1752900	28120	1781020	1.58	1755468	23400	1778868	1.32	2103830	21740	2125570	1.02
Aug.	2745212	31030	2776250	1.10	2082106	42242	2124348	2.00	1887700	27273	1914973	1.42
Sep.	1767171	34915	1802086	1.94	1076762	21875	1098637	2.00	1984560	61555	2046115	3.01
Oct.	2048917	20625	2069542	1.00	1203472	33575	1237047	2.71	1585600	37950	1623550	2.34
Nov.	1052265	26199	1078464	1.39	1472386	6375	1478761	0.43	1515020	13275	1528295	0.87
Dec.	1428259	11730	1439989	0.81	886866	6575	893441	0.74	1187360	12895	1200255	1.07
Total	31403293	494729	31898022	1.55	24520996	320107	24851103	1.29	24973737	337476	25311213	1.33

v) Monthly variation of the catch ratio of 2 subspecies of *tilapia*

It is recognized that the catch ratio of *Tilapia nilotica* vs *Tilapia galilaea* varies from month to month. It may be that though these fish are of the same species, they do not necessarily have the same habits for the sake of species coexistence and exhibit different ecological behavior. Such trends are seen also in sardine species in Japan. These trends seem to suggest a subject for ecological research in the future on these 2 kinds of *tilapia*.

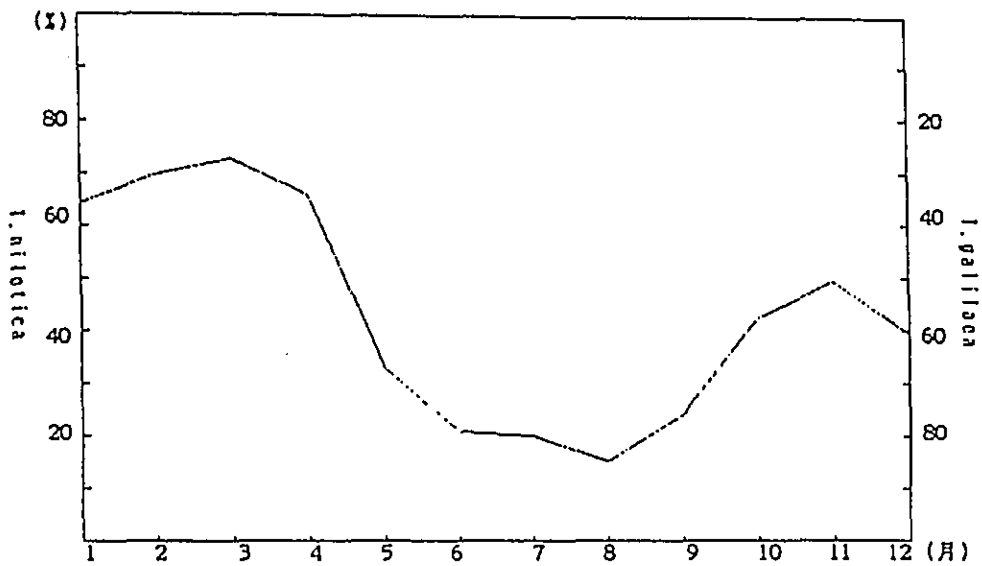


Figure 7. Monthly variation of catch ratio of *T. nilotica* vs *T. galilaea*

(2) Biological knowledge obtained by fish catch landing site investigation

A fish catch survey has been continued twice a week at the landing site since FMC's establishment. Biological measurement of the fish catch is the most fundamental matter in resource research. As for the measurements performed, they are made keeping in mind the following points: a) fish to be measured are randomly sampled; b) the sampling boat shall cover all fishing grounds; c) not less than 200 fish shall be measured during each survey, etc. As of 1988 the number of fish measured exceeded 60,000 and has become valuable biological data for FMC. The research results described hereunder are based on these data.

i) Fish body length distribution

Effective knowledge of fishery resources, i.e., age composition, survival phenomenon, etc., is obtained from the body length distribution. And determining the minimum size of fish which may be caught and the main target fish group is useful for establishing fishing operation controls. Figure 8 shows a fish body length distribution diagram from a one-time measurement investigation of *tilapia nilotica* as an example. The body length distribution can be likened to a sectional view sheet at the present point in time as already mentioned; and the following can be known by observing these distributions.

(a) Age composition

Fish born in the same year generally follow a normal distribution with a single peak. If the fishing gear used has no fish size selectivity, Figure 8 shows the normal distribution for the respective ages. The point marked 0 in the respective figure will show the average body length of each age group. It shows at least 4 age groups for this figure. These distributions become easier to separate if drawn up on

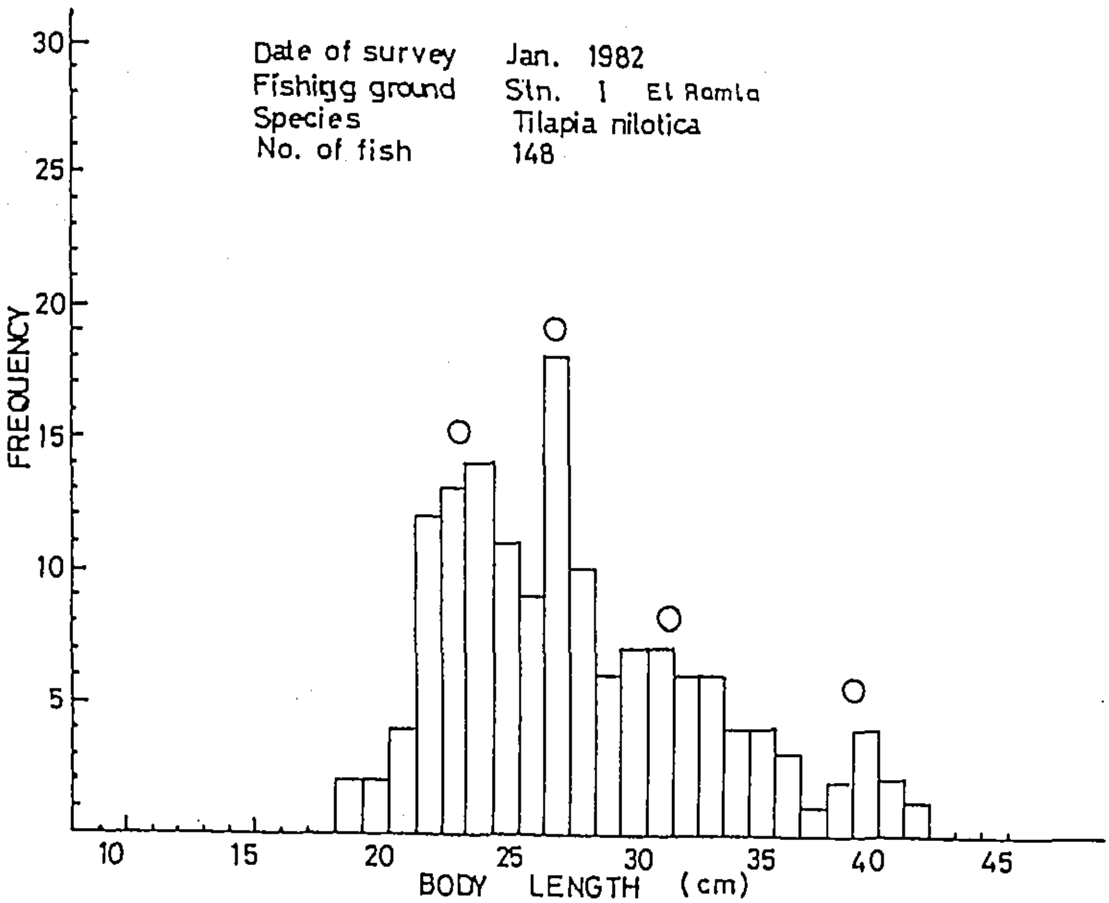


Figure 8. Distribution of body length of *T. nilotica*

normal probability paper (Figure 9). That is, then a folded broken line graph is formed where each age group is displayed as a certain line segment. The center point of this line segment is the average body length of this certain age group. Distribution characteristics of each fishing zone for each survey were researched using this method.

(b) Age determination from the body length distribution

Ordinarily age determination is done by a survey of such age characteristics as the ring pattern of fish scales, otoliths, bones, etc. But these measurements require considerable time and effort.

The relation between body length and age was obtained in FMC by the aforementioned method from body length distribution as a convenient method though age determination by fish scale patterns is also performed at the same time. The values 21.8 cm for one year old, 26.3 cm for two years old, 31.6 cm for three years old, and 39.0 cm for four years old were obtained in the case of *Tilapia nilotica* as shown in Figure 9. Thus approximate age can be estimated from the body length.

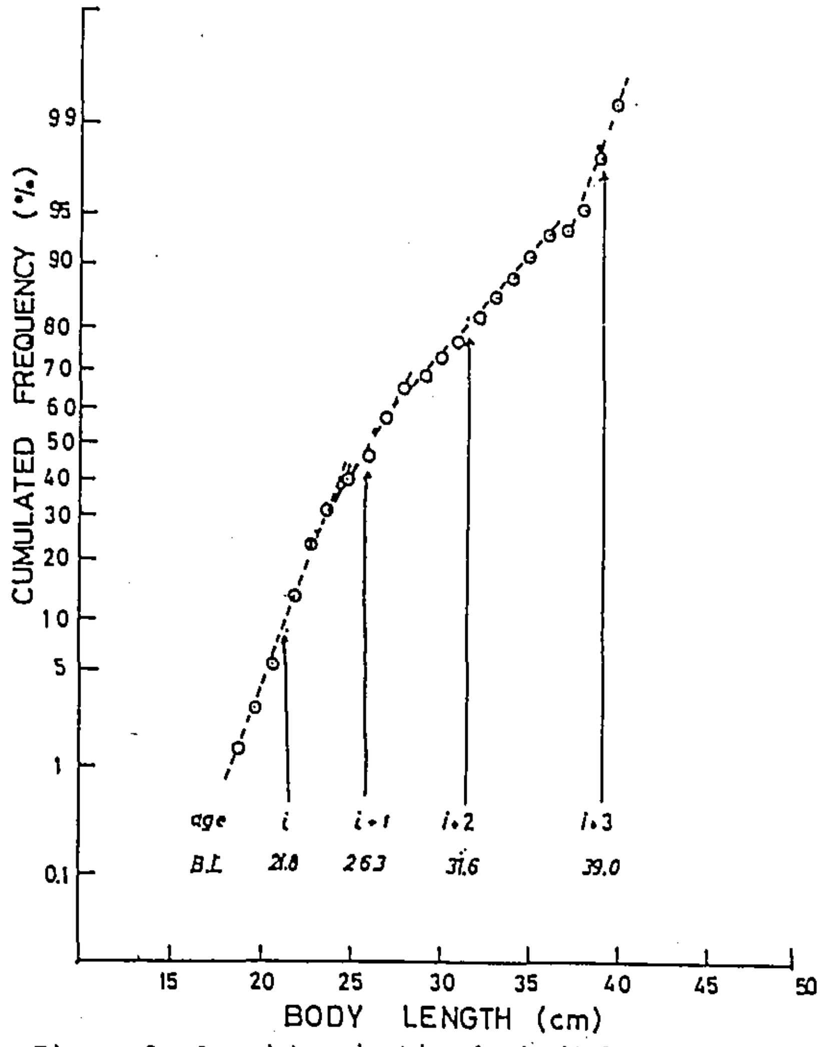


Figure 9. Age determination by body length.

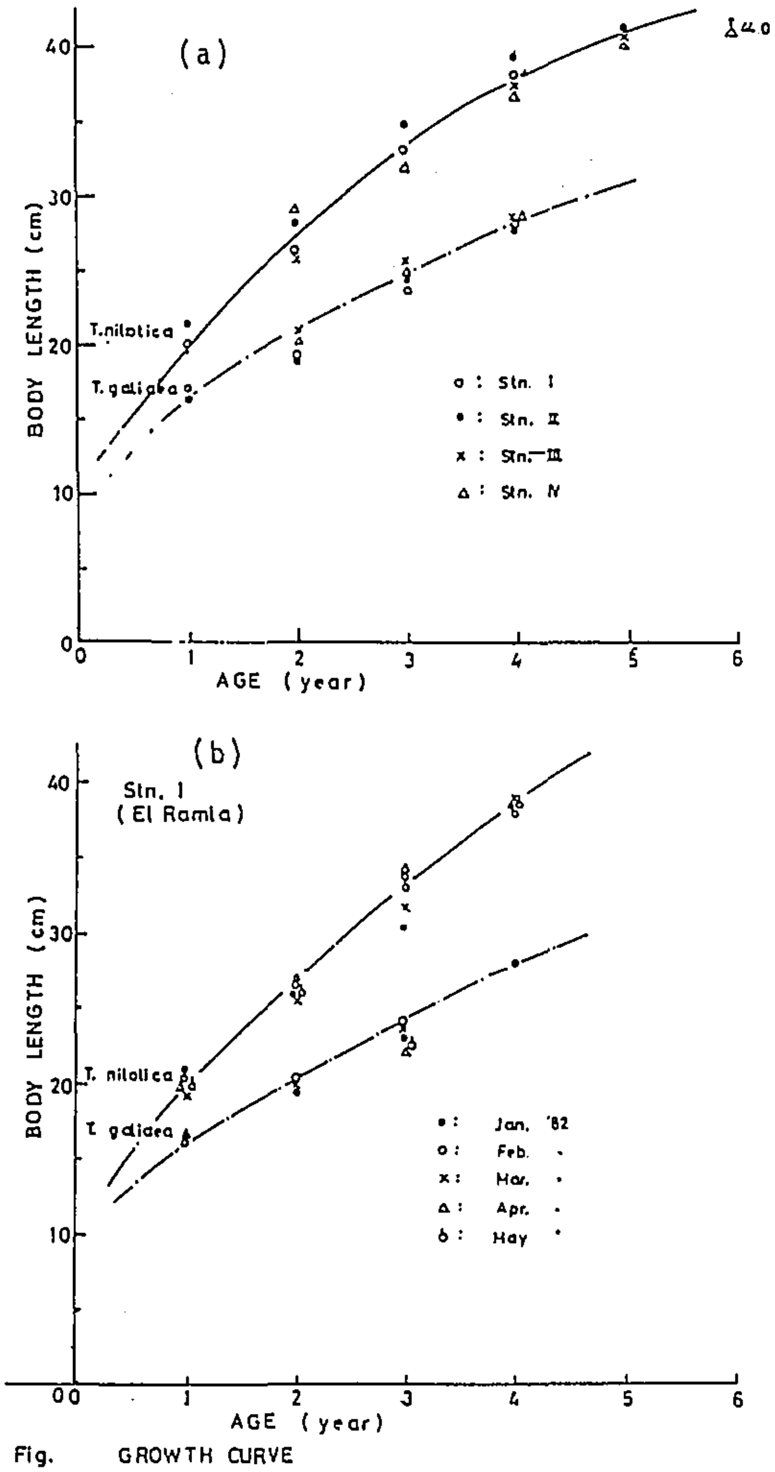


Figure 10. Growth curves by age depend on the body length.

(c) Growth equation of the 2 subspecies of *tilapia* obtained from the results of the age determination from the body length distribution.

The growth equation is important as basic data of fishery operations control. After graphing data based on the fishing grounds (Figure 10 (a)) and the survey months (Figure 10 (b)) by the aforementioned method, there was no large difference in growth seen based on the fishing grounds, and as for classification months, there are seen to be growth variations as much as age differences. However, the accuracy of this method is not so good as exceptions to size trends are also caught.

Next, for the obtained results, the von Bertalanffty equation,

$$\ell(t) = \ell_\infty [1 - \exp [-k(t-t_0)]] \qquad (3)$$

which is generally used as a growth equation, is applied where ℓ (<u>t</u>) is <u>t</u> years old times body length $\ell\infty$; <u>k</u> and <u>to</u> are growth parameters. When a value was obtained for each fishing ground and compared with Dr. Azim's data of 1974, a value was calculated for each subspecies of *tilapia* as in Table 12. These results should be determined by comparison with those ages assessed by fish scales.

ii) Relation between fish body length and body weight and allometry relation equation

Based on the forms, the body length-body weight relation is different according to the fish species, and coefficients of the allometry equation determining this relation can change due to the physiological characteristics of the fish during the spawning season, etc. Generally, if we take ℓ as body length and ω as body weight, we get

$$\omega = a\ell^{n} \quad (4)$$

where a and n are are coefficients. If the body length - body weight relation is shown for main fish species, it becomes as shown in Table 14 and Figures 11-a, b, c, d, e, and f.

iv) Gonad somatic index (G.S.I.) and maturity

The most common method to determine the spawning time period of fish is to survey the gonad somatic index (G.S.I.). At FMC, several fish of each of the 2 subspecies of *tilapia*, which are different in size, were studied during the fish landing site survey, and the gathering of stomach contents and otoliths, and gonad weight measurement, etc., of the sample fishes have also been done. In particular, a gonad weight survey has been done at the fishery resource section.

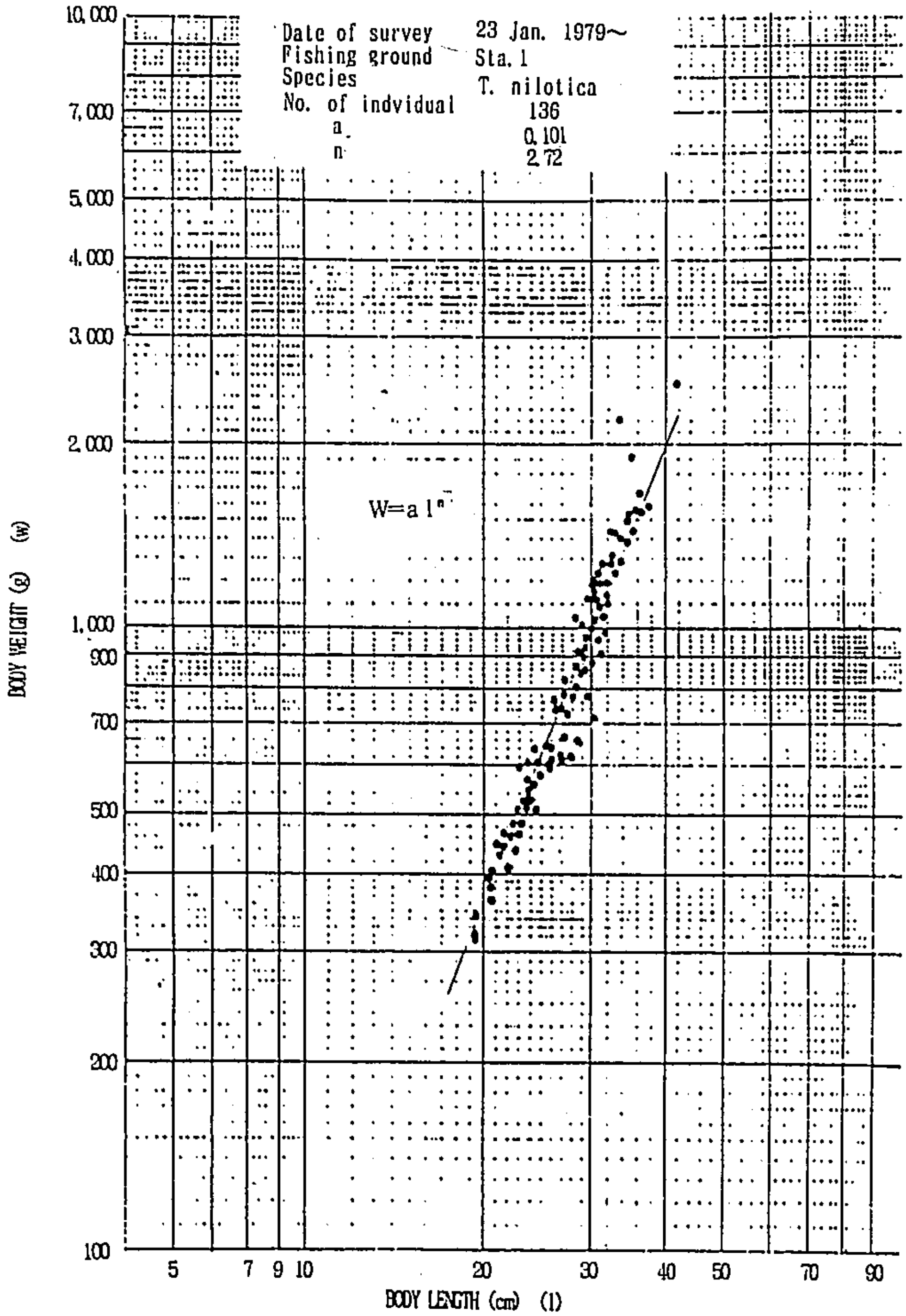
a) Monthly variation of G.S.I.

G.S.I. is calculated as follows:

$$\text{G.S.I.} = \frac{\text{Gonad weight}}{\text{Body weight}} \quad \cdots\cdots\cdots\cdots \quad (5)$$

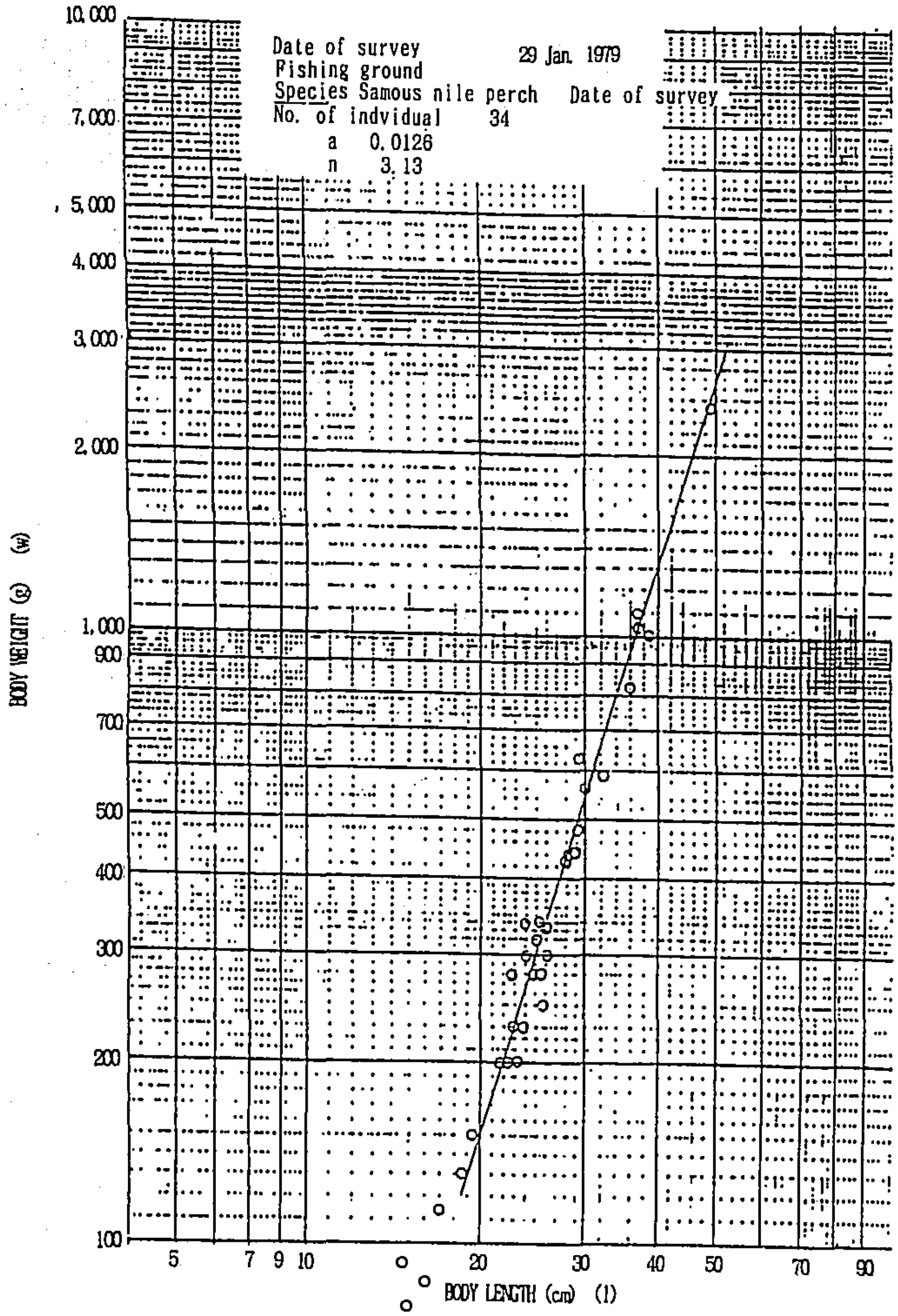
Using the results of investigations, G.S.I. were calculated to determine monthly variation for the 2 subspecies of *tilapia* as shown in Figure 13, and the G.S.I. trend is shown by its average values.

As this figure shows, the main spawning season of the 2 subspecies of tilapia is March - May. But not all individual groups concentrate to spawn in this season, and it can be seen that there exists a spawning parent fish group throughout the year.



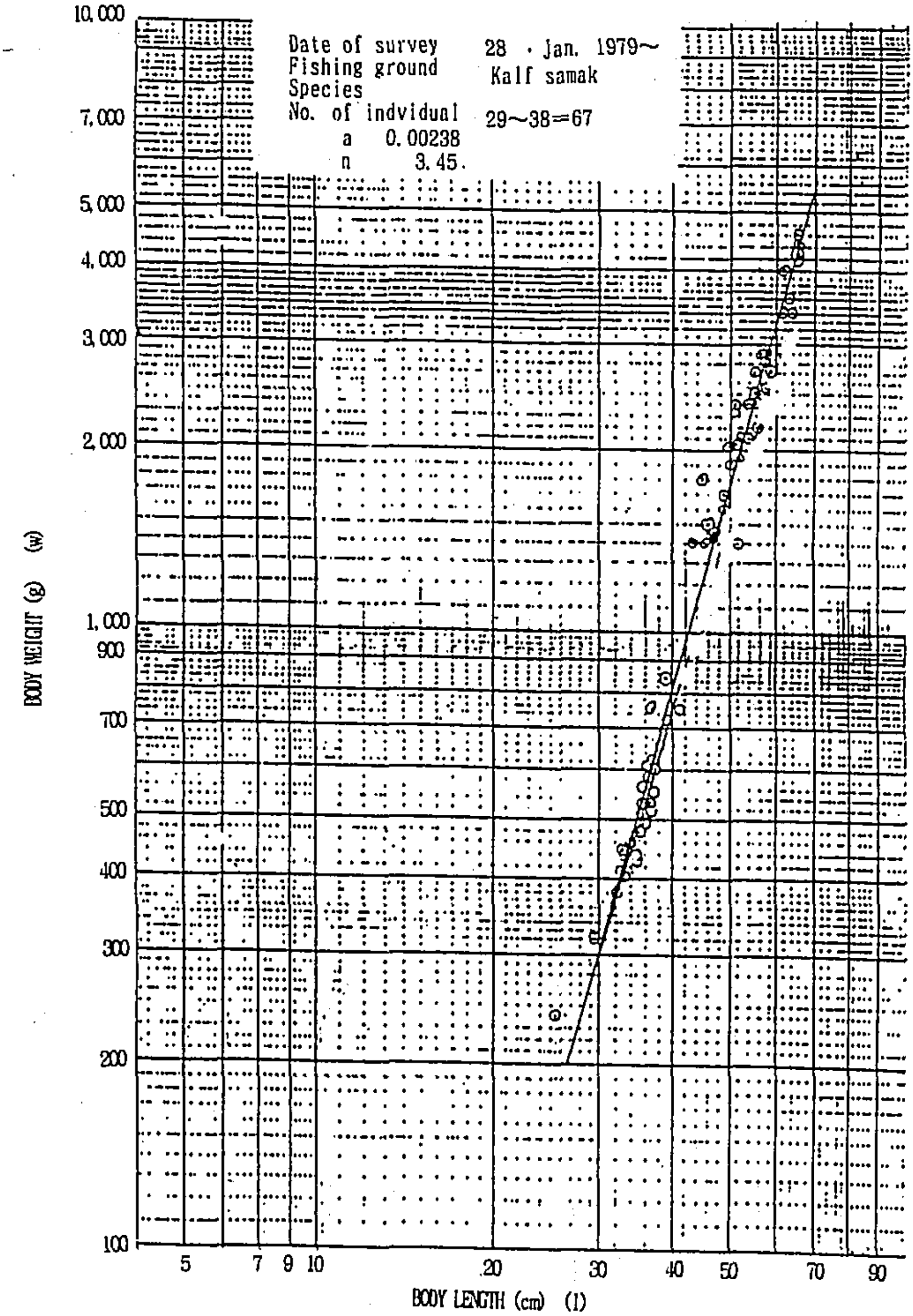
(a)

Figure 11. Relation between fish body length and body weight.
a: *T. nilotica*, b: Samoos, c: Kalb samak, d: Korkar, e: Bayad, f: Zammar



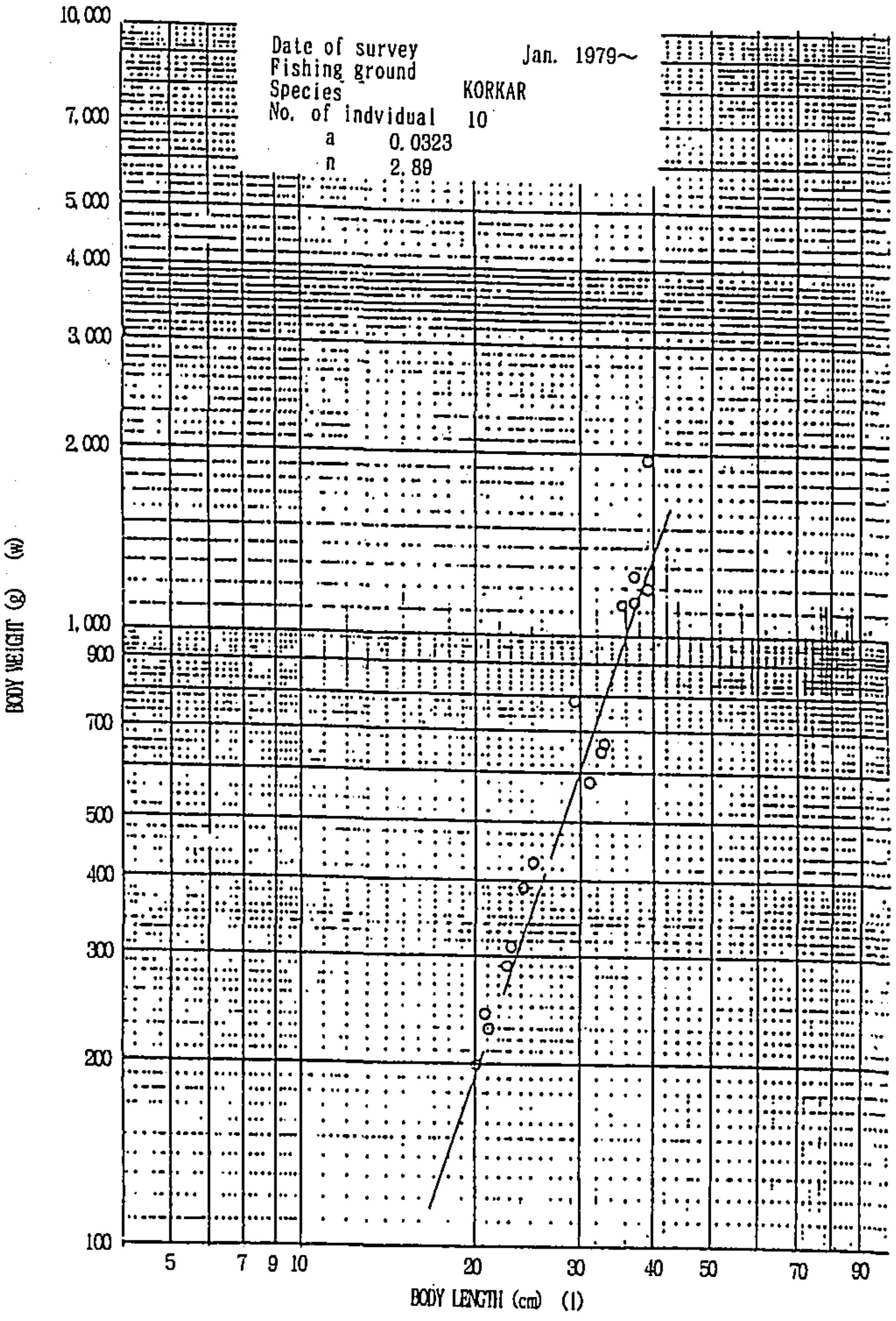
(b)

Figure 11. (Continuation)



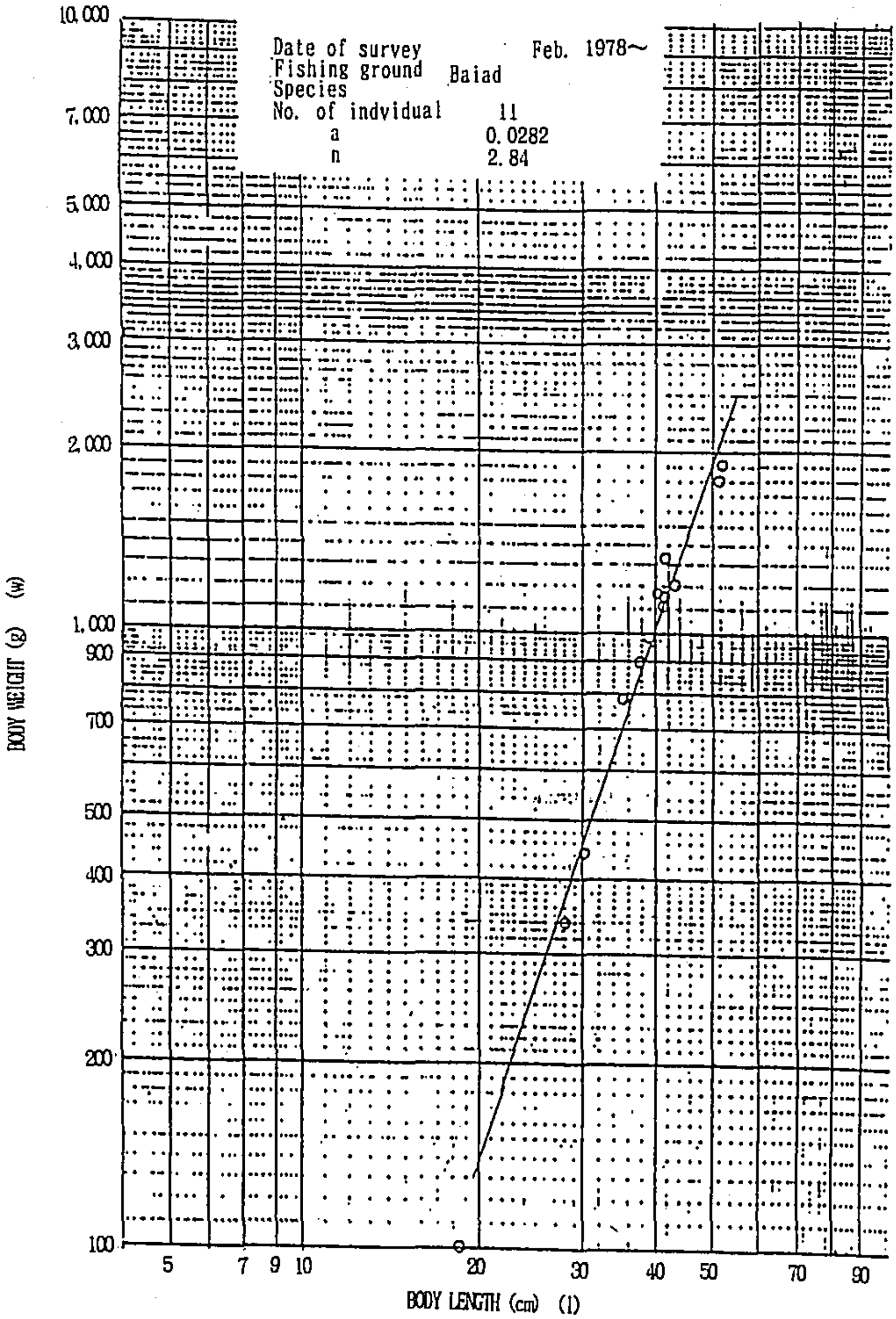
(c)

Figure 11. (Continuation)



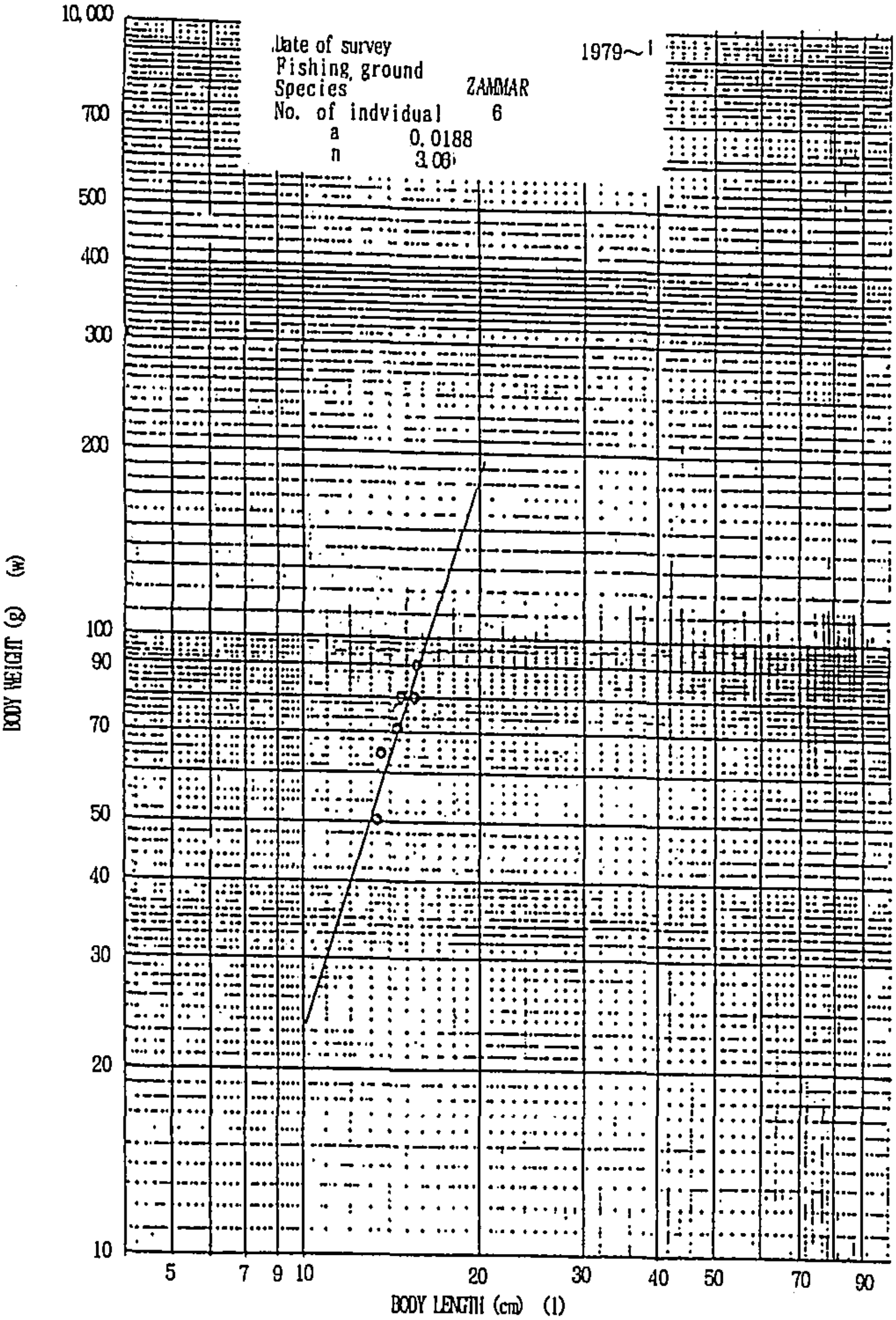
(d)

Figure 11. (Continuation)



(e)

Figure 11. (Continuation)



(f)

Figure 11. (Continuation)

Table 12. Relation between fish body length and age when classified by age groups and estimated using probability paper

Species	Stn / Period / Age	I (El Ramla) '81 Jan.	'82 Feb.	Mar.	Apr.	May	mean	II (Gazal) '81 Dec.	'82 Jan.	Mar.	Apr.	May	mean	III (El Allaqi) '81 Dec.	'82 Feb.	Mar.	mean	IV (Korosko) '82 Jan.	Mar.	Apr.	May	mean	MEAN
T. nilotica	i	21.8	21.4	19.2	20.1	19.5	20.4	22.1	22.5	22.8	21.3	23.5	22.4	·	·	·	·	·	·	·	·	·	19.0
	i+1	25.3	27.1	25.6	27.0	27.2	26.2	28.0	27.3	27.6	28.0	28.6	27.9	28.7	26.8	27.3	26.5	·	29.1	·	·	29.1	26.7
	i+2	31.6	34.0	33.5	34.5	33.6	33.4	34.6	35.5	35.0	34.5	35.6	35.0	·	·	·	·	32.2	32.7	31.3	-	32.1	33.6
	i+3	39.0	37.1	39.0	·	38.0	38.3	39.0	·	39.5	39.8	40.1	39.6	37.9	39.6	37.0	38.3	38.0	37.0	36.4	·	37.1	38.3
	i+4	·	·	·	·	·	·	·	42.0	·	·	·	42.0	·	·	41.0	41.0	41.0	41.7	40.9	·	41.2	41.4
	i+5	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	44.1	43.9	·	44.0	44.0
	No. of fish	148	257	244	65	75		89	80	253	603	123		18	96	87		28	162	75			
T. galilaea	i	·	·	·	17.4	17.1	17.3	16.2	17.0	·	·	·	16.6	·	·	-	·	·	·	·	·	·	16.7
	i+1	19.2	20.2	20.0	·	·	19.8	18.9	20.0	20.9	19.0	19.3	19.6	21.0	21.0	22.8	21.6	23.0	23.5	22.4	22.8	22.9	21.0
	i+2	23.2	24.5	24.0	22.1	23.0	23.4	24.8	23.5	·	25.8	23.8	24.5	25.0	26.0	27.5	26.2	26.0	27.6	25.0	25.1	25.9	25.0
	i+3	28.5	·	·	·	·	28.5	·	27.7	27.5	·	28.3	27.8	27.0	30.0	·	28.5	·	29.1	·	27.1	28.1	28.2
	No. of fish	155	43	71	49	18		360	288	232	123	119		22	101	113		34	38	20	141		

Remark: i was estimated as one year old

Table 13. Growth parameters of 2 subspecies of *tilapia* classified by fishing areas

Species	No. of station	l_{00}	k	t_0
	Stn I El Ramla	68.7	0.166	-0.94
	II Gazal	47.0	0.472	0.09
Tilapia	III El Allaqi	45.2	0.482	0.11
nilotica	IV Korosko	54.0	0.263	-0.44
	Whole	52.0	0.275	-0.75
	(by Azjm (1974)	61.1	0.411	-0.84)
	Stn I	-	-	-
	II	36.0	0.2161	-0.93
Tilapia	III	31.0	0.631	0.04
galilaea	IV	33.5	0.333	-0.46
	Whole	42.0	0.194	-0.64
	(by Azim (1974)	52.0	0.252	-1.41)

$$l_t = l_{00}\ (1 - \exp -k\ (t - t_0))$$

Table 14. Coefficients in the above allometry relation equation (4) between fish body length and body weight

Name of fish	No. of sample	a	n
T. nilotica	5000	0.001-0.2	3.4- 2.4
T. galilata	3000	0.001-0.2	3.4- 2.3
Samoos	34	0.0126	3.13
Tiger fish	67	0.00238	3.45
Korkar	10	0.0323	2.89
Bayad	11	0.0282	2.84
Zammar	6	0.0118	3.06

iii) Age determination by fish scales

Opinions can often be different according to who does the annual ring judgement when age is measured from fish scale patterns. Sufficient results were not obtained in FMC because of the measurement value differences between the different researchers, so collected fish scale samples of known sex were precisely measured at the Fish Population Analysis Laboratory, Tokyo University of Fisheries. Figure 12 shows an assessment of the results for 2 subspecies of *tilapia*. Also, a growth equation calculation was done by the Allen method using these results, and a growth equation was then made to use the growth parameters obtained here. In addition, new data was obtained during this measurement process but is omitted here. Growth parameters are as follows (Table 15).

Table 15. Estimation of growth parameters by the Allen method

fish subspecies	sex	l_∞ [mm]	k	t_0
Tilapia nilotica	♀	43.0	0.38	−0.002
	♂	51.6	0.25	−0.011
Tilapia galilaea	♀	41.1	0.27	−0.05
	♂	38.5	0.31	0.012

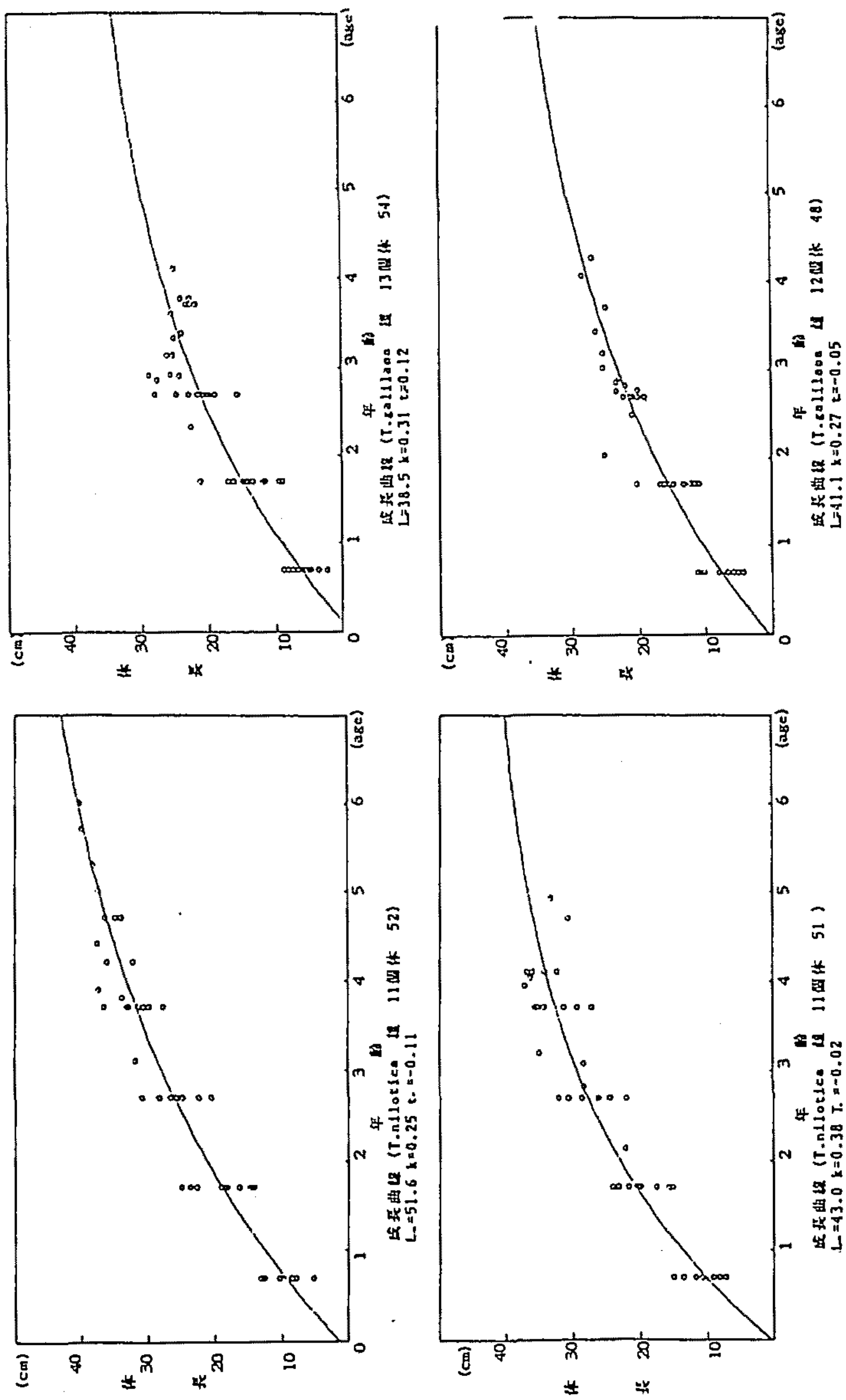
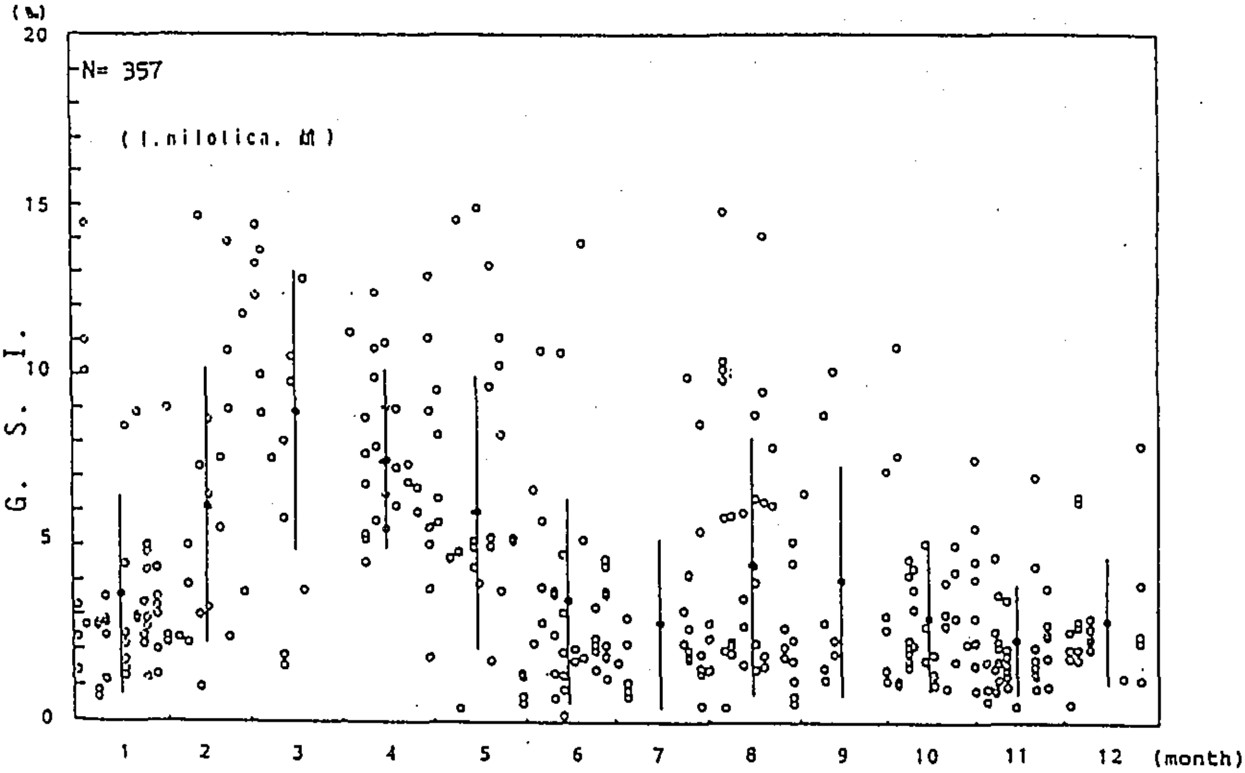
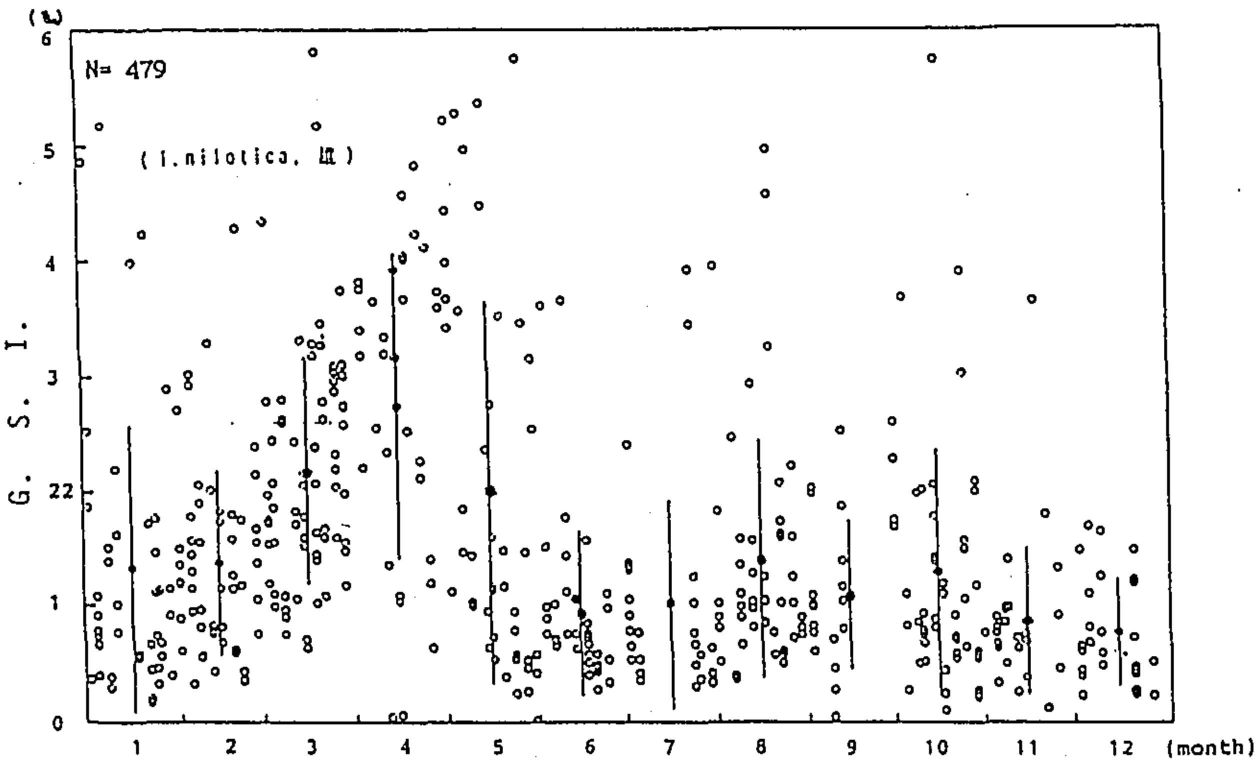


Figure 12. Growth curves by fish scales.



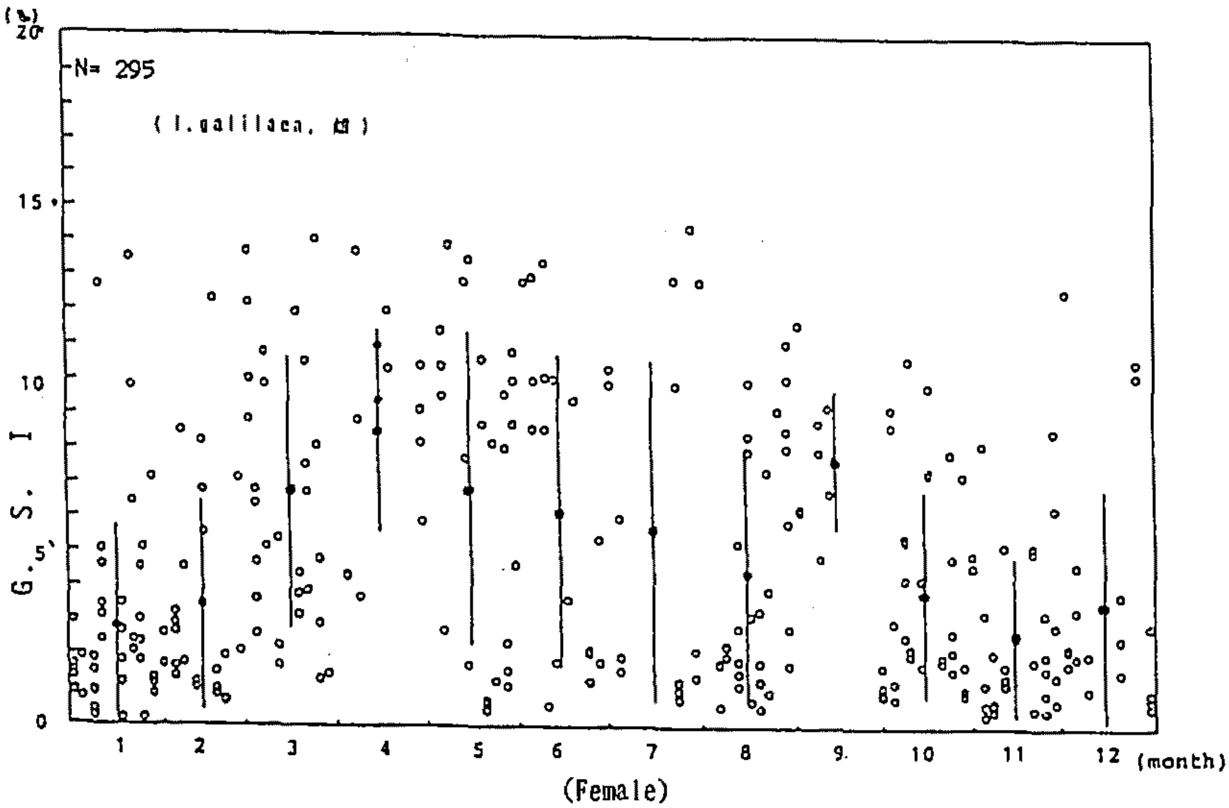
(Male)

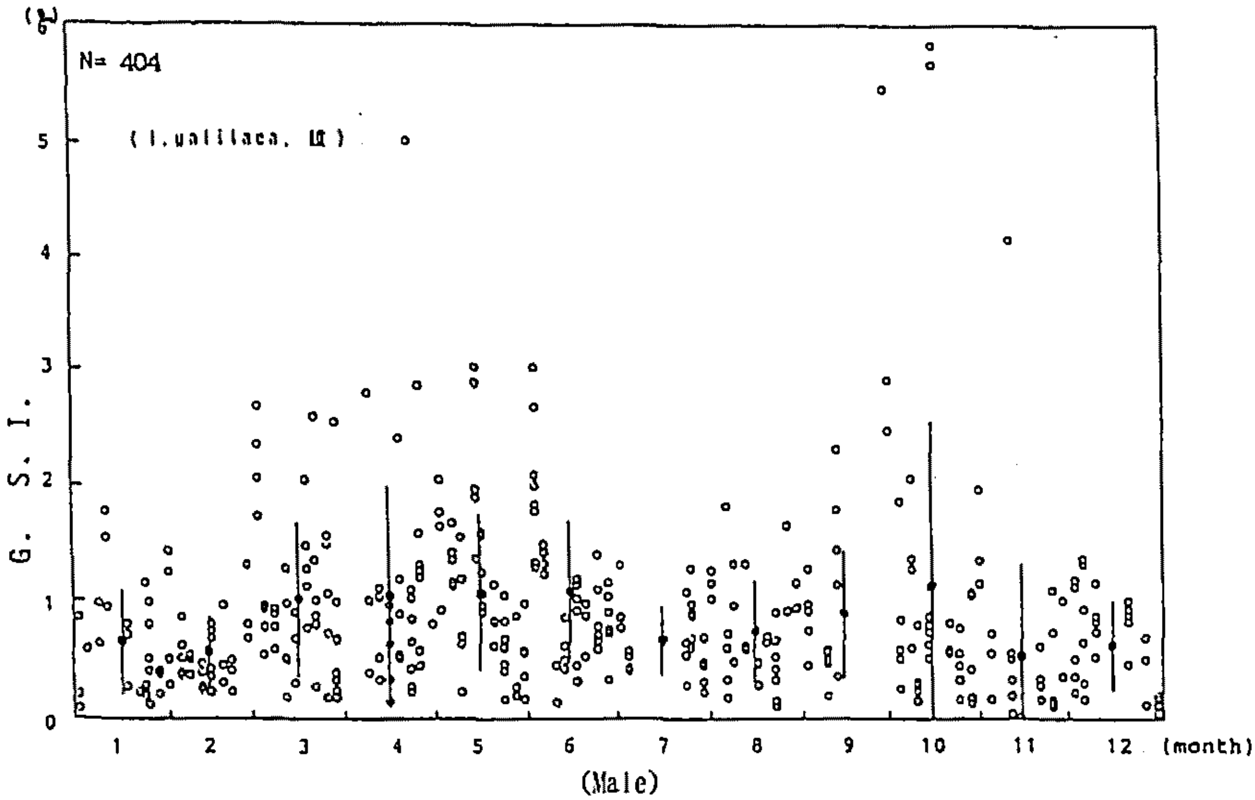


(Female)

(a)

Figure 13. Monthly variation of gonad somatic index (G.S.I.).
a: *T. nilotica*, b: *T. galilaea*
•: Mean -: standard deviation





(b)

図13－b　G.S.I.の分布の経月変化（T.galilaea）

Figure 13. (Continuation)

b) Relation between G.S.I. at full maturity (G_{max}) and fish body weight ω

G.S.I. can be a valid index to determine the spawning season (as already described above) for fish species whose spawning is only at a specified age and which spawn but once in their life. But G_{max}, which is G.S.I. at full maturity, seems to be a function of the body weight ω for a fish species such as *tilapia* which grows quickly to adulthood and continues spawning every year thereafter because full maturity gonad weight/body weight = $G_{max}(w)$ for heavy fish is estimated to be smaller than the $G_{max}(w)$ of light fish, so the fish gonad maturity index (M.I.) should be as follows:

$$M.I. = \frac{G.S.I.\ (\omega)}{Gmax\ (\omega)} = \frac{G.S.I.}{G.S.I.\ \text{at full maturity}} \qquad (6)$$

What time point is the point of full maturity is obtained by looking at each spawning state, but here we graph the relation between body weight ω and its G.S.I. for the data already used above (Figure 14) and draw out the maximum value per body weight class and take this as the G.S.I. of fish of weight ω at full maturity $(G_{max}(w))$. Figure 15 shows the relation between $w-G_{max}(\omega)$ according to sex classification of each *tilapia* species by this method. The following relation is seen between these two according to this graph:

$$Gmax\ (\omega) = a\ \exp(-b\omega) \qquad (7)$$

where a and b are constant. Table 15 shows the calculation resulting from these a and b values for each case.

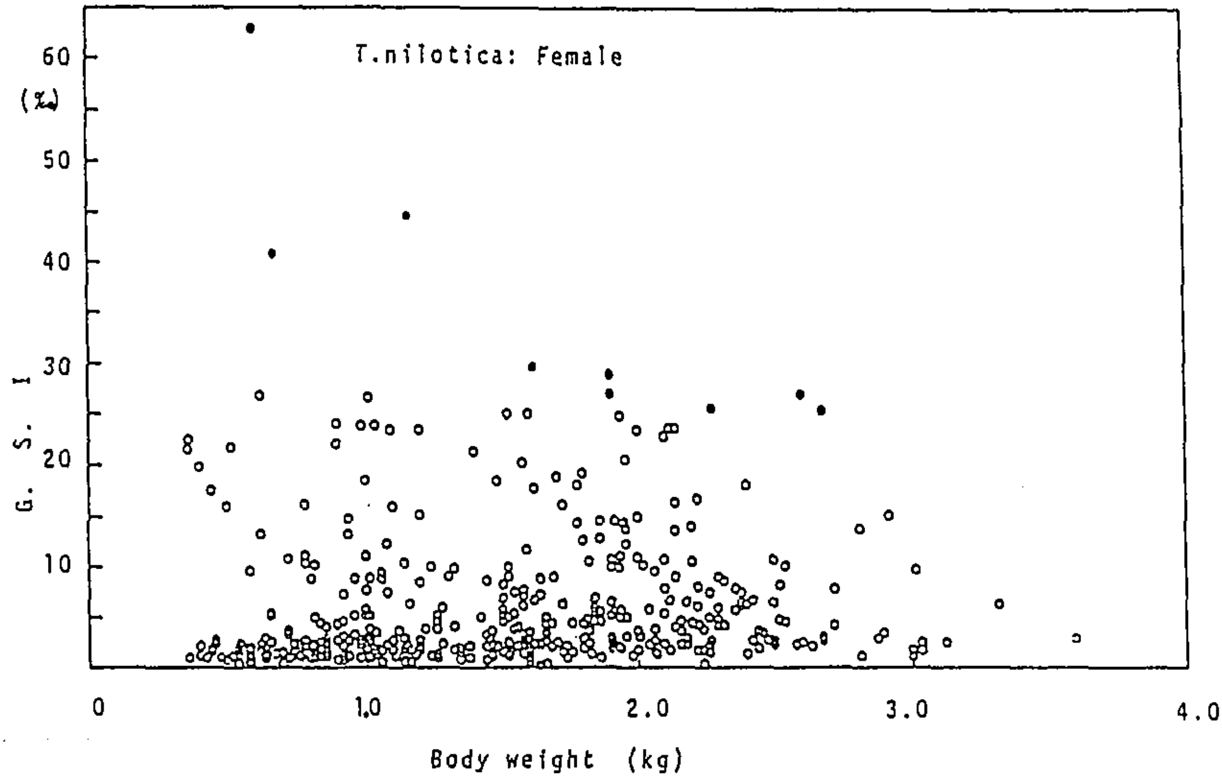


Figure 14. Relation between G.S.I. and fish body weight (*T. nilotica*: female).

•: Gmax(W)

c) *Tilapia* spawning time estimation as viewed from maturity index (M.I.)

We have already tried to estimate the spawning season from G.S.I. in paragraph a), but it is possible to estimate wrong by this method because G.S.I. shows different values according to the body weight though spawning maturity is the same. Consequently, if we graph the same as in Figure 13 a and b calculating G.S.I. $(w)/G_{max}(w)$ = M.I. by Eq. (6) in paragraph b)

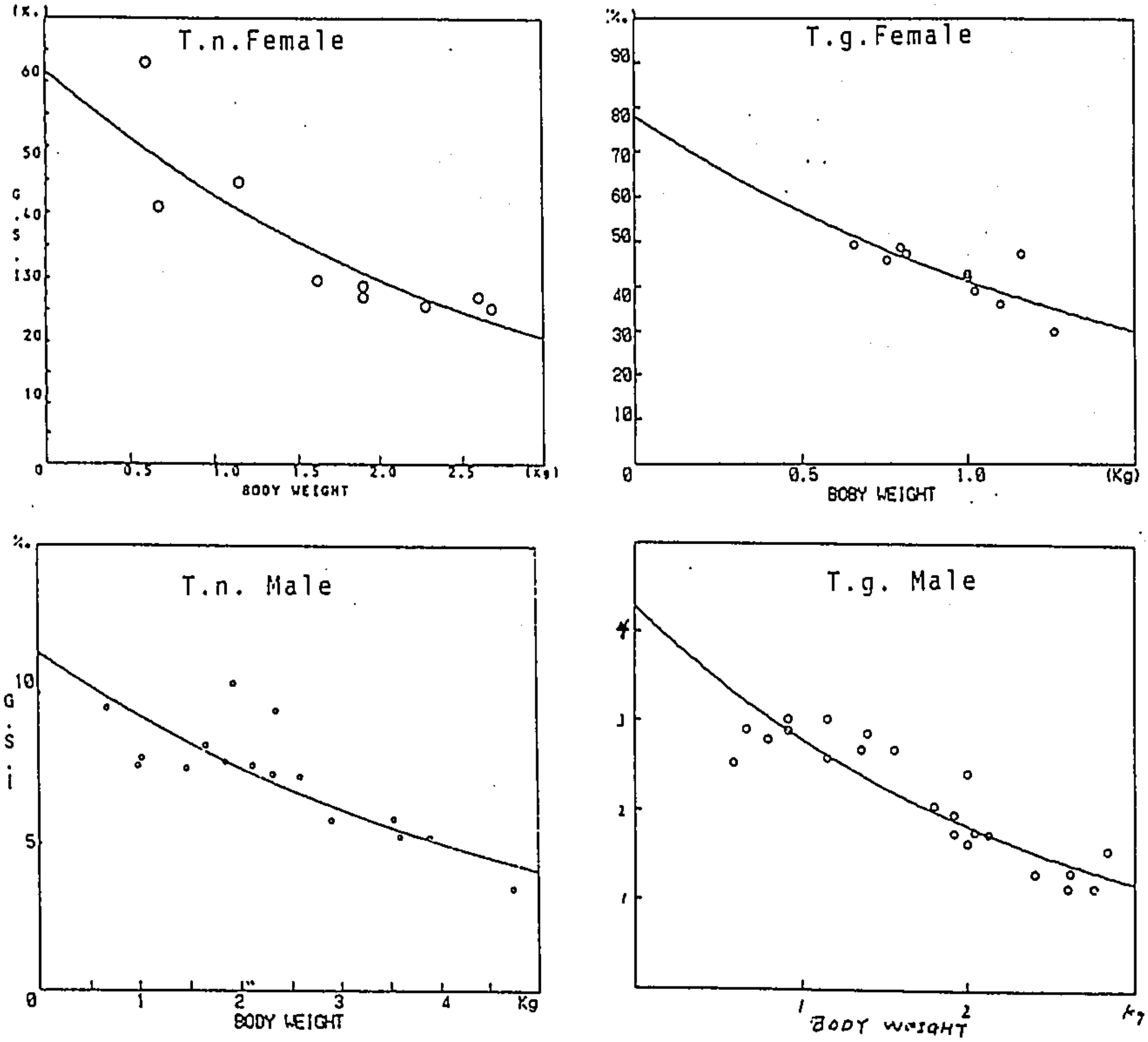


Figure 15. Relation between G.s.I. and fish body weight

Table 16. Values of constants a and b in relation Eq. (7) between (G.S.I.) at full maturity (Gmax) and fish body weight ω

Species	Sex	a	b
T.nilotica	female	61.7	0.366
	male	11.4	0.205
T.galilaea	female	78.0	0.645
	male	4.28	0.854

using the already obtained values according to Eq. (7), then it becomes like Figure 16. It is not so different from the month elapse variation of G.S.I. surveyed in paragraph a) (Figure 13-a and b) but now it has become somewhat clearer. The spawning period can be estimated as follows for each *tilapia* species according to these figures.

Tilapia nilotica : Main spawning season is March/April and secondary spawning season is in August/September so there are two peak spawning seasons.

Tilapia galilaea: Main spawning season is April/May, about a month later than *Tilapia nilotica,* and the secondary spawning season is estimated to be about September/October.

And of both of these species there are fish that continue spawning the year round and whose spawning season is not confined to a limited period during the year.

(3) The fishery status as obtained from the camp survey

The fishermen's camp survey is important understand the actual fishery situation on this lake, and it is also important for FMC researchers to learn through direct contact with fishermen, because they can learn the nature of the fishery industry and the problem points associated with actual fishery work. This survey, which has continued since FMC's establishment, has been carried out by questioning the fishermen and has contributed to FMC and its activities.

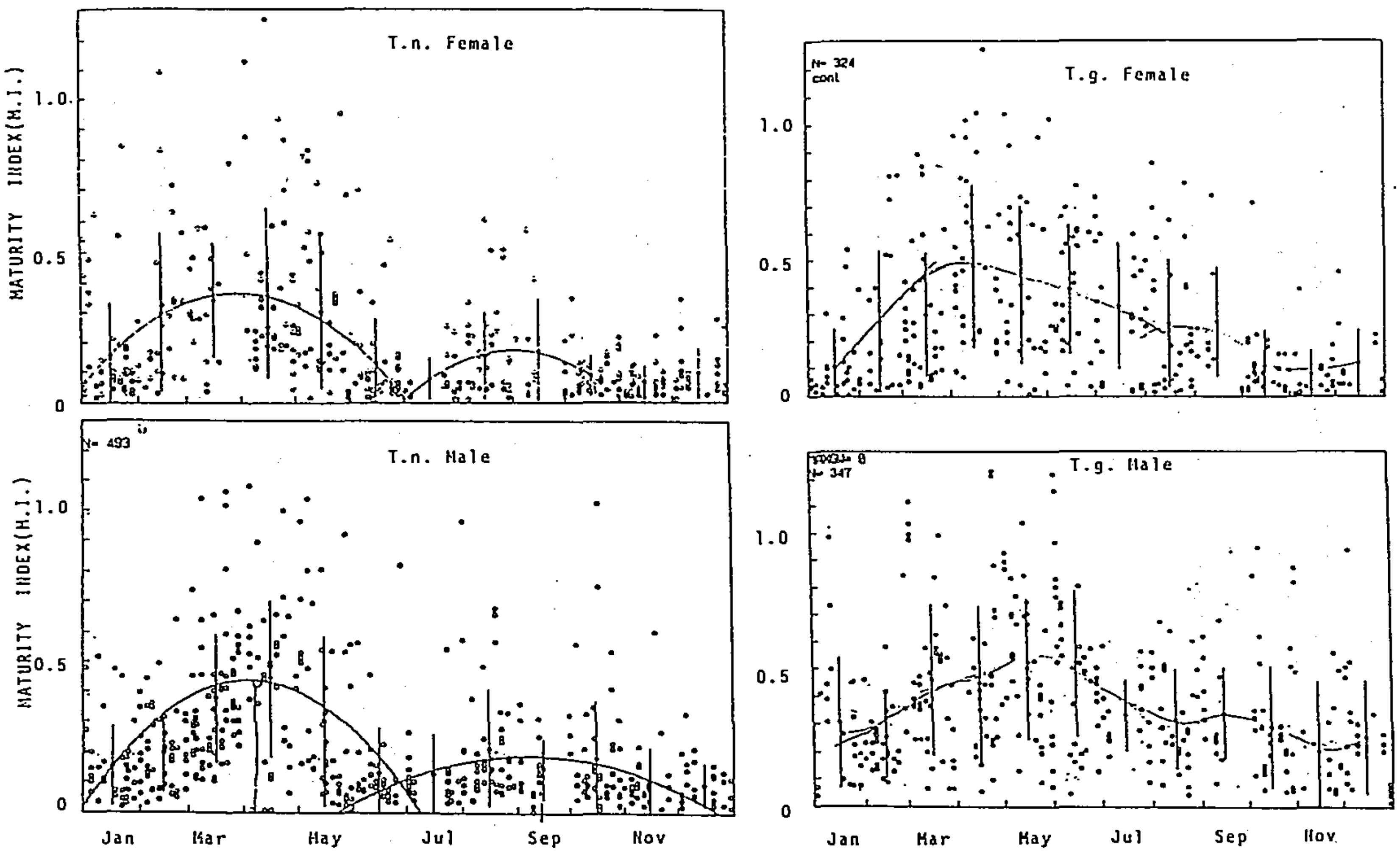


Figure 16. Estimation of spawning time of Tilapia by maturity index.

a) Number of fishermen's camps, number of fishermen, and number of boats

Each base camp survey was done twice in 1983 and 1987 (Figure 17) when personnel going round to the respective base camps did a question survey of the fishermen of several camps. About a year was required for a complete tour around the whole lake. Table 17 shows the number of camps, number of fishermen, and number of boats of each fishing ground.

It can be seen from this that the number of fishermen and, boats, etc., did not vary much in the 4 year period of 1983 through 1987. One characteristic is that the number of camps increased remarkably in the southern fishing ground. It could be that camp transfers were promoted by FMC to fishermen which advice pointed out that there was yet room for fishery development in the southern area as described earlier. Another characteristic is that the number of fishermen

Table 17. Number of the fishermen's camps, number of fishermen, and number of boats as classified by fishing grounds (1983, 1987)

Stn	Fishing: ground	Year	No. of camps	No. of fishermen	No. of boats	F. men/tamp	F. men/boat
I	Ramla	1983 1987	39 (31)	381 236)	211 (126)	9.77 7.61	1.81 1.87
II	Kalabsha	1983 1987	79 (43)	758 (470)	434 (260)	9.59 7.46	1.75 1.81
III	Allaqui	1983 1987	81 146	730 984	317 428	9.01 6.74	2.30 2.06
IV	Korosko	1983 1987	44 89	570 562	216 191	12.95 6.31	2.63 2.94
V	Tushka	1983 1987	47 112	643 732	182 257	13.68 6.54	3.53 2.83
VI	Abusimbel	1983 1987	11 33	87 157	28 63	7.91 4.76	3.11 2.49
	Total	1983 1987	301 474	3159 3141	1388 1379	10.50 6.63	2.28 2.27

Remark: Values in parentheses are estimates

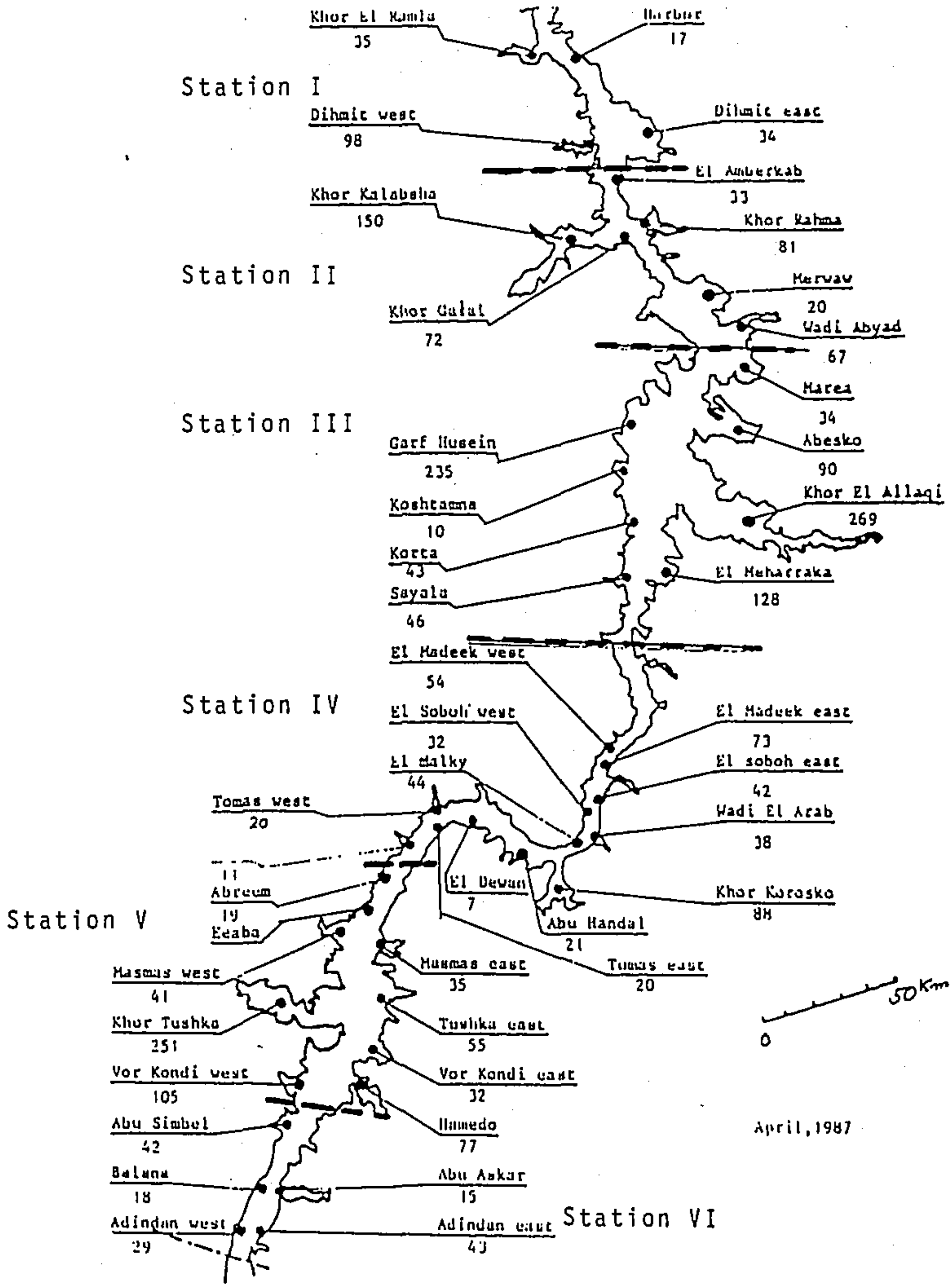


Figure 17. Name of fishermen camps and numbers of fishermen (1987).

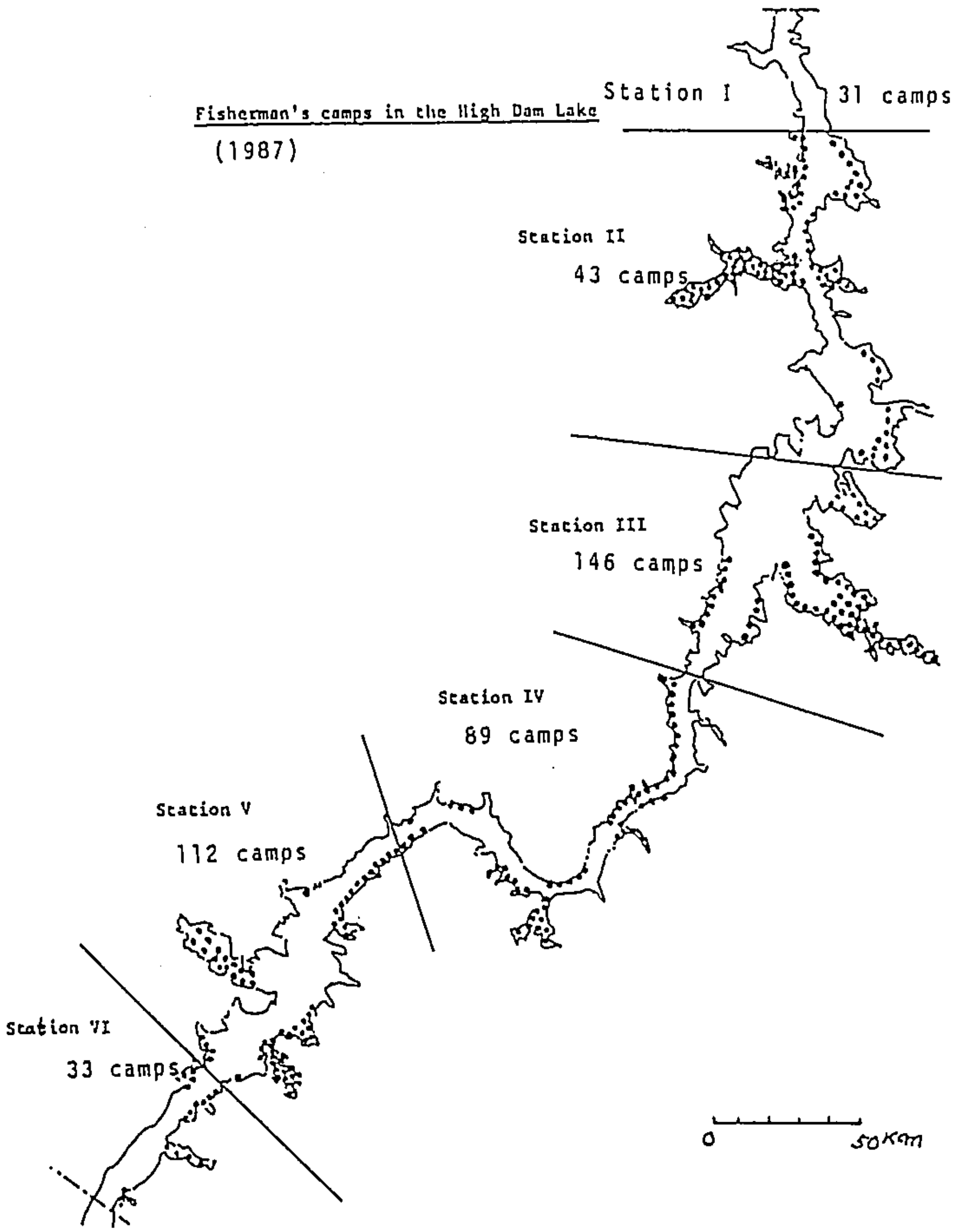


Figure 18. Location and number of fishermen camps (1987).

per fishing boat is decreasing in the southern area. This trend shows on improvement in the fishermen's degree of fishery technique maturity.

b) Fishing gear structure, fishing-boat structure, and fishing operation status

The fishing gear types and structures and fishing boat structures are described in Table 18 as classified into the northern part of the lake and the southern part of the lake. In contrast to the northern area using only trammel nets, the southern area uses bottom gill nets at the same time and is characterized by large net breadth. As for the fishing boats, narrow fishing boats are used in the northern area, but in the southern area, large fishing boats of a breadth about twice as great as the narrow boats are used.

Table 18. The fishing gear and fishing boats used in the lake's northern area and the lake's southern area (1983)

Division	Northern part		Southarn part	
Range	From Dihmit to Khor El-Allaqi		From Khor El-Allaqi to Khor Adindan	
Fishing net 1. Type	Tranrael net only		Bottom gill net	Tramnel net
2. Filament	Mono-filament	Multi-filament	Mono-filament only	Multi-filament only
3. Mesh size"	12-18 cm	12-15 cm	18-22 cm	12-15 cm
4. Net depth	1.2-3.0 m	1.2-2.5 m	3.0-7.0 m	2.0-3.0 m
5. Operation 5a. Daytime	Year-round	no operation	Year-round	no operation
5b. Night • Moon-ligh**	Year-round	no operation	Year-round	no operation
• Dark***	Nov.-May	June-Oct.	Nov.-May	June-Oct.
Size of fishing boat	6.5 m L x 1.2 m W		5.5 m L x 2.2 m W	

c) The work operation situation and fish catch status according to the fishermen's reports

The number of work operation days, etc., is different according to the number of cruises of the fish catch carrier boat, except for the northern area, St.I, where they transfer the catch by their own boats. These can also be estimated from the number of carrier boat trips. And as for the catch (CPUE), about 3 times the catch of other months is taken in the spawning period March - May in all of the fishing areas. It can be understood that an increase in the fish catch is striven for in other months than this peak fishing period March - May and this may be increasing the work operation intensity Table 19).

Table 19. The number of work operation days and the CPUE (1983)

		Northern part		Southern part		
Item	Season	Stn. II (Kalabsha)	Stn. III (Allaqui)	Stn. IV (Korosko)	Stn. V (Tushka)	Stn. VI (AbuSimbel)
No. of camp		95	65	58	68	16
No. of unit gillnet per operation		15	15	10	10	10
No. of operation per day	ordinary	11	11	11	11	11
	spawning	6	6	6	6	6
	mean	14	14	14	14	14
Monthly operating days	ordinary	23	10	10	10	10
	spawning	23	10	10	10	10
CPUE (catch/net) (kg/net)	ordinary	0.95	3.70	5.05	7.35	-
	spawning	3.23	11.07	15.21	20.37	-

Table 20 shows more detailed data from the collected materials in 1987. Comparing this with the data from 4 years ago, it can be seen that the number of work operations a day was increasing but the number of work operation days a month was decreasing. These coincide with the fishermen's report that the number of carrier boat cruises decreased recently. And as for reasons that the catch is decreasing; firstly, the lower water level was mentioned and the resultant narrowing of the fishing ground, and secondly, overfishing is mentioned. But it is very interesting that the fishermen at Korosko/Abusimbel are not cited.

Table 20. The results of investigations conducted at the fishermen's camps (1982)

Item \ Fishing ground	Allaqui	Korosko	Tushka	Abusimbel
No. of operation/day	12	15	15	15
No. of fishing day/month	13.5	15	15	12
No. of net/operation	6	5	11	7
No. of floating gillnet per operaton	34	48	50	43
Spawning season of Tilapia	Apr-May	=	=	=
Spawning season of Tiger fish(salted fish)	Jun-Jul	=	=	=
Catch/day in spawning season	100kg	-	-	-
Catch/day in other season	55kg	52.5	55	40
Catch/night of salted fish	1/4can	-	-	-
Cost of t. and gill nets	57.5L£	200	113	53
Durability of boat	3years	4	5	8
Yearly income of fisherman	1250L£	800	800	600
No. of floats/net	50	50	60	50
Weight of sinker/net	6.6kg	30	18	13
Cause of decrease of catch by fishermen's opinions.	water level	=	=	=
	overfish -ing	x	=	x

(4) Research of resource amount by fish finder

A direct method of resource quantity measurement has been done by examining the intensity of echos and the number and size of the images on a fish finder record. At FMC this method has also been used since its establishment. When the periodic survey on the lake is performed once a month by FMC, taking 6 preset fixed points (buoys were set in 1981) as reference points, measurement is done with the boat running in a straight line slowly for 10 minutes. If the boat speed is low and record paper drift speed is set to maximum, records are obtained for each individual type of fish. The fish density D is calculated by the following equation after counting the record images.

$$D = n / (V \times 10 \times 60 \times 100) \cdot 1/\text{km} \qquad (8)$$

where V is boat speed (cm/sec) and N is the number of recorded fish images. Table 21 shows the 1982 results obtained in this way. This kind of survey has not been continuous for the reasons of the decrease in lake water level, the shift of fixed observation points, fish finder trouble, etc. However, resource density measurement has occasionally been done by the same method using a small type fish finder at fish catch test time.

(5) The water level and its variation, and other problems that influence the lake's fishery

High Dam Lake's dam has been designed so that the highest water level in the lake will be 180 m above sea level. But because of drought in the upstream region of the Nile River since the latter half of 1970, the water level gradually decreased from its highest level of 177.49 m in 1978 and was 156 m in 1987. The lake's area changes remarkably even from a slight water level change because

Table 21. Stock density calculation by fish finder (1982)

Month	Stn. I	Stn. II	Stn. III	Stn. IV	Stn. V	Stn. VI	Total	Mean/km
Jan. 1982								
Feb. 1982	4.44	5.64	48.02	18.88	1.11	6.66	84.75	14.12
Mar. 1982	0	11.86	15.60	26.11	6.66	14.49	74.72	12.45
Apr. 1982	1.66	50.00	14.12	161.10	7.22	6.13	240.23	40.03
May 1982	1.68	123.04	57.20	4.40	30.20	9.09	225.61	37.60
June 1982	2.73	3.27	24.50	6.83	14.40	83.30	134.03	22.33
July 1982	11.66	161.10	127.70	153.00	39.00	232.24	724.70	120.70
Aug. 1982	55.50	18.00	3.30	16.70	41.80	122.95	258.20	43.03
Sept.1982	2.77	2.20	2.77	3.88	38.88	22.20	72.70	12.10
Oct. 1982	1.10	14.40	41.66	61.10	83.33	122.00	213.79	35.63
Nov. 1982	1.66	2.77	0	86.11	116.66	83.33	290.53	48.42
Dec. 1982	0	2.20	0	22.20	5.00	16.66	46.06	7.67
Mean	8.32	35.86	30.35	50.93	34.93	55.38		35.96

almost the entire shore of lake is of the relatively flat topography. This results in a great change in the fishery operation area and at the same time greatly influences the reproductive mechanism of aquatic animals *(Tilapia species)* living in relatively shallow places of the lakeshore zone.

a) The water level and the lakeshore length

The lake surface area shape continuously changes according to water level variation. This lake's southern area is of mountainous geography and the lake bottom is deep and the shape variation is not so great. The north area is a desertic area with a submerged plain whose size changes greatly according to water level variation. If we measure shoreside distance using a contour map of the lake surface, which was performed before the shutting of Aswan High Dam, in order to obtain relation to water level h (m),

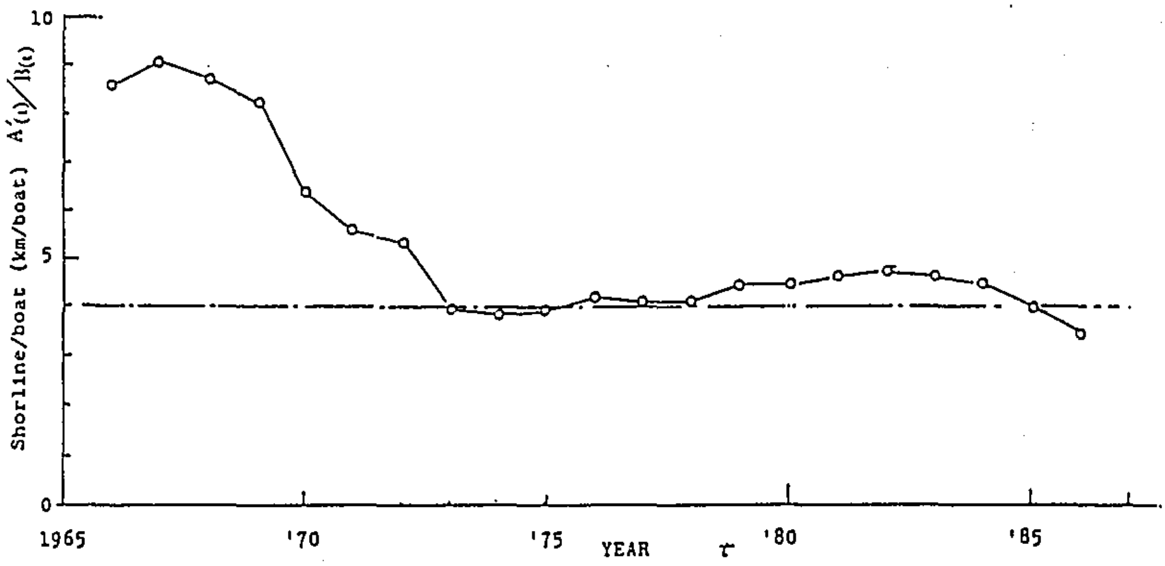
$$A' = 101.2h - 10337.5 \text{ km} \qquad (9)$$

Table 22 shows the lake shoreline length calculation results for each year using this relation. And Table 23 shows the results of water level and lakeshore length distance measurements classified by the fishing grounds and by the east/west lakeshore sides.

b) The fishing ground lakeshore length per fishing boat

Lakeshore length shortens according to Eq. (9) if water level becomes lower. This means a decrease of the fishing ground zone utilized by the fishermen. It becomes as shown in Figure 19 if the fishing ground lakeshore length per fishing boat is calculated taking as the lakeshore length. The fishing ground extent utilized per fishing boat has been stable since 1973 a seen in this figure. Put another way, work operations are considered to be controlled by the decrease in the number of fishing boats in relation to the decrease of the fishing ground resulting from the lower water level. And when the appropriate number of fishing boats for work operation *B(t)* on this lake is set up in the future, it may be calculated as follows:

$$\frac{A'(t)}{B(t)} > 4 \sim 5 \text{ km/ boat} \qquad (10)$$



Yearly change of shorline / boat

Figure 19. Length of fishing ground lakeshore per fishing boat.

c) The resource variation by the fish stock index

Though the absolute quantity of resources may be uncertain, the fish stock index $N'(t)$ in year t as a means to measure relative quantity of stock size would be calculated as follows if CPUE = $\frac{C(t)}{B(t)}$ and lakeshore length distance $\Lambda'(t)$ are known:

$$N'_{(t)} = \frac{C_{(t)}\Lambda'_{(t)}}{B_{(t)}} \qquad (11)$$

where $B(t)$ indicates the number of fishing boats operated in the year and $C(t)$ indicates fish catch. Present resource level can be understood of 1982's level roughly as seen in Figure 20.

Table 22. The water level (m) and the lake shoreline length (km)

t Year	h(t) (m) Lowest level of water	Λ' (t) (km) Length of shoreline
1964	106.0	583.6
1965	115.7	1410.1
1966	119.0	1707.3
1967	133.5	3170.7
1968	145.3	4365.8
1969	150.9	4928.5
1970	153.8	5228.1
1971	159.7	5819.1
1972	162.5	6106.5
1973	158.2	5672.3
1974	161.0	5955.7
1975	165.6	6421.2
1976	172.4	7111.4
1977	171.7	7037.5
1978	172.4	7113.4
1979	173.0	7173.1
1980	171.1	6982.9
1981	171.1	6980.9
1982	170.2	6884.7
1983	165.6	6425.3
1984	163.6	6218.8
1985	156.2	5468.9
1986	(149.0)	4741.3

REMARK; Calculated value by
Eq. $\Lambda'(t) = 101.2h(t)-10337.5$

d) The water level and the fish catch forecast

Tilapia species spawn at the sandy lakeshore and are reared there so securing the sandy ground for spawning is very important from the reproduction standpoint. Now we can assume that the spawning quantity is proportional to the lakeshore length. And also, if the spawning quantity is introduced proportionally, $C(t)$ in the year is considered as a function of $h(t-r)$, the water level, in $(t-r)$ year. Now if the main group of the fish catch is taken as the fish group in the equation, we let $C(t) = f(h(t-r))$. Letting this be represented as

$$c(t) = a \exp [h(t-r)] \qquad (12)$$

Table 23. Lakeshore length distances as classified by the fishing grounds and the shore sides (according to detail map)

Water level	Fishing G. / Shore side	1 Ramla (km)	2 Kalabsha (km)	3 Allaqui (km)	4 Korosko (km)	5 Tushka (km)	6 Abu Simbel (km)	Whole (km)
1 0 6 m	East	23.9	97.1	53.3	90.7	61.0	28.5	354.5
	West	22.2	70.2	46.4	84.0	58.9	33.5	315.3
	Both side	46.1	167.4	99.7	174.6	119.9	62.0	669.8
1 6 0 m	East	118.8	611.8	773.7	690.8	491.4	233.2	2919.7
	West	156.4	852.9	265.8	437.4	638.9	135.7	2487.0
	Both side	275.2	1464.7	1039.5	1128.2	1130.3	368.9	5406.7
1 8 0 m	East	125.4	1075.1	859.8	1802.0	628.0	295.7	4786.0
	West	366.8	1155.2	333.7	483.9	573.3	163.2	3076.2
	Both side	492.2	2230.3	1193.6	2285.9	1201.2	458.9	7862.2

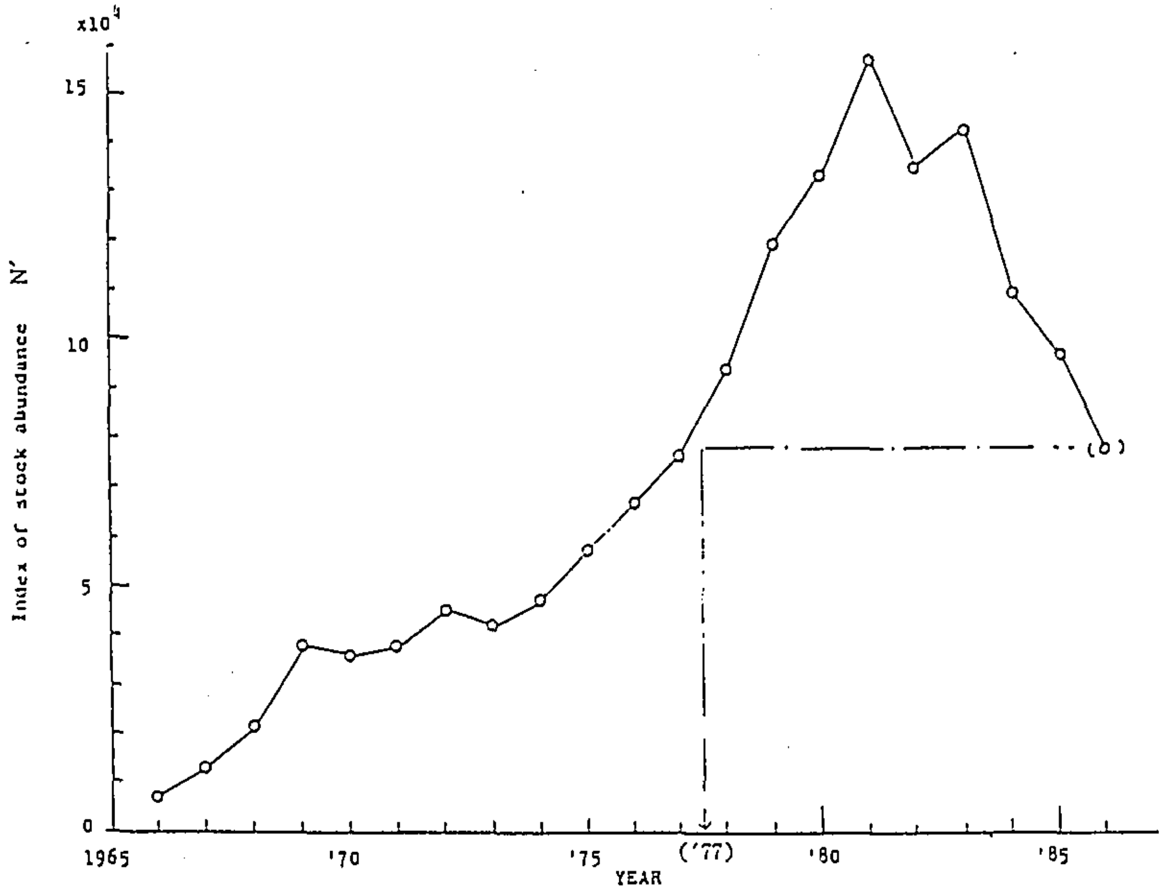


Figure 20. Variation of index of stock abundance.

we may determine r which best fits the above equation by plotting for case r = 1, 2, 3, ... In this case, it becomes

$$c(t) = 0.537 \exp 0.0631\{h(t-2)\} \tag{13}$$

as shown in Figure 21. The yearly fish catch can be estimated by this Eq. (13).

Table 24. Annual catch amount and calculation of CPUE

(t) Year	C(t) (ton) Landings	(B(t)) (nos) Boats	C(t)/B(t) CPUE
1964	–	–	–
1965	–	–	–
1966	761.9	200	3.81
1967	1414.7	350	4.04
1968	2484.5	500	4.97
1969	4676.9	599	7.81
1970	5677.4	816	6.96
1971	6820.2	1039	6.56
1972	8343.8	1135	7.35
1973	10692.5	1440	7.43
1974	12256.7	(1540)"	7.96
1975	14636.0	(1630)"	8.98
1976	15697.0	(1680)"	9.34
1977	18500.0	(1690)"	10.95
1978	22575.0	1700	13.28
1979	27021.4	1613	16.75
1980	30231.6	(1570)"	19.26
1981	34205.6	(1500)"	22.80
1982	28666.7	(1450)"	19.77
1983	31272.2	1388	22.53
1984	24530.9	(1385)"	17.17
1985	24974.6	(1382)"	18.07
1986	(16588.9)"	(1379)"	12.02

Remark " Estimated value

(6) Effect on fishery production of discharging of one million live fish fry

FMC is arranging its fry production and stocking system and promoting its efficiency in consideration of the natural decrease in reproduction owing to the drop in resource level from overcatching and *tilapia* spawning ground loss accompanying the water level decrease.

The fishery resource management section must set up an appropriate policy of its fry production and stocking project estimating the effect of fry discharge by the previous calculation, so estimation was done by the following calculation using the biological parameters of *Tilapia nilotica* (following Table 24) for 2 cases of starting catch ages x_c = 1.5 and 2.0 years old:

$$Y = FRw_{\infty} e^{-M(x_c - x_r)} \int_{x_c}^{x_d} e^{-z(x-x_0)} (1 - e^{-k(x-x_0)})^3 dx \quad (14)$$

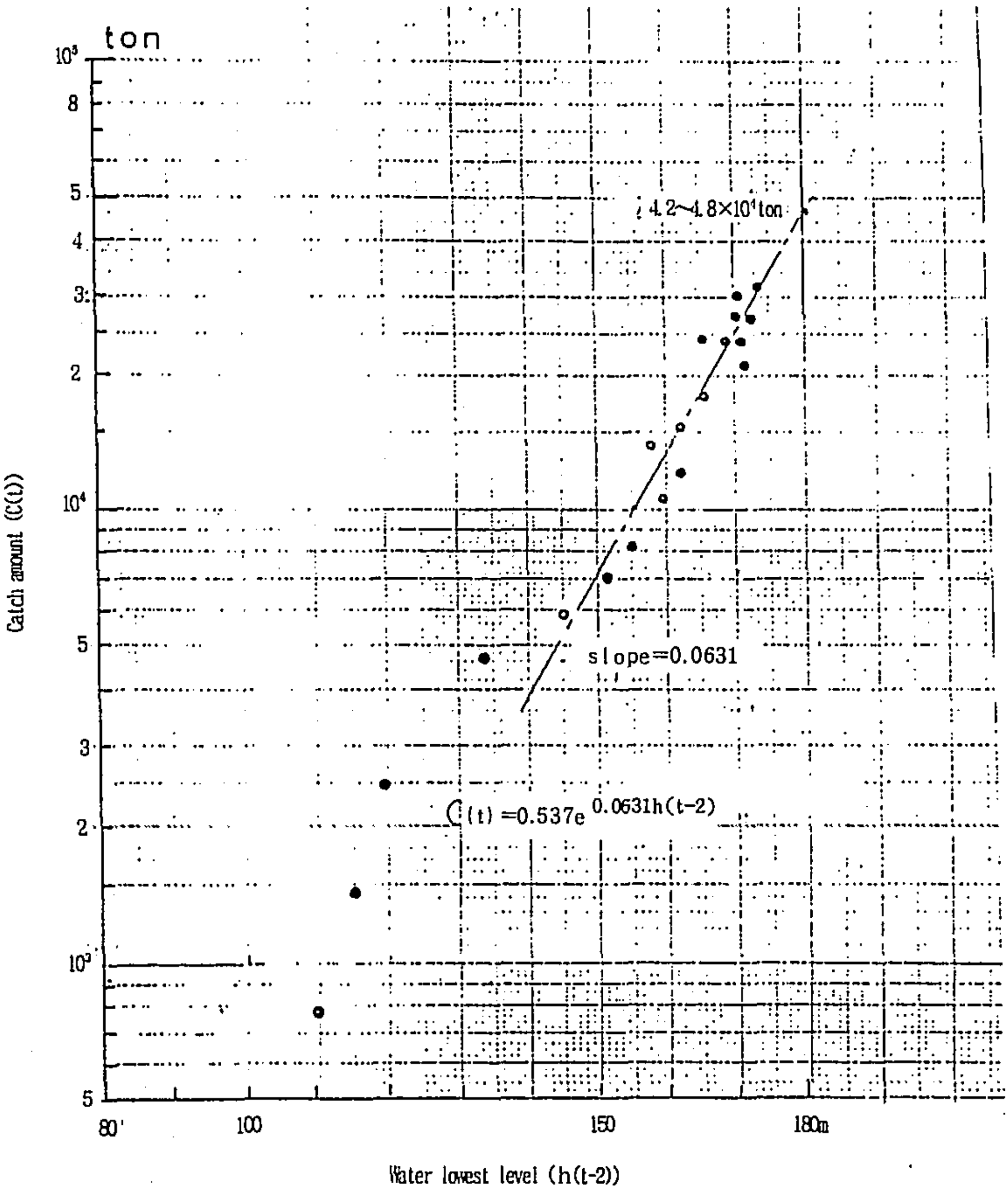


Figure 21. Water level and fish catch amount

Table 25. The biological parameters of 2 spp. of *Tilapia*

Species	Limited body length (cm)	Growth coeffi- cient ($year^{-1}$)	Corrected value of age ($year^{-1}$)	Limited body weight (kg)	Life span (year)	Allometry Parameter	
	l_∞	k	x_0	w_∞	λ	a	n
T. nilotica							
F	43.0	0.38	-0.02	6.56	7+1	0.083	3
M	51.0	0.25	-0.11	11.40	8+1	0.083	3
Mean	47.3	0.31	-0.06	8.78	9	0.083	3
T. galilaea							
F	41.1	0.27	-0.05	5.76	6+1	0.083	3
M	38.5	0.31	0.12	4.74	6+1	0.083	3
Mean	39.8	0.29	0.09	5.23	7	0.083	3

Growth Eq. $l(x) = l_\infty(1-e^{-x(x-xo)})$, l(x): Body length (cm), x: age

$w(x) = w_\infty(1-e^{-x(th)})^3$, w(x): Body weight (kg), x: age

Allometry Eq. ... $w(x) = a(l(x))^n$

where R is the fry discharge number. According to this calculation it is understood that the maximum fish catch when the starting catch age is 2 years old is 970 t and the maximum when the age is 1.5 years old is 850 t so that the fish catch decreases to 87% owing to the half year difference. The starting catch age is understood to considerably influence the fish catch and the fishery industry's performance.

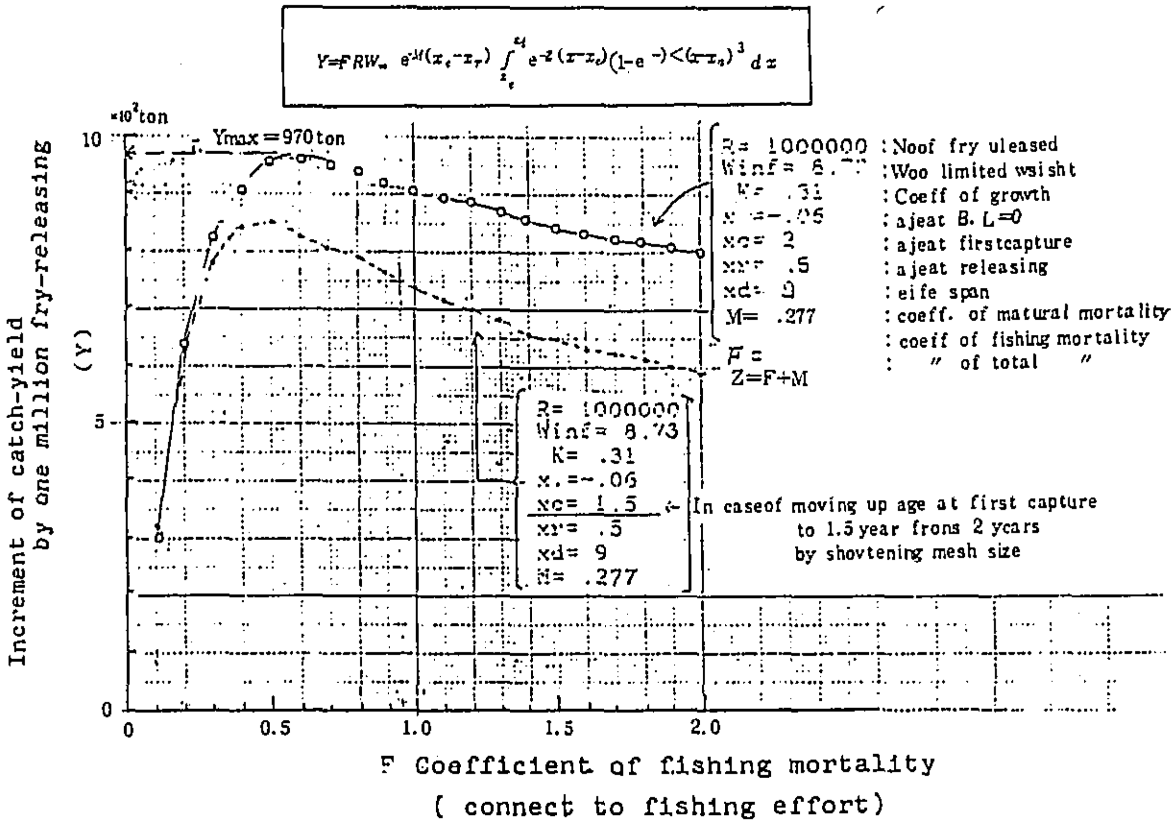


Figure 22. Relation between increment of catch yield and coefficient of fishing mortality.

(7) Selectivity of the fish catch by the trammel net

The main fishing net used in the High Dam Lake fishery had been the trammel net in the past. Nowadays, however, a one sheet net also can be used due to the propagation of the mono-filament net. A material test on the meshes of the two kinds of net has been conducted. As for the multi-filament net, the meshes of the inner net are of 3 sizes, namely, 7.5 cm, 12.0 cm and 16.5 cm (outer net has 39.0 cm mesh). As for the mono-filament net, there are also 3 sizes of inner net meshes, 8.0 cm, 12.0 cm and 18.0 cm (the outer net is of 36.5 cm meshes). In 1982, the fish catch test was conducted using the testing nets. During the period of 1983 to 1985, test fishing operations were conducted for 73 days. A selectivity curve-line by net and by mesh has been obtained with the fish catch consisting of *Tilapia nilotica* and *Tilapia galilaea*.

For the protection of resources since January 1988, the use of 12 cm or larger meshes is being regulated in Kalabusha Bay and its vicinity where there was a tendency to use finer mesh nets. The High Dam Lake Development Authority is in charge of enforcement and the results of the net mesh test conducted by The Fishery Management Center (FMC) and about the recommendations of the specialists concerned in 1984 have brought about the enforcement of such regulations. The FMC has estimated a reduced fish catch if the net mesh size is enlarged to 12.0 cm and it has estimated the length of the target fish of the fish catch in the fishing zone. The FMC has provided the basic data for the regulations regarding net meshes. However, *Tilapia nilotica* and *Tilapia galilaea* are included in the data and the two are different in body shape.

Continuous guidance will be provided for further testing on the net meshes to recalculate the data by type of fish. (See Recommendation No. 1)

(8) Miscellaneous

a) Protection of spoiled fish

This matter has been touched on somewhat by the recommendation of the specialists concerned in 1984, and 20% of the fish becoming spoiled is the result calculated from the data of the actual status survey on the fishery industry. In addition, 10% or so of value being lost is shown according to the results of the further survey over the wider lake.

The fish spoiled is a total of that lost in the fishing camp plus the quantity ordered discarded by the HDLDA inspector when unloading takes place in the fishing port. The quantity discarded in the fishing port is accurate, while the quantity lost at the fishing camps, the data of which is gathered from the recollections of fishermen, is hardly to be considered accurate.

The High Dam Lake Development Authority (HDLDA) is studying in detail how to reduce the amount of fish discarded. For example, ice is being supplied from an ice-making vessel which is anchored in the center of the lake. The discarding of fish is contributed to by the method of carrying the fish catch by powered vessel from the fishermen's camp to the carrier boat, rather than have the carrier ship directly collect the fish catch.

The specialists recommended the water-ice method which is used in Japan. However, it has not been implemented yet. The temperature of the fish hold of a middle-sized carrier boat was 10°C to 15°C.

b) Consolidated actual survey of the fishery resource environment

A joint survey by the staffs of the Fishery Resources Dept. and the Environment Dept. was conducted since the summer of 1987 with the purpose of deepening the understanding and interest of the researchers regarding the fishery industry in this lake through direct dialogue between FMC researchers and fishermen. The surveyed items ranged from the age composition of fishermen, the number of years employed, the fish catch, and utilization of the fishing zone, to an environmental survey of the fishing operations.

The results of the survey are shown in Tables 26 and 27, and Figure 23.

Table 26. The age composition of fishermen and their employment status

Survey of Fishermen

Date of survey	Fishing ground	Name of fishing boat	Fishermen No. of crew	1		2		3		4		5	
				Age	year worked	Age	Y.W	Age	Y.W	Age	Y.W	Age	Y.W
19/Aug/'87	Tushka	A	4	27	14	24	12	24	12	19	2		
19/Aug/'87	Tushka	B	5	27	17	23	9	21	11	19	9	17	6
19/Aug/'87	Tushka	C	5	37	9	30	14	28	7	23	4	18	3
20/Aug/'87	Tushka	D	4	16	1	17	7	19	1	60	40		
20/Aug/'87	Tushka	E	4	30	21	17	1	21	7	47	40		
20/Aug/'87	Tushka	F	3	20	3	20	4	14	2				
23/Aug/'87	Gazal	G	2	26	14	18	3						
23/Aug/'87	Gazal	H	3	30	20	22	10	17	2				
23/Aug/'87	Kalabsha	I	2	33	17	17	3						
24/Aug/'87	Kalabsha	J	2	53	14	25	10						
24/Aug/'87	Kalabsha	K	2	27	10	26	3						
24/Aug/'87	Kalabsha	L	2	33	17	17	3						

Table 27. The results of the fishing gear survey

Name of boat	No. of net per operate	Net					
		Stracture of net	Length (m)	Depth (m)	Mesh size (cm) in	Mesh size (cm) out	Kind of net thread
A	5	Single	—	—	—	—	Mono
B	10	Single	30	2.5	12	—	Mono
C	6	Single	15	2	15	—	Mono
D	3	Single	30	3	12	—	Mono
E	5	Single	20	2.5	15	—	Mono
F	4	Single	15	2	12	—	Mono
G	5	Trammel	20	1.25	11.3	32	Mono
H	5	Trammel	25	1.5	8	30	Mono
I	5	Trammel	25	1.5	11.5	30	Mono
J	4	Trammel	—	—	—	—	Mono
K	5	Trammel	25	1.5	12	30	Mono
L	5	Trammel	20	1.2	11.5	30	Mono

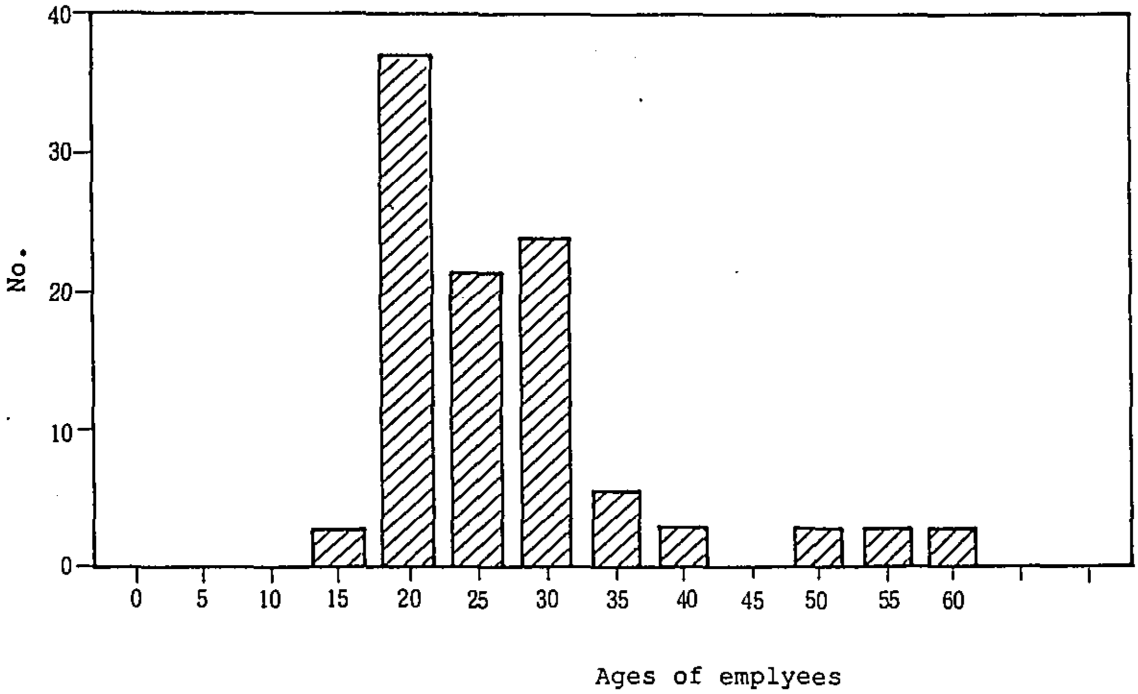


Figure 23. The age composition of employees ages of employees.

Further, in the survey, the initial survey on the ages when employed disclosed the fact that most fishermen were employed when they were 6 - 15 years old. This characterizes the fishery industry of this lake. Also, it is understood that the number of working years ranges from 10 to 15 years which is a considerably long period. The survey of the environment and the fishing operations are omitted.

So far, the performance obtained through paragraph (1) to (8) has been described. The surveyors generally understood the contents of each paragraph and the results calculated by the surveyors are shown through tables in many cases.

Although they are not sufficient, the surveyors are improving and they are able to make a test plan and to analyze the results of the survey, etc.

3. Department of Environment

1) Physical environment

(1) Counterparts

a) Ahmed Abdel Rahman
Graduated from Aswan School of Ashoot University

b) Olfat Anwar Habib
Graduated from Ashoot University

c) Rokaya Hussein Goma
Graduated from Department of Oceanography, Alexandria University

(2) Recommendations

The basic conception of the relationship of the fishery with the environment and the hydrosphere has been explained, and the following are recommended: Concentrate the science and technology existing in the country for its effective utilization in the study of fish resources and the environment, the basic idea is that we should not force the use of technology which is not suitable to the actual situation and to suspend the expansion of unregulated operations and of the fishery production scale. Advice has also been given regarding the following items.

a) On the influence of the environment on the biological processes of fish and on the ecosystem of the lake, its importance and on its relationship with FMC's duties.

b) The survey method of each environmental factor.

c) Installing and handling method of instruments for surveys.

d) Processing method for survey data.

e) Computer programming

f) Processing method for data by personal computer

g) The basic analyzing method for data and materials

h) Temporal and spacial scale of environmental changes

i) Time series analyses of environmental phenomena

j) The periodic analyses of environmental phenomena

k) The relationship between stability of environment and living things

l) The relationship between the environmental change and fish resource change

m) Forecasting the environment and fishing conditions

n) Summarizing method of analyzed results

o) The method of preparing reports and scientific papers

p) Operation, maintenance and check of the research boats

q) The consolidated survey and research methods for fish resources and environment

r) The consolidated survey for fish resources and environment in Wadi Kalabusha

(3) Recommendations submitted

a) On the change of the routine survey on the lake. Kohei Kihara and Masaru Maeda, January, 1985

b) On the holding of the staff meeting and data collection from the institutes concerned. Kohei Kihara, May 19, 1986 (Reference data No. 8)

c) On the collection of the atmospheric data and the request to cooperate in data collection with the fishing boats. Kohei Kihara, January 12, 1987 (Reference data No. 9)

d) On regular checks and maintenance for their research boats. Kohei Kihara, September 17, 1987 (Reference data No. 10)

e) On the employment of researchers and assistants of the Environment Department. Kohei Kihara, July, 1988

f) On the purchase of books and publications. Kohei Kihara, August, 1988

(4) Outcome

General work

a) Observation

The staffs have become able to independently perform surveys utilizing the small-sized research boats in the central and the coastal areas in order to grasp the physical environment of the lake. In particular, they have become able to do the following tasks by themselves: drafting a voyage plan prior to the survey, preparation of reagent and surveying instruments, the preparation of fuel and provisions for the boats, installing the survey instruments on board, surveying item by item at the observation station, and treating and analyzing the samples collected on board. The crews and staff members of the boats have become able to carry out the following: namely, the operation of the ship up to the correct location, maintenance and installation of the survey instruments loaded on the survey vessels and the proper operation of the surveying winch, etc.

b) Data analyses

Researchers have become able to conduct such basic tasks as the necessary revision of the data collected in the routine survey, preparing a data basis using the personal computers. Also, based on the outcome of the surveys, they have become able to do the basic analysis and study on the physical environment of the lake.

Results

a) Water temperature

The routine survey has been conducted in the middle of every month since January 1982 at 6 fixed survey stations installed in the lake from Aswan to Abu Simbel.

The location of each survey station is shown in Figure 24. The seasonal changes between the northernmost survey station (Station 1) and the southernmost survey station in Abu Simbel (Station 6) shall be compared to grasp the character of the change of the water temperature in High Dam Lake in 1986 (Figures 25 and 26). The vertical structure of the water temperature at Station 1 in the vicinity of Aswan in both winter and summer is as shown in Figure 2. The lowest water temperature in the layer 5 m deep or more is in February and the temperature is 17.5°C. The lowest water temperature at the surface which is most affected by solar radiation in January is 17.2°C. The water temperature rises according to the rise of the air temperature in February.

The thermocline begins to be formed in April. The temperature difference between the surface and the 60 m layer reaches 10.1°C in August. The highest water temperatures were observed from the surface to the 10 m layer in August, to the 15 - 20 m layer in September, to the 30 - 40 m layer in October and 50 m or deeper in

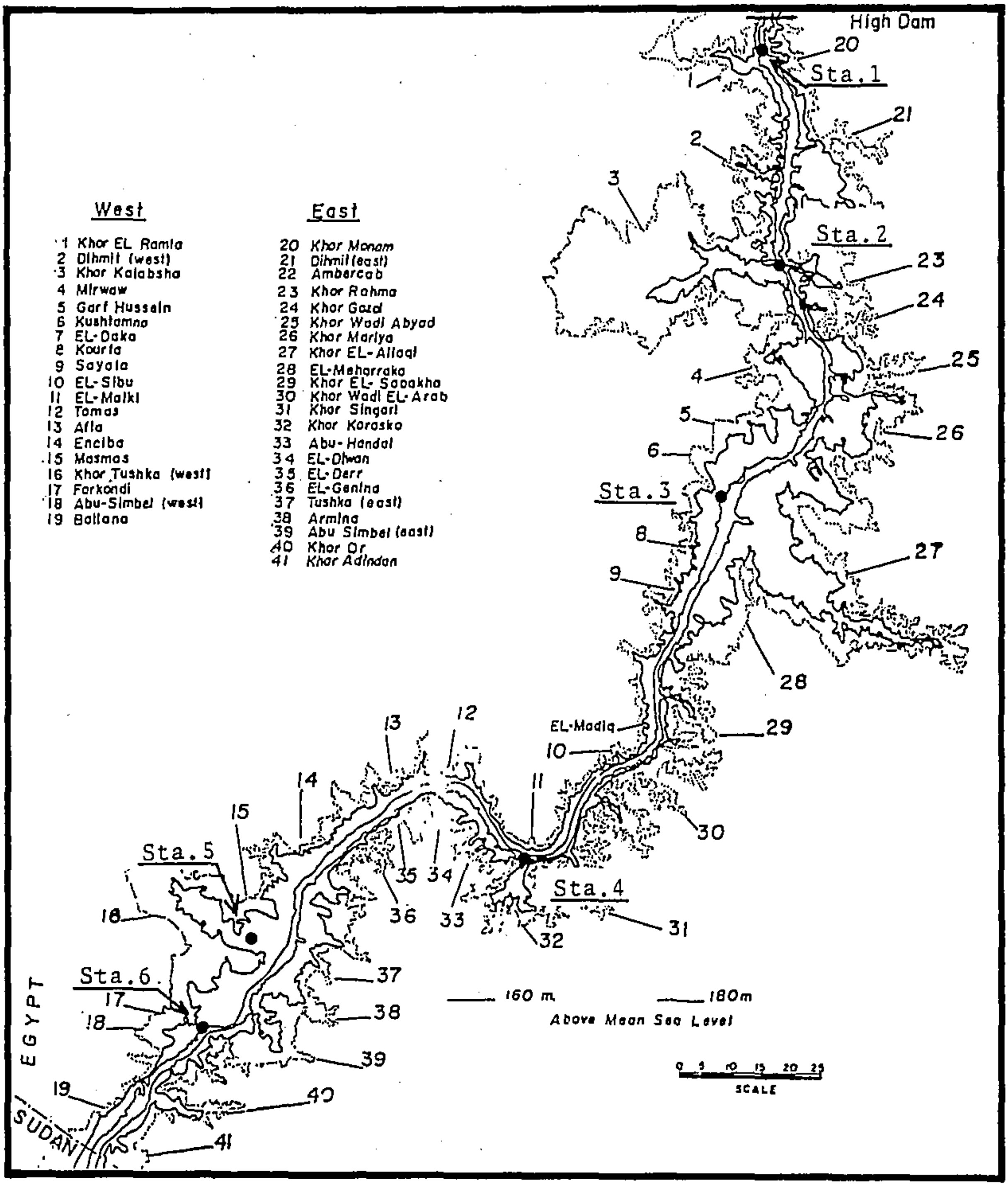


Figure 24. Stations of environmental survey in the High Dam Lake.

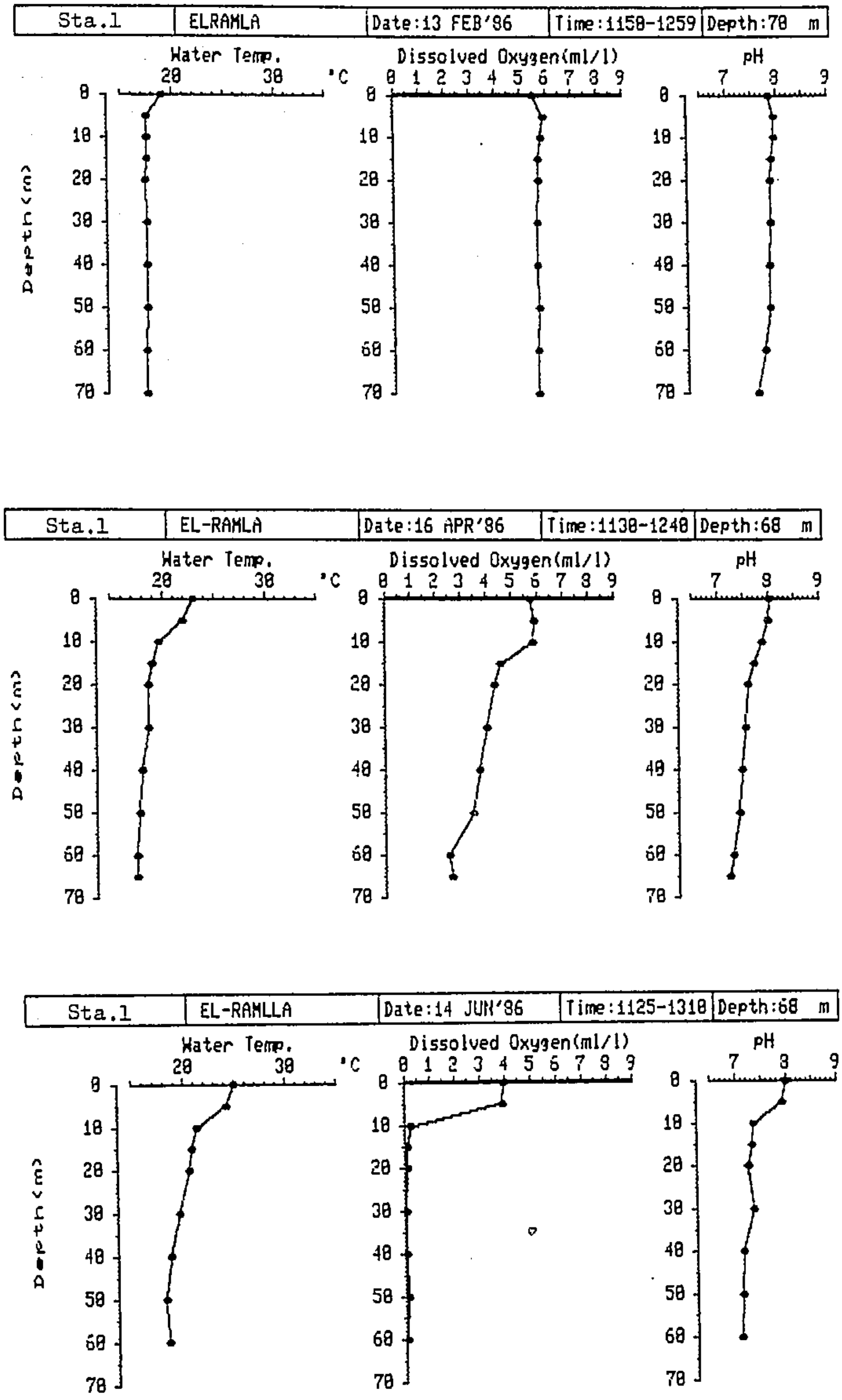


Figure 25. Vertical distribution of water temperature, DO, and pH on February, April, June, August, October, and December of 1986 at Sta.1 in High Dam Lake.

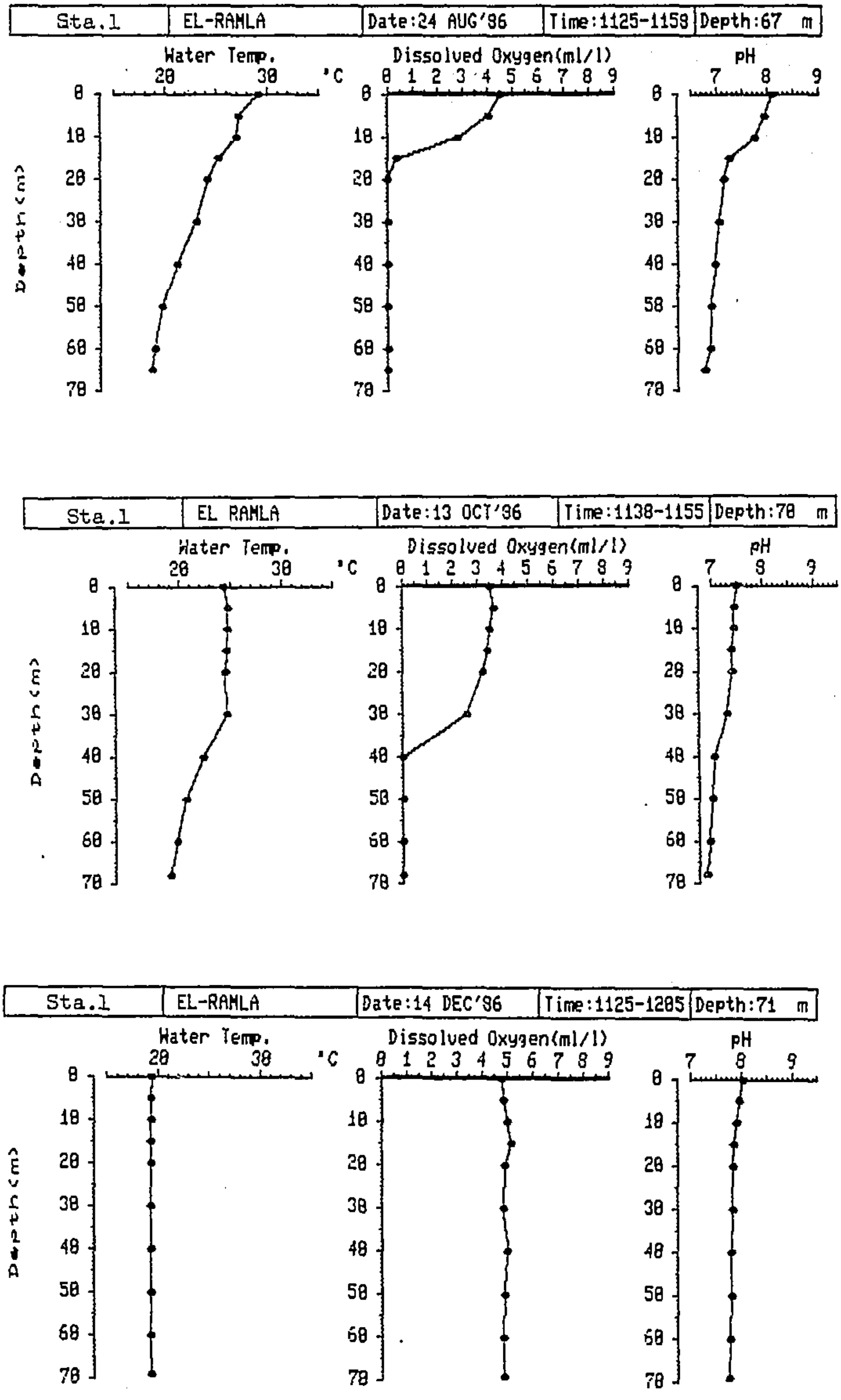


Figure 25. (Continuation)

November. The vertical structure of water temperatures in both winter and summer at Station 6 in Abu Simbel is as shown in Figure 26. The lowest water temperature at the 5 m layer or deeper is in February, the same as in Aswan, and the lowest water temperature is 17.5°C. The lowest temperature at the surface is 16.9°C in February. The lowest one at the 40 m layer is in March. Thereafter, the water temperature rises according to increase of solar radiation and the thermocline begins to be formed in March. Four months later, in July, the temperature difference between the surface and the 30 m deep bottom layer is 7.8°C. The maximum temperature difference from Aswan is also in July; the 10 - 15 m layer is 4.0°C, and the 20 m layer 3.9°C. The highest water temperature is in August; the 5 - 20 m layer is 27.3°C and the maximum difference compared to the highest water temperature of Aswan is 3.9°C at the 30 m layer. Comparing the water temperatures of Aswan and Abu Simbel, those of Abu Simbel are higher than Aswan during the period of February through October. However, in winter, November through January, the temperatures of Abu Simbel, being situated approximately 300 km southward from Aswan, are lower than Aswan by 0.3 - 1.3°C. That is because Abu Simbel is situated more upstream than Aswan and Abu Simbel is earlier affected swells of the river beginning from July and the influence of the wind. It is considered essential to study more details in the future. The following facts have been made clear judging from what have been described above. After the water temperature has become the lowest in February in High Dam Lake, during the period from March to April, the convection season begins to switch over, and it becomes a 2 layer structure with

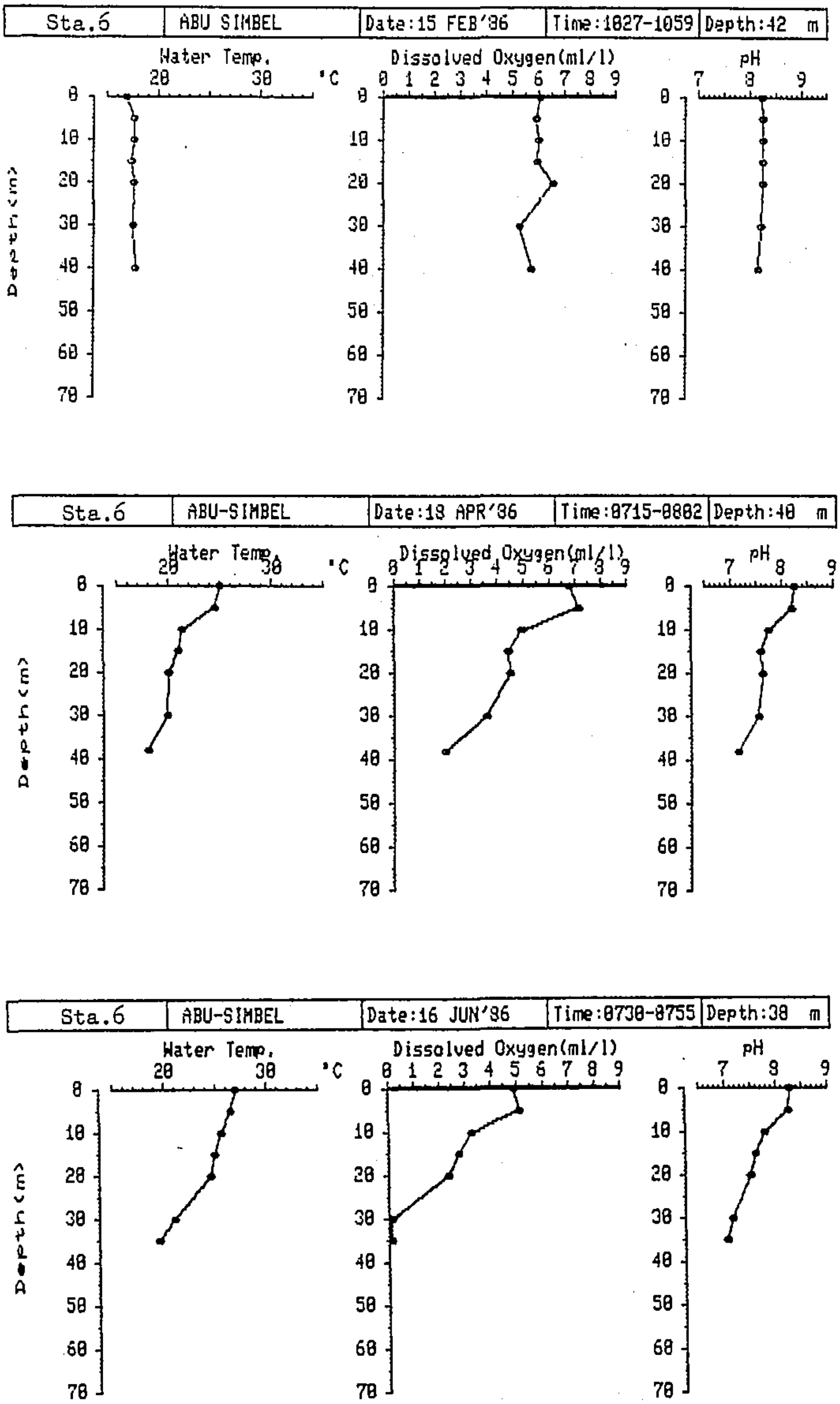


Figure 26. Vertical distribution of water temperature, DO, and pH on February, April, June, August, October, and December of 1986 at Sta. 6 in the High Dam Lake.

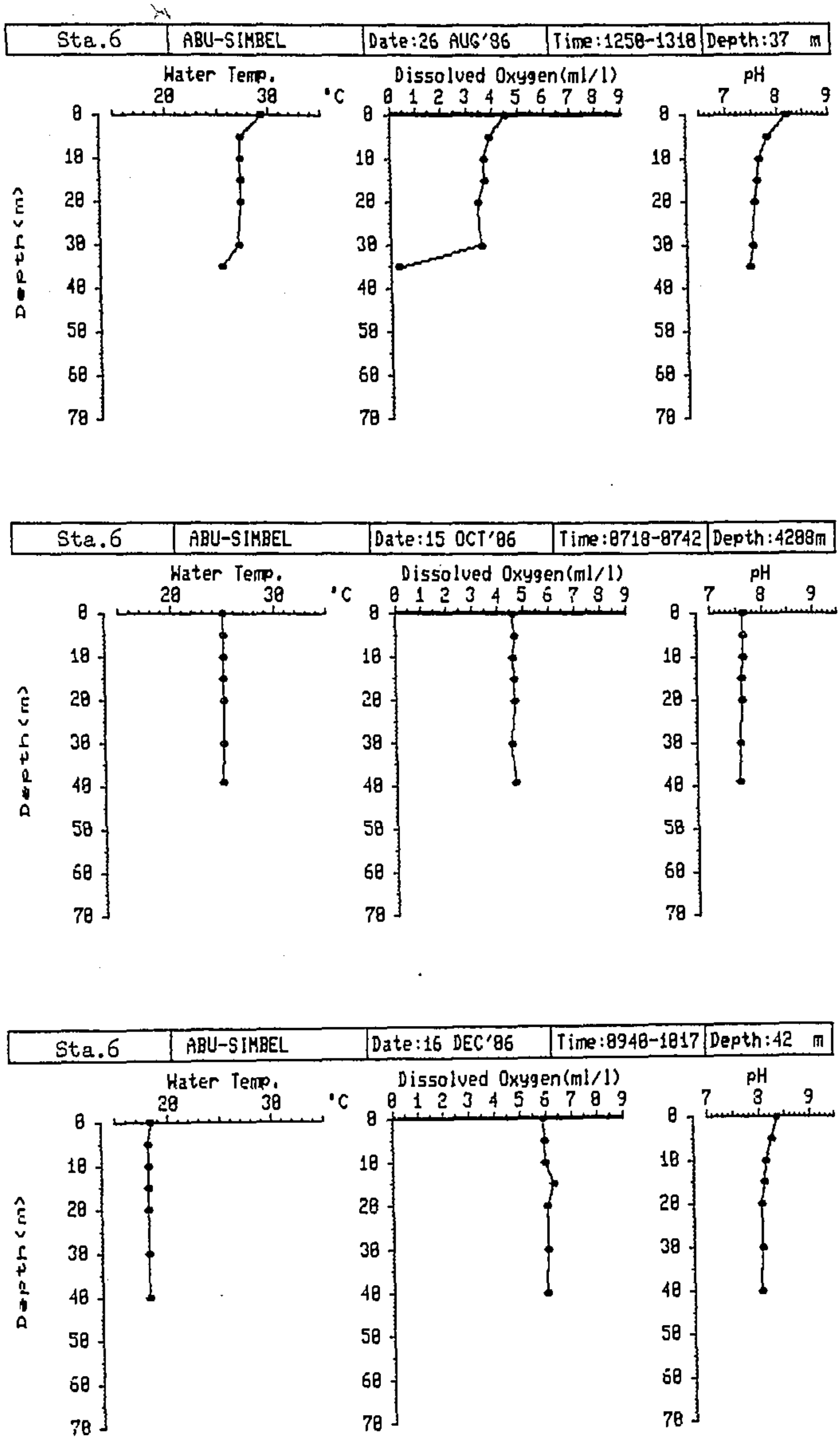


Figure 26. (Continuation)

the 15 m layer as a boundary in July as can be judged from the distribution of oxygen. After the water temperature has reached the maximum high in August, the stratification begins to gradually collapse, the convection begins in September and it completely enters the convection season in December.

b) Water level

Data of the water level of the lake which was collected in Aswan under the cooperation of the High Dam Authority has been analyzed and the following results have been obtained. As the annual change of the water level is shown in Figure 27, after it becomes the lowest in middle of July, it rises rapidly accompanying the flood in the upper stream, and in early November, 4 months later, it reaches the highest level of the year. According to the survey on the long-term change, the water level has become lower every year since 1978, and the lowest water level was 150.62 m on July 19, 1988, which is the lowest water level on record. The difference from the lowest water level in 1978 reaches approximately 22 m (Figure 27).

c) Relation between change of water level and change of fish resources

According to the survey as a part of the fish resources environment survey, *tilapia* spawns in holes which are about 20 cm deep and about 60 cm in diameter in sandy beach areas of the lake at intervals of about 90 cm. Accordingly, if the water level is lowered, the spawning ground is considerably reduced. As mentioned in the paragraph on the water level, the water level had been getting lower since 1978 until 1988 and the annual highest water level has been lower from 178 to 159 m. By the lowering of the water level by 20 m, the shoreline of the lake is reduced from 7,844 km to 5,380 km. If it is assumed that the lake shoreline is approximately equal to the area of spawning ground, the area could be estimated to have been reduced by 31% at least for this 10-year period due to the reduced lake shoreline caused by the lowering of the water level. In like manner, the water volume of the lake was reduced from 132.5 km^3 to 55.6 km^3. This 58% reduction of water volume could be considered as a reduction of environmental capacity of the lake.

Judging from the various above-mentioned facts, it has been made clear that the lowering of the water level has a vitually important influence on the reproduction of the lake's fish resources and that the lower water level is the major cause of the decreased fish catch of the last several years. It is essential that the actual situation be analyzed further along with future data collection.

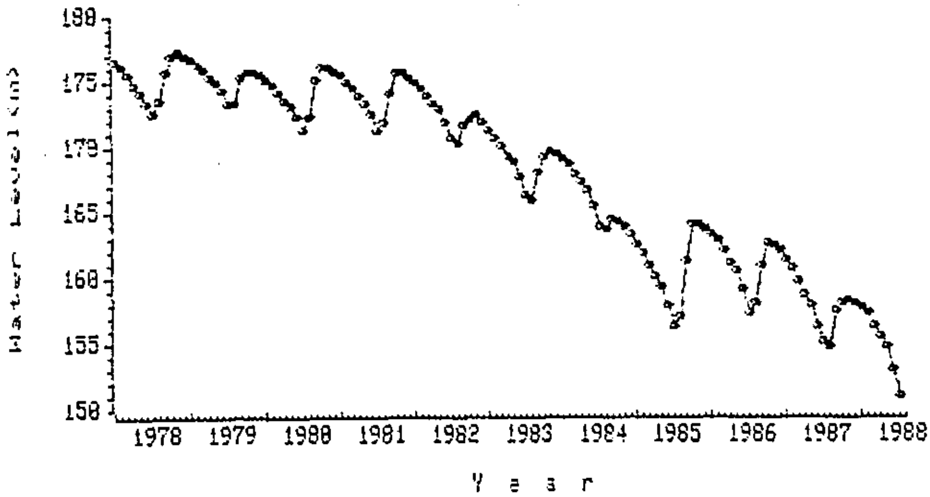


Figure 27. Monthly mean water level in the High Dam Lake.

2) Chemical environment

(1) Counterparts

a) Ahmed Abdel Rahman

Graduated from the Aswan School of Ashoot University

b) Rokaya Hussein Goma

Graduated from Alexandria University

(2) Recommendations

Advice and cooperation concerning the survey and study of the water quality of the lake have been conducted.

a) Time schedule of routine work

Researchers were instructed how to plan an effective time schedule to incorporate various survey items into their routine work. In cooperation with the counterparts and experts of other fields, training periods for survey items and times when the items would be established as routine works were compiled into a 5-year plan.

b) Drafting survey plans

Discussions were conducted on how to draft plans of periodical surveys to reveal the present situation and the direction of change in water quality which are deeply concerned with the productivity of lake organisms. The discussions concentrated mainly on survey areas, locations of observation stations, sampling depths, survey items, technical methods (survey and chemical analyses), etc. Other water quality data (mainy from the survey report by the University of Michigan), the topography of High Dam Lake, equipment and materials possessed by the counterparts and abilities of staff members in charge were also evaluated to make a plan. Finally, a detailed research plan was drafted in cooperation with the counterparts. Concerning the survey items for water quality, some of important ones which could be measured rather easily were incorporated in the routine work from the beginning. The other items which required somewhat technical training would be added to the routine work in the future. The time schedule of the additions was compiled in the 5-year plan.

In January 1985, the data collected by the counterparts in previous years were arranged and analyzed and some parts of the survey plan were modified in cooperation with the counterparts. The points discussed were how precisely the observation stations were reoccupied in the previous surveys, and methods by which the observation vessel could get the stations more precisely.

Afterwards, the necessity of resource surveys in bay areas of the lake was increased, hence, suggestions and guidance for making a suitable survey plan, which could cover many stations within a short period, were given.

c) Practical lake survey

First of all, the importance of proper preparations for survey cruises was emphasized in order to obtain accurate results. Then, instruction and cooperation were conducted regarding the suitable preparation of tools, reagents, etc.

After that, guidance and cooperation on various observation activities were performed on board the survey vessel.

Items concerned were as follows:

- ° The way to use, check, maintain or repair water samplers.
- ° Installation and reading of reverse thermometers.
- ° Sorting out sub-samples from the water samplers (in particular, for measurements of dissolved oxygen, hydrogen sulfide and pH).
- ° Pre-treatment of samples (fixation of dissolved oxygen, fixation of hydrogen sulfide, filtration).
- ° Storage of samples (waters and suspended particles).

° Chemical analyses (dissolved oxygen, pH and hydrogen sulfide).
° Preparation and usage of field notes.
° Confirmation of completion of work.

Whenever the counterparts came to Japan as trainees, they were given chances to be on board a research-training ship belonging to this agency. They were guided to watch and participate in work when the survey was taking place.

d) Chemical analyses of water samples

Lectures were given on the relationship between each item of water quality and living organisms either while the experts were staying in FMC or while some of the staff members of FMC were studying in Japan as trainees. Also, guidance and cooperation were conducted on chemical analyses (including calculations which brought good results).

Chemicals concerned were as follows:
° Dissolved oxygen.
° pH.
° Suspended particulate matter.
° COD (Cr, reflux method).
° Hydrogen sulfide (in water and bottom mud).
° Nitrogen compounds (total nitrogen, nitrite-nitrogen, nitrate-nitrogen, ammonia-nitrogen).
° Phosphorus compound (total phosphorus, phosphate-phosphorus).

In connection with the analysis of these items, lectures and practice on following fundamental techniques for chemical analyses were given.

- How to use, check and repair analytical instruments and tools (balances, spectrophotometers, piston burettes, etc.).
- How to prepare reagents, in particular, how to weigh standard materials and prepare standard solutions.
- How to use and clean up laboratory wares.
- The importance of obtaining analytical precisions and methods how to get them.
- The importance of maintaining a suitable atmosphere in laboratories.

e) Arrangement and analysis of data

Recommendations and cooperation were rendered on the following items:

- Preparation of data bases (formating and usage of personal computer).
- Evaluation of the data quality (from viewpoints of precision and accuracy).
- Procedures of statistical calculations (averages, standard deviations, coefficients of variance, least square method, correlation coefficients).
- The importance of establishing clearly the purposes of data analyses (vertical or lateral distributions, time-course changes, periodicities, correlations).
- Data processing for the data analyses (figures, tables, calculations).
- Preparation of technical reports.
- Preparation of scientific reports.

Exercises on these items were performed using data the counterparts had obtained.

f) Laboratory facilities

Recommendations were given to improve laboratory environments. Facilities recommended to be set up were as follows:

- ° Ventilation or drainage to remove acid or hazardous gases.
- ° Tap water faucets for connection to tubing.
- ° Storage cabinets for reagents and laboratory wares.
- ° Laboratory tables for precision and/or heavy instruments.
- ° Metallic tubing for gas usage.

g) Acquisition of materials

In the near future, the Egyptian counterparts will have to get the materials necessary for their activities by themselves without aid from the Japanese government. In preparation for that situation a comprehensive check was made about the possibilities of getting the materials in Egypt. That is, whether the counterparts' or FMC could get the instruments, reagents and laboratory wares necessary to accomplish the above-mentioned chemical analyses or not was studied by sending a check-list to the counterparts. Thereafter, items which could not be obtained in Egypt have been supplied from Japan to the extent that the Japanese experts could carry them. For items which were difficult to obtain in the country, methods such as collecting catalogues and finding suitable agents were recommended to enlarge acquisition routes.

h) Acquisition of information

To collect background information useful to understand the lake's environment and establish native scientists as advisers after the independence of FMC, the following recommendations and cooperation were rendered.

- ° Collecting catalogues of pertinent books and journals.
- ° Confirming (domestic) locations of pertinent information sources such as books, journals, etc.
- ° How to utilize data bases.
- ° Negotiation to establish official routes for the utilization of the information sources.
- ° Preparing a list of native scientists in related fields and examining their possibilities to become ones of advisory members.
- ° Establishing official relations with the advisers.
- ° Financial assistance to carry out these activities.

i) Miscellaneous

- ° From the facts that the items to be measured have been increasing year-by-year and that the staff members have been conducting difficult work on boats (severe high temperatures in summer, etc.), the employment of new personnel (1 researcher and 1 assistant) was recommended.
- ° Since the usage of materials and information is apt to be sectionalized, the importance of their common use was emphasized.

(3) Recommendations submitted

a) New 5-year plan for FMC activities. M. Maeda (participant), January 13, 1985

b) Change of observation stations in the routine survey on the lake. K. Kihara, M. Maeda, January 12, 1985

c) Detailed manual on dissolved oxygen measurement.
M. Maeda, January 12, 1985 (Reference data No. 11)

d) Manual on measurements of suspended particulate matter.
Y. Aruga, M. Maeda, January 12, 1985

e) Necessary facilities and maintenance of laboratories.
M. Maeda, January 13, 1985

f) Employment of new staff, financial support to get necessary information, and improvement of laboratory facilities. M. Maeda, August 24, 1988

g) Inventory of essential equipment and materials and acquisition methods of them. M. Maeda, December 15, 1985 (Reference data No. 12)

(4) Outcome

General work

a) Survey

As for the routine surveys on the lake, as has been described in the paragraph on the physical environment, the counterparts became able to carry out the work by themselves. However, there were some confusions in accompanying new survey items. It is necessary to solve this problem in the near future.

In 1984, a research program in which the relationship between the productivity of organisms and amounts of fertilizer was examined in a test pond, was planned and carried out by the counterparts themselves (including staff members from other fields). It can be said that this suggested some results of the experts' recommendations and advices.

b) Chemical analysis of lake waters

As for dissolved oxygen and pH, high quality data have been obtained since 1985, and it can be judged that the counterparts are qualified to collect the data. As for suspended particulate matter, nitrite-nitrogen and nitrate-nitrogen, test analyses were started in 1987, and at the present stage, it seems possible for the counterparts to incorporate these items into their routine work. As for other items (COD, hydrogen sulfide, total nitrogen, ammonia-nitrogen, total phosphorus and phosphate-phosphorus), tests were also started in 1986 - 1987. However, it seems that more time will be needed before the counterparts can handle the analyses of these items as routine work.

c) Data analysis

The counterparts have become able to arrange the results of surveys and make data bases using personal computers. However, they have some problems in applying statistical procedures to their data, although they themselves know the methods of data analysis such as statistical calculations and drawing figures. It seems that shortages in time for data analysis caused the situation.

d) Preparation of reports

The periodical survey data obtained in 1983 were summarized as a report on FMC activities (technical report, FMC-use only). The data have thereafter also have been summarized by the counterparts yearly. Judging from these activities, it can be said that the counterparts are qualified to summarize the data into technical reports.

Concerning scientific reports, the counterparts have been processing and analyzing recent data of high quality. With some assistance of experts, they will be able to make manuscripts and submit them to scientific journals in the very near future.

Results of survey

The results of the surveys conducted during the period from 1985 to 1987 are summarized as follows:

- The anoxic water spread at the middle to bottom layers in the lower reaches of the lake in summer. In the main channel near the High Dam (water depth is about 70 m), water masses with oxygen less than 2 ml/l spread from the bottom to even 10m deep through May to August. The bottom layer at that place was completely void of oxygen through July to November.
- In the upper reaches, the scale of the anoxic water mass and the frequency of anoxic situations were reduced. For example, at Abu Simbel, in the uppermost stream, the zero-oxygen situation hardly appeared, and even the oxygen-poor water masses of 2 ml/l or less occupied only the bottom layer through May to August.
- In December, the vertical stratification of oxygen distribution collapsed in a short time and this situation continued till February.
- Judging from the data obtained in Ramla Bay, it seemed that no anoxic situation appeared in shallow ($\sim$10 m) bays.

° It seems that the appearance of either zero-oxygen or oxygen-poor oxygen situations affects the ecological system of the lake a great deal. *Tilapia* is a fish which is resistant to low-oxygen conditions. However, its habitat area or egg-laying area might be somewhat affected by anoxic conditions, because it happens sometimes that low concentrations of oxygen (less than 2 ml/l) appear up to 5 m deep.

3) Biological environment

(1) Counterparts

Olfat Anwar Habib, Mohamed Shahata Mohamed, Ibrahim Omar Mohamed

(2) Recommendations

As the basis for grasping the situation vis-a-vis phytoplankton and its primary productivity, advice and recommendations have been given to the researchers on the following matters: basic matters regarding the survey of the lakes, sampling of plankton (use of plankton net and Van Dorn type water sampler), preparation of slides for microscopic observation, the standing stock of phytoplankton (measurement of settling volume and counting the cell number), analysis of chlorophyll a of phytoplankton (filtration, extraction, extinction measurement, calculation), measurement of the photosynthesis activity of the phytoplankton, the amount of suspended matter in the lake, measurement of light intensity, the calculation method of the primary production, making of figures and tables, and how to analyze the collected data. Also, guidance and recommendations have been given on the cultivation of phytoplankton (isolation, cultivation, preparation of media and sterilizing), how to use the biological microscope (illumination adjustment, use of drawing apparatus, use of microscope camera and cleaning), use of glass wear and its cleaning, etc. Not only were guidance and recommendations given on preparing the report based on the collected data but also on the method of studying lakes and basic matters on the ecosystem and its study.

Also, advice has been given on the zooplankton survey, how to do quantitative sampling using the plankton net with the flow meter, identifying the dominant species, how to measure the standing stock (wet weight, dry weight and dry weight of organic substances, and how to analyze the collected data, etc).

(3) Recommendations submitted

The procedure of the quantitative method of examining the suspended matter of the lake was explained and cautions were given.

(Aruga)

As for the request for cooperation by English researchers concerning the distribution of chlorophyll a in High Dam Lake using a satellite, it was recommended that the cooperation be done after the collected data owned jointly by both FMC and the English researchers have been confirmed. (Ioriya, January 14, 1986)

Since the measurement of the productivity of zooplankton is extremely difficult, as the first step, the data of the standing stock shall be collected and accumulated for years. And accurate identification of species is essential to secure useful international evaluation (Murano).

(4) Outcome

a) The monthly observations on the High Dam Lake by FMC staff members are being carried out skillfully and even now the research is going on smoothly.

b) The quantitative research on the phytoplankton chlorophyll of the High Dam Lake has been performed both at the 6 stations along the main channel and at about 20 stations in the Kohr El Ramla for over 7 years. Important knowledge and information are being collected concerning the vertical distribution of phytoplankton with the chlorophyll concentration as an index. A part of it has already been published in English in the Journal of the Tokyo University of Fisheries, which reads:

Olfat A.H., T. Ioriya and Y. Aruga (1987): The distribution of chlorophyll a as an index of primary productivity of phytoplankton in Khor El Ramla of the High Dam Lake, Egypt.

(A summary of the contents is as follows. The distribution of chlorophyll a was investigated once a month during the period of December 1982 to December 1985 at 13 stations inside and outside of Khor El Ramla located in the northern most part of the High Dam Lake.)

The distribution of chlorophyll showed the higher value at the 0 - 8 m layer; usually the stratified type of vertical distribution was found in April to September and the homogeneous type of vertical distribution was found in November to February. In the former type the subsurface chlorophyll a maximum was found at the 2 - 6 m depth. The observed maximum concentration of chlorophyll a was 57.6 mg/m^3 (Station 1, November 1984), except for an extremely high value of 106.8 mg/m^3 at 4 m in April 1984 at Station 2. The water temperature varied seasonally from 14.1 to 29.9°C. The transparency ranged from 1.0 to 7.4 m, being generally high in October to April and low in March to September. The average chlorophyll *a* concentration of the 0 - 8 m layer was higher at stations inside the Khor than at the stations outside the Khor (main channel). And it is higher in the high water temperature season and lower in the low water temperature season. The transparency was correlated in an exponential manner with the chlorophyll *a* concentration in the surface water and at the 2 m depth.

Also, as for the information on the main channel, the same as above, it has been contributed to the Journal of the Tokyo University of Fisheries for publication in English, which reads as follows:

"Olfat A.H. and Y. Aruga: Changes of the distribution of phytoplankton chlorophyll *a* in the main channel of the High Dam Lake, Egypt."

(A summary follows.)

Based on the results of the survey conducted once a month during the period from September 1982 to December 1985 at the 6 stations in the High Dam Lake, Egypt, the distribution of chlorophyll has been summarized
The density of chlorophyll *a* shows a higher value at the 0 - 8 m layer in April to October; and usually the stratified type of vertical distribution was found in April to September, and the homogeneous type of vertical distribution was found in November to February. In the case of the stratified type distribution, the subsurface chlorophyll *a* maxima were obtained at 2 to 6 m. The maximum value of the chlorophyll *a* concentration

was 42.4 mg/m^3 in the surface layer of Station 4 in January 1984. The average chlorophyll *a* concentration in the 0 to 8 m layer in the southern part of the lake (Stations 4 - 6) is higher than in the northern part of the lake (Stations 1 - 3). It shows seasonal changes with high values in the period of high water temperature and low values in the period of low water temperature. The water temperature varied seasonally from 15.0° to 30.3°C. The transparency ranged from 0.3 to 5.5 m and showed seasonal changes with low values in the period of high water temperature when the chlorophyll *a* concentration is higher and high values in the period of low water temperature when the chlorophyll *a* concentration is lower.

Furthermore, as for the data of 1986 or later succeeding the above-mentioned results, its analysis is under way and the comparison of the yearly changes is now being done. These matters will be reported elsewhere.

c) As for measurements of the photosynthesis activity of the phytoplankton, they have taken place on board in order to prepare the photosynthesis - light curve. Unfortunately, reliable and sufficient measurements have not been achieved yet because of the restricted time for research and unskilled measuring techniques. However, a rough idea of the level of the phytoplankton photosynthesis activity has been obtained.

d) Regarding the daily change of light intensity, the measurement of it from sunrise to sunset once a month since the latter half of 1986 has been conducted and the situation of its seasonal changes is becoming clear.

e) Regarding the primary productivity of the phytoplankton of the entire High Dam Lake, its calculation has to be done after the data of the photosynthesis - light curve have been sufficiently obtained. However, based on such data as the distribution of already obtained chlorophyll _a_ concentrations and the seasonal changes, and the change of the photosynthesis activity, and the change of light intensity and transparency, when calculations on the 6 stations of the main channel have been done, it is able to be estimated that the yearly net production is relatively lower in both Station 1 and Station 6, and is relatively higher in Station 4, and the values were ca. 2.5 to 5.3 kg (d.w.)/m^2/year (average 4.0). Regarding the entire High Dam Lake, the surface area of the lake was calculated taking into consideration the water level; when the water level is 160 m, the entire yearly net production is estimated as 11 x 10^6 tons (d.w.)/year and when the water level is 180 m, it is estimated as 23 x 10^6 tons (d.w.)/year.

f) Based on the data on the above-mentioned primary productivity, the primary approximate estimate of the fish catch level in the High Dam Lake has been tried. Assuming that half of the primary production is directly consumed by the fish (first nutrition stage) and the remaining half of the production is consumed by the fishes through the herbivorous animals (second nutrition stage), and also assuming that the conversion efficiency of each nutrition stage is 10%, the fish production was 5.7 x 10^5 tons (d.w.)/year when the water level was 160 m, and 11.6 x 10^5 tons (d.w.)/year when the water level was 180 m. Furthermore, assuming that the dry weight of fish (d.w.) is 25% of fresh weight (f.w.), the fish production was 2.3 x 10^6 tons/year when the water level was 160 m and 4.6 x 10^6 tons/year when the water level was 180 m.

Assuming that the habitation area of *Tilapia* is 10% of the entire area along the lake basin, the production of *Tilapia* is estimated as 23 x 10^4 tons (f.w.)/year and 46 x 10^7 tons (f.w.)/year respectively. It is, however, considered that these values should be reviewed after more highly reliable data have been obtained.

g) During her training course in Japan, Ms. Olfat Anwar Habib received mainly technical training on the culture of the smaller algae which might be needed as feed for the culture of juvenile fish in FMC in the future and on the measurement of the photosynthesis of the phytoplankton and respiration. Regarding the study of the ecosystem in the High Dam Lake which is an important subject of study for FMC, she was given a lecture on the concept of the the ecosystem, the history of the study and the practices, and explained the study of ecosystem with key species and discussed the direction for further study.

During her training on these subjects, it is very regrettable that regarding the measurement of photosynthesis and respiration, as the period of Olfat's stay in Japan had expired, she had to return to her country before being sufficiently trained in the necessary skills. It is considered that she requires further guidance in the future. Also, regarding summarizing research results into a paper, however, she still has not reached the level where she can do it by herself.

h) Regarding zooplankton research, based on the experts' recommendation and guidance, quantitative sampling has been conducted every month at the 6 stations in the main channel and at the 4 stations in the Khor El Ramla since 1987 (Figure 24). It is still in an undercollection stage and has not been published in a paper. However, the following results are being obtained: (1) On the standing stock of the zooplankton, change approximately corresponding to the chlorophyll concentration can be seen. (2) In the main channel, an approximately stable yearly standing stock is seen in Stations 1, 2, and 3, and in Stations 4, 5 and 6 (particularly, in 4) seasonal change of the standing stock is conspicuous.

Regarding the identification of zooplankton, since it is difficult to obtain the basic reference books in Egypt, no work has been done so far. It is considered necessary to solve this deficiency.

4. Department of Aquaculture

1) Counterparts

Mr. Z.S. Botros, Mr. N. Magdi, and Mr. K.A. Rabia.

2) Recommendations

(1) The mass production technology for tilapia, *Oreochronis niloticus* and the calculation of the needed number of parent fish.

To confirm how many fry are produced from one parent fish in one season is important for planned production. In order to understand this, female tilapia, *Oreochromis niloticus* with a weight of 1 kg per fish were stocked in two 150 m^2 concrete basins (see photo 1) in 1984, one basin for 50 fish and the other basin for 70 fish. Simultaneously, male fish of the same size as the females were stocked (70 fish and 50 fish each in the two basins) and the number of fry was calculated once a month (see photo 2). This research has been continuing for 3 years. The parent fish were fed with the assorted food which is to be described later on.

As the result of the 3 years of research, it was proved to be possible to produce about 600 fry on the average in a month and to obtain about 4,000 fry in one season during March to October, when female parent fish were stocked in the ratio of 1.25 m^2/per fish.

According to this data, the staff of FMC have become able to calculate the number of parent fish stocked per basin in accordance with the annual production target and they understood the initial stage of planned production.

As a result of this, the Egyptian side constructed a large-scale hatchery (See photo 3), the basic design of which was drawn by the Japanese side, and the production work has been carried out since 1988. This hatchery has a total of 135 basins totalling 5,000 m^2 of water surface. Judging from the tentative production performance done by FMC, it is considered possible that 5 million fry can be produced naturally, and the technical cooperation for that level is required in the future.

(2) The mass-culturing technology for plankton as the initial food.

In the production of fry, it can be said that the number of fry depends upon the quantity of zoo plankton. Therefore, the mass-culturing technology of the water flea which can be living food for the fry of *tilapia* and other fishes has been introduced.

Namely, the larvae which were hatched from the resting eggs of *Moina* are put into a culture liquid which is made by mixing them with fowl droppings, river sand and water, and the quantity harvested per 1 m^2 has been reviewed.

As a result, it has been proved that 0.25 kg to 0.58 kg of water fleas can be collected per 1 m^2 during a period of 12 to 21 days.

However, these results are from small-scale propagation in such small basins as 7.2 m^2. It is considered that technical cooperation will be essential in the case of larger-scale propagation.

(3) The mass-production technology of one million tilapia fry

Mass fry production technology is required in order to release sufficient fry for the purpose of maintaining and increasing the fishery resources.

Therefore, the technology by which one million fry of tilapia, Oreochromis niloticus, can be produced has been introduced based on the test results described in paragraph (1) above in the basins of the hatchery (see photo 3) which was constructed by the Egyptian side as has been previously described.

Consequently, one million of fry were able to be produced from 300 parent tilapia, Oreochromis niloticus, from the High Dam Lake each weighing about 1 kg in the 40 basisn (100 m^2 area per basin).

Thereby, FMC has been able to release 520,000 fry with an average weight of 4.5 to 23 g into the High Dam Lake during the period of October to mid-December 1988.

(4) FMC's cultivation of silver carp parent fish and induced spawning technology

In the case when the offing which is the main waterway of the High Dam Lake is used as a fishing zone, silver carp was selected as the candidate kind of fish for stocking because it is less competitive with native fishes and also requires a wide water area to live on.

Before introduction of new species, it is reasonable to research and study the influences of introduced species on the ecosystem of High Dam Lake.

For the introduction of mass production technology of silver carp fry, the parent candidate fish were transported 600 km distance from the hatchery located in the delta of the Nile River and advice was given on how to cultivate even the parent fish.

As a result, FMC cultivated adult silver carp which were transported both by airways and landways during the period of 1984 to 1987 and, furthermore, they were able to cultivate enough of them to obtain eggs for fry.

Furthermore, advice was given on inducement spawning technology which is an essential matter in establishing the mass-production of fry.

First of all, training was conducted for the staff of FMC to familiarize them with techniques of determining the maturity of the parent fish. Thanks to the training, the staff have become able to sort out the good parent fish.

Next, advice was given on the inducement dosing with hormones and the staff technique by familiar with how to regulate the dose, how to administer the dose and how to effectively evaluate the hormone.

As a result of this consolidated technical cooperation, the Egyptian side installed basins for parent fish for the spawning (photo 4) and hatcheries (photo 5 and 6) by their independent efforts and now one million eggs and 100,000 or more fry can be produced.

(5) Cultivation technique for silver carp in a still-water basin without artificial food.

As a part of the basic research to determine the growth of silver carp which are released into the High Dam Lake, their survival and maturity, it was proposed that the fry of silver carp be stocked into a still-water basin, and after a certain period of time, the growth rate and survival rate be determined. The FMC side put this into practice and they have begun to stock the fish since 1986, and in 1988 a part of the fish were taken from the basin and they are being studied for growth and maturity.

(6) Cultivation technology for silver carp in a net cage for the stocking suitability evaluation.

In the case of releasing silver carp into the lake, a close examination shall be done in advance on whether the releasing place is suitable or not. For this purpose, researchers were advised to install a net cage in the prospective release area where the fry of silver carp can be stocked. This is because it is necessary to review the growth, survival, kinds of living food, the quantity available and quantity consumed and advice was given regarding the actual proof testing method.

According to the results of this test, the extent of the impact on the native fishes can be understood and it is possible to evaluate the influence on the ecology in advance and the importance of this point. The following steps were taken.

First, 3 net cages were installed in 3 areas in the lake and fry weighing 20 g were stocked and their number, weights and lengths were periodically measured and the contents of the alimentary canal were examined with standard samples.

As a result of this test, it has been proved that the fry showed remarkable growth, up to 2 kg in one year and 3 months in one area; in other area they hardly grew and showed a remarkably lower rate of survival.

To help the staff understand these reasons, they reviewed the contents of the alimentary canal to check the quantity and the quantitative and qualitative differences of plankton in the net cages installed in the water areas and observed the interrelationships.

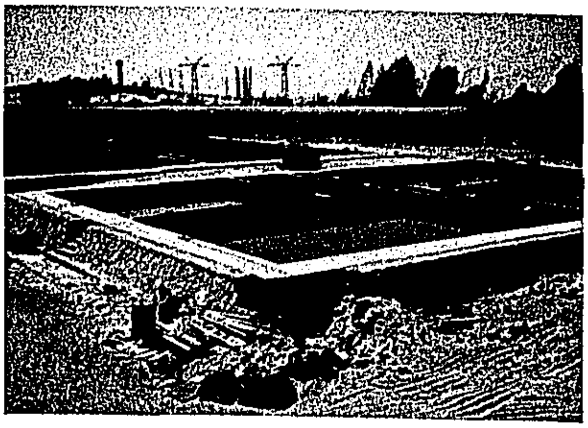
(7) The artificial propagation technology of the useful fishes which are becoming reduced in number

Among the native fishes in the Nile River, the catch has become reduced of some which are favorites of the people of Egypt. Consequently, in order to establish fry production technology for *Labeo niloticus, Barbus bynni,* Nile perch, tigerfish and catfish, biological research methods relating to the sexual maturity of these fishes and their artificial insemination technology were introduced.

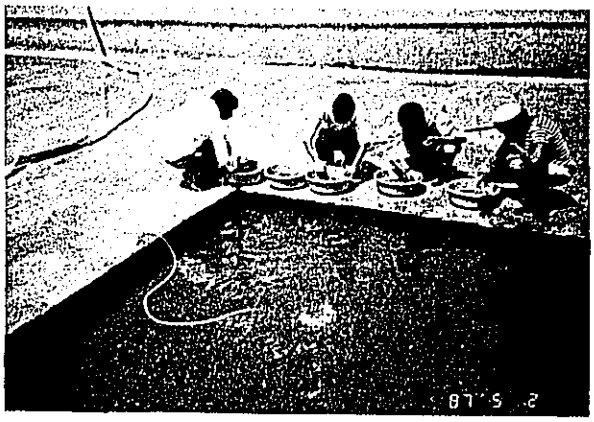
As a result, it has been proved that artificial propagation is applicable to all kinds of fishes (above) and researchers could understand the basic matters related to maintaining the quantity of fry.

(8) Assorted food making technique

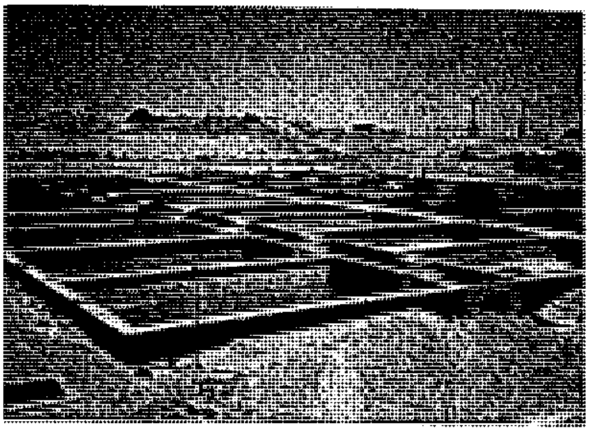
Advice was given on assorted food making techniques and nutritional evaluation methods based on the easily available food material. As a result, the food making technical level has been improved to such an extent that staff of FMC can make assorted food with fish meal utilizing scrap and waste materials from the neighboring fish processing factory.



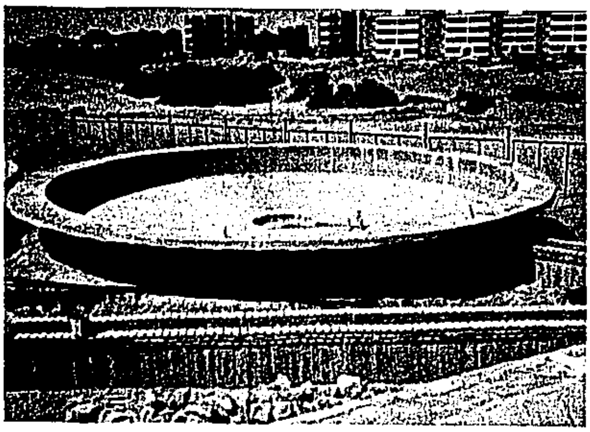
1. FMC's fry production basin



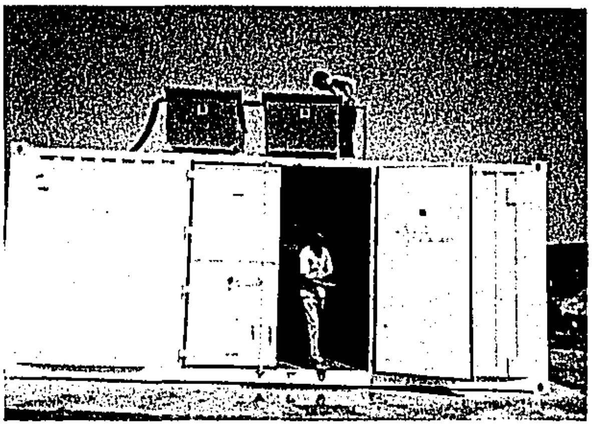
2. Calculating number of fry of tilapia, Oreochromis niloticus, produced



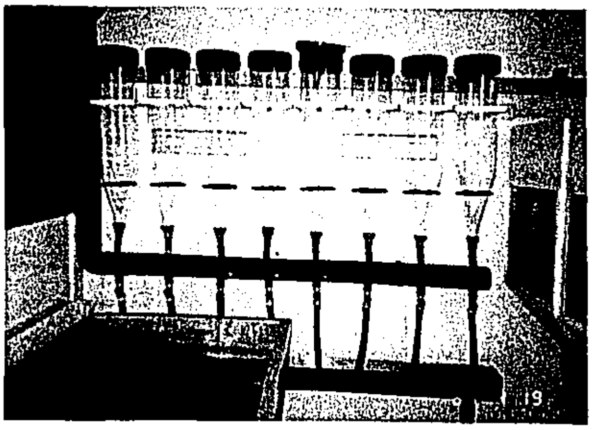
3. Facilities for producing one million *tilapia* fry constructed by the Egyptian side with the basic design by the Japanese side.



4. Parent fish basin for spawning of silver carp.



5. Hatchery for the silver carp eggs. There is a water supply installation on the rooftop which supplies hot water. The incubators are accommodated inside as shown in photo 6.



6. Incubator for silver carp eggs(one set). In the left side facing front, a water tank for parent fish is seen.

3) Recommendations submitted

(a) The outline of FMC's Proj., etc. Minoru Nomura, August, 1983 (Reference data No. 13)

(1) The utilization of open-water areas in the High Dam Lake in connection with the introduction of new pelagic fish species.

(2) The mass production of tilapia fry and their releasing into the High Dam Lake.

(3) Restocking and/or propagation of declining indigenous fish species

(b) Development of the High Dam Lake fishery. Minoru Nomura, January, 1984 (Reference data No. 1)

(1) Coastal fishery zone.

(2) Open-water fishery zone (introduction of silver carp)

(3) FMC's approval of new fish introduction

(4) Urgent demand (4x150 m^2 large-sized basins and 6x15 m^2 small basins are to be constructed.)

(c) Note on artificial breeding trial of silver carp. Minoru Nomura, July, 1984 (Reference data No. 14)

(d) On maintenance and use of generator. Kiyoshi Sakai, May, 1986 (Reference data No. 15)

(e) Food habits research on silver carp cultivated in net cages at 3 areas of High Dam Lake. Kiyoshi Sakai, May, 1986

(f) Ecology research on silver carp in the High Dam Lake. Kiyoshi Sakai, January, 1987

(1) The non artificial food rearing of silver carp in the net cages installed at 3 points in the lake. (Reference data No. 17)

(2) Ecology research on silver carp and native fishes at 3 closed inlets in the lake.

(3) Tracing and surveying of silver carp stocked in the inlets for shoal fish with an echosounder.

(g) Plan on the introduction of new fishes to the High Dam Lake (installation of breeding room and circular pond). Masanori Kawaguchi, February, 1987

(h) On the collection of *tilapia* fry in a basin (fish hatchery). Kiyoshi Sakai, June, 1988

(i) On the location of water inlet and outlet points in the earth pond and the size of basin pond. Kiyoshi Sakai, June, 1988

(j) On the number of silver carp parent fish in the ponds. Kiyoshi Sakai, June, 1988

IV. Utilization of Equipment and Materials

1. Department of Fishery Resources Management

The supplied equipment and materials such as personal computers are being efficiently used. In addition, various kinds of nets are necessary for the routine survey of the fishery resources environment. Net fishing gear for the survey of the selectivity of net meshes is necessary to collect basic data for fishery resources management (bottom gill nets). Nets for the offshore resources survey are also necessary (drift gill nets). This net is particularly fragile and when it is used for 30 days or longer it tends to break. Therefore, the presently used net shall be replaced by another new net for the sake of the accuracy of the survey.

The recording paper used in the fish finder shall be supplied as a lot of it is used. Further, tag guns for releasing tagged fish are necessary. These materials described above are not locally available.

2. Department of Environment

The supplied equipment and materials which are mainly used for physical, chemical, and biological environment experiments are being sufficiently used. Among the equipment supplied at the initial stage of this project, there is a lot of requiring renovation. In particular, on the research boat, which was supplied in 1981 (Name of the ship: El Sadaka, made of fiber glass reinforced platic, 9.4 tons and 120 PS), despite the annual regular checks, maintenance is needed although nothing has been done so far due to problems of technique and the procurement of the spare parts, etc. For example, in the summer of 1987, the main engine was broken and the boat was unable to be operated for about half a year. The routine survey has therefore been impossible since there was no boat being used in FMC for the environmental survey other than the El Sadaka and, accordingly, serious interference with the progress of the work resulted. FMC has frequently been advised that checks and maintenance of all the equipment and materials are essential in order to effectively prevent the recurrence of such trouble in the future.

However, as is shown in the case of the research boat, El Sadaka, in cases where the Egyptian side cannot repair the trouble by themselves because of technical problems, it is necessary for the Japanese side to extend a helping hand. By doing so, the service life of the equipment and materials can be extended and the efficiency can be enhanced. For the El Sadaka, the checks and maintenance are necessary, including an overhaul.

3. Department of Aquaculture

Most of the equipment and materials supplied to FMC are expendable articles except for microtomes, ovens and microscopes. These articles are utilized and consumed for the raising of the parent fish, the egg-taking and the rearing of fry. In particular, large amounts of hormone and other expendable articles have been supplied: however, the researchers are now checking if any substitutes are available locally. Also, among the glassware or chemicals, some are expensive and difficult to find. Therefore, they are carefully stored and used sparingly in many cases.

If the spirit of conservation is too strong, however, they are sometimes never used. It is considered good that the local researchers are helping and supplying each other. However, in many cases nothing can be done since a lot of things are unavailable at the scene. The things which are made locally and the bamboo net brought from Japan are being utilized in the propagation test for silver carp, etc.

V. Impending Tasks and Future Policy

1. Management of the Center

Since its activation in 1982, FMC has been advised and cooperated by 6 short-term specialists and 2 long-term specialists.

During this period, FMC was reorganized and its scale was expanded, and a Fish Hatchery Center has been established. FMC has been developing smoothly thanks to the cooperative work between the center's researchers and FMC researchers. In addition, a total of 10 FMC research staffs have been receiving technical advice from faculty of the Tokyo University of Fisheries at the rate of about 2 persons annually.

As each specialist has pointed out, under the present conditions in which technical advice and recommendations have been given to them, it is difficult for many of the research staffs to draft test planning, analyze the results, and make reports.

There are various reasons for this; firstly, they are lacking in consciousness of the problems relating to the High Dam Lake fishery, secondly, no data and references, etc., are exchanged with other staff members.

On the problem of consciousness, advice has been given to the research staffs since the beginning of the establishment of FMC whenever the occasion arises.

Regarding the lack of sharing of information for example, it has been recommended again and again to make public all the data obtained in Japan to the researchers of FMC after the completion of training in Japan and to hold a morning meeting of FMC staff members or some other meeting within the pertinent department for the exchange of the necessary information, and this is being now put into practice.

On the problem of consciousness, it seems useful for the FMC researchers to make the problem clear in a seminar hosted by FMC where persons engaged in fisheries, the leaders of fishermen's cooperatives and the residents around the lake attend together for discussions on the problems of High Dam Lake. Such a seminar has already been held and was effective.

The FMC research staffs have been seen as persons of a different culture and society by the Japanese, and on the other hand, for the FMC research staffs, the japanese have been the foreigners.

As time passed by, this relationship has changed much with each side absorbing the foreign culture and understanding the other's weak points and strong points, and recommendations and cooperation are smoothly rendered under the relationship of mutual trust.

Regarding the transfer of technology, it is considered fundamental for advising persons to consider the advised and led persons as being equal. It still seems that even though this mini-project is to terminate in March 1991, further recommendation and advice of about 3 specialists are considered to be necessary for several years to come.

The reason is, as has been described on the preceding page, that the fostering of persons qualified to independently draft test planning, to analyze the outcome, and to prepare scientific reports on the application for fish resources management takes 10 years or so in the fishery field, even in Japan.

Also, as FMC is aiming to become the African fishery management center as a regional center, it is necessary for FMC to retain several persons with Doctor degree among the research staffs in the future. It is thought that obtaining a Doctor degree either from the Tokyo University of Fisheries or from some other university in Japan is one of the methods.

In cases where a project in a developing country is receiving advice and technical cooperation is rendered, even though the project is progressing smoothly, if the cooperation of specialists is cut off because of expiration of the agreed period, it is feared that the situation may return to the original status. Aftercare is essential to prevent the above if the welfare of the counterpart country is considered. Long-term advice and recommendations by a few specialists are necessary on as wide a scope as they are permitted. For technical cooperation for developing countries, it is necessary to proceed with a long-term view, even though it may be small-scale cooperation.

The tasks to be independently and continuously performed by FMC as a fish resources management agency are as follows:

1) To make clear its duties and functions based on its assigned mission.
2) To establish proper work objectives and to draft and review flexible and reasonable work plans.
3) To properly assign the work and to confirm and arrange the work contents to be performed.
4) To clarify authority and responsibility and to establish a cooperative work system.
5) The fair evaluation and arrangement of work, unification of will, exchange of ideas, and the continuous holding of the following meetings as a part of the exchange of information:

   (1) Staff meeting (general meeting: with research staff, office workers, technicians and boat officials attending): Once or more a month
   (2) Department meeting (with research staffs and assistants attending): Once or more a month
   (3) Director and specialists meeting: Three times a week
   (4) Meeting for work planning (with director and representative of each department): Once a month
   (5) Morning meeting for staff (with all staff attending): Every morning
   (6) Morning meeting for department (with research staffs and assistants attending): Every morning

(7) Meeting for forecasting of fishing conditions (Fishery Resources Management Dept. and Environment Dept.): Once a month

(8) Meeting for planning and liason (outside fishery-related agencies including fishermen's cooperations): Twice a year

6) Establishing and implementation of training system for staff members

7) Establishment of survey, research and other cooperative work systems with domestic related institutes.

8) Establishment of survey and research cooperative system with the neighboring countries as a regional center.

9) Execution of forecasting of fishing condition.

10) Extension of technical improvement propagation work related to sustaining and managing of fish resources for fishermen.

11) Execution of training on sustaining and manageing of fish resources for fishermen.

surveys and studies as well as the contents of the work.

13) Augmentation of research staffs, technicians and office workers to match the expansion of the work and expansion of the facilities.

2. Department of Fishery Resources Management

Since the activation of FMC, this department has collected the various information relating to fisheries and conducted many different examinations, and has been advising on the analysis method.

In this advising process, many FMC officials and specialists have pointed out the fact that the understanding of problems is not always sufficient among research staffs. It is thought that in the arrangement and analyses of the large amount of data collected, the work would face difficulties without the recommendations of the specialists. Consequently, personal computers (FM-7, FM-8) were introduced and research staffs advised on how to operate them for the arrangement and analyses of these data. However, these computers have low performance and have not been efficient in treating the data FMC has collected. In order to enhance the efficient treatment of the data, 2 new personal computers (NEC 9801 LV 21) were supplied in the summer of 1988. The research staffs are extremely interested in this equipment and most staff took part in the training on the personal computers. In the future, it is expected that based on the many statistics collected, the arrangement and analysis work must make up half of the total work. Therefore, it is necessary to introduce efficient personal computers as it is expected that the work done by personal computers will increase. At the same time, it is also necessary to continue to advise research staffs on how to operate the computers and how to do analysis.

Two research staffs of this department have already completed training in computer operation in Japan and they are now taking part in the actual FMC work.

This department has responsibility for releasing of fry as one of its future tasks. In the summer of 1988 advice was given, and since the autumn of 1988, releasing of fry has begun in earnest. Judging the effects of releasing of fry is an important task in fish farming; however, an effective way of judging has not yet been established.

Therefore, advice has been given on how to release fry and how to collect the necessary data based on this plan since last autumn with a test plan to judge the data, after the specialists were dispatched in the summer. It is thought that it will take several years to ascertain the results of releasing as the main work to be done in this department. It is also though that this work should be performed as work of the entire FMC with the cooperation of other related departments. In such a situation, the present problem is the shortage of ships by which a large quantity of fry can be transported. The Egyptian side was asked to procure the necessary transporting ships; however, it is expected that they will be impossible to procure. Consequently, it is thought that

Japan should provide these ships in order to smoothly accomplish this work. In addition, for fish resources management, it is essential for FMC to grasp the actual situation in the High Dam Lake. For this purpose, it is necessary that the annual actual status survey be carried out by selecting representative fishermen's camps. Further, it is also necessary to decide the age (length of body) of the initial catch in terms of resources management. Also, it is still necessary that the fish catch tests be continued to determine the curved line of the selectivity of the net meshes of the various kinds of drift gill nets, which can become basic data. It is necessary that the net mesh selectivity curved lines of conventional fishes other than *tilapia* be determined. By the same token, it is the same for the drift gill nets mainly targeting Eydrocynus forskalil. The survey of the environmental condition of fish resources survey has been conducted in two or three fishing zones; however, it is still necessary to continue the survey to familialize research staffs with the relationship between the true distribution density and the environment in the lake and the actual status of the fishery. Also, for the effective utilization of fish resources, the improvement of fishing gear and fishing methods is essential.

3. Department of Environment

The tasks which are advisable to be done are as follows:

1) Enhancing the capability of data analyses.
2) Enhancing the capability of analyzing the dynamics of fish resources (ecosystem) and environment and ecosystem.
3) Improving the summarizing of the results of analyses.
4) Making forecasts of fishing conditions.
5) Regular publication of work reports and research reports.
6) Increasing of number of researchers, assistants and technicians to match the expanded work and expanded scope of the facilities.

7) Execution of training and study for researchers and officials.
8) Establishment of research and study cooperative system with the neighboring countries as a regional center for fisheries environment.
9) Supplementing of the research ships and execution of the regular checks and maintenance.
10) Recommendations on methods for the local procurement of the equipment and materials used for research and study.
11) Execution of survey of resources environment in the major lake areas.
12) Introduction of the automatic observation systems.
13) Smooth shifting of water quality tests into routine work.
14) Efficient treatment of samples and chemical analysis.
15) Reducing excessive surveying work on the lake.
16) Recommendations and advice on the concentrated research work.
17) Promotion of study exchange with other institutes.

4. Department of Aquaculture

The task FMC is face with is to maintain and expand the fishery resources in High Dam Lake. For this purpose, the Japanese side encourages the release of useful fish fry. However, it is necessary to establish the techniques, of the mass production of silver carp fry and the native fishes such as *tilapia* and others for stocking. So far, the Japanese side has been mostly transferring technology in the sequence of the cultivation of parent fish, inducement of maturation, egg taking, incubation and fry rearing. The techniques relating to cultivation of silver carp in the net cage and the transportation of live fish already have been introduced. However, still unaddressed matters are left from these points. In particular, regarding the native fishes, there is no biological knowledge on sexual maturity. It is thought that it will take a considerable time to fully familiarize researchers with artificial propagation techniques. Hereafter, Japanese continuous support is necessary to solve the pending problems and systemize the technology. Further, determining the effects of the release of the fry is the work of the fishery resources management department, while the prior evaluation of the effects on the ecosystem of the lake by releasing fry was the work of the aquaculture department. However, as the case stands, there is too little knowledge to do this and even its methodology is pending. It is thought that further intellectual support will be needed at the stage when the pertinent knowledge has been accumulated after the activities of FMC are being successfully carried out in the future.

VI. Reference data

The major recommendations submitted to the Fishery Management Center are attached as follows:

[illegible]

[illegible]

[illegible]

Reference data No. 1

Preliminary report on the development of the High Dam Lake Fisheries

Dr. Minoru Nomura
January 1984

I Coastal Fishery Zone

1) After analyzing the data accummulated by the Fishery Management Center since it opened in 1982, the annual fish output from the lake can reach up to 45,000 tons without affecting the resources of the lake. In order to reach and maintain that level, the following steps must be considered:

   A) Regulating the size of the fish caught by controlling the mesh size of the trammel new.

   B) Efforts directed towatds improving the transportation of fish from the fishing sites to the factory. Through this effort, it is hoped to reduce the subatantial amount of fish wasted due to this reason. This is estimated at 20% ofthe total catch according to interviews at the fishermen camps.

   C) Restoching the lake by large numbers of Tilapia(bolti)fry.

2) In order to achieve the objective, I recommend the following steps be taken:

   A) The High Dam Lake Development Authority decree a restriction on catching Tilapia (bolti) weighing less than 450g (or 500g.). Please refer to the attached report "Restriction of fish size of Tilapia nilotica for commercial fishing in the High Dam Lake" for further details.

   B) The Authority extend the services of its good office to improve the transportation of fish on the lake.

   C) To construct a facility to mass produce Tilapia (bolti) fry This facility should be part of and the responsibility of the Fishery Management Center. The center will oversee the entire production cycle of the Tilapia (egg-taking, rearing of fry, and their release).

   D) The authority review the present living conditions of the fishermen for the purpose of establishing a policy on improving these conditions as an important step in attracting more fishermen to work at the lake. From interviews with the fishermen, many are leaving the lake due to their poor salaries which are connected with the price the boat owner receives from Misr Aswan Comp. and due the their living conditions.

II Open water fishing zone

1. Dr. Elec Woynarovich, Professor of Tropical Fish Culture and former FAO fishery development expert, suggested in his report titled "Ad hoc repord handed over to the High Dam Lake" in 1982 that the fresh-water clupeid is one of the suitable fishes which can be introduced through restocking into the High Dam Lake in orderto increase the open water fish resources. In July 1983, I visited the FAO office and collected some reports concerning the clupeid's feeding habits and ha bitation.

   According to these reports, the clupeid fingerlings and jerveniles stayed in t he coastol zone and their stomachs were filled with Zoo-plankton similar to that which is eaten by the Tilapia nilotica.
2. For the above-mentioned reasons, I recommend the silver carp be introduced on an experimental basis to the restricted ponds at the Center. It is essential to construct two natural nursery ponds to conduct an experiment on acclimatization to the new environment.
3. All new fish species to be introduced to the lake by any company or person must receive prior approval from the High Dam Lake Development Authority (F.M.C) in aneffort to prevent any undersired species.
4. Urgent Requirement

   The Center urgently needs to conetruct four large ponds ($150 m^2$ each) and six small ponds ($15 m^2$ each) for rearing the new species and collecting their egges.

Reference data No. 2

Mr.Mohamed Shahat
Director
Fishery Management Center
Aswan, Egypt

Recommendation concerning cooperative study with staffs of Fishery Management Center(FMC) and foreign scholars

They said that some English scholars are planning to survey environmental condition of the High Dam Lake by satelite in cooperation with staffs of the Fishery Management Center.

If there is an opprtunity to cooperate with foreign scholars who can undertake such kind of research works, it is desirable that results of the cooperative works should be useful for FMC.

It should be noticed that, however, FMC has been established originally for assisting of fishermen in the High Dam Lake,and accordingly secure resources of nutrition of Egyptian peoples.

If their purpose is merely to make a report exclusively, FMC is better not to cooperate with them. Because, as staffs of FMC are not yet so much skillful in making plans of experiments and data analyzing comparing to foreign scholars, I am afraid that staffs of FMC become subordinates of them.

Therefore, it is advisable for you to arrange that staffs of FMC, related staffs of the Tokyo University of Fisheries and foreign scholars discuss about planning, analyses and publishing of results of the cooperative research works in advance.

I wish that you are cheerful and that all staffs of FMC are advancing whole programms cooperatively.

Sincerely yours,

A. Koike

Prof. Dr.Atsushi KOIKE

21 April 1986

Reference data No. 3

Mr.Safat Gahattas Abdel Malek
Undersecretary of State
High Dam Lake Development Authority
Aswan, Arab Republic of Egypt

Dear Sir:

This is an answer for your letter concerning administration of the High Dam Lake Fishery Management Center(FMC) dated on 4th January 1987.

1. Steps needed to raise the ability of F.M.C. staff to analize the accumulated data and to obtain technical recommendations in the field of fish production to be their main aim.

a) Necessary advices have already been providing in comprehensive. Research staffs of FMC have to define purposes of their own duty consciously in order to devise research subjects by themselve.

One way of settling this matter is for FMC to be held on a research meeting to inform research activities to peoples including fishermen. FMC's staffs are supposed to be encouraged inevitably through discussions concerning their own subjects with those peoples.

b) FMC's staffs have all the time to recognize present situation of the Lake from their own aspects.

Scores of staffs of most fisheries experimental stations in Japan have virtually used one office room together. This system is very effective in order to increase chance of discussions among staffs of different fields. They, however, use laboratories in case of necessary. It is advisable for FMC to introduce this system urgently.

c) It is advisable to publish the annual report regularly in Arabic and English in order to record and inform activities in public.

2. Set up a stable system to ensure the following: a) Co-cordenation of the 3 groups: The Japanese experts, F.M.C. staff and the administration. b) Follow up system for carrying out plan of operation, data recording and reporting.

a) Related advisers of the Tokyo University of Fisheries are willing to contact with FMC's staffs by letter and other ways hereafter.

For the sake of carrying out duty·of FMC continuously, it is advisable for FMC to ask cooperation of universities and institutions in your country in order to gain advices concerning basic and standard matters of biology, physics, chemistry, statistics such as analyses, caliculation, identification and others.

b) Important matters concerning research activities are definition of purpose, rationalization of feasible plan, arrangement and checking of data, supplmentary research and submitting reports.

In case of research work, it is necessary to prepare items in detail as much as possible. Creative power depend upon definition of purpose is required to write scientific papers.

Problem is how to bring up creative power. The more staffs endeavor to know actual situation of the Lake through field works, the more they obtain creative powers.

3. Techical programs are needed for the following subjects: a) Re-stocking of Tilapia on coastal fishing grounds. b) Introduction of new fish spechies to the open water fishing grounds mainly silver carp. Taking into consideration mass production of its fry and releasing them to the lake. c) Increasing fish species which are declining such as Benni and Labeo as a second periority for the silver carp. d) Set up plan of operation for fish hatchery under construction at present. Besides the plan of establishment new hatcheries are needed.

a) Water level of the Lake has been going down gradually since 1982. Present level is same as in 1972's.

There are significant relationship between water level and living situation of aquatic animals and their reproduction. Tilapia species inhabit along coast and spawn in shallow water. Therefore fluctuation of water level have significant influence upon reproduction.

According to our study, although resources of Tilapia species were stable from 1971 to 1980, it develop a tendency of decrease due to going down of water level since 1982. One reason of the decreasing is supposed to be diminishing of spawning ground. For instance, about 30 % of coast line of the Lake decrease from the latter half of 1970's to 1985. Reproductivity of Tilapia species which have special spawning behaviour is diminished by decrease of coastal area.

It is considered that, if there are sufficient foods, releasing of fish fry is an effective way in order to increase fish production at present time when water level is low. Increase of fish production by releasing one million fish larvae has been estimating according to results of your staffs' biological studies.

b) The primary production level in open area of the Lake is thought to be high because of the presence of enough amount of the nutrients and phytoplanktons as revealed by FMC staffs in section 7. Therefore, it is highly expectable to increase the stocking density of harvivorous species such as tilapia and silver carp.

However, because of the natural habit of silver carp, they may migrate to upper area of the Lake after growing up to the adults and finally go away from Egyptian territory. Upstream migration at the time of sexual maturation has been observed in Japan and China.

In addition, new species may give unexpected and undesirable impact to the aboriginal animals and change the ecosystem in irreversible. Therefore we should be careful to decide the releasing of silver carp fingerlings into the Lake. Before mass-releasing, we have to define their adaptability to new circumstances and to know how they affect to the environment. For that reason tracing the growth and survival of the fingerlings in different area are necessary. Analysis of their food habit is also important. Resistance to environmental changes must be investigated.

Based on these fundamental knowledge, we can decide property of mass-releasing of silver carp. Therefore, we have recommended net-cage experiments in coastal area of different parts of the Lake. Till now, your staffs' techniques of seed production and transportation of the fingerlings are also not skilfull. Preparation and maintenance of the net-cage are also not yet improved. The staffs in FMC, especially in section 5, and in new hatchery should share equal responsibility, and try to complete the techniques in cooperation.

c) In general, propagation of native species is better method than introduction of foreign one in order to increase fisheries productivity in the water. Accordingly artificial seedling and releasing of Benni and Labeo is highly advisable.

In order to establish techniques of seed production, staffs have to analyze the maturation processes through the year and to clarify the most suitable time of egg collection during spawning season. The optimum environmental condition during incubation and suitable initial diet as well as rearing condition during larval life are also necessary to be investigated.

Small scale(experimental)production of the seed should be followed by large scale(mass)production. However, techniques and facilities for mass production are much more necessary than those of small scale ones. Therefore it may take longer time to obtain complete techniques.

d) Following system is advisable in order to manage the hatchery smoothly:

Director(1) - Leader(1) - Staffs(8) - Assistants(8)

The leader is required enough experience in seed production of tilapia, silver carp and others as well as good personality. He plays a leading role in the hatchery and supervise the staffs by teaching knowledges and techniques. He has to take into consideration about administrative and political situation of the hatchery.

Eight staffs are divided into 4 groups based on their resposibility as following:

Section of seed production and releasing
Section of net-cage and semi-natural pond maintenance
Section of environmental analyses and natural food supply
Section of artificial food and materials supply

Staffs in each section have to discuss about duties every morning and evening in order to exchange their knowledge obtained in each day. Common understanding is quite necessary to improve their own techniques.

Evaluation of releasing the fingerlings into the Lake shall be done by section of fisheries resources management in conjunctin with section of net-cage.

One of staffs has to stay at the hatchery all night long alternatively during operation of the hatchery. His duty is to check the pond periodically and to pay attention carefully to fish, water, airation and electricity in order to keep in good condition. For this purpose, an accomodation is necessary in the site.

Sincerely yours,

Dr.Atsushi Koike A. Koike

Dr.Nobuo Hirayama N. Hirayama

Dr.Fumio Takashima F. Takashima

Dr. Kohei Kihara 木原興平

18 August 1987

Reference data No. 4

To: Mr. Mohamed EL Shahat
Director
Fishery Management Center
High Dam Lake Development Authority
Aswan, Arab Republic of Egypt

Recommendation

It is considered that the Fishery Management Center should contribute to the betterment of the economic condition of the population.

In this respect, the Fishery Management Center is necessary to take into account of economical assessment of projects in advance.

In case of embodying projects of seedling and fish farming, it is advisable for the Fishery Management Center to examine their economic efficiency of investments.

Mean-while, as the center is necessary to estimate the efficiency of restocking of tilapia and silver carp and their influence to ecosystem in the High Dam Lake, it is advisable for the Fishery Management Center to make study concerning these subjects by cooperation of related departments.

Japanese Fisheries Expert

A. Koike

Dr. Atsushi Koike

5 September 1987

Reference data No. 5

Mr. Mohamed El Shahat
General Director
Fishery Management Center (FMC)
High Dam Lake Development Authority
Aswan, Arab Republic of Egypt

Answers

Answers to your questions of 5th September 1987 are as follows;

1. Evaluation of FMC staff:

   Staff members' interest in research work has increased. However, there is a need of their further cooperation in order to analyse collected data in the future.

2. Employment of new staff:

   1) Department of Fishery Resources:
      As the duties of this department concerning fishery management are the most important, the present two staff members are not enough. Accordingly, it is advisable for FMC to employ one more researcher who is interested in analytic statistics or applied mathematics and in field work.

   2) Fish Hatchery Center:
      Please refer to the recommendation paper submitted by Dr. F. Takashima in April 1987.

3) Department of Environment:

It is advisable for FMC to employ a researcher who has studied limnology, ecology, oceanography, or chemistry.

3. Necessary number of fish fry within 5 years:

According the results obtained in the Department of Environment survey, the capacity of the stocks in High Dam Lake is estimated to be double based on the primary production levels. The total catch of tilapia is about 20,000 tons at present. If the findings mentioned above are true, the same volume of fish is expected to be caught. If the survival of the fingerlings (20 g size) is estimated as 1%, 2 billion fry released will produce a catch of 20,000 tons (1 kg size).

4. Increase of fish catch because of rising of water level:

An increase of the fish catch is expected with increases of the water level, the same as since 1967.

5. Information concerning the effects of the release of fish fry and its economic efficiency for fishermen:

According to studies of biological parameters and primary production, it is expected that, if fishing efforts are suitable, the fish catch will surely increase.

6. Proper arrangement of staff:

It is advisable to carry out proper staff arrangement for staff to obtain broad knowledge concerning the lake.

7. Mesh size and fish size:

As the number of small fish increases, it is advisable not to usa nets of small mesh size in order to preserve fish resources.
In other words, as a smaller number of large fish can be caught by nets of large mesh size, this contributes to the preservation of fish resources.

8. Economic efficiency of investment in large-scale farming of silver carp in net cages:

It depends on the relationship between fish price (or tax from fishermen) and expenditures for production such as the cost of the fry (including production facilities), net cages (including repair and checking), labor, transportation (fry and products) and food (if necessary). In addition, for efficient propagation using net cages, we must know about the following:

1) Optimum stocking density in each water area along the lake. For that purpose, the environmental condition of coastal areas near shore should be clear.
2) Suitable materials and structure of the cage.
3) Assessment of water pollution by net-cage propagation.

Japanese Fisheries Experts

Dr. Atsushi Koike
Dr. Nobuo Hirayama
Dr. Fumio Takashima
Dr. Kohei Kihara
September 5, 1987

Reference data No. 6

Dr. N. Hirayama

N. Hirayama

Comments

Since the establishment of the High Dam Lake in 1966, the total catch yield has been continuously increasing till 1981 when the water level of the Lake grew up to maximum.

In 1981, We estimated a prediction-curve of the catch yield, using the actual yield data which FMC collected up to that time, and the relationship between the actual yield and the prediction showed a good fitness, significantly. At that time, We estimated the suitable catch yield, 4.5*10^4 tons in future.

However, the water level has not increased expectively after 1982 and at the same time the catch yield has not grown up till now too.

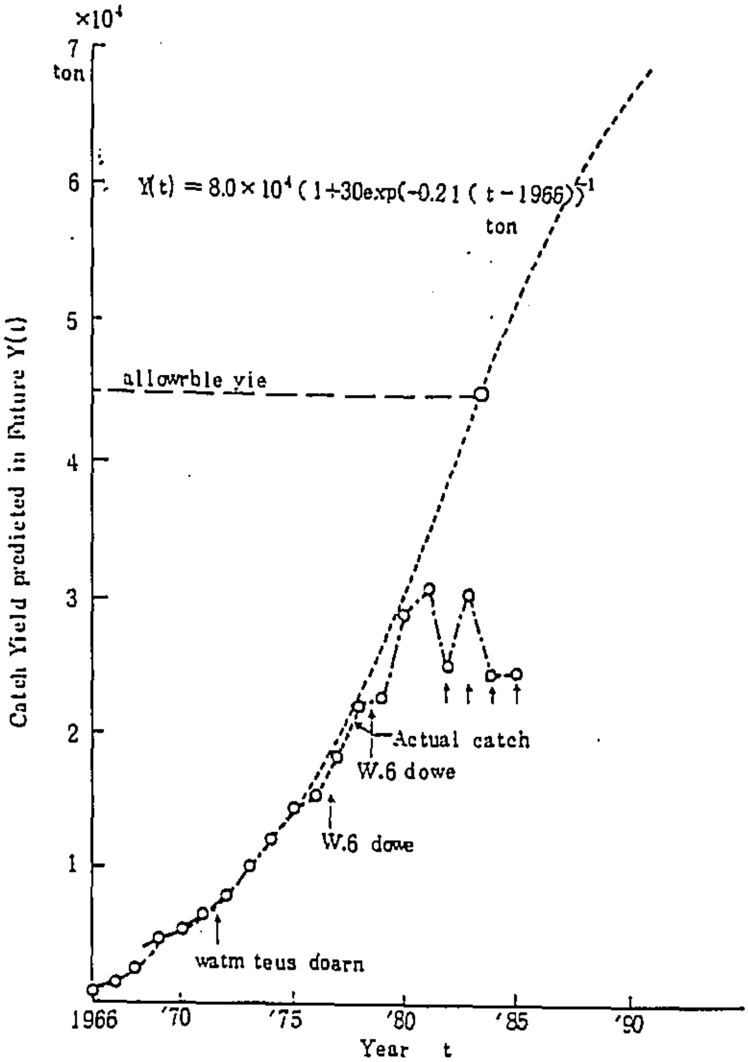
We have continued a study on the stock assessment using data concerning with catch, fishing informations and water level in the H.D.L, collected by FMC.

In consequense, now We suppose that the causes of catch dropping are as follows:

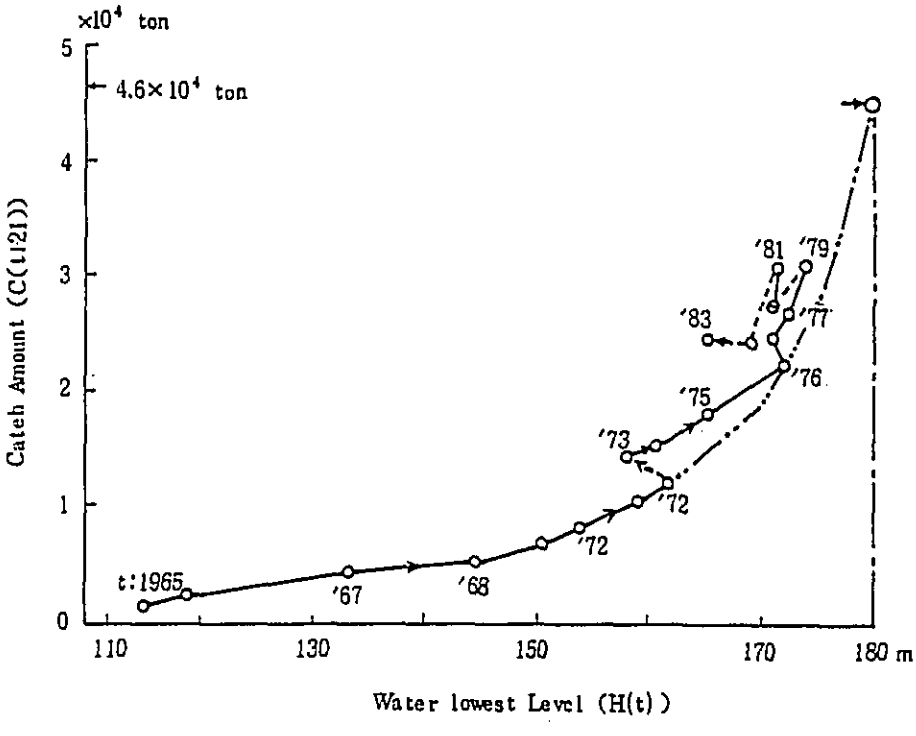
1) Decreasing of fishing effort(fishing intensity against fish stock) due to removing of fishermen from their camps.

2) Changing of fishing grounds caused by the water level falling.

So if the above two causes are recovered, We shall be able to expect good catch yield more than 4.5*10^4 tons not so long.



×10⁴
ton
Y(t) = 8.0×10⁴ (1+30exp(-0.21 (t-1966)))⁻¹
ton
allowrble yie
Actual catch
W.6 dowe
W.6 dowe
watm teus doarn
Catch Yield predicted in Future Y(t)
1966
'70
'75
'80
'85
'90
Year t



×10⁴ ton
4.6×10⁴ ton
Catch Amount (C(H21))
t:1965
'67
'68
'72
'72
'73
'75
'76
'77
'79
'81
'83
110
130
150
170
180 m
Water lowest Level (H(t))

Reference data No. 7

Mr. Mohamed El Shahat
General Director
Fishery Management Center

Recommendation

Fisheries Management Section

The fish catch in High Dam Lake has been decreasing as the water level has decreased. The reasons for this phenomenon can be considered to be as follows:

1) decrease of fishing area
2) decrease in fish reproduction due to the low level of the water
3) regulation of net mesh size has not been completely implemented

Especially in Kalabusha Bay, the decrease of the fishing area and the drop in the catch have been extremely great.
In light of the above situations, we recommend that in Kalabusha Bay the following management procedures should be under taken in order to rebuild the stock, and the following investigations should be conducted in order to measure the effects.

1. Fishing should be prohibited for all areas of Kalabusha Bay from January to June which includes the breeding season. This should be continued for at least 5 years from 1989.

2. Kalabusha Bay is separated into a southern part (Area I) and a northern part and the entrance of the bay (Area II). Tilapia fry are released in Area I but are not released in Area II.

3. Fishing can be permitted from July to December. Every 15 days the fishing area is switched from Area I to Area II or from Area II to Area I. During the fishing season, every 15 days the staff of FMC should investigate the fishing effort and catch species composition in weight. In the case of Tilapia nilotica, length composition should also be investigated.

4. Fry releasing is conducted from September to December in Area I. The number of fry to be released will be more than 500,000 in 1988 and more than 1,000,000 after that.
Released fry are not tagged or marked because it was found to be very harmful for small fish.

5. The effect of fry propagation and releasing on fishing is estimated by the analysis of variance (ANOVA). Data collection should be done utilizing the format which we described in the format sheet.

6. Special researchers are needed to achieve items 3 and 5. It is desirable to have new two assistants.

7. Modification of the ship is needed to transport the fry.

Environmental Study Section

1. Concerning the employment of new staff by the environmental study section, two recommendations were already issued by Japanese experts, namely, on September 5, 1987 and July 31, 1988. We again recommend hiring these researchers as soon as possible.

2. Financial aid for collecting information.

It is very important to collect much needed information from outside of FMC. These activities of collecting information (letters, phone calls, travel, etc.) require financial aid. Please help the staff members financially in this matter.

3. Gas connection system

The staff members of the chemistry section need a gas connection system in one of their laboratories to do some chemical analyses. Please provide the system as soon as possible.

Tokyo University of Fisheries,

Nobuo Hirayama
Masaru Maeda
Kazumi Sakuramoto
August, 1988

Reference data No. 8

Recommendation

1. Matters concerning environmental informations

1) Fishery Management Center needs to collect data of wind which is one of important environmental factors. Accordingly it is advisable to request offering of daily data of wind speed and direction to weather observatories such as the Aswan airport, the Abu Simbel airport, floating weather observatory near the High-Dam and others. Observation time of the data are 0, 3, 6, 9, 12, 15, 18, and 21 local mean time.

2) Fishery Management Center needs to measure the water temperature continuously at major locations in the High-Dam Lake. In this connection, it is advisable to ask sympathetic helping of related organizations such as fishermen cooperations and others in order to carry out continuous long term measurement of water temperature successfully and to prevent some sort of accidents of instruments.

2. Matters concerning management

1) Responding to questions concerning fishery managements of citizens, administrative offices, organizations such as fishermen cooperations and others is one of important duties of the Fishery Management Center.
   If it is necessary for director to refer those quetions to research staffs of the Fishery Management Center in order to answer appropriately, it is advisable to explain about subjects and their backgrounds proposed by citizens and other organizations to whole staffs sufficiently.

2) It is advisable for director to call regular staff meeting at least once a month in order to discuss about necessary matters and to exchange informations.

3) It is advisable for whole staffs to have seminar regularly at least once a month in order to discuss and to solve related subjects synthetically.

4) It is advisable for staff to ask revise of thesis and report through director. If necessary, director is better to ask their revises to appropriate outsiders.

Kohei KIHARA

19 May 1986

Reference data No. 9

Recommendation

1. As atmospheric data such as wind speed, wind direction, air temperature and other factors in the High Dam Lake region are necessary for applied studies conserning improvement of fisheries in the lake as mentioned in recommendation paper dated on 19th May 1986 , it is advisable for you to secure those data through related organizations as early as possible.

2. It is advisable for you to make contract with some commercial fishing boats as the sampling boat in order to collect more actual data concerning fishing and fishing ground. Staffs of Fishery Management Center have to join to fishing operations of those sampling boats in order to obtain correct data.

Kohei KIHARA

木原興平

12th January 1987

Reference data No. 10

Recommendation

1. It is advisable for FMC to subscribe following bulletins continuously:

1. Hydrobiologia
2. Limnology and oceanography
3. Aquaculture
4. Bulletin of the Japanese Society of Scientific Fisheries

2. As data concerning weather conditions are necessary to analyse fishing condition of the lake, it is advisable for FMC to ask about use of data of weather condition, especially wind data of floating station in the High Dam Lake, to the authority of weather of your government as early as possible.

3. If fisheries research boats such as El Sadaka, Raa, Bolti-1 and Bolti-2 which are very important facilities get out of order, FMC cannot conduct fishery management successfully. Therefore, it is advisable for FMC to make overhaul of these boats as early as possible. It is also advisable to check these boats every two years regularly. Otherwise important function of FMC will go down.

Japanese Fisheries Expert

Kohei Kihara

17 September 1987

Reference data No. 11

Detailed Manual on Dissolved Oxygen Measurement

This manuscript is a supplement to the original manual.

Please refer "A Practical Handbook of Seawater Analysis" by J.D.H. Strickland and T.R. Parsons, pp. 21-26.

A. Oxygen bottles.

1. Always check the printed numbers of the stopper and the bottle are the same.

2. Reconfirm the volume of the bottles.

a) Wash the bottles with detergent, rinse them with enough amount of tap water, and then rinse them with distilled water three times.

b) Dry the bottles in a drying oven at 50 -60°C.

c) Cool the bottles in the room where the Electronic Reading Balance is set for one hour.

d) Weigh the empty bottles with the stoppers by the balance.

e) Fill the bottles with distilled water, put the stoppers and wipe out outside completely.

f) Weigh the bottles again.

g) Calculate the difference in weight to get the volumes.

h) Tabulate the volumes for future uses.

Note: Date, room temperature, weights of empty bottles, weights of filled bottles and differences in weights should be recorded.

3. Dry the bottles for water sampling.

a) Prepare the dry bottles as described above (2-a and b).

b) Keep the bottles free from dust until next observation.

Note: Wash and dry the bottles as soon as possible after measurements. Place a small piece of weighing paper between stopper and mouth of a bottle.

B. Reagents.

1. N/10 and N/100 KIO_3 standard solutions.

a) Weigh an approximate but close amount to the calculated weight of KIO_3 by the Electronic Reading Balance. As a container a clean dry weighing bottle is the best and a small beaker is the next.

b) Dry the reagent in an electric oven at 105 - 110 C for one hour.

c) Transfer the container in a desiccater and cool it in the balance-room for one hour.

d) Weigh the container with the reagent precisely by the Direct Reading Balance.

e) Transfer the reagent to a small clean beaker (50 - 100 ml).

f) Weigh the empty container by the balanoe.

g) Calculate the difference in the weights to get a precise weight of KIO_3 to be solved.

h) Dissolve the reagent in the beaker with a small amount of distilled water.

i) Transfer the solution into a clean volumetric flask through a small funnel. (If some solid can be seen, repeat the steps g and h.)

j) Transfer the chemical completely into the flask by rinsing the glass rod, the beaker and then the funnel with distilled water three times.

k) Make the solutiom to the volume by adding distilled water.

l) Stopper and then homoginize the solution (upside down and then shake, at least 20 times).

m) For storage transfervthe solution to a clean amber glass bottle. If the bottle is wet, rinse it with a small amount of the solution 2 to 3 times before transferring the solution.

n) Calculate the actual concentration (or the factor) of KIO_3 by dividing the measured weight by the calculated one:

Actual concentration (N) = 0.N x fl

= 0.1 x(measured W/calcu-lated W)

o) To make N/100 standard solution, dilute the stock solution to 1/10

Use a clean hole-pipet and a clean volumetric flask. If the hole-pipet is wet, rinse it with the stock solution 2 to 3 times before usage. When the diluted standard must be kept for a while, transfer it to an clean ambient bottle. If the bottle is wet, rinse it with the solution 2 to 3 times.

Note: The weightsof container with and without reagent (after the transfer of the reageht) should be recorded.

Label the bottles with the name, concentration and factor of standard and the date of preparation.

2. Other reagents.

Use beakers, measuring sylinders, The electronic reading balance, etc. Be careful in dissolving NaOH and diluting HCl because a great deal of heat will be liberated. Cool the beakers in a tap water bath.

N/100 sodium thiosulphate solution should be prepared in advance, at least 24 hours before usage.

Follow the procedures described in the original manual.

C. Sampling (Dry bottle method).

Samples must be drawn in to the oxygen bottles <u>immediately</u> after they are taken (within 15 min).

a) Use clean dry bottles.

b) Remove air bubbles in a tubing completely.

c) Pinch it with fingers and insert it down to the bottom of the bottle.

d) Introduce the sample water in such a way as to minimize turbulence and agitation of the sample. Keep the end of tubing to the bottom of the bottle.

e) Overflow the water, an equal amount of the bottle or more of water if the oxygen content of the water is suspected to be very low.

f) Take out the tubing under keeping the overflow of water.

g) Put the stopper on the mouth of the bottle upside-down to minimize contant with air.

h) Add 0.5 ml of manganese chloride reagent followed at once by 0.5 ml of alkaline iodide solution.

Note: The outside of the alkaline iodide pipette should not get contaminated with manganese solutions. If a precipitate of higher-valency manganese basic oxides (similar precipitate as samples) appears in the alkaline iodide reagent, it must be discarded. Use two bottles for each reagent, one for daily work and the other for storage during cruise.

How to for the
* volume of the pipetts

i) Stopper the bottle immediately and mix the content thoroughly by shaking.

Note: Take another sample if air remains in the bottle.

j) Wash the outside of the bottle with lake water in a bucket.

k) Allow the samples to stand until the precipitate has settled at least one third of the way down the bottle leaving a clear supernatant solution.

Note: Keep the bottles out of direct sunlight.

D. Titration.

1. Standardization of N/100 sodium thiosulphate solution.

Daily standardization is ideal, but if the measurement lasts several days consecutively, standardization on every 2 or 3 days might be O.K.

a) Shake the container of thiosulphate solution before titration to minimize effects of evaporation and condensation of water.

b) After any shutdown period exceeding a few hours flush the burette and tubing several times with new solution before titrations.

Note: Dilute thiosulphate solution in the burette and the tubings will deteriorate quite rapidly.

c) Take 10 ml of N/100 potassium iodate standard solution by a hole-pipette into a conical beaker. Hold the pipette for 15 sec after the solution goes out, and then push out the remaining solution by warming the pipette.

d) Wash the wall of conical beaker and add some amount (~50 ml) of distilled water to increase the volume of solution.

e) Add KI and 6N HCl. Allow the iodine liberation to proceed for at least 2 min but not for more than 5 min, during which time the solution should be out of direct sunlight.

f) Titrate the solution at once with thiosulphate solution until a very pale straw color remains.

g) Add 1 ml of starch indicator and conclude the titration.

Note: This titration must not be delayed and thiosulphate should be added fairly rapidly. Near the end point continue the titration drop by drop confirming homogenious pale color. At very close to the end point wash the wall of the beaker with distilled water. Add small amount of thiosulphate solution by means of a washing bottle. Solutions should remain colorless for at least 20 sec at the end point.

A creeping end point is due to atmospheric oxidation of iodide to iodine which becomes increasingly rapid as the pH is lowered. At a pH value of 1.3 no tr ouble should be encountered for many minutes. Another source of error, the volatilization of elemental iodine, depends mainly on temperature and is not serious at temperatures less than about 25 C.

h) Calculate the factor (f) of the thiosulphate solution as follows:

$$f = f_1 \times (10/W)$$

Note: The mean value of f should be found from at least three and preferably five replicates.

2. Sample measurements.

a) Add 3 ml of 6N HCl, restopper the bottle and mix so that all the precipitate dissolves.

b) Transfer the solution into a conical beaker.

c) Wash the mouth of the bottle first and then its inside three times with distilled water. Combine the washets with the sample solution.

Note: The acidified iodine solution is stable for many hours or days in most instances. But if the water sample contains much amount of organic matter this may be slowly oxidized by the iodine. It is advisable, therefore, not to delay the titration. Iodine solutions in the oxygen bottles or titration beakers must be kept out of direct sunlight.

d) Titrate at once with standard N/100 thiosulphate solution following the steps described above (Standardization).

E. Determination of blank.

If analytical reagent quality chemicals are used there should be no blue color with starch. If a slight coloration results a blank correction may be ascertained by titrating with thiosulphate until the solution is colorless. If this blank correction exceeds 0.1 ml, the reagents are suspect and should be prepared afresh. The potassium iodide or manganese reagent is generally the cause of the trouble.

If no blue color is formed on adding starch, check that a blue color does result when 0.1 ml or less (1 drop) of N/100 iodate is added. This guards against the presence of reductants.

The blank testing should be undertaken when each new batch of reagents is prepared.

a) Take 100 ml of distilled water in a conical beaker.

b) Add 3 ml of 6N HCl and 0.5 ml of alkaline iodide solution. Mix thoroughly.

c) Add 0.5 ml of manganese chloride solution and mix again.

d) Allow the iodine liberation to proceed for at least 2 min but not for more than 5 min.

e) Add 1 ml of starch.

f) Conclude the titration.

F. Check on the presence of reductants in sample waters.

a) Take 100 ml (or an oxygen bottle-full) of sample water in a conical beaker.

b) Add 3 ml of 6N HCl and 0.5 ml of alkaline iodide solution and mix thoroughly.

c) Add 0.5 ml of manganese chloride solution and mix again.

d) Allow the solution to stand for 2 to 5 min.

e) Add 1 ml of starch..

f) Check that a blue color does result when 0.1 ml or less (1 drop) of N/100 iodate is added.

If no blue colour formed some reductants are in the sample water. In this case the effect of the reductants should be eliminated by adding a known amount of N/100 KIO_3 standard solution. The details of this procedure will be described elsewhere.

G. Calculation of the results.

a). Subtract any blank correction from the filtration to obtain the corrected titration (V ml).

b) Calculate the oxygen content of a sample from the formulae by the manual or computer method.

c) Calculate the saturation amount and the degree of saturation of oxygen.

Note: Always check on a miss-calculation or miss-input of data.

January 12, 1985
M. Maeda

Reference data No. 12

Mr. Ahmed and Miss Rokaya
Environmental Section
Fisheries Management Center
Aswan, Egypt

Dear Ahmed and Rokaya:

It's almost one year since I visited FMC last winter. Are you doing well? Please forgive me my long silence, but I have been having pretty busy days.

How are the matters going on in FMC? Are the rutine works on the schedule? Is the distilation system of water working well? I will be very pleased if you let me know about the matters in FMC.

In TUF the staff members of environmental section of this cooperative program (K. Kihara, T. Maruyama and M. Maeda) had discussions on the chemical components to be observed as a rutine work and their analytical methods. Our conclusions are shown in a table enclosed herewith. The chemical components are almost the same as those described in A Five-Year Plan of Activities at Fisheries Management Center (January 1985). The analytical method for dissolved oxygen, however, is changed to one of the modification methods and those for pH, SS, COD, P, N, SiO_2 and H_2S are identified.

For the preparation to start the work in full scale by youselves in 1987, we need informations how you have equipped your section. We asked Dr. N. Ioriya to check the fercilities, instruments, apparatus, reagents, etc, in your section. Enclosed herewith you will find the copy of check lists we handed to Dr. Ioriya. Please help him and fill out the lists. They will be a great help to us.

We are looking forward to see Miss Rokaya in our campus. At present Maruyama and Maeda are planning to visit FMC in August and December 1986, respectively.

You must be having a comfortable winter. I'm going to stay in Tokyo this winter, so I will have very cold days. Be careful not to catch a cold and to scorpions.

Best wishes,

M. Maeda

Masaru Maeda

December 16, 1985

Reference data No. 13

OUTLINE OF PROJECTS IN FISERY MANAGEMENT CENTER

Dr. Minoru NOMURA
August, 1983

The fundamental purpose of the High Dam Lake Fishery Management Center (FMC) is to conduct applied research for maintain and increase of fishery resources in the High Dam Lake.

The Board of High Dam Lake Development Authority considered the following three major items as a important problems in High Dam Lake fisheries to be solved at present and this consideration is also approved by the Ministry of Development and New Community.

1) Utilization of open water area in the High Dam Lake in connection with the introduction of new pelagic fish species.
2) Mass production of Tilapia seedling and their release to the High Dam Lake.
3) Restocking and / or propagation of decaying indegenous fish species.

Equally urgent is the improvement of method of keeping freshness of fish hauls from catching to landing, which will eliminate the substantial wastage fish catches in a short while and raise the annual production without intensification of fishing efforts. However, this problem is a technical, admministrative and economic subject rather than research subject. Therefore, this problem might be as well treated at other organization.

1. Utilization of Open Water Area in High Dam Lake

Effectively productive management by FMC is heavily dependent upon results of utilization of open water area, namely how to increase fish resources in the Lake, although it is quite difficult and needs a long time for obtaining some results. However, the following experiments will be indispensable for the purpose mentioned above as a work of preparation or a preliminary investigation.

1-1. Selection of Fish Species

First of all fish species suitable for the environmental conditions of open water area must be decided along with environmental survey. Since environmental cues play an imortant role in the synchronization of gonadal maturation in fish. Conditons for choice of fish species are as follows.

1) planktivorous,
2) those suitable for the environmental conditions of the open water area in both water quality and species of plankton,
3) those without adverse effect for other endemic fish species in the Lake,
4) those easily mass-produced in the Center,
5) those with moderate taste and size for Egyptian people,
6) those which can be harvested by an easy fishing methods.

Before selection of fish species survey on environmental water quality together with species and total amount of plankton available for stocked fish including seasonal variation should be completed.

I cannot give any recommendation concerning the decision of new species to be transplanted until obtaining more detail and acurate data mentioned above. However, I can suggest now from the theoretical basis to carry out some preliminary trials concerning with the acclimatization of following species which are thought to be suitable to open water area of the Lake. 1) Fresh water clupeid, 2) silver carp, 3) bighead carp, and 4) Labeo spp.

The introduction of new fish species contains many troublesome problems. For instance, on the introduction of fresh water clupeids, the following descriptions are instructive.

T. Petre and J.M. Kapetsky mentioned in their paper named "Pelagic fish and fisheries of tropical and subtropical natural lakes and reservoirs" (To be published in ICLARM, July, 1983). that; Limnothrissa (Clupeid, pelagic fish), for example, in various ecosystems, at various life stages and in differing seasons is known to be phytoplanktivorous, zooplanktiorous, a periphyton grazer, an insectivore and cannibal.

And also, P.C. Spliethoff et al (Fish. Mgmt., 1983) indicated that; the clupeid (Limnothrissa miodon) has colonized all parts of the lake including vertical and horizontal distribution and migration. Fingerling from 11-40 mm can be seen along the coast at 1-1.5 m depth, and the stomachs of these littoral juveniles were filled with Copepoda, Chrysophyta, Rotatoria and Dinophlagellata. Fish larger than 110 mm were only occasionally caught by artisanal fishermen. Most of these fishes were caught in the inshore waters. Analysis of the stomach contents showed an obvious cannibalistic feeding behaviour.

From the descriptions mentioned above, it is easily realized that a great attention must be paid when the new fish species are transplanted into the natural lakes and reservoirs where hold only endemic species keeping well balanced ecosystems.

1-2. Rearing of Introduced Fry

It must be absolutely avoidable to release directly new species fry into the Lake. These fry introduced from other countries should be reared in restricted tanks and ponds of the Center until they grow up to brood fish by feeding them an artificial diet under strict observation. During of a long-term feeding, some feeding experiments will be essential in order to find out their nutritional requirement together with biological and physiological investigation.

2. Mass production of Seedlings of Imported and Decaying species

This paragraph concern with not only the mass production of seedlings of imported species but also decaying(decreasing) species. The release of large number of fry into the Lake is one of the useful measures to increase natural fisheries resources. For this purpose the following trials should be necessary before conduction of mass propagation of fry.

2-1. Induced Spawning

For this purpose techniqes of artificial spawning, hormonally induced spawning, for well matured brood fish, are clearly necessary for an adequate supply of seedling, of fertile eggs and fry, with which to stock the open area of the Lake, until natural spawnig in the Lake is obtained. However, the above method is clearly inadequate to supply the present and future needs of the Center, since success is heavily dependent upon the brood fish reaching the right stage of gonadal development.

2-2. Mass-culture of Plankton

Live foods available for hatched fry are quite different, in general, from species to species and also from place to place. Although suitable foods for hatched fry are still remained unknown, preparation for mass-culture of phytoplankton and zooplankton will be necessary before the initiation of spawning by the brood fish. At present I can not indicate what kinds of phytoplanktons are available in this Center, but Moina will be one of the most suitable zooplankton relatively easily mass-cultured, their utilization, of course, depends upon fish size and species. Consequently, mass-culture of rotifer Brachionus plicatilis will become necessary as the initial live foods for fry just after opening of mouth. A survey on the ponds in the Center or the Lake to find out some suitable planktons for mass-culture is also necessary. For this purpose, some ponds for mass-culture of planktons should be provided.

2-3. Rearing of Hatched Fry to Stocking Size

After feeding with planktons fry must be reared up to stocking size on an artificial diet prepared by the Center. For this purpose a high amount of diet will be required and some equipments for preparation of diet will be necessary with an aquarium where dietary value for each species should be determined. As under the present conditions dietary ingredients available in Aswan, especially a protein source from scrup meal of Tilapia, are very low quality and high in cost, some improvement of nutritional quality is indispensable.

2-4. Facilities

To accomplish above mentioned works, the following facilities are required.

2-4-1. Outdoor Ponds

Four species mentioned above will be imported as a stage of fingerling because of their short period of incubation of eggs. These imported fry must be reared up to brood fish in the outdoor rearing ponds as mentioned already.

For this purpose, ponds for Tilapia rearing(to be mentioned in later chapter) can be used at present. However, exclusive ponds for new fish species (nearly same scale of ponds for Tilapia rearing might be needed) must be built according to the technical advance and expansion of the Project size in near future.

2-4-2. Hatchery Building

The following ponds and halls should be necessary for artificial egg taking and production of fry in the hatchery building.

a) Brood fish pond; Pond for brood fish in which hormone treated brood fish are kept until ovulation.

- Size 2m(width) x 4m(length) x 1.5m(depth,1m in water depth)
- Number 2 ponds, located at open shed near hatching building

b) Hatching hall; A room for setting incubation troughs.

- Area about 6.5m x 5.5m

c) Rearing hall; A room for setting tanks for rearing alevin(just hatched out fry).

- Area about 6.5m X 11m

d) Others; A office room (6.5m x 5.5m), a laboratory (6.5m x 5.5m), a store room (6.5m x 5.5m), a swich board room, a engine room (compressor room), and toilets, etc.

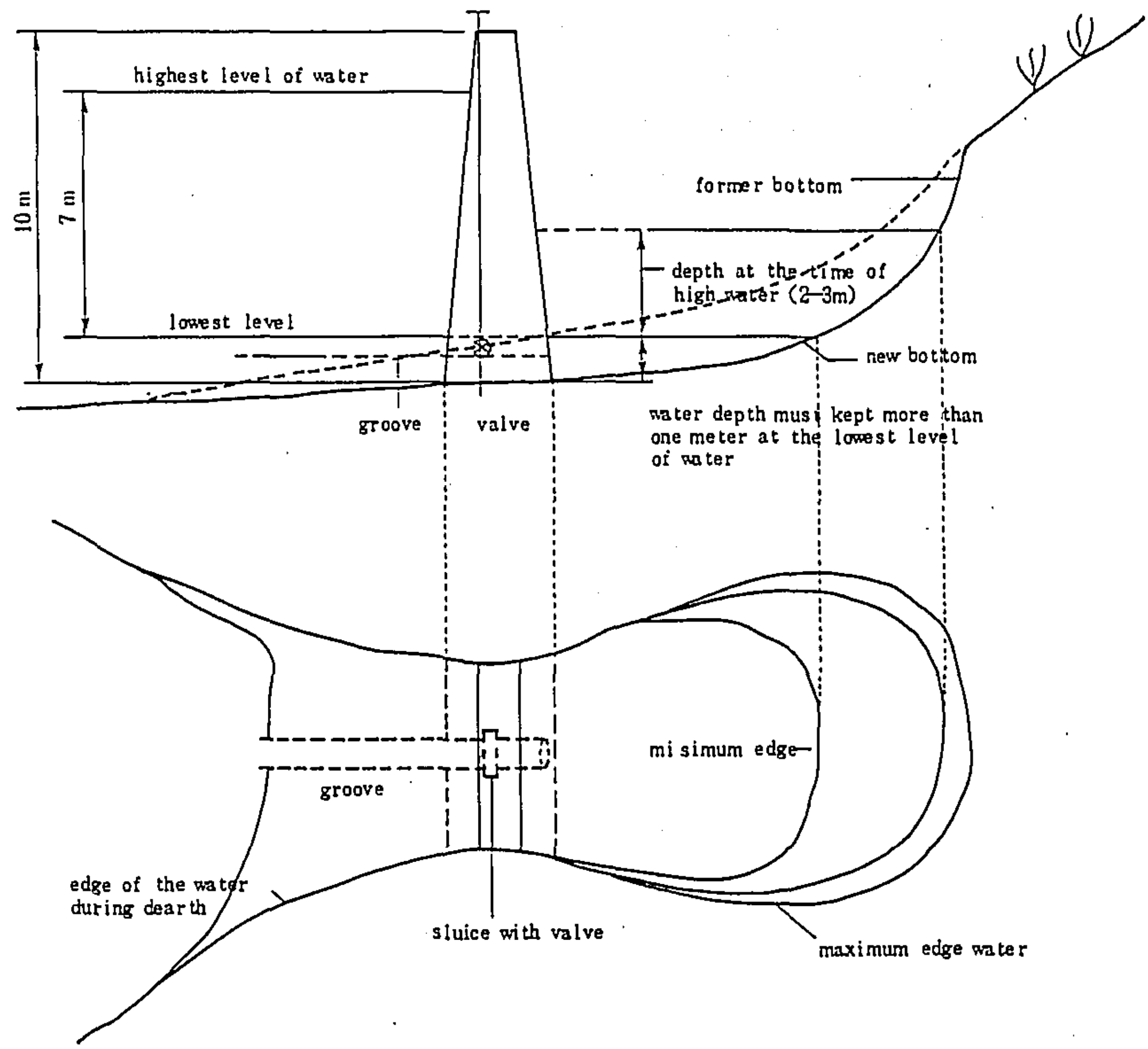
Hatching hall and rearing hall must be equipped with compressed air supply and water supply systems (laying main and branch pipes about 2m above from the floor, near the ceiling), and a floor has a adequate slope for easy drain.

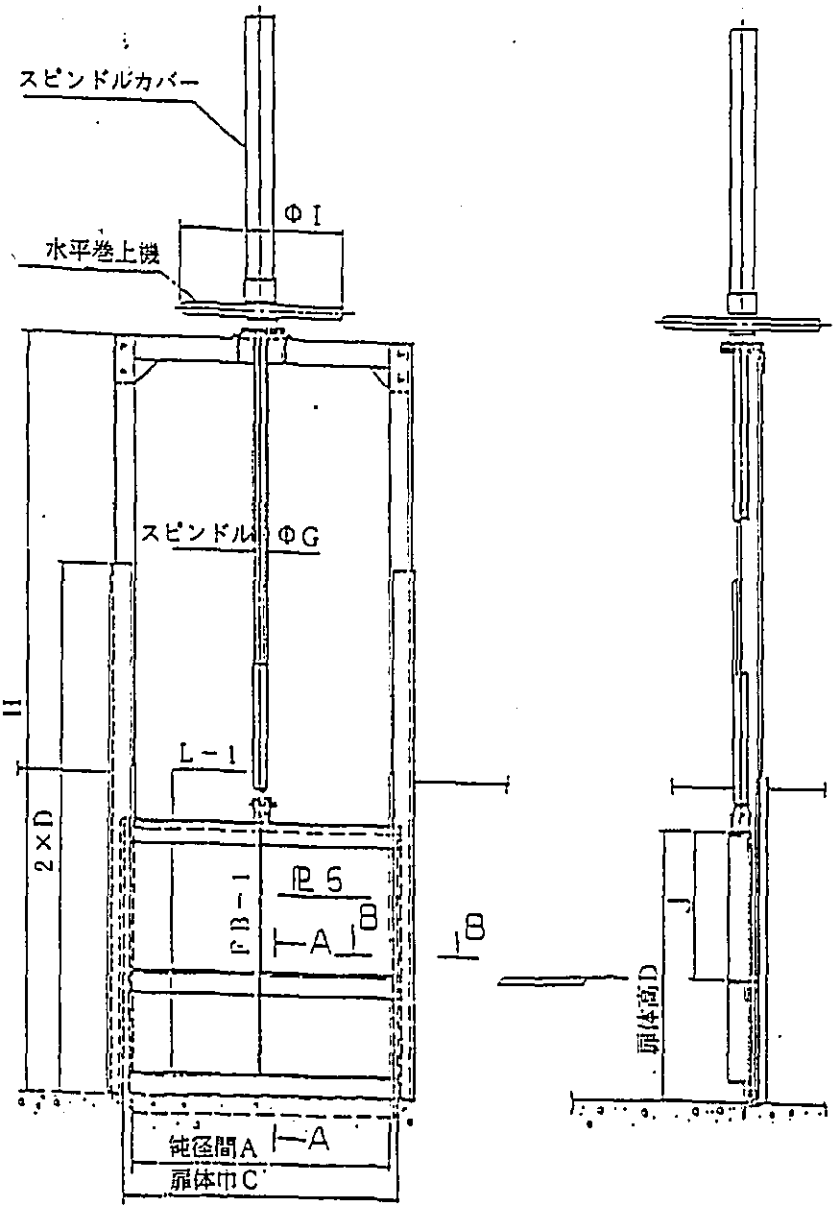
2-4-3. Acclimatization Pond

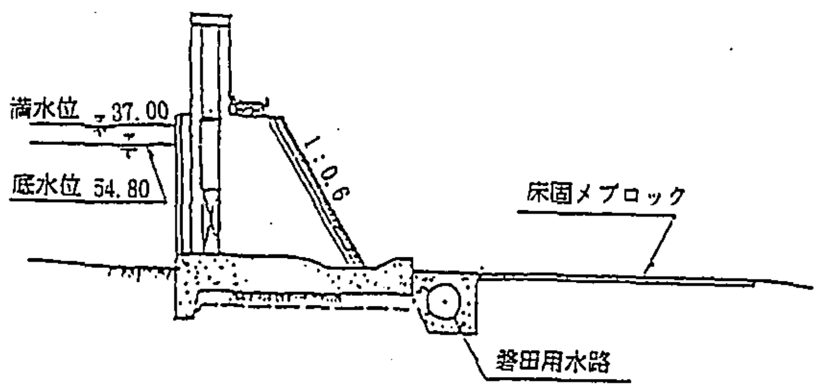
It is necessary to examine the possibility of rearing of new fish species fry only by natural foods such as planktons and benthos and also of acclimatization of new natural environment. For this purpose, the construction of "natural" nursery pond which is sets up along coastal region of the Lake and keeps the water 2m in depth even at the minimum water level of the Lake. The mouth of pond is partitioned by the concrete dam equipping a gate which adjust water level in the pond. Area of this pond is recommendable more than 2 ha.

This pond can also use in Tilapia rearing as the same purpose mentioned above.

Schematic figure of this pond is shown as follows.


highest level of water
10 m
7 m
lowest level
groove
valve
former bottom
depth at the time of high water (2–3m)
new bottom
water depth must kept more than one meter at the lowest level of water
misimum edge
groove
edge of the water during dearth
sluice with valve
maximum edge water


スピンドルカバー
ΦI
水平巻上機
スピンドル ΦG
H
2×D
L－1
FB－1
J
扉体高D
純径間A
扉体巾C


満水位 37.00
底水位 54.80
1:0.6
床固メブロック
磐田用水路

3. Mass Production of Tilapia Seedlings

Mass production of seedlings and their release to a natural habitat is one of the effective measure of propagation of fishery resource not only in coastal region of the High Dam Lake but also in the River Nile especially below the High Dam.

It was pointed out that the rapid increase of fish production in past decade was largely brought by the increased output of the Tilapia. It was also noted that 40 % of the total annual fish production was hauled during the period of March through May when Tilapia nilotica spawned in the shallow waters along the shore. It was reported that the percentage of T. nilotica had been declining relative to T. galilaea in catches. About 10 years ago, the percentage of T. nilotica shows more than 80 % of fresh fish catches. However, according to the data of the FMC, examined 21,746 individuals of landed Tilapia during the period of December of 1981 to June of 1983, the percentage of T. nilotica decreases to 41.8 % (10,468 in number) and T. galilaea 51.9 % (11,278). And the proportion of Landed T. nilotica in the total catch of the Tilapia shows the seasonal variation that the maximum level (60 -70 %) appears in February to April and the minimum (10 - 20 %) in June to September in each year. This tendency may suggest the sign of danger in T. nilotica resource in the Lake in future.

Therefore, it is essential to do the trials such as mass production of T. nilotica seedlings and their release to the khor with tagging in order to examine the effect of the release of seedlings on the increase of T. nilotica resources.

It is desirable to establish, at the earliet possible oppotunity, a system for rearing and releasing T. nilotica seedlings using adult fish caught alive from the Lake. In addition, a number of seedlings should be released with tags to assess the effect of such an undertaking. The success will ensure the increase if the stock base of T. nilotica in the Lake and accumulation of basic knowledge necessary for the future introduction of more advance methods of fish culture.
For this purpose, it is urgently necessary to built the following facilities to produce one million fry of T. nilotica .

3-1. Plan and Facilities Required to Produce One Million Fry of *T. nilotica*

3-1-1. Number of Brood Fish

Brood fish, about 30 cm in body length and 1 kg in body weight, produces about 1,000 eggs during a spawning season. Survival rate from eggs to fry (5 g in body weight) is 50 %. Then the number fo eggs required is two millions. Therefore, number of female brood fish required to produce one million is 2,000 (2,000,000 ÷ 1,000). As recommendable sex ratio at spawning time is one, 2,000 male brood fish are also required. Then, total number of brood fish become 4,000.

3-1-2. Kinds, Area and Number of Ponds

a) Brood fish-spawning ponds;

Total area 4,000 m^2

- Size 8 m × 12.5 m × 1.5 m (· 1 m water depth)
- Number 40

where, total weight of brood fish 4,000 kg (an average weight 1 kg, total number of fish 4,000), carring capacity of brood fish 1 kg/m^2

b) Nursery pond ;

Size	Number	Total area	Height of wall (water depth)
10 m × 15 m = 150 m^2	15	2,250 m^2	1.3 m (0.8 m)
5 × 10 = 50	40	2,000	1.3 (0.8)
3 × 5 = 15	30	450	1.0 (0.6)
2 × 4 = 8	25	200	1.0 (0.6)
1 × 4 = 4	25	100	1.0 (0.6)
Total	135	5,000	

Where, total weight of fry produced 5,000 kg (an average weight 5 g, 1 million in number), carring capacity of fry 1 kg/m^2

Total area of ponds (a) + b)) 9,000 m^2 (0.9 ha)

3-1-3. Water Supply System

Elevated tanks

- Water capacity (4 m × 2.5m × 4 m) 40 m^3
- Number 2

Water is supplied to each elevated tank by the pumping-up at a rate of 20 l/sec from middle layer of the Lake, and water in tanks supply to each ponds through pipes by gravitation. Pumping activity is regulated by the automatic on-off switch set on the elevated tanks.

3-1-4. Fish Feeds Preparation House

Total weight of brood fish is 4,000 kg. As the feeding rate for brood fish is 1.5 % of total body weight at 25 ℃ in water tmeperature, daily amount of feeds is required 60 kg (4,000 x 0.015) and 22 tons per year.

On the other hand, total weight of fry produced is 5,000 kg (1,000,000 × 5 g). We can use conversion factor 1.8. Then, the total weight of feeds required to produce 1 million fry (from alevin to 5 g fry) is 9,000 kg (5,000 × 1.8). It takes 40 days to grow up to 5 g fry from alevin, so daily amount of feeds is 225 kg (9,000 ÷ 40).

From above calculations, average amount of feeds to be prepared daily for both of brood fish and fry is 285 kg (60 + 225), and 31 tons per year.

For the preparation of these large amounts of feeds, equipments for mixing, chopping, drying and sieving are necessary. And also it is essential to set cold storage for feeds materials and fish feeds (30 tons capacity, -5°C).

The area of the house is needed about 65 m^2 (6.5 m x 10 m) including cold storage area.

Reference data No. 14

Notes on artificial breeding trial of silver carp

M. Nomura
M. Nomura, Ph.D.
JICA expert on fisheries
July 1984

An artificial breeding trial of silver carp by hormone injection was undertaken at Fishery Management Center (FMC) under the guidance of Dr. K. Sakai, Japanese expert on fish culture. Six fishes used in this trial were transported from the Fuwa Hatchery in May 1984. Only 4 brooders (3 females and 1 male) were used for the trial after the maturity check. Two others (1 female and 1 male) were immature and not suitable for the trial. Pituitary gland of silver carp being brought from Japan was used for hormone injection. (Detailed methods, meterials and results of the trial will be reported later by FMC staff.) Although the maturity of female and male brooders raised up to fully mature eggs by hormone injection, they did not reach to the level of ovulation (release of fully mature eggs). The followings are probable reasons for the negative results:

1) low activity of brooders
2) limited number of mature brooders, and
3) trial beyond the suitable spawning period of silver carp (May and June are the spawning period of silver carp in Egypt.)

Accrodingly, following items shall be taken into consideration for the next trial:

1) to take necessary steps that Japanase experts are despatched during the optimum period for the artificial breeding,
2) to prepare brooders as many as possible for the artificial breeding of silver carp, because of difficulties in artificial breeding compared with other species, and
3) to transport fingerling or yearling silver carp into FMC and raise them until maturation for the artificial breeding, because silver carp is very sensitive and rough handling of brooders affects on their maturation.

Reference data No. 15

A piece of advice

It is important to supply the water and oxygen to fishes at all times to keep these lives in ponds and aquariums.

Fishery Management Center rears a large number of fishes, Tilapia, Silver carp and Barbus bynni to release them into the High Dam Lake in future and to make use of experiments. Sometimes, the fish in center is collected and stocked into a small pond and a tank in high density in order to count the number, to research the maturity and to measure the body weight. In this case, it is necessary to take care of the suppling of water and oxygen because a short stop of them results in the death of fish. Therefore, the two generator were granted from JICA to center for possible accidents. But the generators are not prepared for use since the fuel and oil tanks of them are always empty.
Under this condition, center will lose a number of fish by a big accident at the collection and stocking of fish into a small pond and a small aquarium in a high density.

So, I hope that the generators are prepared for use at once and tested for operation 30 minuetes once a month.

Dr. K. Sakai

10th May, 1986

Dr. K. Sakai

Reference data No. 16

RECOMMENDATION

For the introduction of useful fishes into the High Dam Lake in future, Fishery Management Center of High Dam Lake Development Authority tried and succeeded to produce the fry of silver carp.

It is important to check the annual productivity of easily digestable phytoplankton for silver carp and measurement the growth and survival rate of silver carp in the lake.

Therefore, I recommend to stock the 3-5 cm. silver carp fry into the floating net cages at different 3 points in the lake and measure its growth and survival rate every two months, comparative with those of it kept in the large acclimatization pond with fertilization and feedings.

Dr. K. SAKAI

20th, May 1986

Dr. K. Sakai

Reference data No. 17

Recommendation

It is important to research and study the relationship between the habit of silver carp and that of the native fishes of the High Dam Lake. Therefore, I recommend the following:

1) Researching the kind of the plankton consumed by the silver carp in the lake.After selection of 3 stations in the lake (north part, middle part and south part of the lake), a unit with 4 net cages (2^m X 3^m X 1.5^m depth/net) or 1 net cage (4 X 8^m X 2^m depth) is set at each station. 150 (or 800) fingerlings of silver carp propagated in pond of Fishery Management Center are caught and body size and introduced into each cage, 10 fish of silver carp are caught from each cage and checked the body length and body weight and the contents of intestine every 3 months in a year. All silver carp in each cage are taken up and checked body size and survivals.

2) Researching the ecological relationship between silver carp and the native fishes of the lake.
3 inlets with same area (1-5ha, 5-10m depth) at middle part of the lake are selected and closed with dust (not to use the net) including the native fishes in them.
The native fishes are removed from all of them with net. 1500-7500 (1500/ha) fingerlings of Tilapia niloticus are released into one of them without the another native fishes. 1500-1750 (1500/ha) fingerlinges of silver carp are introduced into 3 inlets.
The native fishes of one inlet are released into original inlet after cheching the fish number and body size.
One year after introduction, all fishes are caught and counted the number. The growth rate of silver carp and Tilapia are checked and the results are compared among 3 inlets.
The chemical and plankton of each inlet are analized every 3 months in year.

3) Echo sound survey of silver carp in the inlets 6 months and 12 months after introduction of silver carp, echo sound survey are carried out on the distribution and migration in the inlets. After survey, the test of fishing are carried out in order to improve the fishing method in the lake.
The technic of aquaculture and results of experements are applied for the culture of tilapia and silver carp in the inlets closed with dust and in the net cages in the open area of the lake.

12th Jan. 1987

K. Sakai

Reference data No. 18

PLAN OF NEW SPECIES INTRODUCTION IN THE HIGH DAM LAKE

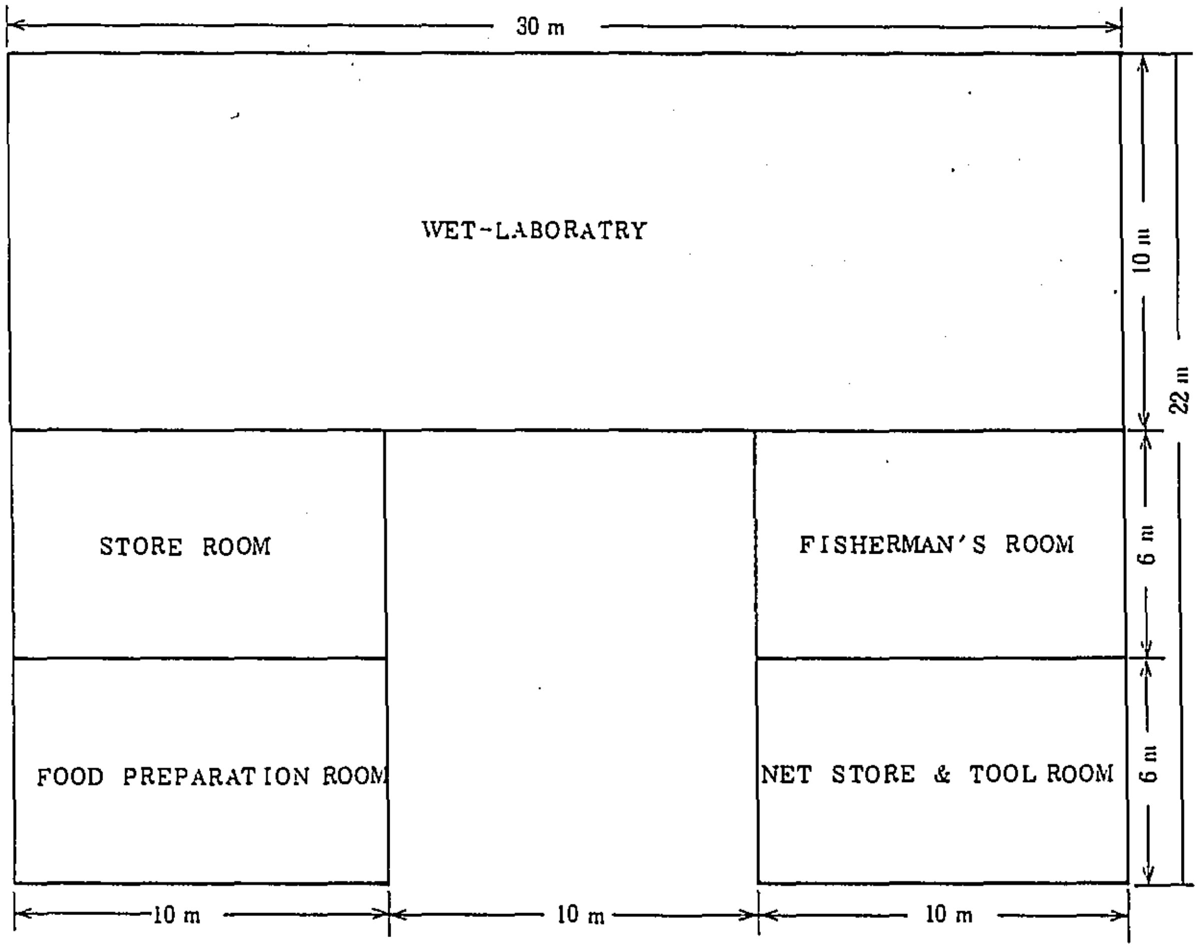
High Dam Lake can be divided 10% of coastal area and 90% of open water area. Now, yearly landed fish in High Dam Lake is 30,000 ton. However, 90% of landed fish were caught from coastal area, and there is very small amount of catching from open water area now.

From this reason, Dr.Nomura and another doctors from Tokyo University of Fisheries suggested to introduce new fish-Silver Carp- for increase the fish stock in the open water area in the High Dam Lake. The feeding habitat of Silver Carp is phyto-plankton, and living area is mainly open water area. In addition to that Silver Carp scarcely compete to feed from other local fish in the High Dam Lake. So introduction of Silver Carp is no problem to destroy fish life cycle in the High Dam Lake. And this kind of fish's growthing rate is very good, and quite economical fish.

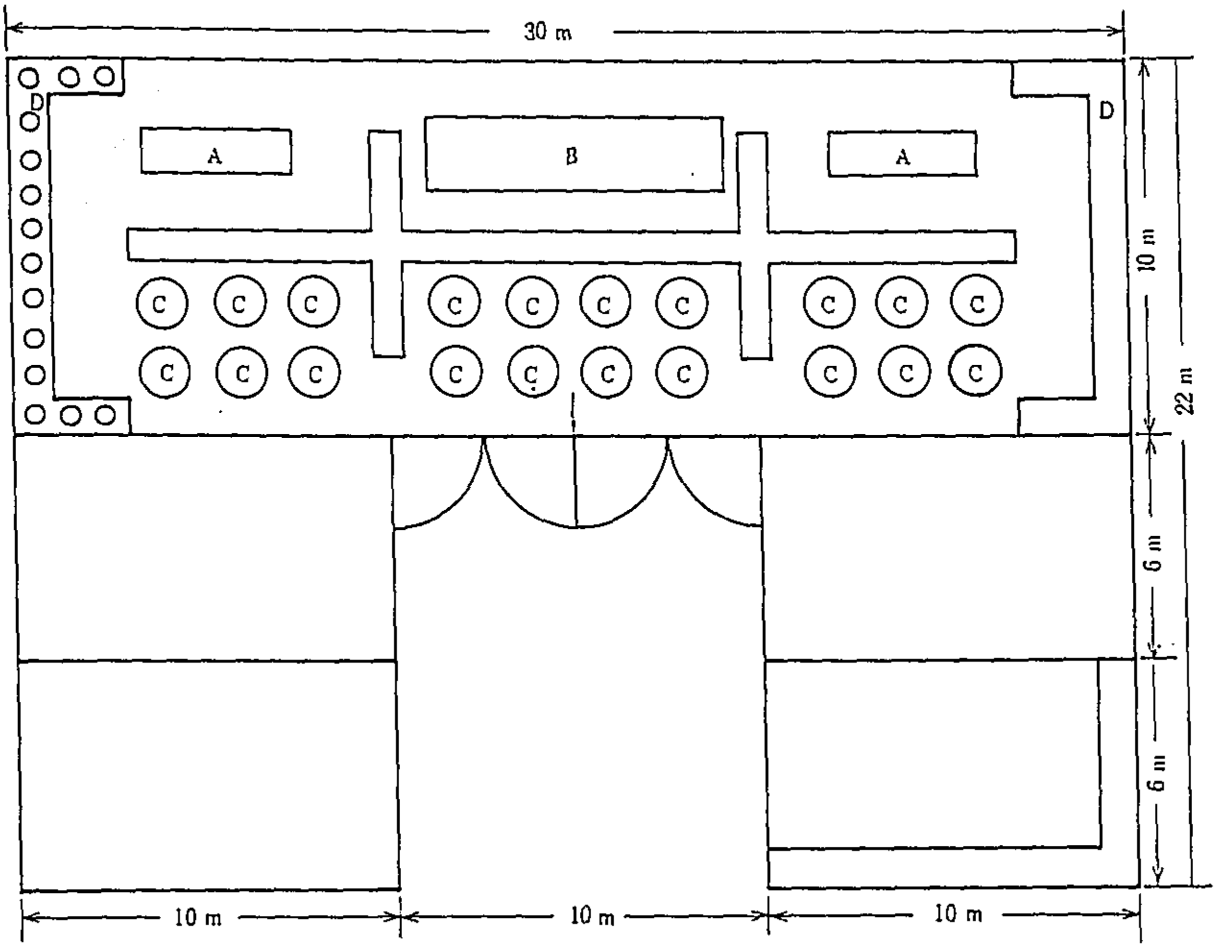
We already start the new experiment of Silver Carp fry production from 1984, and June of this year we succeeded to produce Silver Carp fry about 10,000. And we got some data of local fish (Labeo niloticus, Barbus bynni) for fry production. However, we have not enough equipments to do fry production and another useful experiments. So I suggested to construct the new Wet-Laboratry and new Circle ponds. When these constructions have been finished, I think we can work more activity and get plenty of better result from our experiments.

MASANORI KAWAGUCHI
JICA Expert in F.M.C.

Feb. 1987


30 m
WET-LABORATRY
10 m
22 m
STORE ROOM
FISHERMAN'S ROOM
6 m
FOOD PREPARATION ROOM
NET STORE & TOOL ROOM
6 m
10 m
10 m
10 m

1/200



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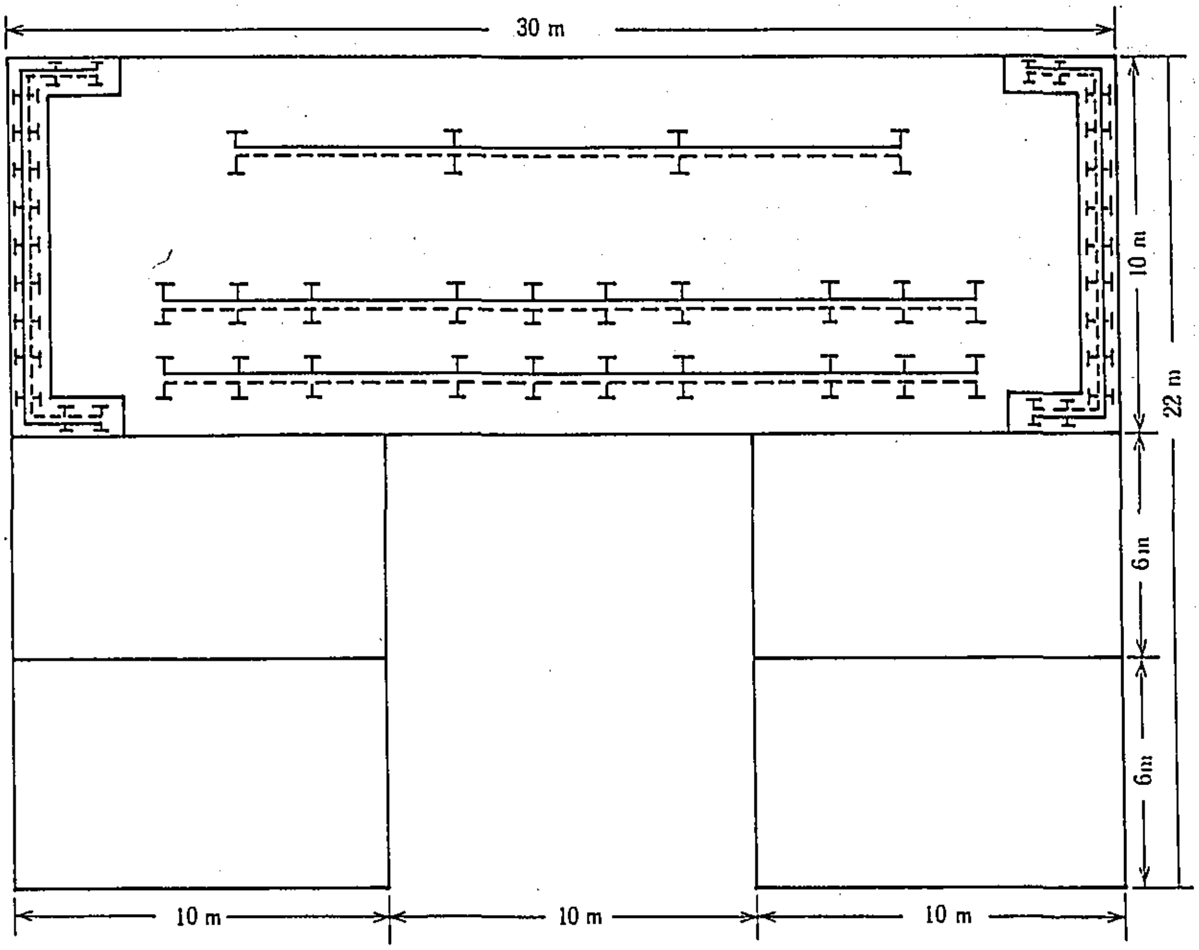
A : Hatching system

B : Brood pond (1.2m H－2m W－8m L)

C : Culture tank (1000L－10, 500L－10)

D : Experimental table and small culture tank (40L－15, 100L－15)

E : Drainage



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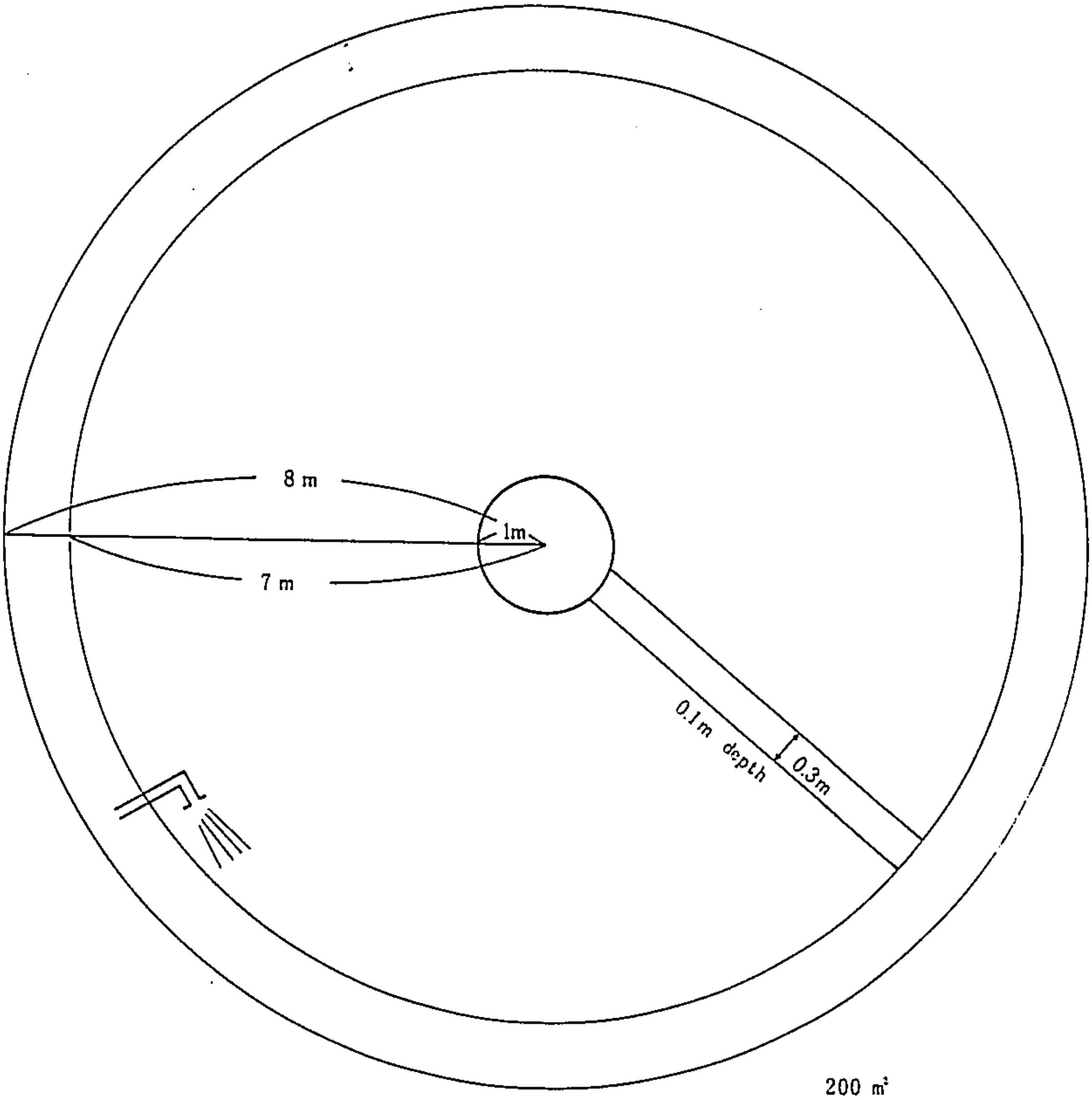
PIPING OF WATER AND AIR

——— Water supply

- - - - - Air supply



150 ton Circle pond

Equipment for wet laboratry

1) Plastic tank ----- 40L --- 15pcs.
100L --- 15
500L --- 10
1000L --- 10

2) Hatching system equipment
specially devised hatch bottle for chinese carp
10L --- 20pcs.
stand for hatch bottle --- 20pcs.

3) Water pump ----- 60L/min. --- 2
16L/min. --- 2

4) Air pump ----- 30L/min. --- 3

5) Air stone ----- large size --- 20
small size --- 30

6) Vinyl tube ----- diameter 7mm --- 100m
9mm --- 100m

7) Plastic pipeand plastic elbow for joint from tap
plastic pipe
elbow --- more than 50 pcs.

Equipment for stre room

1) Plastic container ----- 100cm - 70cm - 60cm --- 5pcs.

2) Plastic bucket ----- 50L(with cover) --- 10pcs.
15L --- 10

3) Balance ----- 50kg max. --- 1pcs.
15kg --- 1
5kg --- 1
1kg --- 1

Equipment for food preperation room

1) Mincer ----- 1pcs.

2) Mixer ----- 1

3) Drying macine ----- 1

Equipment for fisherman's room

1) Table ----- 1pcs.

2) Chair ----- 8

Equipment for net store and tool room

1) Working table ----- 1pcs.

2) Tool box for machinery ----- 1 sets

3) Carpenter's tool ----- 1 sets

4) Portable welding machine ----- 1 unit

JICA