## **BELONIFORMES**

## **BELONIFORMES** – needlefishes and allies

Beloniformes is 1 of 3 orders of the superorder Atherinomorphae (*sensu* Wiley & Johnson, 2010 = series Atherimomorpha of, *e.g.*, Greenwood *et al.*, 1966 and Nelson, 2006); the other 2 orders are Atheriniformes (pp. 318–321) and Cyprinodontiformes (pp. 322–323). Most members of the Beloniformes and its sister group Cyprinodontiformes (Parenti, 2005) are surface-feeding fishes, having a single soft-rayed (spineless) dorsal fin on the posterior part of the body (except for the scomberesocids, with a series of finlets behind the dorsal and anal fins) and abdominal pelvic fins. Internal fertilization is found in a part of both of these 2 orders (*e.g.*, *Gambusia* and *Poecilia* in the Cyprinodontiformes, and *Zenarchopterus* and *Dermogenys* in the Beloniformes).

According to Nelson (2006), the Beloniformes comprises 2 suborders: Adrianichthyoidei (including a single family Adrianichthyidae) and Exocoetoidei (4 families, viz., Belonidae, Scomberesocidae, Exocoetidae, and Hemiramphidae). Many of the former, the Adrianichthyoidei, are small-sized fishes with non-elongated jaws (photo A), and superficially resemble the cyprinodontiform fishes. Rosen & Parenti (1981) and Parenti (1987), however, pointed out the affinity of the adrianichthyids with the other beloniform fishes (rather than the cyprinodontiforms), based on their detailed osteological examinations; their hypothesis was supported by subequent researchers (e.g., Setiamarga et al., 2008; Wiley & Johnson, 2010). Many of the adrianichthyid fishes are found in shallow standing or slowflowing freshwater areas (e.g., paddy fields and irrigation canals), and some can enter to brackish estuaries. Within the family, 6 species of the genus Oryzias (ricefishes or medaka, next page) are knwon from the Mekong.

The other beloniform fish families (all assigned to the suborder Exocoetoidei) are: Belonidae (needlefishes, photo B), Scomberesocidae (sauries, photo D), Exocoetidae (flyingfishes), and Hemiramphidae (halfbeak, photo C). In contrast to the adrianichthyids, many of fishes in these families are usually found in the marine waters, and some of the belonids and hemiramphids are known to enter to, or inhabit whole life in, the brackish estuaries and/or freshwater areas.

Classification of these exocoetoid fishes is still open to debate. Traditionally, with some exceptions, the exocoetoid fishes with long beak-like upper and lower jaws are placed in the Belonidae, the ones with the long javeline-like lower jaw and short triangular upper jaw are placed in the Hemiramphidae, the ones with non-elongate jaws with exceptionally large pectoral fins (for gliding over the water surface) are placed in the Exocoetidae, and the remaining ones with a series of isolated finlets behind the dorsal and anal fins are placed in the Scomberesocidae (e.g., Nelson, 2006). Recent molecular analyses, however, disagreed with this outline; for example, the Hemiramphidae as traditionally recognized is paraphyletic, and the scomberesocids are deeply nested within the Belonidae (Lovejoy, 2000; Lovejoy et al., 2004). Lovejoy et al. (2004) recognized 3 monophyletic lineages (clades) in the Hemiramphidae as traditionally recognized: viz., Zenarchopteridae, the Hemiramphus clade, and the Hyporhamphus clade. Only the Zenarchopteridae, including Zenarchopterus, Dermogenys, and allies, was given the family name, whereas the other two were not. Until the classification of these exocoetoid fishes will be fully resolved, we tentatively follow the "traditional" system, e.g., the classification of Collette (2003, 2004), Nelson (2006), and Wiley & Johnson (2010) (rather than that of Lovejoy et al., 2004). In this sense, at least 5 and 13 species of the belonid and hemiramphid fishes, respectively,





Eurothamphus limbatus (Hemiramphidae), Cán Tho, Vietnam

were hitherto recorded from the Mekong, but the records of some species need confirmation.

We found many fresh (probably defrozen) Pacific saury *Cololabis saira* (Scomberesocidae) commonly sold at local markets in the coastal regions of the Mekong Delta (photo D), together with the indigenous fishes. *Cololabis saira* is, however, distributed restrictedly in the North Pacific from Japan, Korean Peninsula, the Russian Far East, and eastward to the west coast of North America (Aizawa & Doiuchi *in* Nakabo, 2013), and, thus, these fish were undoubtedly imported from the North Pacific.

# ADRIANICHTHYIDAE

### Oryzias mekongensis Uwa & Magtoon, 1986

### Family: Adrianichthyidae (FC: 252)

Size: 1.7 cm SL (Parenti, 2008: 573).

**Distribution:** Mekong Basin in southern Laos, Thailand, and Cambodia.

**Notes:** A small-sized, slender species of *Oryzias*, commonly found in shallow standing waters such as paddy fields and irrigation canals.

Fishes of Oryzias, commonly known as ricefishes or medakas (derived from the Japanese vernacular name of Oryzias latipes), are small surface-swimmers, which are superficially similar to the cyprinodontiform fishes (see general remarks on the Beloniformes, p. 325). The taxonomy of Oryzias was revised by Parenti (2008), who recognized 24 species from Central, South and Southeast Asia. Subsequently an additional 9 species were described from Southeast Asia (Herder & Chapuis, 2010; Magtoon, 2010; Parenty and Hadiaty, 2010; Asai et al., 2012; Herder et al., 2012; Parenti et al., 2013; Mokodongan et al., 2014; Mandagi et al., 2018); thus, the number of species in Oryzias is now 33. Of these, 6 species were recorded from the Mekong (Kottelat, 1998, 2001a; Roberts, 1998a; Parenti, 2008; Magtoon, 2010): O. haugiangensis, O. mekongensis, O. minutillus, O. pectoralis, O. sinensis, and O. songkhramensis. On the records of O. javanicus from the Mekong (e.g., Rainboth, 1996b), see "Notes" of O. haugiangensis.

*Oryzias mekongensis*, endemic to the middle Mekong, is the most common species of the genus in southern Laos and Thailand. It is similar to northern congener *O. songkhramensis* in general appearance and fin-ray counts, but differs in the details of coloration (see below).

### Oryzias songkhramensis Magtoon, 2010

Family: Adrianichthyidae (FC: 252)

Size: 1.9 cm SL (Magtoon, 2010: 112).

**Distribution:** Mekong Basin in central Laos and northern Thailand.

**Notes:** A small-sized, slender species of *Oryzias*, found in shallow standing waters with dense vegetation, *e.g.*, ponds, reservoirs, paddy fields, and irrigation canals. During our field surveys in 2007–2013, we collected numerous specimens of this species from the Nam Ngum Basin (a large tributary of the Mekong) in middle Laos. The distribution of this species appears not to overlap that of the similar-looking southern congeners, *O. mekongensis* (above) and *O. miutillus* (next page).

*Oryzias songkhramensis* was recently described from the Mekong Basin in northern Thailand (Nong Khai and Nakhon Phanum) and Laos (Vientiane) by Magtoon (2010). This species is similar to the other slender species of the Mekong, *viz., O. mekongensis, O. miutillus,* and *O. pectoralis* (not shown in this book), but has: 15–17 anal-fin rays (*vs.* 17–21 and 18–20 in *O. miutillus* and *O. pectoralis,* respectively); 26 or 27 scales in a lateral series (*vs.* 29–32 and 32–34 in *O. mekongensis* and *O. pectoralis,* respectively); and dusky submarginal stripes on the caudal fin when alive or freshly-collected (*vs.* bright orange stripes in *O. mekongensis,* see above photos) (Magtoon, 2010).

The freshly-collected photographs of *Oryzias songkhramensis* are first shown in this book. Magtoon (2010: 221, fig. 3) provided photographs of male and female preserved specimens of this species, but, unfortunately, the image makes the fish appear unusually compressed horizontally (see also the line drawing in Magtoon, 2010, fig. 2).





# ADRIANICHTHYIDAE

### Oryzias minutillus Smith, 1945

Family: Adrianichthyidae (FC: 252)

**Size:** 1.7 cm SL (Parenti, 2008: 575).

**Distribution:** Mekong Basin in Thailand, Cambodia, and Vietnam; Chao Phraya and Salween basins and peninsular Thailand.

**Notes:** A small-sized, slender species of *Oryzias*, commonly found in shallow standing waters with dense vegetation, *e.g.*, clear-water swamps, ditches, and ponds.

Oryzias minutillus is similar to the other slender congeners in the Mekong, viz. O. mekongensis (left page), O. pectoralis (not shown in this book), and O. songkhramensis (left page), but has fewer pelvic (5 vs. 6 in the other 3 species) and branched caudal-fin rays (7 vs. 9). Small specimens of sympatric congener O. haugiangensis (below) may lack yellowish dorsoventral margins of the caudal fin, and are somewhat similar to O. minutillus; O. haugiangensis, however, has 6 pelvic fin rays (vs. 5 in O. minutillus), 9 branched caudal-fin rays (vs. 7), no cluster of melanophores around the anus (vs. present), and a slightly deeper body (see photographs of these 2 species on this page).

Roberts (1998a: 220) and Kottelat (2001a: 143) expected *Oryzias minutillus* from the Laotian Mekong, but no voucher specimens are hitherto shown. Although we also did not collect this species from Laos during our field surveys in 2007–2013, it is presumably distributed northward to the Lao-Thai border, as indicated by Roberts (1998a: 220). Uwa *et al.* (1988) reported this species from the Yunnanese Mekong, but the species was re-identified as an undescribed species by Roberts (1998a: 220); although Parenti (2008: 576) did not concur with it, we tentatively follow Roberts' identification here (the Yunnanese record is not included in the "Distribution", above).

#### Oryzias haugiangensis Roberts, 1998

Family: Adrianichthyidae (FC: 252)

Size: 2.1 cm SL (Parenti, 2008: 564).

**Distribution:** Mekong Basin in Vietnam; Phú Quốc Island of Vietnam, coastal basins of western Cambodia, and southeastern Thailand.

**Notes:** A small-sized, deep bodied species of *Oryzias*, found in brackish estuaries and adjacent freshwater areas; it is particularlly abundant in the mangrove creeks. A species of *Oryzias* shown as *O. javanicus* from the Vietnamese Mekong by Rainboth (1996b) was re-identified as *O. haugiangensis* by Roberts (1998a: 221). The specific name, *haugiangensis*, was derived from Hậu Giang, one of 2 large distributaries of the Mekong in the Mekong Delta, where the type specimens were collected (Roberts, 1998a: 220). After the original description, Magtoon (2011) recorded *O. haugiangensis* from southeastern Thailand; during our field surveys in 2007–2013, this species was also collected from the Phú Quốc Island, off the western coast of the Mekong Delta in Vietnam, and the coastal basins of western Cambodia.

Its relatively deep body and yellowish dorsoventral margins of the caudal fin, as well as its habitat in tidal estuaries, readily distinguish *Oryzias haugiangensis* from the other Mekong congeners. See also "Notes" of the sympatric congener *O. minutillus*, above.

In addition to the 4 species of *Oryzias* shown in this book, 2 congeners were recorded from the Mekong (Kottelat, 1998, 2001a; Magtoon, 2010): *O. pectoralis* and *O. sinensis*. Regarding *O. pectoralis*, see "Notes" of *O. mekongensis* and *O. song*-





*khramensis* (left page). *O. sinensis* is somewhat similar to *O. pectoralis* due to its high count of anal-fin rays (18–20), but differs in lacking a distinct black spot on the upper half of the pectoral-fin base (*vs.* present in *O. pectoralis*) (Roberts, 1998a; Kottelat, 2001a).





### Dermogenys siamensis Fowler, 1934

Family: Hemiramphidae (FC: 252)

Size: 5.3 cm SL (Meisner, 2001: 228).

**Distribution:** Mekong Basin in Laos, Thailand, Cambodia, and Vietnam; Chao Phraya Basin and peninsular Thailand.

**Notes:** A small-sized freshwater species of halfbeaks, found near the water surface around aquatic vegitation in shallow standing waters, *e.g.*, swamps, ponds, lakes, and reservoirs; it is even commonly found in freshwater ditches adjacent to the brackish estuaries in coastal region of the Mekong Delta in Vietnam.

Fishes of *Dermogenys* are viviparous live-bearers; namely, they fertilize eggs internally, and bear live young (Meisner, 2001; Reznick *et al.*, 2007). Due to its attractive coloration, ideal size (for keeping small aquaria), and intriguing "face", they are commonly seen in the aquarium fish trade.

Dermogenus siamensis, the most common species of the genus in the Indochinese region (Meisner, 2001; Farhana *et al.* 2018), is readily distinguished from the other halfbeaks in the Mekong (except for *D. collettei*, noted below) by its diminutive size, shortbased dorsal fin (with its base slightly shorter than anal-fin base), and dorsal-fin origin behind a vertical line through anal-fin origin. The adult male has modified anterior rays of the anal fin (into "andropodium"), yellowish dorsal/anal/caudal/pelvic fins, and a minute black spot at posterior part of dorsal fin; none of these features are found in the females.

Based on morphological and molecular evidences, Farhana *et al.* (2018) identified 5 specimens of *Dermogenys*, collected from Cà Mau of the Mekong Delta in Vietnam, as *D. collettei*; the other 40 specimens from the Vietnamese Mekong (Cần Thơ, Trà Vinh, Sóc Trăng, Kiên Giang, and Long An) that they examined were *D. siamensis*. Although we did not collect any specimens of *D. collettei* from the Mekong during our field surveys in 2007–2013, the species can be distinguished from *D. siamensis* by having: distal part of 2nd anal-fin ray near straight (*vs.* sickle-shaped in *D. siamensis*); anterior and posterior edge of all anal-fin rays smooth (*vs.* anterior and posterior edges of 2nd and 4th anal-fin rays, respectively, with serrations); 3rd or 4th segment in second anal-fin ray (*vs.* slightly elongate, approximately equal in length) (see Meisner, 2001).



Previous records of a congener *Dermogenys pusilla* (or *pusillus*) from the Mekong (*e.g.*, Kottelat, 1989a; Rainboth, 1996b) were based on misidentification of *D. siamensis* (Meisner, 2001; Kottelat, 2001a: 144).



### Zenarchopterus ectuntio (Hamilton, 1822)

Family: Hemiramphidae (FC: 252)

Size: 18.0 cm TL (Kottelat *et al.*, 1993: 88).

**Distribution:** Mekong Basin in Vietnam; Indo-West Pacific from India to Borneo.

**Notes:** A medium-sized species of *Zenarchopterus*, commonly found in brackish estuaries and mangrove canals.

Fishes of Zenarchopterus are somewhat smilar to Dermogenys (p. 329) by having a non-emarginate caudal fin, but have a shortbased anal fin (vs. longer than dorsal-fin base in Dermogenys) and a dorsal-fin origin well before a vertical line through anal-fin origin (vs. behind a vertical line through anal-fin origin); the adults of Zenarchopterus are a much larger size than that of Dermogenys. Zenarchopterus fertilizes eggs internally (like Dermogenys), and lays fertilized eggs (contrary to the live-bearing Dermogenys) (e.g., Meisner, 2001: 210).

The taxonomy of *Zenarchopterus* was revised by Mohr (1926). Subsequently, in his checklist of the hemiramphid fishes, Collette (2004) provisionally recognized 19 species as valid in *Zenarchopterus*, with a note, "an up-to-date revision of the genus is needed." No sufficient morphological data has been published for many of species in this genus, and, thus, the species identification may be difficult in many cases.

Hitherto 5 species of *Zenarchopterus* were recorded from the Mekong (Rainboth, 1996b; Vidthayanon, 2008): *Z. buffonis, Z. clarus, Z. dispar, Z. dunckeri*, and *Z. ectuntio*. Vidthayanon (2008: 285) also reported *Z. beauforti* from the Mekong Delta, but the record needs confirmation; *Z. beauforti* is a junior synonym of *Z. striga*, and is otherwise known from India and Selangor,



Malaysia (Collette, 2004: 22).

During our field surveys of fishes in 2007–2013, at least 3 species of *Zenarchopterus* were collected from the Mekong; all these species are shown in this book. Of these, *Z. ectuntio* is the most common species of the genus in mangrove areas in this region, and is readily distinguished from the other Mekong congeners by its short lower jaw.



#### Zenarchopterus clarus Mohr, 1926

Family: Hemiramphidae (FC: 252)

Size: 16.5 cm TL (Mohr, 1926: 241).

**Distribution:** Mekong Basin in Vietnam; Thailand (Bangkok) and Borneo (Collette, 2004: 20).

**Notes:** A medium-sized species of *Zenarchopterus*, found in brackish estuaries and mangrove canals.

Present identification of this fish as *Zenarchopterus clarus* is merely provisional, and needs more research; it is very similar to *Zenarchopterus* sp. (below), but has a shorter lower jaw, a longer upper jaw, and non-modified dorsal fin rays in the adult male (see figure above).

### Zenarchopterus sp.

Family: Hemiramphidae (FC: 252)

**Size:** 9.7 cm SL (IFREDI-P 3733).

**Distribution:** Mekong Basin in southern Cambodia and Vietnam.

**Notes:** A medium-sized species of *Zenarchopterus*, found in the lower reaches of rivers and adjacent small canals; it is usualy found in the slightly upper reaches compare to the similar *Z. clarus* (above), but is possibly syntopic. See also "Notes" of *Z. clarus*, above.





## The other halfbeaks of Zenarchopterus In addition to the 3 species shown on the left and this pages, at least 3 species of Zenarchopterus, i.e., Z. buffonis, Z. dispar, 4th dorsal-fin ray greatly elongate in male 6th anal-fin ray widened and greatly elongate in male (vs. 6th and 7th rays elongate in male of similar Z. dispar)

upper jaw short, with no blackish midline —

Non-Mekong specimen of Zenarchopterus dunckeri (Phú Quốc Island, Vietnam, CTU-P 4212, photo: LXT and KS)

and Z. dunckeri, were recorded from the Mekong (see "Notes" of Z. ectuntio). Two of these (Z. buffonis and Z. dunckeri) are shown below. The remaining one, Z. dispar, resembles Z. dunckeri, but has 2 greatly elongate anal-fin rays in the males.



 Non-Mekong fish of Zenarchopterus buffonis (Sihanoukville, Cambodia, photo: KS)



### Hyporhamphus limbatus (Valenciennes, 1847)

Family: Hemiramphidae (FC: 254)

Size: 22 cm SL (Collette, 1999: 2191).

**Distribution:** Mekong Basin in Cambodia and Vietnam; Indo-West Pacific.

**Notes:** A medium-sized species of halfbeaks, found in coastal marine waters, brackish estuaries and adjacent freshwater areas.

Eight species of halfbeaks with an emarginate or forked caudal fin of the genera *Hemiramphus* and *Hyporhamphus* were recorded by Vidthayanon (2008) from the Mekong, but we could not collect these except for *Hyporhamphus limbatus* during our field surveys in 2007–2013. The records of the other 7 species, *viz.*, *Hemiramphus far*, *Hyporhamphus affinis*, *Hyporhamphus dussumieri*, *Hyporhamphus intermedius*, *Hyporhamphus melanopterus*, *Hyporhamphus neglectus*, and *Rhynchorhamphus naga*, need confirmation based on voucher specimens; in particular the record of *Hyporhamphus neglectus* from the Mekong is doubtful, because it replaces the closely related *Hyporhamphus limbatus* in, and known only from, the waters around Java, Sumatra, Borneo, Sulawesi, and the Philippines (Collette, 1999: 2195, 2004: 9).





# BELONIDAE



### Strongylura strongylura (van Hasselt, 1823)

Family: Belonidae (FC: 255)

Size: 40 cm SL (Collette, 1999: 2158).

Distribution: Mekong Basin in Vietnam; Indo-West Pacific.

**Notes:** A medium-sized species of needlefishes, found in coastal marine waters and brackish estuaries; it can enter to adjacent freshwater areas.

Within the belonids, *Strongylura* is somewhat similar to *Xenentodon* (next page) in having non-forked caudal fin, but differs in the origin of the dorsal fin behind a vertical line through anal-fin origin (*vs.* above anal-fin origin in *Xenentodon*). Three species of *Strongylura* were recorded from the Mekong (Vidthayanon, 2008), and, of these, *S. strongylura*, which is apparently the most common species of the genus in the Mekong estuaries, is readily distinguished from the other 2 species (*viz., S. incisa* and *S. leiura*) by having conspicuous black spot on the base of the caudal fin. We were not able to collect any specimens of *S. incisa* or *S. leiura* from the Mekong during our field surveys in 2007–2013; non-Mekong specimens of these 2 species, collected from coastal region of western Cambodia, are shown below.



Non-Mekong specimen of Strongylura incisa (Koh Kong, Cambodia, IFREDI-P 6301)



Non-Mekong specimen of Strongylura leiura (Koh Kong, Cambodia, IFREDI-P 6299)



# BELONIDAE



### Xenentodon sp.

Family: Belonidae (FC: 255)

Size: 30 cm SL (Kottelat, 2001a: 144, as X. canciloides).

**Distribution:** Mekong Basin in southern Laos, Thailand, Cambodia, and Vietnam; Chao Phraya Basin.

**Notes:** A medium-sized species of needlefishes, found in various kinds of freshwater habitat, such as rivers, streams, lakes, reservoirs, and marshes. This is the only species of needlefishes in the

middle and upper reaches of the Mekong.

According to an unpublished revisional study on *Xenentodon* by S. Ekajit and P. Musikasinthorn (RLIKU), only a single species is recognized in the Indochinese region; taxonomy of the species, previously misidentified as *X. cancila* or *X. canciloides* in the Mekong (*e.g.*, Kottelat, 1989a, 2001a; Rainboth, 1996b; Vidthayanon, 2008), will be clarified by S. Ekajit and P. Musikasinthorn.

