SEED PRODUCTION OF INLE CARP
Cyprinus intha Annandale, 1918 WITH EMPHASIS ON GROWTH PERFORMANCE IN POLYCULTURE

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SEED PRODUCTION OF INLE CARP *Cyprinus intha* Annandale, 1918 WITH EMPHASIS ON GROWTH PERFORMANCE IN POLYCULTURE

MYO MIN HLAING

This Dissertation is Submitted to the Board of Examiners in Zoology, University of Mandalay for the Degree of Doctor of Philosophy.

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ABSTRACT

The study on *Cyprinus intha* was conducted with the aim to conserve this endangered species which is being driven to near extinction due to overfishing and environmental degradation in its native habitat. This species is an endemic in Inle Lake which has subtropical climate. The study was divided into two parts: seed production and growth performance. Culturing technique was used to assess the possibility of breeding *C. intha*, a bottom dwelling species, together with two other fish species, *Catla catla*, a surface dwelling species and *Labeo rohita*, a column dwelling species. The breeders of *C .intha* used during the study were captured from the protected area maintained by Golden Island Cottages (GIC) hotel near Nangpan village in Inle Lake. Healthy fishes were selected for estimation of the spawning season using length-weight relationship and condition factor revealed the exponent value 'b' ranged from 2.1 to 2.5. The mean value 2.3, indicated negative allometric growth. The mean value of condition factor 2.2 was higher than one. Spawning was achieved by hypophysation method using by common carp pituitary gland. Embryonic development of the fertilized egg of *C. intha* followed successive stages of zygote stage, cleavage, blastula, gastrula, pharyngular and segmentation period within 48 hr after fertilization. The embryonic stages of *C. intha* were studied resulting in the assessment that larvae hatched from the eggs within 72 hours after being placed in the larvae tank. On the sixth day after hatching, the larvae developed into fries with a mean length of 6.8± 0.068 mm (n=20). At this stage the mouth open, alimentary canal and anus well developed. After eight days, the larvae turned into fry stage and cultured one month in nursery pond. The optimal growth and survival of the fingerlings, tested for 70 days with four different stocking densities (3, 5, 7, 9 ind /m^2). The stocking density of 5 ind /m^2 was the optimum for fingerling production. The total yields of 5 ind /m^2 was higher and the FCR value was better than the others. A good growth performance of *C. intha* in captive conditions is reasonable and seed production in hapa is very simple and relevant use for local farmers. *C. intha* therefore can be bred successfully in polyculture, making it a prospective culture species suitable for extensive commercial scale.

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DECLARATION

I declare that this research was conducted by myself and work contained within it was my own.

20/12/2013

Signature ----------------------

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CHAPTER 1

GENERAL INTRODUCTION

Myanmar has impressive freshwater capture fisheries. The inland waters are made up mainly of the interlocking riverine and estuarine systems of the Ayeyawady (Irrawaddy, 2,150 km long), Chindwin (844 km; a tributary of the main Ayeyawady) and Sittaung (563 km) rivers, plus the large Thanlwin River (2,400 km) to the east (Welcomme, 1985). Aquatic resource area of the river systems within Myanmar encompasses a total of 8.2 million ha of permanent and seasonal water bodies and there were 87134.36 ha of freshwater fishponds and a further 86930.80 ha of shrimp ponds in 2009-2010 (DoF, Fishery Statistics, 2009 -2010). The fisheries sector plays a vital role in the culture and socio-economic life of Myanmar. Traditionally Myanmar people prefer freshwater fish to marine fish.

Inle Lake is the second largest natural inland water body in Myanmar. It is situated in Shan State in northeastern Myanmar, 20°27′–20°40′N and 96°52′–96°57′E. The average length is 18km from north to south, and the width is 11km from east to west (Thida Win, 1996). The lake is a big water pot (Ohno, 1978) in Shan Plateau, the open water area which stands at an elevation of 1000 m above sea level. The lake flows mainly north to south. It receives the basins of Shan Plateau drainage and runs off into Mobye Reservoir (JICA 2002). The lake sits in a tropical monsoonal area with an average annual rainfall of 953 mm (Thidar Win, 1996). Water depth is 7m in the rainy season and 4m in the hot season (Butkus and Myint 2001). Luxuriant submerged plants on the bottom and floating leaved macrophytes on the surface cover much of the lake. The flora and fauna of the lake are quite diverse.

Inle Lake has been undergoing environmental degradation over the years. Between 1886 and 1948 Inle Lake has shrunken by 15 %. The open water surface has further decreased by 32.4% between 1935 and 2000 (Sidle *et al*., 2007). One of the major causes of the shrinkage is the sedimentation caused by deforestation in the mountains as well as the banks of the lake. Forests are disappearing partly because of agricultural encroachment, including shifting cultivation (Myint Su and Jassby, 2000). The other reason is the expansion of floating gardens and tomato cultivation on the floating garden has been practiced for a long time on the lake (Sidle *et al*., 2007).

The second change of the lake is water quality due to tomato cultivation, which uses various agrochemicals (Akaishi *et al*., 2006). The unregulated usage of pesticide affects the transparency of the lake water (Myint Su and Jassby, 2000). Several FAO and UNDP reports noted that the dramatic infilling of the lake with sediment, a process that threatens the lake ecosystem, as well as the local economy. Inle carp (*Cyprinus intha*) are believed to be declining due to decreased water clarity levels associated with suspended sediment and eutrophication (Su and Jassby, 2000).

Intha fishermen, who depend on Inle Lake for their livelihood, have been changing steadily in recent years. The main fish resources appear to be snakeheads, featherback, spiny eel and common carp. Intha fishermen use small wooden boats without engines and use several types of gear when fishing. There are four main types gear such as set gill net, hook and line, Inle saung and fish trap. The main fish species currently caught by gill net are tilapia, featherbacks and snakeheads. Some local species such as Inle Carps Nga-hpein, *Cyprinus intha* and Ngalu *Crossocheilus latius* is said to be decreasing year by year. Tilapia came to account of a large share of the catch compare to other species. FAO estimated that the annual production of fisheries in Nyaung Shwe township is about 550-650 tones. In addition, FAO indicated that the consumption of fish was three times higher than that of meat (FAO 2004).

In Myanmar, the most important species for freshwater aquaculture are major carps, Indian carps, like Rohu (*Labeo rohita*), Nga gaung pwa (*Catla catla*) and Nga gin phyu (*Cirrhinus mrigala*). Some introduced species common carp Shwe wha nga gin (*Cyprinus carpio*), Chinese carps Grass carp (*Ctenopharyngodon idella*) and Silver carp (*Hypophthalmichthys molitix)*. Fish seed production is one of the most important aspects of fish culture in Myanmar. Mostly, the fish seed is obtained from natural resources. The collection of fish seed from wild source was an age old practice. The seed collected from natural resources is generally a mixed stock with both desirable and undesirable varieties. Separation of desirable seed from mixed stock is a big problem. Due to the handling, the desirable varieties may die. If any predaceous fish seed is found, they injure desirable fish seed. Another big problem is not getting required number from natural resources collection. Availability of pure fish seed is very difficult. To overcome all these problems induced breeding is an excellent technique to get pure and required fish seed. The first attempt at hypophysation in India was made by Hamid Khan in 1937 when he tried to induce spawning in *Cirrhinus mrigala* by the injection of mammalian pituitary gland. The first success in induced breeding of Indian major carps through hypophysation was achieved in 1957 by Hiralal Chaudhuri and Alikunhi at Central Inland Fisheries Research Institute, India (Hamid Khan, 1937; Hiralal Chaudhuri and Alikunhi, 1957; cited in Piska and Naik, 1960).

Hiralal Chaudhuri, 1967 achieved the first success in induced breeding through hypophysation of Indian major carps *Labeo rohita* in Myanmar. In induced breeding techniques, four main types of hormones are used to give injections to fish: pituitary gland extractions, Human Chorionic Gonadotropin (HCG), Luteinizing Hormone–Releasing Hormone (LHRH), Gonadotropin Releasing Hormone (GnRH) and Buserelin acetate (BUS). Since 1970, fish breeding by pituitary gland extraction is an effective and dependable way of obtaining pure seed of cultivable fishes and is simple practiced on fish famers in Myanmar.

The success in induced breeding of fish depends on the proper selection of the donor fish. The pituitary gland should be collected from fully ripe gravid fishes. Most suitable time for collection of pituitary glands of major carps is during May to July. Majority of carps attain advanced stages of their maturity during this period. Since common carp, *Cyprinus carpio* is a perennial breeder, its mature individuals can be obtained almost all the year round for the collection of pituitary glands. The glands are usually preferred to be collected from freshly killed fishes. If the collected glands are not meant for use and they must be preserved. Due to their glyco- or muco-protein nature, they are liable to immediate enzymatic action. The pituitary glands can be preserved by three methods - absolute alcohol, acetone and freezing. Preservation of fish pituitary gland in absolute alcohol is preferred in Myanmar. The fish seed production of Inle carp *Cyprinus intha* through hypophysation method can be easily transfer to local community. Moreover, the successful breeding can be provide a culturable fish species for local fish farmers and the reduction of poverty alleviation of fisheries community in Inle Lake.

One of the key factors to successful fish breeding and culture is the understanding of culture management especially seed production and culture method. Since the healthy and good condition fishes were selected. Growth of an organism means a change in length or weight. Fajioye and Oluajo (2005) reported the use of length and weight is important for assessment of fish maturity, growth and production.

Condition factor compares the well being of a fish and is based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesh, 1978). Condition factor has been used as an index of growth and feeding intensity (Fagade, 1971). The investigation of marine fish larvae have been carried for a long time, and the identification of this larvae and egg has made possible. As to fresh water fishes such investigation have been as yet insufficient. Special difficulties have been met with in identifying the young of cyprinid fishes, which are the majority of fresh water fishes used for food in the world (Ehrenbaum, 1905-1909; cited in Balinsky, 2009). Fish culture is carried out in this region especially Inle carp because this endemic species as endangered in Inle lake (IUCN 2011).

In general, there are two forms of fish culture: monoculture and polyculture. Each system has its own important characteristics. Mostly, fish are raised in polyculture systems for extensive and semi-intensive culture, while monoculture is suitable for intensive system. Monoculture, which is practiced in many countries, is the stocking of a single species in a pond. In monoculture, there are several stocking practices that affect fish production of a pond. A fish pond, especially a freshwater pond, usually produces a variety of food organisms in different layers of the water. Therefore, stocking species that have complementary feeding habits or that feed in different zones will efficiently utilize space and available food in the pond and increase total fish production. Moreover, polyculture has been commonly practiced to maximize fish production with available food organisms and a variety of fish in different feeding niches in pond (Ling, 1967; Olah 1980). Tang (1970) described that multi species polyculture as a harmonious system where the available fish foods and stocked fish species are balanced. Cyprinids, *Labeo rohita*, *Catla catla* and *Cyprinus carpio* are the main species of polyculture practices in the world. *Catla catla* is a surface feeder fish, *Labeo rohita* is a column feeder fish and *Cyprinus carpio* is bottom feeder fish. Fish culture especially in Inle carp is essentially needed in this region because *Cyprinus intha* is an endemic and endangered species.

The advantage of producing *Cyprinus intha* seed in hapa is to transfer the technique to farmers and to develop polyculture for Inle carp. Thus the objectives of this study are:

- to select the healthy breeder based on their length-weight relationship under experiment condition
- to develop simple hatchery technique for production of *Cyprinus intha* seeds, knowledge of some biological attributes are needed
- to examine the series of embryonic and larval development of *Cyprinus intha*
- to determine the stocking density of fingerling for the potential yield in production
- to evaluate the growth performance and yield with polyculture

CHAPTER 2

LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF *Cyprinus intha* Annandale, 1918 AT THAYETKONE FISHERY STATION, MANDALAY REGION

2.1 Introduction

Inle Lake is the second largest freshwater lake in Myanmar. It is situated in Nyaung Shwe Township, Southern Shan State. During the dry season the average water depth is about 2.1m with the deepest point being about 3.7m, but in the rainy season this can be increased by 1.5 m. The people of Inle Lake called Intha, who depend on the lake for their livelihood. FAO, 2004 estimated that annual production of fisheries in Nyaung Shwe 550-650 tons and grass carp farming inland in Inle Lake contributes to the livelihood of people.

Although it is not a large lake but there is a number of endemic species, nine species of fish are found nowhere else in the world. Some of these endemic fishes like Sawbwa barb *Sawbwa resplendens*, Cross banded dwarf danio *Microrasbora erythromicron* (Kottelat and Witte, 1999) and Ngakhu Shinpha *Silurus burmanensis* (Thant, 1966) are now listed as endangered species (IUCN, 2011).

Length-weight relationship is of great importance in fishery assessments (Garcia *et al.,* 1998; Haimovici and Velasco, 2000). Length and weight measurements in conjunction with age data can give information on the stock composition, age at maturity, life span, mortality, growth and production (Beyer, 1987, Bolger and Connoly, 1989, King, 1996 a and b, Diaz *et al.,* 2000). Length-weight relationship gives information on the condition and growth patterns of fish (Bagenal and Tesch, 1978).

Fishes are said to exhibit isometric growth when length increases in equal proportions with body weight for constant specific gravity. The regression co-efficient for isometric growth is ‘3’ and values greater or lesser than ‘3’ indicate allometric growth, condition factor studies take into consideration of the health and general well being on physiology of fishes related to its environment, so it represents how fairly deep bodied or healthy fishes (Reynold,1968).

The condition factor (K) is a quantitative parameter of the well-being state of the fish and reflects recent feeding conditions. This factor varies according to influence of physiologic factors, fluctuating according to different stage of the development (Lecren, 1951). Olurin and Aderibigbe (2002) stated that the condition factor of fish is important as they are ones used in stocking fish farms. Condition factor studies take into consideration the health and general well-being of a fish as related to its environment (Reynold, 1968). Pauly, (1983) found the difference in weight for all the sampled batches may be due to the individual condition factor as it relates to the well-being and degree of fitness.

Inle carp, locally known as nga-hpein, *Cyprinus intha* is an endemic species and formerly this species was published as a subspecies *Cyprinus carpio intha* by Annandale, 1918. This subspecies has been raised as a species *C. intha* by Doi, 1997 and Ferraris, 1999. Inle carp, nga-hpein is an important commercial species and staple food for local people in Southern Shan State.

Inle carp, nga-hpein is a cultural symbol of the local people. Local fisher men reported that this species has become scarce in many localities around Inle Lake. Unfortunately its population has been declining in the recent years and is highly demanded, *C. intha* a view to determine whether the collected fishes are good condition of health and growth for breeding purpose.

At present, inadequate data on this species indicate and need to examine the reproductive biology for the purpose of seed production, larval rearing and hatchery management practices. Length and weight data for this species is also limited information. Length-weight relationship and condition factor are necessary to select *C. intha* in culture pond.

The objectives of this study are:

- to determine the sexual dimorphism of *C. intha*
- to examine the length-weight relationship and condition factor of *C. intha*

2.2 Materials and Methods

2.2.1 Study Area

Inle Lake is located in Nyaung Shwe Township, Southern Shan State. It is the second largest freshwater lake in Myanmar. It posses an estimated surface water area of 116 km^2, the highest altitude of 1000 m and is situated at 20°27′ N and 96° 58′E of Inle Lake (Fig. 2.1, 2.2).

2.2.2 Study Period

The study period lasted from June 2010 to May 2011.

2.2.3 Collection of Fish

Alive fishes were obtained from the protected area of Golden Island Cottage hotel near Nangpan village in Inle Lake. The engine boat was used for transporting from Nyaung Shwe to Golden Island Cottage hotel. Ten fishermen, five small wooden boats without engine, one seine net and two Inle baskets (Inle Saung) were used. Firstly, the fishermen used the seine net for surrounding the target area. And then some fishermen scared the fishes under the weeds by bamboo pole or paddle. During the fishes are in the middle of seine net, the fishermen used Inle basket (Inle Saung) for catching alive fish. This type of fishing method is used by Intha fishermen in Inle Lake. Then collected fishes were put into polyethylene bags with water and fill up oxygen to transport the Thayetkone fishery station. At Thayetkone fishery station all polyethylene bags were acclimatized in earthen pond and then released into the fish pond (Plate 2.1).

2.2.4 Measurement of Fish Sample

The total length was measured from snout to the tip of the caudal fin by using a ruler to the nearest centimeter. The body weight was taken on the weighing scale balance to the nearest gram (Plate 2.2).

2.2.5 Identification

The collected fishes are compared with *Cyprinus carpio* (Linnaeus, 1758) by using distinguished characteristics and key to species of genus *Cyprinus*. The classification was followed after by Talwar and Jhingran, 1991.

2.2.6 Analysis of Data

Length-weight relationship was assessed from measurement of total weight and total length, and the parameter ‘a’ and ‘b’ were determined by power regression data.

The regression of length-weight and condition factor was computed as follows:

$$W = aL^{b} \text{ (Le Cren, 1951)}$$

Where;

W	=	Weight (g)
L	=	Total Length (cm)
a	=	Constant
b	=	Exponent of values

$$K = W/L^{3} \text{ (Le Cren, 1951)}$$

Where;

K	=	Condition factor
W	=	Weight of fish
L	=	Length of fish

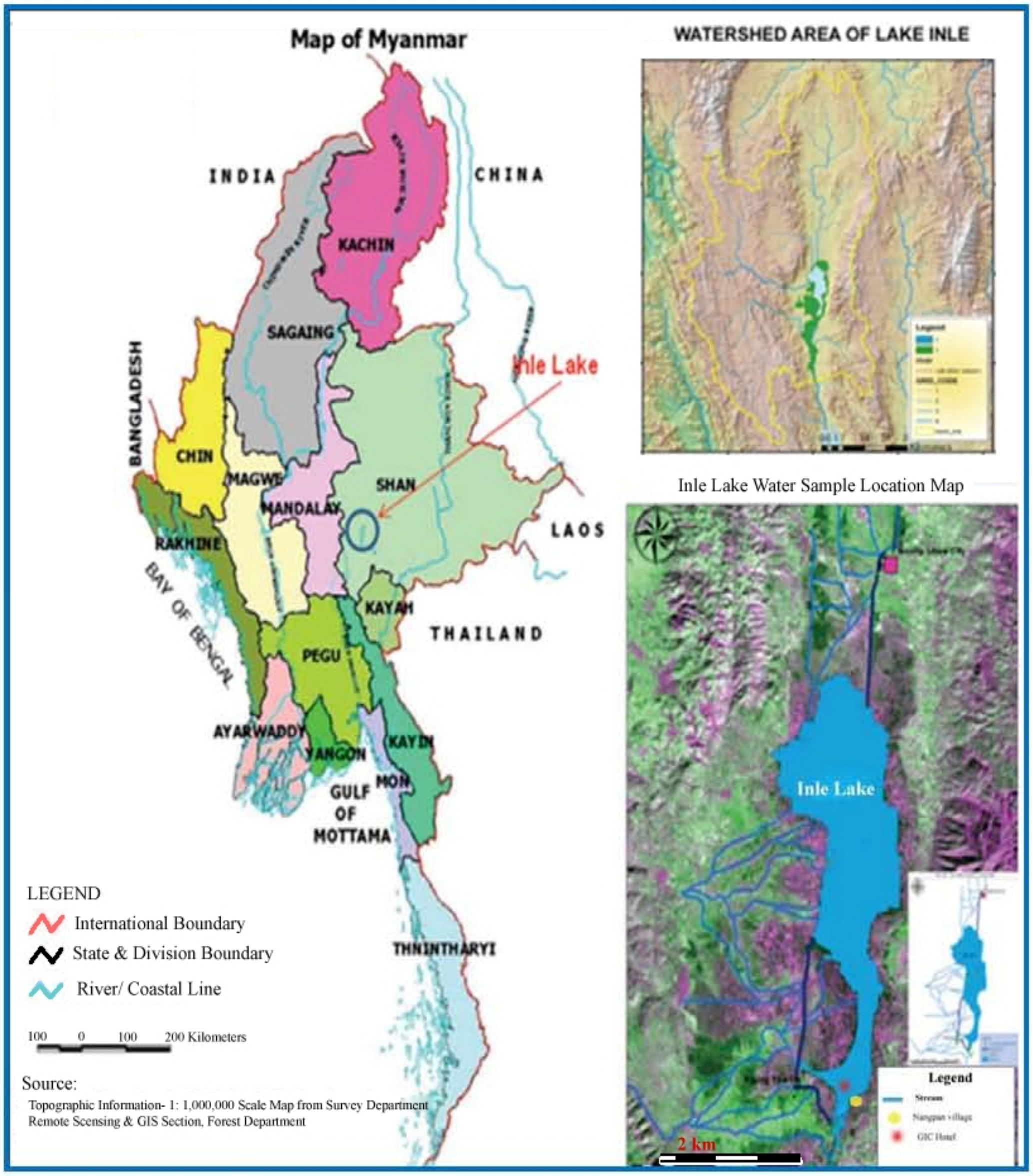


Fig. 2.1 Map of study area and study site

Fig. 2.2 Satellite map of study area (Inle Lake) and study site
(Source: Google Earth 2008)

Plate 2.1 Collection of fishes

A. Setting the seine net

B. Harvesting fishes in seine net

A

B

Plate 2.1

Plate 2.1 Continued

C. Laying down seine net for employment of Inle basket

D. Catching alive fishes by using Inle basket

C

D

Plate 2.1 Continued

Plate 2.2 Measuring the collected fishes

A. Measuring the head and counting of the lateral line scale

B. Counting the ventral fin

C. Total length of *Cyprinus intha*

D. Weighing of *C. intha*

A

B

C

D

Plate 2.2

2.3 Results

2.3.1 Systematic Position and Description of Studied Species

(i) Systematic Position

Classification of studied species was follow after by Talwar and Jhingram (1991).

Phylum	-	Chordata
Subphylum	-	Vertebrata
Class	-	Actinopterygii
Order	-	Cypriniformes
Suborder	-	Cyprinoidea
Family	-	Cyprinidae
Subfamily	-	Cyprininae
Genus	-	*Cyprinus*
Species	-	*Cyprinus intha* Annandale, 1918

(ii) Description

***Cyprinus intha* Annandale, 1918**

Common Name : Inle carp

Vernacular Name : Ngaphein

Number of Samples: 14 (4 ♂and 10 ♀)

Total Length : 28-42 cm

Fin Formula : B III; D II-III 20-22; A i 6; P i 14-16; Vi 9;
C 22; L.l 26-28; L.tr 4.5-5/5.5-6

Snout slightly rounded, scales large, lateral line scales less than 30 (26-28), dorsal fin with 20-22 soft rays, dorsal profile more convex than ventral and body elongate longer compare with *C. carpio,*

Body stout, slightly compressed. Head moderate triangular, mouth small and oblique, protrusible, lips thick and fleshy. Barbels two pairs, maxillary barbells twice as long as rostral pair. Gill rakers 21 to 29 on first arch, dorsal fin inserted midway between snout-tip and base of caudal fin, dorsal spine stout. The distinct characteristic of male and female were showed in (Table2. 1) (Plate 2.3).

2.3.2 Length-weight Relationship

In January, the total length ranged from 26 - 42 cm and the body weight ranged from 500 - 1500g. The correlation coefficient between length and weight of the studied species (mixed-sex) was R^2 =0.90 and the exponent value 'b' were 2.53 (Fig. 2.3).

In February, total length and weight ranged 28-42 cm and 700-1600 g respectively. The correlation coefficient was R^2 = 0.95 and the exponent value 'b 'was 2.37 (Fig. 2.4).

In March, total length and weight ranged 28-42 cm and 600-2000 g respectively. The correlation coefficient was R^2 = 0.89 and the exponent value 'b ' was 2.17 (Fig. 2.5).

In April, total length and weight ranged 30-44 cm and 800-2200 g respectively. The correlation coefficient was R^2 = 0.87 and the exponent value 'b 'was 2.20 (Fig. 2.6).

From the results, the exponent value 'b' ranged from 2.17 to 2.53. The mean value of 'b' was 2.3. Thus species showed a negative allometric growth ($b<3$). The allometric coefficient (b) presented highest values in January and lowest value in March.

The correlation coefficient (R^2) was range from R^2 = 0.87 to 0.95 during studied period. The significantly length-weight was observed between the length and weight of *C.intha*.

2.3.3 Condition Factor

The highest value of condition factor (K) were observed in February (2.9) followed by in March and April (2.1) each while the lowest value was notice in January (1.8). The mean value of condition factor (K) was 2.2.

Table 2.1 Distinct Characters of the male and female of *Cyprinus intha*

No	Female	Male
1	Pectoral fin relatively small and weak with the outermost ray not very thick	Pectoral fin relatively long and prominent with well developed thick outermost ray
2	Inner surface of the pectoral fin facing the body, is smooth to feel by touch	Inner surface of the pectoral fin facing the body, is rough to feel by touch
3	Abdomen shows a conspicuous bulge which extends past the pelvis up to genital aperture. Abdomen soft to touch. No median ridge in front of vent. Bulge in the abdomen may also be due to fat deposit around the gut	Abdomen does not generally show conspicuous bulge and is not very soft to touch. Abdomen shows median ridge in front of vent
4	Genital aperture is protruding and swollen, turgid, shows pinkish margins	Vent not protruding pit-like in appearance
5	Ova visible inside genital aperture when gentle pressure applied to abdomen. Vent may also be swollen and reddish	Milky white milt extrudes through genital aperture on applying gentle pressure to abdomen
6	Body stouter in appearance relative to adult males of same age	Body thinner and linear in shape relative to adult females of same age.

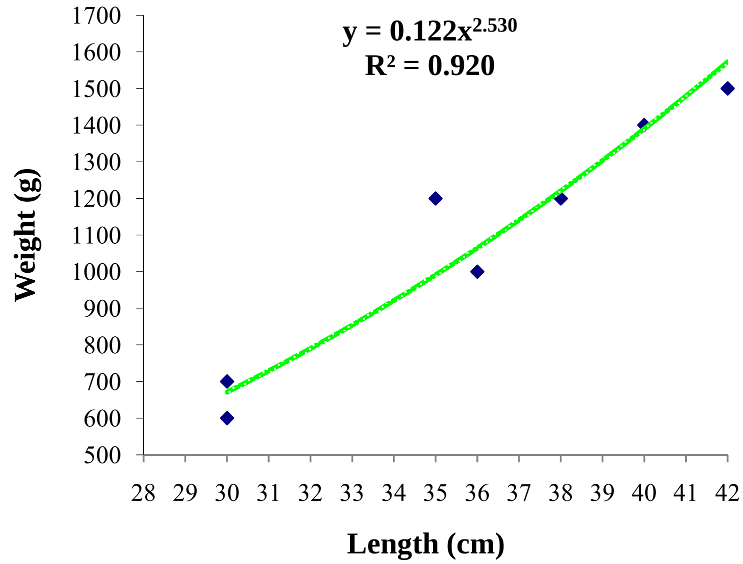


Fig. 2.3 Length-weight relationship of studied species in January, 2011

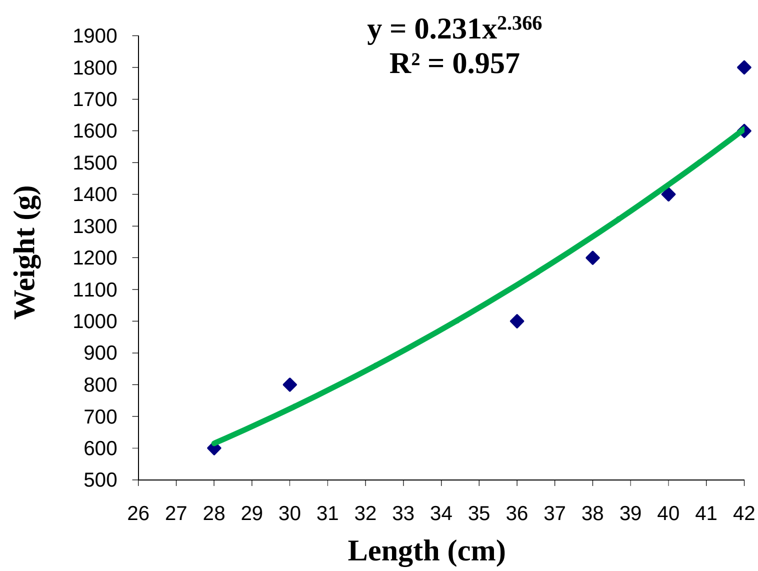


Fig. 2.4 Length-weight relationship of studied species in February, 2011

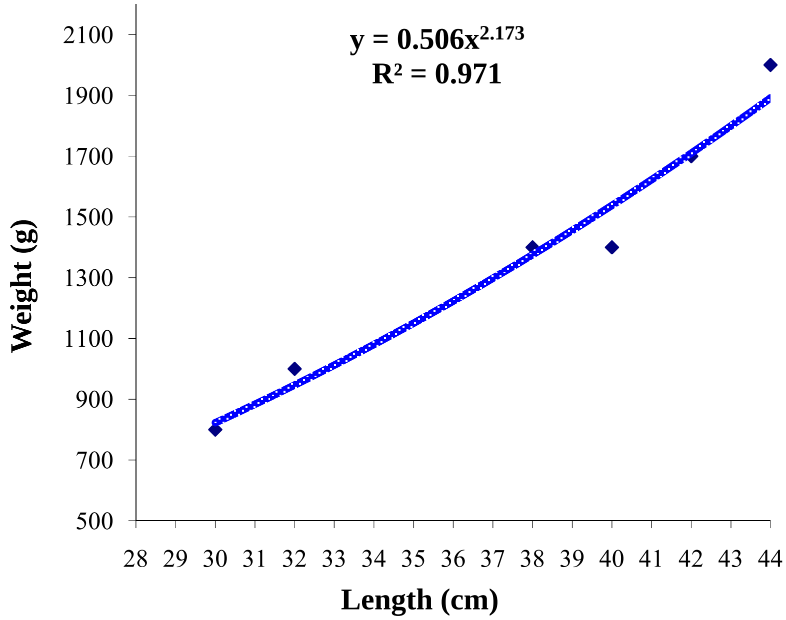


Fig. 2.5 Length-weight relationship of studied species in March, 2011

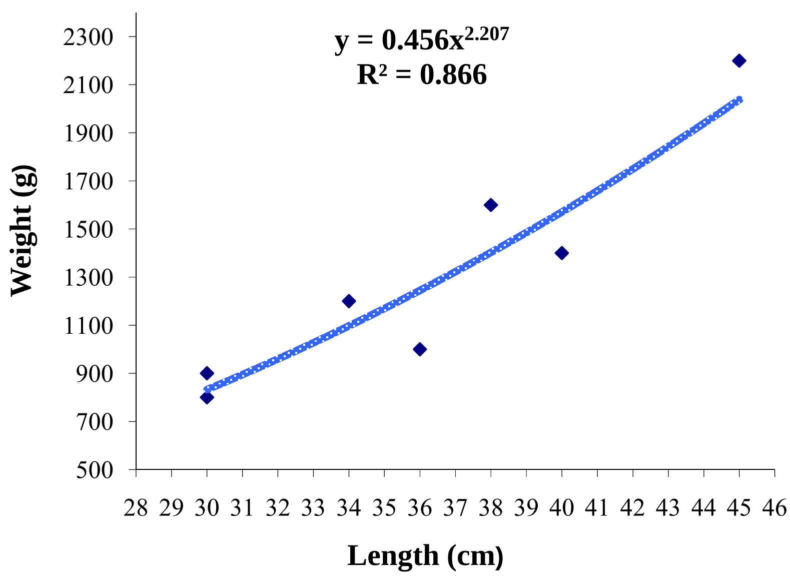
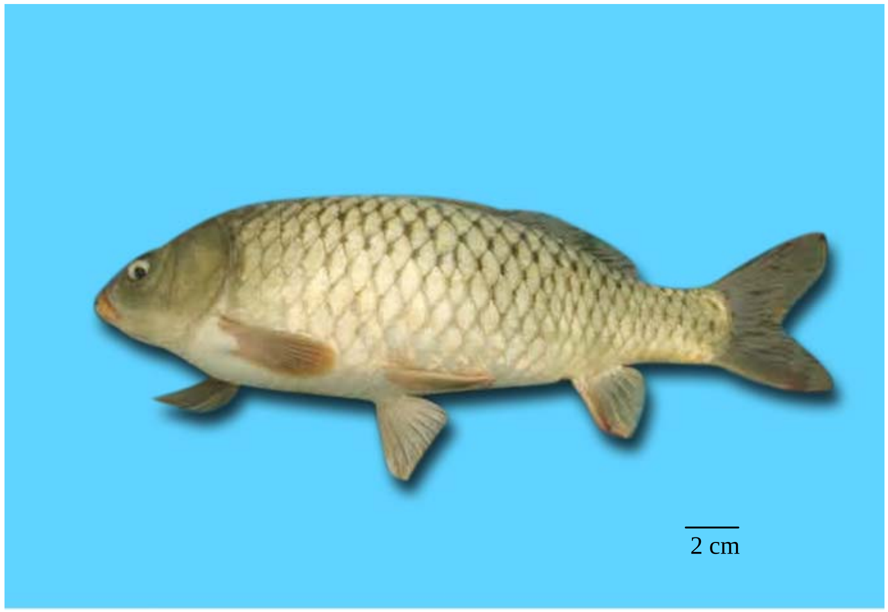


Fig. 2.6 Length-weight relationship of studied species in April, 2011

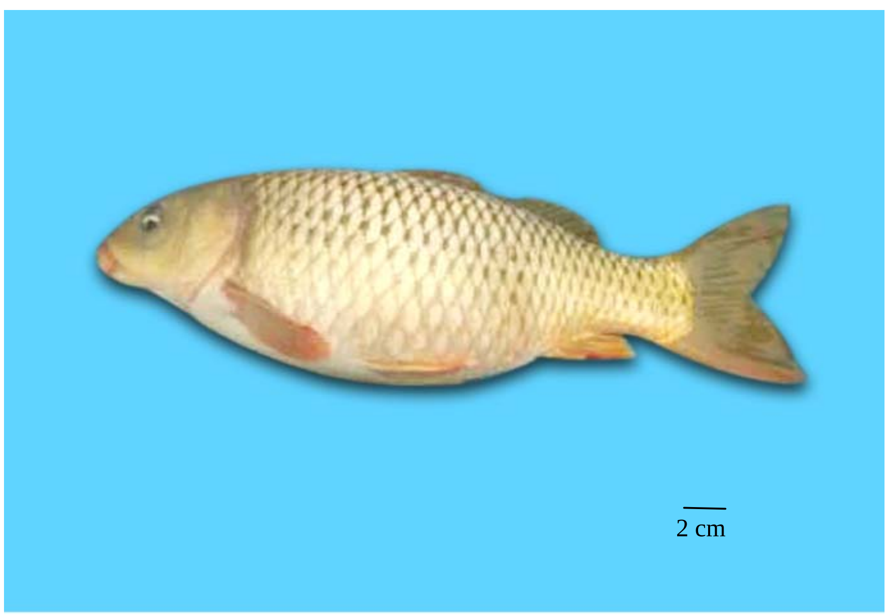
Plate 2.3 Studied fish species

A. *Cyprinus intha* (male)

B. *Cyprinus intha* (female)



A



B

Plate 2.3

2.4 Discussion

Cyprinids are commercial importance groups of inland fisheries in Myanmar. Information on length and weight relationship and relative condition factor of several cyprinids species is available. Moreover, fish normally retained same shape of the body throughout their life span. Inle carp, Nga-hpein is an importance commercial species and staple food for local people Intha in Inle lake. So that the present study investigates length-weight relationship and condition factor for Inle carp *Cyprinus intha* in culture pond. This study should be provided a significant useful technique for further study in breeding program.

Ricker (1968) expressed the importance of length-weight relationship in population assessments. The length-weight relationship of fish is an important fishery management tool (Beyer, 1987). This relation is also a quantitative expression of the development at corporal level of an organism and gives information on the condition and growth patterns of fish (Bagenal and Tesh, 1978). Length –weight relationship of *C. intha* was highly significantly correlated and the correlation coefficient was ranged from $R^2 = 0.87$ to $R^2 = 0.95$. This result agrees with Nuner and Zaniboni-Filho (2009). In the Upper Uruguay River study on *C. carpio* which also showed positively correlation ($R^2 = 0.97$).

Dhakal and Subba (2003) reported that the values of 'a' and 'b' differ not only in different species but in same species due sex, maturity stage and feeding intensity. According to Hile (1936) and Martin (1949) the values of exponent 'b' usually ranges between 2.5 and 4.0.In present study, *C.intha* showed negative allometric growth, the values of 'b' ranged from 2.1to 2.5. This result agree with the findings of Nuner and Zaniboni-Filho (2009) on a related cyprinid, *Cyprinus carpio* from the upper Uruguay river in Brazil which showed negatively allometric ‘b’ value ranging from 2.3- 2.5. Konan *et.al* (2007) reported that isometric growth in two Cyprinids (*Labeo caubie and L. parous)* in South-Easten of Ivory Coast. Khan (1972) observed that the value of 'b' in *Labeo rohita* was 3.06. Sinha (1973) estimated a value of 3.02 in *Puntius sarana.* Dhakal and Subba (2003) observed that high values of 'b' may be due to higher feeding intensity of the juvenile.

Stewart (1988) observed that the reduction in the breeding and nursery ground of *O.niloticus* in lake Turkena, Kenya, as contributing to dramatically lower condition factor, pollution also seen to affect the condition factors of *O. niloticus* in lake Mariat, Egypt (Bakhoum, 1994). Variation in condition factor with seasons and pollution has been documented by Khallaf *et al.,* (2003) in Shanawan drainage canal in Egypt. Olurin and Aderibigbe, (2002) suggested that the condition factor of pond reared juvenile *Oreochromis niloticus* was observed to be in good condition as the value was higher than one.

In the present study condition factor is higher than one. Therefore, it is concluded that *C. intha* examined were in good condition and healthy and can be used for seed production at Thayetkone Fishery Station.

CHAPTER 3

EMBRYONIC AND LARVAL DEVELOPMENTAL STAGES OF *Cyprinus intha* Annandale, 1918 WITH EMPHASIS ON FINGERLING PRODUCTION

3.1 Introduction

Fisheries have been recognized in the last decade as one the fastest growth sector. It is becoming more and more important in times of rural and social development by providing a reliable source of protein, opportunities for employment and supplementary income. It is not only for food security but also as it is a fast renewable resource. The conservation of fisheries resources and the maintenances of ecological system are the main factors in the development of fisheries.

Fish is staple food for people in many parts of the world, particularly in Asia. Aquaculture has become the world's fastest growing food production system, with growth rates of over 9% in last 10 years. The major increases in world aquaculture production have been witnessed in China, India and South-East Asian countries (Gupta *et al.,* 2008).

Cyprinids are the most important group in aquaculture in Asia, accounting for 49% of the total aquaculture production of Asia in 1999 (FAO, 2004). In Myanmar, the contribution of livestock and fishery sector to total gross domestic product (GDP) was 7.6% in 2009-2010. Generally, Myanmar is a carp country. Carps alone contribute 85% of total aquaculture production in the country. The fresh water pond culture of fishes in Myanmar are generally composed of common carp, Indian carps and Chinese carps. These species are characterized by fast growth and well adaptability in confined waters.

Aquaculture, not only in commercial scale but also in small scale is an important protein source for rural community in the country. In 1954, Myanmar aquaculture commenced with introduced species such as tilapia, gouramy and common carp. The success of induced breeding of major carps through hypophysation technique in Myanmar was achieved on early 1960 (Fishery Statistics of Myanmar, 2009-2010). Thereafter several inducing agents have replaced the fish pituitary glands for induced breeding programmed. Most of fishes must be reproduced for long-lasting of their own kinds by seasonal or continuous reproductive cycle. Recently, induced breeding of carps are well-known technologies being extensively adopted on a large scale in almost all parts of the country. Many aquaculturists and farmers were earlier dependent on natural fish seed collection has changed to artificial fish seed production in recent years.

The fish reproduction is generally initiated by environmental factors: temperature, rainfall, water quality, photoperiod and food quality as well as food availability. The fish receives these signals through the brain and interprets them, in oder to determine whether the environmental conditions are suitable for spawning. The message is then sent to the hypothalamus, which produces gonadotropin releasing hormone (GnRH). This is passed to the pituitary gland, which is located underneath the brain. The pituitary gland then produces gonadotropins (GtHs) (Harvey and Carolsfeld, 1993).

Among the oviparous fishes, there are so called demersal spawners and pelagic spawners. Actually, the eggs they extrude are either demersal (on the bottom) or pelagic (above the bottom, and often at or near the surface). Demersal egg spawners produce eggs that are heavier than the surrounding water and which develop on the bottom. These eggs are either attached to the substrate or float loosely on the bottom and are generally adhesive. Eggs of almost all freshwater fishes are attached to the substratum or are loosely in contact with the bottom, that is demersal. Fish eggs are telolecithal, meaning the most of the egg cell is occupied by yolk-free cytoplasm at the animal pole of the egg. The cell divisions do not completely divide the egg, so this type of cleavage is called meroblastic (Gilbert, 1949).

The Inle carp, *Cprinus intha* Annandale, 1918, is a cyprinid fish commonly known as nga-hpein inhabiting in Inle Lake, Nyaung Shwe Township in Southern Shan State. In the last two decade, this species plays an important role in the food supply of local people in Inle Lake. This species is an endemic and gradually decline in various water of Inle Lake. Also that *C. intha* is highly demand in local people but local fish farmers are much less familiar with the culture of *C. intha* , nga-hpein because of the lack of breeding and feeding techniques and non- availability of seeds. Many researchers have attempted to reveal the reproductive biology of various freshwater fish species by applying the criteria of gonadosomatic index, hepatosomatic index, condition factor and defining histological stages of ovum existing within ovary.

At present, inadequate data in this species really need to examine the reproductive process for breeding technique, embryonic development stages, larval development, larvae rearing and further more investigation in stocking density of fingerlings and release the fish seed for the purpose of conservation and sustainable fisheries resources development in Inle Lake.

The objectives of this study are:

- to examine the embryonic development of *C. intha*
- to describe the distinct characteristics of larval stages and fingerling development of *C. intha*
- to observe weight gain (WG), specific growth rate (SGR) and feed conversion ratio (FCR) of *C. intha* fingerlings based on stocking density

3.2 Materials and Methods

3.2.1 Study Area

The experiment was conducted at No. 1 Fisheries Station of Mandalay Region, commonly known as Thayetkone fish seed production hatchery. It was situated at Aung Myay Thasan Township, at Mandalay Region. It possesses the total area of 20.37 hectares, and the pond water area of 11.2 hectares.

3.2.2 Study Period

The study period lasted from June 2011 to March 2012.

3.2.3 Collection of Fish

There are 91 fish ponds and have different range from 0.05 hectare to 0.8 hectare (Plate I). Inle carp, *C. intha* brooder was collected from the area of Golden Island Cottages hotel near Nangpan village at the Southern part of Inle Lake. The total number of 14 collected, 10 females fish were cultured in fish pond number 79 (0.05 hectare) and 4 males in pond number 84 (0.05 hectare) (Plate 3.1).

3.2.4 Breeder Selection

The total number of 14 fishes of *C. intha* (weighing between 600-2000 g) were cultured in earthen pond and fed with supplementary feed of peanut-oil cake, rice-bran, corn and fishmeal. Mature healthy brooders 700-800 g of two females and

600-1000 g of four males were selected for breeding experiments (Plate II). Female has a large soft belly and swollen genital papilla indicate readiness for induced breeding. The belly of a mature female is generally plump and gently presses the belly toward the genital papilla to examine the ripeness of the eggs. Male is usually streamlined and more torpedo shaped. Mature males are easily distinguished by the release of milt, when the belly is gently pressed. They developed breeding tubercles on the head and pectoral fins, mainly along the bones of the fin rays.

3.2.5 Induced Breeding

Fish pituitary extract or hypophysation used to induce fish spawning. Fish pituitary glands are obtained from sexually maturing or mature donors either of the same or different species. The gland may be used fresh or stored in absolute alcohol or acetone. General computation of the hypophysation working dose is based on the fresh weights of the donor and the recipient, Harvey and Hoar (1979).

$$\text{Working Dose} = \frac{\text{Weight of donor fish (kg)}}{\text{Weight of reciptent fish (kg)}}$$

The induced breeding experiment of hypophysation method was conducted in 19 November 2011 at Thayetkhone fish seed production hatchery, Aung Myay Tharsan, Mandalay, Myanmar. Two healthy females' brooders were selected from brood stock pond (Plate I). Four male brooders were also selected for breeding set purposes with sex ratio of one female brooder and two male brooders in fine mesh nylon net breeding hapa. Induced breeding was conducted by using donors of *Cyprinus carpio* (common carp) pituitary gland extract from 3.0 kg body weight (Plate II). After the extraction of pituitary gland, it was put into a glass tube and mix with 1.5ml of normal saline solution and grind with glass rod. A single injection of common carp pituitary extract was administered only to the females at the rate of 1mg/kg body weight at 7:00 pm in 19 November 2011 (Plate 3.2).

After induction of pituitary, breeding set was installed with the fine mesh net nylon hapa in cement tank with male and female sex ratio of 2:1. Aquatic plant, water hyacinths were put into fine mesh net nylon hapa for the purpose of hiding and holding of adhesive eggs. Then the water was shower slowly over the water hyacinth for purpose of stimulation and water exchange from turn down pipe for increase dissolved oxygen in spawning tank (Plate 3.2). The water temperature range from 24 -26 °C and pH value 7.5 was maintained at spawning time (Plate 3.3).

Spawning activity was started after the injection and lasted for about 7 - 8 hrs. During spawning the males were aligned on either side of the female and rubbed their body against the female and released milt. The adhesive eggs were deposited on the roots of water hyacinths and were fertilized externally. After spawning male and female brooders were removed from breeding hapa and unless they are separated from the eggs they begin to eat the eggs in the spawning tank. Descriptions of the embryonic and larval development stages were examined by Ivymen 3000 series microscope, larval and fry weighing by Setra EL-200S digital weighing scale (Plate 3.3).

3.2.6 Experiment Design

In the present study induced breeding experiment of Inle carp, *Cyprinus intha* was conducted in mature females by administrating a single intramuscular injection of pituitary gland (PG) extract at a dosage of 1ml / kg body weight, whereas males were not administered induced breeding for spawning. Spawning tank was used by cement tank (3×2×1) m and fine mesh net nylon hapa (2.3×2.0×1) m was set up into spawning tank and introduced aquatic plants water hyacinths for hiding purposes as well as holding the adhesive eggs.

The distinguished characteristic of the development of early embryonic stages were examined on live specimens under Ivymen 3000 series microscope and microphotographs were taken of the development of embryonic stages and larvae were observed at the laboratory of Department of Zoology, Mandalay University.

The larvae were nursed in fine mesh hapa until completely absorbed the yolk and opened the mouth in spawning tank. At the fry stage, they were nursed with fine mesh net hapa (2.3×2.0×1.0) m in earthen pond 0.05 ha for 30 days. After that the fingerlings were transfer into separate net hapa at different stocking densities (Plate 3.4).

In this experiment fingerlings stage were stocked in nylon net hapa (3×2×2)m set up in the earthen pond in different stocking densities, 3ind./m^2, 5ind./m^2, 7/m^2 and 9/m^2. The weight gain, specific growth rate and feed conversion ratio were examined in the period of ten weeks. The length and weight of fry were measured by using a microscope with an ocular micrometer and Setra EL-200S digital weighing scale.

The length was measured by M&G ARL 96027 millimeters and the weight by FUJI D7030 gram weighing balance (Plate 3.5).

3.2.7 Pond Preparation

The banks of the pond were cleaned and the pond bottom was sun dried for a few days. The pond bottom was limed at the rate of 7-10 kg/100m^2, and 50-100 kg/100m^2 of cow dung was provided as organic fertilizer was spread.

3.2.8 Water Monitoring

Four units of fine mesh hapa were set up in the nursery pond and filled with water to 90 cm. The water parameter were maintained as pH 7.5 – 8.5, water temperature 26 – 28 °C, and dissolved oxygen 5.0 – 7.0 ppm and total alkalinity 80 – 150 throughout the experiment. The pond water depth was maintained at the optimum level of 120 cm by using topping system and no water exchange was undertaken throughout the experiment.

3.2.9 Stocking

The fingerlings were stocked at density of 3 ind./m^2, 5 ind./m^2, 7 ind./m^2 and 9 ind./m^2 in each nylon net hapa.

3.2.10 Feeding

25-100g of peanut-oil cake was soaked in water for 8–10 hours before grinding. Then, it was mixed with 20 litter of water and fry were fed two times at 9:00 am and 3:00 pm per day.

After 35 days fingerling stage started, the percentages of feed were monitored as 5-15 % of body weight. Initial feed consumption per week was (18.9 – 56.7) g and gradually increased to (1345 – 1600) g dry weight within 10 weeks. The composition of supplementary feed for fingerling stage was used such as peanut cake 20 %, rice bran 60 %, and corn 15% and fishmeal 5 %.

3.2.11 Measuring

The fry and fingerlings were measured every week and observed their weight, length, survival rate, growth rate and feed conversion ratio throughout the experiment.

3.2.12 Analysis of Data

Analysis of variance (ANOVA) and standard statistical methods were used for analysis of data (Snedecor and Cochran 1967).

The relationship of stocking density to daily weight gain, specific growth rate and feed conversion rate were calculated according to (De Silva and Anderson 1995) as following:

$$\text{DWG} = \frac{\text{Mean final weight (g)} - \text{Mean initial weight (g)}}{\text{Time (day)}}$$

$$\text{SGR} = \frac{\text{In (final body wt.)} - \text{In (initial body wt.)}}{\text{Feeding period (day)}} \times 100$$

$$\text{FCR} = \frac{\text{Dry weight of feed consumed}}{\text{Wet weight gain}}$$

Fig. 3.1 Map of No.1 Fishery Station, Thayetkone, Aungmyaytharsan Township, Mandalay Region (Source: Department of Fisheries)

Plate 3.1 Brood stock selection of *Cyprinus intha* and preparaing of nylon net hapa

A. Collection of breeder
B. Selected female breeder
C. Male breeder
D. Female breeder
E. Fine mesh nylon net hapa inside the spawning tank
F. Hapa with water hyacinths

A

B

C

D

E

F

Plate 3.1

Plate 3.2 Preparation for induced breeding

A. Weighing female breeder
B. Extracting pituitary gland
C. Placing the pituitary gland on the grinder
D. Grinding the pituitary gland
E. Injecting pituitary solution into the base of pectoral fin in female breeder
F. Releasing the breeders into the fine mesh net nylon hapa

A

B

C

D

E

F

Plate 3.2

Plate 3.3 Collection of *C. intha* fertilized eggs

A. Eggs adhering to water hyacinth roots

B. Incubating fertilized eggs in a circular concrete tank

C. Collecting the fertilized eggs

A

B

C

Plate 3.3

Plate 3.4 Experimental setup

A. Pond preparation

B. Setting up the fine mesh nylon net hapa for fry

C. Setting up the nylon net hapa

D. Rearing different stocking densities of fingerlings in hapa

A

B

C

D

Plate 3.4

3.3 Results

3.3.1 Embryonic Development

(i) First day

The first day eggs of *Cyprinus intha* are spherical, yellowish-green in color, sticky and demersal in nature. The egg envelope was thick and became transparent as development progressed. The diameter of the eggs were 1.68mm ± 0.1532, (n = 20). The cleavage took place only in the blastodisc, a thin region of yolk free cytoplasm at the animal pole of the egg within one hour after fertilization. A small cell morula and germinal rings were formed by the process of blastulation. Yolk invasion completed during the blastula stage within 9 hours after fertilization. The epiboly appeared and the embryo outlines were observed around the yolk plug during 24 hours of fertilization. At that time the head and caudal region of the embryo became distinguishable (Plate 3.6).

(ii) Second day

On the second day, the diameter of the eggs were 1.73mm ± 0.0381, (n = 20). The eye vesicles and the notochord were clearly distinguished. The trunk of the embryo was elongated and encircled the yolk. The somites were distinguished in the caudal section within 30-48 hours after fertilization (Plate 3.6).

(iii) Third day

On the third day, the embryo encircled the whole of the yolk and its dark melanophores gradually increased (dm). The eye lenses and optic vesicle appeared. The notochord (n) and somites were well developed. At this time the embryo showed sudden spasm and heart beat vigorously (h). The caudal region was free from the yolk mass and lashing at egg membrane. The head and tail rudiments were complete, and fin-folds were prominent in caudal region (cf). The embryo showed slight movement and active twitching movement within 68 and 70 hours after fertilization of the egg (Plate 3.6).

(iv) Fourth day

On the fourth day, the growing embryo occupied the entire previtelline space. Hatching of *Cyprinus intha* eggs occurred about 71-72 hours after spawning at water temperature 26 °C. After a few seconds, its twitching movement suddenly broke the previtelline membrane and the hatchling emerged tail first. The hatchlings were transparent and have a large yolk sac. The length of hatchling is 5.21± 0.043 mm, (n=20). At this stage, they have no swim bladder and mouth. They breathe by the blood capillaries which surrounded the yolk sac. The dark melanophore line appeared from head to tail along the dorsal region of the body. The fin folds were found around the tail (Plate 3.7).

3.3.2 Larval Development

(i) First day larval stage

The head of one day old larva was noticed above the yolk sac and the otolith was clearly visible. Six to eight hours after hatching the fin folds were seen continuously around the tail. On the first day larvae, it had a large yolk sac. The pigmented pattern was seen in dorsal, ventral and caudal region, the mouth, digestive tract and swim bladder were not developed. Gas exchange takes place through the blood vessels around the yolk sac. Myotomes was visible and the length of the larvae was 5.67 ± 0.110mm, (n=20) (Plate 3.8).

(ii) Second day larval stage

On the second day, the length of the larvae was 6.40 ±0.136mm, (n=20). Pectoral fin (pf) and swim bladder (sb) were seen. Pigmented pattern (pm) and caudal fin lobe(cfl) were more distinct. On the head there were two lines of dark melanophores (dm) from head to tail along the ventral and dorsal edges of the body. The myotomal count (mc) was 16-18 in pre-anal (pre-anal) and 18-20 in post-anal (post-anal). The rudimentary gut was visible. Pectoral fin and gills were distinguishable (Plate 3.9).

(iii) Third day larval stage

On the third day after hatching, the mean length of the larvae was 6.41 ± 0.075mm, (n=20). They tried to swim upwards, towards the light and attached to the aquatic plants by their head gland and swimming with zigzag movements. When the larvae swam to the surface and then swim bladder filled with gas and became enlarged. The pectoral fins appeared as small round lobes (pfl). Eyes, mouth (m) and jaws (j) were prominent but mouth not open on the third day after hatching (Plate 3.10).

(iv) Fourth day larval stage

On the fourth day after hatching the length of the larvae was 6.52mm ± 0.104mm, (n=20) and the lenses were seen on eye pigment. The ventral fin lobes (vfl) and anal fin lobes (afl) were differentiated, caudal fin lobes were round and fin rays were present (cfr). The gut tube (gt) formed beneath the yolk sac and the gill filaments became functional (Plate 3.10).

(v) Fifth day larval stage

On the fifth day after hatching the length of the larvae is 6.68mm ± 0.064mm, (n=20). The mouth was distinct but not open and the eyes were bright on this stage. A small amount of yolk was left in the yolk sac (Plate 3.11).

(vi) Sixth day larval stage

On the sixth day after hatching the length of the larvae was 6.80 ± 0.068 mm, n=20. Pectoral fins and jaws were prominent. The larvae of the mouth started to open (m), intestine (i) and anus well developed (a). Yellow melanophores appeared on head and operculum (op) prominent (Plate 3.11).

(vii) Seven day larval stage

On the seventh day after hatching the length of the larvae was 6.87 ± 0.162 mm, (n=20) and yolk was completely absorbed. Intestine and anus developed. Dorsal (dfl) and ventral fin lobes (vfl) were more distinct. Pigmented patterns (pp) were more prominent on dorsal and ventral side of the larvae on this stage (Plate 3.12).

(viii) Eight day larval stage

On the eighth day after hatching the length of the larvae was 6.95 ± 0.684mm, (n=20) and yolk was completely absorbed. The pigments were more dispersed on head and dorsal region. Pectoral fin and caudal fin were more differentiated. Dorsal and ventral fin lobes were distinguishable (Plate 3.12).

3.3.3 Fry Development

The larval stage was completed on eight day and the fry stage started. The fry has all characteristic of adult stage and the fry started to swim freely.

(i) First week fry

On the first week, the mean length of fry was 7.60 ± 0.074mm, (n=20) and average body weight 0.06g and the inner part of the caudal fin lobes reduced. The shape of the caudal fin started to change and fins lobes were differentiated by fork. The caudal fin rays were formed and they gradually resembled the adult in external features at this stage (Plate 3.13).

(ii) Second week fry

After two weeks, the mean length of the fry was 11.80 ± 1.483mm, (n=20) and mean weight 0.08 ± 0.055g, (n=20). At this stage, they developed clear unpaired fins, mouth and other organs. The fry had black and orange color patches on head, dorsal and ventral edges of the body. The swim bladder divided and intestine well developed. The caudal fin forked and fin rays developed (Plate 3.13).

(iii) Third week fry

At this stage, the mean length of the fry was 13.4 ± 1.341mm, n=20 and the mean weight 0.158 ± 0.071, n=20. They developed paired fins and locomotion ability increased. No fin-fold was left and pelvic fins were developed (Plate 3.13).

(iv) Fourth week fry

After three week, the mean length of fry ranged 15-20mm and the range of weight 0.858-1.023g. They are entirely covered by scales and appeared as an adult. Paired fins developed and locomotion ability increase at this stage Fins were developed with fin rays, 16-18 in dorsal, 20-22 in caudal, 6 in anal, 8-9 in ventral and 14-16 in pectoral. (Plate 3.13).

3.3.4 Fingerling Production with Four Different Stocking Density

In experiment 1, stocking density was 3ind. /m^2 in nylon net hapa. At initial week, growth parameters were 1.954g in weight (ABW) and 27.5 mm in total length (TL), 0.1360g /day in daily weight gain (DWG), 95.4 % in growth rate (GRP), 0.785mm in daily increment length (DIL), daily feeding rate 15% of body weight, 100 % of survival rate, 0.54 in feed conversion ratio (FCR) and 11.07% in specific growth rate (SGR) (Table 3.1).

In experiment 2, stocking density was 5ind. /m^2 in nylon net hapa. At initial week, growth parameters were 1.82g (ABW), 26.0mm (TL), 0.1171g/day (DWG) and 82% (GRP), 0.571mm (DIL), 15% of body weight daily feed intake,100% survival rate, 0.57 (FCR) and 11.71% (SGR) (Table 3.2).

In experiment 3, stocking density was 7ind. /m^2 and growth parameters of initial week were 1.65g (ABW), 25.0mm (TL), 0.0928g/day (DWG), 65% (GRP), 0.428mm (DIL), 15% of body weight daily feed intake, 100% survival rate (SR), 0.63% (FCR) and 0.834% (SGR) (Table 3.3).

In experiment 4, stocking density is 9ind. /m^2 and growth parameters of initial week were1.5g (ABW) 24.5mm (TL), 0.0714 (DWG) is 0.0714g/day 50% (GRP), 0.357mm (DIL), 15% of body weight daily feed intake, 100% survival rate (SR), 0.7 (FCR) and 8.11% (SGR) (Table 3.4).

After 10 weeks of culture, growth parameters was 40g in (ABW), 130mm in (TL), 0.714g/day (DWG), 14.28% (GRP), 1.428mm (DIL), 5% of body weight daily feed intake, 95% survival rate (SR), 1.97 (FCR) and 1.92% (SGR) with stocking density of 3ind./m^2 in experiment I, 35g (ABW), 120mm (TL), 1.4285g/day (DWG), 40% (GRP), 1.428mm (DIL), 5% of body weight daily feed intake, 90% survival rate, 1.73 (FCR) and 4.80% (SGR) with stocking density of 5ind./m^2 in experiment II, 17 g (ABW), 100mm was (TL), 0.2850g/day in (DWG), 13.33% (GRP), 0.714mm (DIL), 5% of body weight daily feed intake, 80% survival rate (SR), 2.32 (FCR) and 3.19 (SGR) with stocking density of 7ind./m^2 in experiment III, 16g in (ABW), 100mm (TL), 0.2857g/day (DWG). 14.28% (GRP), 07142mm (DIL), 5% of body weight daily feed intake, 80% survival rate (SR), 2.41 (FCR) and 1.91%(SGR) with stocking density 9ind./m^2 in experiment IV (Table 3.1, 3.2, 3.3).

The highest increment of length was observed in the lowest stocking density (3 ind/m^2) (Fig.3.2). The weekly highest increment of SGR and DWG were obtained in 5ind/m^2 (Fig. 3.3). Moreover, the lowest FCR was found in 5ind/m^2 (Fig. 3.4). The lowest weekly increment growth performance was found in the highest stocking density (7ind/m^2 and 9ind/m^2). The survival rate was not affected by stocking density. The highest weight gain was obtained in 3ind/m2 and even though the total yield was lowers than stocking density 5ind/m^2. At the end of the culture period, the better total yield was obtained in 5ind/m^2 and the lowest FCR was found in this stocking densities. The lowest FCR indicated better food utilization. Thus, the stocking density 5ind/m^2 was better growth performance than other stocking densities (3, 7 and 9 ind/m^2). Therefore, the 5ind/m^2 was optimum stocking density in fingerling culture of *C. intha* (Table 3.5).

Table 3.1 Weekly growth increment of *C. intha* fingerling with stocking density 3 ind./m^2 during culture period (10-week)

Week	Age (Days)	ABW (g)	Length (mm)	DWG (g)	GPR (%)	DIL (mm/day)	Feeding rate (%)	Survival Rate (%)	FCR	SGR (%)	Feed (g/day)	DFC (%)	TFC (g)
1	1 - 7	1.954	27.5	0.136	95.4	0.785	15	100	0.54	11.07	2.70	26.11	18.90
2	8 - 14	3.6	30.40	0.235	84.23	0.500	15	100	0.86	8.73	5.27	27.11	55.79
3	15 - 21	5.0	50.00	0.200	38.88	2.800	12	100	1.46	4.69	10.80	35.88	131.39
4	22 - 28	6.0	60.00	0.142	20.00	1.428	10	100	1.91	2.60	10.80	28.05	206.99
5	29 - 35	6.8	75.00	0.114	13.33	2.142	10	100	2.39	1.79	12.24	28.57	292.67
6	36 - 42	14.5	86.00	1.100	113.23	1.571	8	100	1.68	10.82	20.88	28.00	438.83
7	43 - 49	20.5	100.00	0.857	41.37	2.000	8	100	1.74	4.95	29.52	24.09	645.47
8	50 - 56	28.0	110.00	1.071	36.58	1.428	6	100	1.7	4.45	30.24	24.68	857.15
9	57 - 63	35.0	120.00	1.00	25.00	1.428	6	95	1.86	3.19	35.70	21.03	1107.05
10	64 - 70	40.0	130.00	0.714	14.28	1.428	5	95	1.97	1.92	34.00	12.95	1345.05

ABW = Average Body Weight

DWG = Daily Weight Gain

GRP = Growth Rate Percent

DIL = Daily Increment Length

FCR = Feed Conversion Ratio

SGR = Specific Growth Rate

DFC = Daily Feed Consumption

TFC = Total Feed Consumption

Table 3.2 Weekly growth increment of *C. intha* fingerling with stocking density 5 ind./m^2 during culture period (10-week)

Week	Age (Days)	ABW (g)	Length (mm)	DWG (g)	GPR (%)	DIL (mm/day)	Feeding rate (%)	Survival Rate (%)	FCR	SGR (%)	Feed (g/day)	DFC (%)	TFC (g)
1	1 - 7	1.82	26.00	0.1171	82.00	0.571	15	100	0.57	10.54	4.50	45.59	31.50
2	8 - 14	3.18	30.00	0.1942	74.72	0.571	15	90	0.97	7.97	7.37	42.11	83.09
3	15 - 21	4.56	40.00	0.1971	43.39	2.142	12	90	1.40	5.15	12.88	47.54	173.25
4	22 - 28	5.5	70.00	0.1342	20.61	4.285	10	90	1.86	2.68	14.85	42.17	277.20
5	29 - 35	6.0	78.00	0.0714	9.09	1.142	10	90	2.40	1.24	16.20	40.24	390.60
6	36 - 42	10.0	85.00	0.5714	66.66	1	8	90	2.00	7.30	21.60	38.57	541.80
7	43 - 49	14.0	90.00	0.5714	40.00	0.714	8	90	1.90	4.80	30.24	36.00	753.48
8	50 - 56	18.0	100.00	0.5714	28.57	1.428	6	90	1.97	3.59	29.16	26.42	957.60
9	57 - 63	25.0	110.00	1.0000	38.88	1.428	6	90	1.83	4.69	40.50	26.66	1241.10
10	64 - 70	35.0	120.00	1.4285	40.00	1.428	5	90	1.73	4.80	56.70	27.00	1638.00

ABW = Average Body Weight

DWG = Daily Weight Gain

GRP = Growth Rate Percent

DIL = Daily Increment Length

FCR = Feed Conversion Ratio

SGR = Specific Growth Rate

DFC = Daily Feed Consumption

TFC = Total Feed Consumption

Table 3.3 Weekly growth increment of *C. intha* fingerling with stocking density 7 ind./m^2 during culture period (10-week)

Week	Age (Days)	ABW (g)	Length (mm)	DWG (g)	GPR (%)	DIL (mm/day)	Feeding rate (%)	Survival Rate (%)	FCR	SGR (%)	Feed (g/day)	DFC (%)	TFC (g)
1	1 - 7	1.65	25.00	0.0928	65.00	0.428	15	100	0.63	8.34	6.30	67.92	44.10
2	8 - 14	2.90	28.00	0.1785	75.75	0.428	15	90	0.98	8.05	9.12	57.26	107.94
3	15 - 21	4.35	30.00	0.2071	50.00	0.285	12	85	1.25	5.79	12.53	49.38	195.65
4	22 - 28	5.00	40.00	0.650	14.94	1.714	10	80	1.85	1.94	17.00	51.94	314.65
5	29 - 35	5.60	6.00	0.085	12.00	3.714	10	80	2.35	1.62	19.04	51.32	447.93
6	36 - 42	6.80	80.00	0.171	21.42	2.000	8	80	2.49	2.77	18.49	42.60	577.36
7	43 - 49	9.50	85.00	0.385	39.70	0.850	8	80	2.34	4.77	25.84	45.29	758.24
8	50 - 56	12.00	90.00	0.357	26.31	0.714	6	80	2.27	4.77	24.48	42.90	929.60
9	57 - 63	15.00	95.00	0.428	25.00	0.714	6	80	2.24	3.34	30.60	32.38	1143.80
10	64 - 70	17.00	100.00	0.285	13.33	0.714	5	80	2.32	3.19	28.90	25.80	1346.10

ABW = Average Body Weight

DWG = Daily Weight Gain

GRP = Growth Rate Percent

DIL = Daily Increment Length

FCR = Feed Conversion Ratio

SGR = Specific Growth Rate

DFC = Daily Feed Consumption

TFC = Total Feed Consumption

Table 3.4 Weekly growth increment of *C. intha* fingerling with stocking density 9 ind./m^2 during culture period (10-week)

Week	Age (Days)	ABW (g)	Length (mm)	DWG (g)	GPR (%)	DIL (mm/day)	Feeding rate (%)	Survival Rate (%)	FCR	SGR (%)	Feed (g/day)	DFC (%)	TFC (g)
1	1 - 7	1.50	24.5	0.0714	50.00	0.357	15	100	0.70	8.11	8.10	92.57	56.70
2	8 - 14	2.65	26.5	0.1642	76.66	0.285	15	92	1.02	8.13	11.25	77.45	135.45
3	15 - 21	4.27	28.0	0.2314	61.13	0.214	12	89	1.34	6.81	19.87	82.03	274.54
4	22 - 28	5.0	40.0	0.1042	17.09	1.857	10	80	1.97	2.25	21.50	66.27	425.04
5	29 - 35	5.8	56.0	0.1142	17.09	2.285	10	80	2.40	2.12	24.94	65.97	599.62
6	36 - 42	6.5	70.0	0.1000	12.06	2.000	8	80	2.70	1.63	22.36	51.93	756.14
7	43 - 49	8.0	85.00	0.2142	23.07	2.142	8	80	2.75	2.96	27.52	54.22	948.78
8	50 - 56	12.0	90.00	0.5714	50.00	0.714	6	80	2.25	5.79	30.96	44.22	1165.50
9	57 - 63	14.0	95.00	0.2857	16.66	0.714	6	80	2.35	2.20	36.12	39.69	1418.34
10	64 - 70	16.0	100.00	0.2857	14.28	0.714	5	80	2.41	1.91	34.40	32.76	1659.14

ABW = Average Body Weight

DWG = Daily Weight Gain

GRP = Growth Rate Percent

DIL = Daily Increment Length

FCR = Feed Conversion Ratio

SGR = Specific Growth Rate

DFC = Daily Feed Consumption

TFC = Total Feed Consumption

Table 3.5 Results of experiments on fingerling production of *C. intha* with different stocking density 3 ind./m^2, 5 ind./m^2, 7 ind./m^2, 9 ind./m^2 in culture period (10-week)

Parameter	Hapa (1)	Hapa (2)	Hapa (3)	Hapa (4)
Area (m^2)	6	6	6	6
Stocking density (ind / m^2)	3	5	7	9
Initial day	1.1.2012	1.1.2012	1.1.2012	1.1.2012
Duration days	70	70	70	70
Average Water Level (cm)	90	90	90	90
Water temp, ºC	28	28	28	28
pH	7.5	7.5	7.5	7.5
Dissolved O_2 (mg / L)	5.4	5.4	5.4	5.4
Types of Feed	Rice bran, Corn Peanut oil cake, Fish meal	Rice bran, Corn Peanut oil cake Fish meal	Rice bran, Corn Peanut oil cake, Fish meal	Rice bran, Corn Peanut oil cake, Fish meal
Initial Weight (g)	0.9 ± 0.077	0.87 ± 0.077	0.92 ± 0.078	0.85 ± 0.075
Final Weight (g)	40 ± 1.581	35 ± 2.236	17 ± 1.581	16 ± 1.224
Weight Gain (g)	39.10	34.13	16.08	15.15
Total Yield (g)	680	945	578	688
Total Feed Consumption (TFC) (g)	1345	1638	1346	1659
FCR	1.97	1.73	2.32	2.41
SGR (%)	5.42	5.28	4.16	4.19

ABW = Average Body Weight
DWG = Daily Weight Gain
GRP = Growth Rate Percent
DIL = Daily Increment Length
FCR = Feed Conversion Ratio
SGR = Specific Growth Rate
DFC = Daily Feed Consumption
TFC = Total Feed Consumption

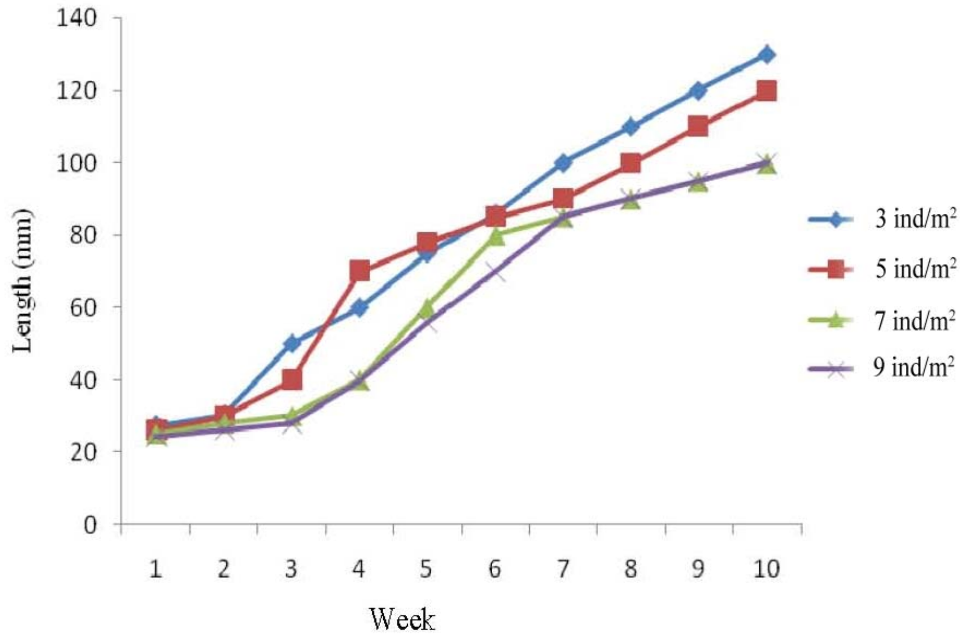


Fig. 3.2 Weekly increment length of *C. intha* with stocking density 3ind/m^2, 5ind/m^2, 7ind/m^2 and 9ind/m^2 were cultured in period (10 week)

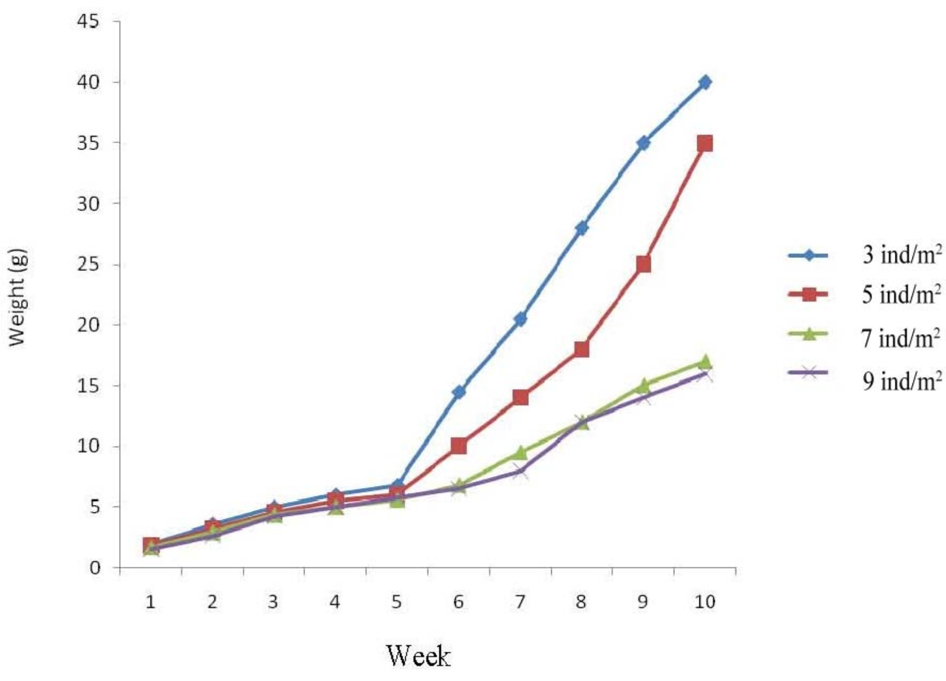


Fig. 3.3 Weekly increment average body weight of *C. intha* with stocking density 3ind/m^2, 5ind/m^2, 7ind/m^2 and 9ind/m^2 were cultured in period (10 week)

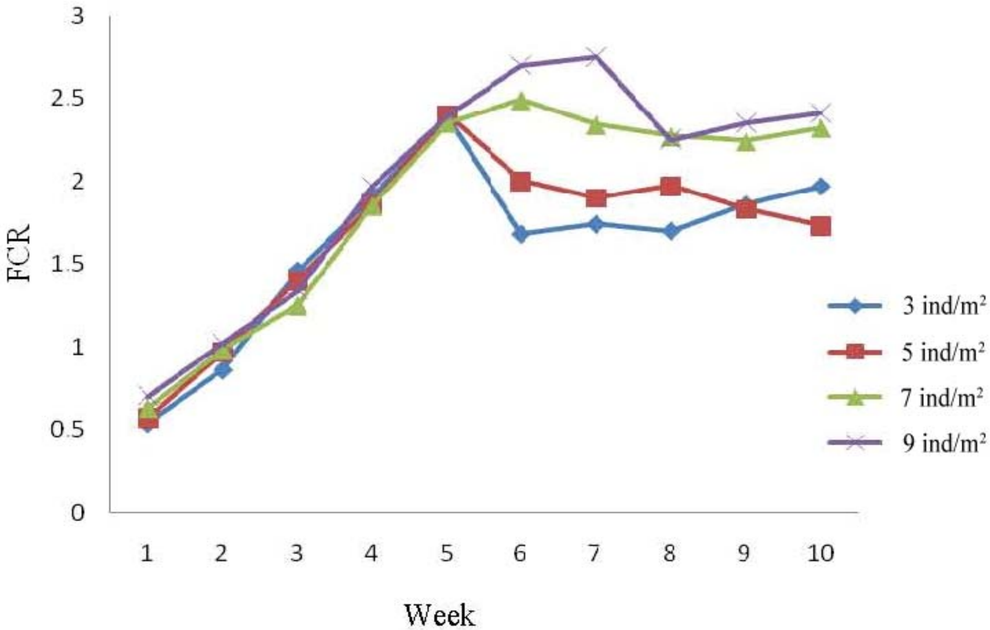


Fig. 3.4 Weekly feed conversion ratio of *C. intha* with stocking density 3ind/m^2, 5ind/m^2, 7ind/m^2 and 9ind/m^2 were cultured in period (10 week)

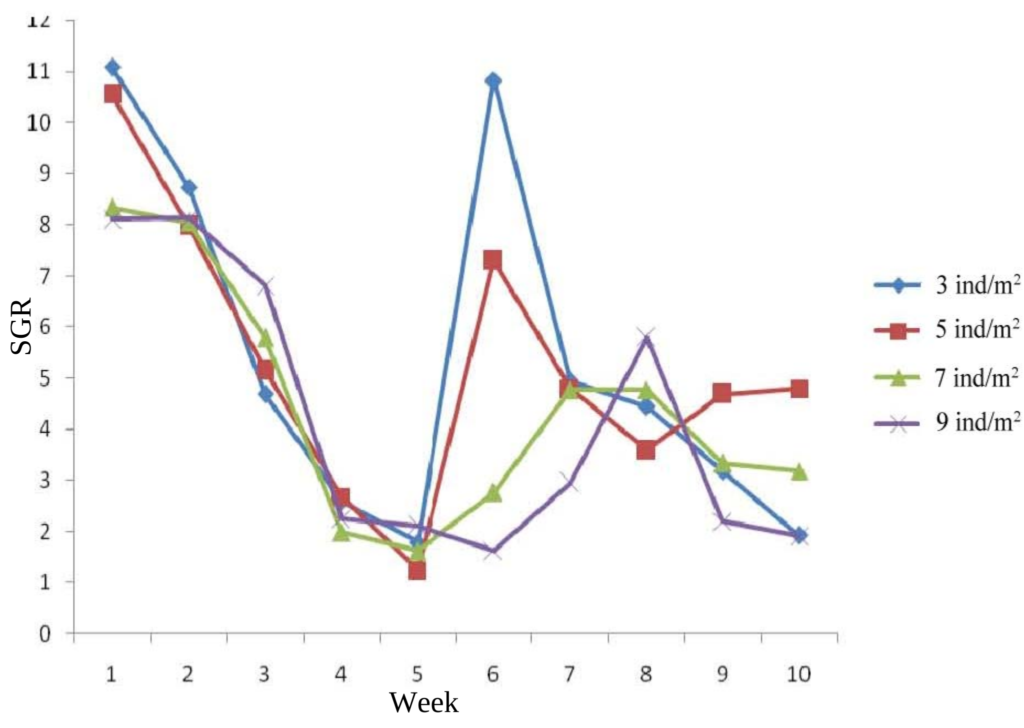


Fig. 3.5 Weekly specific growth rate (SGR %) of *C. intha* with stocking density 3ind/m^2, 5ind/m^2, 7ind/m^2 and 9ind/m^2 were cultured in period (10 week)

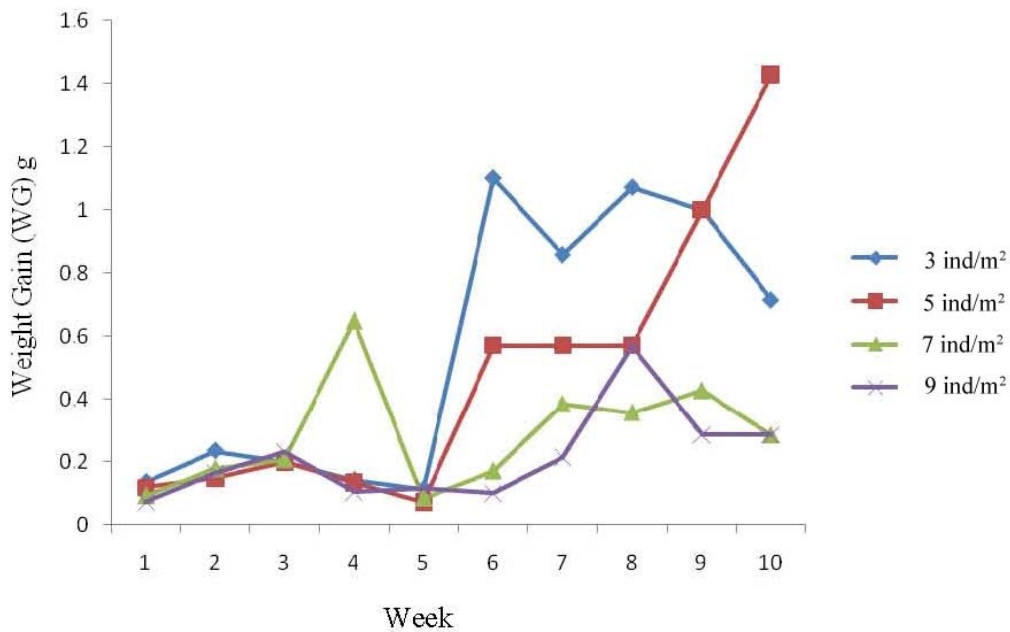


Fig. 3.6 Weekly average daily weight gained (DWG %) of *C. intha* with stocking density 3ind/m^2, 5ind/m^2, 7ind/m^2 and 9ind/m^2 were cultured in period (10 week)

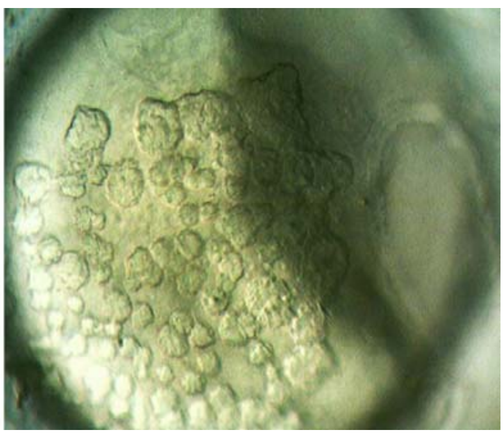
Plate 3.5 Embryonic development of the fertilized egg of *C. intha* in the laboratory

First day

A. Zygote stage
B. Cleavage period
C. Blastula period
D. Gastrula period
E. Segmentation period
F. Formation of myotomal segmentation

A

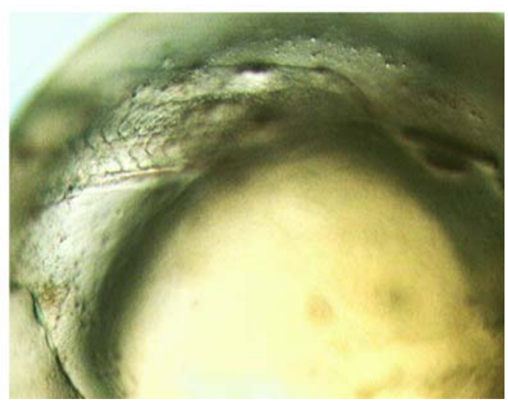
B



C

D

E



F

Plate 3.5

Plate 3.5 Continued

G. Pharyngula period

h = head

dm = dark melanophores

n = notochord

H. Hatching period

h = head

t = tail

ys = yolk sac

I. Newly hatched larva

ys = yolk sac

n = notochord

t = tail

h = head

J. Head region

e =eye

ys = yolk sac

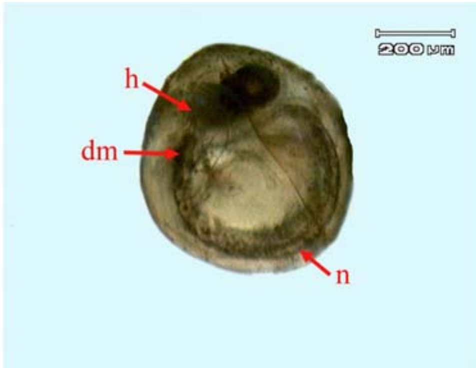
ot = otolith

dm = dark melanophore

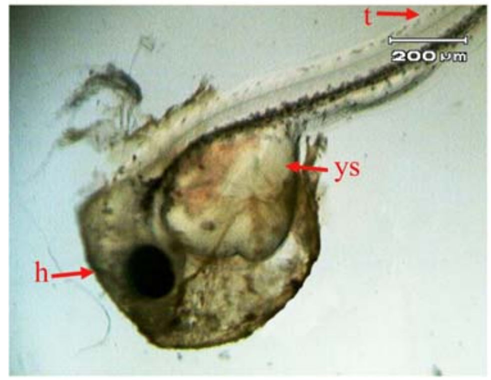
K. Tail region

m = myomere

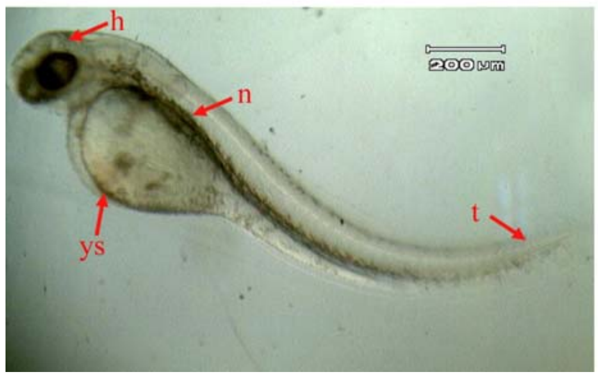
cfl = caudal fin lobe



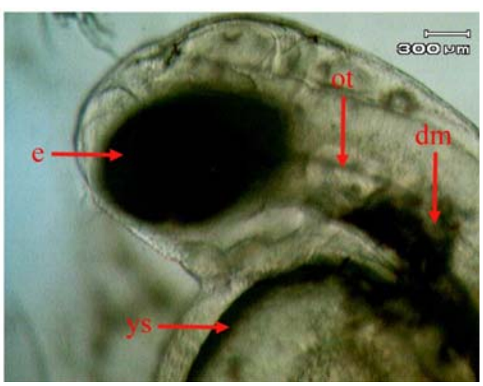
G



H



I



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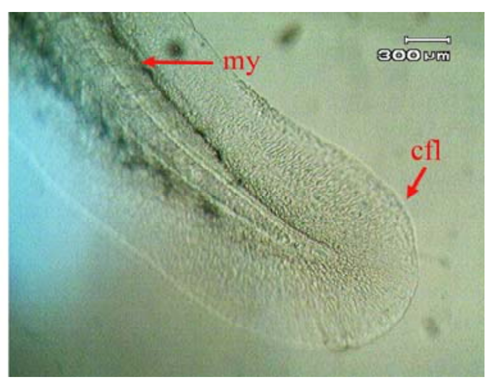


K

Plate 3.5 Continued

Plate 3.6 First day larval stage

A. First day larva
   e = eye
   h = heart
   pp = pigment pattern
   n = notochord

B. Head region
   d = dark melanophore
   h = heart
   e = eye
   ot = otolith

C. Trunk region
   d = dorsal fin fold
   v = ventral fin fold
   a = anus
   mt = myotome

D. Yolk sac

E. Caudal region
   cfl = caudal fin lobe

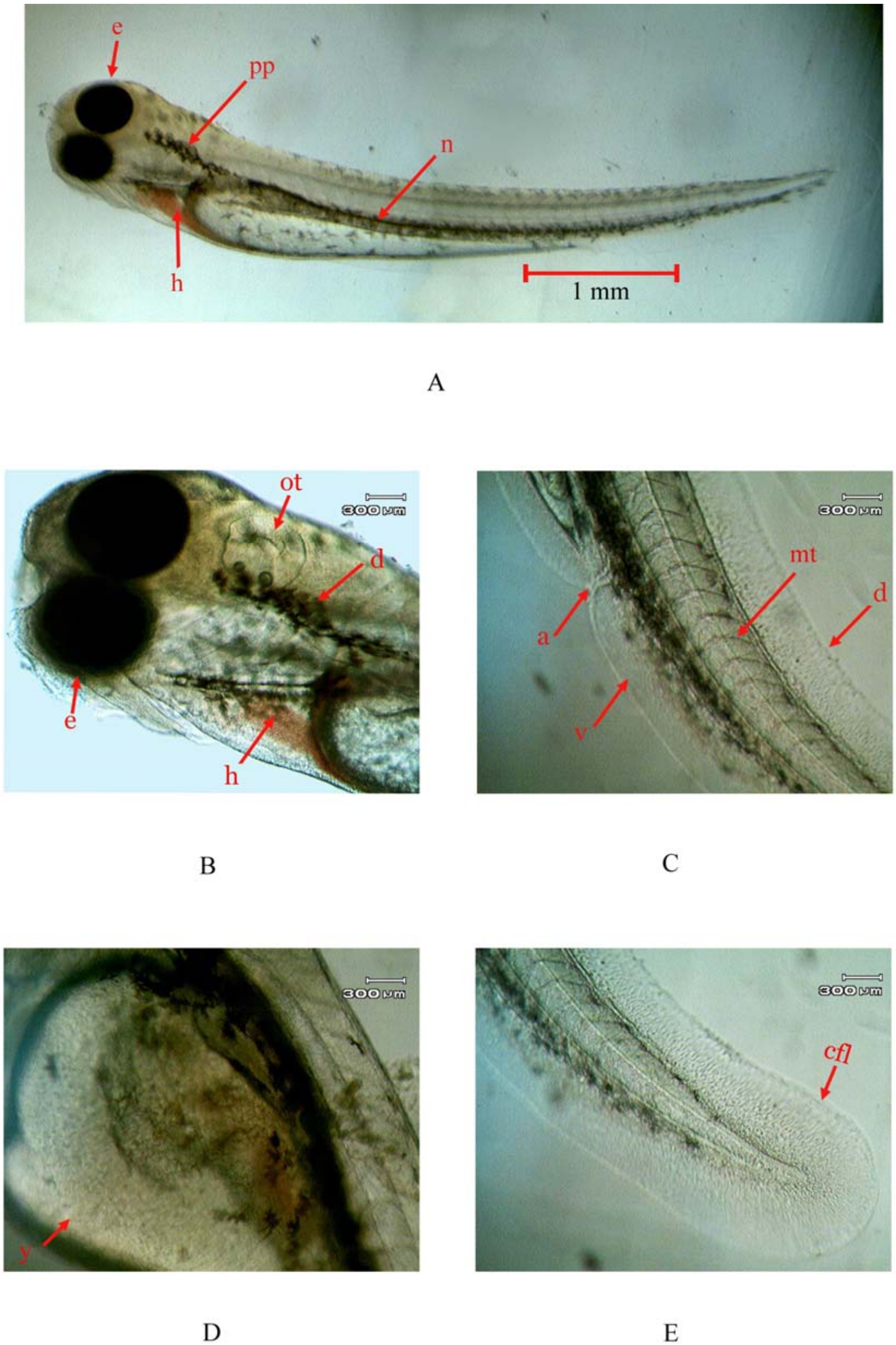


Plate 3.6

Plate 3.7 Second day larval stage

A. Second day larva

e = eye

pf = pectoral fin

sb = swim bladder

pp = pigment pattern

B. Head region

pf = pectoral fin

sb = swim baldder

C. Trunk region

mc = myotomal count

pea = pre-anal

pta = post-anal

D. Anterior trunk region

dm = darkmelanophore

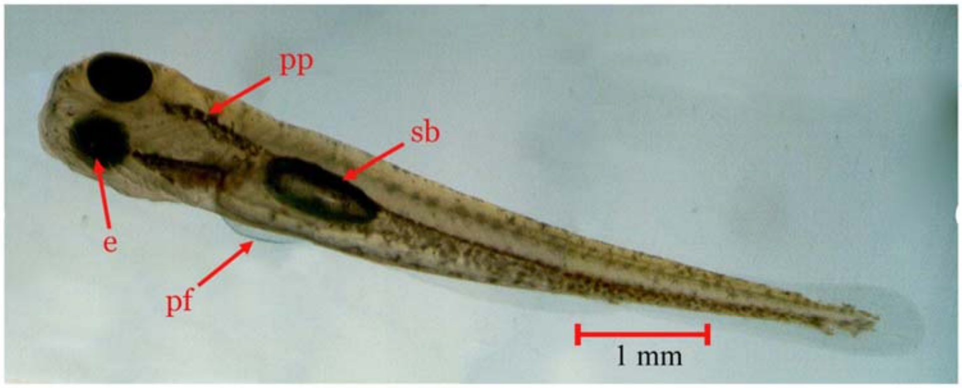
pf = pectoral fin

op = operculum

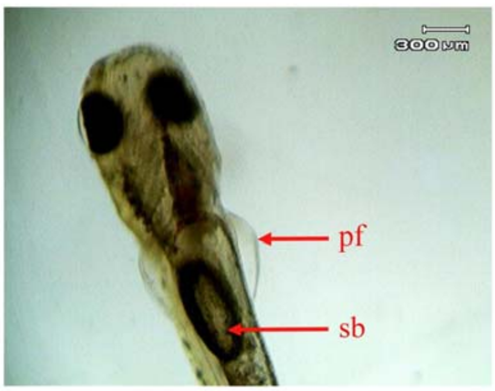
E. Tail region

pm = pigment

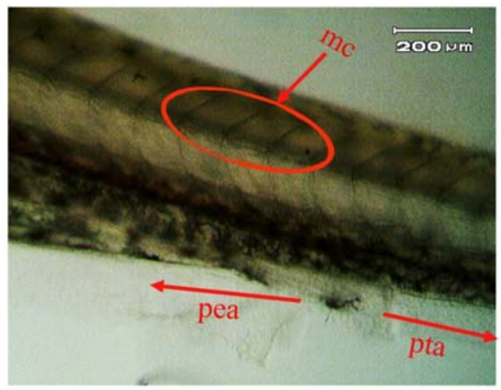
cfl = caudal fin lobe



A



B



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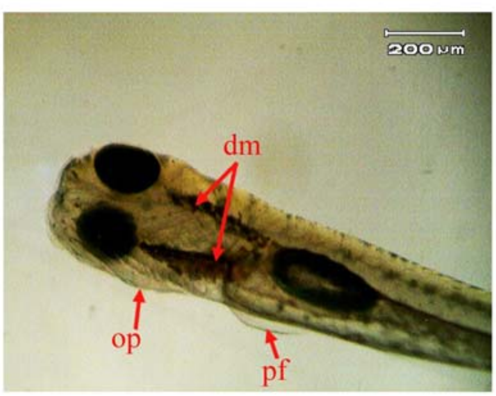

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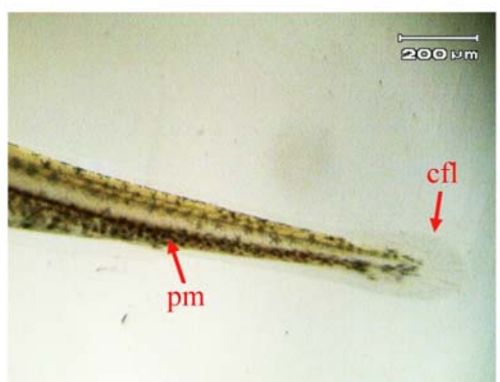


E

Plate 3.7

Plate 3.8 Third and fourth day larval stages

A. Mouth distinguish

   m = mouth

B. Caudal fin rays

   cfr = caudal fin rays

C. Pectoral and ventral fin lobes

   pfl = pectoral fin lobe

   vfl = ventral fin lobe

D. Gut tube

   gt = gut tube

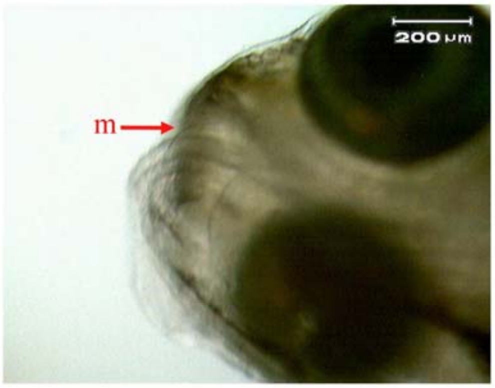
E. Fin lobes in trunk

   dfl = dorsal fin lobe

   vfl = ventral fin lobe

   afl = anal fin lobe

   a = anus



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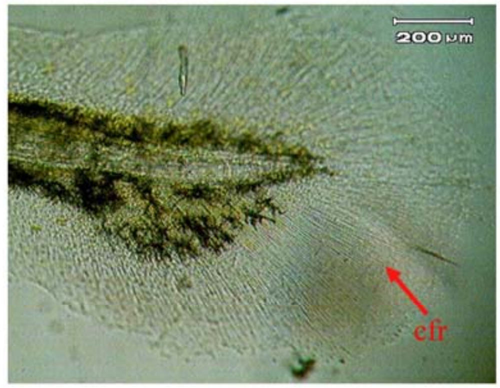

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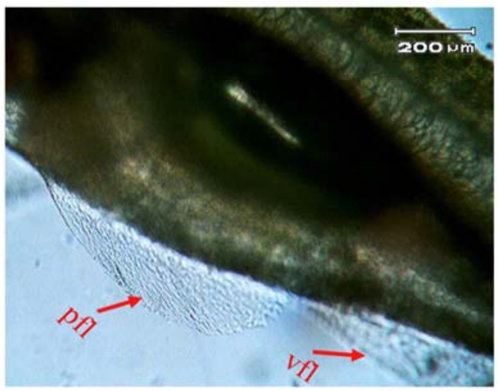

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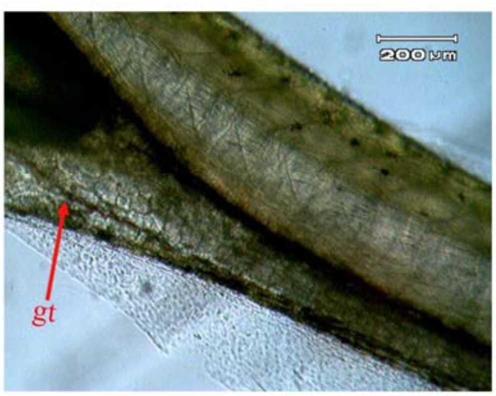

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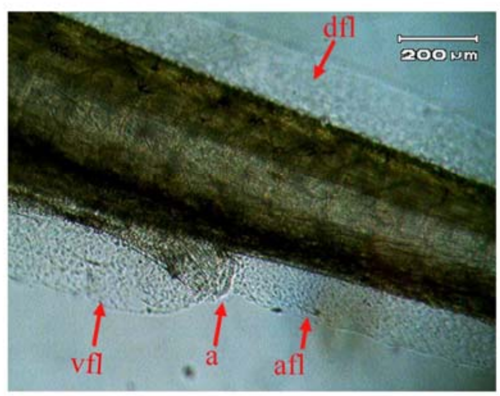
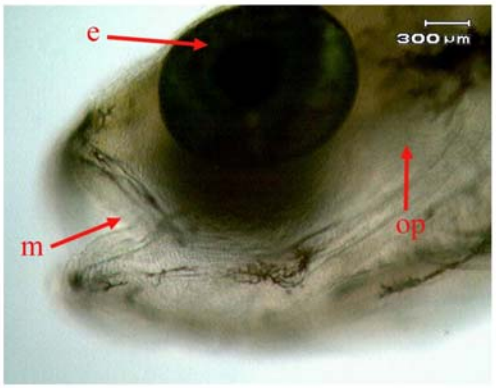


E

Plate 3.8

Plate 3.9 Fifth and sixth day larval stages

A. Head
   m = mouth
   e = eye
   op = operculum
B. Pectoral fin
   op = operculum
   pf = pectoral fin
C. Melanophores
   pp = pigment pattern
   i = intestine
D. Intestine and anus
   i = Intestine
   a = anus
E. Fin lobes in trunk
   dfl= dorsal fin lobe
   vfl = ventral fin lobe
F. Caudal region
   cfl = caudal fin lobe



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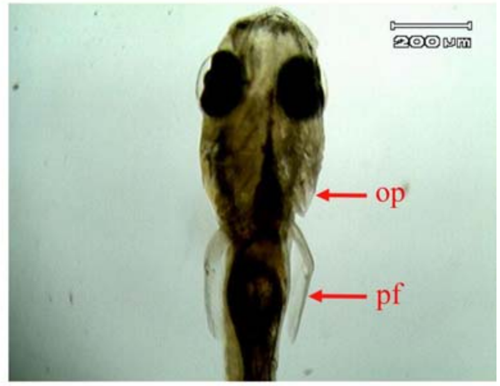

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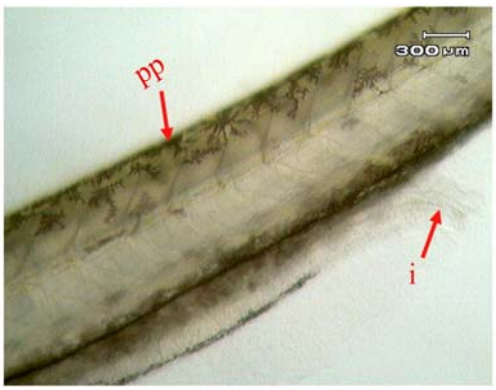

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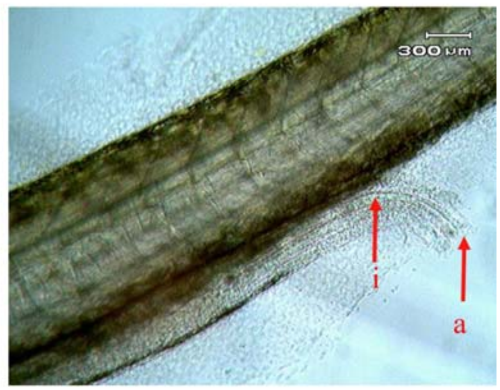

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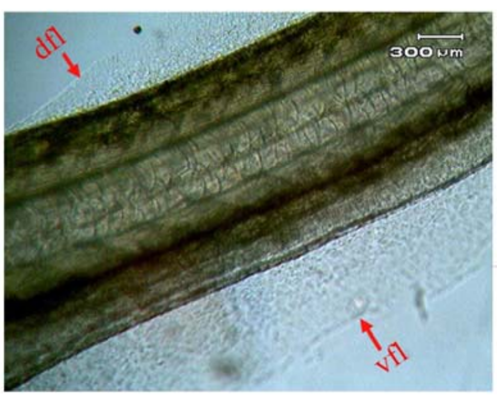

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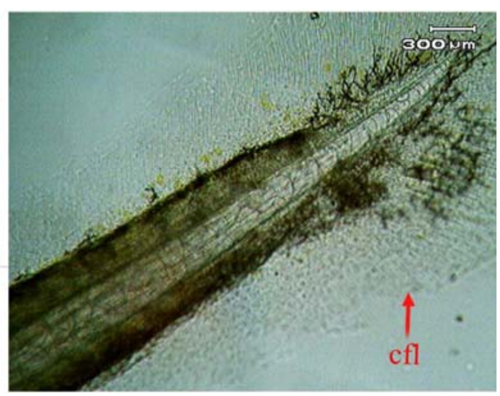


F

Plate 3.9

Plate 3.10 Seven and eight day larval stages

A. Head region

pp= pigment pattern

op= operculum

ot = otolith

sb = swim bladder

B. Trunk region

dfl = dorsal fin lobe

C. Middle trunk region

vfl = ventral fin lobe

D. Anterior trunk region

sb = swim bladder

pp = pigment pattern

i = intestine

my = myotome

E. Pectoral fin

pf = pectoral fin

F. Caudal fin lobe

cfl = caudal fin lobe

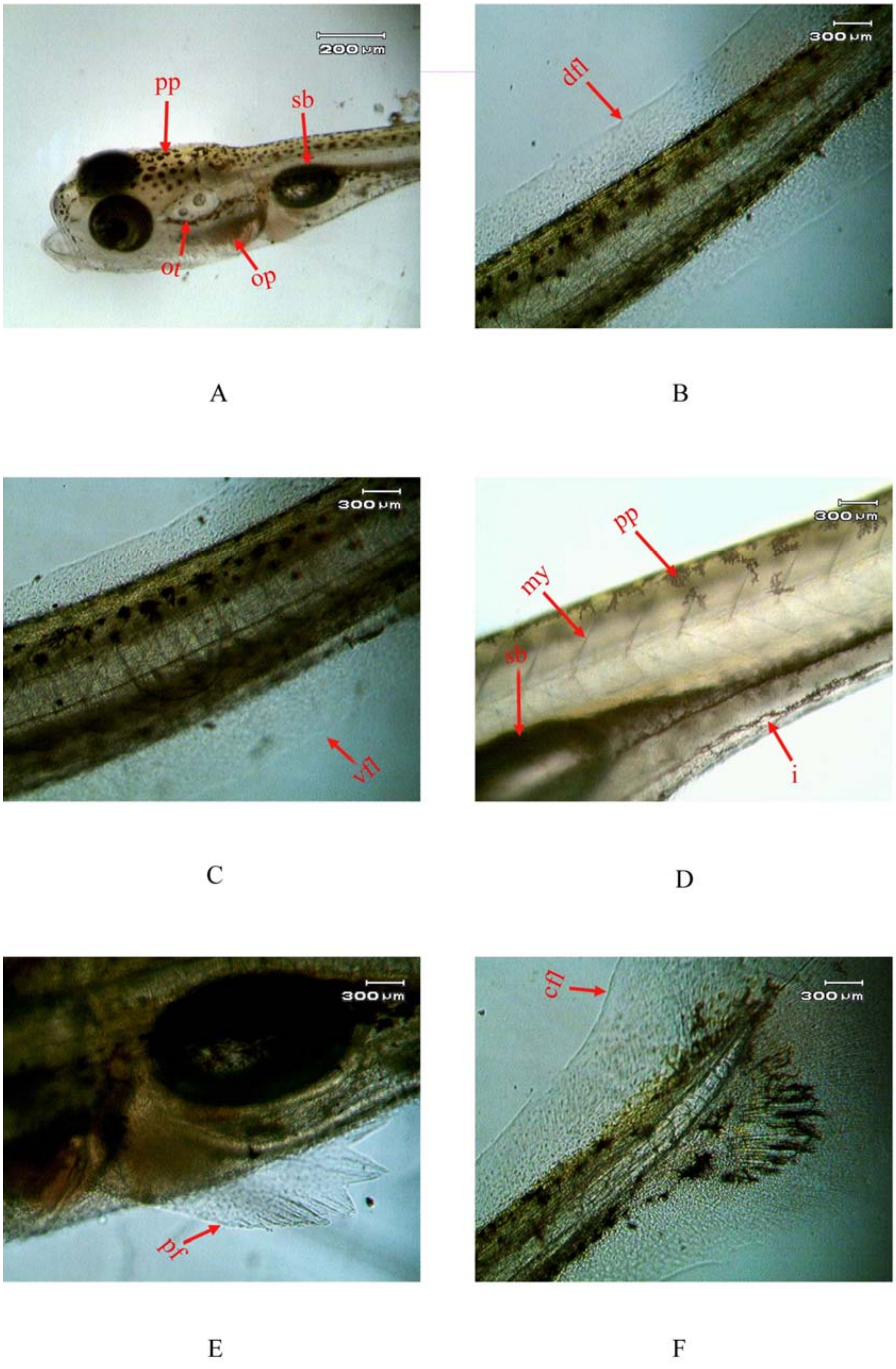

200 µm
pp
sb
ot
op
A
300 µm
dfl
B
300 µm
vfl
C
300 µm
pp
my
sb
i
D
300 µm
pf
E
300 µm
cfl
F

Plate 3.10

Plate 3.11 Fry development of *Cyprinus intha*

A. First week fry

dm = dark melanophores

i = intestine

cfl = caudal fin lobe

B. Caudal portion of first week fry

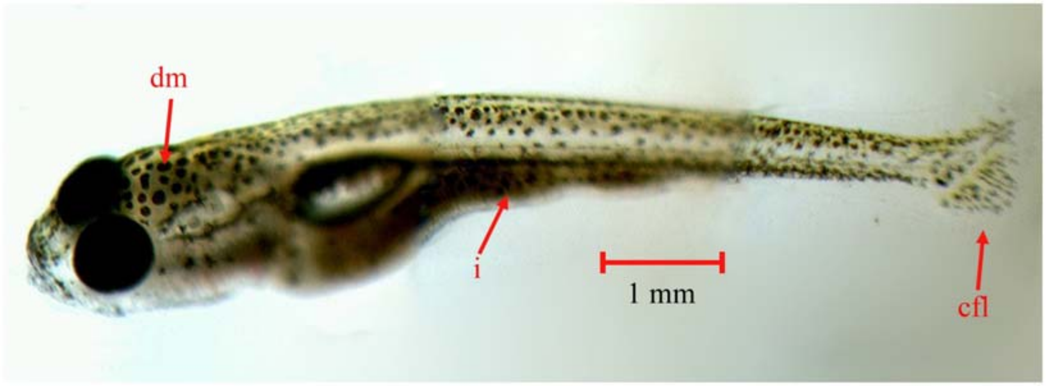
cfl = caudal fin lobe

cfr = caudal fin rays

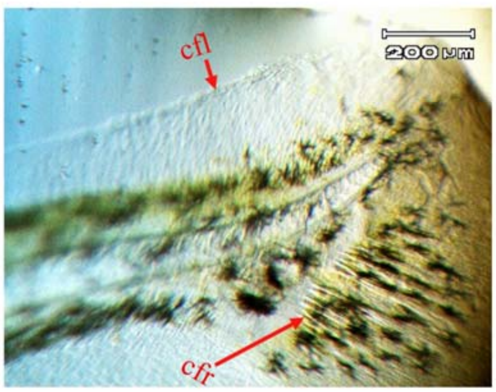
C. Second week fry

D. Third week fry

E. Fourth week fry



A



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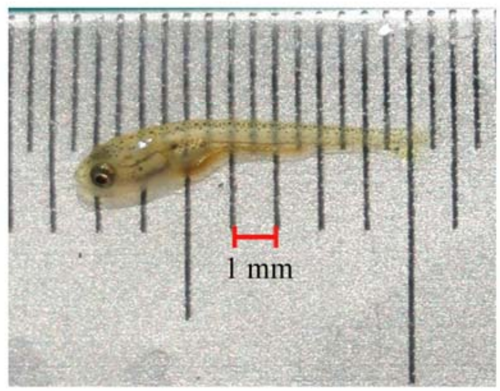

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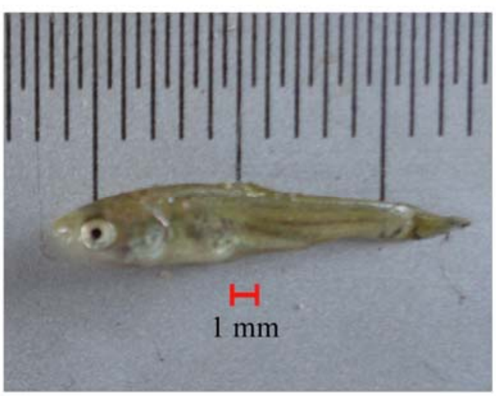

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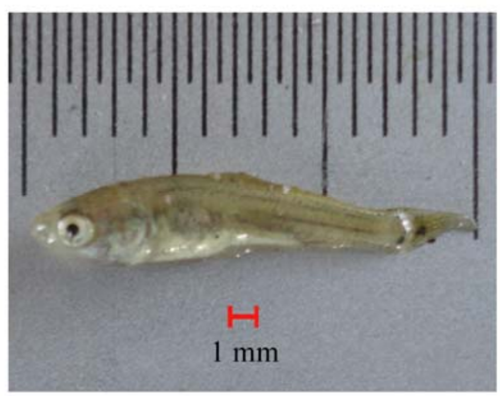


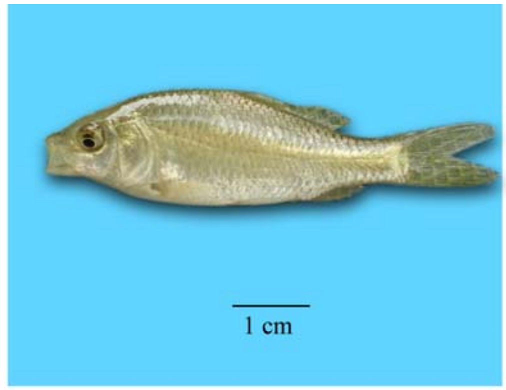
E

Plate 3.11

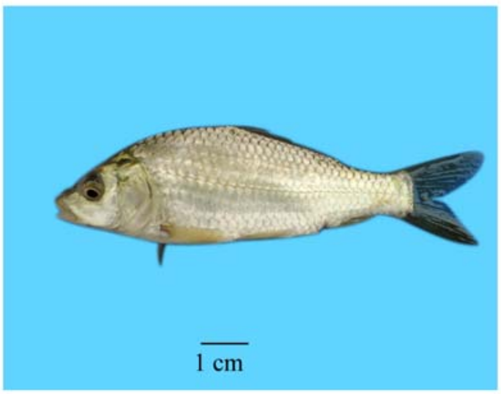
Plate 3.12 Measurements of *C. intha* fingerlings of different ages

A. 14 days fingerling
B. 28 days fingerling
C. 42 days fingerling
D. 56 days fingerling
E. 70 days fingerling

A



B



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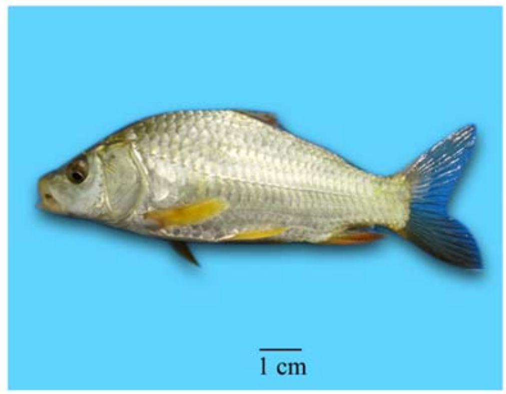

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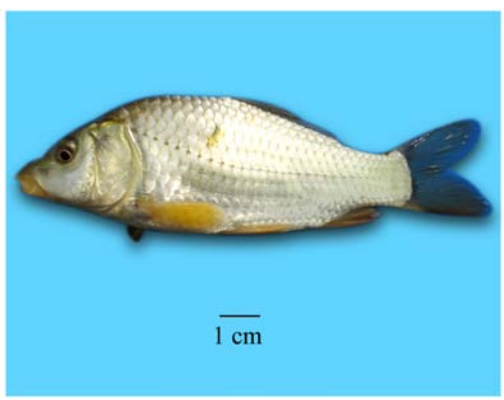


E

Plate 3.12

Plate 3.13 The fin of *C. intha*

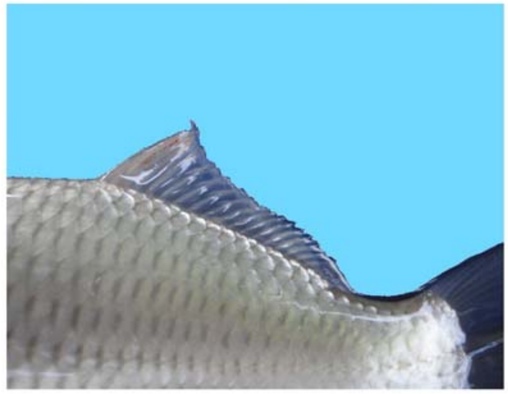
A. Dorsal fin

   r = dorsal fin rays

   s = spine

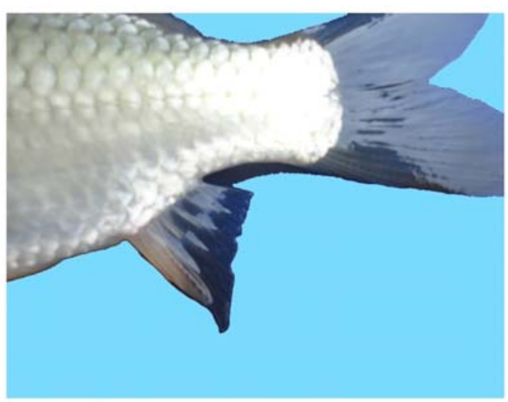
B. Caudal fin

C. Anal fin



A

B



C

Plate 3.13

3.4 Discussion

The eggs of *Cyprinus intha* are spherical, sticky and yellowish green and dermersal in nature. The mean diameter of the eggs was 1.68± 0.153mm in first day egg and 1.73 ± 0.038mm in second day egg. The egg sizes increased significantly during the embryonic developmental stages. The mean egg size of crucium carps was 1.37± 0.09mm Laurila and Holopainen (1990). According to Haniffa (2007), the diameter of the fertilized eggs of *Cyprinus carpio* ranged between 0.99 mm and 1.10 mm. The eggs were deposited singly and were highly adhesive throughout the incubation period. The egg size of *C. intha* was slightly larger than crucian carp and was noticeably larger than *Cyprinus carpio*.

In the present study, a single air bladder was observed in the second day larvae in *Cyprinus intha*. The mouth opened on day six. Metamorphosis from post larva to fry stage took place after 35 days of hatching and the fingerling stage was observed. Hubbs (1943) defined post larva as the stage that began immediately after absorbation of yolk sac. *Cyprinus carpio* had two air bladders in day 7. Balon (1999) revealed that changes in the pattern of entire structure of an organ in relation to the environment were decisive for evaluating the developmental pattern of species.

The highest gonadosomatic index value was observed in November and January observed spawning months and lowest gonadosomatic index was observed in December and March may be considered as spent periods. This finding agree with Aye Min Win Aye (2007) and she reported that the high gonadosomatic index of *Cyprinus intha* possess in November and January considered as spawning periods. December and March with low gonadosomatic index may be considered as spent periods. In the present study, the egg developed within 72 hr to transform larval stages at water temperature 24-26 °C. The finding somewhat agreed with Laurila and Holopainen (1990) who reported that *C.carpio* eggs hatched out 72hr after fertilization at water temperature of 26-28 °C.

Koblitskaya, (1981) reported that the cyprinid species closely resemble each other at larval stages and were difficult to identify. The *C. carpio* has low myotomal count (10-11 pre-anal and 22-23 post-anal myotomes) compared to other cyprinid larvae, which have usually over 13 post-anal myotomes. In the present study, the myotomal count observed as 16-18 in pre-anal and 18-20 in post-anal myotomes.

According to Laurila and Holopainen (1990), the pigmentation pattern was typical for cyprinid fishes with dark melanophores forming lines; crucian carp has two lines from head to tail along the ventral and dorsal edges of the body. In *C. intha* the pigmentation was more distinct with only two rows of melanophores (ventral and dorsal line). The dorsal line forked near the swim bladder. Koblitskaya (1981) revealed that most cyprinid larvae had three pigment lines.

The highest weekly increment of length was found in 3ind/m^2. The lowest increment of length was observed in highest density 9ind/m^2.The optimum length increment was found in 5ind/m^2. Huang and Chiu (1997) reported that when fish density increased, competition for food and living space intensified. Culture can be either density-dependent or density-independent.

The specific growth rate and total yields of *Cyprinus intha* fingerling were significantly higher in 5 ind/m^2 than other densities (3, 7 and 9ind/m^2). This finding agrees with Rahman *et al*. (2004, 2005) and they reported that the stocking density had a direct effect on the growth of fish.

In the present study, feed conversion ratio (FCR) of 5 ind/m^2 was lower than 3,7 and 9 ind/m^2. The low FCR values might be due to smaller ration size, higher digestibility and proper utilization of feed (Rahman *et al*., 2005 etc). Das and Ray (1989) observed increasing trends of FCR values with increasing ration size in the growth trail of Indian major carp (*Labeo rohita*). Ghosh *et al*. (1984) found increasing FCR values with increasing ration size by feeding common carp (*Cyprinus carpio*) with supplementary feeds. The low FCR values in the present study indicated better food utilization efficiency, despite the values increased with increasing stocking density.

The high survival rate of fingerling was observed in 3ind/m^2 followed by 5ind/m^2. The decreasing survival rate was found in higher stocking density, alluded to competition for food and space in the hapa (crowding effect). The finding agrees with Kohinoor *et al*. (1994), Rahman (2003) and Rahman *et al*. (2005) in fry or fingerling rearing experiments of various indigeneous or exotic carp and barb species.

In the present study the results can be comparable with earlier studies on other common carp's culture, 5ind/m^2 was optimum stocking in fingerling culture of *Cyprinus intha*. It may be suggested that stocking density was one of the most important factors of growth. Furthermore, the remarkable high growth performance of

C. intha fingerlings can be found at Thayetkone fishery station. Thus *Cyprinus intha* is a promising species of future culture in Mandalay Region.

CHAPTER 4

GROWTH PERFORMANCE OF *Labeo rohita* Hamilton 1822, *Catla catla* Hamilton 1822 AND *Cyprinus intha* Annandale 1918 IN POLYCULTURE

4.1 Introduction

Aquaculture is a type of agriculture. It is farming in water instead of on land. Often agriculture and aquaculture include all of the activities involved in producing plants and animals, processing and marketing. The Food and Agriculture Organization defines aquaculture as the farming of aquatic, including fish, mollusks, crustaceans, and aquatic plants (FAO, 2006b).

In the middle Ages (500 B.C. – 500 A.D.), the earliest form of fish culture appears to be the common carp (*Cyprinus carpio*), a native of China. It was introduced into several countries of Asia and the Far East by Chinese immigrants and to Europe during the middle ages for culture in monastic ponds. From the 6th century A.D., common carp have been due to the identity with the name of the Tang Dynasty Emperor "Li", which is also the name of common carp in Chinese (Rabanal H.R., 1988).

In Myanmar, fisheries were recognized in the late 1920 and early 1930 as an important provider of income and employment and as a source of revenue to colonial administration. In 1990 hybrid *Clarias* sp. was introduced to Myanmar and in 1994 *Pangasius* culture was initiated. There remains a government focus in freshwater aquaculture with induced breeding of Indian major carps, as well as grass carp, big head carp, silver carp and common carp (FAO, 1996).

The production of quality protein is associated with the development of fisheries on commercial basis. Fish production sector is very important not only as a main source of animal protein to ensure food security but also to improve employment and income for poverty elimination in developing countries (Sheikh and Sheikh, 2004).

In this polyculture system, *Labeo rohita*, *Catla catla* and *Cyprinus intha* are stocked in single pond. According to Jain (2002), *C. carpio* has the ability to survive under various climatic conditions and is found to be most suitable for many fish farming systems. He has an opinion that *C. carpio* has the potential to improve conditions in pond bottom soil, as a result soil perturbation increases the oxygen transfer to the soil, decrease the concentration of toxic compounds and enables more efficient food web recycling and nutrient release (Ritvo *et al*., 2004). According to Milstein *et al*., (2003), bottom feeding fish produces a fertilizing effect through a food web that benefits the filter feeding fishes and reduces the application of organic and inorganic fertilizers applied in the aquaculture practices. It grows rapidly with high protein contents and minimum feed co-efficient.

In this experiments, *C. carpio* replaced with a bottom feeder of Inle carp (Nga phein) *C. intha* considered as a target cultured fish but also play a key role in pond management. It stimulates the efficiency of liming and nutrient availability in the bottom of the ponds. The replacement of bottom feeder in polyculture is helpful to the farmer economically by lowering input and management costs and it also benefits the pond water ecosystem (Wahab *et al*., 2002; Milstein *et al*., 2003; Wahab *et al*., 1995; Ali *et al*., 2003). Culturing different cyprinid species in the same pond optimizes the utilization of food available in the ecological niches of the pond ecosystem. The present experiment has planned to study the effect of *C. intha* in carp polyculture system instead of *C. carpio* in terms of fish production.

Carp culture has the ability to minimize the environmental pollution by the efficient utilization of wastes such as cow, poultry, pig, duck, goat, and sheep excreta, to enhance the production of natural food for carps and other cultured fish species in ponds. Besides, many organic wastes and by products such as agriculture by products, industrial by-products and wastes from animal husbandry have been utilized in the feed formulation of carp as an ingredient to minimize the cost of feed formulation (Seghal and Seghal, 2002). The production of fish pond depends on the production of vegetation which in turn is dependent on the nutrients found in the ponds. It is not possible to increase the production of cultivated fish by giving them the greater quantities of natural food directly. Organic manures and chemical fertilizers can be used to increase the planktonic biomass, on which fish mainly feeds (Qin *et al.*, 1995).

Sustainable and successful freshwater fish culture on scientific basis principally depends upon the use of adequate, economically viable and environmentally friendly artificial feeds. Since the feed costs vary between 40 to 60 percent of the total managerial expenditure in fresh water fish culture system. Sustainable growth and intensification of aquaculture production depends upon the development of protein sources like fish meal (animal source) and peanut oil cake, and maize grains (plant source), which are used traditionally in aquafeed (Gatlin *et al.,* 2007). Fertilization of organic manure and provision of supplementary feed with additives such as mineral and vitamin premix had a positive influence on the growth of major carps that contributed to high fish production (Veerina *et al.*, 1999). Several studies have been carried out to evaluate the effect of feeding frequency on growth, survival, feed intake, body composition, etc. in different fish species (Dwyer *et al*., 2002). Use of supplementary feed is also recommended along with the chemical fertilizers and organic manure in order to get maximum production of fish from limited water bodies within the shortest possible time (Mahboob *et al*., 1995).

Ali *et al*. (2003) also observed prominent increment in weight gain, feed conversion ratio (FCR), feeding rate appeared to be optimal, as it significantly supported the highest fish production and net profit as compared to other levels of supplementary feeding in major carps. Feed with 30% protein is considered best, with respect to the growth and production performance of the fish and the per unit price of the feeds (Islam, 2002). Common carp (*Cyprinus carpio*) and Rohu (*Labeo rohita)* fed with fish meal, rice bran, mustard oil cake showed 1.5 and 2.1 times higher fish yield than in the treatments without supplementary feed (Rahman *et al*., 2006). According to Azim *et al*. (2002) growth, specific growth rate of major carps were higher in fertilized pond with the provision of supplemental feed than fertilization alone. Nandeesha *et al*. (2001) also noted that the specific growth rates, protein efficiency ratio as well as growth rate were more pronounced in animal and plant based diet as compared to animal based diet.

Himri barbell (*Barbus luteus*) is indigenous cyprinid in the basin of Mesopotamia and highly valuable as food in the region. Some observation on Himri indicated to promise possibility of being used for aquaculture in polyculture pond, since it is omnivorous and detritus feeder (Epler *et al*., 2001). Adaptation to earthen ponds with common carps, *C. carpio* and other cyprinids has been noticed when it entered accidentally with water flux to ponds nearby Euphrates River which could consider it as a new species for the aquaculture (Al-Hazza and Hussein, 2003b).

Polyculture is the practice of culturing more than one species aquatic organisms in the same pond. The concept of polyculture of fish is based on concept of total utilization of different trophic and spatial niches of a pond in order to obtain maximum fish production per unit area. In the present study the suitable combination of the surface feeder *Catla catla* and the column feeder *Labeo rohita* are stocked in single pond with the bottom feeder of *Cyprinus intha* as polyculture practice.

Inle carps, Nga phein (*Cyprinus intha*) is an endemic cyprinid species which inhabit in Inle Lake of Southern Shan State in Myanmar. In the last two decades, this species plays an important role in the food supply of local people in Southern Shan State. This species population gradually declined in Inle Lake. *Cyprinus intha* is highly demand in local people but farmers are less familiar with the culture of *C. intha*. Recent studies have been investigated to attempt to propagate this species (*C. intha*) artificially for conservation and aquaculture purposes. Therefore, present study has been designed to evaluate the growth performance of *Labeo rohita, Catla catla* and *Cyprinus intha* in polyculture system.

The objectives of this study are:

- to compare the growth performance of *Labeo rohita, Catla catla* and *Cyprinus intha* under the influence of supplementary feeding and organic fertilization.
- to determine the condition factor, specific growth rate, length-weight relationship and fish production of *Labeo rohita, Catla catla* and *Cyprinus intha* under different treatments.
- to observe the physicochemical parameters of pond water

4.2 Materials and Methods

4.2.1 Study Site

The experiment was conducted at No. 1 Fisheries Station of Mandalay Region, Thayetkone hatchery, Department of Fisheries situated at Aungmyaytharsan Township, Mandalay Region. It has the total area of 20.37 hectares, and 90 fish ponds with different sizes from 0.05 ha to 0.8 ha. The experiment was conducted at pond number 66, 67, 68, 73, 74, 75 and each pond has same area (0.05 ha) (Fig. 4.1).

4.2.2 Study Period

The study period lasted from June 2012 to January 2013.

4.2.3 Experimental Design

In this study, the growth performance of *Labeo rohita*, *Catla catla* and *Cyprinus intha* was investigated under each treatment. Each treatment had using two replications earthen ponds of same size. Each pond had an area of 0.05 ha and divided by mosquito net into two parts for replication. Each experimental pond had 0.025 ha. Before stocking, all the ponds were sun dried for fifteen days. For the purpose of disinfection and the stabilization of pH, lime was applied at the rate of 2.5 kg $pond^{-1}$ (Wahab *et al.*, 2002) with dusting method. Essential precautionary measures were taken to screen the water inlets to avoid the entry of intruders into experimental ponds. After one week, each pond was water up to the level of 1.5 meters and this water level was maintained. All the ponds were fertilized with organic fertilizer (cow manure) as started dose of 75 kg (3000 kg ha^{-1}) to stimulate the productivity of the ponds The method followed after (Javed *et al.*,1988) (Plate 4.1, 4.2).

4.2.4 Stocking Rate of Culture Species

Two weeks after manuring, on June 01, 2012 each pond was stocked with *Labeo rohita, Catla catla* and *Cyprinus intha* in the ratio of 20: 15: 15 respectively. The following morphometric parameters of cultured fish species, body weight and total length were measured and recorded.

4.2.5 Feed types and Feeding Rates

. Three treatments were used each having two replications provided with different feed treatment T_1 (100% supplementary feed), treatment T_2 (100% organic manure) and treatment T_3 (supplementary feed 50% + organic manure 50%). Fish were fed at a rate of 5% of body weight twice daily for initial months. Fish was biweekly weighed and the amount of give feed was accordingly readjusted. The amount of consumed feed for each pond was subsequently calculated.

4.2.6 Feed Formulation

The supplementary feed was formulated for treatments T_2 and $T_{3,}$ (30) % crude protein (Islam, 2002) by following Pearson method (Rath, 2002) including fishmeal, rice bran, ground nut cake, maize grain (Table 4.1).

4.2.7 Formula feed method

Step 1: the crude protein (CP) percentage was assumed as 30 % and supplementary feed was made by four ingredients, such as peanut oil cake, fish meal, rice bran and maize flour (Appendix 1).

The following crude protein (CP) percentages of ingredients were based on analytical laboratory test:

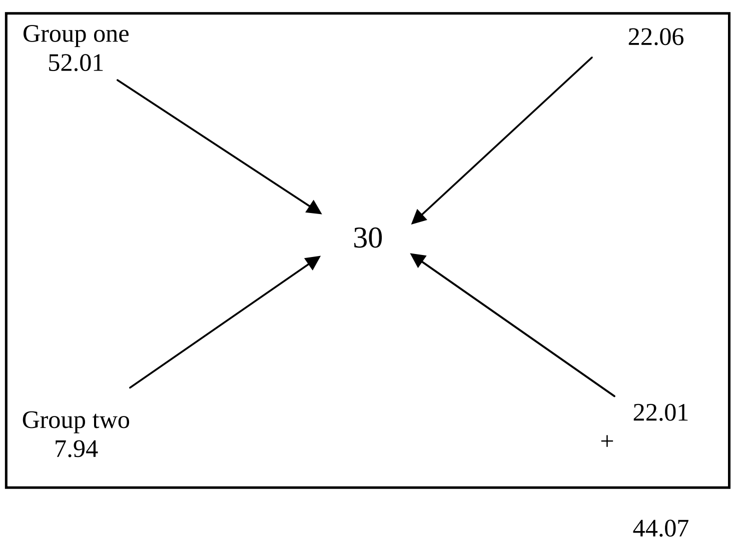
Peanut oil cake	=	45.03%
Rice bran	=	9.84%
Maize flour	=	6.05%
Fish meal	=	58.99%

The feed formulation was to make two groups for four ingredients.

Step 2: the first group consisted of ingredients whose crude protein percentage was higher than the requested and the second group consisted of ingredients whose crude protein percentage was lower than the requested value.

Step 3: peanut oil cake 45.03% and fishmeal 58.99% were the first group (G1) and rice bran 9.84% and maize flour 6.05% were the second group (G2).

Step 4: Pearson Square should be apply for G1 and G2



Percentage of group one: (100 × 22.06) / 44.07 = 50.06

Percentage of group two: (100 × 22.01) / 44.07 = 49.94

Step 5: first group ingredients were ration as 50.06 percentages and second group ingredients were ration as 49.94.

G1 : 50.06 % = 40% peanut oil cake and 10.06 % fishmeal.

G2 : 49.94% = 24.94% rice bran and 25% maize flour.

Step 6: composition of supplementary feed used in treatment 1 and 3 was calculated as follow;

% of Peanut oil cake	:	(45.03 × 40)/ 100	= 18.012
% of Fish meal	:	(58.99 × 10.06) / 100	= 5.934
% of Rice bran	:	(9.84 × 24.94)/ 100	= 2.454
% of Maize flour	:	(6.05 × 25) / 100	= 1.512
Composition of supplementary feed crude protein %			27.912

Step 7: Ingredients percentage

Peanut oil cake	=	40.00%
Fish meal	=	10.06%
Rice bran	=	24.94%
Maize flour	=	25.00%
Total ingredients %	=	100%

4.2.8 Moisture

Moisture was determined by Moisture Balance Method and Oven Method (Cited in SEAFDEC-MFRD, 1992).

Samples were taken in a weighed petri dish (W1) and placed it in the oven at 105ºC for 12 hours. The dried samples were transferred to desiccators for 5 minutes and weighed. The samples were again kept in oven for one to two hours until constant weight (W2) was obtained. The loss in weight was recorded as moisture.

$$\text{Moisture (\%)} = \frac{W_1 - W_2}{W_3}$$

Where,

W1 = weight of petri dish + sample before drying

W2 = weight of petri dish + sample after drying

W3 = weight of the sample

Dry matter percentage was calculated by the following.

Dry matter (%) = 100 - moisture (%)

4.2.9 Crude Protein

Crude protein was determined by Macro Kjeldahl Method, used by DA 7200 feed analyzer (Cited in SEAFDEC-MFRD, 1992).

Crude protein of ingredients samples were analyzed by using micro Kjeldahl's method. A digestion mixture of K_2SO_4 and $CuSO_4$ in proportion of 93:7 was prepared. One gram of dried sample and a 5g of digestion mixture were weighed into Kjeldahl's flask. 30ml of concentrated H_2SO_4 was added to it. The mixture was boiled at low temperature and then vigorously at high temperature until the mixture turned transparent clear greenish. Digested material was cooled down and volume was made up to 250 ml with distilled water 10ml of this diluted volume and 10ml of 40% NaOH were put in apparatus and distilled with steam. Ammonia liberated was collected in 10ml of 2% boric acid solution with a drop of methyl red indicator. Ammonia was collected for about 2 minutes after the colour of indicator changed from pink to golden yellow. Then ammonia in boric acid solution was titrated against (0.1 N) H_2SO_4, volume of H_2SO_4 used was noted and Nitrogen (%) calculated as under:

$$\text{Nitrogen (\%)} = \frac{\text{Volume of } H_2SO_4 \times 0.014 \times 250}{\text{Weight of the sample} \times 10} \times 100$$

Where,

0.014 = Standard volume of (0.1 N) H_2SO_4 used to neutralize 1ml of ammonia

250 = Dilution of the digested mixture

100 = for percentage of N_2

10 = Volume of the digested and diluted sample used

Crude protein in sample was calculated by following formula.

Crude protein (%) = % $N_2 \times 6.25$

Where by;

6.25 = Assumed factor for equation of N_2 % to crude protein.

4.2.10 Crude Fat

Crude fat was determined by Soxhlet Extraction Method (Cited in SEAFDEC-AQD, 1997).

Total fat contents of ingredients samples were determined following petroleum ether extraction method through the Soxhlet Extraction system. The sample was placed in the Soxhlet thimble was attached to the adapter. A defatted cotton wool was plugged on the top of the sample. The thimble was inserted into the condenser. The heating plate handle was pressed down and already weighted extraction cup, having petroleum ether up to 50-70 ml inserted in it. The main switch was switched on and cold water tap was turned on. The extraction cup was then clamped into the condenser. Extraction mode knob was moved to “Boiling” position for 15 minutes. The thimble was then immersed in the solvent. The material was boiled with thimble immersed in it. It was made sure that the condenser valves were opened. The extraction mode knobs were moved to the “Rinsing” position for 30 minutes. Thimble was then hanged above the solvent surface. After rinsing, the condenser valves were closed by turning a quarter turn. The extraction cup was released and the condenser valves were opened. Later on the “Main” switch was switched off and cold water tap was turned off. Extraction cup with trace amount of petroleum ether solvent and fat was placed in oven for drying. After drying, extraction cup was transferred to desicator for 5 minutes and again weighted. Total fat percentage of the sample was calculated by following formula:

$$\text{Crude fats \%} = \frac{W_2 - W_1}{\text{Wt. of sample}}$$

Where,

W_1 = Weight of empty extraction cup

W_2 = Weight of extraction cup with fat after evaporation

4.2.11 Total Ash

Total ash was determined by Muffle Furnace Method (SEAFDEC-AQD, 1997). The total ash was determined by burning 2g of dried fish tissue in a pre-weighed China dish and then samples were placed in a muffle furnace for ignitiation at 550 –600°C till residue was obtained after 4 – 5 hours. Then the samples residue were placed in desicator to cool and then weight was recorded. Percentage of ash was obtained by using the following formula:

$$\text{Total Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

4.2.12 Water Monitoring System

(i) Collection of water samples

For water monitoring system in the experiment, water samples were collected from all the experimental ponds on weekly basis but their average was calculated on the monthly basis. The following parameters of the physico-chemical characteristics of pond water were estimated.

(ii) Physical factors

Chemical analysis of experimental pond water was determined on weekly basis but their average was calculated on the monthly basis.

Water temperature: was recorded with the help of glass rod thermometer by fixing the temperature factor at ^{0}C unit.

Transparency or secchi disc penetration: was measured with the help of "Secchi Disc".

(iii) Chemical factors

Chemical analysis of experimental pond water was determined on weekly basis but their average was calculated on the monthly basis.

pH: hydrogen ion concentration scale was measured by IMPACT pH test kit product from Advance pharma co., Ltd., Bangkok 10310, Thailand.

Dissolved oxygen: was measured by AQUA D.O. (D.O. Test Kit) product from Advance pharma co., Ltd., Bangkok 10310, Thailand

4.2.13 Fish Growth Studies

After every one month, sample of cultured fish species was captured randomly by using drag net from each experimental treatment and these fishes were released back into their respective ponds after recording the data. The following growth parameters were studied during this investigation

(i) **Fish body weight (g):** measured by FUJI D 7030 (1g-400g) gram balance.

(ii) **Total length (mm):** measured by Elsoon LS 12 (0.5mm-300mm) ordinary ruler.

At the end of the experiment, total harvested fishes of three fish species were weighed to calculate the total fish production under different treatments of the experimental unit.

4.2.14 Data Analysis

(i) Condition factor (K)

The value of condition factor (K) was determined by given formula (Carlander, 1970):

$$K = \frac{W \times 10^5}{L^3}$$

Where,

W = fish body weight (g)

L = fish total length (mm)

(ii) Specific growth rate (SGR)

Specific growth rate (SGR) was estimated by the formula given by Dhawan and Kaur (2002):

$$SGR = \frac{\ln(\text{Final wet body weight}) - \ln(\text{Initial wet body weight})}{\text{Time duration (days)}}$$

(iii) Length-weight relationship

The length- weight relationship for these cultured fish species was calculated as per cube law by LeCren (1951) as follows:

$$W = aL^b \quad \text{(Le Cren, 1951)}$$

Where;

Wet weight (g)

L = Total length (mm)

a = Constant

b = Exponent of values

(iv) Survival rate

At the final harvesting, the survival rate of three fish species was calculated by this formula.

$$\text{Survival rate} = \frac{\text{Number of fishes recorved} \times 100}{\text{Number of fishes stocked}}$$

4.2.15 Statistical Analysis

Growth performance of fishes was statistically was analyzed by using variance ANOVA method (one way ANOVA) by using SPSS (Statistical Package for Social Science) statistic software version 19. Mean values of standard deviation for each parameter were computed. The significance of difference between the average mean values was evaluated by using LSD multiple comparisons range test (Steel *et al*., 1997).

Table 4.1 Feed formulation and proximate composition of diet and ingredients

Feed formulation g kg^{-1}					
Peanut oil cake	40.00				
Fish meal	10.06				
Rice bran	24.94				
Maize flour	25.00				
Proximate composition experimental diets g kg^{-1}					
Moisture (%)	8.37				
Crude protein (%)	29.97				
Total fat (%)	8.22				
Total ash (%)	11.00				
Proximate composition of ingredients g kg^{-1}					
	Peanut oil cake	Fish meal	Rice bran	Maize flour	Cow manure
Moisture (%)	5.1	8.4	5.71	14.3	18.25
Crude protein (%)	45.03	58.99	9.84	6.05	10.39
Total fat (%)	10.5	5.9	12.3	4.2	nil
Total ash (%)	7.5	23.0	11.5	2.0	48.5

Fig. 4.1 Map of No.1 Fishery Station, Thayetkone, Aungmyaytharsan Township, Mandalay Region (Source: Department of Fisheries)

4.3 Results

4.3.1 Growth Performance and Feed Utilization Efficiency

(i). Composition of supplementary feed

Experiment was conducted in polyculture system with three different species *L. rohita, C. catla* and *C. intha*. Feed formulation was according to Pearson method (Rath, 2002). Pearson method can be used for two or more ingredients. There were four ingredients used in this experiment; fish meal, rice bran, peanut oil cake and maize flour. The rations of ingredients were calculated by using Pearson square method. Supplementary feed included peanut oil cake 40%, fish meal 10.06%, and rice bran 24.94% and maize flour 25% respectively for supplementary feed. The crude protein content (CP) % of supplementary feed was 27.9. The nutrient value of ingredients was determined based on analytical laboratory test from Analytical Laboratory Section (Table.1).

(ii) Weight gain of study fish

The initial mean weights of the three study fish groups were not significantly different among the treatments. In *Labeo rohita* highest monthly mean increase in average body weight (weight gain) was recorded in July (67.63) g for treatment 1 (T_1), (55.37)g for treatment 2 (T_2) and (70.88)g for treatment 2 (T_3), followed by August and September (59.50 and 47.37) g for T_1 and (60.75 and 53.25) g for T_3 respectively. However, the second highest values of T_2 were recorded in June and August (39.50 and 50.75) g respectively. Significantly low values of monthly weight gains were found in December and January in all treatments (Table 4.2).

In *Catla catla*, the highest monthly mean weight gain was also in July (60.13) g for T_1 and (65.13) g for T_3, followed by August and September (53.62 and 36.13) g for T_1 and (61.25 and 59.75)g for T_3 respectively. However the highest mean weight gain of T_2 was found in August (58.25)g, followed by July and June (50.38 and 44.37)g respectively. The lower monthly weight gain was observed in January (13.00) g for T_1 and (10.5) g for T_2 and in November (14.5) g for T_3 (Table. 4.3).

In *Cyprinus intha*, significantly higher ($P<0.05$) mean monthly weight gain was observed during the month of August in all treatments (56.25g for T_1, 55.38g for T_2 and 62.00g for T_3), followed by July and June (40.25 and 37.75)g for T_1, (40.50 and 34.87)g for T_2 and (49.5 and 39.87) for T_3 respectively. Significantly lower value of weight gain were observed during the month of January (17.5)g in T_1, December (9.00)g in T_2 and January (22.5)g in T_3 (Table 4.4).

The monthly increase in average body weight of *Labeo rohita*, *Catla catla* and *Cyprinus intha* fed feed T_3 were significantly higher ($P<0.05$) than other treatments (Table 4.2, 4.3 and 4.4) (Appendix 5, 6 and 7).

The final average body weight and weight gain of *C. intha* were 323.12 g and 312.37 g were higher and respectively fed feed $T_{3,}$ (273.12 and 262.75) g at T_1 and (228.12 and 217.37) g at T_2. Similar pattern was observed in *L. rohita* and *C. catla* but the *L. rohita* was the best compare with those of *C. catla* and *C. intha* in all treatments. Statistical analysis showed that the final weight gain and average mean weight gain were significantly different among the study species ($P<0.05$). However the final weight gain and average mean weight gain of three study species fed feed treatment 3 significantly higher ($P<0.05$) than treatment 1 and treatment 2 (Table 4.2, 4.3, 4.4).

(iii) Specific growth rate and food conversion ratio

The specific growth rate (SGR) and feed consumption ratio (FCR) of *C. intha* were 1.41 and 3.52 respectively in treatment 3. The poor SGR and FCR were 1.24 and 13.63 respectively in treatment 2. Similarly, the better SGR and FCR found T_3. The poor SGR and FCR were observed in T_2 *L. rohita* and *C. catla*. The better FCR was observed in *C. intha* when compare to those of *L. rohita* and *C. catla* in T_3. The SGR and FCR of T_3 were better than those of the other treatments ($P < 0.05$). The survival rate was also higher (90) % in T_3 and (80) % in T_1 and T_2 (Table 4.8).

(iv) Total biomass

The total average biomass of *C. intha* in $T_{1,}$ T_2 and T_3 were 10.92, 9.12and 14.54 kg respectively, no significant difference ($p > 0.05$) was observed in the biomass of three study fish groups. However, the biomass of fish was significantly different among the treatment ($p < 0.05$).

The result revealed that *L.rohita, C. catla and C. intha* cultured in polyculture system performance was better in T_3 followed by T_1, while lowest growth was observed in T_2. The growth performances were not significantly different among them (Table 4.8).

(v) Condition factor (k)

The average condition factor (K) was 0.71 in *L.rohita*, 0.64 in *C. catla* and 0.70 in *C. intha* for treatment 1, 0.74 in *L. rohita*, 0.69 in *C. catla* and 0.64 in *C. intha* for treatment 2 and 0.71 in *L. rohita*, 0.68 in *C. catla* and 0.75 in *C. intha* for treatment 3. The mean value of condition factor (K) was close to one (Table 4.11 and Fig. 4.4, 4.5 and Fig. 4.6).

(vi) Length-weight relationship:

According to linear regression, the length and weight relationship showed high correlation in *L. rohita, C. catla and C. intha* for all treatments. The average coefficient values of 'b' were 3.3 in *C.intha*, 3.5 in *L. rohita* and 2.8 in *C. catla*. The 'b' value above 3 observed and *C.intha* and *L. rohita* showed positive allometric growth but it was negative allometric growth in *C.catla* (Fig. 8, 10, 11, 13, 14 and 16). Condition factor (K) of three fishes were not significantly different among three treatment feed ($p>0.05$) (Table 4.11 and Fig. 4.7- 4.15).

4.3.2 Water Monitoring

The physico-chemical parameters of water were analyzed during the study period of experiment and which include water, dissolved oxygen, pH, transparency and temperature. Their average values were calculated on monthly basis for all treatment.

(i) Dissolved oxygen:

Dissolved oxygen parameters recorded were (5.05-6.18) mgl^{-1} from June to August, (5.42-5.80) mgl^{-1} from September to November and (5.03-6.18) mgl^{-1} from December to January in all treatments. Minimum dissolved oxygen of T_1, T_2 and T_3 were (5.3, 5.18 and 5.03) found in January. But in T_2 the minimum dissolved oxygen was (5.05 and 5.03) found in both June and January. The maximum dissolved oxygen of T_1, T_2 and T_3 were (6.18, 6.15 and 5.85) found in August (Fig. 4.16).

(ii) pH

The mean average of pH value ranged from (7.5-8.3) in all treatments. But the maximum value was found in August and January ranging 8.0-8.3 respectively (Fig. 4.17).

(iii) Transparency

Monthly fluctuation range of transparency varied from (18-23) cm in June to August, from (14-19) cm in September to November and from (12-16) cm December to January in all treatments. The maximum values were found in June - 23 cm and July - 22 cm, and the minimum values were found in December - 13 cm and January - 12 cm each in all treatment (Fig. 4.18).

(iv) Water temperature:

The water temperature ranged from 27–32 °C from June to August, 26- 30 °C from September to November, 22-26 °C from December to January in all treatments. The minimum average temperature value was recorded during January (22) °C and maximum value was found in June (31)°C. The figure 4.19 showed that the water temperature were not significant different among three treatments. However, water temperature was significant difference among the various months of experiment.

Table 4.2 Monthly increases in average body weight (g) of *Labeo rohita* under different treatments

No.	Month	Duration	T1		T2		T3	
			Av.Body Wt. (g)	Inc.in BodyWt.(g)	Av.Body Wt. (g)	Inc.in BodyWt.(g)	Av.Body Wt. (g)	Inc.in BodyWt.(g)
	Initial	1.6.2012	10.00	0	10.87	0	10.62	0
1	June	1.6.2012-30.6.2012	49.50	44.25	55.12	39.50	60.62	50.00
2	July	1.7.2012-31.7.2012	104.87	67.63	122.75	55.37	131.50	70.88
3	August	1.8.2012-31.8.2012	155.62	59.50	182.25	50.75	192.25	60.75
4	September	1.9.2012-30.9.2012	184.12	47.37	229.62	28.50	245.50	53.25
5	October	1.10.2012-31.10.2012	204.37	22.25	251.87	20.88	274.12	28.62
6	November	1.11.2012-30.11.2012	225.25	20.88	272.75	20.88	304.00	29.88
7	December	1.12.2012-31.12.2012	240.62	10.37	283.12	15.37	321.87	17.87
8	January	1.1.2013-31.1.2013	250.12	15.00	298.12	9.50	334.37	12.50

Av = Average, Wt. = Weight, Inc = Increment

Table 4.3 Monthly increases in average body weight (g) of *Catla catla* under different treatment

No.	Month	Duration	T1		T2		T3	
			Av.Body Wt. (g)	Inc.in Body Wt. (g)	Av.Body Wt. (g)	Inc.in Body Wt. (g)	Av.Body Wt. (g)	Inc.in Body Wt. (g)
	Initial	1.6.2012	10.62	-	10.50	-	10.12	-
1	June	1.6.2012-30.7.2012	60.12	49.50	54.87	44.37	65.12	55.00
2	July	1.7.2012-31.7.2012	120.25	60.13	105.25	50.38	130.25	65.13
3	August	1.8.2012-31.8.2012	173.87	53.62	163.50	58.25	191.50	61.25
4	September	1.9.2012-30.9.2012	210.00	36.13	203.37	39.87	251.25	59.75
5	October	1.10.2012-31.10.2012	240.62	30.62	221.87	18.50	275.62	24.37
6	November	1.11.2012-30.11.2012	255.12	14.50	229.62	7.75	290.12	14.50
7	December	1.12.2012-31.1.2012	271.37	16.25	241.37	11.75	310.00	19.88
8	January	1.1.2013-31.1.2013	284.37	13.00	251.87	10.50	330.62	20.62

Av = Average, Wt. = Weight, Inc = Increment

Table 4.4 Monthly increases in average body weight (g) of *Cyprinus intha* under different treatments

No.	Month	Duration	T1		T2		T3	
			Av.Body Wt. (g)	Inc.in BodyWt.(g)	Av.Body Wt. (g)	Inc.in BodyWt.(g)	Av.Body Wt. (g)	Inc.in BodyWt.(g)
	Initial	1.6.2012	10.37	-	10.75	-	10.75	-
1	June	1.6.2012-30.6.2012	48.12	37.75	45.62	34.87	50.62	39.87
2	July	1.7.2012- 31.7.2012	88.37	40.25	86.12	40.50	100.12	49.50
3	August	1.8.2012- 31.8.2012	144.62	56.25	141.50	55.38	162.12	62.00
4	September	1.9.2012- 30.9.2012	186.12	41.50	168.62	27.12	201.12	39.00
5	October	1.10.201231.10.2012	216.62	30.50	189.37	20.75	251.12	50.50
6	November	1.11.201230.11.2012	235.37	18.75	205.37	16.00	275.37	23.75
7	December	1.12.201231.12.2012	255.62	20.25	214.37	9.00	300.62	25.25
8	January	1.1.2013-31.1.2013	273.12	17.50	228.12	13.75	323.12	22.50

Av = Average, Wt. = Weight, Inc = Increment

Table 4.5 Monthly increases in average total length (mm) of *Labeo rohita* under different treatment

No.	Month	Duration	T1		T2		T3	
			Av.Total Length	Inc.in Total Length	Av.Total Length	Inc.in Total Length	Av.Total Length	Inc.in Total Length
	Initial	1.6.2012	100.75	-	100.00	-	100.50	-
1	June	1.6.2012-30.6.2012	175.00	75.75	170.25	70.25	175.25	75.25
2	July	1.7.2012-31.7.2012	205.12	30.12	200.12	29.87	218.00	42.75
3	August	1.8.2012-31.8.2012	225.50	20.38	218.25	18.13	230.25	12.25
4	September	1.9.2012-30.9.2012	240.00	14.50	230.37	12.12	240.00	9.75
5	October	1.10.2012-31.10.2012	250.00	10.00	240.12	9.75	260.25	20.25
6	November	1.11.2012-30.11.2012	258.12	8.12	245.25	5.13	265.62	5.37
7	December	1.12.2012-31.12.2012	265.75	7.63	250.25	5.00	275.12	9.50
8	January	1.1.2013-31.1.2013	270.62	4.87	255.12	4.87	280.87	5.75

Av = Average, Wt. = Weight, Inc = Increment

Table 4.6 Monthly increases in average total length (mm) of *Catla catla* under different treatment

Av = Average, Wt. = Weight, Inc = Increment

No.	Month	Duration (date)	T1		T2		T3	
			Av.Total Length	Inc.in Total Length	Av.Total Length	Inc.in Total Length	Av. Total Length	Inc.in Total Length
	Initial	1.6.2012	85.12		85.50		85.75	
1	June	1.6.2012-30.6.2012	162.00	76.88	160.00	74.5	164.62	78.87
2	July	1.7.2012-31.7.2012	180.12	18.12	170.75	10.75	184.25	19.63
3	August	1.8.2012-31.8.2012	220.12	40.00	205.37	34.62	229.87	45.62
4	September	1.9.2012-30.9.2012	240.62	20.50	220.00	14.63	260.12	30.25
5	October	1.10.2012-31.10.2012	250.37	9.75	230.37	10.37	270.75	10.63
6	November	1.11.2012-30.11.2012	260.12	9.75	235.12	4.75	280.37	9.62
7	December	1.12.2012-31.12.2012	265.12	5.00	240.12	5.00	290.12	9.75
8	January	1.1.2013-31.1.2013	270.00	4.88	245.50	5.38	300.37	10.25

Table 4.7 Monthly increases in average total length (mm) of *Cyprinus intha* under different treatment

No.	Month	Duration	T1		T2		T3	
			Av.Total Length	Inc.in Total Length	Av.Total Length	Inc.in TotalLength	Av.Total Length	Inc.in Total Length
	Initial	1.6.2012	100.12	0	99.25	0	100.00	0
1	June	1.6.2012-30.6.2012	155.12	55.00	150.50	51.25	160.25	60.25
2	July	1.7.2012-31.7.2012	179.25	24.13	169.50	19.00	194.87	34.62
3	August	1.8.2012-31.8.2012	202.62	23.37	190.25	20.75	230.12	35.25
4	September	1.9.2012-30.9.2012	225.12	22.50	210.37	20.12	245.37	15.25
5	October	1.10.2012-31.10.2012	245.25	20.13	229.50	19.13	260.25	14.88
6	November	1.11.2012-30.11.2012	254.50	9.25	235.12	5.62	269.25	9.00
7	December	1.12.2012-31.12.2012	259.62	5.12	240.12	5.00	275.25	6.00
8	January	1.1.2013-31.1.2013	265.25	5.63	245.50	5.38	280.12	4.87

Av = Average, Wt. = Weight, Inc = Increment

Table 4.8 Results of growth increment on *L. rohita*, *C. catla* and *C. intha* with different treatment in culture period

No.	Parameter	Treatment 1(T_1)			Treatment 2(T_2)			Treatment 3 (T_3)		
		L. rohita	*C. catala*	*C. intha*	*L. rohita*	*C. catala*	*C. intha*	*L. rohita*	*C. catala*	*C. intha*
1	Area ($m^{2)}$	277.55m^2	277.55m^2	277.55m^2	277.55m^2	277.55m^2	277.55m^2	277.55m^2	277.55m^2	277.55m^2
2	Stocking number	20	15	15	20	15	15	20	15	15
3	Initial day	1.6.2012	1.6.2012	1.6.2012	1.6.2012	1.6.2012	1.6.2012	1.6.2012	1.6.2012	1.6.2012
4	Culture period (days)	245	245	245	245	245	245	245	245	245
5	Types of feed	Supplem. feed	Supplem. feed	Supplem. feed	Cow manure	Cow manure	Cow manure	Supplem.+ Cow manu	Supplem.+ Cow manu	Supplem.+ Cow manu
6	Initial weight (g)	10.87	10.62	10.37	10.00	10.50	10.75	10.62	10.12	10.00
7	Fial weight(g)	298.12	284.37	273.12	250.12	251.87	228.12	334.37	330.62	320.00
8	Initial length (mm)	100.00	85.12	100.12	100.00	85.50	99.25	100.50	85.75	100
9	Final length (mm)	270.62	270.00	265.25	255.12	245.50	245.50	280.87	300.37	280.12
10	Weight gain (g)	287.25	273.75	262.75	240.12	241.37	217.37	323.75	320.5	313.12
11	Specific Growth Rate (SGR)	1.35	1.34	1.34	1.31	1.29	1.24	1.41	1.42	1.41
12	Total Feed Consume (TFC)(kg)	50.285	47.357	49.785	137.800	145.088	124.375	57.342	55.752	48.385
13	Feed Conversion Ratio (FCR)	4.21	4.16	4.55	-	-	-	4.05	4.05	3.52
14	Manure Conversion Ratio (MCR)	-	-	-	13.77	14.40	13.63	-	-	-
15	Survival rate	80	80	80	80	80	80	90	90	90
16	Total yield /Biomass (kg)	11.925	11.375	10.925	10.005	10.075	9.125	15.047	14.878	14.540

Table 4.9 Average daily increment in body weight (WG) of *L. rohita, C. catla* and *C. intha* under different treatment

No.	Months	Time duration	Treatment 1 (T_1)			Treatment 2 (T_2)			Treatment 3 (T_3)		
			L .rohita	*C. catala*	*C. intha*	*L. rohita*	*C. catala*	*C. intha*	*L. rohita*	*C. catala*	*C. intha*
1	June	1.6.2012 30.6.2012	1.475	1.650	1.258	1.316	1.479	1.162	1.666	1.833	1.329
2	July	1.7.2012 31.7.2012	2.181	1.939	1.298	1.786	1.625	1.306	2.286	2.100	1.597
3	August	1.8.2012 31.8.2012	1.919	1.724	1.814	1.637	1.879	1.786	1.959	1.976	2.000
4	September	1.9.2012 30.9.2012	1.579	1.204	1.383	0.950	1.329	0.904	1.775	1.991	1.300
5	October	1.10.2012 31.10.2012	0.717	0.987	0.983	0.673	0.597	0.669	0.923	0.812	1.629
6	November	1.11.2012 30.11.2012	0.696	0.483	0.625	0.696	0.258	0.533	0.996	0.483	0.791
7	December	1.12.2012 31.12.2012	0.334	0.524	0.653	0.496	0.379	0.290	0.576	0.641	0.814
8	January	1.1.2013 31.1.2013	0.483	0.419	0.564	0.306	0.338	0.440	0.403	0.665	0.726

Table: 4.10 Specific growth rate (%) of *L. rohita, C. catla* and *C. intha* under different treatments

		Treatment 1	Treatment 2	Treatment 3
Labeo rohita	Initial body weight (g)	10.87	10.00	10.62
	Final body weight (g)	298.12	250.12	334.37
	Specific growth rate (%)	1.35	1.31	1.41
Catla catla	Initial body weight (g)	10.62	10.50	10.12
	Final body weight (g)	284.37	251.87	330.62
	Specific growth rate (%)	1.34	1.29	1.42
Cyprinus intha	Initial body weight (g)	10.37	10,75	10.00
	Final body weight (g)	273.12	228.12	320.00
	Specific growth rate (%)	1.33	1.24	1.41

Table 4.11 Condition factor (k) of *L. rohita, C. catla and C. intha* under different treatment

No.	Months	Treatment 1 (T_1)			Treatment 2 (T_2)			Treatment 3 (T_3)		
		L. rohita	*C. catla*	*C. intha*	*L. rohita*	*C. catla*	*C. intha*	*L. rohita*	*C. catla*	*C. intha*
	Initial	0.9408	0.5807	0.9678	1.0000	0.5874	0.9094	0.9558	0.6182	1.0000
1	June	0.9723	0.7071	0.7757	0.9970	0.7748	0.7472	0.8879	0.6851	0.8130
2	July	0.7031	0.4859	0.6517	0.7642	0.5552	0.5655	0.7878	0.4802	0.7391
3	August	0.6292	0.6134	0.5752	0.6680	0.6523	0.4866	0.6349	0.6343	0.7517
4	September	0.6020	0.6634	0.6130	0.6640	0.6850	0.5521	0.5631	0.7005	0.7345
5	October	0.6203	0.6522	0.6810	0.6777	0.7074	0.6383	0.6430	0.7201	0.7005
6	November	0.6305	0.6899	0.7003	0.6549	0.7665	0.6329	0.6165	0.7596	0.7088
7	December	0.6629	0.6867	0.6846	0.6513	0.7720	0.6458	0.6470	0.7877	0.6937
8	January	0.6648	0.6922	0.6833	0.6639	0.7815	0.6486	0.6626	0.8197	0.6802
	Average	0.71	0.64	0.70	0.74	0.69	0.64	0.71	0.68	0.75

Table 4.12 Monthly growth increment of *Labeo rohita* under treatment 1

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Feeding rate (%)	Feed/ time/ day(g)	Survival rate %	SGR %	TFC/ month (g)	TFC (g)	Total Biomass (g)	FCR
	Initial	1.6.2012	-	10.87	-	100.75	-			100	-	-	-	543.50	-
1	June	1.6.2012 30.6.2012	30	55.12	44.25	175.00	75.75	5	27.17	100	5.41	815.10	815.10	2756.00	0.29
2	July	1.7.2012 31.7.2012	61	122.75	67.63	205.12	30.12	5	137.80	95	2.67	4271.30	5086.4	5830.62	0.87
3	August	1.8.2012 31.8.2012	92	182.25	59.50	225.50	20.38	3	174.92	95	1.32	5422.52	10508.92	8656.87	1.21
4	September	1.9.2012 30.9.2012	122	229.62	47.37	240.00	14.50	3	259.70	90	0.77	7791.00	18299.92	10332.90	1.77
5	October	1.10.2012 31.10.2012	153	251.87	22.25	250.00	10.00	3	309.98	90	0.31	9609.38	27909.30	11334.15	2.46
6	November	1.9.2012 30.9.2012	183	272.75	20.88	258.12	8.12	2	226.68	85	0.26	6800.40	34709.70	11591.87	2.99
7	December	1.12.2012 31.12.2012	214	283.12	10.37	265.75	7.63	2	231.83	85	0.12	7186.73	41896.43	12032.60	3.48
8	January	1.1.2013 31.1.2013	245	298.12	15.00	270.62	4.87	2	240.65	80	0.17	8389.22	50285.65	11924.80	4.21

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length
SGR - Specific Growth Rat
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.13 Monthly growth increment of *Catla catla* under treatment 1

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Feeding rate (%)	Feed/time /day(g)	Survial rate	SGR %	TFC/ month (g)	TFC (g)	Total Biomass (g)	FCR
	Initial	1.6.2012	-	10.62	-	85.12	-	-	-	100	-	-	-	531.00	-
1	June	1.6.2012 30.6.2012	30	60.12	49.50	162.00	76.88	5	26.50	100	5.78	795	795.00	3006.00	0.26
2	July	1.7.2012 31.7.2012	61	120.25	60.13	180.12	18.12	5	150.30	95	2.31	46590	5454.30	5711.87	0.95
3	August	1.8.2012 31.8.2012	92	173.87	53.62	220.12	40.00	3	171.35	95	1.23	5311.85	10766.15	8258.82	1.30
4	September	1.9.2012 30.9.2012	122	210.00	36.13	240.62	20.50	3	247.76	90	0.63	7432.80	18198.95	9450.00	1.92
5	October	1.10.2012 31.10.2012	153	240.62	30.62	250.37	9.75	2	283.50	90	0.45	8788.50	26987.45	10827.90	2.49
6	November	1.9.2012 30.9.2012	183	255.12	14.50	260.12	9.75	2	216.55	85	0.19	6496.50	33484.00	10842.60	3.08
7	December	1.12.2012 31.12.2012	214	271.32	16.25	265.12	5.00	2	216.85	85	0.20	6722.35	40206.35	11533.25	3.48
8	January	1.1.2013 31.1.2013	245	284.37	13.00	270.00	4.88	2	230.66	80	0.15	7150.46	47356.81	11374.80	4.16

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length

SGR - Specific Growth Rate
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.14 Monthly growth increment of *Cyprinus intha* under treatment 1

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Feeding rate (%)	Feed / time / day (g)	Survial rate %	SGR %	TFC/ month (g)	TFC (g)	Total Biomass (g)	FCR
	Initial	1.6.2012	-	10.37	-	100.12	-			100	-	-	-	518.50	-
1	June	1.6.2012 30.6.2012	30	48.12	37.75	155.12	55.00	5	25.92	100	5.11	777.60	777.60	2406.00	0.32
2	July	1.7.2012 31.7.2012	61	88.37	40.25	179.25	24.13	5	209.87	95	1.96	6505.97	7283.57	4197.57	1.73
3	August	1.8.2012 31.8.2012	92	144.62	56.25	202.62	23.37	3	206.08	95	1.59	6388.48	13672.05	6869.45	1.99
4	September	1.9.2012 30.9.2012	122	186.12	41.50	225.12	22.50	3	251.26	90	0.84	7537.80	21209.85	8375.40	2.53
5	October	1.10.2012 31.10.2012	153	216.62	30.50	245.25	20.13	3	292.43	90	0.49	9065.33	30275.18	9747.90	3.10
6	November	1.9.2012 30.9.2012	183	235.37	18.75	254.50	9.25	2	200.06	85	0.28	6001.80	36276.98	10003.22	3.62
7	December	1.12.2012 31.12.2012	214	255.62	20.25	259.62	5.12	2	217.27	85	0.26	6735.37	43012.35	10863.85	3.95
8	January	1.1.2013 31.1.2013	245	273.12	17.50	265.25	5.63	2	218.49	80	0.21	6773.19	49785.54	10924.80	4.55

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length
SGR - Specific Growth Rate
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.15 Monthly growth increment of *Labeo rohita* under treatment 2

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Manure (%)	Manure/ time /day (g)	Survial rate %	SGR	TMC/ month (g)	TMC (g)	Total Biomass (g)	MCR
	Initial	1.6.2012	-	10.00	-	100.00	-	-	-	100	-	-	-	500	-
1	June	1.6.2012 30.6.2012	30	49.50	39.50	170.25	70.25	15	75.00	100	5.33	2250	2250.0	2475.00	0.90
2	July	1.7.2012 31.7.2012	61	104.87	55.37	200.12	29.87	12.5	309.37	95	2.50	9590.5	11840.5	4981.32	2.37
3	August	1.8.2012 31.8.2012	92	155.62	50.75	218.25	18.13	12.5	622.66	95	1.31	19302.5	31143.0	7391.95	4.21
4	September	1.9.2012 30.9.2012	122	184.12	28.50	230.37	12.12	10	739.19	90	2.56	22175.7	53318.7	8285.40	6.40
5	October	1.10.2012 31.10.2012	153	204.37	20.88	240.12	9.75	10	828.54	90	2.35	25684.7	79003.4	9196.65	8.59
6	November	1.9.2012 30.9.2012	183	225.25	20.88	245.25	5.13	7.5	689.74	85	2.32	20692.2	99695.6	9573.12	10.41
7	December	1.12.2012 31.12.2012	214	240.62	15.37	250.25	5.00	7.5	717.98	85	2.22	22257.2	121952.8	10226.35	11.92
8	January	1.1.2013 31.1.2013	245	250.12	9.50	255.12	4.87	5	511.31	80	2.13	15850.7	137803.5	10004.80	13.77

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length

SGR - Specific Growth Rate
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.16 Monthly growth increment of *Catla catla* under treatment 2

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Manure (%)	Manure/time /day(g)	Survial rate	SGR	TMC/ month (g)	TMC (g)	Total Biomass (g)	MCR
	Initial	1.6.2012	-	10.50	-	85.12	-	-	-	100	-	-	-	525.00	-
1	June	1.6.2012 30.6.2012	30	54.87	44.37	162.00	76.88	15	78.5	100	5.51	2355	2355	2743.50	0.85
2	July	1.7.2012 31.7.2012	61	105.25	50.38	180.12	18.12	12.5	343.0	95	2.17	10633	12988	4999.37	2.59
3	August	1.8.2012 31.8.2012	92	163.50	58.25	220.12	40.00	12.5	625.0	95	1.47	19375	32363	7766.25	4.16
4	September	1.9.2012 30.9.2012	122	203.37	39.87	240.62	20.50	10	776.5	90	0.73	23295	55658	9151.65	6.08
5	October	1.10.2012 31.10.2012	153	221.87	18.50	250.37	9.75	10	915.0	90	0.29	28365	84023	9984.15	8.41
6	November	1.9.2012 30.9.2012	183	229.62	7.75	260.12	9.75	7.5	749.0	85	0.11	22470	106493	9758.85	10.91
7	December	1.12.2012 31.12.2012	214	241.37	11.75	265.12	5.00	7.5	732.0	85	0.17	22692	129185	10258.22	12.59
8	January	1.1.2013 31.1.2013	245	251.87	10.50	270.00	4.88	5	513.0	80	0.14	15903	145088	10074.80	14.40

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length

SGR - Specific Growth Rate
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.17 Monthly growth increment of *Cyprinus intha* under treatment 2

No	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Manure (%)	Manure/time /day(g)	Survial Rate %	SGR	TMC/ month (g)	TMC (g)	Total Biomass (g)	MCR
	Initial	1.6.2012	-	10.75	-	99.25	-	-	-	100	-	-	-	537.50	-
1	June	1.6.2012 30.6.2012	30	45.62	34.87	150.50	51.25	15	80.5	100	4.82	2415.0	2415.0	2281.00	1.05
2	July	1.7.2012 31.7.2012	61	86.12	40.50	169.50	19.00	12.5	285.0	95	2.12	8835.0	11250.0	4090.70	2.75
3	August	1.8.2012 31.8.2012	92	141.50	55.38	190.25	20.75	12.5	511.5	95	1.65	15856.5	27106.5	6721.25	4.03
4	September	1.9.2012 30.9.2012	122	168.62	27.12	210.37	20.12	10	672.0	90	0.58	20160.0	47266.5	7587.90	6.22
5	October	1.10.2012 31.10.2012	153	189.37	20.75	229.50	19.13	10	759.0	90	0.38	23529.0	70795.5	8521.65	8.30
6	November	1.9.2012 30.9.2012	183	205.37	16.00	235.12	5.62	7.5	639.0	85	0.27	19170.0	89965.5	8728.22	10.30
7	December	1.12.2012 31.12.2012	214	214.37	9.00	240.12	5.00	7.5	654.5	85	0.14	20289.5	110255.0	9110.72	12.10
8	January	1.1.2013 31.1.2013	245	228.12	13.75	245.50	5.38	5	455.5	80	0.21	14120.5	124375.5	9124.80	13.63

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length
SGR - Specific Growth Rate
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.18(a) Monthly growth increment of *Labeo rohita* under supplementary feed 50% and organic manure 50% of treatment 3

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Feed (%)	Feed / time / day (g)	Survial rate %	SGR %	TFC/ month (g)	TFC (g)	Total Biomass (g)	FCR
	Initial	1.6.2012	-	10.62	-	100.50	-			100	-	-	-	531.00	-
1	June	1.6.2012 30.6.2012	30	60.62	50.00	175.25	75.25	2.5	13.27	100	5.81	398.25	398.25	3031.00	0.13
2	July	1.7.2012 31.7.2012	61	131.50	70.88	218.00	42.75	2.5	75.77	100	2.58	2394.02	2747.27	6575.00	0.42
3	August	1.8.2012 31.8.2012	92	192.25	60.75	230.25	12.25	1.5	98.62	95	1.26	3057.37	5804.65	9131.87	0.63
4	September	1.9.2012 30.9.2012	122	245.50	53.25	240.00	9.75	1.5	136.97	95	0.81	4109.25	9913.90	11661.25	0.85
5	October	1.10.2012 31.10.2012	153	274.12	28.62	260.25	20.25	1.5	174.92	95	0.37	6120.02	16033.92	13020.70	1.23
6	November	1.9.2012 30.9.2012	183	304.00	29.88	265.62	5.37	1.0	130.20	90	0.34	3906.15	19940.07	13680.00	1.45
7	December	1.12.2012 31.12.2012	214	321.87	17.87	275.12	9.50	1.0	136.80	90	0.19	4240.80	24180.87	14484.15	1.66
8	January	1.1.2013 31.1.2013	245	334.37	12.50	280.87	5.75	1.0	144.84	90	0.13	4490.04	2867.41	15046.65	1.90

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length
SGR - Specific Growth Rate
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.18 (b): Monthly growth increment of *Labeo rohita* under supplementary feed 50% and organic manure 50% of treatment 3

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Manure (%)	Manure / time / day (g)	Survial rate %	SGR %	TMC/ month (g)	TMC (g)	Total Biomass (g)	MCR
	Initial	1.6.2012	-	10.62	-	100.50	-	-	-	100	-	-	-	531.00	-
1	June	1.6.2012 30.6.2012	30	60.62	50.00	175.25	75.25	7.5	39.82	100	5.87	1194.60	1194.60	3031.00	0.394
2	July	1.7.2012 31.7.2012	61	131.50	70.88	218.00	42.75	6.25	189.44	100	2.58	5872.64	7067.24	6575.00	1.075
3	August	1.8.2012 31.8.2012	92	192.25	60.75	230.25	12.25	6.25	410.94	95	1.26	12739.14	19806.38	9131.87	2.169
4	September	1.9.2012 30.9.2012	122	245.50	53.25	240.00	9.75	5.00	456.59	95	2.81	13697.70	33504.08	11661.25	2.873
5	October	1.10.2012 31.10.2012	153	274.12	28.62	260.25	20.25	5.00	583.06	95	2.37	18074.86	51578.94	13020.70	3.961
6	November	1.9.2012 30.9.2012	183	304.00	29.88	265.62	5.37	3.75	488.28	90	2.34	14648.40	66227.34	13680.00	4.841
7	December	1.12.2012 31.12.2012	214	321.87	17.87	275.12	9.50	3.75	513.00	90	2.19	15903.00	82130.34	14484.15	5.670
8	January	1.1.2013 31.1.2013	245	334.37	12.50	280.87	5.75	2.50	362.10	90	2.13	11225.10	93355.44	15046.65	6.204

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length

SGR - Specific Growth Rate
TMC - Total Feed Consumption
MCR - Feed Conversion Ratio

Table 4.19(a) Monthly growth increment of *Catla catla* under supplementary feed 50% and organic manure 50% of treatment 3

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Feed (%)	Feed / time / day (g)	Survial rate %	SGR %	TFC/ month (g)	TFC (g)	Total Biomass (g)	FCR
	Initial	1.6.2012	-	10.20	-	85.75	-	-	-	100	-	-	-	510.00	-
1	June	1.6.2012 30.6.2012	30	65.12	55.00	164.62	78.87	2.5	12.75	100	6.18	382.50	382.50	3256.00	0.11
2	July	1.7.2012 31.7.2012	61	130.25	65.13	184.25	19.63	2.5	81.40	100	2.31	2523.40	2905.90	6512.50	0.44
3	August	1.8.2012 31.8.2012	92	191.50	61.25	229.87	45.62	1.5	97.68	95	1.28	3028.23	5934.13	9096.25	0.65
4	September	1.9.2012 30.9.2012	122	251.25	59.75	260.12	30.25	1.5	136.44	95	0.90	4093.20	10027.33	11934.37	0.84
5	October	1.10.2012 31.10.2012	153	275.62	24.37	270.75	10.63	1.5	179.01	95	0.31	5549.46	15576.80	13091.95	1.18
6	November	1.9.2012 30.9.2012	183	290.12	14.50	280.37	9.62	1	130.92	90	0.17	3927.60	19504.40	13055.40	1.48
7	December	1.12.2012 31.12.2012	214	310.00	19.88	290.12	9.75	1	130.55	90	0.22	4047.05	23551.45	13950.00	1.68
8	January	1.1.2013 31.1.2013	245	330.62	20.62	300.37	10.25	1	139.50	90	0.21	4324.50	27875.95	14877.90	1.87

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length
SGR - Specific Growth Rate
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.19(b) Monthly growth increment of *Catla catla* under supplementary feed 50% and organic manure 50% of treatment 3

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Manure (%)	Manure / time / day (g)	Survial rate %	SGR %	TMC/ month (g)	TMC (g)	Total Biomass (g)	MCR
	Initial	1.6.2012	-	10.20	-	85.75	-	-	-	100	-	-	-	510.00	-
1	June	1.6.2012 30.6.2012	30	65.12	55.00	164.62	78.87	7.5	38.25	100	6.18	1147.50	1147.50	3256.00	0.352
2	July	1.7.2012 31.7.2012	61	130.25	65.13	184.25	19.63	6.25	203.50	100	2.31	6308.50	7456.00	6512.50	1.145
3	August	1.8.2012 31.8.2012	92	191.50	61.25	229.87	45.62	6.25	407.03	95	1.28	12617.93	20073.93	9096.25	2.207
4	September	1.9.2012 30.9.2012	122	251.25	59.75	260.12	30.25	5.00	454.81	95	0.90	13644.30	33718.23	11934.37	2.825
5	October	1.10.2012 31.10.2012	153	275.62	24.37	270.75	10.63	5.00	596.72	95	2.31	18498.32	52216.55	13091.95	3.988
6	November	1.9.2012 30.9.2012	183	290.12	14.50	280.37	9.62	3.75	490.95	90	0.17	14728.50	66945.05	13055.40	5.128
7	December	1.12.2012 31.12.2012	214	310.00	19.88	290.12	9.75	3.75	489.58	90	0.22	15176.98	82122.03	13950.00	5.887
8	January	1.1.2013 31.1.2013	245	330.62	20.62	300.37	10.25	2.50	348.75	90	0.21	10811.25	92933.28	14877.90	6.246

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length

SGR - Specific Growth Rate
TMC - Total Manure Consumption
MCR - Manure Conversion Ratio

Table 4.20(a) Monthly growth increment of *Cyprinus intha* under supplementary feed 50% and organic manure 50% of treatment 3

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Feeding rate (%)	Feed / time / day (g)	Survial rate %	SGR %	TFC/ month (g)	TFC (g)	Total Biomass (g)	FCR
	Initial	1.6.2012	-	10.00	-	100.00	-	-	-	100	-	-	-	500.00	-
1	June	1.6.2012 30.6.2012	30	50.62	39.87	160.25	60.25	2.5	12.50	100	5.40	375.00	375.00	2531.00	0.15
2	July	1.7.2012 31.7.2012	61	100.12	49.50	194.87	34.62	2.5	63.27	100	2.27	1961.37	2336.37	5006.00	0.47
3	August	1.8.2012 31.8.2012	92	162.12	62.00	230.12	35.25	1.5	75.09	95	1.60	2327.79	4664.16	7700.70	0.60
4	September	1.9.2012 30.9.2012	122	201.12	39.00	245.37	15.25	1.5	115.51	95	0.72	3465.30	8129.46	9553.20	0.85
5	October	1.10.2012 31.10.2012	153	251.62	50.50	260.25	14.88	1.5	143.30	95	0.74	4442.30	12571.76	11951.95	1.05
6	November	1.9.2012 30.9.2012	183	275.37	23.75	269.25	9.00	1.0	119.52	90	0.30	3585.60	16157.36	12391.65	1.30
7	December	1.12.2012 31.12.2012	214	300.62	25.25	275.25	6.00	1.0	123.92	90	0.29	3841.52	19998.88	13527.90	1.48
8	January	1.1.2013 31.1.2013	245	323.12	22.50	280.12	4.87	1.0	135.28	90	0.24	4193.68	24192.56	14540.40	1.66

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length
SGR - Specific Growth Rate
TFC - Total Feed Consumption
FCR - Feed Conversion Ratio

Table 4.20(b) Monthly growth increment of *Cyprinus intha* under supplementary feed 50% and organic manure 50% of treatment 3

No.	Month	Time duration	Culture period (days)	ABW (g)	Inc.in Body Wt.(g)	Av.TL (mm)	Inc.in T L (mm)	Manure (%)	Manure / time / day (g)	Survial rate %	SGR %	TMC/ month (g)	TMC (g)	Total Biomass (g)	MCR
	Initial	1.6.2012	-	10.00	-	100.00	-	-	-	100	-	-	-	500.00	-
1	June	1.6.2012 30.6.2012	30	50.62	39.87	160.25	60.25	7.5	37.50	100	5.40	1125.00	1125.00	2531.00	0.44
2	July	1.7.2012 31.7.2012	61	100.12	49.50	194.87	34.62	6.25	158.19	100	2.27	4903.89	6028.89	5006.00	1.20
3	August	1.8.2012 31.8.2012	92	162.12	62.00	230.12	35.25	6.25	312.87	95	1.60	9698.97	15727.86	7700.70	2.04
4	September	1.9.2012 30.9.2012	122	201.12	39.00	245.37	15.25	5.00	385.03	95	0.72	11550.90	27278.76	9553.20	2.85
5	October	1.10.2012 31.10.2012	153	251.62	50.50	260.25	14.88	5.00	477.66	95	0.74	14807.46	42086.22	11951.95	3.52
6	November	1.9.2012 30.9.2012	183	275.37	23.75	269.25	9.00	3.75	448.20	90	0.30	13446.00	55532.22	12391.65	4.48
7	December	1.12.2012 31.12.2012	214	300.62	25.25	275.25	6.00	3.75	464.69	90	0.29	14405.39	69937.61	13527.90	5.17
8	January	1.1.2013 31.1.2013	245	323.12	22.50	280.12	4.87	2.50	270.56	90	0.24	8387.36	78324.97	14540.40	5.39

ABW - Average Body Weight
Inc. in Body Wt. - Increase in Body Weight
Av. TL - Average Total Length
Inc. in TL - Increase in Total Length
SGR - Specific Growth Rate
TMC - Total Manure Consumption
MCR - Manure Conversion Ratio

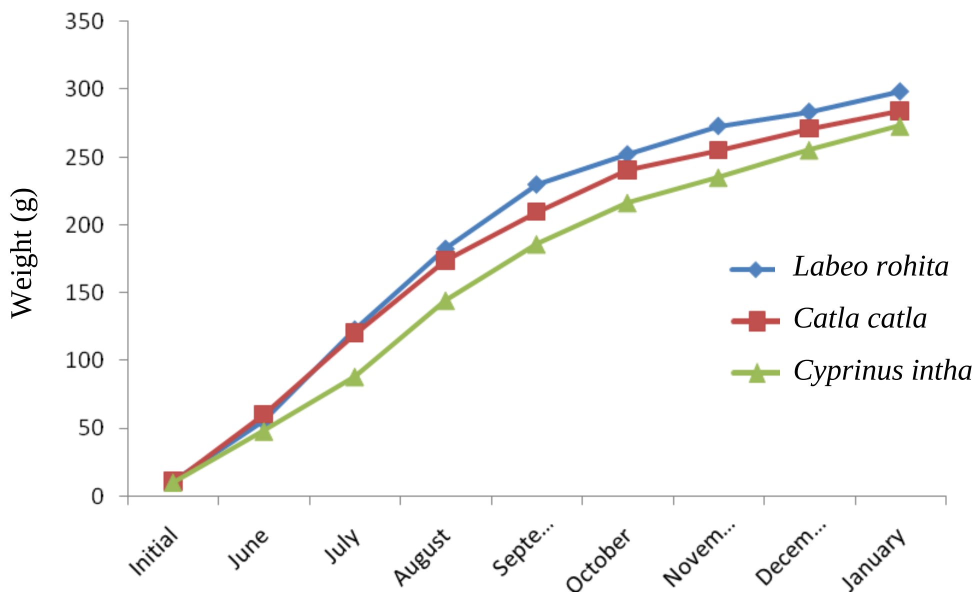


Fig. 4.2 Monthly increase in average body weight of three fish species under treatment 1

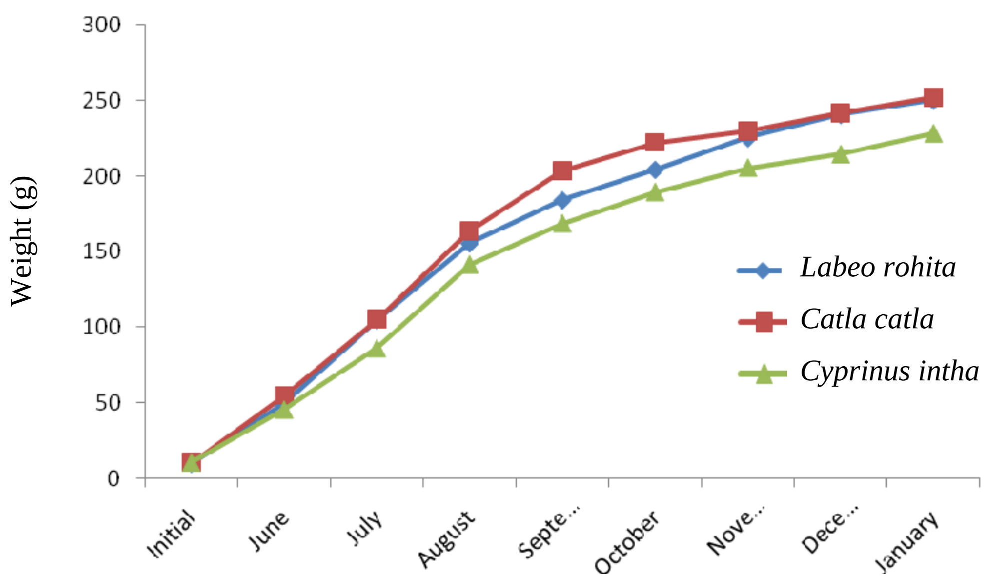


Fig.4.3 Monthly increase in average body weight of three fish species under treatment 2

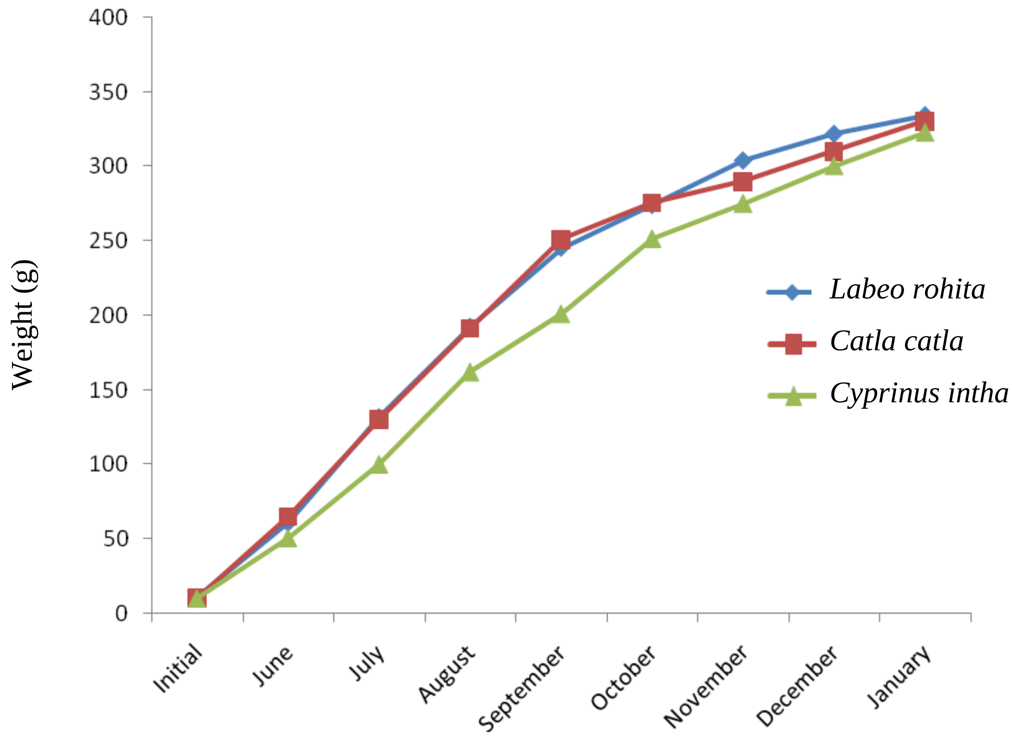


Fig.4.4 Monthly increase in average body weight of three fish species under treatment 3

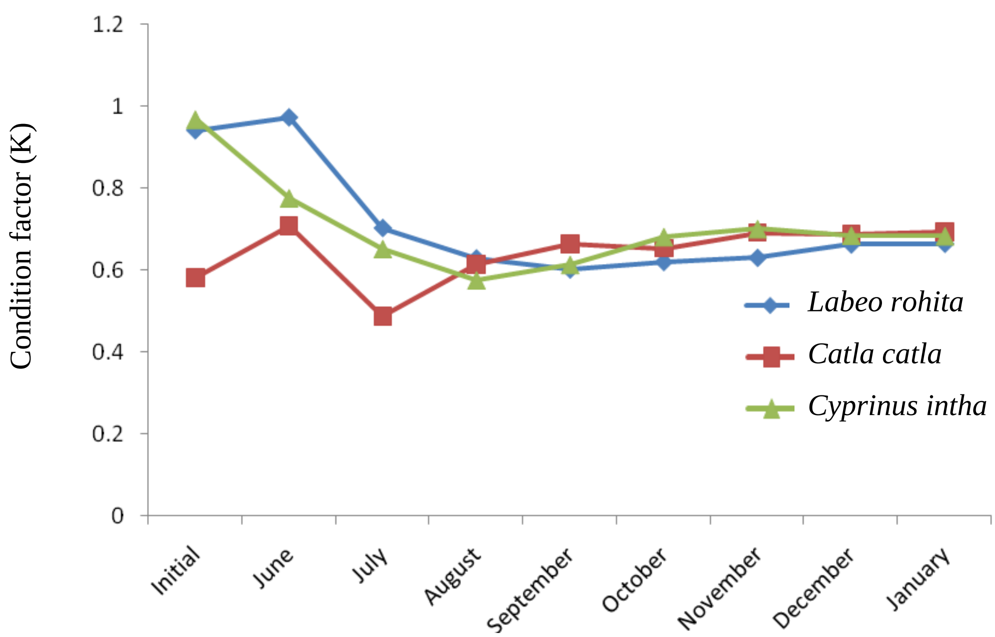


Fig. 4.5 Condition factor (K) of three fish species under treatment 1

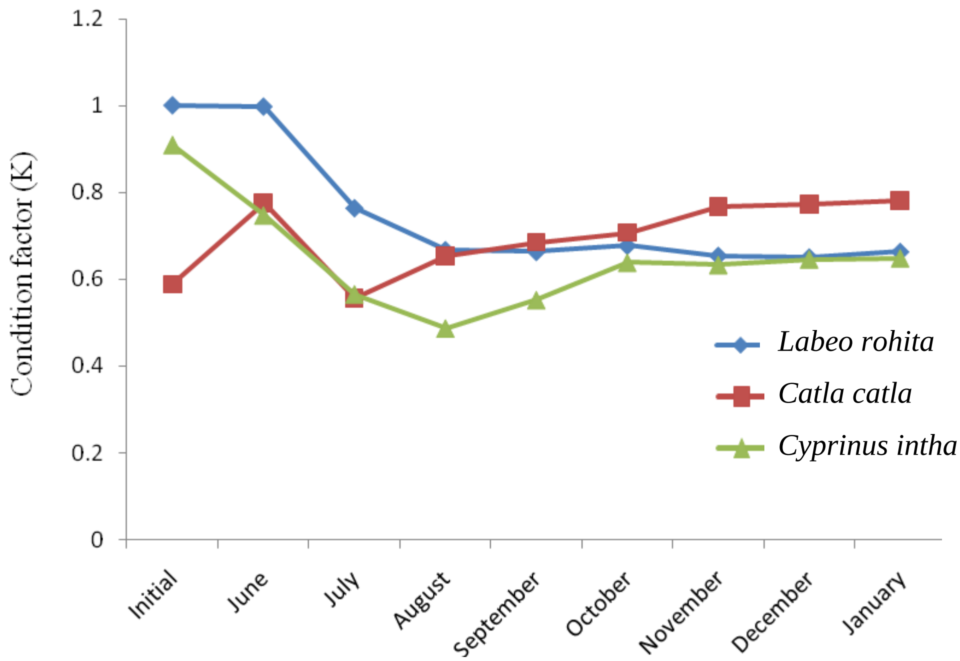


Fig. 4.6 Condition factor (K) of three fish species under treatment 2

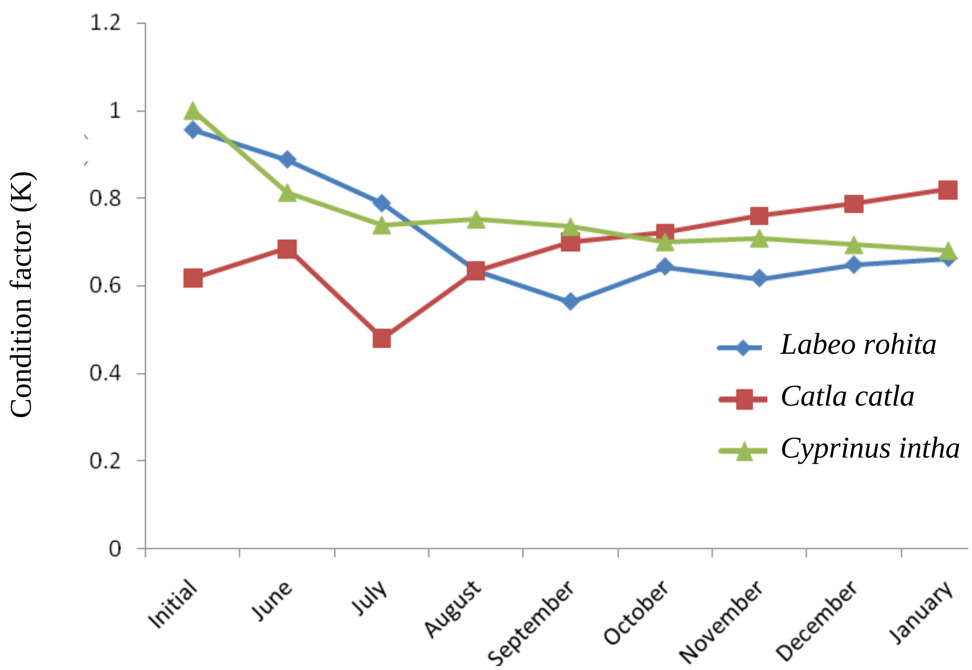


Fig. 4.7 Condition factor (K) of three fish species under treatment 3

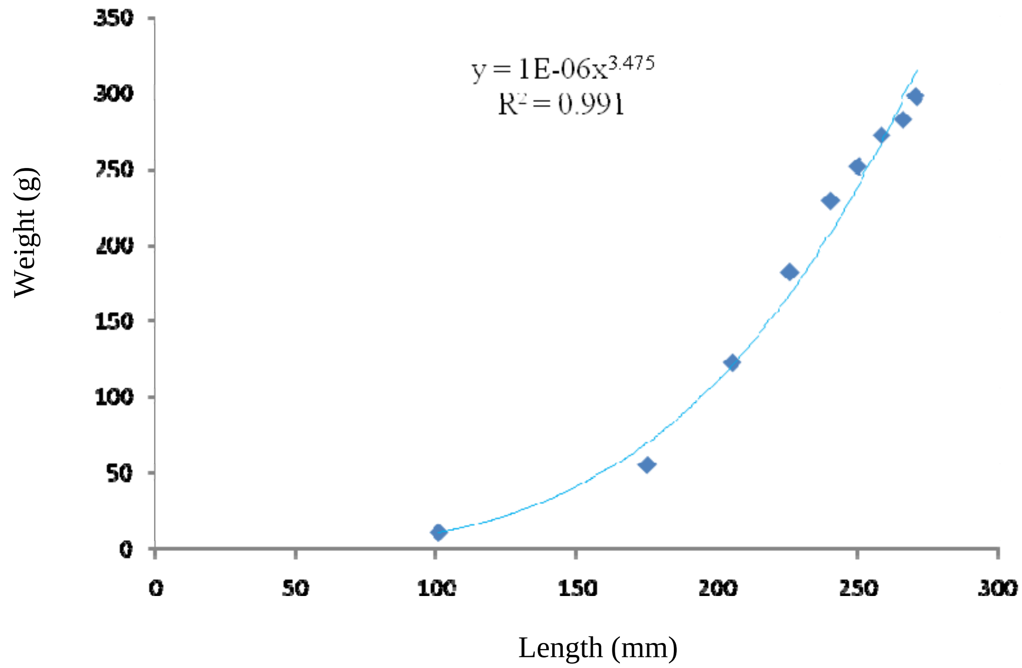


Fig. 4.8 Length-weight relationship of *Labeo rohita* under treatment 1

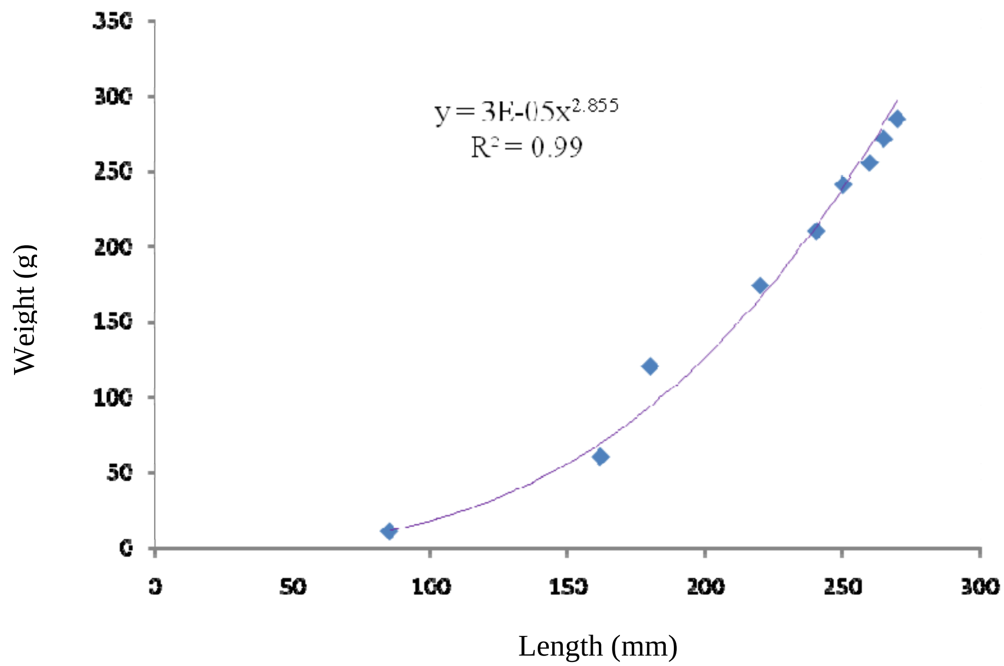


Fig. 4.9 Length-weight relationship of *Catla catla* under treatment 1

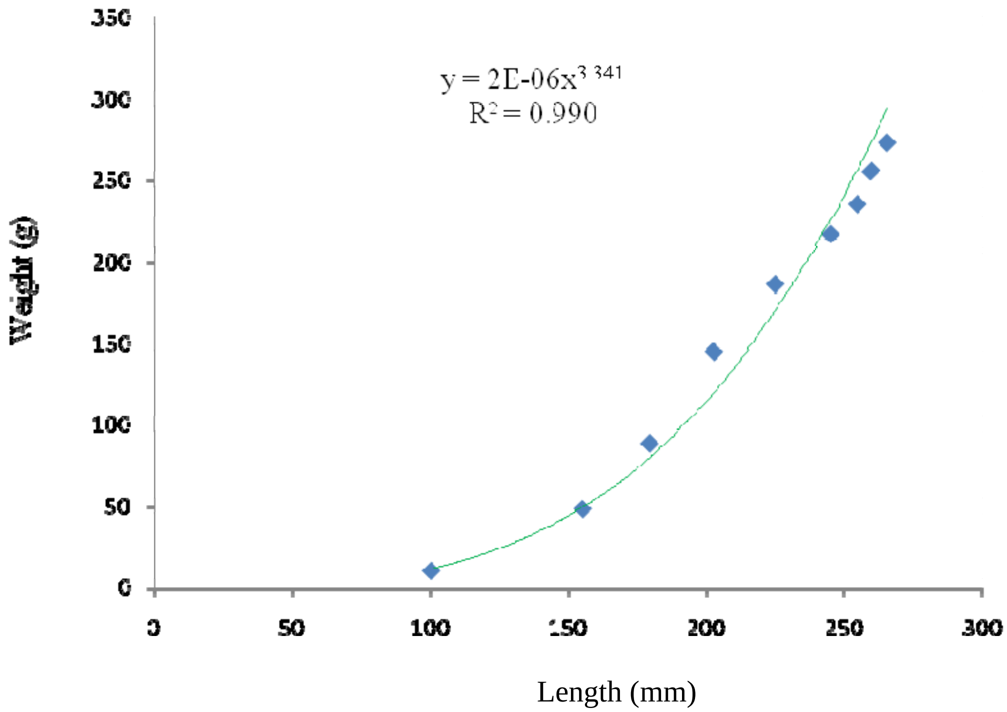


Fig. 4.10 Length-weight relationship of *Cyprinus intha* under treatment 1

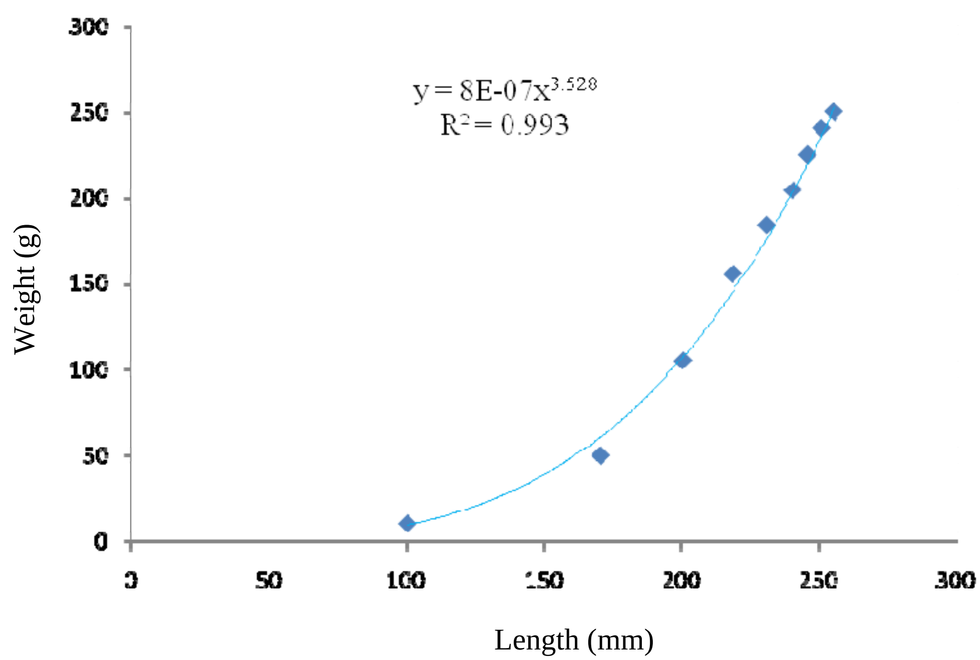


Fig. 4.11 Length-weight relationship of *Labeo rohita* under treatment 2

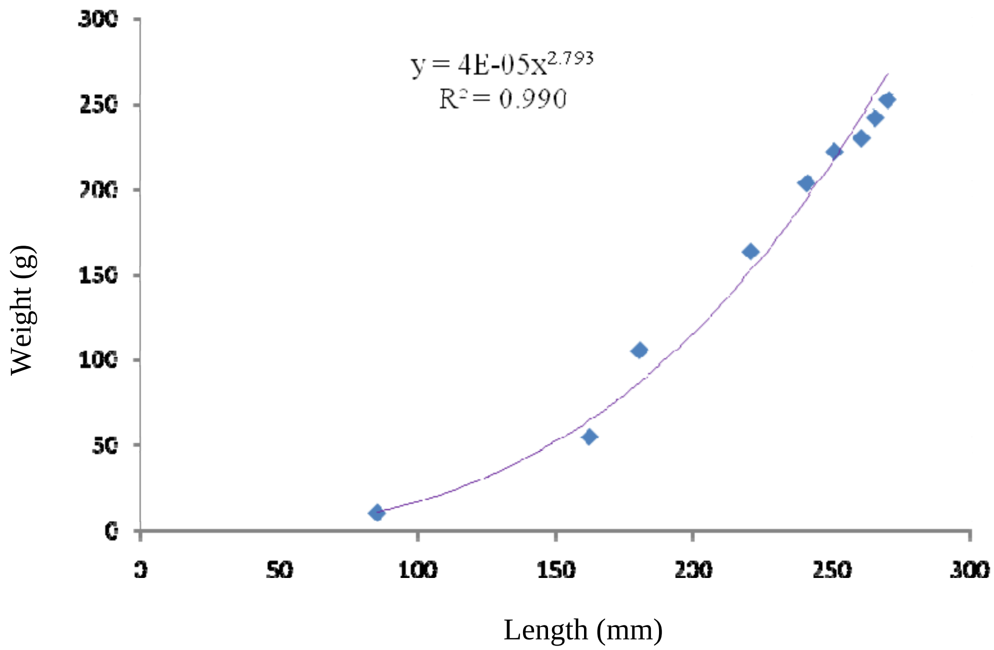


Fig. 4.12 Length-weight relationship of *Catla catla* under treatment 2

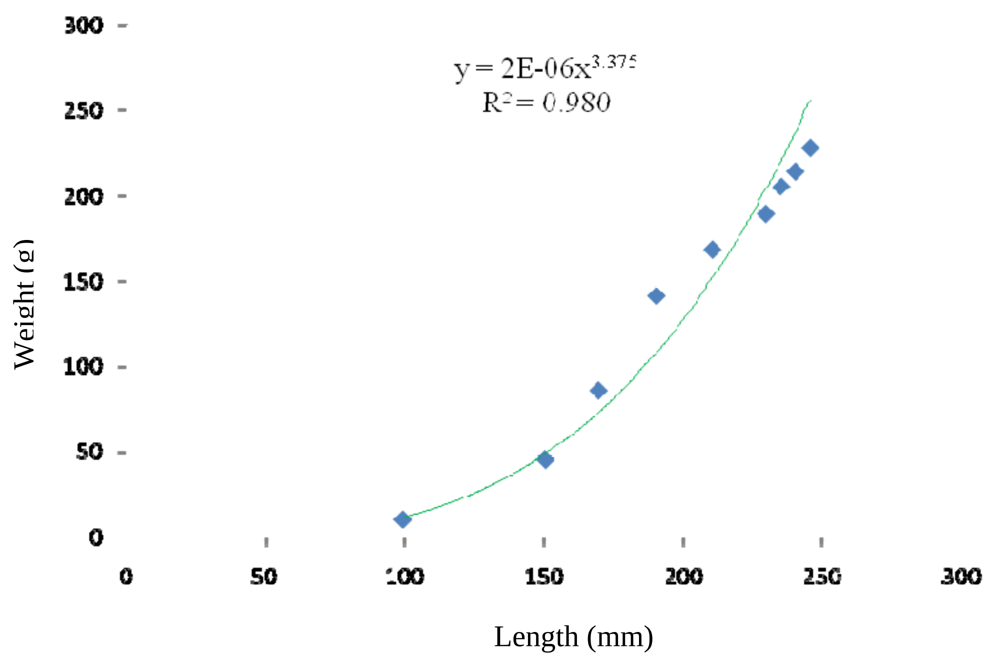


Fig. 4.13 Length-weight relationship of *Cyprinus intha* under treatment 2

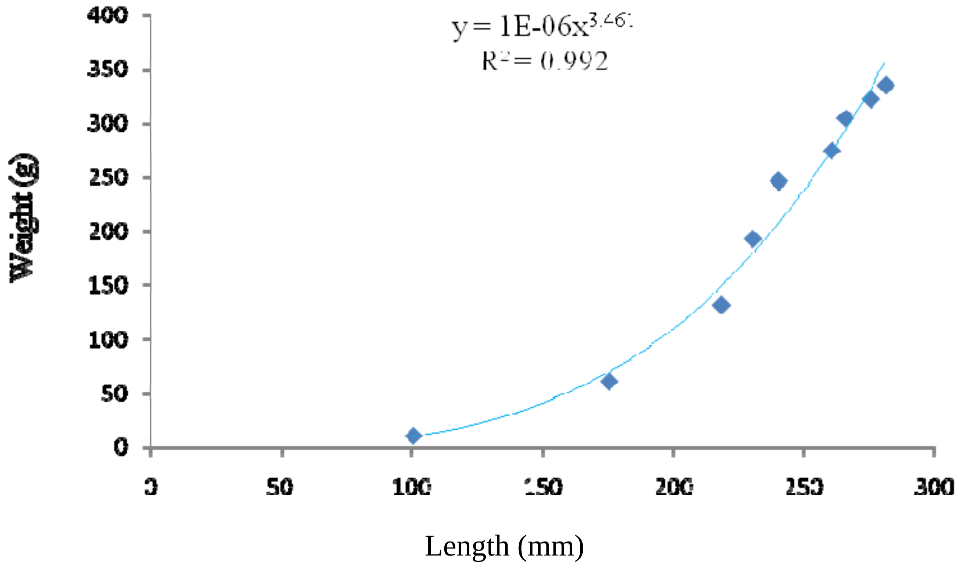


Fig. 4.14 Length-weight relationship of *Labeo rohita* under treatment 3

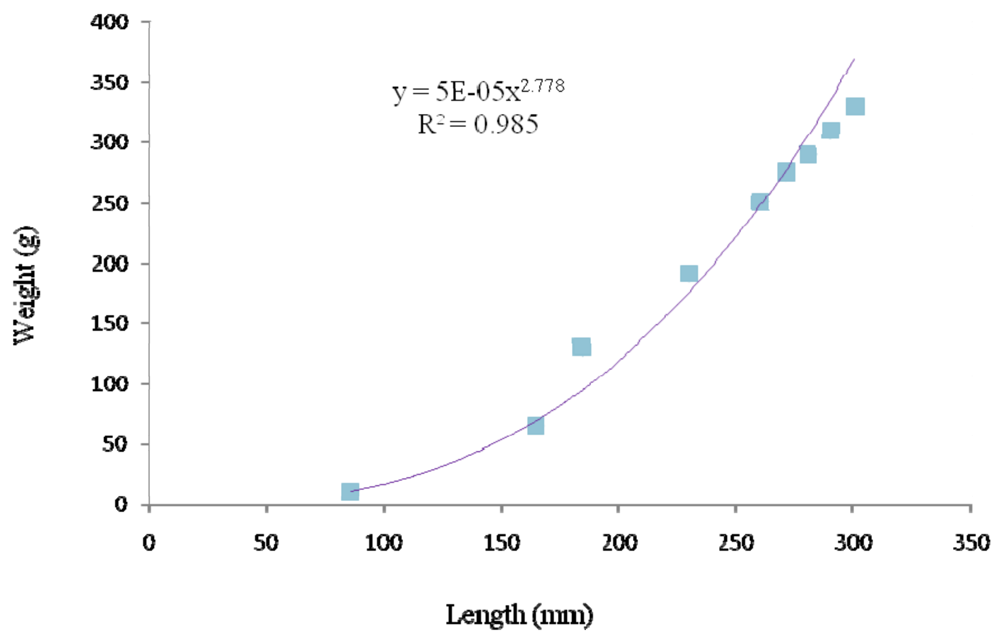


Fig. 4.15 Length-weight relationship of *Catla catla* under treatment 3

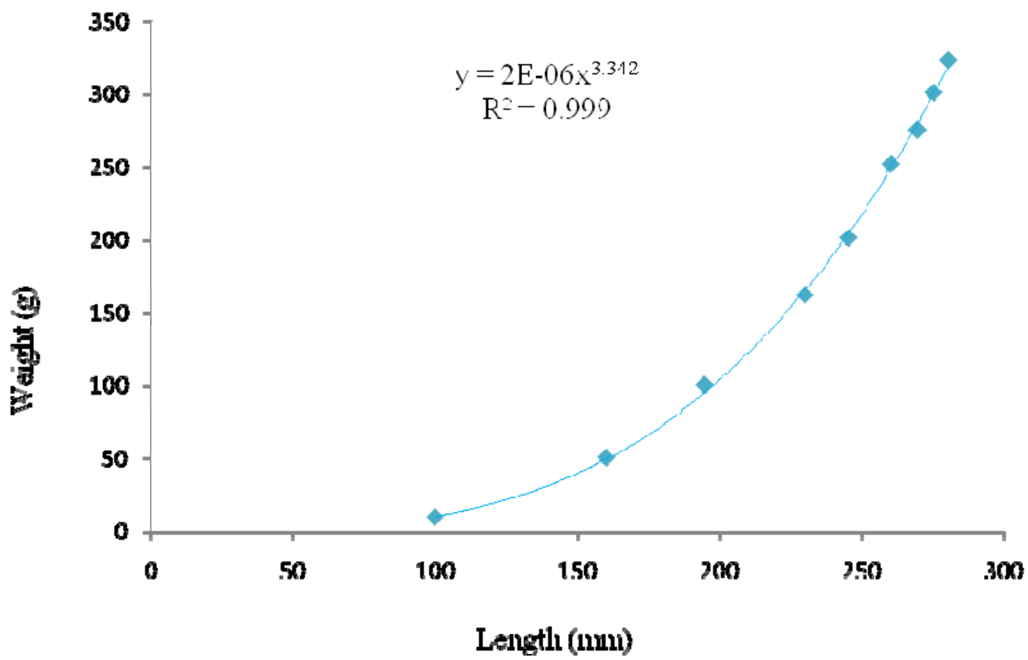


Fig. 4.16 Length-weight relationship of *Cyprinus intha* under treatment 3

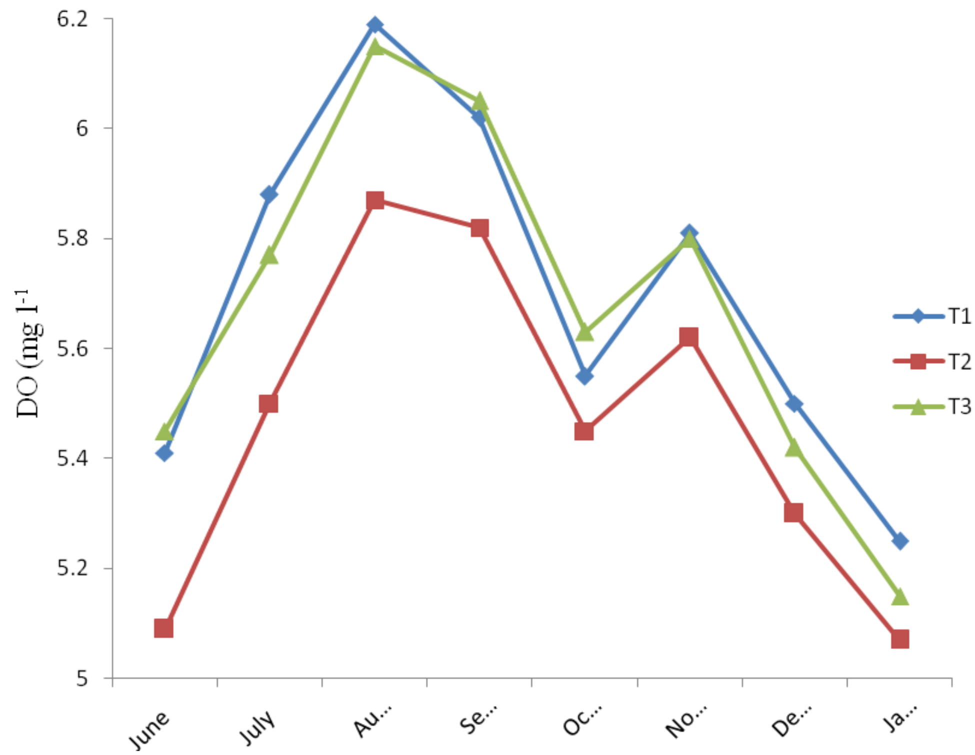


Fig. 4.17 Monthly variations in dissolved oxygen (DO) of pond water under different treatment

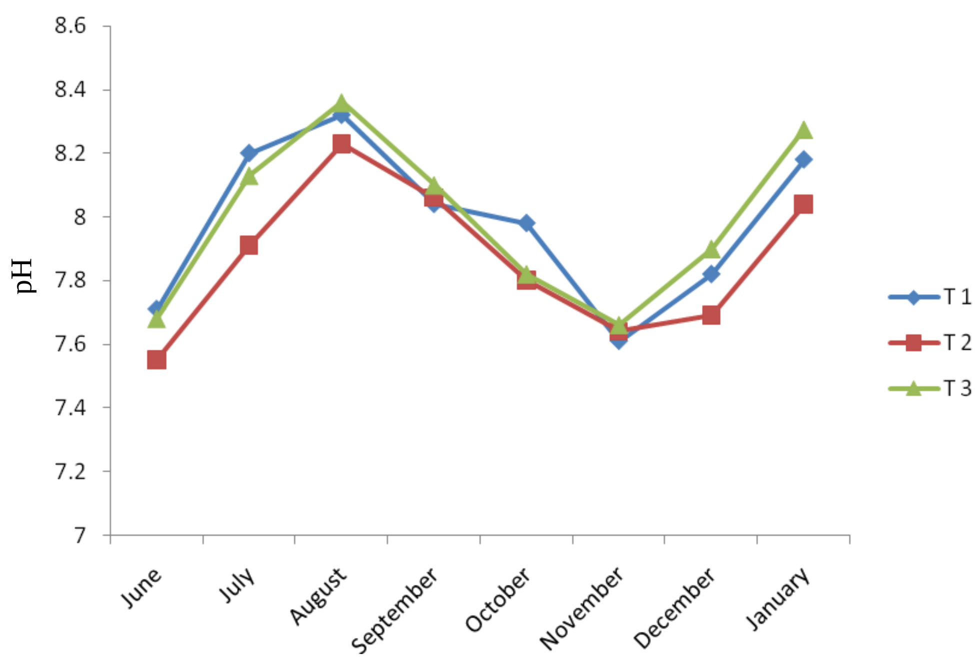


Fig. 4.18 Monthly variations in pH of pond water under different treatment

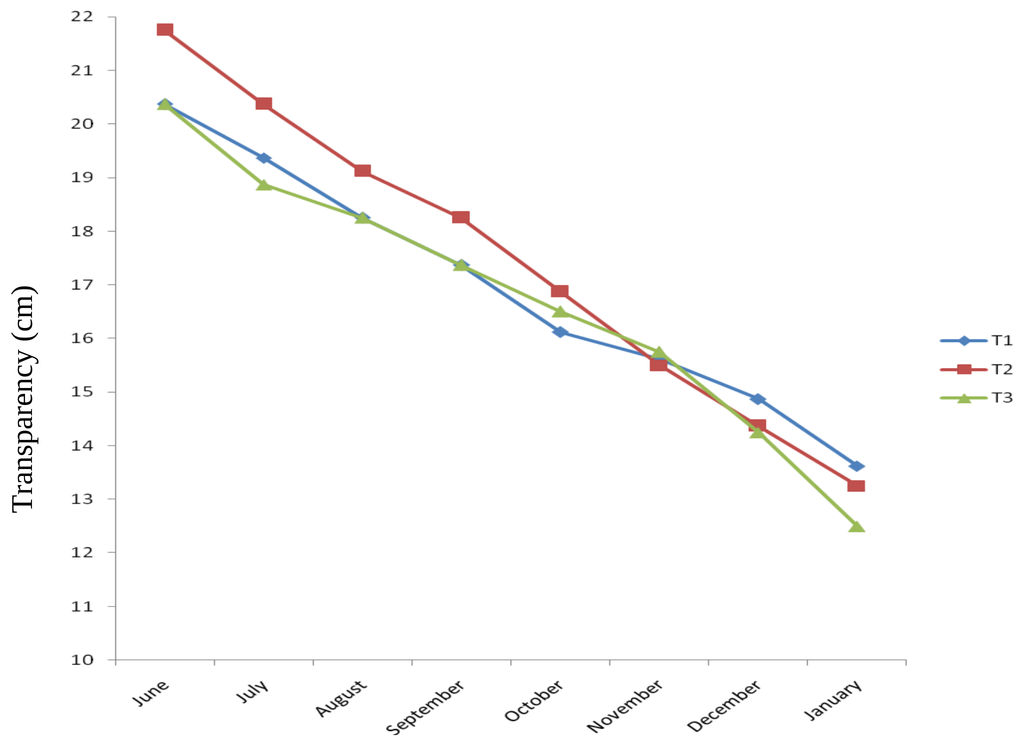


Fig. 4.19 Monthly variations in transparency (cm) secchi's disc penetration of pond water under different treatment

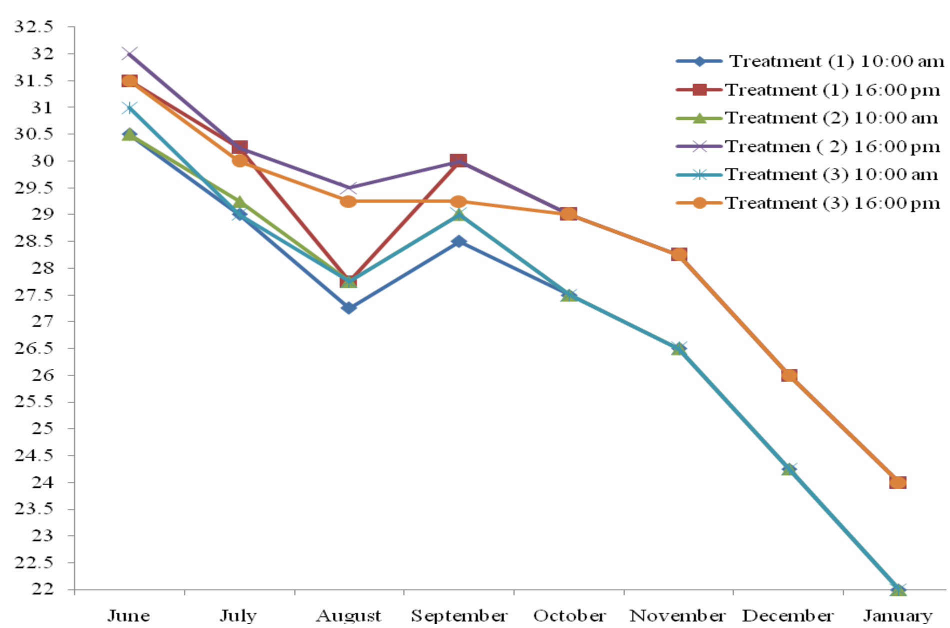


Fig. 4.20 Monthly average water temperature (°C) of pond water under different treatment

Plate 4.1 Experiment ponds before stocking

A. Lime added into experiment ponds before stocking

B. Cow manure added into experiment ponds before stocking

A

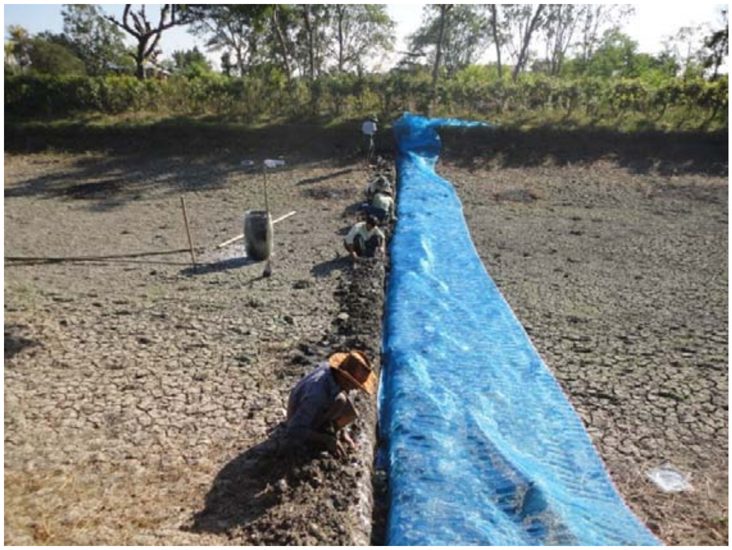
B

Plate 4.1

Plate 4.2 Preparing experiment ponds

A. Preparation of the pond into two sections

B. Experiment ponds separated into two sections by using nylon net reinforced by bamboo poles



A

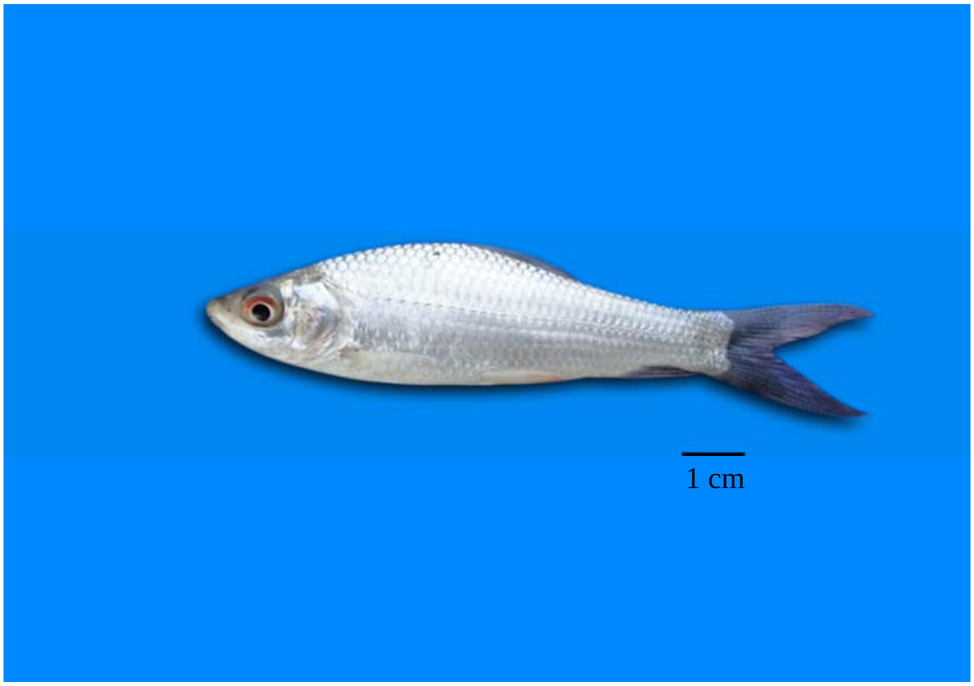
B

Plate 4.2

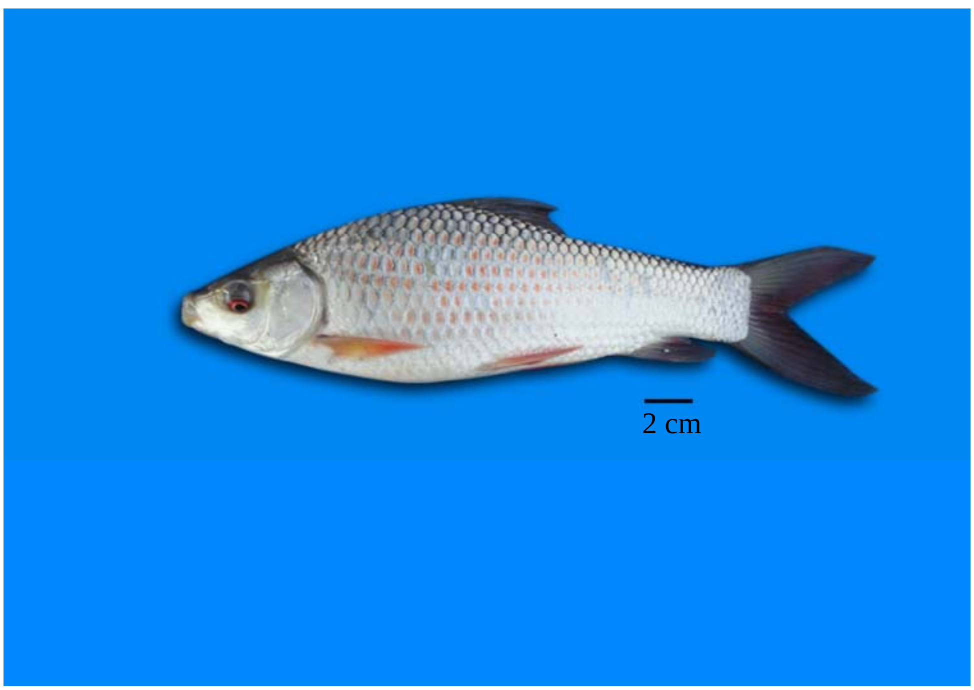
Plate 4.3 Comparison between the initial and final stages of *Labeo rohita*

A. Initial stage

B. Final stage



A



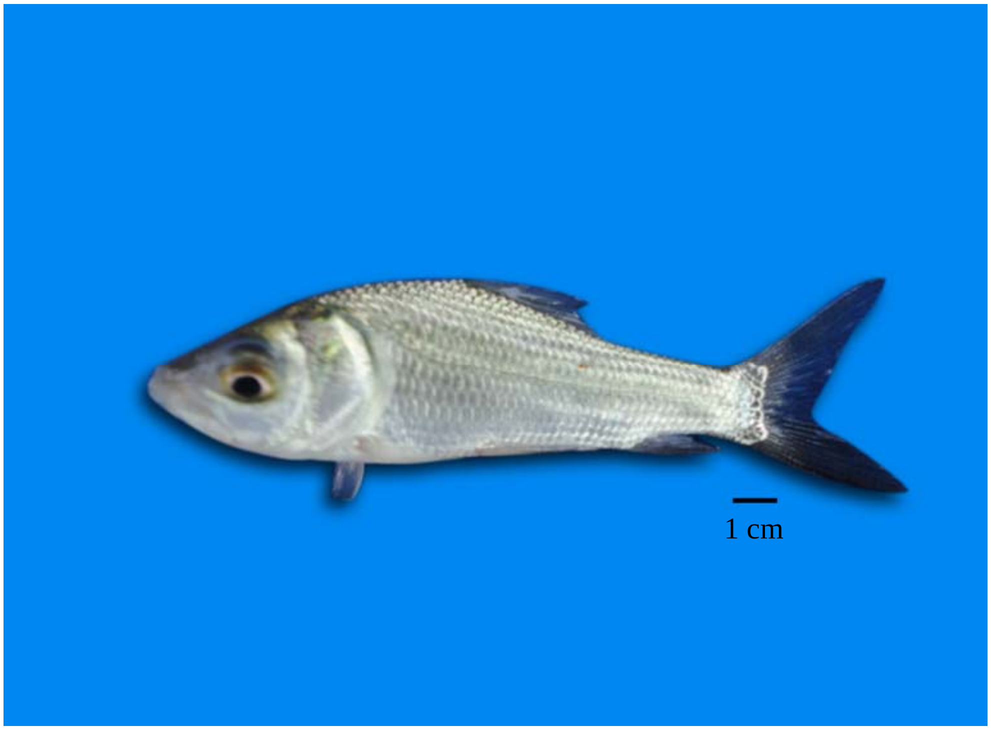
B

Plate 4.3

Plate 4.4 Comparison between the initial and final stages of *Catla catla*

A. Initial stage

B. Final stage



A

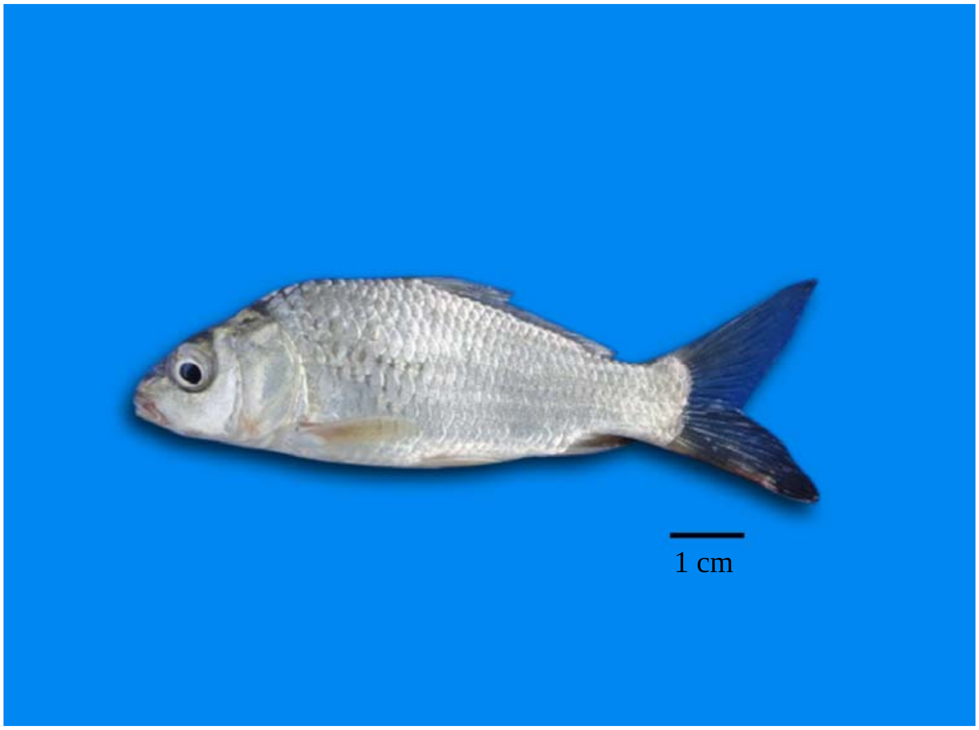
Plate 4.4

Plate 4.5 Comparison between the initial and final stages of *Cyprinus intha*

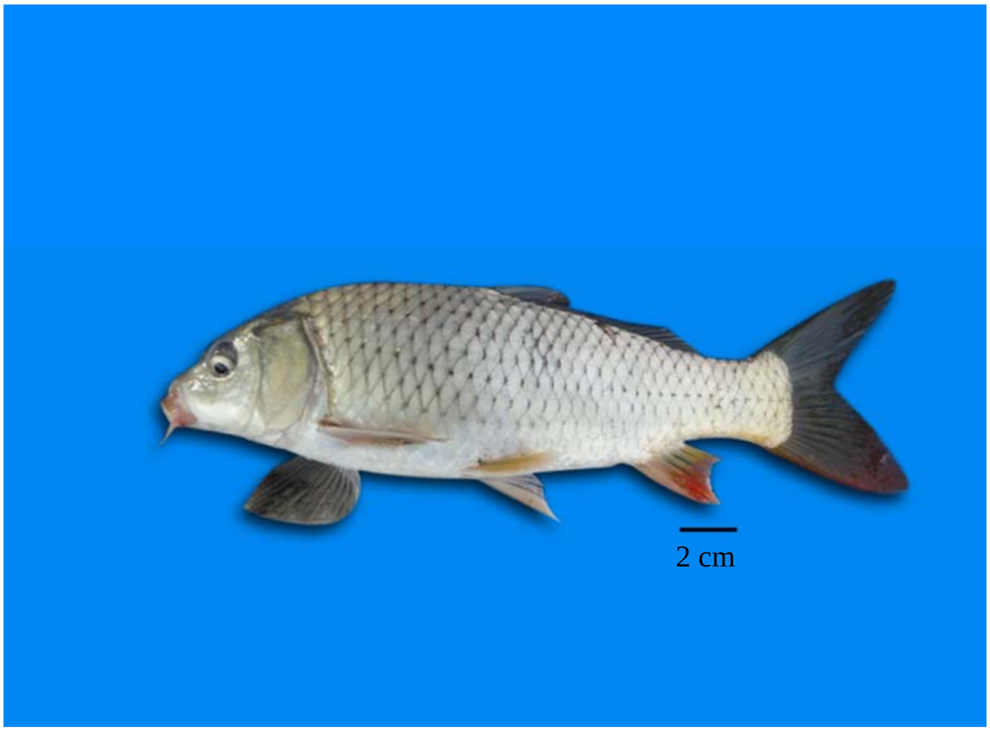
A. Initial stage

B. Final stage

Plate 4.5



A



B

Plate 4.5

4.4 Discussion

The results of present study revealed that, three weight gains of the study fish species were observed with maximum weight in T_3, in which cow manure and supplementary feed was added. These results confirmed the findings of Liang *et al*., (1999) and Keshavanath *et al*., (2001), who reported that ground nut oil cake, cotton seed meal, deoiled rice bran and sunflower meal and additives in the feed such as salt and mineral mix along with organic manure (buffalo manure and poultry dropping), contributed to high yield in carp polyculture. Jena *et al*., (1999) and Islam *et al*., (2008) also concluded that supplementary feed comprising of rice bran, soybean meal, fish meal, vegetable oil, vitamin and mineral mixture (40: 20: 10:3: 2) influence the growth and survival of carp fingerlings on the basis of specific growth rate and harvested fish yield. Mahboob *et al.*, (1995) suggested that application of supplementary feed along with organic manure is the best mean to obtained maximum production in fish culture practices from confined water bodies within the limited possible time in semi intensive polyculture system.

In the present study, the highest fish production was observed in T_3 (organic manure with supplementary feed) when compared with T_1 and $T_{2,}$ organic manure or supplementary feed alone was used. The results are agreement with the findings of Mahboob and Sheri (1997) who obtained the higher fish production by using broiler dropping as compared to by using NPK fertilizer with major carps. The result was recommended that by Yadava and Garg (1992), who observed that organic manure was to benefit the farmer economically as it serves to reduce 50% cost of inorganic fertilizer and supplementary feed.

Among the study three fish species, *L. rohita*, showed the maximum average final body weight 334.37 g, followed by *C. catla* 330.62 g and *C. intha* 323.12 g in T_3. Growth performance of three fish species under three types of feed showed that, the average final weight gains were significantly different ($p<0.05$) among the treatments. Moreover, the specific growth rate of three fish species in T_3 was also the best in compare to those of T_1 and T_2. The result also showed that the best feed conversion ratio (FCR) and survival rate were 3.5 and 90% respectively in T_3. This result was in agreement with Hussein (1995) who reported that the highest growth of mullet (*Mugil cephalus*) in polyculture with organic fertilizer and supplementary feeding.

Supplementary feeding is known to increase the carrying capacity of culture systems and can enhance fish production by several folds (Jhingran, 1995). The recent study showed that different species cultured in polyculture performed better in T_3 followed by T_1, while the lowest growth performance was observed in T_2. The maximum weight gain was recorded in July, followed by August and June. Lower values of monthly weight gain were recorded in December and January, which might be due to decrease food intake by fish at low temperatures. Kolar *et al*. (2005) also inferred Asian carp genus *Hypophthalmichthys* found in lower value of monthly weight gain recorded in December, January and February, which might be due to decreased food intake by fish at low temperature. The better monthly FCR was found in the month of June, July and August in present study, which is similar to Sinha and Saha (1980) but higher than 1.75-1.77 (FCR) reported by Sahu *et al*. (2007). The growth performance and FCR are good tools to compute the acceptability of supplementary feed in fish feeding experiments (Inayat and Salim, 2005).

The results of condition factor based on length and weight of study fishes were showed nearly one. Thus, growth pattern was the best base on body weight and total length. The seasonal variation in growth rates showed prominent growth in July and August. The growth performance of remaining months between average body weight and total length showed the linear trend. These results of condition factor (K) was proved by the conclusion of Yildiz *et al*. (2006), who observed that condition factor was influenced by seasonal changes as low in winter as compared to summer.

Present study indicated that the coefficient values ‘b’ was less than 3 ($b<3$) in *Catla catla* (2.85, 2.79 and 2.78) in $T_{1,}$ T_2 and $T_{3.}$ The 'b' values ($b>3$) were in *Labeo rohita* (3.475, 3.528 and 3.461) and *Cyprinus intha* (3.341, 3.375 and 3.342) in $T_{1,}$ T_2 and T_3 respectively. Gayando and Pauly (1997) reported that, isometric growth when length increases in equal proportion with body weight for constant specific gravity. The regression co-efficient for isometric growth is ‘3’ and ‘b’ values greater or lesser than ‘3’ indicate allometric growth.

According to Le Cren (1951), the present study of length-weight relationship of value R^2 (regression coefficient) for study fishes were positively correlated. In this result, the values of R^2 were nearly equal to ‘1’ for each fishes and all treatment, which represent that highly accuracy of these Le Cren (1951) regression model. The value obtained from this study showed that the three study fishes were in good condition.

Water temperature did not differ between the three treatment ponds, but found to be different among the months. Low temperature was recorded during December and January and the optimum temperature during June to August. The pond water temperature ranged between 27°C - 30°C found during July to September and which is suitable for growth performance of three study fish species. The pond water temperature between 26°C - 33°C during June to August was found to be suitable for growth of bighead carp as at these temperature fish fed extensively on natural and supplementary feeds (Bettoli *et al.*, 1985). In the present study, it was observed that higher fish production was obtained in warmer months than colder ones due to the reduction of feed consumption and metabolic rates in cold. Similar results were observed by Hassan *et al*., (1996) who reported that water temperature is the only variable that affect significantly the growth rate of major carps (*C. catala, L. rohita* and *C. mrigala*) which is indicated by an increase in fish yield that showed the linear trends with the increase in temperature.

Dissolved oxygen (DO) in three treatments showed some seasonal variations but it had no adverse effect on fish growth (Shah *et al.*, 1998). In this study the high range of DO was (5.8-6.2) mgl^{-1} found in August and September. In this result DO > $5mgl^{-1}$ showed the best growth performance on all treatments and fish can survive DO< 5 (1-5) mgl^{-1} but growth is slow in long term.

According to Randall (1991), fish are tolerant to pH extreme outside of the range (5-9). In this result, the pH value was range from 6.5 to 8.3 in all treatment and pH values which were considered suitable for fish growth in polyculture.

Transparency is one of the limiting factors in pond ecosystem. Primary productivity was depending upon pond water transparency and various activity of metabolic process of aquatic organisms was affected by light penetration and temperature (Singh *et al*., 2000). In this study, the higher value of transparency found in June-August 18 - 22 cm respectively and the lower value found in December and January 12-14 cm respectively. Stikney (1979) recommended that a depth of 30 cm to achieve and maintain proper fertilization. The mean transparency in this experiment was around within (20) cm, which is lower in compare with recommendation but suitable for primary productivity in polyculture.

From the present study it was concluded that, the effect of organic fertilizer (Cow manure) and supplementary feed support the best growth performance in polyculture. There were significant differences in the final average body weights and weight gains of three study fish species in all treatments. Moreover, the better SGR and FCR were found in T_3. The total average biomass of fish was not significantly different ($p>0.05$) but the results revealed that T_3 showed the best growth performance of studied species *C. intha* the best in FCR. In condition factor 'K' in length-weight relationship the value was close to one. The coefficient value 'b' was found ($b>3$) in *L. rohita* and *C. intha*, which were positively allometric and *C. catla* was found with negatively allometric condition in all treatments. The correlation coefficient R^2 was not significantly different in three study species in all treatments. Physicochemical parameters of experiment ponds of the three feed types were not significantly different but seasonal variation of culture months were significantly different. The high values of DO and pH were found in August, with high growth performance. The lower DO and temperature values were found in December and January with lowest weight gain in all treatments. The growth performance and feed utilization efficiency of *L. rohita*, *C. catla* and *C. intha* was significantly different in among treatments. It indicated that supplementary feed with addition of organic manure (cow manure) plays an important role for better growth and FCR maximizing the yield of fish production.

CHAPTER 5

GENERAL DISCUSSION

Inle carp (*Cyprinus intha*) is a Cyprinid fish commonly found in Inle Lake, is endemic species in Myanmar. According to IUCN Red List 2011, this species is endangered species and may be impacted (competition and hybridisation) by the introduced *Cyprinus* species. It is assessed as endangered as the extent of occurrence meets the threshold of less than 5000 km^2, An area of occupancy is less than 500 km^2 and it is native to only one location and the major threat alluded to overfishing (Kullander *et al.*, 2011; cited in IUCN 2011).

Cyprinus intha inhabits in the shallow zone of the lake, in area with dense submerged vegetation and muddy, high organic bottom. The spawning of this species takes place in water with the temperature range 24°C- 26°C. The spawning season is between November and March. Previous worker Aye Min Win Aye (2007) studied the Gonadosomatic Indexof *Cyprinus intha* during November 2006 to April 2007. She reported that the highest GSI value was November 2006 and January 2007. The lowest GSI value was December 2006 and March 2007. According to Smith (2004) peaks of GSI value occur prior to spawning (prespawning) and spawning is evidenced by sharp decline in GSI value.

In the present study, all breeders of *C. intha* were captured in Jan 2011 at Golden Island Cottage hotel, near Nangpan village; the gonad development was estimated based on length-weight relationship. Bagenal and Tesch (1978) reported the length and weight relationship may vary significantly according to factors such as the food availability, feeding rate, gonad development and spawning period.

The length-weight and length- length relationship have been applied for basic use for assessment of fish stocks and population (Ricker 1975). The length-weight relationships also help to figure out the condition, reproduction history, life history and the general health of fishing species. In the present experimental ponds, the length and weight relationship of *C. intha* was found to be significant. It was suggested that *C. intha* could be cultured in pond for both breeding and commercial purpose. Bagenal *et al.* and Tesch (1971) cited in Sedagnat (2013) stated that the parameters of the fish, length and weight relationship are affected by a series of factors including season, habitat, gonad maturity, sex, diet, stomach fullness, health and preservation techniques.

In the present study, the eggs of *C. intha* were observed at the roots of the water hyacinth or float loosely at the bottom. The envelope of egg is thick. It is demersal in nature. The eggs of almost all fresh water fishes are attracted to the substratum or are loosely in contact with the bottom. This is a reflection of the fact that protein is the main constituent of fish eggs and protein has a higher specific gravity than fresh water, and demersal eggs have low water content.

The embryonic development of *C. intha* was divided into six periods; zygote, cleavage, blastula, gastrula, segmentation and pharyngula and hatching period. Hatching occurred 71-72 hours after spawning. The newly hatched larva was 5.21 to 0.04 mm in length and surrounding the yolk sac. According to Kimmel *et al.,* 1995, Stroban *et al*., 1992, 1995 and Steven *et al*., 1996, 1998 cited in Nica *et al.* (2012) stated that carp embryonic development is more or less similar in nature. Dumitrescu *et al.* (2009) reported that in Zebra fish and common carp, the embryo development characteristics are similar with the described by Kimmel *et al.* (1995).

In present study, after 8 days of hatching the larvae reached the fry stage. After four week; the fry increased in length to 18-23 mm, with distinct dorsal, anal, ventral and pectoral fin and the body entirely covered by scales and appeared similar to an adult. In present study the result denotes that hatching and larval development occurred in water temperature 24°C-26°C that is normal temperature of water in Inle Lake. Ghosh *et al.* (2012) found that 72-73 hours are needed for hatching Koi crap eggs at the temperature of 26°C-28°C. Kuo *et al.,* 1973; Liao, 1975 reported the incubation period of egg and larval development depends largely on water quality parameters such as salinity and temperature.

Culture of fingerlings is very important in culture-based fishes because survival rate of fingerling declined within the culture period. Consequently, culture based fishery and most aquaculture did not produce adequate number of fingerlings. Moreover, stocking density also affected on yield of fingerlings in mass production. Thus present study with four different stocking densities (3,5,7 and 9 ind./m^2) revealed the best growth performance. The optimum stocking density was found to be

5 ind/m^2. Stocking density caused negative effects on fish growth, so that culture is density dependent. Thus, lower growth in higher stocking densities was found in the present study. However, the higher biomass was found in higher stocking density. Smith *et al.* (1978) reported that stocking density is one of the most important factors affecting growth, yield and survival of culture fish.

Growth rate is one of the most important parameters determining the economic efficiency of commercial fish culture, which influenced by several biotic and abiotic factors (Brett and Graves, 1979; cited in Das *et al.*, 2005). In present study, polyculture was used to examine the growth rate of *C. intha* with other cyprinid fish *Catla catla* and *Labeo rohita.* Polyculture or composite fish culture is the system in which fast growing compatible species with different feeding habits are grown in the same pond (Jhingran, 1975; cited in Chakraborty and Nur, 2012). There is no information on polyculture practice of *C. intha* and other cyprinid fish in this studied area. In this study, three formulated feeds are supplied for the growth of *C. intha, Catla catla* and *L. rohita.* The highest biomass was recorded in the subject of treatment III. The lowest FCR value was also revealed in treatment III. De Silva and Davy (1992) cited by Chakraborty and Nur (2012) stated that digestibility plays an important role in lowering the FCR values by efficient utilization of food. The FCR values of different treatments were acceptable and indicated better food utilization, which agreed with Das and Ray (1989), Reddy and Katro (1979) and Islam (2002). Polyculture of *C. intha* with treatments III can be recommended for fish production and may also be helpful in protecting *C. intha* from extinction.

Inle carp *C. intha* has been considered to be an endangered species in IUCN Red List 2011. *Cyprinus intha* is affected by over fishing and increased sedimentation and eutrophication from expanding agriculture around the margins of the lake. The species is also impacted (competition and hybridization) imposed by the introduction of other *Cyprinus* species. During the present study, it was found that there is decreased seed production, leading to the decrease in fish population. It was observed that the main reasons for the decrease of seed production are: (1) according to gonadosomatic index, the spawning season of *C. intha* fall between December and March when water temperature ranged from 24°C-26°C. It is known that temperature directly affects the growth of fish, food intake, metabolism and nutrional efficiency

(Brett, 1979; Burel *et al.,* 1996 and Smith, 1989; cited in Das, 2005), (2) the duration for growth of fry and fingerling is between February and May in nature, the warmest months in Myanmar, resulting in the raising up of water temperature. Because of the weather changes and the deposit of silt and sediment, the water level of Inle Lake become lower having great effects on the water depth which may be one of the limiting factor for the fingerlings, (3) some exotic species like tilapia and common carps were negatively impact on adhesive eggs of *C.intha* that attached at submerged plants (4) the weeds and submerged plants become bountiful, making the growth of fry and fingerling difficult.

The results of the present study indicated that there is an urgent need to maintain the habitat of *Cyprinus intha* to be environmentally friendly for the species to thrive successfully, if not one of our natural assets of Inle Lake, an endemic species may disappeared, eventually it might even lead them to extinction.

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APPENDICES

Appendix 1

THE REPUBLIC OF THE UNION OF MYANMAR
MINISTRY OF LIVESTOCK & FISHERIES
DEPARTMENT OF FISHERIES
FISH INSPECTION AND QUALITY CONTROL DIVISION
YANGON, MYANMAR
ANALYTICAL LABORATORY SECTION

TEST REPORT

Our Reference:

Report Date : 15.2.2013
Sender's Name : U Myo Min Hlaing
Address : Department of Fisheries , Mandalay Region
Attention :
Date Received : 2.2.2013
Sample Description :
Date Analyzed : 3.2.2013
RESULTS : On analysis, the following result was obtained:

Proximate analysis %	Moisture	Crude Protein	Total Fat	Total Ash
Cow Manure (MMH)	18.25	10.39	nil	48.5
Rice Polish (MMH)	10.97	6.16	11.96	12.5
Maize grain(MMH)	13.3	9.96	3.9	2.0
Pea nut oil cake(MMH)	5.2	48.71	11.97	7.5
Fishmeal(MMH)	8.3	60.47	6.4	22.0
Maize grain (200)g	14.3	6.05	4.2	2.0
Fishmeal (50)	8.4	58.99	5.9	23.0
Pea nut oil cake (500)	5.1	45.03	10.5	7.5
Rice Polish (250)g	5.71	9.84	12.3	11.5

Analysed by

Moe Thu Zar
In-charge of Nutrition Lab
Chemical Laboratory

Approved by

Thet Naing
Head of Chemical Laboratory
Analytical Laboratory Section
Department of Fisheries

Appendix 2

ANOVA

Monthly increase in weight gain (g) of *Labeo rohita* under differents

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21164.640	7	3023.520	10.791	.000
Within Groups	4483.065	16	280.192		
Total	25647.705	23			

Multiple Comparisons

Monthly increase in weight gain (g) of *Labeo rohita* under different

LSD

(I) month	(J) month	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
June	July	-64.79000*	13.66727	.000	-93.7633	-35.8167
	August	-12.41667	13.66727	.377	-41.3900	16.5567
	September	1.54333	13.66727	.911	-27.4300	30.5167
	October	20.66667	13.66727	.150	-8.3067	49.6400
	November	20.70333	13.66727	.149	-8.2700	49.6767
	December	30.04667*	13.66727	.043	1.0733	59.0200
	January	32.25000*	13.66727	.031	3.2767	61.2233
July	June	64.79000*	13.66727	.000	35.8167	93.7633
	August	52.37333*	13.66727	.001	23.4000	81.3467
	September	66.33333*	13.66727	.000	37.3600	95.3067
	October	85.45667*	13.66727	.000	56.4833	114.4300
	November	85.49333*	13.66727	.000	56.5200	114.4667
	December	94.83667*	13.66727	.000	65.8633	123.8100
	January	97.04000*	13.66727	.000	68.0667	126.0133

August	June	12.41667	13.66727	.377	-16.5567	41.3900
	July	-52.37333*	13.66727	.001	-81.3467	-23.4000
	September	13.96000	13.66727	.322	-15.0133	42.9333
	October	33.08333*	13.66727	.028	4.1100	62.0567
	November	33.12000*	13.66727	.028	4.1467	62.0933
	December	42.46333*	13.66727	.007	13.4900	71.4367
	January	44.66667*	13.66727	.005	15.6933	73.6400
September	June	-1.54333	13.66727	.911	-30.5167	27.4300
	July	-66.33333*	13.66727	.000	-95.3067	-37.3600
	August	-13.96000	13.66727	.322	-42.9333	15.0133
	October	19.12333	13.66727	.181	-9.8500	48.0967
	November	19.16000	13.66727	.180	-9.8133	48.1333
	December	28.50333	13.66727	.053	-.4700	57.4767
	January	30.70667*	13.66727	.039	1.7333	59.6800
October	June	-20.66667	13.66727	.150	-49.6400	8.3067
	July	-85.45667*	13.66727	.000	-114.4300	-56.4833
	August	-33.08333*	13.66727	.028	-62.0567	-4.1100
	September	-19.12333	13.66727	.181	-48.0967	9.8500
	November	.03667	13.66727	.998	-28.9367	29.0100
	December	9.38000	13.66727	.502	-19.5933	38.3533
	January	11.58333	13.66727	.409	-17.3900	40.5567
November	June	-20.70333	13.66727	.149	-49.6767	8.2700
	July	-85.49333*	13.66727	.000	-114.4667	-56.5200
	August	-33.12000*	13.66727	.028	-62.0933	-4.1467
	September	-19.16000	13.66727	.180	-48.1333	9.8133
	October	-.03667	13.66727	.998	-29.0100	28.9367
	December	9.34333	13.66727	.504	-19.6300	38.3167
	January	11.54667	13.66727	.411	-17.4267	40.5200

December	June	-30.04667*	13.66727	.043	-59.0200	-1.0733
	July	-94.83667*	13.66727	.000	-123.8100	-65.8633
	August	-42.46333*	13.66727	.007	-71.4367	-13.4900
	September	-28.50333	13.66727	.053	-57.4767	.4700
	October	-9.38000	13.66727	.502	-38.3533	19.5933
	November	-9.34333	13.66727	.504	-38.3167	19.6300
	January	2.20333	13.66727	.874	-26.7700	31.1767
January	June	-32.25000*	13.66727	.031	-61.2233	-3.2767
	July	-97.04000*	13.66727	.000	-126.0133	-68.0667
	August	-44.66667*	13.66727	.005	-73.6400	-15.6933
	September	-30.70667*	13.66727	.039	-59.6800	-1.7333
	October	-11.58333	13.66727	.409	-40.5567	17.3900
	November	-11.54667	13.66727	.411	-40.5200	17.4267
	December	-2.20333	13.66727	.874	-31.1767	26.7700

*. The mean difference is significant at the 0.05 level.

Appendix 3

ANOVA

Monthly Weight Gain (g) of *Catala catala* under different treatments

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8372.699	7	1196.100	26.819	.000
Within Groups	713.580	16	44.599		
Total	9086.279	23			

Multiple Comparisons

Monthly Weight Gain (g) of *Catala catala* under different treatments

LSD

					95% Confidence Interval	
(I) Month	(J) Month	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
June	July	-8.92333	5.45275	.121	-20.4827	2.6360
	August	-8.08333	5.45275	.158	-19.6427	3.4760
	September	4.37333	5.45275	.434	-7.1860	15.9327
	October	25.12667*	5.45275	.000	13.5673	36.6860
	November	37.37333*	5.45275	.000	25.8140	48.9327
	December	33.66333*	5.45275	.000	22.1040	45.2227
	January	34.91667*	5.45275	.000	23.3573	46.4760
July	June	8.92333	5.45275	.121	-2.6360	20.4827
	August	.84000	5.45275	.879	-10.7193	12.3993

	September	13.29667*	5.45275	.027	1.7373	24.8560
	October	34.05000*	5.45275	.000	22.4907	45.6093
	November	46.29667*	5.45275	.000	34.7373	57.8560
	December	42.58667*	5.45275	.000	31.0273	54.1460
	January	43.84000*	5.45275	.000	32.2807	55.3993
August	June	8.08333	5.45275	.158	-3.4760	19.6427
	July	-.84000	5.45275	.879	-12.3993	10.7193
	September	12.45667*	5.45275	.036	.8973	24.0160
	October	33.21000*	5.45275	.000	21.6507	44.7693
	November	45.45667*	5.45275	.000	33.8973	57.0160
	December	41.74667*	5.45275	.000	30.1873	53.3060
	January	43.00000*	5.45275	.000	31.4407	54.5593
September	June	-4.37333	5.45275	.434	-15.9327	7.1860
	July	-13.29667*	5.45275	.027	-24.8560	-1.7373
	August	-12.45667*	5.45275	.036	-24.0160	-.8973
	October	20.75333*	5.45275	.002	9.1940	32.3127
	November	33.00000*	5.45275	.000	21.4407	44.5593
	December	29.29000*	5.45275	.000	17.7307	40.8493
	January	30.54333*	5.45275	.000	18.9840	42.1027
October	June	-25.12667*	5.45275	.000	-36.6860	-13.5673
	July	-34.05000*	5.45275	.000	-45.6093	-22.4907
	August	-33.21000*	5.45275	.000	-44.7693	-21.6507
	September	-20.75333*	5.45275	.002	-32.3127	-9.1940
	November	12.24667*	5.45275	.039	.6873	23.8060
	December	8.53667	5.45275	.137	-3.0227	20.0960

	January	9.79000	5.45275	.091	-1.7693	21.3493
November	June	-37.37333*	5.45275	.000	-48.9327	-25.8140
	July	-46.29667*	5.45275	.000	-57.8560	-34.7373
	August	-45.45667*	5.45275	.000	-57.0160	-33.8973
	September	-33.00000*	5.45275	.000	-44.5593	-21.4407
	October	-12.24667*	5.45275	.039	-23.8060	-.6873
	December	-3.71000	5.45275	.506	-15.2693	7.8493
	January	-2.45667	5.45275	.658	-14.0160	9.1027
December	June	-33.66333*	5.45275	.000	-45.2227	-22.1040
	July	-42.58667*	5.45275	.000	-54.1460	-31.0273
	August	-41.74667*	5.45275	.000	-53.3060	-30.1873
	September	-29.29000*	5.45275	.000	-40.8493	-17.7307
	October	-8.53667	5.45275	.137	-20.0960	3.0227
	November	3.71000	5.45275	.506	-7.8493	15.2693
	January	1.25333	5.45275	.821	-10.3060	12.8127
January	June	-34.91667*	5.45275	.000	-46.4760	-23.3573
	July	-43.84000*	5.45275	.000	-55.3993	-32.2807
	August	-43.00000*	5.45275	.000	-54.5593	-31.4407
	September	-30.54333*	5.45275	.000	-42.1027	-18.9840
	October	-9.79000	5.45275	.091	-21.3493	1.7693
	November	2.45667	5.45275	.658	-9.1027	14.0160
	December	-1.25333	5.45275	.821	-12.8127	10.3060

*. The mean difference is significant at the 0.05 level.

Appendix 4

ANOVA

Monthly Weight Gain (g) of *Cyprinus intha* under different treatments

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4485.601	7	640.800	11.328	.000
Within Groups	905.075	16	56.567		
Total	5390.677	23			

Multiple Comparisons

Monthly Weight Gain (g) of Cyprinus intha under different treatments

LSD

(I) Month	(J) Month	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
June	July	-5.92000	6.14097	.349	-18.9383	7.0983
	August	-20.38000*	6.14097	.004	-33.3983	-7.3617
	September	1.62333	6.14097	.795	-11.3949	14.6416
	October	3.58000	6.14097	.568	-9.4383	16.5983
	November	17.99667*	6.14097	.010	4.9784	31.0149
	December	22.66333*	6.14097	.002	9.6451	35.6816
	January	19.58000*	6.14097	.006	6.5617	32.5983
July	June	5.92000	6.14097	.349	-7.0983	18.9383
	August	-14.46000*	6.14097	.032	-27.4783	-1.4417
	September	7.54333	6.14097	.237	-5.4749	20.5616
	October	9.50000	6.14097	.141	-3.5183	22.5183

	November	23.91667*	6.14097	.001	10.8984	36.9349
	December	28.58333*	6.14097	.000	15.5651	41.6016
	January	25.50000*	6.14097	.001	12.4817	38.5183
August	June	20.38000*	6.14097	.004	7.3617	33.3983
	July	14.46000*	6.14097	.032	1.4417	27.4783
	September	22.00333*	6.14097	.002	8.9851	35.0216
	October	23.96000*	6.14097	.001	10.9417	36.9783
	November	38.37667*	6.14097	.000	25.3584	51.3949
	December	43.04333*	6.14097	.000	30.0251	56.0616
	January	39.96000*	6.14097	.000	26.9417	52.9783
September	June	-1.62333	6.14097	.795	-14.6416	11.3949
	July	-7.54333	6.14097	.237	-20.5616	5.4749
	August	-22.00333*	6.14097	.002	-35.0216	-8.9851
	October	1.95667	6.14097	.754	-11.0616	14.9749
	November	16.37333*	6.14097	.017	3.3551	29.3916
	December	21.04000*	6.14097	.003	8.0217	34.0583
	January	17.95667*	6.14097	.010	4.9384	30.9749
October	June	-3.58000	6.14097	.568	-16.5983	9.4383
	July	-9.50000	6.14097	.141	-22.5183	3.5183
	August	-23.96000*	6.14097	.001	-36.9783	-10.9417
	September	-1.95667	6.14097	.754	-14.9749	11.0616
	November	14.41667*	6.14097	.032	1.3984	27.4349
	December	19.08333*	6.14097	.007	6.0651	32.1016
	January	16.00000*	6.14097	.019	2.9817	29.0183
November	June	-17.99667*	6.14097	.010	-31.0149	-4.9784

	July	-23.91667*	6.14097	.001	-36.9349	-10.8984
	August	-38.37667*	6.14097	.000	-51.3949	-25.3584
	September	-16.37333*	6.14097	.017	-29.3916	-3.3551
	October	-14.41667*	6.14097	.032	-27.4349	-1.3984
	December	4.66667	6.14097	.458	-8.3516	17.6849
	January	1.58333	6.14097	.800	-11.4349	14.6016
December	June	-22.66333*	6.14097	.002	-35.6816	-9.6451
	July	-28.58333*	6.14097	.000	-41.6016	-15.5651
	August	-43.04333*	6.14097	.000	-56.0616	-30.0251
	September	-21.04000*	6.14097	.003	-34.0583	-8.0217
	October	-19.08333*	6.14097	.007	-32.1016	-6.0651
	November	-4.66667	6.14097	.458	-17.6849	8.3516
	January	-3.08333	6.14097	.622	-16.1016	9.9349
January	June	-19.58000*	6.14097	.006	-32.5983	-6.5617
	July	-25.50000*	6.14097	.001	-38.5183	-12.4817
	August	-39.96000*	6.14097	.000	-52.9783	-26.9417
	September	-17.95667*	6.14097	.010	-30.9749	-4.9384
	October	-16.00000*	6.14097	.019	-29.0183	-2.9817
	November	-1.58333	6.14097	.800	-14.6016	11.4349
	December	3.08333	6.14097	.622	-9.9349	16.1016

*. The mean difference is significant at the 0.05 level.

Appendix 5

ANOVA

Monthly increase in average body weight (g) *Labeo.rohita* under different treatments

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	153140.211	7	21877.173	22.304	.000
Within Groups	15693.518	16	980.845		
Total	168833.729	23			

Multiple Comparisons

Monthly increase in average body weight (g) *Labeo.rohita* under different treatments

LSD

(I) Month	(J) Month	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
June	July	-68.16667*	25.57140	.017	-122.3756	-13.9577
	August	-125.16667*	25.57140	.000	-179.3756	-70.9577
	September	-168.20667*	25.57140	.000	-222.4156	-113.9977
	October	-191.91333*	25.57140	.000	-246.1223	-137.7044
	November	-215.79333*	25.57140	.000	-270.0023	-161.5844
	December	-230.33000*	25.57140	.000	-284.5390	-176.1210
	January	-242.66333*	25.57140	.000	-296.8723	-188.4544
July	June	68.16667*	25.57140	.017	13.9577	122.3756
	August	-57.00000*	25.57140	.040	-111.2090	-2.7910
	September	-100.04000*	25.57140	.001	-154.2490	-45.8310
	October	-123.74667*	25.57140	.000	-177.9556	-69.5377

	November	-147.62667*	25.57140	.000	-201.8356	-93.4177
	December	-162.16333*	25.57140	.000	-216.3723	-107.9544
	January	-174.49667*	25.57140	.000	-228.7056	-120.2877
August	June	125.16667*	25.57140	.000	70.9577	179.3756
	July	57.00000*	25.57140	.040	2.7910	111.2090
	September	-43.04000	25.57140	.112	-97.2490	11.1690
	October	-66.74667*	25.57140	.019	-120.9556	-12.5377
	November	-90.62667*	25.57140	.003	-144.8356	-36.4177
	December	-105.16333*	25.57140	.001	-159.3723	-50.9544
	January	-117.49667*	25.57140	.000	-171.7056	-63.2877
September	June	168.20667*	25.57140	.000	113.9977	222.4156
	July	100.04000*	25.57140	.001	45.8310	154.2490
	August	43.04000	25.57140	.112	-11.1690	97.2490
	October	-23.70667	25.57140	.368	-77.9156	30.5023
	November	-47.58667	25.57140	.081	-101.7956	6.6223
	December	-62.12333*	25.57140	.027	-116.3323	-7.9144
	January	-74.45667*	25.57140	.010	-128.6656	-20.2477
October	June	191.91333*	25.57140	.000	137.7044	246.1223
	July	123.74667*	25.57140	.000	69.5377	177.9556
	August	66.74667*	25.57140	.019	12.5377	120.9556
	September	23.70667	25.57140	.368	-30.5023	77.9156
	November	-23.88000	25.57140	.364	-78.0890	30.3290
	December	-38.41667	25.57140	.152	-92.6256	15.7923
	January	-50.75000	25.57140	.065	-104.9590	3.4590
November	June	215.79333*	25.57140	.000	161.5844	270.0023

	July	147.62667*	25.57140	.000	93.4177	201.8356
	August	90.62667*	25.57140	.003	36.4177	144.8356
	September	47.58667	25.57140	.081	-6.6223	101.7956
	October	23.88000	25.57140	.364	-30.3290	78.0890
	December	-14.53667	25.57140	.578	-68.7456	39.6723
	January	-26.87000	25.57140	.309	-81.0790	27.3390
December	June	230.33000*	25.57140	.000	176.1210	284.5390
	July	162.16333*	25.57140	.000	107.9544	216.3723
	August	105.16333*	25.57140	.001	50.9544	159.3723
	September	62.12333*	25.57140	.027	7.9144	116.3323
	October	38.41667	25.57140	.152	-15.7923	92.6256
	November	14.53667	25.57140	.578	-39.6723	68.7456
	January	-12.33333	25.57140	.636	-66.5423	41.8756
January	June	242.66333*	25.57140	.000	188.4544	296.8723
	July	174.49667*	25.57140	.000	120.2877	228.7056
	August	117.49667*	25.57140	.000	63.2877	171.7056
	September	74.45667*	25.57140	.010	20.2477	128.6656
	October	50.75000	25.57140	.065	-3.4590	104.9590
	November	26.87000	25.57140	.309	-27.3390	81.0790
	December	12.33333	25.57140	.636	-41.8756	66.5423

*. The mean difference is significant at the 0.05 level.

Appendix 6

ANOVA

Monthly increase in average body weight (g) *Catala catala* under different treatments

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	137834.431	7	19690.633	28.773	.000
Within Groups	10949.449	16	684.341		
Total	148783.880	23			

Multiple Comparisons

Monthly increase in average body weight (g) *Catala catala* under different treatments

LSD

(I) Months	(J) Months	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
June	July	-58.54667*	21.35947	.014	-103.8267	-13.2666
	August	-116.25333*	21.35947	.000	-161.5334	-70.9733
	September	-161.50333*	21.35947	.000	-206.7834	-116.2233
	October	-186.00000*	21.35947	.000	-231.2801	-140.7199
	November	-198.25000*	21.35947	.000	-243.5301	-152.9699
	December	-214.21000*	21.35947	.000	-259.4901	-168.9299
	January	-228.91667*	21.35947	.000	-274.1967	-183.6366
July	June	58.54667*	21.35947	.014	13.2666	103.8267
	August	-57.70667*	21.35947	.016	-102.9867	-12.4266
	September	-102.95667*	21.35947	.000	-148.2367	-57.6766
	October	-127.45333*	21.35947	.000	-172.7334	-82.1733
	November	-139.70333*	21.35947	.000	-184.9834	-94.4233

	December	-155.66333*	21.35947	.000	-200.9434	-110.3833
	January	-170.37000*	21.35947	.000	-215.6501	-125.0899
August	June	116.25333*	21.35947	.000	70.9733	161.5334
	July	57.70667*	21.35947	.016	12.4266	102.9867
	September	-45.25000	21.35947	.050	-90.5301	.0301
	October	-69.74667*	21.35947	.005	-115.0267	-24.4666
	November	-81.99667*	21.35947	.001	-127.2767	-36.7166
	December	-97.95667*	21.35947	.000	-143.2367	-52.6766
	January	-112.66333*	21.35947	.000	-157.9434	-67.3833
September	June	161.50333*	21.35947	.000	116.2233	206.7834
	July	102.95667*	21.35947	.000	57.6766	148.2367
	August	45.25000	21.35947	.050	-.0301	90.5301
	October	-24.49667	21.35947	.268	-69.7767	20.7834
	November	-36.74667	21.35947	.105	-82.0267	8.5334
	December	-52.70667*	21.35947	.025	-97.9867	-7.4266
	January	-67.41333*	21.35947	.006	-112.6934	-22.1333
October	June	186.00000*	21.35947	.000	140.7199	231.2801
	July	127.45333*	21.35947	.000	82.1733	172.7334
	August	69.74667*	21.35947	.005	24.4666	115.0267
	September	24.49667	21.35947	.268	-20.7834	69.7767
	November	-12.25000	21.35947	.574	-57.5301	33.0301
	December	-28.21000	21.35947	.205	-73.4901	17.0701
	January	-42.91667	21.35947	.062	-88.1967	2.3634
November	June	198.25000*	21.35947	.000	152.9699	243.5301
	July	139.70333*	21.35947	.000	94.4233	184.9834

	August	81.99667*	21.35947	.001	36.7166	127.2767
	September	36.74667	21.35947	.105	-8.5334	82.0267
	October	12.25000	21.35947	.574	-33.0301	57.5301
	December	-15.96000	21.35947	.466	-61.2401	29.3201
	January	-30.66667	21.35947	.170	-75.9467	14.6134
December	June	214.21000*	21.35947	.000	168.9299	259.4901
	July	155.66333*	21.35947	.000	110.3833	200.9434
	August	97.95667*	21.35947	.000	52.6766	143.2367
	September	52.70667*	21.35947	.025	7.4266	97.9867
	October	28.21000	21.35947	.205	-17.0701	73.4901
	November	15.96000	21.35947	.466	-29.3201	61.2401
	January	-14.70667	21.35947	.501	-59.9867	30.5734
January	June	228.91667*	21.35947	.000	183.6366	274.1967
	July	170.37000*	21.35947	.000	125.0899	215.6501
	August	112.66333*	21.35947	.000	67.3833	157.9434
	September	67.41333*	21.35947	.006	22.1333	112.6934
	October	42.91667	21.35947	.062	-2.3634	88.1967
	November	30.66667	21.35947	.170	-14.6134	75.9467
	December	14.70667	21.35947	.501	-30.5734	59.9867

*. The mean difference is significant at the 0.05 level.

Appendix 7

ANOVA

Monthly increase in average body weight (g) *Cyprinus intha* under different treatments

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	137923.539	7	19703.363	23.314	.000
Within Groups	13522.265	16	845.142		
Total	151445.803	23			

Multiple Comparisons

Monthly increase in average body weight (g) *Cyprinus intha* under different treatments

LSD

(I) Month	(J) Month	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
June	July	-43.41667	23.73663	.086	-93.7361	6.9027
	August	-101.29333*	23.73663	.001	-151.6127	-50.9739
	September	-137.16667*	23.73663	.000	-187.4861	-86.8473
	October	-170.91667*	23.73663	.000	-221.2361	-120.5973
	November	-190.58333*	23.73663	.000	-240.9027	-140.2639
	December	-208.75000*	23.73663	.000	-259.0694	-158.4306
	January	-226.66667*	23.73663	.000	-276.9861	-176.3473
July	June	43.41667	23.73663	.086	-6.9027	93.7361
	August	-57.87667*	23.73663	.027	-108.1961	-7.5573
	September	-93.75000*	23.73663	.001	-144.0694	-43.4306
	October	-127.50000*	23.73663	.000	-177.8194	-77.1806

	November	-147.16667*	23.73663	.000	-197.4861	-96.8473
	December	-165.33333*	23.73663	.000	-215.6527	-115.0139
	January	-183.25000*	23.73663	.000	-233.5694	-132.9306
August	June	101.29333*	23.73663	.001	50.9739	151.6127
	July	57.87667*	23.73663	.027	7.5573	108.1961
	September	-35.87333	23.73663	.150	-86.1927	14.4461
	October	-69.62333*	23.73663	.010	-119.9427	-19.3039
	November	-89.29000*	23.73663	.002	-139.6094	-38.9706
	December	-107.45667*	23.73663	.000	-157.7761	-57.1373
	January	-125.37333*	23.73663	.000	-175.6927	-75.0539
September	June	137.16667*	23.73663	.000	86.8473	187.4861
	July	93.75000*	23.73663	.001	43.4306	144.0694
	August	35.87333	23.73663	.150	-14.4461	86.1927
	October	-33.75000	23.73663	.174	-84.0694	16.5694
	November	-53.41667*	23.73663	.039	-103.7361	-3.0973
	December	-71.58333*	23.73663	.008	-121.9027	-21.2639
	January	-89.50000*	23.73663	.002	-139.8194	-39.1806
October	June	170.91667*	23.73663	.000	120.5973	221.2361
	July	127.50000*	23.73663	.000	77.1806	177.8194
	August	69.62333*	23.73663	.010	19.3039	119.9427
	September	33.75000	23.73663	.174	-16.5694	84.0694
	November	-19.66667	23.73663	.420	-69.9861	30.6527
	December	-37.83333	23.73663	.131	-88.1527	12.4861
	January	-55.75000*	23.73663	.032	-106.0694	-5.4306
November	June	190.58333*	23.73663	.000	140.2639	240.9027

	July	147.16667*	23.73663	.000	96.8473	197.4861
	August	89.29000*	23.73663	.002	38.9706	139.6094
	September	53.41667*	23.73663	.039	3.0973	103.7361
	October	19.66667	23.73663	.420	-30.6527	69.9861
	December	-18.16667	23.73663	.455	-68.4861	32.1527
	January	-36.08333	23.73663	.148	-86.4027	14.2361
December	June	208.75000*	23.73663	.000	158.4306	259.0694
	July	165.33333*	23.73663	.000	115.0139	215.6527
	August	107.45667*	23.73663	.000	57.1373	157.7761
	September	71.58333*	23.73663	.008	21.2639	121.9027
	October	37.83333	23.73663	.131	-12.4861	88.1527
	November	18.16667	23.73663	.455	-32.1527	68.4861
	January	-17.91667	23.73663	.461	-68.2361	32.4027
January	June	226.66667*	23.73663	.000	176.3473	276.9861
	July	183.25000*	23.73663	.000	132.9306	233.5694
	August	125.37333*	23.73663	.000	75.0539	175.6927
	September	89.50000*	23.73663	.002	39.1806	139.8194
	October	55.75000*	23.73663	.032	5.4306	106.0694
	November	36.08333	23.73663	.148	-14.2361	86.4027
	December	17.91667	23.73663	.461	-32.4027	68.2361

*. The mean difference is significant at the 0.05 level.

External Examiner's Report on the Dissertation:

SEED PRODUCTION OF INLE CARP *Cyprinus intha* Annandale, 1918 WITH EMPHASIS ON GROWTH PERFORMANCE IN POLYCULTURE

and the performance in Viva Examination of PhD Candidate

MYO MIN HLAING

4 PhD - Zool – 17

The Dissertation entitled "Seed Production of Inle Carp *Cyprinus intha* Annandale, 1918 with Emphasis on Growth Performance in Polyculture" presented by Myo Min Hlaing is a result of his original work.

The research work was well planned and pursued systematically. The objectives of the thesis, methods and results achieved have been systematically stated. The species *Cyprinus intha* was an endangered species and endemic to the Inle Lake. Experiment on seed production of this species was conducted using induced breeding method. Growth performance of *C. intha* in polyculture system was also investigated. The findings of his research are greatly helpful towards effective wildlife conservation and aquaculture sector. I, therefore, have no hesitation on recommending that the candidate be awarded the Degree of Doctor of Philosophy.

Your's faithfully,

Dr Win Maung
Pro-Rector (Rtd)
University of Sittway

Referee's Report on the Dissertation:

SEED PRODUCTION OF INLE CARP *Cyprinus intha* Annandale, 1918 WITH EMPHASIS ON GROWTH PERFORMANCE IN POLYCULTURE

and the performance in Viva Examination of PhD Candidate

MYO MIN HLAING

4 PhD - Zool – 17

I have examined the Thesis entitled "Seed Production of Inle Carp *Cyprinus intha* Annandale, 1918 with Emphasis on Growth Performance in Polyculture". Inle Carp is an endemic species of Inle lake due to massive human intervention in the lake, the once abundant and staple food species of the Inthas is noted on an endanger list of IUCN. The research is timely and artificial propagation techniques reported here can be utilized to bring back the Inle carp to its former status. The Thesis was well researched and documented. I therefore recommend that Myo Min Hlaing be award the Degree of Doctor of Philosophy in Zoology, by this University

Dr Swe Thwin
Professor (Head of Department) (Rtd)
Department of Marine Science
University of Mawlamyine