A guide to larvae and juveniles of some common fish species from the Mekong River Basin

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Figure 1. Fish larvae sampling net being retrieved from the Mekong River upstream of Vientiane
Summary

The Mekong River Basin has one of the world’s richest fish faunas, with about 850 species now recorded. While guidebooks are available for the identification of adult or sub-adult fish, there is very little published information on early life-stages. This guidebook provides descriptions and illustrations for larval and juvenile stages of 64 indigenous Mekong fishes, most of which are important in fisheries and some of which have high conservation significance, as well as one exotic species.

The guides for each species include hand-drawn figures of the stages of development of each species from early larvae, through pre-larvae and post-larvae to juvenile fish. The descriptions and tabulations cover important diagnostic features, including morphology, meristics and pigmentation. The guide also summarises some basic information on classification, size, ecology, biology and conservation status for each species.

The book will be useful for anyone involved in monitoring or surveys of the Mekong basin’s fishes. Accurate identification is required in all ichthyological studies. In many studies, for example of migration and spawning, it is particularly important to be able to identify larvae and juveniles. This guide will also support those involved in applied research, such as on the impacts of hydroelectric and irrigation dams on fish spawning and recruitment, as well as in aquaculture and other fields. Much basic work will be facilitated by the availability of this manual and it is hoped that many similar guidebooks will be produced to enhance the quality of research on Mekong fisheries.

KEY WORDS: Mekong River Basin; fish larvae; fisheries.

Figure 2. A typical tray of fish larvae prior to sorting from debris
Abbreviations and acronyms

For technical terms refer to Figures 4 to 10 and the Glossary.

FAO Food & Agriculture Organisation of the United Nations
IUCN International Union for the Conservation of Nature
LMB Lower Mekong Basin
max. maximum
min. minimum
MRC Mekong River Commission
MRCS Mekong River Commission Secretariat
PDR People’s Democratic Republic
SL Standard Length (of a fish)
TL Total Length (of a fish)
WWF World Wide Fund for Nature

The tables on meristics and morphometrics of larvae and juveniles use the following abbreviations.

DFC Dorsal Fin Count
AFC Anal Fin Count
P1 FC Pectoral Fin Count
P2 FC Pelvic Fin Count
MC Myomere Count

Ratio between HL:SL Ratio between Head Length: Standard Length
Ratio between SnL-DF:SL Ratio between Snout Length - Dorsal Fin: Standard Length
Ratio between SnL-AF:SL Ratio between Snout Length - Anal Fin: Standard Length
Ratio between SnL-P2 F:SL Ratio between Snout Length - Pelvic Fin: Standard Length
Figure 3. Map of the Lower Mekong River Basin
Introduction

The Mekong River originates in China in the upper Mekong Basin, then flows through five other countries (Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam) in the Lower Mekong Basin to discharge to the South China Sea. It is one of the world’s largest river systems, with a catchment area of about 795,000 km$^2$ and a mean annual discharge of about 475 km$^3$ (MRC, 2010). The Mekong River basin supports one of the world’s largest inland capture fisheries, a resource that provides food and livelihoods for millions of people (MRC, 2010). Maintaining the productivity of the system requires a good understanding of fishes’ life cycles, their migratory habits, as well as their dependence on different habitats at different stages in their lives.

Accurate identification of fish species at all stages from larva to adult is necessary to support the ichthyological studies which provide basic information for management. Several guides have been recently published for the identification of the adult or sub-adult stages of fishes of the Mekong Basin (e.g. Kottelat, 2001; Rainboth, 1996 and Vidthayanon, 2008). By contrast, there is little or no published information to assist in identification of larvae or juveniles, as is the case generally for fishes of inland tropical waters. Existing regional guides to larvae and juveniles (e.g. Leis and Carson-Ewart, 2000) cover mainly marine species, so they are useful only for identifying some of the coastal fishes that penetrate inland waters, or for identifying to family level some freshwater representatives of marine fish families. There are about 850 fish species recorded from the Mekong basin, and about two thirds of these (including most of the common species) are from purely freshwater families (Hortle, 2009), so there is a very large gap in the information that can be used to identify larvae and juveniles of Mekong basin fishes.

The Mekong River Commission has actively sponsored basin-wide fisheries research since the mid-1990s, including local ecological knowledge surveys, logbook monitoring of fisher catches, household surveys, catch assessment surveys, sampling of larvae and juveniles and research on aquaculture of indigenous species. The results have been widely publicized and as a result the importance of fisheries in the Mekong basin is now well-recognised. At the same time, many counterpart staff from the fisheries agencies of the Lower Mekong Basin countries have been trained, including in identification of fish larvae and juveniles. This guidebook includes in a systematic form much of the diagnostic information used during the MRC-sponsored studies of larvae and juveniles.

This guide is primarily the result of studies by Dr Apichart Termvidchakorn based on samples of fish collected in the Mekong basin in Cambodia, Thailand and Viet Nam. For each species, a series of specimens at various stages was built up, and then for each stage the important diagnostic features were measured and/or counted, and drawings were made of each stage to provide a representation of a typical fish at that stage. For most species, a series of specimens was also obtained from aquaculture fish for which the identity was certain so that there would be no doubt as to the identity of the immature stages. Measurements of smaller specimens or characters (< 1 cm) were made using an eyepiece micrometer (accurate to 0.01 mm), and to measure larger specimens or characters (> 1 cm) a dial calliper (accurate to 0.1 mm) was used. Drawings were made using a camera lucida where necessary to ensure accurate depictions of shape and proportion.
This publication covers 64 species known from the basin, as well as one introduced species. It is intended to be the first in a series of publications on the larvae and juveniles of Mekong basin fishes. The guide is expected to be widely used in the Mekong basin for ichthyological research, which is expected to become increasingly important as the basin becomes more developed. In particular, information is needed to manage the impacts caused by dams that block fish migration pathways and modify rivers.

The study of fish larvae and juveniles is also necessary in development of aquaculture and in many other applied research fields. The Mekong is a regional hotspot for biodiversity, and several of the fish featured in this guide are listed on the IUCN Red List of threatened species; these are the giant barb, *Catlocarpio siamensis* (listed as critically endangered in 2006 but not currently listed), Jullien’s barb, *Probarbus jullieni* (endangered) and Bocourt’s catfish, *Mystus bocourti* (vulnerable). Unfortunately, as a result of lack of basic research, the conservation status of most of the species covered in this manual and many more Mekong species cannot be evaluated at present, highlighting the need for manuals of this type to support basic research.

All information contained in this publication and more is available in electronic format in the Mekong Fish Database 2003 (MRC, 2003) available from the Mekong River Commission Secretariat. Various guides to fish larvae in Thai language are produced by the senior author and colleagues (e.g. Piamthipmanus et al., 2004; Termvidchakorn, 2003, 2005; Termvidchakorn et al., 2005). Reports on fish distribution with various biological observations are also published regularly in Thai language (e.g. Tungmas et al., 2004).

**Fish reproduction and development**

Fish have a wide array of reproductive behaviours, but they can be broadly classed as (1) non-guarders, (2) guarders or (3) bearers, as summarised in Moyle and Cech (2004). The majority of Mekong species are non-guarders, i.e. after their eggs are spawned they are not protected by the parents. Within this group, Mekong fishes may be classed as pelagic or benthic (demersal) spawners.

Some of the common lowland river fishes spawn pelagic eggs, which can drift with rising waters. Pelagic eggs are buoyant or semi-buoyant as they contain oil globules and have high water content. Pelagic eggs are very small (about 0.5–1.2 mm diameter when spawned) and typically hatch within 1–2 days. The newly hatched larvae continue to drift with the current as they develop. Most species spawn early in the flood season when the eggs and larvae may drift with the rising waters to colonise floodplains where food is abundant. However, there are risks; pelagic spawned eggs may be eaten by predators while they are drifting or may be dispersed into unfavourable environments.

Many Mekong species, including most catfishes and cyprinids, are benthic spawners, i.e. the eggs are deposited on the substrate or on submerged plants, including on tree trunks or bushes, as well as on snags or rocks, thereby reducing the predation and dispersal risk incurred by pelagic spawners. Demersal eggs are usually adhesive, so they tend to stick to the surface where they are laid. They may be laid in long strings or wrapped around objects, or may drop into crevices in the substrate. Fish eggs absorb water and swell after they are laid, so benthic eggs (after swelling) tend to become wedged into place. However, fine sediment may adhere to eggs to produce aggregates, which are more likely to become suspended and drift with the current. Benthic eggs tend to be larger (typically 1-3 mm diameter when spawned) than pelagic eggs. After hatching, the larvae may remain benthic and stay
near the spawning locale, or they may become pelagic and drift with the current. Many mainstream fish are benthic spawners, and benthic spawning is also common among floodplain spawners and in some tributary fishes that are relatively non-migratory (e.g. Tor spp.).

Guarders are so-called because the eggs and/or young are guarded by one or both of the parents. They produce relatively few eggs which are larger than those of non-guarders. In the Mekong system, guarders include featherbacks (Notopteridae), snakeheads (Channidae) and gouramies (Betta spp. and Osphronemus spp.).

Bearers are fish that carry eggs on or in their bodies during development. In the Mekong system bearers include Aribid catfishes, in which the male parent broods the eggs in his mouth until after hatching, and rice-fishes (Oryzias spp.), in which the fertilised eggs are carried internally or externally (between the pelvic fins) by the female before being laid on vegetation at an advanced stage of development.

Each species description in this manual includes notes on the basic breeding ecology of each species, which can be updated from FishBase (www.fishbase.org). When considered with environmental data (on flow rates and habitats), as well as estimates of the likely age of specimens, field workers may be able to draw some conclusions about the likely time and place of spawning of the fishes. For example, pelagic eggs are likely to drift downstream immediately after spawning, whereas benthic adhesive eggs are more likely to remain where they are spawned until they hatch.

Although some inferences may be drawn based on the sampling location and stage of development of the early life stages of fishes, little is known about the distribution of fish larval drift within river channels in this region, so it should not be assumed that larvae drift passively with the current. Rather, as they develop they may move vertically or laterally in the water column, resting at times on the bed or edges. Much research still needs to be pursued in this area.

**Development of fish**

Fish pass through several stages and change greatly in size and appearance as they develop from an egg to an adult. There are many variations in schemes used to classify the early life stages of fish. The simple scheme referred to in this manual follows the nomenclature developed by several earlier workers (Hubbs, 1943; Balon, 1975; Russell, 1976 and Kendal et al., 1984). It should be noted that some species do not develop through the stages precisely as described below. For example, longtoms (Xenentodon spp.), half-beaks (Hemiramphus spp.) and rice-fishes (Oryzias spp.) develop for an extended period within the egg, so that when they hatch they are already at a post-larval stage.

Note that the term ‘fry’ is widely used to refer to advanced larvae or juveniles.

1. *Egg, embryonic phase or incubation period*

This phase covers the period from fertilisation to hatching of the egg. During incubation, the embryo cannot feed, but is nourished by the egg yolk and other food stores. The embryo’s cells divide and differentiate to produce body somites (forerunners of muscle blocks), a beating heart and circulatory system and various other organs or their precursors. Hatching involves the breaking of the chorionic membrane or ‘egg shell’, usually by thrashing movements of the embryo’s tail and body, to release the larva.
2. The larval phase

This phase covers the period from hatching up to the time the fish is a juvenile. The larval phase can be divided into three stages.

- **Yolk-sac stage:** after hatching the larva has a yolk sac, which is visibly attached to the antero-ventral part of its body. During this phase the fish is nourished by yolk while the main body parts and sensory systems develop; these include the mouth, gut, anus, eyes and primordial fins or anlages.

- **Pre-larval stage:** this stage begins when the eye is fully pigmented and the mouth and anus are open and the fish begins to feed on external prey. In pre-larvae, the vertebral column terminates in a urostyle, a long unsegmented rod-shaped bone, which represents a number of fused vertebrae. During this stage, the urostyle begins to flex upwards and the caudal fin rays begin to develop.

- **Post-larval stage:** during this stage, the urostyle completes upward flexion, the caudal, dorsal and anal fins develop, and the small fish begins to resemble a juvenile. This stage ends when the larva has undergone metamorphosis (some species) or when its pelvic fins have developed.

3. Juvenile phase or stage

A juvenile fish is one in which all organs (except the gonads) are functioning. The fish gradually assumes the full adult shape as it grows. Certain parts of the fish may increase in number as the fish grows, for example, the number of scales or gill rakers.

4. Adult phase

An adult fish is one that has all organs functioning, including mature or maturing gonads.

Terminology

The main features used in describing fish larvae and juveniles are discussed below, with reference to developmental phases as appropriate. Figures 4 to 10 illustrate the position and shape of the main diagnostic features mentioned in the guide.

*Myomeres*

Myomeres are blocks of skeletal muscle. Myomere counts are expressed as those anterior to and posterior to (pre- and post-) the anus. Myomere counts in older specimens are often equivalent to vertebral counts.
Introduction

Gut

All fish have a rudimentary straight gut (alimentary canal) as pre-larvae, when most fish feed on easily digestible microscopic zooplankton. The gut folds or coils as the digestive tract develops and as the diet changes, with the timing and shape differing between species. The anus tends to move closer to the head as a fish develops and its position is a useful diagnostic feature.

Gas bladder

By the pre-larval stage, most species develop a visible gas bladder, whose shape, size and position may be useful characteristics for identification. The larvae of Clupeiformes and Gobiidae always have visible swim-bladders. As a fish develops it becomes more opaque, so that as a juvenile or adult its gas bladder is usually not visible. A few fishes (e.g. glass perchlets *Ambassid spp.*) are transparent as adults, but once fixed in formaldehyde their internal features are not visible.

Head spination

Some fish larvae have on their head and operculum spines which are important as armour against predators. Spination is useful diagnostically for most marine fishes that have pelagic larvae. Spines are present on the pre-larvae of all Perciformes (perch-like fishes). In this manual, spines are important diagnostically for Lobotidae (head spines) and for Cobitidae (spines below the eye).

Eyes

All of the fish larvae in this guide have round eyes except for some Clupeoid larvae which have oval eyes. Most early pre-larvae (i.e. immediately post-hatching) have no pigment in their eyes; the pigment appears later, typically after one day. In some families, (Belonidae and Adrianichthyidae) development is to an advanced stage in the egg, so that when the fish hatches it is a post-larva in which the eyes are already developed and densely pigmented.

Fin formation

The size and position of fins and the number of spines and rays are diagnostically important. The median fins (dorsal, caudal and anal) begin to form from a finfold which is present in the pre-larva; dorsal and anal fins first begin to differentiate as anlagen, which are the bud-shaped initial clustering of embryonic cells from which a body part or an organ develops. The paired fins (pectoral and pelvic) develop later than the median fins. The pectoral fins become visible in pre-larvae and begin to develop their spines and rays at the late post-larval stage. Pelvic fins usually develop last. Where fin spines are present they develop before fin rays.
Meristics

Meristics refers to counts of features and the most important are shown for each fish as follows.

- DFC - Dorsal fin ray count
- AFC - Anal fin ray count
- PFC - Pectoral fin ray count
- P,FC - Pelvic fin ray count

Note: for each fin, the number of spines is denoted by Roman numerals and the number of rays by normal numbers. For example, a fin with one spine and six rays is denoted as I, 6.

- MC - Myomere count

Morphometrics

Morphometrics refers to measurements that relate to the shape of the fish, which changes as it grows. Body lengths are expressed in this guide in mm (millimetres) as total length or as standard length, as shown in Figure 4.

The approximate total length is noted next to each developmental stage, together with its typical age in days. Standard length is used for morphometric tables because total length cannot be accurately measured if fins are damaged. Important measurements are shown in Figure 4 as follows.

- Sn-DF - Snout to dorsal fin origin
- Sn-AF - Snout to anal fin origin
- Sn-P,2F - Snout to pelvic fin origin

Pigmentation

The extent, position and shape of pigmentation are important diagnostically. Many fish have internal pigments as post-larvae, with external pigmentation developing later. Colours are lost during fixation so only melanophores (pigment-producing cells) and black pigmentation (melanin) are shown on the drawings. Figure 10 shows the terminology used in the descriptions of pigmentation.
Figure 4  Morphology and characteristics of yolk-sac larva, early post-larva, late post-larva and juvenile
Figure 5  Position of fish barbels (Rainboth, 1996)

Figure 6  Form of fish teeth (Rainboth, 1996)

Figure 7  Types of fish scales (Rainboth, 1996)

Figure 8  Types of fish mouths (Rainboth, 1996)
**Figure 9** Types of fish tails (Rainboth, 1996)

- Rounded
- Truncate
- Emarginate
- Lunate
- Forked
- Pointed and Continuous with Dorsal and Anal Fin
- Pointed and Separated from Dorsal and Anal Fin

**Figure 10** Terms used in describing melanophore pigmentation and fin structure of fish larvae

- Dorsal or ventral double body contour
- Single body contour
- Along fin ray
- Interspine base
- Dorsal or Anal Fin
- Fin ray base
- Pectoral Fin
- Radial
- Marginal
- Caudal Fin
- Epural
- On fin
- Hypural
- Pelvic fin
- Web
- Punctate
- Stellate
- Branched
- Melanophores

Swim Bladder (internal)
**Notopterus notopterus**

Adult *Notopterus notopterus* (Pallas, 1769)
Bronze featherback, reproduced from Chevey and Le Poulain, 1940.

A crepuscular, omnivorous species found in standing and sluggish water from the Mekong Delta to at least as far upstream as Chiang Saen. It undertakes localised lateral migrations from the main river to floodplains during the flood season. At several places it is reported to move into tributaries during the flood season. It carries eggs in May and June, and is reported to spawn from May to August; the eggs are laid in small clumps on submerged vegetation in seasonally inundated areas, although it may breed in both riverine and standing water habitats. It is sexually mature at a weight of 250 g; a female measuring 21–25 cm usually lays 1,200–3,000 eggs. It is an important commercial food fish and is caught by seines, lift-nets, weirs and barrages. It can reach 60 cm in length and is commonly about 25 cm.

*Main references:* Baird and Phylavanh, 1999; Bardach, 1959; Kottelat, 1998; Poulsen *et al*., 2004; Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | 7   | 7   | 7    |
| Anal Fin Count           | 92  | 92  | 92   |
| Pectoral Fin Count       | 10  | 8   | 9    |
| Myomere Count            | 75  | 70  | 72   |
| Ratio between HL:SL      | 0.31| 0.31| 0.31 |
| Ratio between Sn-DF:SL   | 0.54| 0.54| 0.54 |
| Ratio between Sn-AF:SL   | 0.33| 0.33| 0.33 |
| Ratio between Sn-P,F:SL  | 0.3 | 0.3 | 0.3  |

**Ecology**

**Morphological characteristics**

**Pigmentation**

| Yolk-sac larva | Ecology | The yolk-sac is ovoid, with homogenous yolk. No row of pigment on tail. | Melanophores on head and trunk. |
|----------------|---------|------------------------------------------------------------------|-------------------------------|
| Pre-larva      | Develops in swamps; feeds on zooplankton. | Compressed body with large terminal mouth and a triangular-shaped gut; 70–75 myomeres and 14–18 pre-anal myomeres; no spines on head. Short dorsal fin, very long anal fin and very small pelvic fin. | Melanophores on head and trunk in young and old larvae. No pigmentation on peritoneum, pectoral or pelvic fins. |
| Post-larva     | Carnivorous. | Compressed body with large terminal mouth and a triangular shaped gut. Short dorsal fin, very long anal fin. | Melanophores on head and trunk. |
Developmental stages of *Notopterus notopterus* (Pallas, 1769)
Developmental stages of *Notopterus notopterus*
Chitala ornata

Adult, *Chitala ornata* (Gray, 1831)
Clown featherback, reproduced from Chevey and Le Poulain, 1940.

A carnivorous, nocturnal species, found in rapids and pools in large and medium-sized rivers throughout the Mekong Basin. It migrates locally and moves into smaller tributaries and flooded areas including inundated forest during the flood season, and returns to main river channels when the water starts to recede. It spawns from March to July, attaching eggs to submerged wood. At least one of the parents guards the eggs and fry. It is an important species in the fishery, caught with a variety of gear, and it is also seen in the aquarium trade. It reaches 100 cm standard length.

*Main references*: Bardach, 1959; Kottelat, 1998; Poulsen et al., 2004; Rainboth, 1996; Smith, 1945.

**Meristics and morphometrics of larvae and juveniles**

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | 1,6 | 1,6 | 1,6  |
| Anal Fin Count       | 1,76| 1,76| 1,76 |
| Pectoral Fin Count   | 1,9 | 1,8 | 1,9  |
| Pelvic Fin Count     | 1   | 1   | 1    |
| Myomere Count        | 66  | 64  | 64   |
| Ratio between HL:SL  | 0.33| 0.33| 0.33 |
| Ratio between Sn-DF:SL| 0.52| 0.52| 0.52 |
| Ratio between Sn-AF:SL| 0.38| 0.38| 0.38 |
| Ratio between Sn-P,2,F:SL| 0.35| 0.35| 0.35 |

**Ecology**

|                        | Morphological characteristics | Pigmentation                         |
|------------------------|-------------------------------|---------------------------------------|
| Yolk-sac larva         | Place of development is on river floodplains. It is characterised by a round yolk-sac with homogenous yolk, no pigment on tail nor oil globules. | Melanophores on head. |
| Pre-larva              | Larvae develops on floodplains, first feeding at around 12.5–17.3 mm, feeding on zooplankton. Hatchet-like body shape with triangular gut, subterminal mouth; 64–66 myomeres and 12–15 pre-anal myomeres. Short dorsal fin and long mouth; anal fin connected with caudal fin. | Melanophores on head and trunk in early and late larvae. Peritoneum covered with melanophores, pectoral fins without melanophores, pelvic fins not present in larva. |
| Post-larva             | Carnivorous. Body shape deeply compressed, terminal mouth, gut shape triangular. | Melanophores on trunk. |
Developmental stages of *Chitala ornata*
Developmental stages of *Chitala ornata*

21 days
27.4 mm post-larva

27 days
34.0 mm post-larva

31 days
42.4 mm post-larva

35 days
48.9 mm post-larva

40 days
57.0 mm post-larva

70 days
67.8 mm juvenile
**Opsarius koratensis**

**Cyprinidae**

Adult *Opsarius koratensis* (Smith, 1931)

**Stream barilius**

An insectivorous species with a preference for trichopterans. Found over gravel substrate in fast current. Spawning and rearing grounds are on the floodplain, juveniles move to the main stream with the flow of water at the end of the flood season. It is of limited commercial importance; caught with seines and cast-nets. It grows to a length of about 10 cm.

**Main reference:** Rainboth, 1996.

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**Meristics and morphometrics of larvae and juveniles**

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | i,9 | i,9 | i,9  |
| Anal Fin Count       | i,10| i,10| i,10 |
| Pectoral Fin Count   | i,6 | i,6 | i,6  |
| Pelvic Fin Count     | 6   | 6   | 6    |
| Myomere Count        | 35  | 37  | 36   |
| Ratio between HL:SL  | 0.25| 0.25| 0.25 |
| Ratio between Sn-DF:SL| 0.57| 0.57| 0.57 |
| Ratio between Sn-AF:SL| 0.65| 0.65| 0.65 |
| Ratio between Sn-P,F:SL| 0.48| 0.48| 0.48 |

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**Ecology**

| Yolk-sac larva | Ecology | Morphological characteristics | Pigmentation |
|---------------|---------|-------------------------------|--------------|
| Pre-larva     | Develops on floodplains, first feeding on zooplankton at 4.4–5.6 mm. | Body cylindrical, with superior mouth and long gut shape; 34–37 myomeres and 20–21 pre-anal myomeres. | Melanophores on head and peritoneum; Melanophore series along dorsal mid-line from head to end of tail, along lateral mid-lines of trunk and tail, over gut and along ventral mid-line of tail. |

**Post-larva**: Omnivorous

Body elongated, with small superior mouth and long gut shape.

Melanophores on head and peritoneum; in older post-larvae on the trunk. Mid-lateral stripe, with short vertical bands through it in larger juveniles.
Cyprinidae

Developmental stages of *Opsarius koratensis*

12 hours
3.7 mm
yolk-sac larva

2 days
4.4 mm
pre-larva

3 days
6.8 mm
pre-larva

5 days
7.3 mm
post-larva

7 days
8.3 mm
post-larva

9 days
9.6 mm
post-larva

12 days
11.1 mm
post-larva
Developmental stages of *Opsarius koratensis*
**Leptobarbus hoevenii**

Adult *Leptobarbus hoevenii* (Bleeker, 1851)

Mad barb

An omnivorous species occurring in large rivers. It migrates seasonally into the flooded forest, and may display longitudinal migrations upstream during January and February and downstream in May-June. It is a pelagic spawner in floodplains during the wet-season from May to September. The eggs are semi-buoyant and hatch within 15–18 hours at 26–29°C. Newly hatched larvae are about 5 mm long. Fish weighing 0.5–0.6 kg are mature and a 1-kg mature female may carry 50,000–70,000 eggs. Occasionally this fish feeds on poisonous fruit which makes it behave strangely and makes the meat toxic to eat; it is an important food fish in part of the basin; caught with nets, traps and hooks. It grows to a maximum length of 70 cm, more commonly 50 cm.

*Main references:* Baird *et al.*, 1999; Poulsen *et al.*, 2004; Rainboth, 1996; Roberts, 1993.

**Meristics and morphometrics of larvae and juveniles**

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | 1,7 | 1,7 | 1,7  |
| Anal Fin Count           | 1,7 | 1,7 | i,7  |
| Pectoral Fin Count       | i,12| i,10| i,10 |
| Pelvic Fin Count         | i,6 | i,6 | i,6  |
| Myomere Count            | 41  | 38  | 40   |
| Ratio between HL:SL      | 0.30| 0.28| 0.30 |
| Ratio between Sn-DF:SL   | 0.46| 0.46| 0.46 |
| Ratio between Sn-AF:SL   | 0.76| 0.76| 0.76 |
| Ratio between Sn-P>F:SL  | 0.53| 0.53| 0.53 |

**Ecology**

Yolk-sac larva: Develops on the floodplain.

Pre-larva: Develops on the floodplain, first feeding at 4.8–5.9 mm when it feeds on zooplankton.

Post-larva: Omnivorous.

**Morphological characteristics**

Yolk-sac larva: Elongate yolk-sac with homogenous yolk.

Pre-larva: Body elongate with a terminal mouth and long gut; slightly hunch-backed nape has 38–41 myomeres and 26–29 pre-anal myomeres. Large gap between dorsal and anal fins.

Post-larva: Body with superior mouth and elongated gut.

**Pigmentation**

Yolk-sac larva: Larvae have pigmentation on head and trunk. No pigmentation on peritoneum, pectoral nor pelvic fins. Dorsal mid-line head to tail, lateral mid-line of trunk and tail, dorsally along gut and ventral mid-line of tail.

Pre-larva: Mid-lateral stripe that intensifies with growth and the pigment is dense on the dorsal part of body.
A guide to larvae and juveniles of some common fish species from the Mekong River Basin

Developmental stages of *Leptobarbus hoevenii*

Just hatched
4.4 mm
yolk-sac larva

1 day
5.3 mm
pre-larva

3 days
5.9 mm
pre-larva

5 days
7.0 mm
post-larva

7 days
7.5 mm
post-larva

9 days
8.2 mm
post-larva

12 days
10.2 mm
post-larva
Developmental stages of *Leptobarbus hoevenii*

- **15 days**
  - 12.5 mm post-larva

- **17 days**
  - 15.3 mm post-larva

- **21 days**
  - 22.6 mm post-larva

- **23 days**
  - 25.5 mm post-larva

- **25 days**
  - 31.3 mm juvenile
Cyprinus carpio

Adult *Cyprinus carpio* Linnaeus, 1758
Common carp

A species introduced from China, adaptable to various environments, conditions and foods. It is apparently well established in some parts of the Mekong and may cause considerable ecological damage. It migrates upstream at the Khone Falls in May-July; as flow volumes increase rapidly in June migratory activity intensifies and become more regular. This migration is mainly for dispersal and feeding. Local fishers claim that the small individuals that move upstream at this time do so to feed on eggs released by native spawners. It spawns in spring and summer from January to June sometimes extending to August. Spawning is typically in shallow water among aquatic plants. It seems to be capable of reproducing in cooler waters within the Mekong basin. A 47-cm female releases about 300,000 sticky eggs. It is important as a food fish and is caught with nets and hook-and-line. It can grow to a maximum length of 120 cm, but is more commonly caught in the range of 30–50 cm.

*Main references:* Baird et al., 1999; Rainboth, 1996 and Singanouvong et al., 1996.

Meristics and morphometrics of larvae and juveniles

|                          | Max  | Min  | Mode |
|--------------------------|------|------|------|
| Dorsal Fin Count         | 1,20 | 1,20 | 1,20 |
| Anal Fin Count           | 1,6  | 1,6  | 1,6  |
| Pectoral Fin Count       | i,12 | i,12 | i,12 |
| Pelvic Fin Count         | i,5  | i,5  | i,5  |
| Myomere Count            | 43   | 39   | 41   |
| Ratio between HL:SL      | 0.32 | 0.32 | 0.32 |
| Ratio between Sn-DF:SL   | 0.47 | 0.47 | 0.47 |
| Ratio between Sn-AF:SL   | 0.78 | 0.78 | 0.78 |
| Ratio between Sn-P$_{2F}$:SL | 0.54 | 0.50 | 0.52 |

|                          | Ecology                                      | Morphological characteristics                  | Pigmentation                                      |
|--------------------------|----------------------------------------------|-------------------------------------------------|--------------------------------------------------|
| Yolk-sac larva           | Develops both on floodplains and in riverine environments. | Elongated yolk-sac with homogenous yolk.        | Melanophores on head and yolk sac.                |
| Pre-larva                | Starts feeding on zooplankton at 6.2–7.0 mm in length. | Elongate body, with a long gut; 39–43 myomeres and 23–26 pre-anal myomeres. | Melanophores on head and trunk in young and older larvae. Peritoneum covered with melanophores. |
| Post-larva               | Herbivorous.                                 | Elongated body with small terminal mouth and elongated gut. | Over entire body except for ventral margin of head and gut. |
Developmental stages of *Cyprinus carpio*
Developmental stages of *Cyprinus carpio*
**Catlocarpio siamensis**

Adult *Catlocarpio siamensis* (Boulenger, 1898)

Giant barb

A very large, mainly herbivorous fish, which is widely distributed in the Mekong system. It is a long-lived species which reaches sexual maturity late in life and adult specimens are increasingly rare. It is migratory: juveniles enter inundated areas during the rainy season. It spawns in the rainy season between June and August in swamps which receive water from the river. Eggs are seen from January to August, but fishers mostly report eggs from May to July. Juveniles 2–4 cm long appear from July to November. The giant barb reaches sexual maturity at an age of 7 years, at a body weight of 9 kg. A 60 kg female sheds about 400,000 semi-buoyant eggs that are dark brown in colour and have an initial size of 1 mm expanding to 3 mm after water absorption. Hatching occurs within 20–22 hours after fertilization at 28–29°C. Occasionally caught with middle or large scale gears and sold for food. Maximum length is 300 cm, more commonly 100–200 cm.

*Main references*: Baird and Phylavanh, 1999; Baird *et al.*, 1999; Poulsen *et al.*, 2004; Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                     | Max | Min | Mode |
|---------------------|-----|-----|------|
| Dorsal Fin Count    | 1,9 | 1,9 | 1,9  |
| Anal Fin Count      | 1,5 | 1,5 | 1,5  |
| Pectoral Fin Count  | 1,9 | 1,9 | 1,9  |
| Pelvic Fin Count    | 1,5 | 1,5 | 1,5  |
| Myomere Count       | 37  | 34  | 36   |
| Ratio between HL:SL | 0.42| 0.41| 0.41 |
| Ratio between Sn-DF:SL | 0.49 | 0.49 | 0.49 |
| Ratio between Sn-AF:SL | 0.76 | 0.76 | 0.76 |
| Ratio between Sn-P,F:SL | 0.51 | 0.51 | 0.51 |

| Ecology            | Morphological characteristics | Pigmentation                                      |
|--------------------|--------------------------------|---------------------------------------------------|
| Yolk-sac larva     | Develops in floodplain and riverine habitats. | Elongated yolk-sac with homogenous yolk.          |
|                    |                                  |                                                   |
| Pre-larva          | Develops in floodplain and riverine habitats, starts feeding on zooplankton at 6.9–7.6 mm in length. | Hunch-back body from about 13.0 mm, long gut; has 34–37 myomeres and 22–25 pre-anal myomeres. | Melanophores on head, dorsally over gut and along mid-line of the tail. Peritoneum covered with melanophores. Pigmentation on dorsal fin, anal fin and caudal fin starting from 19.6 mm. |
| Post-larva         | Omnivorous.                      | Elongated body with long gut and a high dorsal fin. | Pigmentation dorsally on head, trunk, tail, dorsal, anal and caudal fins. |

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**Page 25**
Developmental stages of *Catlocarpio siamensis*
Developmental stages of *Catlocarpio siamensis*
**Probarbus jullieni**

Adult *Probarbus jullieni* Sauvage, 1880
Jullien’s barb

A large omnivorous freshwater species that occurs basin-wide in the Mekong basin and in large tributaries with hard substrates. It migrates to spawning grounds in the dry season, often in association with *P. labeamajor*. Spawning grounds are shallow rapids with strong currents in the mainstream of large rivers with sand and gravel substrates. Juveniles often migrate downstream with small cyprinids for dispersal and feeding. These trophic migrations by juveniles and sub-adults occur mainly at the onset of the flood season and are reported throughout the distributional range. In captivity, both males and females mature when five years old. A 4-kg female was recorded as producing about 500,000 eggs. The eggs are buoyant or semi-buoyant, but slightly heavy and adhesive and about 2 mm in diameter. Hatching occurs in 32–72 hours at 23°C. It is an important commercial species that is caught mainly during the spawning period with large meshed gill-nets, seines and hook-and-line. It has a maximum length of 165 cm, more commonly 28–30 cm.

*Main references:* Baird et al., 1999; Poulsen et al., 2004; Rainboth 1996; Smith, 1945.

**Meristics and morphometrics of larvae and juveniles**

|                  | Max | Min | Mode |
|------------------|-----|-----|------|
| Dorsal Fin Count | 1,9 | 1,9 | 1,9  |
| Anal Fin Count   | i,6 | i,6 | i,6  |
| Pectoral Fin Count | i,9 | i,8 | i,9  |
| Pelvic Fin Count | i,6 | i,6 | i,6  |
| Myomere Count    | 40  | 37  | 40   |
| Ratio between HL:SL | 0.31 | 0.31 | 0.31 |
| Ratio between Sn-DF:SL | 0.49 | 0.49 | 0.49 |
| Ratio between Sn-AF:SL | 0.75 | 0.75 | 0.75 |
| Ratio between Sn-P,F:SL | 0.55 | 0.55 | 0.55 |

**Ecology**

| Ecology                                                                 | Morphological characteristics                      | Pigmentation                                      |
|------------------------------------------------------------------------|-----------------------------------------------------|---------------------------------------------------|
| Yolk-sac larva Develops on sandy/gravel substrate in rivers.           | Elongated yolk-sac with homogenous yolk.             | Melanophores on posterior ventral part of trunk.  |
| Pre-larva Starts feeding on zooplankton at 8.6–9.2 mm length.          | Elongated body, with small mouth and long gut. Has a gas bladder, 37–40 myomeres and 25–28 pre-anal myomeres. | Pigmentation on caudal fin. Dorsally and laterally on head, dorsally along posterior half of gut, along ventral mid-line of tail, dorsal mid-line of caudal peduncle and series mid-laterally on tail along myotomes. |
| Post-larva Omnivorous.                                                 | Slightly inferior mouth, elongated gut.              | Pigmentation on caudal fins, dorsally and laterally on head and body. |
Developmental stages of *Probarbus jullieni* (Sauvage, 1880)
Developmental stages of *Probarbus jullieni*
**Tor tambroides**

Adult *Tor tambroides* (Bleeker, 1854)
Thai mahseer

An omnivorous species that is found in undisturbed rivers and is sensitive to human activities. In central Thailand the species moves downstream at the onset of the flood and returns upstream after one or two months to spawn in July near the mouths of small streams which the young subsequently ascend as larvae. Collection of young fish in Cambodia showed that the migration pattern and timing is probably similar to Thailand. Juveniles enter streams and feed on floodplains. Caught with nets and hooks; it is eaten, but the meat is sometimes toxic when it feeds on certain kinds of fruits. Its maximum length is 80 cm.

*Main references*: Baird and Phylavanh, 1999; Baird *et al.*, 1999; Bardach, 1959; Poulsen *et al.*, 2004; Rainboth, 1996; Smith, 1945.

Meristics and morphometrics of larvae and juveniles

|                      | Max  | Min  | Mode |
|----------------------|------|------|------|
| Dorsal Fin Count     | 1,11 | 1,10 | 1,10 |
| Anal Fin Count       | 1,6  | 1,6  | 1,6  |
| Pectoral Fin Count   | 1,10 | 1,10 | 1,10 |
| Pelvic Fin Count     | 1,5  | 1,5  | 1,5  |
| Myomere Count        | 36   | 34   | 35   |
| Ratio between HL:SL  | 0.28 | 0.28 | 0.28 |
| Ratio between Sn-DF:SL| 0.49 | 0.49 | 0.49 |
| Ratio between Sn-AF:SL| 0.75 | 0.75 | 0.75 |
| Ratio between Sn-P,F:SL| 0.52 | 0.52 | 0.52 |

**Ecology**

| Yolk-sac larva       | Ecology                           | Morphological characteristics                  | Pigmentation                        |
|----------------------|-----------------------------------|-----------------------------------------------|-------------------------------------|
|                      | Develop in riverine environment.  | Elongated yolk-sac with homogenous yolk.      | Melanophores on head.               |
| Pre-larva            | Small clear streams, move to floodplain for feeding. It starts feeding on zooplankton at 10.7–11.8 mm length. | Elongated body with small mouth and long gut; 34–36 myomeres and 12–13 pre-anal myomeres. | Dorsolaterally on head and body, some laterally on gut, absent over gut, large triangular melanopore laterally over hypural bones. |
| Post-larva           | Carnivorous.                      | Elongated body with terminal mouth and long gut. | Dorsally, laterally on head and body, ventrally on tail. Large triangular melanopore laterally over hypural bones, dorsal and anal fin. |
Developmental stages of *Tor tambroides*
Developmental stages of *Tor tambroides*
**Cyclocheilichthys enoplos**

Adult *Cyclocheilichthys enoplos* (Bleeker, 1850)

Soldier river barb

A common omnivorous species, that is found basin-wide. It is migratory and spawns in the mainstream and on floodplains and in inundated riparian forests in the early flood season. Females reach sexual maturity at a length of 10.3 cm, males at 9.7 cm. The average fecundity of a 15 cm fish is 3,000–4,000 eggs and it is a total spawner. Eggs and larvae are pelagic and they drift from spawning grounds into flooded areas or quiet, shallow parts of the mainstream. It is an important food fish caught with small, medium and large-scale gears. It grows to a maximum length of 74 cm, commonly 45 cm.

*Main references*: Baird and Phylavanh, 1999; Baird *et al*., 1999; Lieng *et al*., 1995; Poulsen *et al*., 2004; Rainboth, 1996; Smith, 1945.

Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| **Dorsal Fin Count**     | 1,9 | 1,8 | 1,8  |
| **Anal Fin Count**       | 1,6 | 1,5 | 1,5  |
| **Pectoral Fin Count**   | 1,9 | 1,9 | 1,9  |
| **Pelvic Fin Count**     | 1,5 | 1,5 | 1,5  |
| **Myomere Count**        | 36  | 30  | 33   |
| **Ratio between HL:SL**  | 0.31| 0.31| 0.31 |
| **Ratio between Sn-DF:SL**| 0.47| 0.47| 0.47 |
| **Ratio between Sn-AF:SL**| 0.73| 0.73| 0.73 |
| **Ratio between Sn-P,F:SL**| 0.51| 0.51| 0.51 |

**Ecology**

| Yolk-sac larva | Ecology | Morphological characteristics | Pigmentation |
|----------------|---------|-------------------------------|--------------|
|                | Develops in main river channels and on floodplains. | Elongated yolk-sac with homogenous yolk. | No information available |

| Pre-larva | Develops in shallow parts of main river channels and on floodplains. Starts feeding on zooplankton at 6–7.3 mm length. | Hunch-back appearance, dorsal spine with spinales. 30–36 myomeres and 17–23 pre-anal myomeres. | Dorsally on head and irregular series along dorsal mid-line of body, lateral mid-line of trunk, mid-laterally on tail with an elongated melanopore on each myoseptum. Dorsally over gut, dark melanophore laterally over hypural plate started from 13.9 mm. |

| Post-larva | Herbivorous | Elongated body. | Dorsally on head and trunk, dorsal and anal fins, laterally on tail. |
Developmental stages of *Cyclocheilichthys enoplos*
Developmental stages of *Cyclocheilichthys enoplos*
**Barbonymus altus**

Adult *Barbonymus altus* (Günther, 1868)

Red-tailed tinfoil

An omnivorous species, which is found basin-wide in large and medium-sized rivers at mid-water depths. It undertakes annual upstream and downstream non-reproductive and reproductive migrations and colonises flooded areas during the inundation period. Matures at a length of 13 cm. Females of 19–21 cm length may carry up to 25,000 eggs. It spawns in July-August, however the species appears to have a protracted spawning season with a peak in the late rainy season in September. It spawns in midwater in floodplains and flooded forest, or among flooded vegetation. It has buoyant or semi-buoyant eggs, with an initial diameter of 0.74 mm. The eggs hatch 12 hours after fertilization at 28°C. Although the species appears to thrive in standing water, it has a requirement to return to flowing water to spawn. It is important in the fishery, has good aquaculture potential and is also used in the aquarium trade; maximum length is 20 cm.

*Main references:* Baird and Phylavanh, 1999; Baird *et al*., 1999; Jala *et al*., 2004; Leelapatra *et al*., 2000; Poulsen *et al*., 2004; Rainboth, 1996; Smith, 1945.

Meristics and morphometrics of larvae and juveniles

|                        | Max | Min | Mode |
|------------------------|-----|-----|------|
| Dorsal Fin Count       | 1,9 | 1,8 | 1,9  |
| Anal Fin Count         | 1,5 | 1,5 | 1,5  |
| Pectoral Fin Count     | 1,9 | 1,8 | 1,9  |
| Pelvic Fin Count       | 1,5 | 1,5 | 1,5  |
| Myomere Count          | 35  | 33  | 33   |
| Ratio between HL:SL    | 0.31| 0.31| 0.31 |
| Ratio between Sn-DF:SL | 0.49| 0.47| 0.48 |
| Ratio between Sn-AF:SL | 0.66| 0.66| 0.66 |
| Ratio between Sn-P,F:SL| 0.59| 0.59| 0.59 |

|                             | Ecology            | Morphological characteristics                        | Pigmentation                      |
|-----------------------------|--------------------|-----------------------------------------------------|-----------------------------------|
| Yolk-sac larva              | Develops on floodplains in swamps. | Elongated yolk-sac with homogenous yolk. | No melanophores.                  |
| Pre-larva                   | Starts feeding on zooplankton at 4.8–5.6 mm length. | Hunch-back body, has a gas bladder; 33–35 myomeres and 19–21 pre-anal myomeres. | Dorsally and laterally on head, scattered melanophores dorsally on trunk and tail, lateral mid-line of trunk and tail from 16.0 mm. Ventral mid-line of tail and dorsally along posterior of gut. Large, dense melanophores laterally. |
| Postlarva                   | Herbivorous.       | Elongated body with terminal mouth and long gut.     | Dorsally and laterally on head and body. Ventrally on tail. Dorsal-fin spine, anterior, distal half of dorsal fin. |
Developmental stages of *Barbonymus altus*
Developmental stages of *Barbonymus altus*

15 days  
10.9 mm  
post-larva

23 days  
13.8 mm  
post-larva

27 days  
16.4 mm  
post-larva

35 days  
22.5 mm  
post-larva

45 days  
25.3 mm  
juvenile
Barbonymus gonionotus

Adult *Barbonymus gonionotus* (Bleeker, 1850)

Silver barb

An omnivorous species, which lives basin-wide in a variety of freshwater habitats, but with a preference for standing water. It is a migratory species, however most reports indicate that it is a “local migrant” migrating from the Mekong up into small streams and canals and onto flooded areas during the rainy season and back again when the water recedes. It is an opportunistic spawner: it spawns in the rainy season between May and August depending on environmental factors such as rainfall and water current. The species normally reach maturity after one year, but it can reach this stage only eight or ten months at a body length of 8–8.5 cm and a weight of 9–20 g. The species is known to have a high fecundity between with 200,000 and 800,000 eggs/kg. The eggs are semi-buoyant, with an initial size of 0.5–0.8 mm. The maximum size after water absorption is 2.5–3.5 mm. Hatching occurs 12 hours after fertilization at 25ºC. The total length of the larva at hatching is 2–3 mm. It is an important food fish and is important both in fisheries and aquaculture. Maximum length is about 33 cm.

*Main references:* Baird and Phylavanh, 1999; Baird *et al*., 1999; Jala *et al*., 2004; Leelapatra *et al*., 2000; Poulsen *et al*., 2004; Rainboth, 1996; Smith, 1945.

Meristics and morphometrics of larvae and juveniles

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | 1,10| 1,9 | 1,9  |
| Anal Fin Count       | i,6 | i,5 | i,6  |
| Pectoral Fin Count   | i,9 | i,9 | i,9  |
| Pelvic Fin Count     | i,6 | i,5 | i,5  |
| Myomere Count        | 35  | 32  | 33   |
| Ratio between HL:SL  | 0.32| 0.32| 0.32 |
| Ratio between Sn-DF:SL| 0.52| 0.52| 0.52 |
| Ratio between Sn-AF:SL| 0.7 | 0.7 | 0.7  |
| Ratio between Sn-P,F:SL| 0.51| 0.51| 0.51 |

| Ecology | Morphological characteristics | Pigmentation |
|---------|--------------------------------|--------------|
| Yolk-sac larva | Develops on floodplains in swamps. | Elongated yolk-sac with homogenous yolk. | Stick to melanophore only because often don’t have chromatophore data, has one dorsal-ventral cluster or band on tail. |
| Pre-larva | Starts feeding on zooplankton at 5.2–6.1 mm length. | Elongated body, with terminal mouth and long gut, has a conspicuous gas bladder; 32–35 myomeres and 19–22 pre-anal myomeres. | Dorsally on head. From 6.0 mm melanophores spread to dorsal surface of trunk and long dorsal mid-line of tail. Series dorsally on posterior-half of gut along ventral mid-line of tail. Scattered melanophores laterally over hypural plates. Mid-lateral series spreads anteriorly from tail onto trunk. Peritoneum is covered with melanophores. |
| Post-larva | Herbivorous. | Elongated body with terminal mouth shape and long gut. | Concentrated on dorsal half of head and body. |
Developmental stages of *Barbonymus gonionotus*
Developmental stages of *Barbonymus gonionotus*
Barbonymus schwanenfeldii

Adult *Barbonymus schwanenfeldii* (Bleeker, 1853)
Goldfoil barb

An omnivorous fish that occurs in a variety of flowing waters in rivers, streams, canals and ditches; it seems to be slightly less common than *B. altus*. It feeds on aquatic macrophytes, submerged land plants, filamentous algae, small fishes, insects, worms, crustaceans and zoobenthos. It has some importance as a food fish and is usually marketed fresh. It is caught with gill-nets, cast-nets, lee traps and fence filter traps (*tone* traps). It grows to a maximum length of 35 cm and is commonly about 25 cm.

*Main references:* Jala *et al.*, 2004; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                    | Max | Min | Mode |
|--------------------|-----|-----|------|
| Dorsal Fin Count   | 1,9 | 1,8 | 1,8  |
| Anal Fin Count     | 1,6 | 1,6 | 1,6  |
| Pectoral Fin Count | 1,9 | 1,9 | 1,9  |
| Pelvic Fin Count   | 1,6 | 1,5 | 1,6  |
| Myomere Count      | 35  | 32  | 34   |
| Ratio between HL:SL| 0.30| 0.30| 0.30 |
| Ratio between Sn-DF:SL| 0.48| 0.48| 0.48 |
| Ratio between Sn-AF:SL| 0.69| 0.69| 0.69 |
| Ratio between Sn-P,F:SL| 0.52| 0.52| 0.52 |

| Ecology               | Morphological characteristics                                    | Pigmentation                                      |
|-----------------------|-------------------------------------------------------------------|---------------------------------------------------|
| Yolk-sac larva        | Develops on floodplains in swamps.                                | Elongated yolk-sac with homogenous yolk.          | No pigmentation.                                   |
| Pre-larva             | Develops on floodplain, starts feeding on zooplankton at 5–5.8 mm length. | Hunch-back body, with small mouth and long gut; 32–35 myomeres and 19–21 pre-anal myomeres. | Melanophores dorsally on head over gut and along ventral mid-line of tail. A few expanded melanophores laterally over hypural plates develop in larvae from 9.5 mm. |
| Post-larva            | Herbivorous.                                                      | Elongated body, with small/terminal mouth long gut. The gas bladder is visible in early post-larvae stage. | Dorsally on head and body. Intensification of melanopores laterally on caudal-fin base. Distal tip of dorsal fin and along caudal-fin rays. |
Developmental stages of *Barbonymus schwanenfeldii*

- **Just hatched**
  - 3.1 mm
  - yolk-sac larva

- **1 day**
  - 3.9 mm
  - pre-larva

- **2 days**
  - 4.5 mm
  - pre-larva

- **3 days**
  - 4.9 mm
  - pre-larva

- **12 days**
  - 6.5 mm
  - post-larva

- **15 days**
  - 7.0 mm
  - post-larva

- **19 days**
  - 8.1 mm
  - post-larva
Developmental stages of *Barbonymus schwanenfeldii*
**Hypsibarbus malcolmi**

Adult *Hypsibarbus malcolmi* (Smith, 1945)
Goldfin tinfoil barb

An omnivorous species, that is found in large and medium-sized rivers and floodplains. A migratory species that moves between large and medium sized rivers, displays both longitudinal and lateral movements. It is a mainstream pelagic spawner that produces buoyant or semi-buoyant eggs. Spawning takes place during late the wet- or early dry-season in December or January as water levels fall. Three spawning grounds have been identified just below the Khone Falls. Vocalisations appear to be closely associated with spawning behaviour. It becomes mature at a length of about 30 cm. It is an important food fish which is marketed fresh. It is caught with seines, gill-nets and traps. It can grow up to 50 cm.

*Main references*: Baird and Phylavanh, 1999; Baird et al., 1999; Bardach 1959; Poulsen et al., 2004; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | 1,8 | 1,8 | 1,8  |
| Anal Fin Count       | 1,6 | 1,6 | 1,6  |
| Pectoral Fin Count   | i,12| i,12| i,12 |
| Pelvic Fin Count     | i,6 | i,6 | i,6  |
| Myomere Count        | 37  | 35  | 36   |
| Ratio between HL:SL  | 0.31| 0.31| 0.31 |
| Ratio between Sn-DF:SL| 0.52| 0.49| 0.52 |
| Ratio between Sn-AF:SL| 0.74| 0.74| 0.74 |
| Ratio between Sn-P,F:SL| 0.53| 0.53| 0.53 |

| Yolk-sac larva       | Ecology               | Morphological characteristics                      | Pigmentation                      |
|----------------------|-----------------------|-----------------------------------------------------|-----------------------------------|
|                      | Develops in streams.  | Elongated yolk-sac with homogenous yolk.             | No melanophores on head or trunk. |
| Pre-larva            | First feeding on zooplankton at 6.4–7.6 mm. | Elongated body, with terminal mouth and long gut shape; 35–37 myomeres and 22–24 pre-anal myomeres. | Melanophores on operculum, dorsally on head and on gas bladder. |
| Post-larva           | Omnivore.             | Elongated body, with terminal mouth and long gut shape; 35–37 myomeres and 22–24 pre-anal myomeres. | Melanophores dorsally on head and over gut in post-flexion larvae from 8.8 mm. Series along ventral mid-line of tail. Concentration of melanophores laterally on caudal-fin base. Series on lateral mid-line of tail. |
Developmental stages of *Hypsibarbus malcolmi*
Developmental stages of *Hypsibarbus malcolmi*
**Hampala dispar**

Adult *Hampala dispar* Smith, 1934  
Eye-spot barb

An endemic carnivorous species which is found basin-wide in slowly moving or standing waters and which adapts readily to reservoirs. It displays both longitudinal and lateral movements. It breeds in the beginning of the rainy season and the young are found in seasonally flooded habitats in June. It is of some importance as a food fish and is caught with various nets and traps. It is grows to maximum length of 35 cm.

*Main references*: Baird and Phylavanh, 1999; Baird *et al.*, 1999; Kottelat, 2001; Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                         | Max | Min | Mode |
|-------------------------|-----|-----|------|
| Dorsal Fin Count        | 1.7 | 1.7 | 1.7  |
| Anal Fin Count          | 1.6 | 1.6 | 1.6  |
| Pectoral Fin Count      | 1.10| 1.9 | 1.9  |
| Pelvic Fin Count        | i.5 | i.5 | i.5  |
| Myomere Count           | 35  | 34  | 34   |
| Ratio between HL:SL     | 0.34| 0.34| 0.34 |
| Ratio between Sn-DF:SL  | 0.50| 0.50| 0.50 |
| Ratio between Sn-AF:SL  | 0.74| 0.74| 0.74 |
| Ratio between Sn-P,F:SL | 0.53| 0.53| 0.53 |

**Ecology**

| Yolk-sac larva | Ecology | Morphological characteristics | Pigmentation |
|----------------|---------|--------------------------------|--------------|
|                | Develops in swamps. | Elongated yolk-sac with homogenous yolk. | Melanophores dorsally on head and trunk. |

| Pre-larva | Starts feeding on zooplankton at 5.1–6.2 mm. | 34–35 myomeres and 22–24 pre-anal myomeres. | Pigmentation on head and trunk in older larvae; dorsally on head. Series along dorsal mid-line of body. Band dorsolaterally from origin of dorsal fin and on caudal peduncle, on lower jaw from 8.2 mm. Mid-laterally on trunk from 9.7 mm. |

| Post-larva | Omnivore. | Serrate dorsal-fin spine. | Band below dorsal fin and on peduncle intensify mid-laterally, fine melanophores dorsally on head and body. |
Developmental stages of *Hampala dispar*
Developmental stages of *Hampala dispar*
Puntius aurotaeniatus

Adult *Puntius aurotaeniatus* (Tirant, 1885)
Gold-lined barb

A carnivorous species, which occurs in streams, canals, ditches and occasionally in impoundments in the Middle and Lower Mekong Basin. It spawns during the rainy season and juveniles are caught in March. It is mainly caught with nets and traps. It is an important food fish that grows to about 6 cm in length.

*Main references:* Baird *et al*., 1999; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                           | Max | Min | Mode |
|---------------------------|-----|-----|------|
| Dorsal Fin Count          | 1,8 | 1,8 | 1,8  |
| Anal Fin Count            | 1,6 | 1,6 | 1,6  |
| Pectoral Fin Count        | i,10| i,9 | i,9  |
| Pelvic Fin Count          | i,5 | 1,5 | i,5  |
| Myomere Count             | 34  | 32  | 34   |
| Ratio between HL:SL       | 0.33| 0.29| 0.32 |
| Ratio between Sn-DF:SL    | 0.51| 0.44| 0.49 |
| Ratio between Sn-AF:SL    | 0.73| 0.71| 0.71 |
| Ratio between Sn-P,F:SL   | 0.53| 0.51| 0.51 |

|                          | Ecology                                      | Morphological characteristics                  | Pigmentation                                      |
|--------------------------|----------------------------------------------|-------------------------------------------------|--------------------------------------------------|
| Yolk-sac larva           | Develops in flood plain.                     | Elongated yolk sac with homogenous yolk.         | Melanophores dorsally on head and trunk.          |
| Pre-larva                | Start feeding on zooplankton at 4.8–5.7 mm.  | Elongated body with terminal mouth and long gut; 32–34 myomeres and 20–21 pre-anal myomeres. | Large dark spot on caudal peduncle. Dorsally on head and nape extending laterally and posteriorly with growth, midlaterally series along trunk and tail. Along dorsal-fin spine which extends dorsolaterally to trunk by 18.5 mm. Dense melanophore at anal-fin origin from 8.9 mm. |
| Post-larva               | Omnivore.                                    | Elongated body with terminal mouth and long gut. | Dorsal and lateral surface of head and body, dark mid-lateral spots above the lateral line. A dense spot at the origin of the dorsal and anal fins. |
Developmental stages of *Puntius aurotaeniatus*
Developmental stages of *Puntius aurotaeniatus*
**Puntius orphoides**

Adult *Puntius orphoides* (Valenciennes, 1842)

Red-cheeked barb

An omnivorous species, which is found basin-wide in rivers of all sizes. It migrates onto floodplains where it breeds in areas covered with vegetation during the wet season. Adults leave floodplains as the water subsides in December and January. The exact timing of spawning varies according to environmental factors such as rainfall and current. The eggs are adhesive with an initial diameter of 0.7 mm and will hatch 18–19 hours after fertilization at 27–28°C. The larvae is about 3 mm long at hatching. Fish mature at 10–11 cm; fecundity varies in fish in different environments, with 20,000–100,000 eggs for fish weighing 15–80 g. In culture, fish with a total length of 10.9–12.3 cm and a body weight of 18–23 g contain about 7,300–15,000 eggs. Red-cheeked barb are caught with nets and traps and may be processed into fish paste. Maximum length is about 25 cm.

Main references: Baird and Phylavanh, 1999; Baird *et al.*, 1999; Leelapatra *et al.*, 2000; Rainboth, 1996.

### Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | i,7 | i,7 | i,7  |
| Anal Fin Count           | i,6 | i,6 | i,6  |
| Pectoral Fin Count       | i,10| i,10| i,10 |
| Pelvic Fin Count         | i,6 | i,6 | i,6  |
| Myomere Count            | 40  | 36  | 38   |
| Ratio between HL:SL      | 0.35| 0.35| 0.35 |
| Ratio between Sn-DF:SL   | 0.53| 0.53| 0.53 |
| Ratio between Sn-AF:SL   | 0.78| 0.78| 0.78 |
| Ratio between Sn-P,F:SL  | 0.59| 0.59| 0.59 |

### Ecology

| Yolk-sac larva | Ecology | Morphological characteristics | Pigmentation |
|----------------|---------|-------------------------------|--------------|
|                | Develop on floodplain or in riverine habitats. | Elongated yolk-sac with homogenous yolk. | No information available. |
| Pre-larva      | Starts feeding on zooplankton at 4.2–4.8 mm length. | Hunch-back body, with long gut and terminal mouth, has gas bladder; 36–40 myomeres and 21–24 pre-anal myomeres. | Peritoneum covered with melanophores. Caudal fin is pigmented. Dorsally on head and along dorsal mid-line of body. Mid-lateral series on body. Dorsally over gut and along ventral mid-line of tail. Laterally on caudal-fin base. On the leading edge of dorsal fin from 11.9 mm. |
| Post-larva     | Omnivore. | Moderately-short head elongated body with terminal mouth shape and long gut. | Pigment dorsally and dorsolaterally on head and body. Dense pigment laterally over hypural plates. Spot on dorsal mid-line at origin of dorsal fin. |
Developmental stages of *Puntius orphoides*
Developmental stages of *Puntius orphoides*
Bangana behri

Adult *Bangana behri* (Fowler, 1937)
Humphead carp

An herbivorous species preferring rocky stretches of the Mekong mainstream and large tributaries upstream of Sambor. It migrates to spawning grounds at the beginning of the dry season and is reported to move into tributary streams during high waters. The species is reported to migrate in schools together with other cyprinids such as *Bangana pierrei*, *Cirrhinus microlepis*, *Morulius chrysophekadion* and *Cyclocheilichthys enoplos* as well as *Yasuhikotakia modesta*. It carries mature eggs in June-July. It is an important species, caught with various gears. It attains a maximum length of about 40 cm.

*Main references:* Baird *et al*., 1999; Poulsen *et al*., 2004; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                  | Max    | Min    | Mode |
|------------------|--------|--------|------|
| Dorsal Fin Count | I,12   | I,11   | I,12 |
| Anal Fin Count   | I,7    | I,6    | I,6  |
| Pectoral Fin Count| i,12  | i,11   | i,12 |
| Pelvic Fin Count | i,7    | i,6    | i,7  |
| Myomere Count    | 34     | 32     | 34   |
| Ratio between HL:SL | 0.35 | 0.34   | 0.34 |
| Ratio between Sn-DF:SL | 0.49 | 0.48   | 0.49 |
| Ratio between Sn-AF:SL | 0.77 | 0.77   | 0.77 |
| Ratio between Sn-P,F:SL | 0.64 | 0.63   | 0.63 |

| Ecology       | Morphological characteristics | Pigmentation                                                                 |
|---------------|-------------------------------|-------------------------------------------------------------------------------|
| Yolk-sac larva| Develop in riverine habitats. | Elongated yolk-sac with homogenous yolk.                                      | No information available.                                           |
| Pre-larva     | Starts feeding phytoplankton at 5.9–6.5 mm. | Elongated body with a long gut and conspicuous gas bladder; 32–34 myomeres and 20–24 pre-anal myomeres. | Melanophores on head and body both in early and older larva, peritoneum covered with melanophores. |
| Post-larva    | Herbivore.                     | Elongated body with inferior mouth and elongate gut. The gas bladder is visible until juvenile fish of 30.5 mm. | Dorsally on head and body.                                        |
Developmental stages of *Bangana behri*
Developmental stages of *Bangana behri*
**Henicorhynchus siamensis**

Adult *Henicorhynchus siamensis* (Sauvage, 1881) 
Siamese mud carp

An abundant herbivorous species occurring basin-wide in large and small rivers. It is highly migratory. During reproductive migrations, fish feed very little, relying on fat deposits around their viscera. Mature eggs are reported from April to July with a strong peak during May-June and the species spawns at the beginning of the flood. The species is extremely important in the *dai* fisheries and is also caught basin-wide with other gears. This fish is commonly processed by fermenting. It occurs in the aquarium trade.

**Main references:** Baird et al., 1999; Poulsen et al., 2004; Rainboth, 1996; Singanouvong et al., 1996.

Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| **Dorsal Fin Count**     | 1,10| 1,10| 1,10 |
| **Anal Fin Count**       | 1,7 | 1,7 | 1,7  |
| **Pectoral Fin Count**   | 1,9 | 1,9 | 1,9  |
| **Pelvic Fin Count**     | 1,5 | 1,5 | 1,5  |
| **Myomere Count**        | 35  | 32  | 34   |
| **Ratio between HL:SL**  | 0.34| 0.34| 0.34 |
| **Ratio between Sn-DF:SL**| 0.48| 0.48| 0.48 |
| **Ratio between Sn-AF:SL**| 0.75| 0.75| 0.75 |
| **Ratio between Sn-P₂F:SL**| 0.54| 0.54| 0.54 |

- **Ecology**
  - Yolk-sac larva: Develops in floodplain habitats.
  - Pre-larva: Starts feeding on phytoplankton at 5.1–6.3 mm in length.
  - Post-larva: Herbivore.

- **Morphological characteristics**
  - Yolk-sac larva: Elongated yolk-sac with homogenous yolk.
  - Pre-larva: Elongated body with terminal mouth and long gut; 32–35 myomeres and 21–24 pre-anal myomeres.
  - Post-larva: Elongated body with terminal mouth and long gut, the gas bladder is visible until 15.0 mm.

- **Pigmentation**
  - Yolk-sac larva: Melanophores on ventral part of the head.
  - Pre-larva: Larvae have melanophores dosally on the head that extend onto the trunk from 12 mm. Mid-lateral series posteriorly on trunk and tail, about 1 melanophore per myomere. Over gas bladder and dorsally over gut. Ventral mid-line of tail.
  - Post-larva: Dorsally and laterally on head and body. Proximally on dorsal and anal fins.
Developmental stages of *Henicorhynchus siamensis*
Developmental stages of *Henicorhynchus siamensis*
Cirrhinus molitorella

Adult *Cirrhinus molitorella* (Valenciennes, 1844)
Mud carp

An omnivorous migratory riverine species, which occurs in large rivers in the Middle and Upper Mekong Basin. Engages in upstream dry-season migrations in the Mekong mainstream of Southern Lao PDR and either enters tributaries, or remains in the Mekong mainstream for spawning during the wet-season months. It spawns on floodplains and in large rivers during wet-season. It is a pelagic spawner, producing buoyant or semi-buoyant eggs. It is an important commercial species, which has good potential for aquaculture. Its maximum length is 50 cm; more commonly it reaches 25 cm.

Main references: Baird et al., 1999; Rainboth, 1996; Singanouvong et al., 1996; Warren, 2000.

Meristics and morphometrics of larvae and juveniles

|                  | Max  | Min  | Mode |
|------------------|------|------|------|
| Dorsal Fin Count | 1,12 | 1,11 | 1,12 |
| Anal Fin Count   | 1,6  | 1,5  | 1,6  |
| Pectoral Fin Count| i,12 | i,10 | i,12 |
| Pelvic Fin Count | i,7  | i,6  | i,7  |
| Myomere Count    | 34   | 32   | 33   |
| Ratio between HL:SL | 0.31 | 0.27 | 0.31 |
| Ratio between Sn-DF:SL | 0.48 | 0.45 | 0.48 |
| Ratio between Sn-AF:SL | 0.79 | 0.77 | 0.78 |
| Ratio between Sn-P,F:SL | 0.60 | 0.54 | 0.56 |

**Ecology**

| Stage          | Characteristics                                                                                      | Pigmentation                                  |
|----------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| Yolk-sac larva | Develops in floodplain and mainstream habitat. Elongated yolk-sac with homogenous yolk.            | Melanophores on ventral part of the head.     |
| Pre-larva      | Starts feeding on phytoplankton at 5.5–6.4 mm length. Elongated body with terminal mouth and long gut; 34–35 myomeres and 23–25 pre-anal myomeres. | Dorsally on head and body which extend to lateral surfaces by 8.5 mm. Dorsally over posterior, portion of gut, extending anteriorly with growth. Ventral mid-line of tail. Dense arrangement of melanophores on caudal-fin base. Dorsal-fin spine, distally on dorsal fin membrane, proximally on anal-fin from 3.0 mm, along caudal-fin rays. |
| Post-larva     | Omnivore. Elongated body with terminal mouth long gut and the gas bladder is visible with 10.0 mm.   | Diffuse melanophores dorsally and laterally on head and body, along dorsal-fin spine and melanophores proximally on anal-fin membranes, along caudal-fin rays. |
The developmental stages of *Cirrhinus molitorella*
The developmental stages of *Cirrhinus molitorella*
**Labeo chrysophekadion**

Adult *Labeo chrysophekadion* (Bleeker, 1850)  
Black shark minnow

A predominantly herbivorous species occurring in flowing and standing waters including reservoirs throughout the Mekong Basin. At the onset of the rainy season it starts longitudinal migration that continue into tributaries, small streams and canals and seasonally flooded areas. Spawning begins at the onset of the rainy season and peaks in June-July in the Mekong River and in July-October in reservoirs. It is reported to spawn in swamps, flooded areas, or upstream of shallow sandbars in the mainstream. It can reproduce when two years old at 40 cm length. Fecundity estimates are highly variable from 10,000 to 1,000,000 for 49 cm female. Eggs are semi-buoyant and hatch in 14–16 hours at 28ºC. The fry move into inundated grasses or other shelter along the bank and continue to follow the leading edge of the advancing water as floodwaters spread. It is very important commercially and is marketed fresh or dried and salted. The fish is caught with various small to large-scale gears. Maximum length is 50 cm.

**Main references:** Baird and Phylavanh, 1999; Baird et al., 1999; Leelapatra et al., 2000; Poulsen et al., 2004; Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | 1,19| 1,17| 1,18 |
| Anal Fin Count       | 1,6 | 1,5 | 1,6  |
| Pectoral Fin Count   | i,12| i,10| i,12 |
| Pelvic Fin Count     | 1,6 | 1,5 | 1,5  |
| Myomere Count        | 38  | 34  | 35   |
| Ratio between HL:SL  | 0.32| 0.32| 0.32 |
| Ratio between Sn-DF:SL| 0.48| 0.48| 0.48 |
| Ratio between Sn-AF:SL| 0.74| 0.74| 0.74 |
| Ratio between Sn-P,F:SL| 0.55| 0.55| 0.55 |

**Ecology**

- **Yolk-sac larva**
  - Develops in floodplain and riverine habitats.
  - Elongated yolk-sac with homogenous yolk.
  - No information available.

- **Pre-larva**
  - Starts feeding on zooplankton at 5.3–6.3 mm in length.
  - Elongated body with a long gut and prominent gas bladder; 34–38 myomeres and 22–26 pre-anal myomeres.
  - Long dorsal-fin base.
  - Dorsally on head and along lateral mid-line of trunk and tail. Dorsally over gas bladder. By 13.4 mm, melanophores over head and body except for ventral margin of head and gut. Dorsal fin spine by 13.4 mm, heavy pigment on proximal portions of caudal-fin rays.

- **Post-larva**
  - Omnivore.
  - Elongated body with terminal mouth and long gut, the gas bladder is visible until 10.4 mm.
  - Long-based dorsal fin.
  - Entire head and body except ventral margin of head and gut. Proximally on dorsal, pelvic, anal and caudal fins, expanding with growth.
A guide to larvae and juveniles of some common fish species from the Mekong River Basin

Developmental stages of *Labeo chrysophekadion*

1 day
4.0 mm
yolk-sac larva

2 days
4.9 mm
pre-larva

3 days
5.5 mm
pre-larva

4 days
6.4 mm
post-larva

5 days
7.8 mm
post-larva

7 days
9.3 mm
post-larva

9 days
10.4 mm
post-larva
Developmental stages of *Labeo chrysophekadion*
Labeo dyocheilus

Adult *Labeo dyocheilus* (Mc Clelland, 1839)  
Lipped barb

An herbivorous white fish species found in floodplains and lowland rivers with fairly fast currents and it also adapts to reservoirs. It enters flooded forests, preferring areas with at least some current. It spawns pelagically in the mainstream in the wet season; the eggs are buoyant or semi-buoyant. The fish are marketed fresh or processed by fermenting (e.g. to *prahoc*). It is caught with nets and traps. This species has good aquaculture potential. Maximum length is 45 cm.

Main references: Baird et al., 1999; Bardach, 1959; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                         | Max | Min | Mode |
|-------------------------|-----|-----|------|
| Dorsal Fin Count        | 1,9 | 1,9 | 1,9  |
| Anal Fin Count          | 1,6 | 1,6 | 1,6  |
| Pectoral Fin Count      | 1,9 | 1,9 | 1,9  |
| Pelvic Fin Count        | i,6 | i,6 | i,6  |
| Myomere Count           | 34  | 32  | 34   |
| Ratio between HL:SL     | 0.31| 0.31| 0.31 |
| Ratio between Sn-DF:SL  | 0.47| 0.47| 0.47 |
| Ratio between Sn-AF:SL  | 0.74| 0.74| 0.74 |
| Ratio between Sn-P,F:SL | 0.53| 0.53| 0.53 |

|                         | Ecology                                     | Morphological characteristics                                      | Pigmentation                                                   |
|-------------------------|---------------------------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------|
| Yolk-sac larva          | Develops in floodplain habitats.            | Elongated yolk-sac with homogenous yolk.                            | No melanophores on head or trunk.                               |
| Pre-larva               | Starts feeding on phytoplankton at 5.9–7.4 mm in length. | Elongated body with superior mouth, long gut and conspicuous gas bladder; 32–34 myomeres and 22–25 pre-anal myomeres. | Melanophores dorsally on head. Dorsally and laterally on body by 12.6 mm. Along ventral mid-line of tail by 15.0 mm. Dorsally on posterior of gut. Denser patch laterally on caudal-fin base. |
| Post-larva              | Herbivore.                                  | Elongated body, superior small mouth and long gut.                 | Dorsally on head and body, extending laterally with growth. Dark patch laterally on caudal-fin base. Diffuse melanophores along dorsal-fin spine and on dorsal-fin membrane. |
Developmental stages of *Labeo dyocheilus*
Developmental stages of *Labeo dyocheilus*
**Crossocheilus reticulatus**

Adult *Crossocheilus reticulatus* (Fowler, 1934)
Reticulated barb

An omnivorous species found in fast-running water where there is a rocky substrate. Fish migrate longitudinally in schools from Cambodia to Lao PDR in December and January and laterally to the tributaries and floodplains during high water in June-July and back to the mainstream at the end of the flood season. This species has some importance as a food fish and is becoming common in the aquarium trade. It is caught with a variety of gears, including seines, set-nets, cast-nets, gill-nets, *lee* traps and *tone* traps. It grows to a maximum length of 17 cm.

*Main references:* Baird *et al*., 1999; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                           | Max | Min | Mode |
|---------------------------|-----|-----|------|
| Dorsal Fin Count          | 1,9 | 1,9 | 1,9  |
| Anal Fin Count            | 1,6 | 1,6 | 1,6  |
| Pectoral Fin Count        | i,9 | i,9 | i,9  |
| Pelvic Fin Count          | i,6 | i,6 | i,6  |
| Myomere Count             | 31  | 30  | 30   |
| Ratio between HL:SL       | 0.33| 0.31| 0.31 |
| Ratio between Sn-DF:SL    | 0.46| 0.46| 0.46 |
| Ratio between Sn-AF:SL    | 0.72| 0.72| 0.72 |
| Ratio between Sn-P₂,F:SL  | 0.53| 0.53| 0.53 |

**Ecology**

| Ecology                        | Morphological characteristics                | Pigmentation                                                                 |
|--------------------------------|-----------------------------------------------|------------------------------------------------------------------------------|
| Yolk-sac larva                 | Develops in floodplain habitats.              | Elongated yolk-sac with homogenous yolk.                                     |
| Pre-larva                      | Starts feeding on zooplankton at 4.3–4.7 mm in length. | Elongated body, sub-terminal mouth and long gut; 30–31 myomeres and 19–21 pre-anal myomeres. Barbels form by 16.8 mm. | No melanophores in small larvae to 9.0 mm, melanophores on snout and dorsally on head by 15.0 mm. Opposing pair of melanophores on dorsal and ventral margin of caudal-fin base which intensify with growth. Melanophore on ventral margin of tail started from 10.6 mm. |
| Post-larva                     | Carnivore.                                    | Elongated body, sub-terminal mouth and long gut.                             | Snout, dorsally on head and body, spreading to lateral surfaces by 23.2 mm, patch on opercle. Caudal-fin base and anal-fin base with dense melanophores, dorsal-fin membranes. |
Developmental stages of *Crossocheilus reticulatus*
Developmental stages of *Crossocheilus reticulatus*
Epalzeorhynchos frenatus

Adult *Epalzeorhynchos frenatus* (Fowler, 1934)
Rainbow sharkminnow

A mainly herbivorous fish, which is found in streams and rivers over sandy substrates. It migrates from Cambodia to southern Lao PDR in January-February and moves into seasonally flooded habitats and returns to rivers as floodwaters recede. It spawns in floodplains. Important in the aquarium trade and caught with various gears including seines, set-nets, cast-nets, gill-nets, *lee* traps and *tone* traps. It grows to 12 cm.

*Main references*: Baird et al., 1999; Rainboth, 1996.

| Meristics and morphometrics of larvae and juveniles | Max | Min | Mode |
|-----------------------------------------------------|-----|-----|------|
| Dorsal Fin Count | 1,12 | 1,11 | 1,11 |
| Anal Fin Count | 1,7 | 1,6 | 1,6 |
| Pectoral Fin Count | 1,9 | 1,9 | 1,9 |
| Pelvic Fin Count | i,5 | i,5 | i,5 |
| Myomere Count | 37 | 31 | 32 |
| Ratio between HL:SL | 0.3 | 0.3 | 0.3 |
| Ratio between Sn-DF:SL | 0.5 | 0.5 | 0.5 |
| Ratio between Sn-AF:SL | 0.75 | 0.75 | 0.75 |
| Ratio between Sn-P,F:SL | 0.53 | 0.53 | 0.53 |

Yolk-sac larva

- Develops in floodplain and riverine habitats.
- Elongated yolk-sac with homogenous yolk.
- No information available.

Pre-larva

- Starts feeding on zooplankton at 4.8–5.5 mm in length.
- Elongated body, terminal mouth with long gut; 31–37 myomeres and 21–24 pre-anal myomeres.
- On snout and dorsally on head. Dorsally over gut, with dark patch above pectoral fin. Laterally along trunk and tail, with melanophores along myosepta, caudal-fin base.

Post-larva

- Herbivore.
- Elongated body, with inferior mouth and long gut; gas bladder visible until 8.4 mm.
- Entire head and body pigmented except for ventral margin of head and gut. Dark line through snout and onto operculum from 12.5 mm. Caudal-fin base patch intensifies with growth. Dorsal-fin, pelvic-fin and anal-fin membranes.
Cyprinidae

Developmental stages of *Epalzeorhynchos frenatus*

- **Just hatched**
  - 3.1 mm
  - yolk-sac larva

- **12 hours**
  - 3.7 mm
  - yolk-sac larva

- **1 day**
  - 4.3 mm
  - pre-larva

- **2 days**
  - 4.5 mm
  - pre-larva

- **3 days**
  - 4.8 mm
  - pre-larva

- **7 days**
  - 5.6 mm
  - post-larva

- **9 days**
  - 6.0 mm
  - post-larva
Developmental stages of *Epalzeorhynchos frenatus*
**Garra cambodgiensis**

Adult *Garra cambodgiensis* (Tirant, 1883)
Stone-lapping minnow

An omnivorous species with a preference for algae. Found in fast flowing, small and medium sized streams with rocky substrates. Migrates to rice fields and floodplains in July–August for spawning and feeding. It feeds on periphyton, phytoplankton and some insects. Of limited use as food fish, but used in the aquarium trade. Caught with cast-nets, gill-nets, scoop-nets, tone traps and occasionally taken with seines. It attains a maximum length at 15 cm.

Main references: Baird et al., 1999; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                         | Max | Min | Mode |
|-------------------------|-----|-----|------|
| Dorsal Fin Count        | 1,9 | 1,9 | 1,9  |
| Anal Fin Count          | 1,6 | 1,6 | 1,6  |
| Pectoral Fin Count      | 1,10| 1,10| 1,10 |
| Pelvic Fin Count        | 1,6 | 1,6 | 1,6  |
| Myomere Count           | 36  | 32  | 34   |
| Ratio between HL:SL     | 0.31| 0.29| 0.31 |
| Ratio between Sn-DF:SL  | 0.50| 0.45| 0.48 |
| Ratio between Sn-AF:SL  | 0.79| 0.75| 0.76 |
| Ratio between Sn-P₂F:SL | 0.54| 0.51| 0.54 |

Ecology

| Yolk-sac larva | Ecology                   | Morphological characteristics       | Pigmentation                                 |
|---------------|---------------------------|-------------------------------------|----------------------------------------------|
|               | Develops in floodplain, swamp and riverine habitats. | Elongated yolk-sac with homogenous yolk. | No information available.                     |
| Pre-larva     | Starts feeding on phytoplankton at 4.6–6.1 mm in length. | Elongated body with terminal mouth and long gut; 32–36 myomeres and 23–26 pre-anal myomeres. Late forming pectoral-fin elements. | No pigmentation in early larvae until 4.1 mm. Melanophores dorsally on head and body from 4.5 mm. Stripe through snout, operculum, dorsally over gut and along ventral margin of tail. Mid-lateral series along trunk and tail, intensities with growth. Large spot laterally on caudal-fin base. |
| Post-larva    | Herbivore.                | Elongated body, with terminal mouth and long gut; gas bladder visible until 14.4 mm. | Pigment dorsally on head and body. Dark stripe from snout through operculum to mid-laterally along body. |
Developmental stages of *Garra cambodgiensis*
Developmental stages of *Garra cambodgiensis*
**Syncrossus helodes**

**Cobitidae**

Adult *Syncrossus helodes* (Sauvage, 1876)

Tiger botia

A nocturnally active carnivore, which is widely distributed in flowing waters of the Mekong Basin, where the substrate is covered with rocks or logs. It feeds on molluscs, worms, benthic insect larvae and planktonic crustaceans. A white fish species, which moves into flooded areas during the rainy season and returns to rivers during November and December. It is caught with artisanal and large scale gears, cast-nets, set-nets, traps, seines and drifting hook-with-float. It is also a common element in the *dai* (bag net) catches of the Tonle Sap. It is important as a food and also in the aquarium trade. Maximum length is about 25 cm.

*Main references:* Baird *et al.*, 1999; Bardach, 1959; Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                        | Max | Min | Mode |
|------------------------|-----|-----|------|
| Dorsal Fin Count       | 1,13| 1,12| 1,12 |
| Anal Fin Count         | 1,6 | 1,6 | 1,6  |
| Pectoral Fin Count     | i,12| i,12| i,12 |
| Pelvic Fin Count       | i,6 | i,5 | i,6  |
| Myomere Count          | 35  | 32  | 34   |
| Ratio between HL:SL    | 0.37| 0.35| 0.36 |
| Ratio between Sn-DF:SL | 0.58| 0.55| 0.55 |
| Ratio between Sn-AF:SL | 0.79| 0.77| 0.78 |
| Ratio between Sn-P,F:SL| 0.62| 0.58| 0.61 |

**Ecology**

| Yolk-sac larva | Morphological characteristics | Pigmentation |
|----------------|--------------------------------|--------------|
| Develops in floodplain habitats. | Elongated yolk-sac with homogenous yolk. | Melanophores on head. |

| Pre-larva | Morphological characteristics | Pigmentation |
|-----------|--------------------------------|--------------|
| Starts feeding on zooplankton at 3.3–3.8 mm in length. | Elongated body, with small superior mouth and long gut; 32–35 myomeres and 21–25 pre-anal myomeres. Barbels form by 14.2 mm. | Scattered melanophores on head and trunk in both early and older larvae, peritoneum with a row of melanophores. Melanophores are arranged in 6 bands from 13.3 mm. Dorsal fin and anal fin pigment develops on distal margins by 13.3 mm. |

| Post-larva | Morphological characteristics | Pigmentation |
|------------|--------------------------------|--------------|
| Carnivore. | Elongated body, with small superior mouth at the larval stage and modified to terminal in juvenile and long gut; gas bladder is visible until 10.5 mm. Suborbital spine forms at 10.5 mm. | Horizontal stripe through snout. Melanophores dorsally on head, 6–10 transverse bands along body, some extend to dorsal and anal fins. Juveniles have more than 10 transverse dark bands from nape to caudal fin. |
Developmental stages of *Syncrossus helodes*

- **12 hours**
  - 3.4 mm
  - yolk-sac larva

- **1 day**
  - 4.5 mm
  - pre-larva

- **2 days**
  - 4.7 mm
  - pre-larva

- **3 days**
  - 4.9 mm
  - pre-larva

- **5 days**
  - 5.2 mm
  - post-larva

- **7 days**
  - 5.8 mm
  - post-larva

- **9 days**
  - 7.1 mm
  - post-larva

- **12 days**
  - 11.4 mm
  - post-larva
Developmental stages of *Syncrossus helodes*
**Yasuhikotakia modesta**

Adult *Yasuhikotakia modesta* (Bleeker, 1864)  
Red-tail botia

A highly migratory nocturnal carnivore, which is found in large rivers with sand-mud substrates. It is primarily a mollusc eater, but also eats benthic insect larvae, worms and crustaceans. It migrates in large schools; it moves into small streams and inundated areas during high water periods and returns to rivers as water levels drop. Eggs are reported to be in fish from February to July throughout the distribution range. There is a strong peak around May-June, indicating that spawning takes place during this period. It is believed to spawn on or near floodplain areas. The eggs are grey-green and are semi-buoyant. After hatching, larvae live and forage near the hatching area, but will move to small canals and then to large rivers. A brood fish of about 130 g and 19.5 cm spawns 60,000–80,000 eggs. Taken by seines, traps, push-nets, cast-nets and drifting hook-with-float; it also forms a substantial part of the dai catches in the Tonle Sap in November and December and is one of the most important species in the tone trap fishery at the Khone Falls. It is very important both as a food and aquarium fish. Maximum length is 25 cm.

*Main references*: Baird *et al.*, 1999; Bardach, 1959; Khamtorn, 1999; Poulsen *et al.*, 2004; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                     | Max | Min | Mode |
|---------------------|-----|-----|------|
| Dorsal Fin Count    | 1,8 | 1,8 | 1,8  |
| Anal Fin Count      | 1,5 | 1,5 | 1,5  |
| Pectoral Fin Count  | 1,10| 1,9 | 1,10 |
| Pelvic Fin Count    | 1,5 | 1,5 | 1,5  |
| Myomere Count       | 36  | 33  | 34   |
| Ratio between HL:SL | 0.38| 0.33| 0.36 |
| Ratio between Sn-DF:SL | 0.57| 0.52| 0.56 |
| Ratio between Sn-AF:SL | 0.78| 0.75| 0.76 |
| Ratio between Sn-P,F:SL | 0.61| 0.55| 0.60 |

| Yolk-sac larva | Ecology                                    | Morphological characteristics                                      | Pigmentation                                           |
|---------------|--------------------------------------------|---------------------------------------------------------------------|-------------------------------------------------------|
|               | Develops on floodplain and wetland habitats.| Elongated yolk-sac with homogenous yolk.                            | Melanophores on head and trunk.                      |
| Pre-larva     | Starts feeding on zooplankton at 3.3–3.7 mm in length. | Elongated body, with terminal mouth and long gut; 33–36 myomeres and 22–25 pre-anal myomeres. Barbels form by 12.5 mm. | Horizontal stripe on snout. Scattered melanophores on head and body form bands by 11.3 mm. |
| Post-larva    | Carnivore.                                 | Elongated body, with small superior mouth and long gut; gas bladder is visible until 5.7 mm. Suborbital spine forms at 11.8 mm. | Horizontal stripe on snout, 6 vertical bands on trunk and tail, the third band extends onto dorsal-fin spine. Fine melanophores in middle of dorsal fin. |
Developmental stages of *Yasuhikotakia modesta*
Developmental stages of *Yasuhikotakia modesta*
Yasuhikotakia nigrolineata

Adult *Yasuhikotakia nigrolineata* (Kottelat and Chu, 1987)
Black-lined loach

An omnivorous schooling species found in small muddy lakes and other standing water habitats; it feeds on aquatic invertebrates including worms, crustaceans, insects and also plant matter. It is an uncommon species. Not fished commercially, but highly regarded as aquarium fish. Maximum length is 5.5 cm.

*Main references:* Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | 1.9 | 1.8 | 1.8  |
| Anal Fin Count       | 1.5 | 1.5 | 1.5  |
| Pectoral Fin Count   | i.9 | i.9 | i.9  |
| Pelvic Fin Count     | i.5 | i.5 | i.5  |
| Myomere Count        | 30  | 30  | 30   |
| Ratio between HL:SL  | 0.31| 0.31| 0.31 |
| Ratio between Sn-DF:SL| 0.52| 0.52| 0.52 |
| Ratio between Sn-AF:SL| 0.76| 0.76| 0.76 |
| Ratio between Sn-P,F:SL| 0.57| 0.57| 0.57 |

|                      | Ecology                       | Morphological characteristics                                                                 | Pigmentation                                                                                     |
|----------------------|-------------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Yolk-sac larva       | Develops in streams and on floodplain. | Elongated yolk-sac with homogenous yolk.                                                          | No melanophores on head or trunk.                                                               |
| Pre-larva            | Starts feeding on zooplankton at 3–3.2 mm in length. | Elongated body, with moderate mouth and long gut; 30 myomeres and 22 pre-anal myomeres. Barbels form at 15.0 mm. | Scattered, large melanophores dorsally on head and body. Stripe runs from snout through operculum, dorsally over gut. Opposing pair of dark patches on dorsal and ventral margins of caudal peduncle. Large patch laterally on caudal-fin base. |
| Post-larva           | Omnivore.                     | Elongated body, with terminal mouth and long gut. Suborbital spine forms at 13.2 mm.             | Horizontal stripe through snout and operculum. Dorsally on head and body. Large patches mid-laterally that fuse into a discontinuous stripe by 23.8 mm. Patch on caudal peduncle is largest. |
Developmental stages of *Yasuhikotakia nigrolineata*
Developmental stages of *Yasuhikotakia nigrolineata*
**Gyrinocheilus aymonieri**  

Adult *Gyrinocheilus aymonieri* (Tirant, 1883)  
Asian algae eater

An omnivorous species found basin-wide on hard surfaces in tributaries, where it holds on to fixed objects with its sucker-like mouth. Its diet consists largely of mud detritus, algae, periphyton and phytoplankton, but it also feeds on insect larvae and zooplankton. It is caught with seines, trawls, set-nets, traps, or gill nets. It is of some importance as a food. Large individuals are sold in markets; smaller ones are used to make prahoc (salted fish). Its maximum length is 20 cm.

*Main references:* Bardach 1959; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| **Dorsal Fin Count**     | 1,10| 1,9 | 1,9  |
| **Anal Fin Count**       | 1,5 | 1,5 | 1,5  |
| **Pectoral Fin Count**   | 9   | 9   |      |
| **Pelvic Fin Count**     | 1,7 | 1,6 | 1,6  |
| **Myomere Count**        | 35  | 32  | 33   |
| **Ratio between HL:SL**  | 0.32| 0.32| 0.32 |
| **Ratio between Sn-DF:SL**| 0.47| 0.47| 0.47 |
| **Ratio between Sn-AF:SL**| 0.78| 0.78| 0.78 |
| **Ratio between Sn-P,AF:SL**| 0.56| 0.56| 0.56 |

**Ecology**  
Develops in floodplain and riverine habitats.

**Morphological characteristics**  
Elongated yolk-sac with homogenous yolk, contains oil globules.

**Pigmentation**  
No information available.

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**Yolk-sac Larva**  
Develops in floodplain and riverine habitats.

**Pre-larva**  
Starts feeding on phytoplankton at 4.5–5.4 mm in length.  
Elongated body, with terminal mouth and long gut; 32–35 myomeres and 24–28 pre-anal myomeres.  
Anterior insertion of pectoral fin, posterior placement of anal fin.  
Body depth rapidly reduce at midgut.

**Post-larva**  
Herbivore.  
Elongated body, with inferior mouth and long gut.

**Ecology**  
Herbivore.

**Morphological characteristics**  
Elongated body, with inferior mouth and long gut.

**Pigmentation**  
Snout and maxilla, dorsally on head and body. Dark mid-lateral stripe along body and through snout.
Developmental stages of *Gyrinocheilus aymonieri*
Developmental stages of *Gyrinocheilus aymonieri*
**Pseudomystus siamensis**

**Bagridae**

Adult *Pseudomystus siamensis* (Regan, 1913)
Asian bumblebee catfish

An omnivorous species that does not undertake longitudinal migrations, but migrates into flooded areas during the high water season. Found in rivers and streams and seasonally in flooded areas. It feeds on insects, aquatic insect larvae, including odonatans, fish and large crustaceans, earthworms, snails, roots, fruits and detritus. It probably spawns throughout the rainy season; adult females have well-developed ova in February and spawning takes place at the beginning of the rainy season, with the young being caught during August. However the presence of eggs in adult fish in July and August indicates that the spawning season is protracted. It is sexually mature at 13 cm and 20 g. It is caught with seines, gill-nets and traps. Maximum length is about 17 cm.

Main references: Baird and Phylavanh, 1999; Bardach, 1959; Kottelat, 1998; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | 1.7 | 1.7 | 1.7  |
| Anal Fin Count           | V,12| III,10| V,11 |
| Pectoral Fin Count       | 1.8 | 1.7 | 1.8  |
| Pelvic Fin Count         | i,5 | i,5 | i,5  |
| Myomere Count            | 40  | 37  | 38   |
| Ratio between HL:SL      | 0.36| 0.36| 0.36 |
| Ratio between Sn-DF:SL   | 0.38| 0.38| 0.38 |
| Ratio between Sn-AF:SL   | 0.64| 0.64| 0.64 |
| Ratio between Sn-P,F:SL  | 0.56| 0.56| 0.56 |

**Ecology**

**Yolk-sac larva**
Develops in riverine habitats.

**Morphological characteristics**
Round yolk-sac with homogenous yolk.

**Pigmentation**
Melanophores on head and trunk.

**Pre-larva**
Starts feeding on zooplankton at 5.8–7.6 mm in length.

Elongated body, with inferior mouth and short gut; 37–40 myomeres and 13–15 pre-anal myomeres.
Short dorsal fin.
Barbels form by 4.0 mm.

Head and body heavily pigmented except for ventral portions of head and gut. Caudal-fin heavily pigmented. As larvae develop, pigment spreads to all fins and into patches of dense pigment as they approach the juvenile stage.

**Post-larva**
Carnivore.

Elongated body, with inferior mouth and moderately long gut.
Long adipose fin.

Patchy dense pigment similar to adult pigment.
Developmental stages of *Pseudomyustus siamensis*
Developmental stages of *Pseudomystus siamensis*
**Mystus albolineatus**

Adult *Mystus albolineatus* Roberts, 1994
Striped mystus

An omnivorous species known from flowing and standing waters especially around submerged woody vegetation. It feeds on insect larvae, including chironomid worms, as well as zooplankton and fishes. It spawns just prior to, or at the onset of the rainy season and its young are first seen in July and August. It is caught with nets and traps and is brought to the market fresh or smoked forms. Maximum length is 25 cm.

*Main reference:* Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | 1,7 | 1,7 | 1,7  |
| Anal Fin Count           | III,8 | III,8 | III,8 |
| Pectoral Fin Count       | i,9 | i,9 | i,9  |
| Pelvic Fin Count         | i,5 | i,5 | i,5  |
| Myomere Count            | 50  | 48  | 48   |
| Ratio between HL:SL      | 0.31| 0.31| 0.31 |
| Ratio between Sn-DF:SL   | 0.33| 0.33| 0.33 |
| Ratio between Sn-AF:SL   | 0.65| 0.65| 0.65 |
| Ratio between Sn-P,F:SL  | 0.50| 0.50| 0.50 |
| Ratio between Sn-P,F:SL  | 0.51| 0.51| 0.51 |

| Yolk-sac Larva | Ecology | Morphological characteristics | Pigmentation |
|----------------|---------|--------------------------------|--------------|
|                | Develops on floodplain. | Ovoid yolk-sac with homogenous yolk. | Melanophores on dorsal part of head and trunk. |
| Pre-larva      | Starts feeding on zooplankton at 4–4.6 mm in length. | Elongated body, with terminal mouth and loop; has 38–43 myomeres and 12–15 pre-anal myomeres. Barbel form by 4.5 mm. Serrate dorsal spine by 17.0 mm. | Uniform pigment on head and body, except no pigment ventrally on head and gut. Darker patches above eyes and over gas bladder. |
| Post-larva     | Carnivore. | Elongated body, with terminal mouth. Maximally barbel reaches after anus by 15.8 mm. Long adipose fin. | Uniform pigment over head and body, except ventral surface of head and gut. Mid-lateral un-pigmented stripe on trunk and tail appears by 25.0 mm. Dorsal-fin membrane pigmented by 17.5 mm. |
Developmental stages of *Mystus albolineatus*
Developmental stages of *Mystus albolineatus*

- **21 days**
  - 21.6 mm
  - post-larva

- **27 days**
  - 27.6 mm
  - post-larva

- **35 days**
  - 33.0 mm
  - post-larva

- **40 days**
  - 37.1 mm
  - juvenile
**Mystus gulio**

Adult *Mystus gulio* (Hamilton, 1822)
Long whiskers catfish

A diurnally active, brackish water species which enters large rivers. It is also known as the lower Mekong Catfish. Occurs in the Mekong delta and near the mouth of the Tonle Sap River. Caught with seines, cast-nets and gill-nets; marketed fresh or smoked. Maximum length is 40 cm.

*Main references:* Rainboth, 1996; Sanchandang, 2001.

### Meristics and morphometrics of larvae and juveniles

|                          | Max   | Min   | Mode |
|--------------------------|-------|-------|------|
| Dorsal Fin Count         | 1,7   | 1,7   | 1,7  |
| Anal Fin Count           | V,10  | III,8 | IV,9 |
| Pectoral Fin Count       | i,8   | i,7   | i,8  |
| Pelvic Fin Count         | i,5   | i,5   | i,5  |
| Myomere Count            | 36    | 35    | 36   |
| Ratio between HL:SL      | 0.32  | 0.29  | 0.30 |
| Ratio between Sn-DF:SL   | 0.38  | 0.35  | 0.37 |
| Ratio between Sn-AF:SL   | 0.68  | 0.61  | 0.66 |
| Ratio between Sn-P,F:SL  | 0.71  | 0.55  | 0.68 |
| Ratio between Sn-P,F:SL  | 0.56  | 0.52  | 0.54 |

### Ecology

| Yolk-sac Larva | Pre-larva | Post-larva |
|----------------|-----------|------------|
| Develops in freshwater on floodplain. | Starts feeding on zooplankton at 3.7–4.2 mm in length. | Carnivore. |
| Ovoid yolk-sac with homogenous yolk. | Terminal mouth; 39–42 myomeres and 13–14 pre-anal myomeres. | Elongated body with small terminal month. |
| Melanophores on dorsal part of head and trunk. | Evenly-distributed melanophores over entire head and body, except ventrally on head and gut. Body pigment spreads to dorsal adipose, caudal and anal fins. | Entire head and trunk, heaviest dorsally and absent ventrally on head and gut. Dark spot above pectoral fin. Unpigmented stripe along lateral mid-line. |
Developmental stages of *Mystus gulio*
Developmental stages of *Mystus gulio*
**Mystus mysticetus**

Adult *Mystus mysticetus* Roberts, 1992  
Striped mystus

A carnivorous catfish. Often found in mixed schools with *M. multiradiatus*, which congregate around tree limbs and other solid objects, browsing the hard surfaces. It feeds on insect larvae, worms, freshwater prawns, small fishes, zooplankton, aquatic insects, crustaceans and rotifers. It moves into flooded forests during the rainy season. The spawning period is from April to August. It is mature at a length of 11–12 cm. The eggs are spherical, yellow in colour, demersal and attached to the substrate. It is taken with seines, cast-nets, gill-nets, set-nets and traps. It is sold fresh or smoked and also as an aquarium fish. It grows to a maximum length of 13 cm.

*Main references:* Pongsirijun et al., 2002; Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                     | Max | Min | Mode |
|---------------------|-----|-----|------|
| Dorsal Fin Count    | 1,7 | 1,7 | 1,7  |
| Anal Fin Count      | IV,11 | III,8 | IV,10 |
| Pectoral Fin Count  | 1,9 | 1,8 | 1,9  |
| Pelvic Fin Count    | i,5 | i,5 | i,5  |
| Myomere Count       | 37  | 36  | 36   |
| Ratio between HL:SL | 0.31 | 0.31 | 0.31 |
| Ratio between Sn-DF:SL | 0.33 | 0.33 | 0.33 |
| Ratio between Sn-AF:SL | 0.65 | 0.65 | 0.65 |
| Ratio between Sn-P,F:SL | 0.64 | 0.64 | 0.64 |
| Ratio between Sn-P,F:SL | 0.48 | 0.48 | 0.48 |

**Ecology**  
**Morphological characteristics**  
**Pigmentation**

| Yolk-sac larva | Develops in wetland areas. | Elongated yolk-sac with homogenous yolk. | Melanophores on head and trunk. |
|----------------|----------------------------|----------------------------------------|--------------------------------|
| Pre-larva      | Starts feeding on zooplankton at 6.5–7.4 mm in length. | Elongated body, with small slightly inferior mouth and spherical or gut loop; 36–37 myomeres and 12–14 pre-anal myomeres. Early-forming barbels about 4.0 mm. | Evenly-distributed melanophores dorsally and laterally on head and trunk and entire tail. |
| Post-larva     | Carnivore. | Elongated body, with small slightly inferior mouth; gas bladder visible until 13.9 mm. | Uniform pigment becomes broken by longitudinal line of unpigmented areas along trunk and tail. |
Developmental stages of *Mystus mysticetus*
Developmental stages of *Mystus mysticetus*
**Hemibagrus filamentus**

**Adult Hemibagrus filamentus (Fang & Chaux, 1949)**

Black mystus

A common carnivore, in both rivers and standing waters; occurs in rapids, deeper slow reaches and standing waters. It feeds on fishes and crustaceans including crabs, shrimps and planktonic crustaceans and it also eats aquatic insect larvae, mud and plant fragments. Undertakes shorter local reproductive migrations within the Mekong mainstream at the onset of the flood season; as the water level rises it continues into small seasonal tributaries and flooded forests. When water levels start to recede at the end of the flood season, fish return to the main river channel where they spend the dry season. This species probably breeds through most of the year with a peak in the rainy season when it spawns on the floodplain. It is caught basin-wide with seines, hook-and-line, gill-nets, set-nets and in *tone, chan, kha* and *lee* traps at the Khone Falls. It has some importance as food and is marketed fresh.

**Main references:** Bardach, 1959; Poulsen et al., 2004; Rainboth, 1996; Singanouvong et al., 1996.

**Meristics and morphometrics of larvae and juveniles**

|                        | Max | Min | Mode |
|------------------------|-----|-----|------|
| Dorsal Fin Count       | I,7 | I,7 | I,7  |
| Anal Fin Count         | IV,9| III,7| IV,8 |
| Pectoral Fin Count     | I,9 | I,8 | I,9  |
| Pelvic Fin Count       | I,5 | I,5 | I,5  |
| Myomere Count          | 42  | 39  | 40   |
| Ratio between HL:SL    | 0.31| 0.31| 0.31 |
| Ratio between Sn-DF:SL | 0.34| 0.34| 0.34 |
| Ratio between Sn-AF:SL | 0.66| 0.66| 0.66 |
| Ratio between Sn-AF:SL | 0.64| 0.64| 0.64 |
| Ratio between Sn-P,F:SL| 0.61| 0.60| 0.60 |

**Ecology**

| Yolk-sac larva | Develops in floodplain habitats and swamps. | Round yolk-sac with homogenous yolk. | Melanophores on head and trunk. |
|---------------|---------------------------------------------|------------------------------------|-------------------------------|
| Pre-larva     | Starts feeding on zooplankton at 5.0–5.7 mm in length. | Elongated body with a deep gut (BD = 17% SL) that reach about 71% of SL; 39–42 myomeres and 13–17 pre-anal myomeres. Inferior mouth. Barbels present by 4.2 mm. | Melanophores evenly distributed over head and body. Pigment dorsally over gut. Pigment spreads to adipose, dorsal and anal fins as larvae develop. |
| Post-larva    | Carnivore. | Elongated body with inferior mouth. | Entire head and body, plus dorsal and adipose fins. |
Developmental stages of *Hemibagrus filamentus*
Developmental stages of *Hemibagrus filamentus*
**Hemibagrus wyckioides**

Adult *Hemibagrus wyckioides* (Fang and Chaux, 1949)  
Red-tail catfish

A carnivorous species that occurs in large upland and lowland rivers with an irregular substrate. Occurs most commonly in areas with irregular depths, tree roots and rocky substrates. It feeds on shrimps, fishes, crabs, insects, earthworms and snails. It is, at least locally, a migratory fish; although it is indicated as a black fish species it has been found to migrate upstream, it also enters inundated areas. The migration seems to be for dispersal and feeding. It is usually caught by hook-and-line, less often by drift gill-nets and seines; the hooks are often baited with live fish such as *Gyrinocheilus pennocki* or *Clarias batrachus*. It is also one of the most important species in the *lee* trap fisheries in southern Lao PDR. It is commercially high-valued species which is marketed fresh. Maximum length is about 65 cm.

*Main references*: Baird and Phylavanh, 1999; Rainboth, 1996; Singanouvong *et al.*, 1996.

Meristics and morphometrics of larvae and juveniles

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | 1,7 | 1,7 | 1,7  |
| Anal Fin Count       | IV,11 | III,8 | IV,10 |
| Pectoral Fin Count   | 1,9 | 1,8 | 1,9  |
| Pelvic Fin Count     | 1,5 | 1,5 | 1,5  |
| Myomere Count        | 44  | 38  | 42   |
| Ratio between HL:SL  | 0.28 | 0.28 | 0.28 |
| Ratio between Sn-DF:SL | 0.36 | 0.36 | 0.36 |
| Ratio between Sn-AF:SL | 0.63 | 0.63 | 0.63 |
| Ratio between Sn-P,F:SL | 0.58 | 0.58 | 0.58 |

| Ecology | Morphological characteristics | Pigmentation |
|---------|--------------------------------|--------------|
| **Yolk-sac larva** Develops in floodplain habitats. | Round yolk-sac with homogenous yolk. | Melanophores on head and stomach. |
| **Pre-larva** Starts feeding on zooplankton at 4.0–4.7 mm in length. | Elongated body with inferior mouth and gut; gas bladder visible until 15.0 mm; 41–46 myomeres and 14–18 pre-anal myomeres. Barbels are formed at 3.1 mm. | Scattered melanophores dorsally and laterally on head. Series along dorsal mid-line and mid-laterally along trunk. Pigment over anterior half of gut. Dorsal pigmentation intensifies with growth. |
| **Post-larva** Carnivore. | Elongated body, with a wide inferior mouth and gut. | Pigment on head and body intensified to all surfaces of head and except ventrally on head and gut. |
Developmental stages of *Hemibagrus wyckioides*
Developmental stages of *Hemibagrus wyckioides*
**Mystus bocourti**

Adult *Mystus bocourti* (Bleeker, 1864)
Golden mystus

A carnivorous non-migratory species, common in the Tonle Sap near the Great Lake. It feeds on crustaceans and benthic invertebrates. It is caught with seines, cast-nets and gill-nets; of some importance as food and usually marketed fresh. It grows to a maximum length of 24 cm.

*Main reference:* Rainboth, 1996.

| Meristics and morphometrics of larvae and juveniles |
|----------------------------------------------------|
| **Dorsal Fin Count** | Max: 1,7 | Min: 1,7 | Mode: 1,7 |
| **Anal Fin Count** | Max: II,13 | Min: II,11 | Mode: II,12 |
| **Pectoral Fin Count** | Max: 1,8 | Min: 1,7 | Mode: 1,7-8 |
| **Pelvic Fin Count** | Max: i,5 | Min: i,5 | Mode: i,5 |
| **Myomere Count** | Max: 47 | Min: 45 | Mode: 46 |
| **Ratio between HL:SL** | Max: 0.30 | Min: 0.30 | Mode: 0.30 |
| **Ratio between Sn-DF:SL** | Max: 0.30 | Min: 0.30 | Mode: 0.30 |
| **Ratio between Sn-AF:SL** | Max: 0.69 | Min: 0.69 | Mode: 0.69 |
| **Ratio between Sn-PF:SL** | Max: 0.48 | Min: 0.48 | Mode: 0.48 |

| Ecology | Morphological characteristics | Pigmentation |
|---------|-------------------------------|--------------|
| Yolk-sac Larva | Develops in wetland areas. | Spherical yolk-sac with homogenous yolk. | Melanophores on head and trunk. |
| Pre-larva | Starts feeding on zooplankton at 8.3–9.2 mm in length. | Elongated body, with small terminal mouth; 45–47 myomeres and 22–25 pre-anal myomeres. Barbels present by 3.5 mm. | Diffuse melanophores dorsally on head and trunk and over entire tail. |
| Post-larva | Carnivore. | Elongated body, with a small, looks inferior mouth and long gut. The gas bladder is visible until 10.2 mm. The dorsal spine is not serrate. | Melanophores intensify with growth but do not extend onto the fins. |
Developmental stages of *Mystus bocourti* from natural collection
Developmental stages of *Mystus bocourti* from natural collection
**Belodontichthys truncatus**

Adult *Belodontichthys truncatus* Kottelat & Ng, 1999

Sharp-tooth sheat fish

A carnivore with a preference for fish. It is widely distributed in large rivers of the Mekong Basin, found from middle depths to the surface in deeper parts of large rivers. The dry season habitat appears to be rapids and rocky areas. It feeds mainly on smaller fishes near the water surface, but also takes ants, leaves and bark. It is classified as a white fish species, which migrates for feeding. Fishers report that this species enters flooded forests and streams in the high-water season. The length at first maturity is around 55 cm. It apparently spawns in the early flood although it is not known where it spawns. It can be taken by hook-and-line, but is usually caught by cast-nets, gill-nets, or seines. Individuals 10–50 cm long are abundant in the *dai* fishery. It is one of the most important fishes in the *lee* trap fishery in southern Lao PDR; an excellent game fish which may be caught using hook and line. It is a very important species in the fisheries. It is marketed fresh or dried and salted; around the Great Lake it is put on ice for export to Thailand. Maximum length is about 70 cm.

*Main references:* Baird and Phylavanh, 1999; Bardach, 1959; Rainboth, 1996; Singanouvong *et al.*, 1996.

Meristics and morphometrics of larvae and juveniles

|                         | Max | Min | Mode |
|-------------------------|-----|-----|------|
| Dorsal Fin Count        | 1,3 | 1,2 | 1,2  |
| Anal Fin Count          | 1,89| 1,83| 1,85 |
| Pectoral Fin Count      | 1,12| 1,10| 1,12 |
| Pelvic Fin Count        | 1,6 | 1,6 | 1,6  |
| Myomere Count           | 65  | 60  | 62   |
| Ratio between HL:SL     | 0.25| 0.25| 0.25 |
| Ratio between Sn-DF:SL  | 0.36| 0.35| 0.35 |
| Ratio between Sn-AF:SL  | 0.44| 0.43| 0.43 |
| Ratio between Sn-P,F:SL | 0   | 0   | 0    |

**Ecology**

| Yolk-sac larva          | Morphological characteristics | Pigmentation          |
|-------------------------|-------------------------------|-----------------------|
| Develops in floodplain and riverine habitats. | Ovoid yolk-sac with homogenous yolk. | Melanophores on head. |

| Pre-larva                | Morphological characteristics | Pigmentation          |
|--------------------------|-------------------------------|-----------------------|
| Starts feeding on zooplankton at 6.8–7.7 mm in length. | Elongated body, with terminal mouth and triangular gut; 60–65 myomeres and 16–20 pre-anal myomeres. Barbels form by 6.0 mm. Very short dorsal fin and long anal fin. | Early larvae only have melanophores on head, whereas older larvae have melanophores on head and laterally on the gut. Stripes along dorsal and lateral mid-lines form at 10.8 mm. |

| Post-larva               | Morphological characteristics | Pigmentation          |
|--------------------------|-------------------------------|-----------------------|
| Carnivore.               | Elongated body, with superior mouth and short gut. | Dorsal mid-line stippled from head to tail. Lateral mid-line stippled from trunk to tail. Ventral mid-line stippled. |
Developmental stages of *Belodontichthys truncatus*
Developmental stages of *Belodontichthys truncatus*

9 days
13.2 mm
post-larva

12 days
16.6 mm
post-larva

15 days
18.6 mm
post-larva

21 days
21.4 mm
post-larva

31 days
24.9 mm
post-larva

40 days
42.3 mm
juvenile
**Phalacronotus apogon**

Adult *Phalacronotus apogon* (Bleeker, 1851)
Silver sheat fish

A carnivorous species that occurs throughout the mainstream and in some large tributaries with turbid waters and adjacent streams and canals. It feeds on pelagic fishes and large crustaceans in mid to surface water. This is a white fish that moves into flooded riparian forests and probably into floodplains during high water levels. It spawns throughout the flood season. Young fish begin to move back to the rivers in October, where they remain common until January. It is caught with seines, gill-nets and hook-and-line. It is an important food fish sold fresh, dried and salted. It is one of the principal economic species in Cambodia. It grows to a maximum length of 77 cm.

*Main references:* Bardach, 1959; Kottelat, 1998; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                     | Max | Min | Mode |
|---------------------|-----|-----|------|
| Dorsal Fin Count    | i,2 | 0   | 0    |
| Anal Fin Count      | i,90| i,78| i,85 |
| Pectoral Fin Count  | i,10| i,9 | i,9  |
| Pelvic Fin Count    | i,6 | i,5 | i,5  |
| Myomere Count       | 65  | 60  | 62   |
| Ratio between HL:SL | 0.21| 0.21| 0.21 |
| Ratio between Sn-DF:SL | 0.31| 0.30| 0.31 |
| Ratio between Sn-AF:SL | 0.36| 0.36| 0.36 |
| Ratio between Sn-P,F:SL | 0.31| 0.31| 0.31 |

| Ecology                          | Morphological characteristics                                                                 | Pigmentation                                                    |
|----------------------------------|---------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| Yolk-sac larva                   | Develops in floodplain and riverine habitats.                                               | Ovoid yolk-sac with homogenous yolk.                            |
|                                  |                                              | Melanophores on head and trunk                                 |
| Pre-larva                        | Starts feeding on zooplankton at 6.7–8.0 mm in length.                                      | Elongate body, with terminal mouth and short gut; 60–65 myomeres and 11–16 pre-anal myomeres. Barbels form by 5.0 mm. Dorsal-fin form by 9.6 mm and reduce their size or disappear in juvenile, long anal fin. | Dorsal on head and diffuse laterally. Dorsolateral stripe on trunk and most of tail. Ventro-lateral stripe on tail. |
| Post-larva                       | Carnivore.                                                                                  | Elongate body, with terminal mouth and short gut to 33% SL percent of standard length. | Dorsally and laterally on head and body. Ventral mid-line series on tail. |
Developmental stages of *Phalacronotus apogon*
Developmental stages of *Phalacronotus apogon*
*Phalacronotus bleekeri*

Adult *Phalacronotus bleekeri* (Günther, 1864)
Bleeker’s sheat fish

A predominantly carnivorous species, occurring in both flowing and standing water throughout the LMB in rivers, streams, lakes and impoundments, with a preference for rapids and faster flowing waters. It feeds on small fishes, shrimps, aquatic insect larvae and leaves. Deep pools are important dry season habitats. It migrates upstream in May-July, mainly for reproduction. It also undertakes lateral migrations from the main river into smaller tributaries and inundated riverine habitats at the onset of the flood season. It returns to the main river channel when water starts to recede at the beginning of the dry season. Below Khone Falls, these lateral migrations are followed by a longitudinal migration within the mainstream. The purpose of this upstream migration is reportedly to find a deep pool where it can spend the dry season. It mainly carries eggs in May and June, corresponding to a spawning period in May-August. Eggs have been reported in females from 320 g (length about 22 cm). It is taken by seines, gill-nets, or hook-and-line and mainly sold fresh. It attains a maximum length of 60 cm.

*Main references*: Baird and Phylavanh, 1999; Poulsen et al., 2004; Rainboth, 1996; Singanouvong et al., 1996.

Meristics and morphometrics of larvae and juveniles

|                           | Max | Min | Mode |
|---------------------------|-----|-----|------|
| Dorsal Fin Count          | 1,2 | 0   | 0    |
| Anal Fin Count            | 1,77| 1,85| 1,80 |
| Pectoral Fin Count        | 1,9 | 1,9 | 1,9  |
| Pelvic Fin Count          | 1,5 | 1,5 | 1,5  |
| Myomere Count             | 56  | 54  | 55   |
| Ratio between HL:SL       | 0.22| 0.22| 0.22 |
| Ratio between Sn-DF:SL    | 0.32| 0.32| 0.32 |
| Ratio between Sn-AF:SL    | 0.37| 0.37| 0.37 |
| Ratio between Sn-P,F:SL   | 0.31| 0.31| 0.31 |

| Yolk-sac larva | Ecology                        | Morphological characteristics                                                                 | Pigmentation                                      |
|----------------|--------------------------------|------------------------------------------------------------------------------------------------|---------------------------------------------------|
|                | Develops in wetland areas.     | Ovoid yolk-sac with homogenous yolk; contains pigmented oil globules.                               | Melanophores on head and trunk.                   |
| Pre-larva      | Starts feeding on zooplankton at 5.5–6.3 mm in length. | Elongated body with terminal mouth; 54–56 myomeres and 12–14 pre-anal myomeres. Shot dorsal fin and long anal fin. | Melanophores dorsally and laterally on head and body and ventrally on tail. A dorsolateral and ventro-lateral stripe on the posterior half of the tail. A row of melanophores dorsal to the gut. |
| Post-larva     | Carnivore.                     | Elongated body with terminal mouth.                                                               | Dorsally and laterally on head and body, ventrally on tail. Dorsolateral stripe on tail absent by 29.4 mm. |
Developmental stages of *Phalacronotus bleekeri*
Developmental stages of *Phalacronotus bleekeri*
Wallago micropogon

Adult Wallago micropogon Ng, 2004
Black giant sheat fish

A carnivore, which lives in large streams and rivers throughout the basin; less common than Wallago attu. It enters flooded forest in high water and stays near the edge of the forest in low water. Schooling behaviour has also been observed outside the Mekong basin in the Kapuas River where its congener W. leerii used to form large migratory schools. Its apparently migrates into smaller streams to spawn when the water level starts rising after strong rain. Eggs have been observed in fish from April to October, with the majority of observations between May and July. It is reported to spawn in flooded grassland in July, at night, and it breeds in deeper water than Wallago attu. During spawning the fish swim in pairs and the eggs are spawned near the surface. It is caught with seines, gill-nets, hooks, and by explosives in northern Cambodia. It is usually marketed fresh. It attains a maximum length of 145 cm.

Main references: Poulsen et al., 2004; Rainboth, 1996; Roberts, 1989; Roberts, 1993.

Meristics and morphometrics of larvae and juveniles

|                               | Max  | Min  | Mode |
|-------------------------------|------|------|------|
| Dorsal Fin Count              | i,4  | i,4  | i,4  |
| Anal Fin Count                | i,58 | i,52 | i,55 |
| Pectoral Fin Count            | i,9  | i,8  | i,9  |
| Pelvic Fin Count              | i,5  | i,5  | i,5  |
| Myomere Count                 | 61   | 58   | 60   |
| Ratio between HL:SL           | 0.32 | 0.32 | 0.32 |
| Ratio between Sn-DF:SL        | 0.39 | 0.39 | 0.39 |
| Ratio between Sn-AF:SL        | 0.46 | 0.46 | 0.46 |
| Ratio between Sn-P_{2}F:SL    | 0.40 | 0.40 | 0.40 |

Ecology

| Yolk-sac larva | Ecology                                      | Morphological characteristics            | Pigmentation                |
|----------------|----------------------------------------------|-------------------------------------------|-----------------------------|
|                | Develops in wetland and floodplain habitats. | Ovoid yolk-sac with homogenous yolk.      | Melanophores on head.       |
| Pre-larva      | Starts feeding on zooplankton at 6.4–7.8 mm in length. | Elongated body, with large and terminal mouth, triangular gut, with gas bladder visible; 58–61 myomeres and 14–16 pre-anal myomeres. Short dorsal fin and long anal fin. Barbels form by 5.4 mm. | Early larvae have melanophores on head and on tail, older larvae from 7.4 mm have melanophores on head and trunk. Pectoral fin has fine melanophores by 17.7 mm. Mid-lateral stripe along trunk and tail. Along base of anal fin there is a longitudinal stripe which is absent by 29.1 mm. |
| Post-larva     | Carnivore.                                   | Elongated body with large and terminal mouth. | Uniform pigment over head and body. Pectoral fin pigmented. Dorsal and anal fins become pigmented by 32.5 mm. |
Developmental stages of *Wallago micropogon*
Developmental stages of *Wallago micropogon*
**Laides longibarbis**

Adult *Laides longibarbis* (Fowler, 1934)  
Flat-barbel catfish

An omnivorous species found in large rivers with turbid and slow or standing waters. It feeds on forest fruits and vegetation, along with insects, fish, zooplankton and detritus. A possible migrant that can be found in medium-sized rivers and may be found in flooded riparian forests where the water has a pronounced current. It is reported to inhabit deep pools for at least part of the year. It is caught with seines, cast-nets, traps, lift nets and hook-and-line. It is marketed fresh. It grows to a maximum length of 17 cm.

*Main references:* Baird and Phylavanh, 1999; Kottelat, 1998; Rainboth, 1996; Termvidchakorn, 1997.

**Meristics and morphometrics of larvae and juveniles**

|                  | Max  | Min  | Mode |
|------------------|------|------|------|
| Dorsal Fin Count | 1.6  | 1.5  | 1.5  |
| Anal Fin Count   | 1.44 | 1.42 | 1.42 |
| Pectoral Fin Count | 1.9  | 1.8  | 1.8  |
| Pelvic Fin Count | 1.5  | 1.5  | 1.5  |
| Myomere Count    | 45   | 40   | 44   |
| Ratio between HL:SL | 0.27 | 0.27 | 0.27 |
| Ratio between Sn-DF:SL | 0.34 | 0.34 | 0.34 |
| Ratio between Sn-AF:SL | 0.52 | 0.52 | 0.52 |
| Ratio between Sn-P,F:SL | 0.76 | 0.76 | 0.76 |

**Ecology**

Yolk-sac larva: Develops in floodplain habitats.

Pre-larva: Starts feeding on zooplankton at 5.7–6.2 mm in length.

Post-larva: Carnivore.

**Morphological characteristics**

Yolk-sac larva: Round yolk-sac with homogenous yolk.

Pre-larva: Elongated body with terminal mouth and triangular gut; 40–45 myomeres and 12–16 pre-anal myomeres. Short dorsal fin and adipose fin, long anal fin barbels by 4.8 mm.

Post-larva: Elongated body, with terminal mouth and triangular gut. Long anal fin, flat barbells, maxillary barbel longest and reaches to anus.

**Pigmentation**

Yolk-sac larva: No melanophores on head or trunk and gut.

Pre-larva: Gut is covered with melanophores dorsally and laterally-pigment develops dorsally on head and nape by 27.7 mm.

Post-larva: Dorsally on head, trunk tail.
Developmental stages of *Laides longibarbis*
Developmental stages of *Laides longibarbis*

12 days
21.8 mm post-larva

15 days
23.5 mm post-larva

19 days
24.5 mm post-larva

25 days
27.7 mm post-larva

35 days
33.1 mm post-larva

45 days
46.7 mm juvenile
**Pangasianodon hypophthalmus**

**Pangasiidae**

Adult *Pangasianodon hypophthalmus* Sauvage, 1878

Iridescent shark catfish

An omnivorous catfish found basin-wide in large rivers; it is most abundant in the Lower Mekong. It feeds on fishes and crustaceans, vegetable debris, small fruits and forest vegetation during the rainy season. A white fish, it migrates upstream for reproduction; it probably spawns in deep pools in the Mekong mainstream between Kratie and Khone Falls at the beginning of the flood season. The larvae drift downstream until they are swept out onto floodplain areas in southern Cambodia and Viet Nam. The current in the Tonle Sap River reverses resulting in a proportion of the larvae drifting into the Tonle Sap and onto flooded areas along the Tonle Sap River and the Great Lake. The eggs are adhesive and hatch after 22–24 hours at 30°C. The species reaches maturity when three and four years old in males and females respectively. It is caught with nets, traps and explosives. The drifting larvae are caught with special gears and are cultured. It is very important as food in the Lower Mekong and also is used in the aquarium trade. Its maximum length is 150 cm.

**Main references:** Baird and Phylavanh, 1999; Bardach, 1959; Poulsen *et al*., 2004; Rainboth, 1996; Singanouvong *et al*., 1996; Termvidchakorn, 1997.

**Meristics and morphometrics of larvae and juveniles**

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | I,6 | I,6 | I,6  |
| Anal Fin Count           | I,30| I,29| I,29 |
| Pectoral Fin Count       | I,9 | I,8 | I,9  |
| Pelvic Fin Count         | i,5 | i,5 | i,5  |
| Myomere Count            | 42  | 37  | 38   |
| Ratio between HL:SL      | 0.28| 0.28| 0.28 |
| Ratio between Sn-DF:SL   | 0.36| 0.36| 0.36 |
| Ratio between Sn-AF:SL   | 0.53| 0.53| 0.53 |
| Ratio between Sn-AdiF:SL | 0.71| 0.71| 0.71 |
| Ratio between Sn-P,F:SL  | 0.43| 0.43| 0.43 |

**Ecology**

| Yolk-sac larva | Develops in riverine habitats. | Ovoid yolk-sac with homogenous yolk. | On peritoneum. |
|---------------|-------------------------------|---------------------------------|----------------|

**Pre-larva**

| Starts feeding on zooplankton at 5.8–7.2 mm in length. | Elongated body, with wide terminal mouth and short gut; 37–42 myomeres and 12–16 pre-anal myomeres. | Melanophores dorsally and laterally on head and trunk; patches of pigment mid-laterally on the tail, which gradually merge to form a mid-lateral body stripe; anal-fin base is heavily pigmented; caudal-fin base and longest rays of caudal fin are pigmented. Heavy pigmentation dorsally on gut. |

| Post-larva | Carnivore. | Long body, wide terminal mouth and moderately short gut. | Snout, dorsally on head and body, mid-lateral stripe on body and pigment dorsal to gut persists. |
Developmental stages of *Pangasianodon hypophthalmus*
Developmental stages of *Pangasianodon hypophthalmus*
Helicophagus leptorhynchus

Adult *Helicophagus leptorhynchus*
(Ng and Kottelat, 2000)
Short nose catfish

A molluscivorous catfish that occurs basin-wide in large rivers. It stays in permanent river channels and does not move into flooded forests. Above the Khone Falls it migrates upstream during the late dry season and/or early flood season for spawning, for sub-adult dispersal and feeding. Below the Falls, the pattern is reversed, with a downstream migration at the onset of the flood season. Some populations migrate into major tributaries. Eggs occur from March to July with a peak in May-June, which probably is the main spawning season, but the species has also been reported to spawn from January to April. Juveniles of 2–4 cm have been reported both below (downstream to Can Tho and Dong Thap) and above Khone Falls (upstream to Nong Khai Province, Thailand). It can be caught with seines, gill-nets, cast-nets, traps, driftnet and hook-and-line; it has some importance as food and is marketed fresh. It grows to a maximum length of 79 cm.

Main references: Baird and Phylavanh, 1999; Poulsen *et al.*, 2004; Rainboth 1996; Singanouvong *et al.*, 1996; Termvidchakorn, 1997.

Meristics and morphometrics of larvae and juveniles

|                           | Max | Min | Mode |
|---------------------------|-----|-----|------|
| Dorsal Fin Count          | 1.7 | 1.7 | 1.7  |
| Anal Fin Count            | 1.52| 1.50| 1.52 |
| Pectoral Fin Count        | 1.7 | 1.7 | 1.7  |
| Pelvic Fin Count          | 1.5 | 1.5 | 1.5  |
| Myomere Count             | 39  | 37  | 38   |
| Ratio between HL:SL       | 0.30| 0.30| 0.30 |
| Ratio between Sn-DF:SL    | 0.36| 0.36| 0.36 |
| Ratio between Sn-AF:SL    | 0.55| 0.55| 0.55 |
| Ratio between Sn-AdiF:SL  | 0.72| 0.72| 0.72 |
| Ratio between Sn-P,F:SL   | 0.46| 0.46| 0.46 |

| Yolk-sac Larva            | Ecology                                               | Morphological characteristics                        | Pigmentation                                      |
|---------------------------|--------------------------------------------------------|------------------------------------------------------|---------------------------------------------------|
|                           | Develops mainly in streams, but also in floodplain habitats. | Ovoid yolk-sac with homogenous yolk.                  | Melanophores on head and trunk.                    |
| Pre-larva                 | Starts feeding on zooplankton at 7.0–8.5 mm in length.   | Elongated body with large, inferior mouth; 37–39 myomeres and 13–15 pre-anal myomeres. Elongate anal fin. | Melanophores dorsally on head and body in both early and older larvae; a few melanophores on caudal-fin base; mid-lateral body series forms by 15.3 mm. a few melanophores dorsally on gut. |
| Post-larva                | Omnivore.                                              | Elongated body with a large and inferior mouth. Pectoral-fin 1,7. Maxilla barbels reach to behind the operculum. | Dorsally head and body; laterally on nape and dorsal to gut. Pigment spreads to most of the head and body surfaces. |
Developmental stages of *Helicophagus leptorhynchus*
Developmental stages of *Helicophagus leptorhynchus*

- **19 days**
  - 17.7 mm
  - post-larva

- **23 days**
  - 20.8 mm
  - post-larva

- **31 days**
  - 30.7 mm
  - post-larva

- **40 days**
  - 38.6 mm
  - post-larva

- **50 days**
  - 46.6 mm
  - juvenile
Adult *Pangasius larnaudii* Bocourt, 1866
Black-ear catfish

An omnivorous species with a very broad diet; it occurs basin-wide in large rivers and floodplains. Juveniles feed on insects. A white fish species that is highly migratory in the mainstream in the beginning of the flood season; migrates both for feeding and reproduction. In some areas it is reported to move between the Mekong and smaller streams, it is also known to migrate into floodplains. It is reported to spawn both at the beginning of the flood season and in August-October. In Cambodia, it spawns on floodplains and/or at mainstream spawning grounds near Stung Treng from where larvae drift to the Bassac region in six to eight days. It is caught with seines, gill-nets, traps, hook-and-line and trawl; one of the most important species in the wet season lee and tone trap fishery at Khone Falls. It is one of the most esteemed food fish; it is also used as an aquarium fish. It has a maximum length of 150 cm, more commonly at 90–100 cm.

*Main references*: Bardach, 1959; Pongsirijun *et al*., 2001; Poulsen *et al*., 2004; Rainboth, 1996; Singanouvong *et al*., 1996; Termvidchakorn, 1997.

**Meristics and morphometrics of larvae and juveniles**

|                        | Max | Min | Mode |
|------------------------|-----|-----|------|
| Dorsal Fin Count       | 1.7 | 1.7 | 1.7  |
| Anal Fin Count         | 1.32| 1.28| 1.30 |
| Pectoral Fin Count     | 1.9 | 1.9 | 1.9  |
| Pelvic Fin Count       | 1.5 | 1.5 | 1.5  |
| Myomere Count          | 38  | 36  | 38   |
| Ratio between HL:SL    | 0.30| 0.27| 0.28 |
| Ratio between Sn-DF:SL | 0.36| 0.33| 0.35 |
| Ratio between Sn-AF:SL | 0.61| 0.56| 0.59 |
| Ratio between Sn-AdiF:SL | 0.68| 0.50| 0.66 |
| Ratio between Sn-P,F:SL | 0.49| 0.40| 0.46 |

**Yolk-sac larva**
- Develops in riverine habitats.
- Ovoid yolk-sac with homogenous yolk.
- Melanophores on ventral part of the trunk.

**Pre-larva**
- Starts feeding on zooplankton at 6.4–7.0 mm in length.
- Elongated body with inferior mouth and short gut 56–61 percent of standard length; 38–43 myomeres and 14–18 pre-anal myomeres.
- Early larvae have melanophores dorsally on head and dorsally and laterally on gut. Large patches laterally on trunk. Large patch over urostyle. Caudal-fin base pigmented along margin. Laterally on head and on snout by 20.6 mm.

**Post-larva**
- Omnivore.
- Elongated body, wide inferior mouth and short gut.
- Dorsally and laterally on head and trunk.
Developmental stages of *Pangasius larnaudii*
Developmental stages of *Pangasius larnaudii*
**Pangasius macronema**

Adult *Pangasius macronema* Bleeker, 1851
Yellow catfish

A schooling, omnivorous species, which is found basin-wide in the mainstream of the Mekong. It migrates into the flooded forest during high water and spawns in the mainstream most of the year with a peak late in the flood or early in the dry season. Eggs have been observed in the abdomen all year round except for February, but most often reported from April to June. It spawns in rapids at the beginning of the rainy season; in Viet Nam it is reported to spawn in August to September in the main river. Females are sexually mature at 13 cm and 25 g. At least locally a very important species in the fisheries, it is caught with various small- to large-scale gears. It is marketed fresh and sold in the aquarium trade. Its maximum length is 35 cm SL.

*Main references:* Bardach, 1959; Poulsen *et al*., 2004; Rainboth, 1996; Singanouvong *et al*., 1996; Termvidchakorn, 1997.

Meristics and morphometrics of larvae and juveniles

|                         | Max | Min | Mode |
|-------------------------|-----|-----|------|
| Dorsal Fin Count        | 1,7 | 1,7 | 1,7  |
| Anal Fin Count          | 1,33| 1,30| 1,32 |
| Pectoral Fin Count      | 1,9 | 1,9 | 1,9  |
| Pelvic Fin Count        | 1,5 | 1,5 | 1,5  |
| Myomere Count           | 39  | 37  | 38   |
| Ratio between HL:SL     | 0.29| 0.29| 0.29 |
| Ratio between Sn-DF:SL  | 0.35| 0.35| 0.35 |
| Ratio between Sn-AF:SL  | 0.51| 0.51| 0.51 |
| Ratio between Sn-AdiF:SL| 0.59| 0.59| 0.59 |
| Ratio between Sn-P_{2}F:SL | 0.45| 0.45| 0.45 |

**Ecology**

| Yolk-sac Larva | Ecology | Morphological characteristics | Pigmentation |
|----------------|---------|--------------------------------|--------------|
|                | Develops in stream and floodplain habitats. | Ovoid yolk-sac with homogenous yolk. | No melanophores on head or trunk. |
| Pre-larva      | Starts feeding on zooplankton at 6.1–7.5 mm in length. | Elongated body with moderate and inferior mouth; 37–39 myomeres and 13–15 pre-anal myomeres. Serrate form on dorsal-fin spine by 15.2 mm. | Patch of melanophores on head and nape of post-larvae, peritoneum with row of melanophores. |
| Post-larva     | Omnivore. | Elongated body with moderate size, inferior mouth. | Head and nape patches expend to cover all of dorsal surface of head and body by 38.8 mm. |
Developmental stages of *Pangasius macronema*
Developmental stages of *Pangasius macronema*
**Heteropneustes kemratensis**

Adult *Heteropneustes kemratensis* (Fowler, 1937)

Stinging catfish

A medium-sized carnivore which mainly occurs in stagnant water and swamp forest habitats; found mainly in ponds, ditches, swamps and marshes and sometimes in muddy rivers. It can tolerate slightly brackish water and is adapted to survive in oxygen-poor water. It is a predator of small fishes and insects. It breeds in small standing water bodies during the flood season, including ponds, derelict ponds and ditches. It can be caught with cast-nets and by dry pumping, but is rarely seen in markets. It can be kept alive out of water for long periods of time as long if the skin is kept damp. The demand of this species is great due to its medicinal value. It has a maximum length of 30 cm TL.

*Main references:* Rainboth, 1996; Talwar and Jhingran, 1992.

Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | I,5 | I,5 | I,5  |
| Anal Fin Count           | 1,60| 1,60| 1,60 |
| Pectoral Fin Count       | I,10| 1,9 | 1,9  |
| Pelvic Fin Count         | I,5 | I,5 | I,5  |
| Myomere Count            | 46  | 42  | 45   |
| Ratio between HL:SL      | 0.25| 0.25| 0.25 |
| Ratio between Sn-DF:SL   | 0.35| 0.35| 0.35 |
| Ratio between Sn-AF:SL   | 0.43| 0.43| 0.43 |
| Ratio between Sn-P,F:SL  | 0.39| 0.39| 0.39 |

| Ecology                  | Morphological characteristics | Pigmentation |
|--------------------------|--------------------------------|--------------|
| Yolk-sac larva           | Develops in floodplain habitats. | Ovoid yolk-sac with homogenous yolk. | Melanophores on head. |
| Pre-larva                | Starts feeding on zooplankton at 4.4–6.4 mm in length. | Elongated body with terminal mouth and long narrow tail; has 44–46 myomeres and 12–14 pre-anal myomeres. Gut < 50% BL | Small larvae have melanophores only on head, whereas larvae from 4.4 mm are evenly covered in small melanophores except for the gut ventrally. There is a dark patch of pigment above the pectoral-fin base. |
| Post-larva               | Carnivore.                      | Elongated body with terminal mouth. | From 7.7 mm pigment increases on body so juveniles have dark bodies. |
Developmental stages of *Heteropneustes kemratensis*
Developmental stages of *Heteropneustes kemratensis*
**Dermogenys siamensis**  

Adult *Dermogenys siamensis* Fowler, 1934  
Wrestling half-beak

This is a small carnivorous species, found in rivers, rivulets, canals, drains, ponds and lakes. It mainly occurs at the surface in quiet waters where there are aquatic plants. It feeds on aquatic insects, crustaceans and worms. It is a minor element of commercial catches, but is commonly caught by subsistence fishers using seines, dip-nets, or cast-nets. It is sold fresh for food and in Cambodia as smoked fish eaten for snacks. It is also found in the aquarium trade. It grows to a maximum length of 7 cm. This is a live-bearing species; fish hatch as post-larvae because they complete earlier stages of development in the egg.

*Main references:* Mills and Vevers, 1989; Rainboth, 1996; Talwar and Jhingran, 1992.

### Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | I,8 | I,8 | I,8  |
| Anal Fin Count           | I,12| I,12| I,12 |
| Pectoral Fin Count       | I,9 | I,9 | I,9  |
| Pelvic Fin Count         | I,5 | I,5 | I,5  |
| Myomere Count            | 42  | 40  | 42   |
| Ratio between HL:SL      | 0.31| 0.31| 0.31 |
| Ratio between Sn-DF:SL   | 0.81| 0.81| 0.81 |
| Ratio between Sn-AF:SL   | 0.74| 0.74| 0.74 |
| Ratio between Sn-P,F:SL  | 0.60| 0.60| 0.60 |

### Ecology

| Yolk-sac larva | Morphological characteristics | Pigmentation |
|----------------|-------------------------------|--------------|
| Develops in riverine and wetland habitats. | Elongated yolk-sac with segmented yolk. | Melanophores on head and trunk. |

| Pre-larva | Morphological characteristics | Pigmentation |
|-----------|-------------------------------|--------------|
| Starts feeding at 4.2–4.5 mm in length, feeds on zooplankton. | Elongated body with superior mouth and long gut; 40–42 myomeres and 20–22 pre-anal myomeres. Lower jaw protrudes. | On snout, dorsally and laterally on head; dorsal mid-line of head and body; laterally and ventro-laterally on trunk and tail. |

| Post-larva | Morphological characteristics | Pigmentation |
|------------|-------------------------------|--------------|
| Carnivore. | Elongated body with superior mouth and elongate lower jaw. | Extends to most parts of head and body, with a dark series along the lateral mid-line of the trunk and tail. On lower jaw. |
Developmental stages of *Dermogenys siamensis*
**Xenentodon cancila**

Belonidae

Adult *Xenentodon cancila* (Hamilton, 1822)
Freshwater garfish

Garfish are found basin-wide in large and medium-sized rivers especially in slow-flowing pools with rock or sand substrates and also in ponds, canals, beels and inundated fields. They are common in open waters on the floodplain where they are usually found at the surface in sluggish or standing waters. Adults live in areas that lack floating vegetation; juveniles always live in running water. They feed on small fishes, crustaceans including shrimps, insects and zooplankton. They reach maturity at 16.2 cm. Fish of 16.2–23.5 cm bear about 200–1,400 eggs with a diameter of 1.50–2.48 mm. They are caught with seines, set-nets and cast-nets and in large quantities in barrages along the Tonle Sap during the flood recession. They are sold in markets fresh or dried. They attain a maximum length of 40 cm and more commonly are 30 cm TL. This fish hatches as a post-larva because of extended development in the egg.

*Main references:* Krachangdara, 1994; Rainboth, 1996; Talwar and Jhingran, 1992.

**Meristics and morphometrics of larvae and juveniles**

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | i,19| i,16| i,16 |
| Anal Fin Count       | i,18| i,16| i,16 |
| Pectoral Fin Count   | i,9 | i,9 | i,9  |
| Pelvic Fin Count     | i,6 | i,6 | i,6  |
| Myomere Count        | 54  | 50  | 50   |
| Ratio between HL:SL  | 0.39| 0.39| 0.39 |
| Ratio between Sn-DF:SL| 0.79| 0.79| 0.79 |
| Ratio between Sn-AF:SL| 0.78| 0.78| 0.78 |
| Ratio between Sn-P,F:SL| 0.63| 0.63| 0.63 |

**Ecology**

- **Yolk-sac larva**
  - Develops in riverine habitats.
  - Ovoid yolk-sac with homogenous yolk. Embryo has a further development and hatch at the post-larvae stage.
  - Melanophores on head.

- **Pre-larva**
  - Starts feeding on zooplankton at 9.7–10.3 mm in length.
  - Elongated body with long gut and alongate jaws; 50–54 myomeres and 32–35 pre-anal myomeres.
  - Dorsally on head and along dorsal mid-line of body; mid-lateral body series apparent from 13.6 mm; ventro-lateral and ventral surfaces of trunk and tail.
  - Row of melanophores dorsally over gut.

- **Post-larva**
  - Carnivore.
  - Very elongated body with a long gut and very long jaws. Gas bladder is visible until 35.7 mm.
  - Jaws; dorsal mid-line of head and body; mid-lateral body stripe, thick ventro-lateral stripe; caudal peduncle.
Developmental stages of *Xenentodon cancila*

1 day
9.4 mm
post-larva

2 days
10.2 mm
post-larva

3 days
12.2 mm
post-larva

4 days
13.1 mm
post-larva

5 days
13.9 mm
post-larva
Developmental stages of *Xenentodon cancila*
Macrognathus semiocellatus

Adult *Macrognathus semiocellatus* Roberts, 1986
Freckle-fin spiny eel

A carnivorous species that occurs in the Mekong Basin in Lao PDR (in the Xe Bangfai Basin), Thailand, Cambodia and Viet Nam. It is non-migratory. It grows to a maximum length of 19.2 cm SL.

Main references: Kottelat, 2001.

Meristics and morphometrics of larvae and juveniles

|                          | Max     | Min     | Mode    |
|--------------------------|---------|---------|---------|
| Dorsal Fin Count         | XXXI,48 | XXIX,45 | XXIX,46 |
| Anal Fin Count           | III,54  | II,50   | III,54  |
| Pectoral Fin Count       | 17      | 16      | 16      |
| Myomere Count            | 79      | 76      | 78      |
| Ratio between HL:SL      | 0.25    | 0.25    | 0.25    |
| Ratio between Sn-DF:SL   | 0.43    | 0.43    | 0.43    |
| Ratio between Sn-AF:SL   | 0.70    | 0.70    | 0.70    |

| Ecology                  | Morphological characteristics          | Pigmentation                                                                 |
|--------------------------|----------------------------------------|------------------------------------------------------------------------------|
| Yolk-sac larva           | Elongated yolk-sac with homogenous yolk. | Melanophores on trunk; one dorsoventral cluster or band of melanophores on tail. |
| Pre-larva                | Elongated body, with inferior mouth and long gut; 76–79 myomeres and 40–43 pre-anal myomeres. Posteriorly placed dorsal and anal fins. | Dark stripe from snout to operculum, through level of eye; mottled pattern over whole body except for ventral surfaces of head and gut; the pigment patch extends onto dorsal and anal fins. |
| Post-larva               | Elongated body, long gut, snout modified to proboscis. | Pigment patch intensified and resembles adult coloration.                       |
Developmental stages of *Macrognathus semiocellatus*
**Parambassis apogonoides**

Adult *Parambassis apogonoides* (Bleeker, 1851)
Iridescent glass perchlet

A carnivorous species that feeds on aquatic invertebrates. It is an oral-booder, the only one in the family Ambassidae. It is found in sluggish rivers and floodplains in the Lower Mekong Basin. It is caught with seines, set-nets, cast-nets and traps. It is sold for food and occasionally seen in markets. Its bright coloration makes it a desirable aquarium fish. It has large 2nd and 3rd anal spines, of which the 2nd anal spine is the larger. Its maximum length is 10 cm.

*Main references:* Rainboth, 1996; Roberts, 1989.

Meristics and morphometrics of larvae and juveniles

|                      | Max  | Min  | Mode |
|----------------------|------|------|------|
| Dorsal Fin Count     | VIII,10 | VIII,10 | VIII,10 |
| Anal Fin Count       | III,10 | III,10 | III,10 |
| Pectoral Fin Count   | i,14 | i,12 | i,12 |
| Pelvic Fin Count     | i,5 | i,5 | i,5 |
| Myomere Count        | 26 | 24 | 24 |
| Ratio between HL:SL  | 0.38 | 0.38 | 0.38 |
| Ratio between Sn-DF:SL | 0.40 | 0.40 | 0.40 |
| Ratio between Sn-AF:SL | 0.59 | 0.59 | 0.59 |
| Ratio between Sn-P,F:SL | 0.60 | 0.60 | 0.60 |

| Ecology                          | Morphological characteristics                          | Pigmentation                                      |
|----------------------------------|-------------------------------------------------------|---------------------------------------------------|
| Yolk-sac larva                   | Develops in swamps and wetland areas.                 | Ovoid yolk-sac with homogenous yolk.              | No melanophores on head or trunk.                |
| Pre-larva                        | Starts feeding on zooplankton at 3.4–3.8 mm in length. | Moderately deep body, with large mouth and triangular gut; 24–26 myomeres and 10–12 pre-anal myomeres. Supraocular and preopercular spiriation. | Dorsally on gas bladder.                        |
| Post-larva                       | Carnivore sometime insectivore.                       | Compressed body, with large mouth and triangular gut; gas bladder is visible until 12.1 mm. | On head, dorsal and anal fins starting from 18.1 mm. |
Developmental stages of *Parambassis apogonoides*
Developmental stages of *Parambassis apogonoides*
**Parambassis siamensis**

Adult *Parambassis siamensis* (Fowler, 1937)
Siamese glass perchlet

A carnivorous species which is found in sluggish and standing water including reservoirs in the Middle and Lower Mekong Basin. It is a common species that proliferates in impoundments. It feeds on invertebrates. It is caught with seines, traps, lift-nets, cast-nets and set-nets. It is caught mostly by artisanal and subsistence fishermen for family consumption; occasionally seen in markets and often sold in the aquarium trade. It has a maximum length of 6 cm SL.

*Main references*: Baird et al., 1999; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                      | Max      | Min      | Mode |
|----------------------|----------|----------|------|
| Dorsal Fin Count     | VIII,13  | VIII,13  | VIII,13 |
| Anal Fin Count       | III,13   | III,13   | III,13 |
| Pectoral Fin Count   | i,14     | i,14     | i,14 |
| Pelvic Fin Count     | 1,5      | 1,5      | 1,5  |
| Myomere Count        | 26       | 24       | 24   |
| Ratio between HL:SL  | 0.32     | 0.32     | 0.32 |
| Ratio between Sn-DF:SL| 0.49  | 0.49     | 0.49 |
| Ratio between Sn-AF:SL| 0.55  | 0.55     | 0.55 |
| Ratio between Sn-P,F:SL| 0.38 | 0.38     | 0.38 |

| Ecology | Morphological characteristics | Pigmentation                     |
|---------|--------------------------------|----------------------------------|
| Yolk-sac larva | Develops in swamps and wetland areas. | Ovoid yolk-sac with homogenous yolk. | No melanophore pigment on head and trunk. |
| Pre-larva | Starts feeding on zooplankton at 4.3–5.4 mm in length. | Moderately deep body, with large mouth and triangular gut; 24–26 myomeres and 12–13 pre-anal myomeres. Supraocular and preopercular spiration. | Dorsally on gas bladder. |
| Post-larva | Carnivore | Body, with large mouth and triangular gut; gas bladder is visible until 10.0 mm. | Dorsally on head and distally on membrane of dorsal and anal fins. As juveniles develop, on the dorsal, dorsolateral and ventral surface of the trunk and tail. |
Developmental stages of *Parambassis siamensis*
Developmental stages of *Parambassis siamensis*

- 19 days
  - 15.9 mm
  - post-larva

- 25 days
  - 18.3 mm
  - post-larva

- 30 days
  - 27.8 mm
  - post-larva

- 35 days
  - 35.1 mm
  - juvenile
**Datnioides undecimradiatus**

Adult *Datnioides undecimradiatus* (Roberts & Kottelat, 1994)  
Mekong tiger fish

A carnivore that occurs in the Middle and Lower Mekong Basin. The family is marine, but this species has adapted for freshwater life. It feeds on fish and shrimps. It spawns at the end of the dry season; females examined in February were full of eggs and males examined in early March were in spawning condition. It has a maximum length of 40 cm SL.

*Main references:* Baird and Phylavanh, 1999; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                        | Max          | Min          | Mode         |
|------------------------|--------------|--------------|--------------|
| Dorsal Fin Count       | XII,15       | XII,11       | XII,14       |
| Anal Fin Count         | III,9        | III,9        | III,9        |
| Pectoral Fin Count     | 1,13         | 1,9          | 1,12         |
| Pelvic Fin Count       | 1,5          | 1,5          | 1,5          |
| Myomere Count          | 26           | 23           | 25           |
| Ratio between HL:SL    | 0.43         | 0.43         | 0.43         |
| Ratio between Sn-DF:SL | 0.43         | 0.43         | 0.43         |
| Ratio between Sn-AF:SL | 0.71         | 0.71         | 0.71         |
| Ratio between Sn-P:F:SL| 0.40         | 0.40         | 0.40         |

**Ecology**  

|                | Morphological characteristics | Pigmentation                  |
|----------------|-------------------------------|------------------------------|
| Yolk-sac larva| Spherical yolk-sac with homogenous yolk. | Melanophores on head. |
| Pre-larva     | Moderately deep body with large mouth and triangular gut; 23–26 myomeres and 12–14 pre-anal myomeres. Preopercular and supraoccipital spines. | Melanophores on head and trunk. |
| Post-larva    | Carnivore. Preopercular and supraoccipital spines. Moderately deep-bodied. | Head and body uniformly covered in large, expanded melanophores. Banding begins to develop by 15.7 mm. Pigment spreads to spinous dorsal fin by 9.0 mm, to pelvic fin by 15.7 mm and to anal fin by 12.7 mm. |
Developmental stages of *Datnioides undecimradiatus*
Developmental stages of *Datnioides undecimradiatus*
**Oxyeleotris marmorata**  
Eleotridae

Adult *Oxyeleotris marmorata* (Bleeker, 1852)  
Marbled sleeper

A non-migratory, slow-moving species, which occurs in flowing and standing, fresh and brackish waters, including reservoirs in the Middle and Lower Mekong Basin. It prefers standing water with dense aquatic plants. Juveniles are found in running streams with sand and rock substrates. It feeds on fishes, shrimps, molluscs, aquatic insects, crabs, insect larvae and detritus. It spawns at the beginning and end of the dry season. This fish becomes sexually mature at about 8 cm in length and fish measuring 15–30 cm have 6,800–90,000 eggs. The eggs are yellow, pear-shaped and they measure 0.6 x 2.2 mm. It is caught with seines, trawls and gill-nets and is a very important commercial species, marketed alive or fresh and considered a delicacy over much of eastern Asia, where exported fishes command a high price. It attains a maximum length of 50 cm, but more commonly reaches 30 cm.

*Main references:* Bardach, 1959; Leelapatra *et al.*, 2000; Rainboth, 1996; Rojanapittayakul *et al.*, 2000

**Meristics and morphometrics of larvae and juveniles**

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | v+10| v+10| v+10 |
| Anal Fin Count           | i,9 | i,9 | i,9  |
| Pectoral Fin Count       | 18  | 14  | 15   |
| Pelvic Fin Count         | 5   | 5   | 5    |
| Myomere Count            | 30  | 28  | 28   |
| Ratio between HL:SL      | 0.32| 0.32| 0.32 |
| Ratio between Sn-DF:SL   | 0.41| 0.41| 0.41 |
| Ratio between Sn-AF:SL   | 0.55| 0.55| 0.55 |
| Ratio between Sn-PF:SL   | 0.30| 0.30| 0.30 |

**Ecology**  
Develops in swamps and floodplain habitats.

**Ovoid yolk-sac with homogenous yolk; contains multiple oil globules at anterior.**

**No information available.**

| Yolk-sac larva | Ecology | Morphological characteristics | Pigmentation |
|----------------|---------|-------------------------------|--------------|
|               | Develops in swamps and floodplain habitats. | Elongated body with terminal mouth and short gut. Separate spinous and soft dorsal fins. Myomeres 26 (11+15). | Patch below pectoral fin base; dorsally on head and behind operculum by 4.5 mm. Along anal fin base and anterior half of caudal peduncle; band from posterior of dorsal fin to posterior of anal fin; band at caudal-fin base. |
| Pre-larva     | Starts feeding on zooplankton at 3.7–4.1 mm in length. | Pigment distributed in solid patches on body, spreads onto dorsal and caudal fins. Head is uniformly pigmented, becoming darker with development. |
| Post-larva    | Benthic omnivore. | Moderately long body with only in juvenile mouth; gas bladder is visible until 11.0 mm. |

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Developmental stages of *Oxyeleotris marmorata*
Developmental stages of *Oxyeleotris marmorata*
*Gobiopterus chuno*

**Adult *Gobiopterus chuno* (Hamilton, 1822)**
Glass goby

A small zooplanktivorous species that inhabits estuaries and the lower courses of rivers and ascends the Mekong as far as Phnom Penh. It is caught with fine-meshed seines, trawls, set-nets and cast-nets; not seen in markets. It grows to a maximum length of 3 cm.

*Main references:* Rainboth, 1996; Talwar and Jhingran, 1992.

**Meristics and morphometrics of larvae and juveniles**

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| **Dorsal Fin Count**     | v+9 | v+9 | v+9  |
| **Anal Fin Count**       | 13  | 10  | 11   |
| **Pectoral Fin Count**   | 15  | 15  | 15   |
| **Pelvic Fin Count**     | 5   | 5   | 5    |
| **Myomere Count**        | 26  | 23  | 24   |
| **Ratio between HL:SL**  | 0.29| 0.29| 0.29 |
| **Ratio between Sn-DF:SL**| 0.41| 0.41| 0.41 |
| **Ratio between Sn-AF:SL**| 0.59| 0.59| 0.59 |
| **Ratio between Sn-P<sub>2</sub>F:SL** | 0.30| 0.30| 0.30|

**Ecology**

| Yolk-sac larva | Morphological characteristics | Pigmentation |
|----------------|-------------------------------|--------------|
| Develops in wetland areas. | Short yolk-sac with segmented yolk; contains a single oil globule. | No melanophores on head or trunk. |

| Pre-larva | Morphological characteristics | Pigmentation |
|-----------|-------------------------------|--------------|
| Starts feeding on zooplankton at 4–4.5 mm in length. | Elongated body with large superior mouth and long gut; 23–26 myomeres and 10–12 pre-anal myomeres. | Melanophores ventrally along caudal peduncle. |

| Post-larva | Morphological characteristics | Pigmentation |
|------------|-------------------------------|--------------|
| Omnivore. | Elongated body with large superior mouth; gas bladder conspicuous. | Series along anal-fin base and ventrally on caudal peduncle. |
Developmental stages of *Gobiopterus chuno* from wild specimens
Developmental stages of *Gobiopterus chuno* from wild specimens
Anabantidae

Adult *Anabas testudineus* (Bloch, 1792)  
Climbing perch

A common inhabitant of all types of water bodies that have slow currents, such as canals, lakes, ponds and swamps. It can occupy seasonal water bodies because it has an accessory air-breathing organ, which allows it survive for long periods out of water. It is an omnivore with a very broad diet, ranging from macrophytic vegetation to fish and detritus. A black fish species, it does not migrate longitudinally within the Mekong and other large rivers, but migrates laterally from large rivers or other permanent water bodies to flooded areas during the wet season. It spawns from the end of the dry season until the beginning of the flood typically in floodplain habitats. It is sexually mature when it is ten months old. The eggs are buoyant with a diameter of 0.75 mm. It is an important food fish in southeast Asia; usually it is sold in markets where it is kept alive for several days by keeping it moist. It grows to a maximum length of 23 cm, but is more commonly 10 cm.

*Main references:* Bardach, 1959; Poulsen *et al.*, 2004; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                      | Max | Min | Mode |
|----------------------|-----|-----|------|
| Dorsal Fin Count     | XVI,8 | XIII,9 | XIV,9 |
| Anal Fin Count       | XI,8 | VIII,9 | X, 9 |
| Pectoral Fin Count   | 1,12 | 1,10 | 1,10 |
| Pelvic Fin Count     | 1,5 | 1,5 | 1,5 |
| Myomere Count        | 32 | 30 | 30 |
| Ratio between HL:SL  | 0.40 | 0.39 | 0.40 |
| Ratio between Sn-DF:SL | 0.39 | 0.37 | 0.37 |
| Ratio between Sn-AF:SL | 0.66 | 0.65 | 0.66 |
| Ratio between Sn-P,F:SL | 0.45 | 0.44 | 0.44 |

**Ecology**

**Morphological characteristics**

**Pigmentation**

| Stage         | Develops in swamps and in floodplain habitats. | Elongated yolk-sac with homogenous yolk. | Melanophores on head and trunk. |
|---------------|-----------------------------------------------|----------------------------------------|-------------------------------|
| Yolk-sac larva| Starts feeding on zooplankton at 3.2–3.6 mm in length. | Moderately deep body. Large oblique mouth and triangular gut; 30–32 myomeres and 11–12 pre-anal myomeres. | Melanophores dorsally on head, nape and along dorsal & ventral mid-line of trunk and tail and ventrally on gut. Row of melanophores mid-laterally on trunk and tail. Large melanophores laterally on middle of hypurals. Just after flexion, melanophores uniformly distributed over head and body except for ventral surface of gut and caudal-fin base. Hypural spot persists. Dark patch above pectoral-fin base. |
| Pre-larva     | Omnivore. | Deep body with large mouth and triangular gut. Serrated preopercle by 16.9 mm. | Uniformly distributed melanophores differentiate into lateral body bands by 10.1 mm. Patch above pectoral-fin base and over hypurals persist. |
| Post-larva    |                                                |                                        |                                |
Developmental stages of *Anabas testudineus*
Anabantidae

Developmental stages of *Anabas testudineus*

7 days
6.8 mm
post-larva

9 days
8.2 mm
post-larva

12 days
10.1 mm
post-larva

15 days
12.2 mm
post-larva

23 days
16.9 mm
juvenile
Betta splendens

Adult *Betta splendens* Regan, 1910
Siamese fighting fish

An air-breathing species found in standing waters of floodplains, canals and rice paddies. It feeds on zooplankton, mosquito and other insect larvae. It is a bubble nest builder; males are colourful and aggressive toward each other. It is caught with seines, cast-nets and traps. The many colourful varieties are popular aquarium fish and it is rarely sold for food. It attains a maximum length of 6.5 cm TL.

*Main reference:* Rainboth, 1996.

| Meristics and morphometrics of larvae and juveniles | Max | Min | Mode |
|---------------------------------------------------|-----|-----|------|
| Dorsal Fin Count                                  | II,7| I,10| I,9  |
| Anal Fin Count                                    | VI-21| I,26| III,25|
| Pectoral Fin Count                                | i,12| i,12| i,12 |
| Pelvic Fin Count                                  | i,5 | i,5 | i,5  |
| Myomere Count                                     | 36  | 32  | 34   |
| Ratio between HL:SL                               | 0.34| 0.33| 0.33 |
| Ratio between Sn-DF:SL                            | 0.66| 0.64| 0.65 |
| Ratio between Sn-AF:SL                            | 0.54| 0.49| 0.53 |
| Ratio between Sn-P_F:SL                           | 0.37| 0.35| 0.36 |

| Ecology                                         | Morphological characteristics                                      | Pigmentation                                           |
|-------------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------|
| Yolk-sac larva                                   | Ovoid yolk-sac with homogenous yolk.                               | Melanophores on head and trunk.                        |
| Pre-larva                                       | Start feeding on zooplankton at 3.1–3.7 mm in length.             | Moderately deep body with oblique superior mouth and triangular gut; short-based dorsal fin over middle of long-based anal fin 32–36 myomeres and 10–11 pre-anal myomeres. | Melanophores on entire head and dorsally on trunk; mid-lateral stripe from snout to operculum; dorsally over gut. |
| Post-larva                                      | Omnivore.                                                         | Slightly compressed body with superior mouth and triangular gut. | By 8.8 mm small melanophores distributed uniformly except for darker opercular stripe and lack of pigment ventrally on head and gut. Mid-lateral opercular stripe extends auto trunk and anterior of tail; an additional stripe from dorsolaterally. Pigment intensified dorsally, melanophores develop ventro-laterally on tail. |
Developmental stages of *Betta splendens*
Developmental stages of *Betta splendens*

- 23 days
  - 8.8 mm
  - post-larva

- 27 days
  - 11.0 mm
  - post-larva

- 31 days
  - 11.9 mm
  - post-larva

- 35 days
  - 14.9 mm
  - post-larva

- 45 days
  - 22.6 mm
  - juvenile
**Trichogaster pectoralis**

Adult *Trichogaster pectoralis* (Regan, 1910)
Snake-skin gouramy

An omnivorous species found in sluggish and standing waters including reservoirs. It can breathe atmospheric air and live in oxygen-poor standing-waters, typically with dense aquatic plants. It is non-migratory; found in flooded forests and moves back to rivers and permanent waterbodies as floodwaters recede. The male spawner makes a bubble nest; the eggs are buoyant, with an initial diameter of 0.91–2 mm and they hatch after 27 hours at 28°C, or after 18–20 hours at 28–30°C. The larvae measure about 2.7 mm at hatching. Fish reach maturity at 7–12 months at a length of 8–10 cm. Fecundity is around 18-36,000 eggs depending on the size of fish; an 18 cm-female can lay around 30,000 eggs. It is caught with seines, set-nets, cast-nets and traps and is an important food fish sold fresh, dried or grilled. It grows to a maximum length of 25 cm, but is more commonly about 18 cm.

*Main references*: Bardach, 1959; Leelapatra *et al.*, 2000; Rainboth, 1996; Warren, 2000.

Meristics and morphometrics of larvae and juveniles

|                          | Max   | Min   | Mode  |
|--------------------------|-------|-------|-------|
| Dorsal Fin Count         | IX,10 | VIII,11| VIII,10 |
| Anal Fin Count           | XIV,25| XII,30| XIII,28 |
| Pectoral Fin Count       | i,10  | i,9   | i,10  |
| Pelvic Fin Count         | i,5   | i,5   | i,5   |
| Myomere Count            | 33    | 33    | 33    |
| Ratio between HL:SL      | 0.36  | 0.34  | 0.35  |
| Ratio between Sn-DF:SL   | 0.57  | 0.56  | 0.56  |
| Ratio between Sn-AF:SL   | 0.48  | 0.46  | 0.47  |
| Ratio between Sn-P,F:SL  | 0.34  | 0.34  | 0.34  |

| Ecology                  | Morphological characteristics                          | Pigmentation                                      |
|--------------------------|--------------------------------------------------------|---------------------------------------------------|
| Yolk-sac larva           | Develops in swamps and floodplain habitats.            | Round yolk-sac with homogenous yolk.               |
| Pre-larva                | Starts feeding on zooplankton at 3.4–3.9 mm in length. | Hatchet-like body with superior, oblique mouth and triangular gut; short-based dorsal fin over middle of long-based anal fin; 38–40 myomeres and 9–12 pre-anal myomeres. |
| Post-larva               | Omnivore.                                              | Melanophores dorsally and laterally on head and trunk. Peritoneum covered with melanophores; a row of elongated melanophores on the ventral lateral surface of the trunk and tail. Patch on hypural plate. By 13.2 mm, dorsal and lateral surfaces of head and trunk covered in fine melanophores, and a ventral-lateral stripe beginning to form on the trunk and tail by 24.4 mm. |

Small, uniformly-distributed, melanophores dorsally and dorsolaterally on the head and body. Mid-lateral stripe intensified from operculum to caudal base. Caudal spot remains separate from mid-lateral stripe.
Developmental stages of *Trichogaster pectoralis*
Developmental stages of *Trichogaster pectoralis*

- **19 days**
  - 8.9 mm
  - post-larva

- **27 days**
  - 13.0 mm
  - post-larva

- **31 days**
  - 13.2 mm
  - post-larva

- **40 days**
  - 21.6 mm
  - post-larva

- **45 days**
  - 24.4 mm
  - juvenile
**Trichopodus trichopterus**

**Adult Trichopodus trichopterus** (Pallas, 1770)
Two-spot gouramy

This fish is found in shallow sluggish or standing-water habitats from Chiang Saen to the Mekong Delta. It feeds on zooplankton, crustaceans and insect larvae. It is a black fish species that does not undertake longitudinal migrations within the Mekong, but migrates from the main river, or other permanent water bodies to flooded areas during the wet season and returns to permanent water bodies at the beginning of the dry season. It nests in rain-fed paddy fields in June-July. It is caught with seines, cast-nets, set-nets and traps. It is in marketed fresh, salted and dried. It is also a popular aquarium fish. It attains a maximum length of 15 cm, more commonly 8.5 cm TL.

**Main references:** Bardach, 1959; Poulsen et al., 2004; Rainboth, 1996.

### Meristics and morphometrics of larvae and juveniles

|               | Max       | Min       | Mode   |
|---------------|-----------|-----------|--------|
| Dorsal Fin Count | VIII,9    | VIII,8    | VIII,8 |
| Anal Fin Count   | XI,35     | X,34      | XI,35  |
| Pectoral Fin Count | ii,9      | ii,8      | ii,9   |
| Pelvic Fin Count  | i,5       | i,5       | i,5    |
| Myomere Count    | 38        | 34        | 36     |
| Ratio between HL:SL | 0.32      | 0.32      | 0.32   |
| Ratio between Sn-DF:SL | 0.56   | 0.56      | 0.56   |
| Ratio between Sn-AF:SL | 0.47   | 0.47      | 0.47   |
| Ratio between Sn-P,F:SL | 0.35 | 0.35      | 0.35   |

### Ecology

| Yolk-sac larva | Develops in swamps and floodplain habitats. | Round yolk-sac with homogenous yolk. | Melanophores on head and trunk. |
|---------------|---------------------------------------------|------------------------------------|---------------------------------|
| Pre-larva     | Starts feeding on zooplankton at 3.6–4.1 mm in length. | Elongated body with superior mouth and triangular gut; 34–38 myomeres and 7–11 pre-anal myomeres. Short dorsal fin over middle of long anal fin. | Melanophores dorsally on head and series along dorsal mid-line of body. Series of melanophores mid-laterally on trunk and tail; series along ventral mid-line of tail disappears by 19.7 mm. Dorsal surface of gut covered with melanophores which extends as internal pigment onto tail. |
| Post-larva    | Omnivore. | Compressed body with small superior mouth and triangular gut. | Dorsally on head and body, extending ventrally as weak, narrow bands by 17.7 mm. Dark spot ventro-laterally below dorsal-fin origin by 17.7 mm. A second dark spot on caudal-fin base by 18.2 mm. |
Developmental stages of *Trichopodus trichopterus*
Developmental stages of *Trichopodus trichopterus*
Osphronemus goramy

Adult Osphronemus goramy Lacepède, 1802
Giant gouramy

An omnivorous fish that can breath air and is found in sluggish and standing-waters with dense vegetation, such as swamps, lakes and rivers. It feeds on submerged terrestrial plants and aquatic macrophytes, fruits, seeds, filamentous algae, insects, fish, frogs, earthworms and sometimes dead animals. After hatching, the fry feeds on the yolk sac for 5–7 days. After the yolk sac has been absorbed, fry feed on zooplankton. After 1 month it becomes omnivorous, first feeding mainly on animals and then changing gradually to vegetable matter. It spawns in a nest in the dry season and has floating eggs, which hatch in 36 hours at 25–30°C. After hatching, the larvae attach to the nest materials and start feeding after eight days. Fish reach sexual maturity at the age of 2½ years, a body weight of 1.2–1.5 kg and a length of 37.5–40 cm. Fecundity is 500–5,000 eggs/kg of bodyweight. It is caught with seines, lift-nets, cast-nets and baited hooks; utilized fresh and eaten after steaming, pan-frying or baking. It reaches a length of 70 cm and is more commonly caught at 40–50 cm SL.

Main references: Krachangdara, 1994; Leelapatra et al., 2000; Rainboth, 1996.

| Meristics and morphometrics of larvae and juveniles |
|-----------------|-----------------|-----------------|
|                | Max             | Min             | Mode            |
| Dorsal Fin Count | XIII,13        | XII,11          | XII,12          |
| Anal Fin Count   | XI,21           | IX,19           | X,10            |
| Pectoral Fin Count | ii,13         | ii,11           | ii,12           |
| Pelvic Fin Count | i,5             | i,5             | i,5             |
| Myomere Count    | 35              | 32              | 35              |
| Ratio between HL:SL | 0.41         | 0.41            | 0.41            |
| Ratio between Sn-DF:SL | 0.52        | 0.52            | 0.52            |
| Ratio between Sn-AF:SL | 0.54        | 0.54            | 0.54            |
| Ratio between Sn-P,F:SL | 0.41        | 0.41            | 0.41            |

| Yolk-sac Larva | Ecology | Morphological characteristics | Pigmentation |
|----------------|---------|--------------------------------|--------------|
|                | Develops in riverine and floodplain habitats. | Round yolk-sac with homogenous yolk; contains one pigmented oil globule at posterior. | Melanophores on head and trunk. |
| Pre-larva      | Starts feeding on zooplankton at 6.3–7.0 mm in length. | Moderately deep body with small, terminal mouth and triangular gut; 32–35 myomeres and 12–16 pre-anal myomeres. Moderately long dorsal fin over long anal fin. | Melanophores distributed over entire head and body; black band on caudal peduncle; by 8.5 mm a dark patch develops dorsally on head above eye; darker vertical bands from mid-laterally from 9.6 mm. |
| Post-larva     | Omnivore. | Compressed body with small mouth and triangular gut. | Banding intensifies on body and extends from dorsal to ventral body margins; melanophores extend onto dorsal and anal fins. |
1 day
5.2 mm
yolk-sac larva

3 days
6.3 mm
pre-larva

7 days
7.0 mm
post-larva

12 days
7.5 mm
post-larva

17 days
8.5 mm
post-larva

Developmental stages of Osphronemus goramy
Developmental stages of *Osphromenus goramy*

21 days
9.6 mm
post-larva

23 days
10.1 mm
post-larva

27 days
11.7 mm
post-larva

35 days
18.0 mm
juvenile
Trichopsis schalleri

Adult *Trichopsis schalleri* Ladiges, 1962
Three-stripe gouramy

A minute endemic species found in the Middle and Upper Mekong Basin; it prefers fast flowing waters with stones and boulders. It feeds on zooplankton and aquatic insects. Females are sexually mature at 3 cm SL. It is not fished commercially, but can be taken with seines and cast-nets. It is important in the aquarium trade. It grows to a maximum length of 3.5 cm.

*Main references*: Kottelat, 1998; Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                             | Max     | Min     | Mode |
|-----------------------------|---------|---------|------|
| Dorsal Fin Count            | III,7   | III,7   | III,7|
| Anal Fin Count              | VIII,23 | VIII,23 | VIII,23|
| Pectoral Fin Count          | i,10    | i,10    | i,10 |
| Pelvic Fin Count            | i,5     | i,5     | i,5  |
| Myomere Count               | 32      | 30      | 30   |
| Ratio between HL:SL         | 0.39    | 0.39    | 0.39 |
| Ratio between Sn-DF:SL      | 0.62    | 0.62    | 0.62 |
| Ratio between Sn-AF:SL      | 0.49    | 0.49    | 0.49 |
| Ratio between Sn-P,F:SL     | 0.37    | 0.37    | 0.37 |

**Ecology**

Develops in swamps and floodplain habitats.

**Morphological characteristics**

Ovoid yolk-sac with homogenous yolk.

**Pigmentation**

Melanophores on head and trunk.

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**Yolk-sac larva**

Starts feeding on zooplankton at 3.5–4.2 mm in length.

**Pre-larva**

Moderately deep body with superior vertical mouth and triangular gut; dorsal profile approximately straight; ventral profile convex. 30–32 myomeres and 8–9 pre-anal myomeres.

Melanophores on snout, dorsally on head and trunk; series along ventral mid-line of tail; ventro-lateral melanophores on tail by 10.5 mm.

**Post-larva**

Omnivore.

Slightly compressed body with small oblique, superior mouth and triangular gut.

Dorsally and laterally on head, body and ventrally on tail. Two dark stripes along body differentiate by 24.6 mm.
Developmental stages of *Trichopsis schalleri*
Developmental stages of *Trichopsis schalleri*
**Trichopsis vittata**

Adult *Trichopsis vittata* (Cuvier, 1831)  
Croaking gouramy

This gouramy is found in shallow sluggish or standing-water habitats with dense vegetation in the Middle and Lower Mekong basin. It feeds on zooplankton, crustaceans and insect larvae. It is not fished commercially, but larger individuals are sometimes taken by seines, cast-nets or set-nets. It is occasionally sold as part of mixed catches in markets and is regularly seen in the aquarium fish trade. It attains a maximum length of 7 cm and is more commonly seen up to 4 cm TL.

*Main reference:* Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                          | Max       | Min       | Mode     |
|--------------------------|-----------|-----------|----------|
| Dorsal Fin Count         | IV,7      | III,6     | III,7    |
| Anal Fin Count           | VIII,26   | VIII,25   | VIII,25  |
| Pectoral Fin Count       | 1,10      | i,8       | i,9      |
| Pelvic Fin Count         | 1,5       | i,5       | i,5      |
| Myomere Count            | 31        | 28        | 30       |
| Ratio between HL:SL      | 0.34      | 0.34      | 0.34     |
| Ratio between Sn-DF:SL   | 0.63      | 0.63      | 0.63     |
| Ratio between Sn-AF:SL   | 0.49      | 0.49      | 0.49     |
| Ratio between Sn-P_F:SL  | 0.34      | 0.34      | 0.34     |

**Ecology**

- **Yolk-sac larva**
  - Develops in swamps and floodplain habitats.
  - Ovoid yolk-sac with homogenous yolk.
  - Melanophores on head and trunk.

- **Pre-larva**
  - Starts feeding on zooplankton at 3.3–3.9 mm in length.
  - Moderately deep with oblique superior mouth and triangular gut; 28–31 myomeres and 7–8 pre-anal myomeres.
  - Stripe mid-laterally on head from snout to posterior edge of operculum. Short vertical bars dorsally along body, intensifying with growth.

- **Post-larva**
  - Omnivore.
  - Slightly compressed body with oblique superior mouth and triangular gut. Elongate dorsal fin.
  - Mid-lateral head stripe extends to body by 16.4 mm. Melanophores increase in number with growth; dorsal surface of head and body. There are transverse melanophores on dorsal, pelvic and anal fins by 11.3 mm.
Developmental stages of *Trichopsis vittata*
Developmental stages of *Trichopsis vittata*
**Helostoma temminkii**

Adult *Helostoma temminkii* Cuvier, 1829
Kissing gouramy

An omnivorous fish found in sluggish or standing waters in canals, swamps, ponds and lakes with vegetation. It feeds on a variety of plants and animals, including zooplankton, green algae, phytoplankton and aquatic insects near the water surface. It is caught by seines, cast-nets and lift-nets; it is an important food and aquarium fish. It grows to a maximum length of 30 cm, more commonly about 20 cm TL.

*Main reference:* Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                         | Max     | Min     | Mode    |
|-------------------------|---------|---------|---------|
| Dorsal Fin Count        | XVII,18 | XVII,13 | XVII,16 |
| Anal Fin Count          | XVII,18 | XVII,17 | XVII,18 |
| Pectoral Fin Count      | i,12    | i,12    | i,12    |
| Pelvic Fin Count        | i,5     | i,5     | i,5     |
| Myomere Count           | 34      | 30      | 33      |
| Ratio between HL:SL     | 0.36    | 0.36    | 0.36    |
| Ratio between Sn-DF:SL  | 0.41    | 0.41    | 0.41    |
| Ratio between Sn-AF:SL  | 0.60    | 0.60    | 0.60    |
| Ratio between Sn-P,F:SL | 0.48    | 0.48    | 0.48    |

| Ecology                  | Morphological characteristics                  | Pigmentation                                |
|--------------------------|------------------------------------------------|---------------------------------------------|
| Yolk-sac larva           | Develops in swamps, riverine and floodplain habitats. | Ovoid yolk-sac with homogenous yolk.         |
|                          |                                                 | Melanophores on head, trunk and yolk sac.   |
| Pre-larva                | Starts feeding on zooplankton at 6.4–6.9 mm length. | Moderately deep body with oblique superior mouth and triangular gut; 30–34 myomeres and 7–12 pre-anal myomeres. | Dorsally on head. Series on dorsal and lateral mid-lines of trunk and tail and on ventral mid-line of tail. Dorsally on gut and extends as internal pigment on tail. |
| Post-larva               | Omnivore.                                       | Oblique superior mouth and triangular gut. Long dorsal and anal fins. | Uniform coverage dorsally, laterally on head, body and ventrally on gut. Stripes begin to form on body by 13.9 mm. Base of caudal fin. |
Developmental stages of *Helostoma temminkii*
Developmental stages of *Helostoma temminckii*
**Channa striata**

Adult *Channa striata* (Bloch, 1793)
Striped snakehead

A non-migratory, predominantly carnivorous species which is found in slow flowing or standing water, commonly on floodplains and smaller streams in the lowlands; it prefers relatively deep (1–2 m), still water with dense vegetation. It feeds on fishes, crustaceans, frogs, insects, earthworms and occasionally on plant fragments. A black fish which does not undertake longitudinal migrations within the Mekong, it migrates laterally from the main river, or any other permanent water body, to flooded areas including flooded forests during the flood season and returns to permanent water bodies at the beginning of the dry season. It spawns in flooded areas such as swamps and rice fields and also in slow-flowing parts of rivers. Striped snakeheads spawn year-round, with a peak from March to June. Parent fish guard their young for about a month. It is caught with seines, gill-nets, traps and baited hooks. It is a very important food fish, usually sold alive. It attains a maximum length of 90 cm, more commonly 45 cm SL.

*Main references:* Bardach, 1959; Krachangdara, 1994; Poulsen et al., 2004; Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | 43  | 41  | 42   |
| Anal Fin Count           | 27  | 26  | 27   |
| Pectoral Fin Count       | 17  | 16  | 16   |
| Pelvic Fin Count         | i,5 | i,5 | i,5  |
| Myomere Count            | 42  | 38  | 40   |
| Ratio between HL:SL      | 0.36| 0.35| 0.35 |
| Ratio between Sn-DF:SL   | 0.38| 0.38| 0.38 |
| Ratio between Sn-AF:SL   | 0.61| 0.59| 0.60 |
| Ratio between Sn-P, F:SL | 0.38| 0.38| 0.38 |

**Ecology**

| Yolk-sac larva            | Morphological characteristics | Pigmentation                                  |
|---------------------------|-------------------------------|-----------------------------------------------|
| Develops in rivers and on floodplains. | Round yolk-sac with homogenous yolk. | Melanophores on head and trunk. |
| Pre-larva                 | Starts feeding on zooplankton at 6.8–7.7 mm in length. | Elongated to moderately deep body with oblique superior mouth and long triangular gut; 38–42 myomeres, 18–20 pre-anal myomeres. | Melanophores on snout and dorsally on head and trunk, ventrally on gut and tail; gut and pectoral fin covered with melanophores. |
| Post-larva                | Carnivore.                     | Moderately deep body with wide and superior mouth. Mouth becomes terminal by 15.5 mm. | Dorsally on head, body and ventrally on gut and tail. Diffuse melanophores on dorsal and venral fin absent by 24.0 mm. Blotches on dorsal fin and dorsal surface of body by 28.1 mm. |
Developmental stages of *Channa striata*
Developmental stages of *Channa striata*
Brachirus harmandi

Adult *Brachirus harmandi* (Sauvage, 1878)
Harmand’s sole

This sole feeds on benthic invertebrates. The eyes are on the right side of the body; dorsal and anal fins are confluent with the caudal fin; the mouth is nearly terminal and without a bony process on the snout. The opercular membrane is not joined to the pectoral fin when it is well-developed, but may be joined when the pectoral fin is rudimentary. The pre-larvae and post-larvae are bilaterally symmetrical. After metamorphosis, the left eye moves to the right side and the fish moves down to the bottom. Occurs in flowing waters of large and medium rivers on the southeast Asian mainland. Caught with seines, trawls and set nets. It is of limited commercial importance and is marketed fresh in mixed catches. It grows to about 10 cm.

*Main reference:* Rainboth, 1996.

Meristics and morphometrics of larvae and juveniles

|                          | Max | Min | Mode |
|--------------------------|-----|-----|------|
| Dorsal Fin Count         | 56  | 54  | 55   |
| Anal Fin Count           | 49  | 45  | 48   |
| Pectoral Fin Count       | 6   | 6   | 6    |
| Pelvic Fin Count         | 4   | 4   | 4    |
| Myomere Count            | 42  | 38  | 40   |
| Ratio between HL:SL      | 0.24| 0.23| 0.23 |
| Ratio between Sn-DF:SL   | 0.37| 0.25| 0.36 |
| Ratio between Sn-AF:SL   | 0.20| 0.19| 0.20 |
| Ratio between Sn-P,F:SL  | 0.16| 0.16| 0.16 |

| Ecology                  | Morphological characteristics | Pigmentation                                      |
|--------------------------|------------------------------|---------------------------------------------------|
| Yolk-sac larva           | Occurs on floodplains.       | Body elongate and bilaterally symmetrical.         |
|                          |                              | Melanophores on head.                              |
| Pre-larva                | Develops on floodplains and feeds on zooplankton. | Body bilaterally symmetrical, anus opens at anterior part of body. |
|                          |                              | Melanophores on head and trunk.                    |
| Post-larva               | Occurs on floodplains and rivers on or near the bottom after metamorphosis. | Body oval, trunk strongly dorsally-laterally flattened. Left eye moves to the right side during metamorphosis. |
|                          |                              | The upper side (right side) has a brownish background with several large dark spots on the body and the underside (left side) is white. |
Developmental stages of *Brachirus harmandi* from natural collection.
Cynoglossidae

**Cynoglossus microlepis**

**Adult Cynoglossus microlepis** (Bleeker, 1851)
Small-scale tongue sole

A freshwater species which has eyes on the left side of its body. Only its left pelvic fin is developed and it is connected to the anal fin. Dorsal and anal fins are confluent with the caudal fin. The snout projects well beyond the mouth opening. It lives on the bottom where it feeds on benthic invertebrates. Caught with seines, trawls and set nets. Marketed fresh in mixed catches and with little commercial importance. It grows to a length of about 25 cm.

*Main reference:* Rainboth, 1996.

**Meristics and morphometrics of larvae and juveniles**

|                      | Max  | Min  | Mode |
|----------------------|------|------|------|
| Dorsal Fin Count     | 115  | 108  | 110  |
| Anal Fin Count       | 92   | 84   | 88   |
| Pelvic Fin Count     | 4    | 4    | 4    |
| Myomere Count        | 57   | 50   | 55   |
| Ratio between HL:SL  | 0.24 | 0.21 | 0.22 |
| Ratio between Sn-DF:SL | 0.02 | 0.02 | 0.02 |
| Ratio between Sn-AF:SL | 0.36 | 0.34 | 0.35 |
| Ratio between Sn-P,F:SL | 0.28 | 0.28 | 0.28 |

|                | Ecology | Morphological characteristics                      | Pigmentation                      |
|----------------|---------|--------------------------------------------------|-----------------------------------|
| **Yolk-sac larva** | Occurs on floodplains. | Body elongated and bilaterally symmetrical. | Melanophores on head. |
| **Pre-larva**     | Develops on floodplains. | Body elongate and bilaterally symmetrical Stomach long and bag-like. | Melanophores on head and trunk. |
| **Post-larva**    | Occurs on floodplains and moves to main streams in flowing water and feeds on bottom invertebrates after metamorphosis. | Body elongated and bilaterally symmetrical. Stomach long and bag-like. After metamorphosis right eye moves to left side of head. Body strongly compressed and asymmetrical. Dorsal and anal fin confluent with caudal fin. Dorsal fin origin on the head. Only left pelvic fins developed and connected to anal fin. Snout projecting well beyond mouth opening. | Melanophores on head and trunk on the left side; white on the right (under) side. |
Developmental stages of *Cynoglossus microlepis* from natural collection

5.8 mm pre-larva

9.8 mm pre-larva

12.0 mm post-larva

18.0 mm juvenile
**Tetraodon cochin chinensis**

Adult *Tetraodon cochin chinensis* Steindachner, 1856

Spotted puffer

A benthic feeder on molluscs, crustaceans and other invertebrates as well as some vegetable matter. The body is inflatable and the skin has small prickles that may be confined to the belly. It has four fused teeth. It has no pelvic fins and the caudal fin is truncate to round in shape. Nostrils have a tubular nasal tentacle that is distally divided into two tips that are less than one half its length. Found in slowly flowing streams throughout the LMB. Not fished commercially and possibly poisonous. Sometimes taken accidentally in seines, cast-nets, set nets and traps. It grows to a length of about 6 cm.

*Main reference:* Rainboth, 1996.

### Meristics and morphometrics of larvae and juveniles

|                     | Max | Min | Mode |
|---------------------|-----|-----|------|
| Dorsal Fin Count    | 14  | 12  | 13   |
| Anal Fin Count      | 12  | 10  | 11   |
| Pectoral Fin Count  | 13  | 12  | 12   |
| Myomere Count       | 22  | 19  | 21   |
| Ratio between HL:SL | 0.39| 0.38| 0.38 |
| Ratio between Sn-DF:SL | 0.75| 0.73| 0.74 |
| Ratio between Sn-AF:SL | 0.78| 0.78| 0.78 |

### Ecology

|                      | Morphological characteristics | Pigmentation                               |
|----------------------|-------------------------------|--------------------------------------------|
| Yolk-sac larva       | Body short, balloon-like and with few myomeres. | Melanophores on head above the eye.       |
| Pre-larva            | Balloon-like body, large eyes and few myomeres. | Melanophores on head above the eye, snout on ventral part of the head. |
| Post-larva           | Small single gill opening on each side, teeth fused, beak-like, no pelvic fin, dorsal and anal fins on the posterior part of body. Nostrils with tubular nasal tentacle. | Brownish background on dorsal part of body with several large dark spots and a large mid-lateral ocellus below the dorsal fin. |
Developmental stages of *Tetraodon cochinchinensis* from wild collections
| Term                        | Definition                                                                                                                                 |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| abbreviate heterocercal     | Tail in which the vertebral axis is prominently flexed upward, only partly invading upper lobe of caudal fin, fin fairly symmetrical externally. |
| abdominal cavity            | Cavity containing the viscera.                                                                                                             |
| actinotrichia               | Thread-like fibres in the fin folds of fish larvae that eventually develop into fin rays.                                                  |
| adult                       | Fish that have fully developed morphological and meristic characters and that have attained sexual maturity.                               |
| allometric                  | Different growth of a part of an organism in relation to the growth of the whole organism or some other part of it.                      |
| allometry                   | 1. The relative growth rates of the different parts of a given organism. 2. The study or measurement of the size or growth rate of organisms. |
| amnion                      | Membrane surrounding the developing embryo.                                                                                               |
| anal fin origin             | Anterior-most point at which the anal fin attaches to the body.                                                                             |
| anatomy                     | The science that deals with the structure of animals and plants as determined by dissection.                                               |
| aspect ratio                | A dimensionless ratio expressing how elongated the shape of a flat organ, e.g., a fin might be. Here calculated for the caudal fin as the ratio \( h^2/s \), where \( h^2 \) is the height squared and \( s \) the surface of that fin. |
| asymmetrical                | Not symmetrical; one side is not the mirror image of the other.                                                                           |
| aphagous                    | Lacking the ability to feed.                                                                                                              |
| aplacental                  | Viviparous reproduction in which embryos are not connected to their mother's blood supply by a placenta, as is the case in some sharks.  |
| auditory vesicle            | Sensory anlage from which the ear develops, clearly visible during early development.                                                     |
| aquatic insect              | Insect having at least part of its life cycle in water; important food for many fishes.                                                   |
| blastocoel                  | Cavity of the blastula, segmentation cavity.                                                                                               |
| biometry                    | The statistical study of biological data.                                                                                                |
| blastoderm                  | Early embryonic tissue composed of blastomeres, more generally, embryonic tissue prior to formation of embryonic axis                   |
| blastodisc                  | Embryo-forming area of egg prior to cleavage.                                                                                              |
| blastomere                  | Individual cells formed during cleavage.                                                                                                  |
| blastopore                  | Opening formed by and bordered by the germ ring as it extends over the yolk.                                                              |
| blastula                    | Stage in embryonic development which represents the final product of cleavage stages, characterized by formation of the blastocoel, [pl. blastulae]. |
| body depth                  | The vertical distance from the dorsal margin of the body to the ventral margin of the body measured at the base of the pectoral fin where it attaches to the body; fins or fin bases are not included in the measurement. |
| brood pouch                 | Sac-like cavity in the parent’s body in which eggs are deposited and fertilized and larvae develop, such as in seahorses.                  |
| Term                      | Definition                                                                                                                                 |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| bulbous                   | Shape swollen or bulging.                                                                                                                                 |
| cleavage stages           | Initial stages in embryonic development where divisions of blastomeres are clearly marked, usually includes first through sixth cleavages (2-64 cells). |
| coalesced                 | United or fused in growth.                                                                                                                                 |
| complex life cycle        | A life cycle that consists of several distinct stages (e.g., larva and adult).                                                              |
| confluent gill membranes  | Ventrally continuously united gill membranes.                                                                                               |
| contour                   | A line on a chart representing points of equal value with relation to datum. It is called an isobath when connecting points of equal depth below sea level. |
| contour interval          | The difference in value between two adjacent contours.                                                                                      |
| cranial fontanelle        | An unossified median opening, covered only by membrane, in the top of the skull.                                                            |
| dai                       | A stationary anchored trawl net. The most famous dais are large nets, 25 m wide, 12 m deep and 80–148 m long, anchored in rows across the Tonle Sap River in Cambodia for intercepting fish during the massive migrations in December–March; the majority of the catch is composed of the cyprinid Trey Riel (*Henicorhynchus* spp.). |
| deciduous                 | Easily shed or rubbed off; usually referring to denticles; body parts lost during metamorphosis; falling off at some stage of maturity.       |
| depressed                 | Dorso-ventrally flattened; [i.e. from top to bottom]; The opposite of compressed.                                                            |
| diastema                  | A gap in the dentition sometimes found between fangs and smaller teeth in the jaws.                                                           |
| dimorphic                 | Having two forms; a species is sexually dimorphic in morphology when males and females are structurally different, sexually dimorphic in colour when the sexes differ in colour. |
| diptera                   | An order of two-winged insects with complete metamorphosis. The order encompasses mosquitoes, midges, gnats, and relatives.                    |
| direct length             | Shortest distance between two points.                                                                                                         |
| disc                      | The combined head, trunk and enlarged pectoral fins of some cartilaginous fishes with depressed bodies.                                          |
| dissection                | The process of cutting open a dead animal or a plant to study the morphology.                                                                 |
| dorsal                    | Toward the upper part of the body as opposed to ventral.                                                                                     |
| dorsolateral              | Positioned or orientated between the dorsal and lateral surfaces                                                                              |
| dorsoventral              | Stretching from the dorsal to the ventral surface                                                                                             |
| dragonflies               | Odonata, an order of insects with an aquatic nymph; important food for some fishes. The nymphs are large and eat small animals, including fish larvae and fry. |
| drift                     | Animals and plants carried downstream by the river current                                                                                     |
| duct                      | Small tube or canal through which some material is passed.                                                                                     |
| early embryo              | Stage in embryonic development characterized by formation of embryonic axes.                                                                  |
| early life history        | The early phase in life usually spanning the developmental stages from egg to juvenile.                                                       |
| earth form                | A geo-morphological feature of the earth's crust.                                                                                             |
| eco-morphology            | The study of the relationship between the morphology (form) of an organism and its environment and ecology.                                  |
| elevated                  | Higher than adjacent parts of the body.                                                                                                         |
| Term            | Definition                                                                 |
|-----------------|---------------------------------------------------------------------------|
| elevated fin    | Some part of a fin higher than the adjacent parts of the fin or body.      |
| elliptical      | Shaped like an ellipse, oval.                                             |
| elongate        | Extended or drawn out.                                                    |
| elver           | Small cylindrical young eel, more advanced in development than leptocephalus. |
| embryo          | The early stage of development before an organism becomes self supporting. |
| embryology      | The scientific study of embryos; the study of the development of an organism from a fertilized egg. |
| embryonic axis  | Primitive differentiation of the embryo; an elongate thickening of blastodermal tissue. |
| embryonic shield| Thickened shield-like area of the blastoderm at caudal edge of the germ ring. |
| engyodontic stage | Early stage of anguilliform larvae characterized by few needle-like teeth, the upper and lower jaws equal in length, no nasal capsule, no hyurals, the notochord tip straight, and the head and pre-anal region of the body relatively large. |
| epaxial musculature | Body muscles above the horizontal septum.                              |
| epiboly         | Movement of the embryonic cell mass over the surface of the yolk; the germ ring marks the boundary of the advancing sheet of cells. |
| erectile        | Capable of being raised, erected, or elevated.                           |
| exserted        | Projecting outward.                                                       |
| exterillium stage | Larval stage with a looped, trailing gut.                                  |
| eyed egg        | A fish egg containing an embryo that has developed enough so the eyes are visible through the egg membrane. |
| eyestalk        | Moveable peduncles bearing the eyes at the tip.                           |
| finfold         | Median fold skin surrounding the body within which the dorsal, anal and caudal fins develop. |
| first-feeding larva | Larva that has used all or most of its yolk and is capable of capturing prey. |
| fish larva      | A term covering developmental stages in the early life history of a fish between the time of hatching and transforming to a juvenile, the latter a miniature replica of the adult; [young fish between time of hatching and attainment of minimum adult fin ray counts, which at birth or hatching is fundamentally unlike its parents and must pass through metamorphosis before assuming adult characters; (pl. larvae)]. |
| fish larva identification | Determining which species a fish larvae or juvenile belongs to based on both meristic characteristics (measurements of morphological characteristics) and ontogenic development. |
| flexion larva   | A fish larva at the stage of development when the posterior end of the vertebral column starts to bend upwards, as a preparation for the development of the caudal fin; marks a mid-point in larval development when caudal fin rays start to appear. |
| flexuose        | Winding or having turns or undulations.                                   |
| fossil          | A part or record of behaviour of an organism that has been preserved from past time, usually in sedimentary rock. |
| front           | In morphology, an anterior position.                                      |
| fry             | A young fish, usually a late post-larva or juvenile.                     |
| fusiform        | Spindle-shaped; used in reference to the body shape of a fish which is cylindrical or nearly so and tapers toward the ends. |
| gastrula        | Stage in embryonic development between blastula and embryonic axes.      |
| geography       | A branch of science that deals with describing the Earth and its life.    |
| Term                      | Definition                                                                                                                                 |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| geological time           | 1. The period of time from the formation of the earth to the beginning of recorded history; prehistoric time.  
2. A very long span of time extending over millions of years. |
| gill filaments            | The threadlike structures on the posterior edge of each gill arch; [The soft, red, fleshy part of the gills]; contain a network of blood vessels that facilitate the exchange of gasses between the blood and the external environment. |
| gill opening              | The opening behind, and sometimes under, the head where the water of respiration is expelled. Bony fishes have a single such opening on each side.     |
| globiform                 | Formed like a globe, or sphere.                                                                                                             |
| granular yolk             | Yolk consisting of discrete units of finely to coarsely granular material.                                                                   |
| gular fold                | A transverse fold or membrane across the neck.                                                                                              |
| gut                       | The alimentary canal. A term used when describing fish larvae.                                                                             |
| hatching                  | The process when a fish larva frees itself from the egg membrane.                                                                            |
| histology                 | The study of the fine structure of body tissues.                                                                                                |
| hypurals                  | In fish larvae, flattened bones along the ventral side of the urostyle. From these bones the caudal fin rays arise.                         |
| ichnotaxon                | A taxon based on the fossilized work of an animal, including fossilized trails, tracks and/or burrows.                                  |
| ichthyologist             | A person who studies fish.                                                                                                                  |
| ichthyoplankton           | Eggs and larvae of fish drifting in the water column.                                                                                       |
| identification            | The art of assigning the correct scientific name to a specimen [based on published descriptions; an important tool for the proper identification of a fish is a taxonomic key]. |
| imago                     | The last or adult stage of insect metamorphosis; the perfect insect.                                                                       |
| incubation period         | The time taken for development from the time of fertilization to hatching of the larva; varies according to the temperature and the size of the egg and amount of yolk it contains; can reach days to months. |
| indented                  | Refers to a structure with a small notch in the middle.                                                                                     |
| interdorsal               | The space on the dorsal surface between the first and second dorsal fins; measured from the point of insertion of the first to the origin of the second. |
| interorbital distance     | The shortest distance between the eyes.                                                                                                     |
| interorbital space        | The area on top of the head between the eyes; measurements may be taken of the least width, either fleshy (to the edges of the orbits) or bony (between the edges of the frontal bones which rim the orbits). |
| interradial membrane      | The soft membrane between rays and spines in the fins of fishes.                                                                             |
| interspinous membrane     | Skin between the spines of, e.g., the dorsal fin.                                                                                           |
| intestine                 | Part of the alimentary canal, from the end of the stomach to the anus.                                                                       |
| invertebrate drift        | Stream and terrestrial invertebrates that float with the current.                                                                           |
| juvenile                  | Young fish after attainment of minimum adult fin ray counts but before sexual maturation.                                                    |
| juvenile stage            | Young fish, fundamentally like the adult in meristic characters (excluding escalation) but smaller and reproductively inactive.            |
| Kupffer's vesicle         | A small, vesicular, ventro-caudal pocketing which forms as blastopore narrows. The origin and function of this vesicle is still not clear, however there are indications for metabolic function. The vesicle is a transitory structure. |
| larva                     | A juvenile animal which does not have the characteristics of the adult e.g. fish and some insects (cf. fry, nymph). [pl. larvae] |
| Glossary | Definition |
|----------|------------|
| larval development | After hatching, fish larval development can be regarded as a sequence of three major phases: yolk-sac stage, pre-larval stage and post-larval stage. Undergoing metamorphosis, a fish larva turns into a juvenile. Larval development varies according to temperature and food availability. |
| late embryo | Stage prior to hatching in which the embryo has developed external characteristics of its hatching stage. |
| lateral scale rows | The number of near-vertical scale rows between the upper end of the gill opening and the base of the caudal fin; sometimes called vertical scale rows. This count is taken on fishes which lack a lateral line or on which the lateral-line scales are difficult to enumerate. |
| leptocephalus | The elongate highly compressed transparent, ribbon-like and pelagic larval stage of some primitive teleost fishes such as the tarpon (*Megalops*), and eels (*Anguilla*); (pl. leptocephali). |
| lozenge-shaped | Shaped like a rhombus. |
| median predorsal scales | The number of scales running in a median row anteriorly from the origin of the dorsal fin. |
| median septum | The ventral septum, between the left and right side of muscle tissue. |
| membrane | The thin layer of tissue covering a part of an animal or connecting the fin elements. |
| metamorphosis | Change of body shape, e.g., the change from a larval form to a juvenile adult form. [The process is especially dramatic in soles (Soleidae) and tongue fishes (Cynoglossid) where the larvae are pelagic and symmetrical while the later stages are benthic and asymmetrical; (alt. transformation)]. |
| microencapsulated diets | Special feeds developed for the rearing of larvae or some forms of animal where their normal food item are microscopic and of a particular size. |
| microphagous | Feeding on microscopic particles; [eg. filter feeders]. |
| migration | Movement that results in an alternation between two or more separate habitats, occur with a regular periodicity, and involves a large proportion of the population. [The direction of the migration can be lateral, longitudinal or vertical and can be repeated either diurnally or seasonally. Fish migrate for several reasons e.g. feeding, spawning or to avoid desiccation, deoxygenation and predation. Migration can occur at all stages in a fish's life, and can be either active or passive (eggs and larvae) and cover distances from a few metres to several hundred kilometres]. |
| modal | Relating to the statistical mode, which is the value that occurs most frequently in a series of numbers; e.g., if, in a species of fish, two individuals have 14 pectoral-fin rays, seven have 15 rays, and four have 16 rays, 15 is the modal count. |
| morphology | The scientific study of the form and structure of organisms, especially their external form or the form and structure of a given organism, considered as a whole. |
| morphometric | Relative to measurements of the shape of an individual; body proportions; the size relationships of various morphological characteristics of an animal. |
| morphometrics | The scientific measurement or analysis of the shape or form of organisms. |
Mosquitoes are parasitic, blood sucking insects of the family Culicidae; the larvae are aquatic and are important food items for many fishes. In tropical countries some mosquitoes carry dangerous diseases and a lot of effort is put into eradicating them including spraying water bodies with DDT and introduction of mosquito-eating fishes, potentially with severe environmental side effects.

Connective tissue partitions separating myomeres.

Early egg-shaped larval stage of prawns and other crustaceans. Nauplii are unsegmented and bear three pairs of appendages. Important fish food, especially for fish larvae.

A transparent, moveable membrane or inner eyelid that protects and helps to keep the eye clean.

Straight-line distance from anterior most part of head to posterior tip of notochord; used prior to and during notochord flexion.

Growth areas for juvenile fishes, most often on the floodplain in the case of the Mekong.

The place where a juvenile fish first feeds and grows.

In insects a juvenile form, which is similar to the adult; some nymphs are important food items for fishes.

The order of dragonflies; The larvae of dragon flies are entirely aquatic and constitute part of the food of some fishes, however the larvae are rather large and may sometimes feed on fish larvae and fry.

Discrete sphere(s) of fatty material within the yolk-sac of a fish larva; the size and number of globules are used for species identification.

Those characters associated with developmental stages.

The early life history of an organism, i.e., the succession of stages it passes through from the zygote to the adult.

Embryos feeding on eggs produced by the ovary while still inside the mother's uterus, as is the case with some sharks.

The embryonic or larval kidney.

Embryonic vesicular structures which give rise to the eyes.

The relatively advanced period of embryonic development characterized by formation of the organ system.

A cyst that contains the otoliths. Sensory organ for the perception of gravity and acceleration.

Method of embryonic nutrition where one embryo feeds on unfertilized eggs or other embryos within the uterus.

Also called larval drift. The relatively passive movement of fish larvae from the spawning ground to the nursery areas.

Fossil history.

A layer of tissue between the yolk and cells of blastoderm which is observed as a thin border around blastula.

The membranous lining of the body cavity; the pigmentation of the peritoneum is an important character in the identification of fish larvae.

Evolutionary relationships and history; the sequence of events that make up the evolutionary past, often depicted by a branching tree-like diagram.

Viviparous reproduction in which embryos are connected to their mother's blood supply by a placenta.

Passively floating or weakly swimming aquatic organisms; planktonic organisms vary considerably in size and include algae, crustaceans, and larval fishes among others.
| Term                     | Definition                                                                 |
|-------------------------|---------------------------------------------------------------------------|
| posterior               | The tail end; at or towards the rear end of the fish; the opposite of anterior; situated farther back than something else. |
| post-larva              | Animals that have changed from the larval form to juvenile or adult form; usually refers only to the stage immediately following the larvae and which shows already juvenile characters such as fin rays; [(pl. post-larvae)]. |
| preanal length          | The measurement from the snout tip to the origin of the anal fin; [equivalent to snout to vent length in larvae]. |
| preanal myomeres        | The number of myomeres between the anterior most myoseptum and the posterior margin of anus. |
| Pre-juvenile            | Developmental stage immediately following acquisition of minimum fin ray complement of adult and before assumption of adult-like body form; used only where strikingly different from juvenile. |
| primordium              | Rudimentary form of an anatomical structure; anlage.                        |
| production capacity     | The capacity of a water body or production facility to produce fish.       |
| protolarva              | Yolk sac type of fish larvae, also called pro-larvae.                      |
| pupa                    | A resting stage in the life cycle of some insects; the larval insect is enclosed in a protective case where it changes into the adult form, e.g., a butterfly (pl. pupae). |
| quaternary              | The recent prehistoric past which has been dominated by the arrival of Man. |
| querimana stage         | Silvery pelagic juvenile stage of mullets (Mugilidae).                     |
| reflexed                | Bent or turned backwards.                                                 |
| sagittal                | 1. Relating to the imaginary mid-line of the body dividing it vertically into two symmetrical halves.  
2. Relating to the line of function of the two halves of the skull. |
| Secchi depth            | The depth at which a Secchi disc is no longer visible.                     |
| secretory               | Involved in producing a secretion, or exuding a substance.                 |
| septum                  | In anatomy, a dividing wall or partition.                                 |
| skeletogenesis          | The growth or formation of the skeleton.                                  |
| spinous                 | With a spine or containing a spine.                                       |
| spiral valve            | A spiral structure in the intestines of some fish; a spiral fold of mucous membrane projecting into the intestines. |
| somites                 | Primitive, segmented, mesodermal tissue along each side of notochord.     |
| stellate                | Star-shaped; with radial form.                                            |
| swim-up fry             | Fry that is swimming in the water column in search for food.              |
| tail ring               | Body segments of a pipefish located between the anus and the base of the caudal fin. |
| tail-bud stage          | Stage of embryonic development characterized by a prominent caudal bulge and marked development of cephalic region. |
| tail-free stage         | Stage of embryonic development characterized by separation of the tail from the yolk. |
| telolecithal eggs       | In contrast to most invertebrates (holoblastic cleavage, yolk incorporated into the dividing cells), teleosts have telolecithal eggs, with the yolk mass separate from the developing embryo. This egg type undergoes meroblastic or discoidal cleavage, where yolk is not incorporated during cell division. |
| tides                   | Periodic movement of water resulting from gravitational attraction between the earth, sun, and moon. |
| Term                          | Definition                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| trailing gut                 | A gut shape that protrudes from the body cavity downward like a sac. Can be found e.g. Pleurotidae larvae.                                                                                                                                                                                                                             |
| transformation in fish larva | The process (synonymous with metamorphosis) at the end of the larval stage, characterized by a marked change in form or structure and involving acquisition of juvenile or adult characters and loss of larval character; also refers to the stage where this process occurs; the term "transitional" is used sometimes for larvae that undergo a gradual transformation. The transformation is especially dramatic in soles (Soleidae) and tonguefishes (Cynoglossidae) where the larvae are pelagic and symmetrical while the later stages are benthic and asymmetrical. |
| transverse groove            | A horizontal furrow across the head, such as it is seen in *Bangana behri*.                                                                                                                                                                                                                                                             |
| Triassic                     | From approximately 225 to 185 million years before present.                                                                                                                                                                                                                                                                              |
| tubular                      | Having the form of a tube, such as the snout in sea horses.                                                                                                                                                                                                                                                                               |
| type horizon                 | The geological stratum from which the name-bearing type of a nominal species or subspecies was collected.                                                                                                                                                                                                                               |
| urostyle                     | In fish larvae, a backwardly projecting process on the most posterior vertebra. The urostyle is usually included when counting vertebrae. Terminal vertebral element in higher teleosts, derived from the fusion and loss of several of the most posterior centra of the more primitive forms. |}

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**Continued from previous page...**

| Term                          | Definition                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| uterine cannibalism           | The first hatching derives nourishment in the mother's reproductive tract by consuming either younger hatchlings (embryophagy) or unfertilized eggs (ophagy).                                                                                                                                                                                                 |
| uterus                        | An enlarged portion of the oviduct modified to serve as a place for development of young or eggs.                                                                                                                                                                                                                                                                 |
| ventral                       | Describes a feature anatomically located on, in or near the belly. Relating to the underside or lower surface of an animal or body part.                                                                                                                                                                                                     |
| ventro-lateral                | Positioned or orientated between the ventral and lateral surfaces.                                                                                                                                                                                                                                                                       |
| vesicle                       | In anatomy, a small cavity, sac or air space.                                                                                                                                                                                                                                                                                               |
| vestibular                    | In anatomy, relating to or designating an opening at the entrance to a canal.                                                                                                                                                                                                                                                            |
| viviparous development        | Refers to development of an organism through the juvenile stage within a parent.                                                                                                                                                                                                                                                    |
| yolk                          | Food reserve of embryonic and early larval stages, usually seen as a yellowish sphere diminishing in size as development proceeds.                                                                                                                                                                                                  |
| yolk-sac                      | A bag-like ventral extension of the gut containing nutritive materials that first appears in the fish embryo and is later absorbed by the larva during the stage after hatching and before feeding.                                                                                                                                                |
| yolk-sac larva                | Fish larva which has already hatched from the egg but has not started feeding yet and still absorbs the yolk in the ventrally attached sac. At the end of the yolk-sac stage the yolk and oil globule(s) have been used up and the major organ and sensory systems required to capture prey are functional. The mouth and gut have formed, the anus is open at the margin of the ventral finfold, the eyes are pigmented, and the primordial pectoral fins are present. |
| zooplankton                   | Small suspended and passively floating or weakly swimming aquatic animals. Zooplankton vary considerably in size and include such animals as bacteria, protozoans, crustaceans, molluscs and fish larvae.                                                                                                                                           |
| zygote                        | Cell formed from the union of an egg and a sperm; fertilized egg.                                                                                                                                                                                                                                                                       |
References

Baird, I.G. and B. Phylavanh (1999) Fishes and forests: fish foods and importance of seasonally flooded riverine habitats for Mekong River fish. Technical Report, Environmental Protection and Community Development in the Siphandone Wetland, Champasak Province, Lao PDR. Funded by European Union, implemented by CESVI, 46pp.

Baird, I. G.; Inthaphaisy, V.; Kisouvannalath, P.; Phylavanh, B. and B. Mounsouphom (1999) The Fishes of Southern Lao. Lao Community Fisheries and Dolphin Protection Project. Ministry of Agriculture and Forestry, Lao PDR, 161pp.

Balon, E.K. (1975) Terminology of intervals in fish development. *Journal of the Fisheries Research Board of Canada, 32*(9): 1663-1670.

Bardach, J. (1959) Report on Fisheries in Cambodia. USOM/Cambodia, Phnom Penh, 80pp.

Chevey, P. and F. Le Poulain (1940) La pêche dans les eaux douces du Cambodge 5e mémoire. Travaux de l’Institut Océanographique de l’Indochine, 195pp. + plates.

Hortle, K.G. (2009) Fishes of the Mekong - how many species are there? *Catch and Culture, 15*: 4-12.

Hubbs, C.L. (1943) Terminology of early stages of fishes. *Copeia, 4*: 260.

Jala, A.; Termvidchakorn, A.; Sridee, N. and S. Suksri (2004) The development and species identification of fish larvae in the genus *Barbodes*. *Technical Paper No. 55/2004*. Inland Fisheries Research and Development Bureau, Department of Fisheries, 39pp.

Kendall, A.W.; Alstrom, E.H. and H.G. Moser (1984) Early life history stages of fishes and their characters. *Ontogeny and Systematics of Fishes, 1*: 11-22.

Khamtorn, C. (1999) Some aspects of biology, behaviour and ecology of Yellow-tail botia (*Yasuhikotakia modesta* Bleeker, 1865). MSc Thesis. Faculty of Graduates, Kasetsart University.

Kottelat, M. (1998) Fishes of the Nam Theun and Xe Bangfai basins, Lao PDR, with diagnoses of twenty-two new species (Teleostei: Cyprinidae, Balkeridae, Cobitidae, Coidae and Odontobutidae). *Ichthyological Exploration of Freshwaters, 9*(1): 1-128. 194 figs, 14 tabs.

Kottelat, M. (2001) *Fishes of Laos*. WHT Publications Pty Ltd: Colombo, Sri Lanka, 198pp.
A guide to larvae and juveniles of some common fish species from the Mekong River Basin

Krachangdara, T. (1994) Taxonomy and some biological aspects of fishes found in the impoundment of Rajjaprabha Dam, Surat Thani Province. MSc Thesis. Faculty of Graduates, Kasetsart University.

Leelapatra, W.; Srisakultiew, P. and N. Sukumasavin (2000) Biology and Breeding of Indigenous Mekong Fish Species in Thailand. Management of Reservoir Fisheries in the Mekong Basin II, Vientiane.

Leis, J.M. and B.M. Carson-Ewart (Eds) (2000) The Larvae of Indo-Pacific Coastal Fishes: An Identification Guide to Marine Fish Larvae. Fauna Malesiana Handbooks No. 2. Koninkije, Brill, the Netherlands and the Fauna Malesiana Foundation, 850pp.

Lieng, S.; Yim C. and N.P. van Zalinge (1995) Freshwater fisheries of Cambodia, I: The bagnet (dai) fishery in the Tonle Sap River. Asian Fisheries Science, 8: 255-262.

Mills, D. and G. Vevers (1989) The Tetra Encyclopedia of Freshwater Tropical Aquarium Fishes. Tetra Press, New Jersey, 208pp.

Moyle, P.B. and J.J. Cech (2004) Fishes: an Introduction to Ichthyology. 5th edition. Prentice-Hall Inc., New Jersey, USA, 726pp.

MRC (2003) Mekong Fish Database 2003. CD-ROM, Mekong River Commission, Phnom Penh, Cambodia.

MRC (2010) State of the Basin Report 2010. Mekong River Commission, Vientiane, Lao PDR, 232pp.

Piamthipmanus, M.; Jala, R.; Termvidchakorn, A.; Sridee, N. and S. Suksri (2004) The Family Identification of Fish Larvae in the Order Cypriniformes. Technical Paper No. 56/2004. Inland Fisheries Research and Development Institute, Dept of Fisheries, Bangkok, Thailand.

Pongsirijun, S.; Rungtongbaisuree, S. and T. Pongjanyakul (2001) Induced breeding of black ear catfish, Pangasius larnaudii Bocourt, 1886. Technical Paper No. 15/2001, Sisaket Inland Fisheries Station, Sisaket, Thailand.

Pongsirijun, S.; Boongarm, J. and T. Pongjanyakul (2002) Some biological aspects of striped catfish, Mystus mysticetus Roberts, 1992 in the Mun River, Sisaket Province. Technical Paper No. 4/2002. Inland Fisheries Division, Department of Fisheries, Thailand.

Poulsen, A.F.; Hortle, K.G.; Valbo-Jörgensen, J.; Chan, S.; Chhuon, C.K.; Viravong, S.; Bouakhamvongsa, K.; Suntornratana, U.; Yoorong, N.; Nguyen, T.T. and B.Q. Tran (2004) Distribution and ecology of some important riverine fish species of the Mekong River basin. MRC Technical Paper, 10: 116pp.
Rainboth, W.J. (1996) *Fishes of the Cambodian Mekong*. FAO: Rome, Italy, 256pp + plates.

Roberts, T.R. (1993) Artisanal fisheries and fish ecology below the great waterfalls of the Mekong River in southern Lao PDR. *Natural History Bulletin of the Siam Society*, 42: 67-77.

Roberts, T.R. (1989) The freshwater fishes of Western Borneo (Kalimantan Barat, Indonesia). *Memoirs of the Californian Academy of Sciences*, 14: xii + 210pp.

Rajanapittayakul, S.; Kongkumnerd, J; Pechmanee, T.; Sahawatcharin, S. and W. Sriwattana (2000) Preliminary Study on Sand Goby, *Oxyeleotris marmoratus* larval rearing in brackishwater. *Thai Fisheries Gazette*, 53(1): 27-32.

Russell, F.S. (1976) *The Eggs and Planktonic Stages of British Marine Fishes*. Academic Press, London, 524pp.

Sanchandang, P. (2001) Comparative anatomy and redescription of bagrid catfishes (Pisces: Bagridae) of Thailand. MSc Thesis. Faculty of Graduates, Kasetsart University.

Singanouvong, D.; Soulignavong, C.; Vonghachak, K.; Saadsy B. and T.J. Warren (1996) The main wet-season migration through Hoo Som Yai, a steep-gradient channel at the great fault line on the Mekong River, Champassack Province, Southern Lao PDR. *IDRC Fisheries Ecology Technical Report*, 4: 115pp.

Smith, H.M. (1945) The fresh-water fishes of Siam, or Thailand. *Bulletin of the US National Museum*, 188: 633pp.

Talwar, P.K. and A.G. Jhingran (1992) *Inland Fishes of India and Adjacent Countries*. Volume 2. A.A. Balkema, Rotterdam, 541pp.

Termvidchakorn, A. (1997) The development and taxonomy of the catfishes larvae Family Pangasiidae. *Technical Paper* No. 3/1997, Aquatic Natural Resources Museum, Department of Fisheries, Thailand.

Termvidchakorn, A. (2003) *Freshwater Fish Larvae*. Inland Fisheries Resources Research and Development Institute, Inland Fisheries Research and Development Bureau, Department of Fisheries, 130pp.

Termvidchakorn, A. (2005) *Freshwater Fish Larvae in Thailand II*. Inland Fisheries Resources Research and Development Institute, Inland Fisheries Research and Development Bureau, Department of Fisheries, 125pp.

Termvidchakorn, A.; Buanak, T.; Soonthornvipat, S.; Hunpongkittikul, A. and S. Suksri (2005) The development of tribe and subtribe identification of fish larvae in Subfamily Cyprininae. *Technical Paper* No. 44/2005. Inland Fisheries Research and Development Bureau, Department of Fisheries, 77pp.
Tungmas, B.; Termvidchakorn, A.; Vidthayanon, C.; Sridee N. and S. Suksri (2004) Biodiversity of aquatic fauna in the watershed of Doi Chiang Dao Wildlife Sanctuary. *Technical Paper* No. 36/2004. Inland Fisheries Research and Development Bureau, Department of Fisheries, 48pp.

Vidthayanon, C. (2008) *Field Guide to Fishes of the Mekong Delta*. Mekong River Commission: Vientiane, Lao PDR, 288pp.

Warren, T.J. (2000) *Indigenous Mekong Fish Species with Potential for Aquaculture, Stocking or Translocation*, Management of Reservoir Fisheries in the Mekong Basin II, Vientiane 2000, 92pp.
Colour plates

PLATE I

Notopterus notopterus

Chitala ornata

Opsarius koratensis
PLATE II

Leptobarbus hoevenii

Cyprinus carpio

Catlocarpio siamensis
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Probarbus jullieni

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Cyclocheilichthys enoplos
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Barbonyxmus gonionotus

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Hypsibarbus malcolmi

Hampala dispar

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Puntius orphoides

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*Helostoma temminkii*

*Channa striata*

*Brachirus harmandi*
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Cynoglossus microlepis

Tetraodon cochinchinensis
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