

Polyculture of Fishes

(E-Contents prepared by Prof. Sunil P. Trivedi, Deptt. of Zoology, University of Lucknow)

I. Concept & Definitions

In order to obtain high production per ha of water body, fast growing compatible species of fish of different feeding habits, or different weight classes of the same species, are stocked together in the same pond so that all its ecological niches are occupied by the fishes. This system of pond management is called *mixed farming* or *composite fish culture* or *polyculture* (Jhingran, 1991).

Polyculture, technique of growing at least two compatible aquatic species together in a single pond or lake, has the objective of increasing production using organisms with different feeding habits or spatial distribution (Zimmermann et al., 2009).

Culturing two or more species in one physical space at the same time is known as polyculture. One of the main aims of polyculture is production of multiple products that are economically valuable. It is comprised of combination of animals, plants and animals, aquatic species only, or aquatic and terrestrial species (Stickney, 2013).

In mixed culture the fish usually stocked are a mixture of plankton feeders and macrophyte (waterweed) feeders. In ponds we try to maintain a balance by using both the phytoplankton feeders and the water-weed feeders. Thus, different species fish grazing down both, planktons and macrophytes, are introduced in the pond (<http://www.fao.org>).

Thus, this can be summarized that –Introduction of fast growing compatible fish species having different food preferences and occupying different ecological niches in ponds/reservoirs to obtain maximum yield by utilizing maximum extent of pond's productivity is termed as composite fish culture or mixed farming or polyculture.

II. Introduction

With the purpose of getting maximum production of fishes from a water body (lake/reservoir/pond) culture of fast growing compatible species of different feeding habits and ecological niches is being practiced in different parts of the globe. This is popularly known as composite fish culture or mixed farming. Term 'polyculture' is also loosely applicable for such a culture. In composite fish culture, all available food supply of the pond (phytoplankton, zooplankton, periphyton, macrophytes, benthos and detritus matter etc.) is most

efficiently utilized by the cultured fishes. Such fishes do not harm each other; rather, they promote growth of other fishes. By proper care and management fish production can be raised by 5-6 times more than usual production through polyculture.

For the ages, mixed fish farming is practiced in China. Chinese system of culture involves Chinese carps *viz.*,

- i. Black carp, *Mylopharyngodon piceus* that feeds on snails and other molluscs at pond bottom,
- ii. Grass carp, *Ctenopharyngodon idella* that subsists on or macrovegetation,
- iii. Silver carp, *Hypophthalmichthys molitrix*, a phytoplankton feeder,
- iv. Big head, *Aristichthys nobilis* that feeds on macroplanktons,
- v. Common carp, *Cyprinus carpio* which is an omnivore,
- vi. Bream, *Prabramis pekinsis*, also an omnivore,
- vii. Mud carp, *Cirrhinus molitorella*, a bottom feeder.

Hora and Pillay, 1962 have recognized following three types of Chinese system of fish culture (Jhingran, 1991):

- a) The Kiangsu and Chekiang system -that employs natural climatic conditions of the ponds and available stocking material. On account of market preference and easy availability of choice food, the black carp is preferred over grass carp in this region.
- b) The system of the West River regions-in some parts of South China and the Tonkin Province of Vietnam, stocking strategy is greatly influenced by the local climatic and ecological conditions. The mud carp, *Cirrhinus molitorella*, a subtropical species, is preferred over the cold resistant black carp, *Mylopharyngodon piceus* in these regions.
- c) The Hong Kong system- involves utilization of slightly brackish water in ponds and lesser stocking of black and mud carps due to warmer climate. The most striking feature of this system is the use of gray mullets for pond stocking on account of their great local abundance.

Indian Polyculture System

In India, initially the multi species culture was started with Indian major carps-rohu (*Labeo rohita*), catla (*Catla catla*) and mrigal (*Cirrhinus mrigala*) alone. Later, the major carps were stocked in combination with calbasu (*Labeo calbasu*), sometimes with bata (*L.bata*) and with pearl spot (*Etroplus*

suratensis), gorami (*Osphronemus gorami*) and acclimatized milk fish (*Chanos chanos*). (Sinha, 1985; <http://www.fao.org>). Alikunhi (1957) have listed an exhaustive list of cultivable fish species in India. As far as stocking ratio in earliest composite fish culture is concerned, Indian major carps were introduced at different rates (Table 1).

Table1. Stocking ratio of different Indian major carps in earliest mixed fish farming

Sl. No.	Catla	Rohu	Mrigal	Reference	Pond area
1.	03	03	04	Alikunhi, 1957	
2.	1975	3750	625	Hora and Pillay, 1962	One hectare
3.	04	03	03	CIFRI, 1960s	@ 3750 per hectare density
4.	03	03	03	CIFRI, 1960s	
5.	01	01	01	CIFRI, 1960s	@ 15,000 per hectare
6.	04	03	03	Chakrabarty et al., 1979c	

Following reasons may be attributed for selection of Indian major carps in mixed fish culture

- (1) Catla (*Catla catla*) being a surface feeder on planktonic organisms particularly zooplanktons.
- (2) Rohu (*Labeo rohita*) is a column feeder, consumes vegetable matter including decaying aquatic plants, algae, etc.
- (3) Mrigal (*Cirrhinus mrigala*) a bottom feeder, prefers decayed plant and animal matter, algae, detritus, organic matter, etc.
- (4) Calbasu (*Labeo calbasu*), being a bottom feeder utilizes selectively benthic and epiphytic organisms and organic debris as its feed.

Further, with the advent of exotic Chinese carps, viz, silver carp, grass carp and Bangkok strain of common carp in India, several experiments were conducted at CIFRI, Cuttack to establish their suitability for mixed culture. It was concluded that:

- (1) Exotic Chinese carps are fast growing, non-predatory and compatible with Indian major carps.
- (2) Exotic Chinese carps always gave better rate of production when they were stocked with Indian major carps rather than when Indian or Chinese carps were stocked alone under identical managerial/material input (Sinha, 1985, <http://www.fao.org>).

Thus, depending on compatibility, feeding habits and preference of ecological niches, a high yielding six species combination (Table 2), commonly known as composite fish culture was evolved and recommended in India (Sinha, 1985, <http://www.fao.org>; Padhi, et al., 2015 and Panda, 2016).

Polyculture has further been expanded via addition of new species combinations and pond health boosters, e.g.

- i. grey mullets (*Mugil cephalus*) a benthic-feeder and
- ii. chital (*Notopterus chitala*) a carnivorous weed controlling fish.
- iii. Culture of freshwater shrimp (*Macrobrachium rosenbergii*) with tilapia (Brick and Stickney, 1979).
- iv. Algal blooming is regular problem in ponds and it can be controlled by culturing phytoplanktophagus Silver carp (Islam et al., 2019).
- v. Utility of bottom dwelling fishes, e.g., mrigal and common carp in recycling of nutrients to water while digging the base mud while looking for food. Such an activity of bottom tenants additionally circulates air through the water (Rahman, 2006).

Table 2. Typical six-carp species composite fish culture

Fish	Species	Feeds upon	Trophic Habitat/Feeding habit
Exotic Carps			
Silver carp	<i>Hypophthalmichthys molitrix</i>	Phytoplanktons (Plankton feeder)	Surface feeder
Grass carp	<i>Ctenopharyngodon idella</i>	Macrovegetation (Hervivorous)	Surface, column and marginal areas
Common carp	<i>Cyprinus carpio</i>	Detrivorous/Omnivorous	Bottom feeder
Indian Major Carps			
Catla	<i>Catla catla</i>	Zooplanktons (Plankton feeder)	Surface feeder
Rohu	<i>Labeo rohita</i>	Omnivorous	Column feeder
Mrigal	<i>Cirrhinus mrigala</i>	Detrivorous	Bottom feeder

III. Objectives of polyculture

Polyculture should fulfill the following prime objectives

- Raising healthy and economically viable fish crop.
- Maximum yield or fish production per hectare/ season.
- Production of multiple and economically valuable products.
- Utilization of full potential of pond's productivity.
- Utilization of different types of food available in all available ecological niches.
- Proper financial return to the farmers.
- Aggressive marketing strategy.
- Appropriate ecological balance of the pond.
- Acceptance of low-cost feed by culturable fishes.
- Preference of compatible and pond fertilizing fishes, e.g. grass carp.

IV. Advantages of polyculture

- (3) Increases employment opportunities.
- (4) Intensive polyculture of fish is fully controlled by the farmer.
- (5) More fish can be cultivated and produced within a small water body.
- (6) Fish polyculture enhances the pond productivity.
- (7) Maintains water quality.
- (8) No competition among cultured fishes for food and space in the same water body.
- (9) Complete utilization of spatio-trophic habitats.
- (10) Fishes can be grown as per market preference.
- (11) Various species combined in polyculture framework adequately contribute to improve the health of the pond (<http://aquafind.com/articles/Polyculture.php>).
- (12) Defecated semi-digested food of grass carp serves both as a feed for bottom-dwellers and a pond fertilizer with high cellulose-digesting microbes. Thus, this species has the ability to promote synergistic composite fish culture (Jhingeran, 1991).

V. References

- Alikunhi, K.H.,1957. "fish Culture in India". Fm.Bull., Indian Coun.Agr.Res.,20:144p.
- Brick RW, Stickney RR (1979) Polyculture of *Tilapia aurea* and *Macrobrachium rosenbergii* in Texas. Proc World Maricult Soc 10:222-228.
- <http://aquafind.com/articles/Polyculture.php>.
- <http://www.fao.org>

- Hora, S.L. and Pillay, T.V.R.1962. "Handbook on Fish Culture in the Indo-pacific Region". FAO Fish. Biol. Tech.Paper, 14: 204 pp.
- Jhingran, V.G.1991. "Fish and Fisheries of India". Hindustan Publishing Corporation, Deli, India, 416-441pp.
- Islam, S., Bhadra, A., Rahman, A., Khan, M.M., 2019. Pond management and fish polyculture technique in lalmonirhat of 0–3.
- Padhi, S. N.; Das, S.K.; Panda, A.and Panda, S., 2015. In,"Employment Through Aquaculture". Nand Kishore Publication, Bhubaneswar.
- Panda, S.,2016. Composite fish culture for gainful employment. International J. Bioassays: 4593-4596.
- Rahman, M.M., 2006. Food web interactions and nutrients dynamics in polyculture ponds. Wageningen University, Netherlands.
- Sinha, V.R.P. 1985. Principles of composite fish culture in undrainable ponds. In, "Lecture notes on composite fish culture and its extention in India. NACA, F.A.O../TR/85/15; <http://www.fao.org>
- Sinha, V.R.P. 1985. General Methodology of Composite Fish Culture. In, "Lecture notes on composite fish culture and its extention in India. NACA, F.A.O../TR/85/15; <http://www.fao.org>
- Stickney, R.R., 2013. Polyculture polyculture in Aquaculture, in: Sustainable Food Production. Springer New York, New York, NY, pp. 1366–1368. https://doi.org/10.1007/978-1-4614-5797-8_176
- Zimmermann, S., Nair, C.M., New, M.B., 2009. Grow-Out Systems-Polyculture and Integrated Culture, in: Freshwater Prawns: Biology and Farming. Wiley-Blackwell, pp. 195–217. <https://doi.org/10.1002/9781444314649.ch11>