

MORPHOLOGICAL DEVELOPMENT OF HATCHERY-REARED LARVAL AND JUVENILE *PANGASIU*S *BOCOURTI*

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ABSTRACT

We describe the morphological development of hatchery-reared larvae and juveniles of *Pangasius bocourti* using 111 specimens of 5.35 to 38.1 mm in body length (BL) sampled from day 1 to day 35. BLs of larvae and juveniles on day 1 were 5.99 ± 0.47 mm (mean \pm SD), reaching 13.3 ± 0.76 mm BL on day 14, 30.0 ± 2.37 mm BL on day 28 and 33.5 ± 3.00 mm BL on day 35. The notochord tip was slightly bent upward in the smallest larva of 5.35 mm BL, and a completely flexed notochord tip was evident in specimens of about 11 mm BL. Melanophores started appearing in larvae on such body parts as the yolk sac surface, eyes, dorsal surface of gut, head region, anterior part of lateral line, snout, dorsal contour of body, upper and lower jaws, and maxillary barbel, although those on the last four body parts were subjected to individual variation. Fin rays first appeared in the anal fin, followed by the caudal, dorsal and pectoral/pelvic fins, and fin-ray numbers were completed in the order of caudal, dorsal, anal, pelvic and then pectoral fins. The juvenile stage started consequently at 12.2 mm BL; however, at which point many the body proportions were in the process of developmental change, and most of them reached constant values relative to BL at about 30 mm BL.

Key words: Pangasiidae, morphology, ontogeny, developmental stage

INTRODUCTION

The pangasiid catfish *Pangasius bocourti* is a freshwater fish occurring in large rivers of the Mekong and Chao Phraya basins (FROESE & PAULY, 2013). This species is recognized as an important commercial fish, as well as for its potential use in cage culture in the Mekong Delta (CACOT, 1993; VAN ZALINGE *ET AL.*, 2002; POULSEN *ET AL.*, 2004). *Pangasius bocourti* is an omnivorous fish feeding on fruits and other plants, mollusks, shrimps, and fishes (RAINBOTH, 1996). It can reach a maximum size of 100 cm in total length (TL) (POULSEN *ET AL.*, 2004). Adults of this species migrate upstream to spawning grounds and spawn at the beginning of the flood season (POULSEN & VALBO-JORGENSEN, 2001); the larvae then drift to their nursery grounds, where the larvae of about 5 cm TL are first seen in June (RAINBOTH, 1996).

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Many pangasiid catfishes occur in the Mekong–Chao Phraya region, all performing seasonal migrations similar to that of *P. bocourti*. These species are now in need of conservation action due to environmental deterioration caused by human activities, including capture fisheries and aquaculture operations. So far, there have been many studies on pangasiids focused primarily on ecology and aquaculture. The identification guidelines for adult pangasiids are well established, based mainly on morphology, by ROBERTS & VIDTHAYANON (1991). However, knowledge of morphological development of pangasiid larvae and juveniles is not available other than for descriptions of *Pangasianodon hypophthalmus* by ISLAM (2005), BARAS ET AL. (2010) and MORIOKA ET AL. (2010), some figures of *Pangasianodon gigas* and *Pangasius larnaudii* drawn by A. Termvidchakorn in the work of ROBERTS & VIDTHAYANON (1991) without any additional comments, and a description of the morphological development of hatchery-reared larval and juvenile *P. larnaudii* (VISETH ET AL., 2011). Information about the morphological development of pangasiid larvae and juveniles would contribute to further understanding not only of pangasiid ecology and phylogeny, but also on the larval/juvenile identification for stock assessment, and on the improvement of seed production.

The purpose of this study is to clarify the growth and morphological development of *P. bocourti* to provide information necessary for conservation of its natural populations and for the analysis of phylogenetic relationships of the species and its congeneric and confamilial species.

MATERIALS AND METHODS

Pangasius bocourti larvae and juveniles used in this study originated at the spawning and rearing facilities of the Chiang Rai Fisheries Station of the Department of Fisheries, Chiang Rai Province, Thailand, where they were being reared at ambient water temperature. Six to 14 specimens were sampled every day from day 1 to day 8 and on days 10, 14, 18, 21, 28 and 35; they were preserved in 5% formalin solution immediately after collection. A total of 111 specimens of 5.35 to 38.1 mm in body length (BL) used in this study are deposited in the Museum of the Tokyo University of Marine Science and Technology under catalog numbers MTUF-P(L) 26611 and 26612.

The general morphology and fin development of all of the specimens were observed, and the following nine body dimensions were measured and expressed as a percentage of BL: head length, snout length, eye diameter, mouth width, upper jaw length, maxillary barbel length, maximum body depth and its position, and pre-anal length. The specimens sampled from day 1 to day 14 (5.35 to 14.4 mm BL) were measured under a binocular microscope with an ocular micrometer, and those from day 18 and older (16.7 to 38.1 mm BL) were measured by using a dial caliper; both types of measurement were recorded to the nearest 0.01 mm.

The myomeres were counted on the specimens from days 1 to 7 ($n = 28$). The distribution of melanophores was observed on all specimens. The volume of the yolk and oil globules was computed by applying the equation of BLAXTER & HEMPEL (1963): $V = \pi/6 \cdot l h^2$, where l is length and h is height. “Yolk volume” in this study refers to the combined volume of the yolk and oil globules. Measurement and counting methods followed LEIS & TRNSKI (1989), VIDTHAYANON (1993), POUYAUD ET AL. (1999), and CARL & KARL (2004).

RESULTS

Growth

The mean BL \pm SD of day 1 larvae was 5.99 ± 0.47 mm ($n = 7$) (Fig. 1), and the larvae grew to 7.58 ± 0.49 mm BL ($n = 7$) by day 3 and to 7.81 ± 0.48 mm BL by day 4, when the yolk was completely absorbed. Thereafter, the larvae grew to 10.5 ± 0.35 mm BL ($n = 6$) by day 7, 13.3 ± 0.76 mm BL ($n = 7$) by day 14, 20.6 ± 1.80 mm BL ($n = 7$) by day 21, 30.0 ± 2.37 mm BL ($n = 10$) by day 28, and 33.5 ± 3.00 mm BL ($n = 14$) by day 35 (Fig. 1).

Notochord Flexion

The smallest specimen (5.35 mm BL, day 1) had a slightly upward-bent notochord tip (25° angle, Figs. 2, 3a). Notochord flexion progressed slowly with larval growth, to 25° to 30° in specimens between 5.35 and 7.00 mm BL of days 1 to 3 and 30° to 40° in specimens between 7.00 and about 11 mm BL of days 3 to 7. Thereafter, notochord flexion became complete, about 40° to 50° , in specimens larger than about 10 mm BL (day 6; Figs. 2, 3g).

General Morphology

Drawings of larvae and juveniles collected on days 1, 2, 3, 4, 5, 6, 8, 10, 14, 18, and 21 are shown in Figure 3, and photos of specimens on days 28 and 35 are presented in Figure 4, showing the gross morphology.

The head and body of day 1 larvae (5.35 to 6.70 mm BL) were transparent and compressed laterally, and a large oval yolk sac was located at the anterior part of the body (Fig. 3a); their yolk sac length and height ranged from 1.70 to 1.90 mm (mean \pm SD = 1.80 ± 0.07 mm) and from 1.20 to 1.40 mm (1.32 ± 0.07 mm), respectively, and the yolk volume was 1.64 ± 0.20 mm³. The yolk volume decreased to 1.22 ± 0.17 mm³ at day 2 (6.95 to 7.50 mm BL, Fig. 3b), 0.07 ± 0.03 mm³ at day 3 (6.7 to 8.1 mm BL, Fig. 3c), and was completely absorbed by day 4 at a BL of 7.20 to 8.50 mm (Fig. 3d).

The mouth and anus opened and the eyes were well-pigmented in day-1 specimens (Fig. 3a). The mouth reached beyond the vertical line of the posterior edge of eyes in the day-2 specimens (Fig. 3b). The nostril buds were well developed at day 1 (Fig. 3a), their shape having changed from round to slender gourd-shaped with larval growth, and they were divided into two nostrils by 9.27 mm BL of day 6 (Fig. 3f).

The buds of maxillary and mandibular barbels were present at day 1 (Fig. 3a), and their length increased with increasing size of the larvae (Figs. 3b-k, 4).

Myomeres numbered 15–17 + 24–27 = 39–42 in the day 1 to day 7 specimens. In larger/older specimens, myomeres were not countable because of lack of body transparency.

Fin Development

The day-1 specimens (5.35 to 6.70 mm BL) had a fin-fold originating from the anterior part of the dorsal contour, continuing around the caudal region and ending at the yolk sac; the height of the fin-fold was relatively lower in the dorsal part than in the ventral part (Fig. 3a). The fin-fold was constricted around the caudal peduncle in specimens of 6.50 mm BL

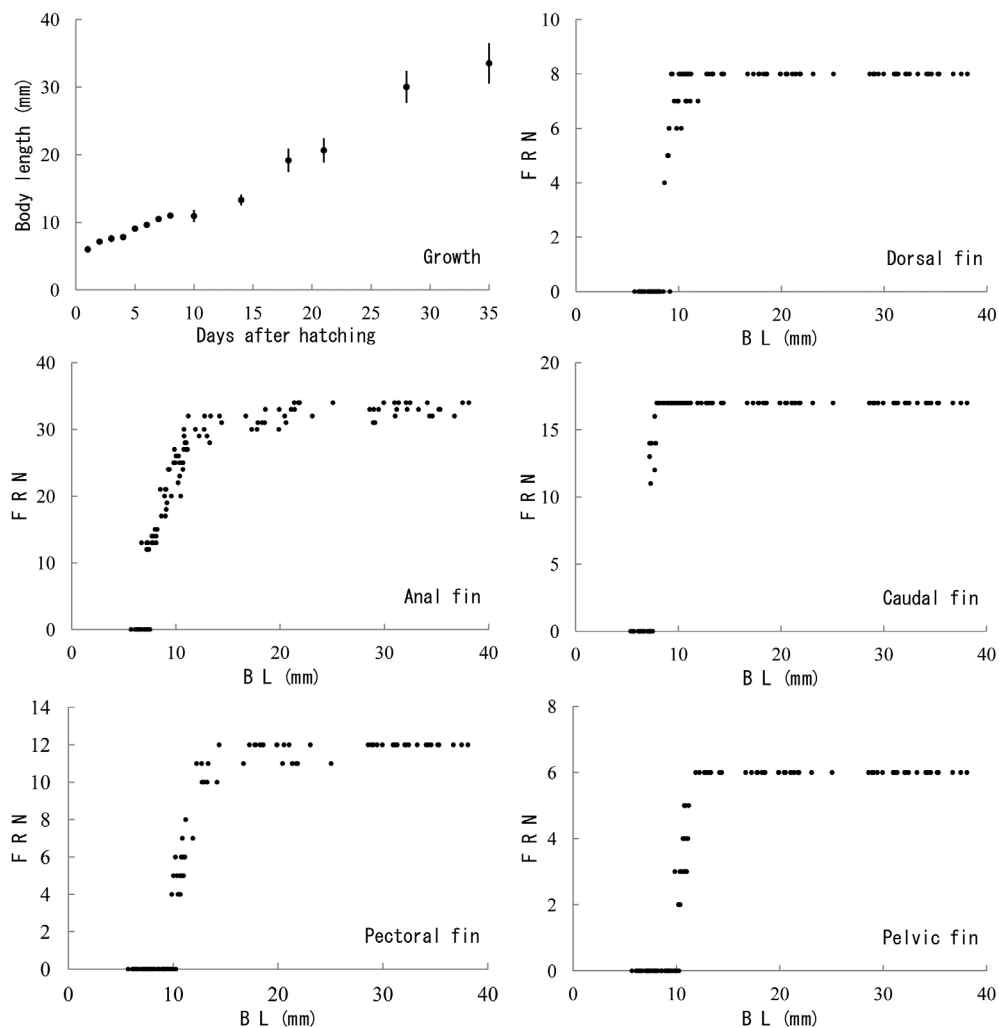


Figure1. Growth and relationships between body length (BL, mm) and fin ray numbers (FRN) in hatchery-reared larval and juvenile *Pangasius bocourti* from day 1 to day 35 after hatching. Solid circles indicate means and vertical bars show standard deviations.

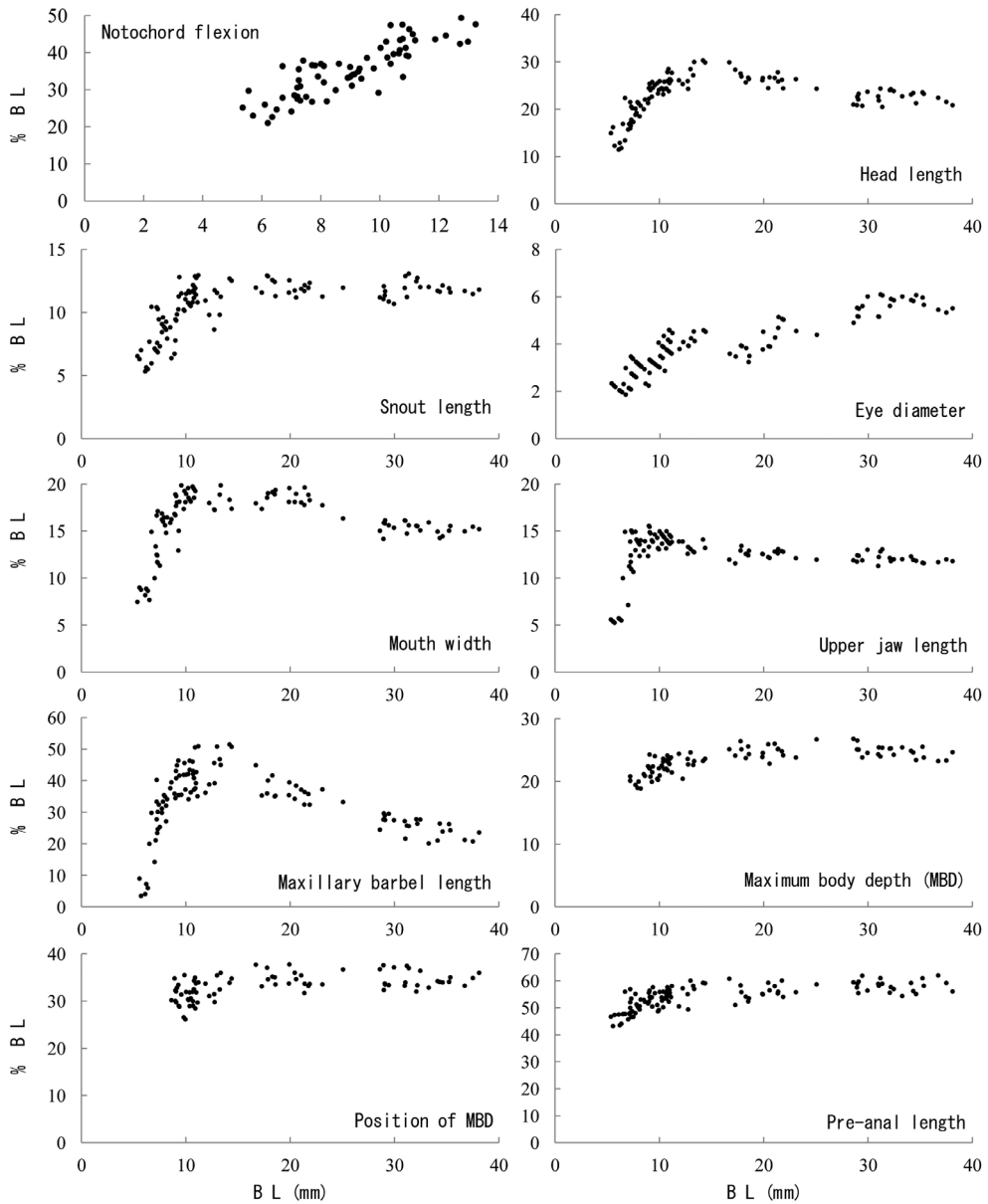


Figure 2. Angle of notochord flexion and nine body parts dimensions expressed as a percentage of body length (%BL) in hatchery-reared larval and juvenile *Pangasius bocourti* from day 1 to day 35 after hatching.

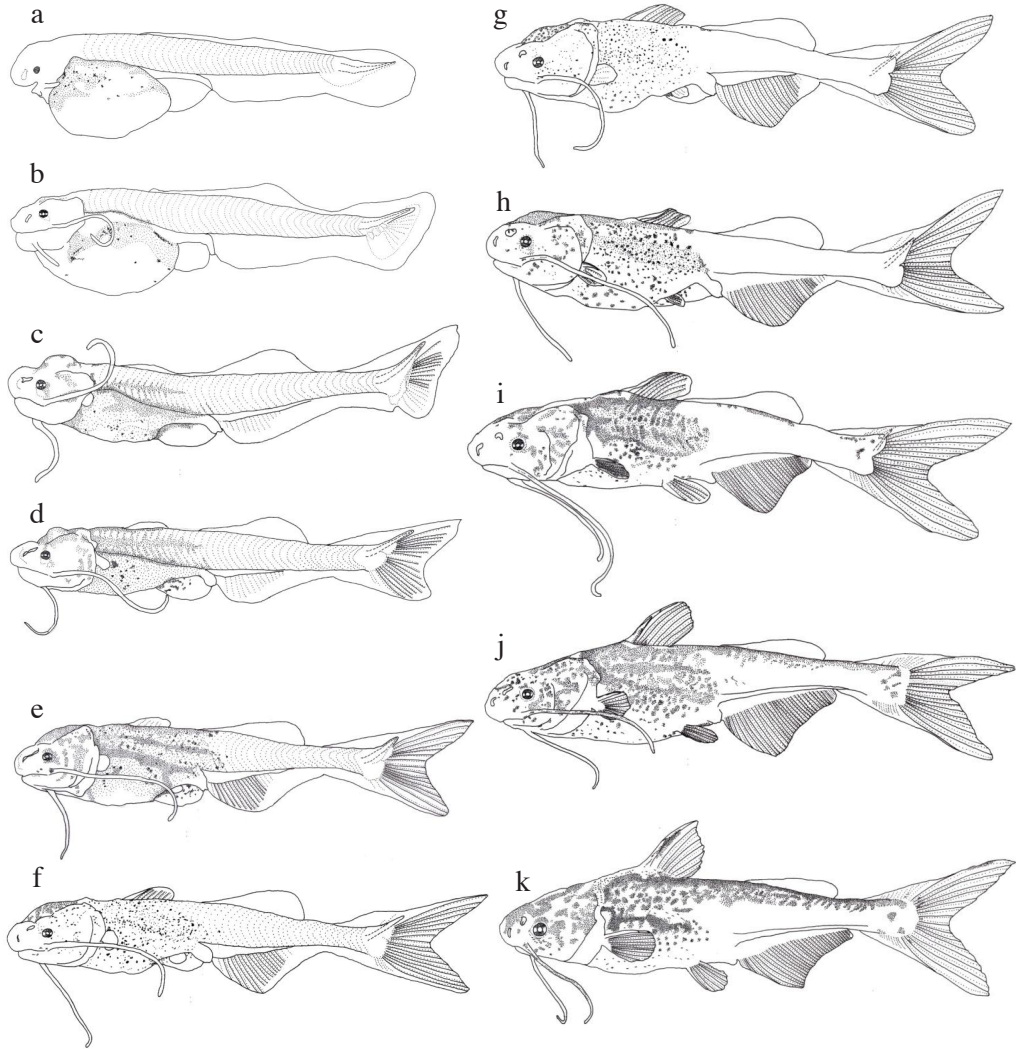


Figure 3. Hatchery-reared larval and juvenile *Pangasius bocourti* from day 1 to day 21 after hatching. a, Yolk sac (YS)/ flexion larva (day 1, 6.10 mm BL); b, YS/flexion larva (day 2, 6.50 mm BL); c, YS/flexion larva (day 3, 7.30 mm BL); d, Flexion larva (day 4, 7.90 mm BL); e, Flexion larva (day 5, 8.99 mm BL); f, Flexion larva (day 6, 9.27 mm BL); g, Postflexion larva (day 8, 10.5 mm BL); h, Postflexion larva (day 10, 10.6 mm BL); i, Juvenile (day 14, 14.2 mm BL); j, Juvenile (day 18, 18.6 mm BL); k, Juvenile (day 21, 21.9 mm BL).

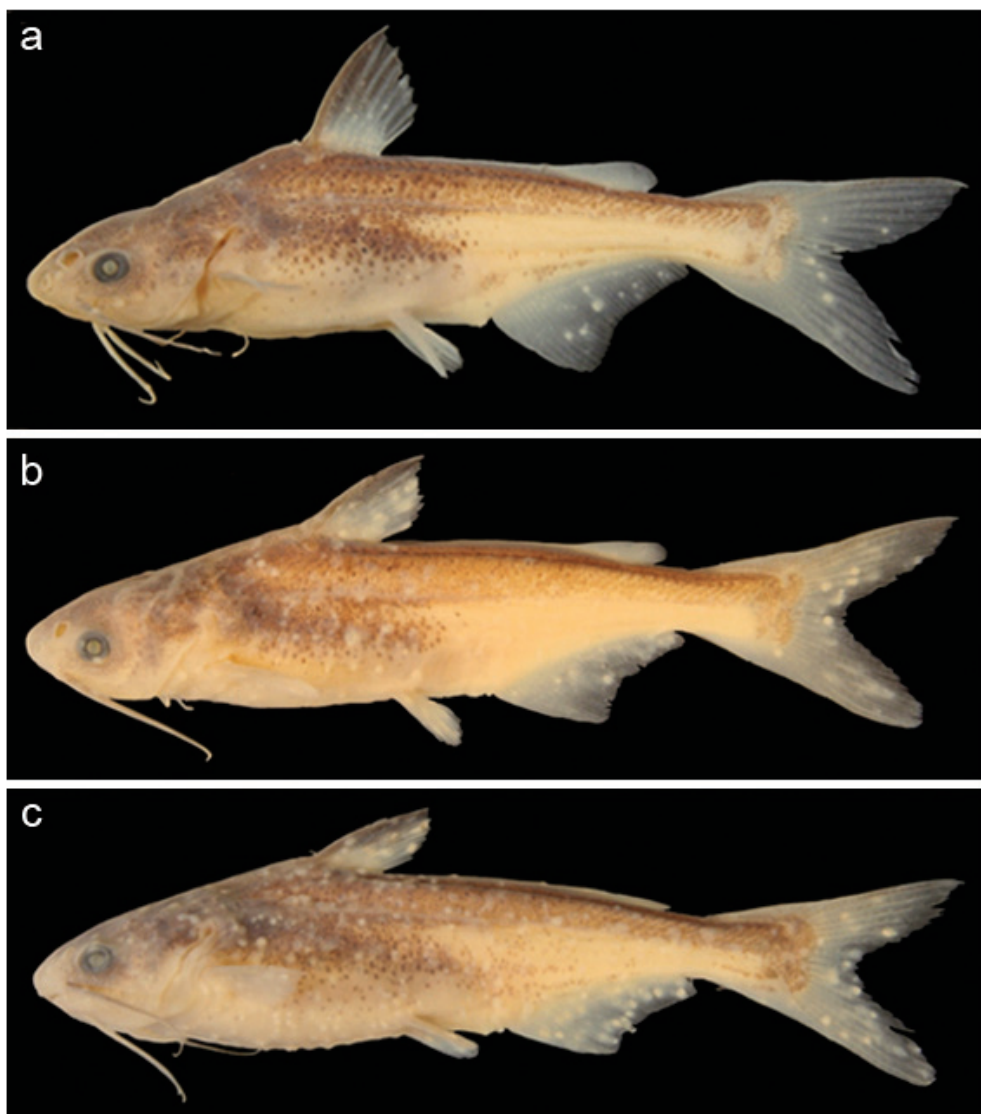


Figure 4. Photographs of hatchery-reared juvenile *Pangasius bocourti* from day 28 to day 35. a, day 28, 29.1 mm BL; b, day 35, 32.5 mm BL; c, day 35, 37.5 mm BL.

and larger (day 2, Fig. 3b), and it became separated dorsally into the adipose and caudal-anal fin-folds at 7.30 mm BL (day 3, Fig. 3c). The caudal and anal fins became separated at a BL of 12.2 mm on day 14 (Fig. 3i), in which the pre-anal fin-fold was completely lost.

The dorsal fin bud first appeared at 6.50 mm BL on day 2 in a position anterior to the adipose fin-fold (Fig. 3b). The dorsal and adipose fins became separated at a BL of 7.90 mm and larger (day 4; Fig. 3d). The dorsal fin-ray formation was initially apparent at 8.60 mm BL of day 5 (4 soft fin rays observed) (Figs. 1, 3e); a full complement of 7–8 fin rays was attained at 9.30 mm BL (day 6; Figs. 1, 3f).

The smallest specimen having anal fin rays was 6.70 mm BL on day 3 (13 soft fin rays observed; Figs. 1, 3c). The full complement of 27–34 fin rays was attained at 10.8 mm BL on day 8.

The caudal fin was rounded fan-shaped in the day 1 specimens of 5.35–6.70 mm BL (Fig. 3a). The dorsal part extended posteriorly, becoming pointed with the progress of notochord flexion at 7.30 mm BL (day 3, Fig. 3c), and subsequently the lower part extended posteriorly to form an asymmetrical forked caudal fin at 7.90 mm BL (Fig. 3d–e). The lower lobe extended to almost the same length as the upper one in specimens of 9.27 mm BL and larger (Figs. 3f–k, 4). The principal caudal fin rays first appeared at 7.20 mm BL (8+5 rays observed) (Fig. 1). The full complement of 8+9 principal caudal fin rays was attained at 7.90 mm BL on day 4 (Figs. 1; 3d–k, 4).

The pectoral fin buds first appeared at 6.70 mm BL on day 3 (Fig. 3c). The pectoral fin rays were initially observed at 9.86 mm BL (4 soft fin rays), and a full complement of 10–11 fin rays was attained at 12.2 mm BL on day 14 (Figs. 1, 3i–k, 4).

The smallest specimen having pelvic fin buds was 8.61 mm BL on day 5, and the first pelvic fin rays were initially observed at 9.86 mm BL (3 soft fin rays) (Fig. 3e). The full complement of 6 fin rays was attained at 11.9 mm BL (day 8, Figs. 1, 3i–k, 4).

Relative Growth

The ratio of head length increased from 11.5% at 6.10 mm BL to a peak of 30.3% at about 14 mm BL, and declined gently thereafter to a constant level of 21–24% at about 29 mm BL and larger (Fig. 2). The ratio of snout length to BL, initially 5.3% at 6.10 mm BL, increased and attained the constant level of 11–13% at about 12 mm BL and larger (Fig. 2). The ratio of eye diameter to BL increased gradually from 2.0% at 6.10 mm BL to about 4% at 10 mm BL and then became a constant level of 5–6% at about 29 mm BL and larger (Fig. 2). The mouth width increased rapidly from 7.5% at 5.35 mm BL to a peak of 20.7% at 11.1 mm BL, and subsequently declined gradually to a level of 15–16% at about 30 mm BL and larger (Fig. 2). The upper jaw length increased rapidly from 5.6% at 5.35 mm BL, to a peak of 15.6% at 8.99 mm BL and then declined gradually to a constant level of 12–13% at about 17 mm BL and larger (Fig. 2). The maxillary barbell length increased rapidly from 3.5% at 5.70 mm BL to a peak of 52% at 14.2 mm BL and thereafter declined, reaching a constant level of 20–26% of about 33 mm BL and larger (Fig. 2). The ratios of maximum body depth (Fig. 2) and maximum body depth position (Fig. 2) increased from 18.9% at 7.90 mm BL and 25.3% at 6.70 mm BL, respectively, to respective constant levels of about 25% at about 12 mm BL and 35% at about 13 mm BL and larger. The pre-anal length increased slightly from 43.3% at 5.55 mm BL to a constant level of about 50–60% at about 13 mm BL and larger (Fig. 2).

Pigmentation

Many melanophores were scattered on the lateral–dorsal surface of the yolk sac of days 1 to 2 of larvae (5.35–7.50 mm BL, Fig. 3a, b), and the ventral side of the yolk sac was also pigmented thereafter, covering the entire yolk sac surface at 7.30 mm BL of day 3 (Fig. 3c). Even after the absorption of yolk, the melanophores remained, covering the abdominal cavity of day 4–14 specimens (7.30–13.0 mm BL, Fig. 3c–h), and the number of the melanophores decreased in specimens at 14.2 mm BL and larger (Figs. 3i–k, 4).

Several small melanophores started appearing on the dorsal surface of the gut at 6.50 mm BL (Fig. 3b), and the number of melanophores increased and extended backward, reaching the anus region at 7.90 mm BL and larger (Fig. 3d). Melanophores appeared on the anterior part of the body along the lateral line at 6.70 mm BL and developed to form an obscure line parallel to the dorsal surface of the gut, although the melanophores did not expand posteriorly (Figs. 3c–k, 4).

All specimens had fully pigmented eyes at day 1 (5.35–6.7 mm BL, Fig. 3a). Small melanophores appeared on the snout at 7.10 mm BL, and on the opercle and cheek at 6.70 mm BL (Fig. 3c). The number increased to expand the pigmented area with growth, and these body areas were more or less heavily pigmented in all specimens larger than 7.50 mm BL (Figs. 3e–k, 4). Some melanophores appeared on the top of the head at 6.50 mm BL (Fig. 3b), and the number increased and covered the entire head at 7.30 mm BL and larger (Figs. 3d–k, 4).

Melanophore started appearing on the posterior edge of the lower jaw at 7.50 mm BL (Fig. 3d), and all specimens larger than 25.1 mm possessed lower jaw melanophores (Fig. 4). Two melanophores appeared on the upper jaw at 8.99 mm BL (Fig. 3e), and all specimens larger than 31.0 mm had melanophores (Fig. 4).

Melanophores first appeared on the base of maxillary barbel at 8.91 mm BL (Fig. 3e), and all specimens of 14.2 mm BL and larger had melanophores (Figs. 3i–k, 4). The maxillary barbel melanophores continued to develop toward the tip with growth, reaching to about 70–80% of the maxillary barbel length in specimens of 16.7 mm BL and larger (Figs. 3j–k, 4). Melanophores on the mandibular barbel started appearing at 28.9 mm BL, and all specimens larger than 36.7 mm BL had them (Fig. 4c).

Melanophores started appearing on the pre-dorsal fin area and on the dorsal fin base at 6.70 mm BL, but the size at all specimens possessing them was 7.25 (Fig. 3c) and 7.50 (Fig. 3d) mm BL and larger, respectively. With growth, these melanophores expanded posteriorly and connected with the lateral line melanophores in specimens of 7.90 mm BL and larger (Fig. 3d–k). The dorsal contour was heavily pigmented in specimens of 18.6 mm and larger (Figs. 3j, k, 4). However, the ventral contour of the trunk was palely pigmented in some specimens larger than 23.1 mm BL (Fig. 4). The lateral side of the caudal peduncle was pigmented at 14.2 mm BL and larger specimens (Figs. 3i–k, 4).

Some melanophores appeared on the anterior part of dorsal fin on the 9.86 mm BL specimen, and all specimens of 18.3 mm BL and larger had the dorsal fin melanophores (Figs. 3j–k, 4). Several melanophores appeared on the pre-anal fin-fold at 6.70 mm BL, and all specimens from 7.30 to 12.2 mm BL had these melanophores (Fig. 3c–h), the fin-fold disappearing thereafter. No melanophores were observed on the anal fin-fold/fin in specimens examined in this study, except in some specimens larger than 28.6 mm BL (Fig. 4), in which the anterior part of the anal fin was pigmented.

Some melanophores started appearing on the upper and lower lobes of the caudal fin at 19.9 and 28.9 mm BL, respectively (Fig. 3k), and all specimens larger than 25.1 and 33.3 mm BL had the respective melanophores (Fig. 4); the melanophores were not scattered over the caudal fin lobes but concentrated on the upper and lower parts of each caudal fin lobe. Melanophores started appearing near the base of the pectoral spine at 28.6 mm BL, increasing in number and extending toward the tip of the spine with growth (Fig. 4). No melanophores were observed on the pelvic fins in any specimens examined in this study.

All specimens of 6.50 mm BL and larger possessed melanophores on the pectoral symphysis (Fig. 3b–k), but the number of melanophores decreased with growth.

DISCUSSION

The largest specimen possessing a yolk sac was 8.10 mm BL on day 3, although the smallest one in which the yolk was completely absorbed was 7.20 mm BL on day 4. The notochord tip was bent slightly upward, even in the smallest specimen examined (5.35 mm BL, day 1), and none of the specimens having a straight notochord observed. Therefore, in this study we could not detect the yolk-sac and preflexion larval stages; the 5.35 to 8.10 mm BL specimens of days 1–3 were classified as the “yolk-sac/flexion larva” (Table 1). MORIOKA *ET AL.* (2010) reported the presence of both the yolk-sac/preflexion larva at 2.8 to 3.2 mm BL (day 0) and the yolk-sac/flexion larva at 3.3 to 6.4 mm BL (days 0 to 2) in *Pangasianodon hypophthalmus*; however, we did not observe the *Pangasius bocourti* specimens of day 0. VISETH *ET AL.* (2011) also could not observe the yolk-sac/preflexion larva in specimens of 3.42–6.03 mm BL *Pangasius larnaudii* specimens on day 0, but attributed the reason to the surprisingly short duration of this stage.

The size of *P. bocourti* with a completely flexed notochord tip was about 11 mm BL on day 7, and thus the flexion larval stage was defined as from 7.20 mm BL (day 4) to about 11 mm BL (day 6), after which the larvae enter to the postflexion larval stage, which lasted until the completion of fin ray numbers at 12.2 mm BL on day 14 (Table 1). Although the postflexion larva lasts longer until about 14 mm BL in *P. hypophthalmus* (MORIOKA *ET AL.*, 2010) and *P. larnaudii* (VISETH *ET AL.*, 2011) than in *P. bocourti*, the attainment size of the juvenile stage is 12.2, 12.8 and 14.4 mm BL in *P. bocourti*, *P. hypophthalmus* and *P. larnaudii*, respectively.

Fin rays in *P. bocourti* first appeared in the anal fin (6.70 mm BL), followed by the caudal (7.20 mm), dorsal (8.61 mm), and then pectoral and pelvic fins (9.86 mm). The order of completion in number was caudal (7.90 mm), dorsal (9.30 mm), anal (10.8 mm), pelvic

Table 1. Body length (BL) and age for each developmental stage of *Pangasius bocourti*.

Developmental stage	BL (mm)	Age (days)
Yolk sac/flexion larva	5.35 – 8.10	1–3
Flexion larva	7.20 – ca. 11	4–6
Postflexion larva	ca. 10 – 11.2	7–10
Juvenile	≥ 12.2	≥ 14

(11.9 mm) and pectoral fin (12.2 mm); thus the juvenile stage starts at 12.2 mm BL upon the completion of its pectoral fin rays. The appearance order of fin rays in *P. bocourti* in this study is almost the same as in *P. larnaudii* (caudal fin [6.03 mm BL], anal fin [6.55 mm], dorsal fin [8.33 mm] and pectoral and pelvic fins [10.2 mm]: VISETH ET AL., 2011) and in *P. hypophthalmus* (caudal and anal fins [6.7 mm BL], dorsal fin [8.9 mm], pectoral fin [9.4 mm] and pelvic fin [10.3 mm]: MORIOKA ET AL., 2010). The completion order of fin rays appears to be similar as follows: caudal fin (7.54 mm BL), dorsal fin (10.2 mm), pelvic and anal fins (11.1 mm) and pectoral fin (14.4 mm) in *P. larnaudii* (VISETH ET AL., 2011); caudal fin (7.1 mm BL), dorsal fin (10.2 mm), pelvic fin (11.2 mm), anal fin (11.4 mm BL) and pectoral fin (12.8 mm) in *P. hypophthalmus* (MORIOKA ET AL., 2010).

As mentioned by VISETH ET AL. (2011), it is difficult to compare the morphological development of larval and juvenile pangasiid species, because no such information is available for them, other than descriptions of *Pangasianodon hypophthalmus* (ISLAM, 2005; BARAS ET AL., 2010; MORIOKA ET AL., 2010), *Pangasius larnaudii* (VISETH ET AL., 2011), and some figures of *Pangasianodon gigas* and *P. larnaudii* drawn by A. TERMVIDCHAKORN without any comments (included in the work of ROBERTS & VIDTHAYANON, 1991), and a description of the development of sensory organs in *P. hypophthalmus* (MUKAI ET AL., 2010). An important study was done by TERMVIDCHAKORN & SUKRI (2011); they drew larvae and juveniles of four pangasiid species, *Helicophagus leptorhynchus*, *P. hypophthalmus*, *P. bocourti* and *Pteropangasius pleurotaenia* and compared by “yolk sac”, “pre larval”, “post larval” and “juvenile” stages at the genus level. However, they did not provide enough description to compare them in detail; no morphometric data are available and melanophore development is ambiguous. The following is, therefore, a comparison of those seven body dimensions for *P. bocourti* (this study), *P. larnaudii* (VISETH ET AL., 2011) and *P. hypophthalmus* (MORIOKA ET AL., 2010).

The head length of *P. bocourti*, 21–24% of BL, once it reaches a constant level, is a little smaller than that of *P. larnaudii* and *P. hypophthalmus*, about 30% of BL; however, a peak is detected in the former two species, declining and stable thereafter, no peak is observed in the last species. The snout length is clearly shorter in *P. hypophthalmus* (smaller than 10% of BL) than in the two *Pangasius* species (10–15% of BL). Although the eye diameter increases rapidly and becomes stable at 10 mm BL in *P. hypophthalmus*, it increases slowly to be stable at about 20 mm BL in the two *Pangasius* species. The stable upper jaw length is smaller in *P. hypophthalmus* (about 5% of BL) than in the two *Pangasius* species (about 10% of BL). The body of *P. larnaudii* is more slender than that of *P. hypophthalmus* and *P. bocourti* during the larval size intervals of 5 to 10 mm BL (10–15% of BL vs about 20%) and of 10 to 15 mm BL (less than 20% vs more than 20%). Although the pre-anal length is smaller than 50% of BL in larvae smaller than 10 mm BL in *P. bocourti*, that is larger than 50% in *P. hypophthalmus* and *P. larnaudii*. The developmental mode of maxillary barbel length is similar in the three species, although the peak is smaller in *P. bocourti* (about 50% of BL) than in *P. hypophthalmus* and *P. larnaudii* (about 60%).

We could not compare enough the morphological differences between *Pangasius bocourti* and other pangasiid species other than *Pangasianodon hypophthalmus* and *Pangasius larnaudii*, because of the lack of substantial information. Acquisition of more information about the morphological development of pangasiid larvae and juveniles, therefore, would not only lead to further consideration of pangasiid ecology and phylogeny, but also contribute to the identification of larvae and juveniles for stock assessment and to the improvement of seed production.

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