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HISTORY OF AQUACULTURE

by

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Coastal Fisheries Development Project

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FOREWORD

This was originally delivered by Dr. Herminio R. Rabanal to the FAO/UNDP Network of Aquaculture Centers in Asia (NACA) Training Programme for Senior Aquaculturists, SEAFDEC, Tigbauan, Iloilo, Philippines, 24 March 1988. We have requested the author to contribute it as a technical paper to this Project because of its relevance to fisheries and aquaculture in the region. We are grateful to the author for agreeing to this publication.

(Sgd.) MEDINA N. DELMENDO
Project Coordinator

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HISTORY OF AQUACULTURE^{1/}

by

Herminio R. Rabanal^{2/}

1. EARLY BEGINNINGS

Students of aquaculture have advanced various theories on how aqua-culture started. It is noted that all these versions could really be factual but are perhaps applicable in different areas of the world where aquaculture may have started independently from each other. It is only within recent period when means of communication and transportation and exchanges beyond continental and national boundaries were possible that aquaculture development has become unified, intensified and in some cases, integrated.

Examination of available literature on aquaculture history shows that there are at least 4 theories that may explain the beginnings of aquaculture. These are described in the following paragraphs.

1.1 Oxbow theory

This version on the origin of aquaculture relates the beginnings of this industry to existing natural rivers and streams especially in inland areas. These rivers, in the course of time, develop curves and oxbows which, due to natural topography and physiography of the area, may farther result into long, winding oxbows of varying sizes. As time went on, under varying flood levels that occurred in different years such rivers may have changed their courses, leaving behind the formed oxbows together with the fish and other living organisms in them. Human population along the rivers, who by adaptation are natural fishermen, discovered a good harvest of fish could be derived from these naturally formed oxbows. It was also found that seasonal flooding of these water areas restocked them with fish which again could be harvestable during the ensuing dry season. Taking full advantage of this occurrence, enterprising individuals in the surrounding communities would begin to improve the embankments, enclosing such oxbow areas. Subsequently, in addition to the seasonal natural stock of fish that enter the modified oxbows, additional stock may be planted, thus starting aquaculture management in them. This continued on till complete aquaculture management was attained. Development of this nature is exemplified by extensive low-lying level areas with a network of rivers and a distinct monsoonal, annual rainy and dry period. Bangladesh may be a good example of this type of terrain.

^{1/} Lecture contributed to the FAO/UNDP Network of Aquaculture Centers in Asia (NACA) Training Programme for Senior Aquaculturists, SEAFDEC, Tigbauan, Iloilo, Philippines, 24 March 1988.

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1.2 Catch-and-hold theory

Fish and other aquatic products have always been held in high esteem by the early rulers of big empires. At the same time, it was a practice to build water areas as source of water, recreation, or a means of defense around castles. Such water areas were not really intended for rearing fish but some of the rulers demanded fish, regardless of the season so that the responsible officers around these rulers had to provide means to obtain fish even during winter. Due to this necessity, the practice has developed to stock fish caught from natural waters into the water areas constructed around castles or communities. As it turned out, some of the fish planted in these artificial waters were able to survive and grow while others perished. In the course of time, the species that survived and grow such as the common carp were selected for this catch-and-hold system of providing fish. As a further development, stocking of the right amount and kind of fish and feeding them when necessary also developed resulting in actual aquaculture practice. The monasteries of Europe and the palaces of emperors and other rulers exemplified this type of venue for aquaculture development.

1.3 Concentration theory

Many tropical areas of the world are affected by monsoons, one bringing strong rains with some floods and the other the dry season. During the rainy system, the rivers which provided the waterways get swollen and if the watershed was extensive, wide-level lowland places were likewise flooded. Extensive marshlands rich in vegetation and aquatic organisms, including fish, provided wide and favourable habitat for growth and reproduction during the flood season of the year. When the rainy season decreases until it finally stops, the water in these floodlands also gradually receded. As the dry season progressed, the water further receded, draining almost all the flood plains but leaving only spots of deep areas and the rivers with water. These resulted in the concentration of the fish that have grown and reproduced during the wet season into the watered depressions or back into the rivers. Fishermen from the surrounding communities catch fish from these concentrated depressions. At the beginning, most of the fish were caught without regard to size or kind. Later on, the small ones were left behind or gathered and transferred to other rearing areas. If suitable, some of these depressions would be provided with embankments in which culture of suitable fish stock in them was conducted, thus starting aquaculture management which began through the concentration version. The low level extensive plains in the African continent exemplified the environment suitable for this type of management. As a matter of fact, the prevailing practice which could be described mainly as capture fisheries but with some element of culture management have been in existence in such areas.

1.4 Trap-and-crop theory

While the first three versions have been observed as developments from inland freshwater areas, this fourth development is characteristic of brackish and marine areas affected by tidal fluctuations. Coastal areas usually abound with coves, lagoons, permanent ponds, enclosed swamps or even depressions which were periodically watered and fully or partially drained during ordinary or extreme low tides. The population along these coastal communities or owners or lessors of tidal lands with these types of water areas have long realized that these areas were regularly stocked with fin-fish, crustaceans and even molluscs and other aquatic economic resources naturally found in these waters. With these knowledge, they started to install traps that would block the exit of these fish and crustaceans that may have entered the water area during a flood tide. A fisherman realized that by this management, he could be regularly

provided with fish for his table and some extra for the market. As time developed, however, and as more fishermen fish in the surrounding waters, the amount trapped in these water areas declined. Therefore, instead of harvesting at each periodic tide fluctuations, the barricade to the watered area was kept in place for sometime, say, one to three months before the fish that have entered have grown to good size. Thus starting a primitive form of aquaculture. Later on, actual aquaculture management was developed consisting of providing the necessary dikes for the watered area, excavating and levelling the area to provide more space and stocking additional finfish or crustacean seeds to augment the trapped fish and crustaceans brought in by the tide. This chronology of development was what actually happened in the development of brackishwater aquaculture which probably began in Indonesia and spread to the Philippines, and later into Thailand, Malaysia, India and other areas in the world.

2. MILESTONES IN AQUACULTURE DEVELOPMENT

2.1 2000-1000 B.C.

C. F. Hickling the English aquaculture author, citing S. Y. Lin a noted Chinese aquaculturist, considered the earliest beginnings of aquaculture as during the period 2000-1000 B.C. This indicated that aquaculture has a long history dating as far as 4000 years ago. However, during the period, and especially before the advent of printing, no records were available except the narratives handed down from one generation to another especially those found in the seat of power during those periods. Admittedly, China was the cradle of the beginning of aquaculture utilizing mainly the common carp (*Cyprinus carpio*). It is said that aquaculture as a husbandry developed in China resulting from the fact that population started to have a settled condition and has been kept as an unbroken tradition. No detailed description of aquaculture practices was however available during that early period.

2.2 500 B.C. (473 B.C. or 475 B.C.)

This year is considered of very great significance in the annals of the history of aquaculture. Many authors round the year as 500 B.C. although most agree that the exact year is 475 B.C. and some even use 473 B.C. as the period when Fan Lai (also spelled Li or Lee by some authors) wrote his book, "The Classic of Fish Culture". This book consisted the earliest monograph of fish culture. Although the narrative also dealt on fantasies and metaphysical aspects, it is the first to record and describe the structure of ponds, the method of propagation of the common carp and the growth of fry. Excerpts of an English translation and Chinese facsimile of this book are appended (Appendix 1 and 2).

2.3 500 B.C.-500 A.D.

This period can be considered the Golden Age of common carp culture which has continued to develop in China as well as in neighboring countries where the Chinese people migrated or have some form of foreign relations. Not only is actual progress attained in the techniques of culture but also scattered records of the culture systems were made during this period. At about this time in the Indian sub-continent, specifically during the period 321 to 300 B.C., the use of reservoirs to hold fish was first described.

2.4 618 to 906 A.D. (Tang Dynasty in China)

The reign of the Tang Dynasty is particularly significant in the history of world aquaculture. The Tang emperor in China had the family name of Li which happened to be the common name of the widely-cultivated common carp. Because of this

coincidence, an imperial decree was issued prohibiting the culture as well as other activities connected with this fish. This decree, however, instead of putting a constraint to the development of aquaculture turned to be a blessing in disguise. The Chinese people who were then at the time very much engrossed in fish culture as a source of food and livelihood, looked for other species of fish for pond culture. This resulted in the discovery of the silver carp, the big-head carp, the grass carp and the mud carp, all very suitable pond culture species. It was also found that when raised in polyculture in the same pond, these species complement each other by eating different types of food and staying in different environmental strata within the pond. This led not only in the discovery of new species for culture but also in maximizing the productivity of freshwater pond culture,

2.5 906 to 1900 A.D.

2.5.1 906 to 1120 (Sung Dynasty), The initiative to collect fry of cultivable species seasonally along the rivers was started during the Tang Dynasty as a result of the prohibition decree on the common carp, Systematic fry collection and dispersal in natural waters was highly developed during following period under the Sung Dynasty, At about this time in India, the published work Namasollasa presented a compilation describing the fattening of fish in reservoirs. In China, in 1243, Chow Mit published his Kwei Sin Chek Shik which described fry transport in bamboo baskets.

2.5.2 1368 to 1644 (Ming Dynasty). It was during the Ming period that works describing the complete aquaculture process were detailed. Methods for culturing fry to adult, the structure of ponds, rearing density, polyculture, stocking/catching rotation, application of food and fertilizer and disease control were dealt with in aquaculture works during this period. In the year 1400 brackishwater aquaculture was recorded as having been started in Indonesia. This was suggested in the penal laws of the country (Kutara Menawa) which provided for the prohibition of stealing fish from ponds. In China, in 1639, the Complete Book of Agriculture which included pond fish culture was released.

2.5.3 1644 to 1911 (Ching Dynasty). During this period, further detailed description of fish culture methods were emphasized. This included fry production, season of occurrence of fry, differentiation and separation of fry and transport.

2.6 Independent developments in other areas

2.6.1 French Indochina. In the French Indochinese countries, the waves of Chinese migration had influenced the development of aquaculture. Due to the indigenous species in this area which became of value to the native population, cage culture of siluroids and related species developed independently and became a distinct aquaculture practice in this area. This practice has continued up to the present time (e.g. cage culture along Mekong River in Kampuchea).

2.6.2 Sub-continent of India. The practice of building water reservoirs of varying sizes as source of water and for religious purposes, started at very early period in this area. At the beginning, they were not used for fish culture. Subsequently, however, they were initially used To hold fish and later on to culture them.

2.6.3 Indonesia. The early development of brackish water aquaculture is attributed to this country at the beginning of the 15th century. This initiative was spread to neighboring areas including the Philippines, Malaysia, Thailand and southern parts of China (Taiwan).

2.6.4 Europe. Aquaculture in Europe also started during early period. Palaces of the early rulers, as well as temples and monasteries of the religious, were provided with water areas. Later on, these were used for temporary holding of fish and subsequently, they were used as environment for the culture of fish. Common carp and trout were recorded as the major species.

2.6.5 North America. There were attempts to develop aquaculture during the 19th century specially aimed at the development of sport fishing. A book, A Manual of Fish Culture, was published by the United States Commission of Fish and Fisheries in 1897. This dealt mainly on established hatcheries for the production of seeds to stock game waters but also includes some food species of finfish, oysters, clams, etc.

2.6.6 Africa. There were earlier attempts mainly from Europe to spread aquaculture in African countries. Due to the nomadic nature of most African communities at the time, the establishment of aquaculture became difficult. However, the presence of extensive flood plains provided environment for growth and reproduction of indigenous species during the rainy season and concentrating them in depressions or marshes during the dry season. This stimulated the early beginnings of aquaculture in that continent. At the present time, many initiatives for aquaculture development are being started in several countries in Africa. The tilapia, common carp and catfish are the selected species for culture.

2.6.7 Elsewhere.

a) Latin America. There is no local tradition of aquaculture in this region but widespread development are being initiated at the present time which are gaining interest and support,

b) Australia and New Zealand. Aquaculture development in these countries has been very recent and is just gaining momentum. Trout and other cold water species and mollusc culture, mussels and oysters, are developed.

c) Pacific Island countries. Varied types of development, especially sea farming activities, are just being initiated in the various Pacific Island countries,

d) Middle East and Israel. Although there are existing rivers which can be focal points of development for aquaculture in this region, early historical records did not mention any early aquaculture activities. Religious tradition in this area, however, indicated heavy utilization of fish for food. Present development show that much progress in aquaculture has occurred in the area especially in Israel. Here carp and tilapia culture have attained advanced state, and the other countries in the region have initiated aquaculture development programs.

e) Japan and Korea. There is no doubt that aquaculture developed in these two countries during very early period. Perhaps China had some influences in this development such as in the use of goldfish and carp for culture. But at same period in their history especially in Japan, the "closed door policy" was enforced in that country. At that time aquaculture continued to flourish especially in the culture of a very wide variety of species. This is probably the reason why in that country most any aquatic species of high economic value are subjected to culture - fin fishes, crustaceans, molluscs, other vertebrates and many kinds of marine invertebrates that could be the subject of trade. Development of efficient and high culture technology is also a characteristic of Japanese and Korean aquaculture.

2.7 1900-1700 - Expansion in operation and breakthroughs in seed production

This period witnessed worldwide expansion of aquaculture. Easy means of communications and widespread exchange of information through national and international agencies have stimulated the acceleration of the expansion in aquaculture.

The urgent need for seeds to fill the expanded aquaculture industry resulted in technology breakthroughs in inducing the spawning of cultivable species, the seeds or fry of which were only formerly obtained from wild waters. In this period the cultivated Asiatic carps and the Indian major carps were induced to spawn under controlled conditions. Likewise the penaeid shrimp species and the giant freshwater prawns used in culture were also hatched under control in hatcheries.

2.8 1970-near future - Continued expansion and selective culture of high value and exportable species and intensification

In this period more species were brought into culture. The industry continued to expand both in area and in quantity of production,

A new trend to select species that are most profitable to culture was adopted by operators in the industry. Therefore, high value species especially those with high export demand were emphasized. Penaeid shrimps, high value fin fishes (seabass/groupers), seaweeds and related species became important aquaculture items.

As demand and high market value for selected species persisted, high technology methods and intensification of operations became the norm of the industry. There is competition for major markets and maintenance of product quality standards also became a major concern.

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APPENDIX 1
EXCERPTS FROM CHINESE FISH CULTURE

by

Fan Lee
(5th Century B.C., China)
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Translator's note: "The Chinese Fish Culture Classic" was originally written by Fan Lee, a politician turned fish culturist, in ancient China during the 5th Century B.C.

China has a long history of fish culturing. As long ago as the 12th Century B.C., there were fish rearing records in the Chinese Classics of early Chou Dynasty (1112-221 B.C.). However, Fan Lee's work is the oldest known publication in Chinese literature on fish culture methods. Due to the antiquity of the article, some of the points mentioned in the text do not seem to make any sense. They are therefore not to be taken literally. For fear of second guessing the intent of the original author, however, this translator has tried the rendition rather literally. The purpose of this translation is merely to offer documentation of ancient Chinese fish culture work to Western literature and to give modern fish culturists some insight to the techniques of domesticating the common carp practiced nearly twenty-five hundred years ago.

King Wei of Chi², upon learning that Chu Kung was visiting in neighboring Lau, invited him over and asked: "I hear that you have been calling yourself a different name every time you visit a different country, and in Yuch you are called Fan Lee. Is it true?" "True," answered Chu Kung. The King continued, "You live in a very expensive house, and you have accumulated millions. What is the secret?" Whereupon Chu Kung responded: "Here are five ways of making a living, the foremost of which is in aquatic husbandry, by which I mean fish culture. You construct a pond out of six mou³ of land. In the pond you build nine islands. Place into the pond plenty of aquatic plants that are folded over several times. Then collect twenty gravid carp that are three chih⁴ in length and four male carp that are also three chih in length. Introduce these carp into the pond during the early part of the second moon⁵ of the year. Leave the water undisturbed, and the fish will spawn. During the fourth moon, introduce into the pond one turtle, during the sixth moon, two turtles; during the eighth moon, three turtles. The turtles are heavenly guards, guarding against the invasion of flying predators. When the fish swim round and round the nine islands without finding the end, they would feel as if they are in natural rivers and lakes. By the second moon of the next year, you can harvest 15,000 carp of one chih in length, 45,000 carp of two chih and 10,000 carp of three chih.⁶ The total harvest can render a cash value of 1,250,000 coins. The following year, you can get 100,000 carp of one chih, 50,000 carp of two chih, 50,000 carp of three chih, and 40,000 carp of four chih. Save 2,000 carp that are two chih in length as parent stock and market the remainder. The take will amount to 5,150,000 coins. In one more year, the increase in income is countless."

Following the advice of Chu Kung, King Wei started a fish pond in his garden. In his first year, the King made more than 300,000 coins. In his pond, there were built nine islands, In addition, eight depressions were excavated. Each depression had two chih of water at the rim and six chih of water in the center. The carp would segregate

themselves according to size in these depressions. The reason to raise carp rather than other species of fish is that the carp is not cannibalistic, that it is fast growing, and that it is inexpensive to raise,

Addendum7; Pond fish culture. Carp as large as three chih long are obtained only in the vicinity of large rivers and lakes. If you start with small fish, they would take too long to mature. If you start with the spawn, the method to collect spawn is to go to shore areas of rivers and lakes where large carp gather, Collect the mud at the water's edge, take a dozen loads or so and spread the mud on the bottom of the culture pond. Within two years there will be grown large carp, This is because the mud contains eggs of large carp, which hatch readily in pond water.

¹ Contribution No. 459, Chesapeake Biological Laboratory. University of Maryland, Solomons, Maryland, U.S.A.

² Chi, a kingdom ruled by King Wei, 378-344 B.C.

³ Mou is a Chinese land measure of area. In today's standard, 6.6 mou is equal to one mile.

⁴ Chih is a Chinese measure of length. In today's standard, 1 chih is equal to 0.3581 meters, or 1.175 feet.

⁵ Chinese calendar goes by moon phases. Each moon of the year is 29 or 30 days. Generally it is approximately 1 to 1.5 months later than the Western calendar. The second moon is roughly equivalent to March, the fourth moon to May, etc.

⁶ The original versions have it as 15,000 carp of one chih in length, 45,000 carp of three chih, and 10,000 carp of two chih. I feel that this is a distinct error and have therefore changed the order to make better sense.

⁷The addendum section appears only in the Ching version but not in the Ming version.

周 陶朱公 撰

威王聘朱公問之曰聞公在湖爲漁父在齊爲鴟夷
 子皮在西戎爲赤犢子在越爲范蠡有之乎曰有之
 曰公在足千萬家累億金何術乎朱公曰夫治生之
 法有五水畜第一水畜所謂魚池也以六畝地爲池
 池中有九洲求蝦子鯉魚長三尺者二十頭在鯉魚
 長三尺者四頭以二月上庚日內池中令水無聲魚
 必生至四月內一神守六月內二神守八月內三神
 守神守者僮也所以內僮者魚滿三百六十則蛟龍
 爲之長而將魚飛去內僮則魚不復去在池中周遊
 九洲無窮自謂江湖也至來年二月得鯉魚長一尺
 者一萬五千枚三尺者四萬五千枚二尺者萬枚枚
 直五十得錢一百二十五萬至明年得長一尺者十
 萬枚長二尺者五萬枚長三尺者五萬枚長四尺者
 四萬枚長一尺者二千枚作種所餘皆取錢五百
 二十五萬錢候至明年不可勝計也王乃於後苑治
 池一年得錢三十餘萬池中九洲八谷谷上立水二
 尺又谷中立水六尺所以養鯉者鯉不相食又易長
 也齊民要術卷六太平御覽卷九百二十五
引多賦陶朱公說都亭第一百七首有朱公居
商澤
 又作魚池法三尺大鯉非近江湖倉卒難求若養小
 魚積年不大欲令生大魚法要須截取陂澤陂湖傍
 大魚之處近水際土四十數畝以布池底一年之內
 能生大魚陂土中先有大魚子得水即生也陂類

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