Descriptions of larval development and assessment of the potential of morphological and pigmentation larval development characters for phylogenetic analysis of Eleotridae and Gobiidae

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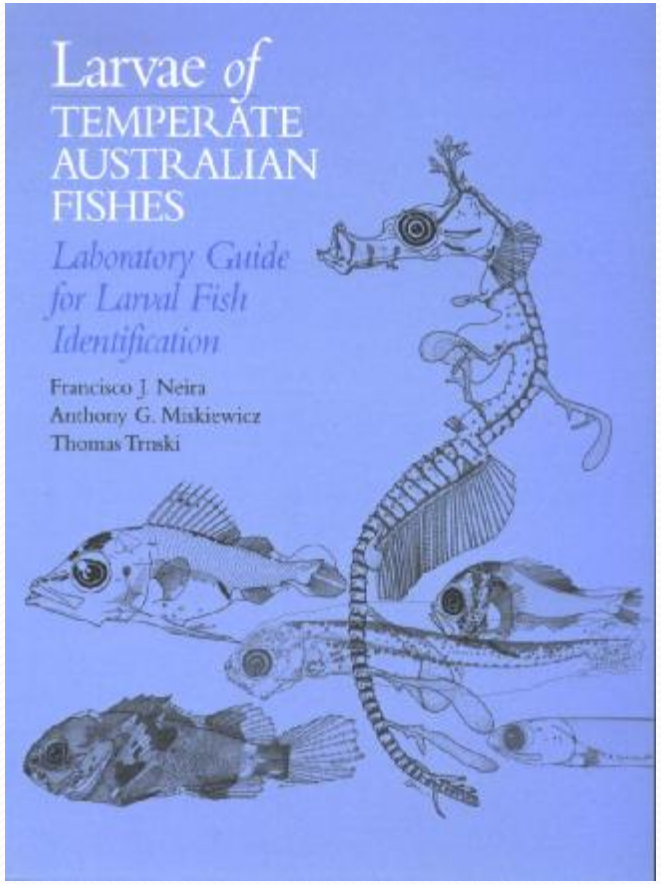
Aims of the talk

- Describe and compare the larval development of two Eleotrid and eight Gobiid species
- Assess similarities and differences between species in the pigmentation patterns and morphology
- Assess differences in larval characters between families and genera to determine whether they support current phylogenies for the two families based on adult characters such as osteological differences, head pore patterns and genetic analysis

Australian studies of goby larvae



Meristic characters of eleotrid genera of temperate Australia

	(n)	Dorsal	Anal	Pectoral	Pelvic	Caudal (segmented)	Vertebrae
Gobiomorphus	(2)	VI–VIII + I, 8–9	I, 7–9	14–19	I, 5	15	12–13 + 16–17 = 28–29
* *Hypseleotris*	(5)	VI–IX + I, 8–13	I, 9–13	13–17	I, 5	15	27–32
Mogurnda	(4)	VI–IX + I, 10–14	I, 10–13	14–16	I, 5	15	14–15 + 16–19 = 31–34
* *Philypnodon*	(2)	VI–VIII + I, 8–10	I, 7–10	15–20	I, 5	15	12–14 + 17–20 = 29–32
Thalasseleotris	(1)	V–VII + I, 9–10	I, 8–9	17–21	I, 5	15–17	10 + 17 = 27

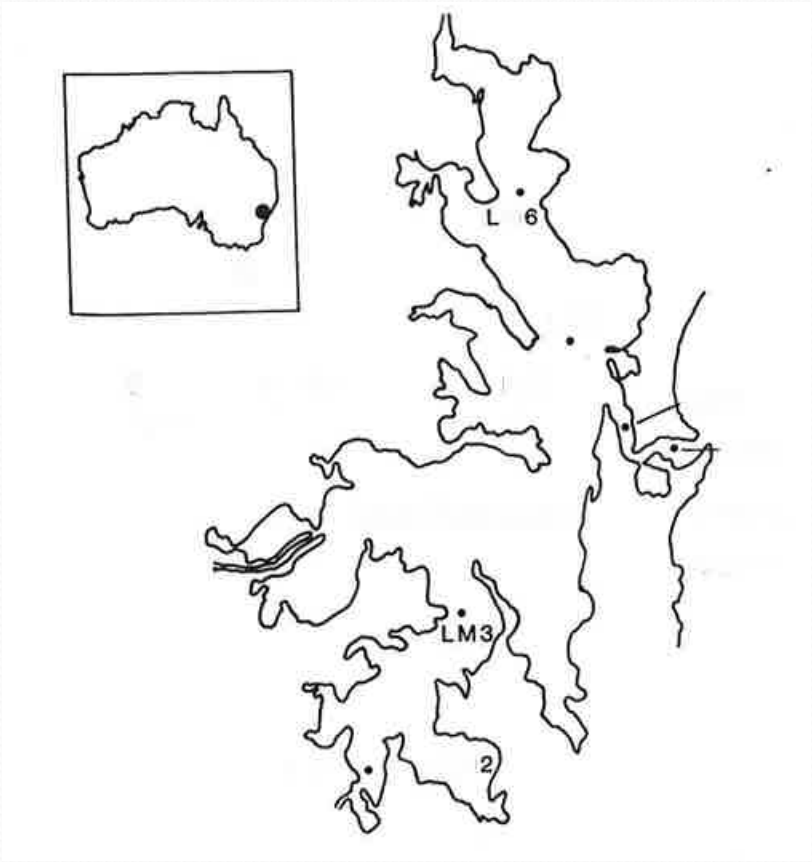
Meristic characters of gobiid genera of temperate Australia

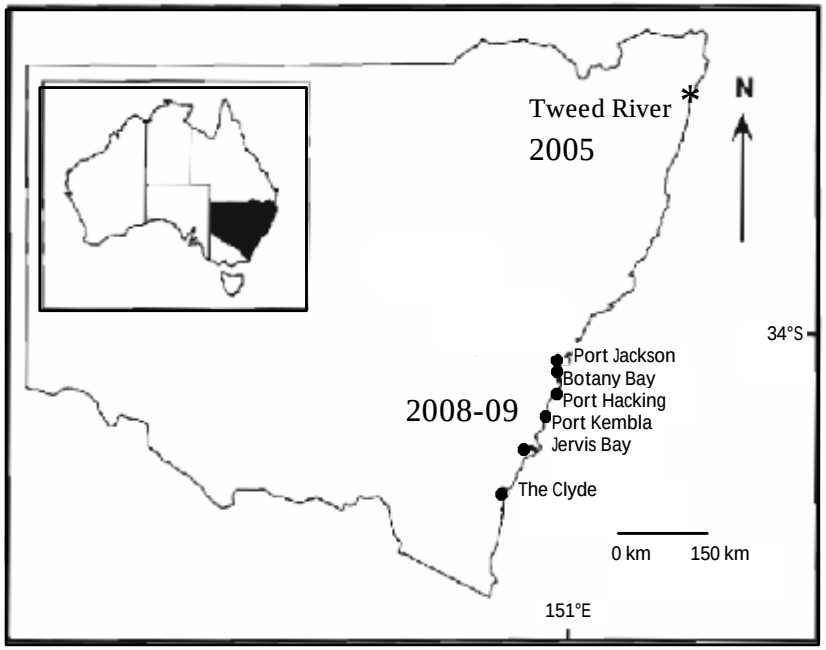
	(n)	Dorsal	Anal	Pectoral	Pelvic	Caudal (segmented)	Vertebrae
*Acanthogobius**	(1)	VIII–IX + I,12–14	I, 11–12	21	I, 5	17	13 + 20–21 = 33–34
Acentrogobius	(2)	VI + I, 9–10	I, 8–10	17–19	I, 5	17	–
* *Afurcagobius*	(2)	VI + I, 8	I, 7–8	15–18	I, 5	17	10–11 + 16–17 = 27
Amblygobius	(1)	VI + I, 13–15	I, 13–14	13–14	I, 5	17	10 + 16 = 26
* *Arenigobius*	(2)	VI + I, 10–11	I, 10	16–19	I, 5	17	10 + 16 = 26
Batrygobius	(1)	VI + I, 9–11	I, 8–10	16–21	I, 5	17	10 + 17 = 27
Callogobius	(2)	VI + I, 10–12	I, 8–10	15–18	I, 5	17	10 + 16–17 = 26–27
Eviota	(1)	VI + I, 9	I, 8	16–17	I, 5	17	10 + 15–16 = 25–26
* *Favonigobius*	(2)	VI + I, 8–9	I, 8–9	15–19	I, 5	17	10 + 16 = 26
Gnatholepis	(1)	VI + I, 11	I, 11	15–17	I, 5	17	10 + 16 = 26
* Gobiid sp. 1	(1)	0 + I, 12–14	I, 12–14	17–19	I, 3	17	10 + 15 = 25
* *Gobiopterus*	(2)	V + 7–10	11–13	14–15	I, 5	17	10 + 15 = 25
Mugilogobius	(2)	V–VI + I, 7–10	I, 7–10	13–18	I, 5	15–18	10–11 + 15–17 = 26–27
Nesogobius	(10)	VI–IX + 0–I, 7–12	0–I, 7–12	16–21	I, 5	13	10–12 + 18–21 = 29–33
Pandaka	(1)	VI + 6–8	6–8	14–16	I, 5	17	10 + 14–15 = 24–25
Papillogobius	(4)	VI + I, 7–9	I, 8–9	15–16	I, 5	17	10 + 16 = 26
Parkraemeria †	(1)	VI + 14	14	12–13	I, 5	13	10 + 15–16 = 25–26
* *Pseudogobius*	(2)	VI + I, 7–9	I, 7–9	14–17	I, 5	16	10 + 15–17 = 25–27
* *Redigobius*	(1)	VI + I, 7	I, 6–7	16–18	I, 5	17	10 + 16 = 26
Teenioides †	(1)	VI + 35	38	16–17	I, 5	17	10 + 16 = 26
* *Tasmanogobius*	(3)	VI–VIII + 0–I, 13–16	0–I, 12–16	16–21	I, 5	17	11–13 + 15–20 = 26–32
Tridentiger *	(1)	VI + I, 12–13	I, 10–11	18–22	I, 5	17	10 + 16 = 26
Valenciennea	(1)	VI + I, 13–17	I, 11–16	18–20	I, 5	17	10 + 16 = 26

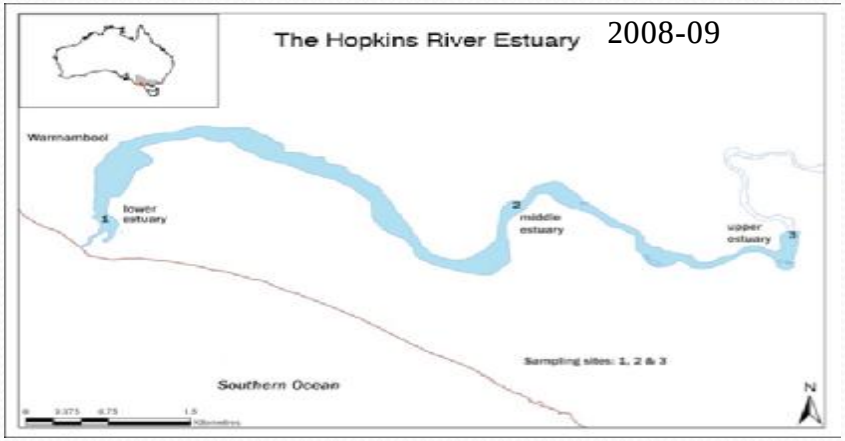
* Introduced species
† Counts from cleared and stained specimens

Location of sampling sites

Lake Macquarie 1981-84







Taxa assessed in this study F. Eleotridae

Philipnodon grandiceps
Australia (3 species)
TL 11 cm

Hypseleotris sp.
Australia (5 species)
TL 6 cm

Taxa assessed in this study F. Gobiidae

Gobiopterus semivestita

Indo W Pacific (10 species)

TL 3.5 cm

Paedogobius kimurai Indo W Pacific (1 species)

TL 2 cm

Taxa assessed in this study F. Gobiidae

Favonogobius exquisitus
Indo W Pacific (10 species)
TL 9 cm

Arenigobius spp.

Australia (2 species)

TL 15 cm

Taxa assessed in this study F. Gobiidae

Redigobius macrostoma
Indo W Pacific (15-20 species)

TL 5 cm

Psuedogobius sp. Indo W Pacific (15 species)

TL 6 cm

Taxa assessed in this study F. Gobiidae

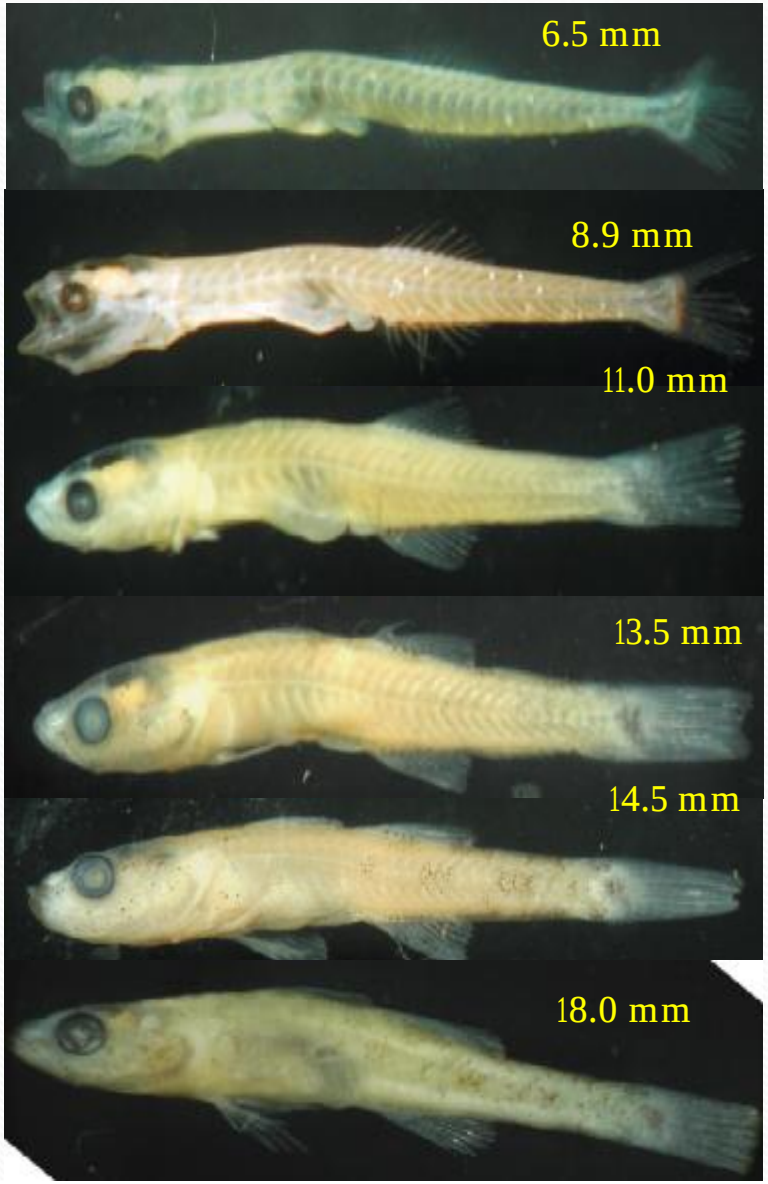
Afurcagobius tamarensis
Southern Australia (2 species)
TL 11 cm

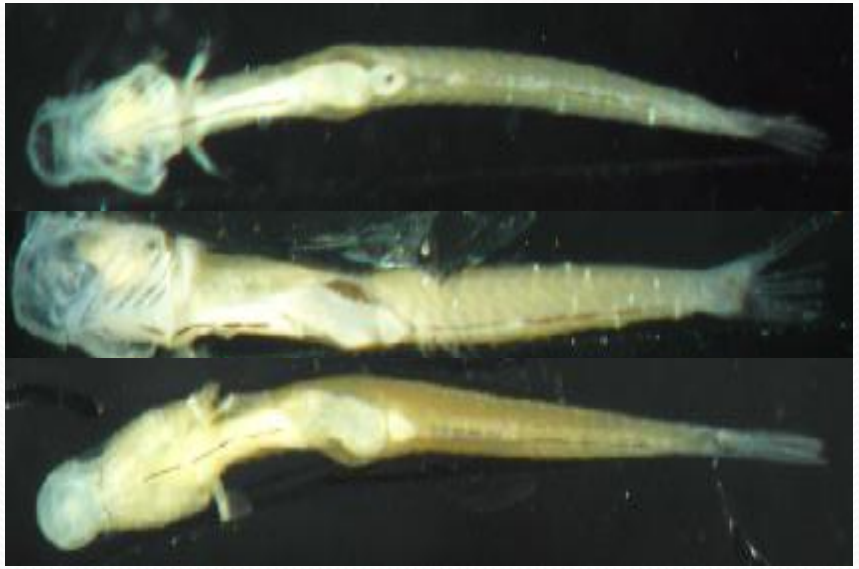
Tasmangobius sp.
Southern Australia (2 species)
TL 5.5 cm

Characters for identification of Eleotrid and Gobiid larvae

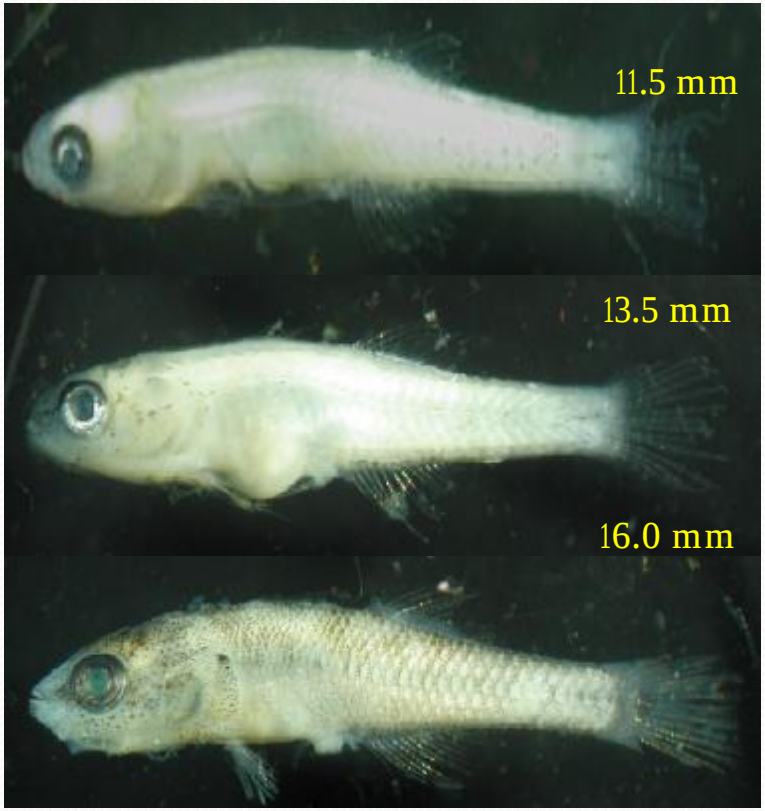
- Pigmentation characters
  - Size, shape, number and pattern of melanophores along the ventral surface of the cleithrum and gut and postanally along the tail
  - Size, shape, number and pattern along dorsal surface of the trunk and tail
  - Presence/absence of melanophore at angle of jaw and ventral tip of lower jaw
  - Pattern of lateral pigment development on head and trunk in transforming larvae
- Morphological characters
  - Size at flexion
  - Body proportions
  - Sequence of fin development

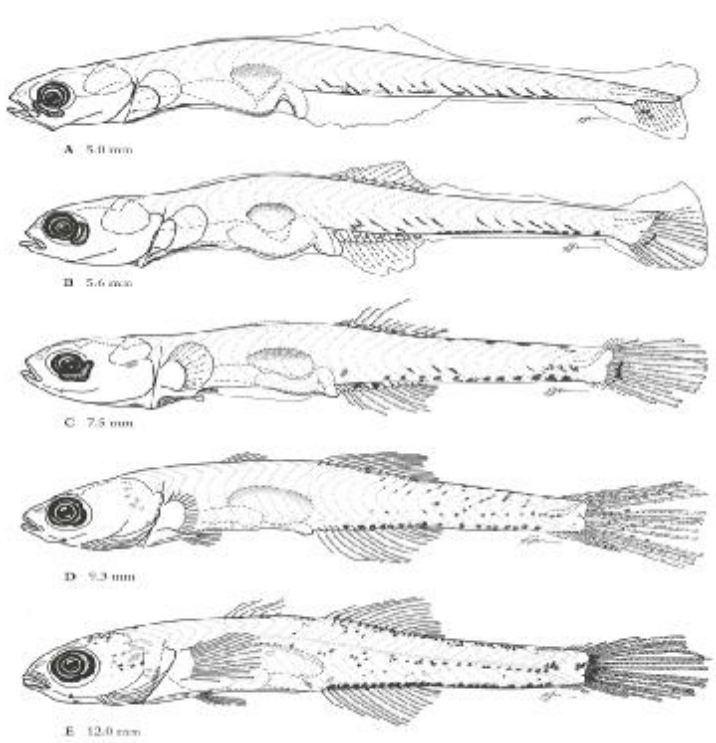
Philipnodon grandiceps





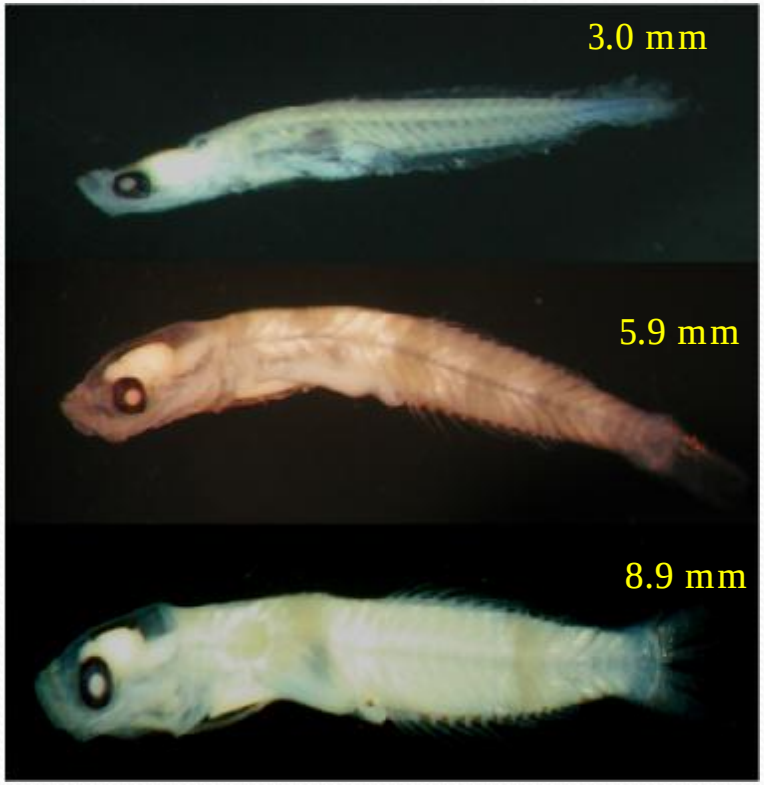
Hypseleotris sp.



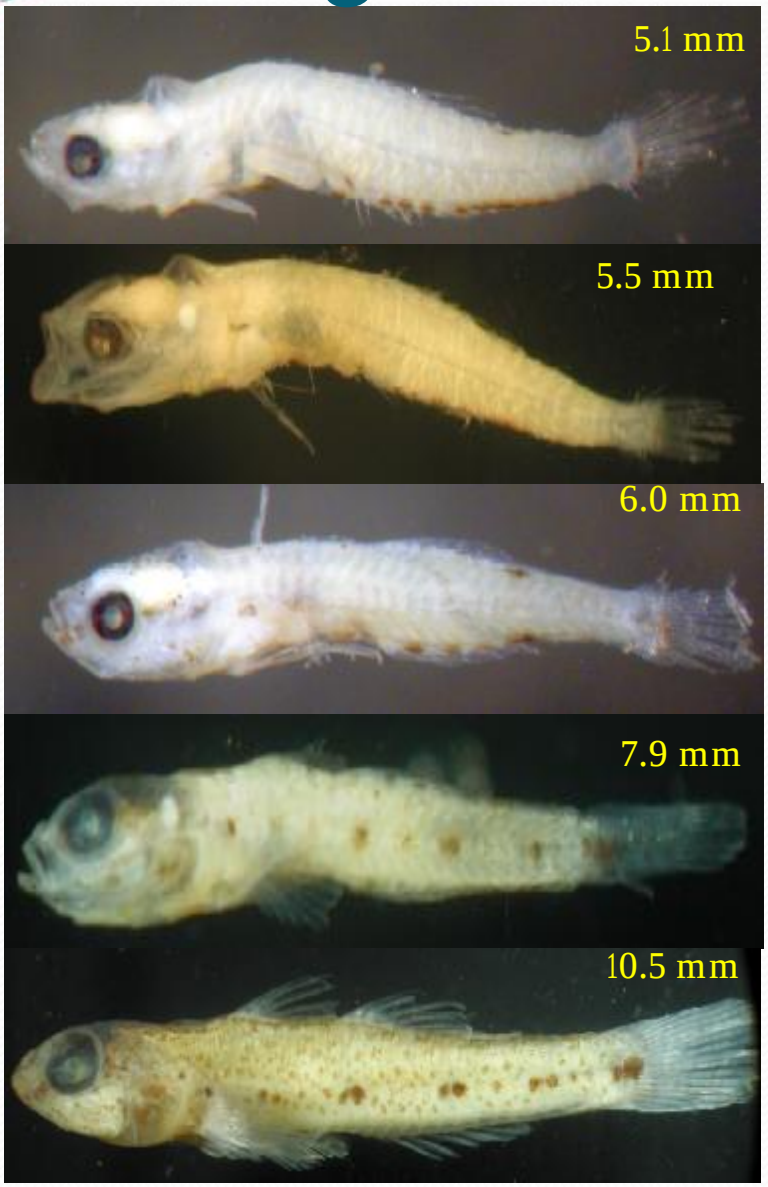


Gobiopterus semivestita

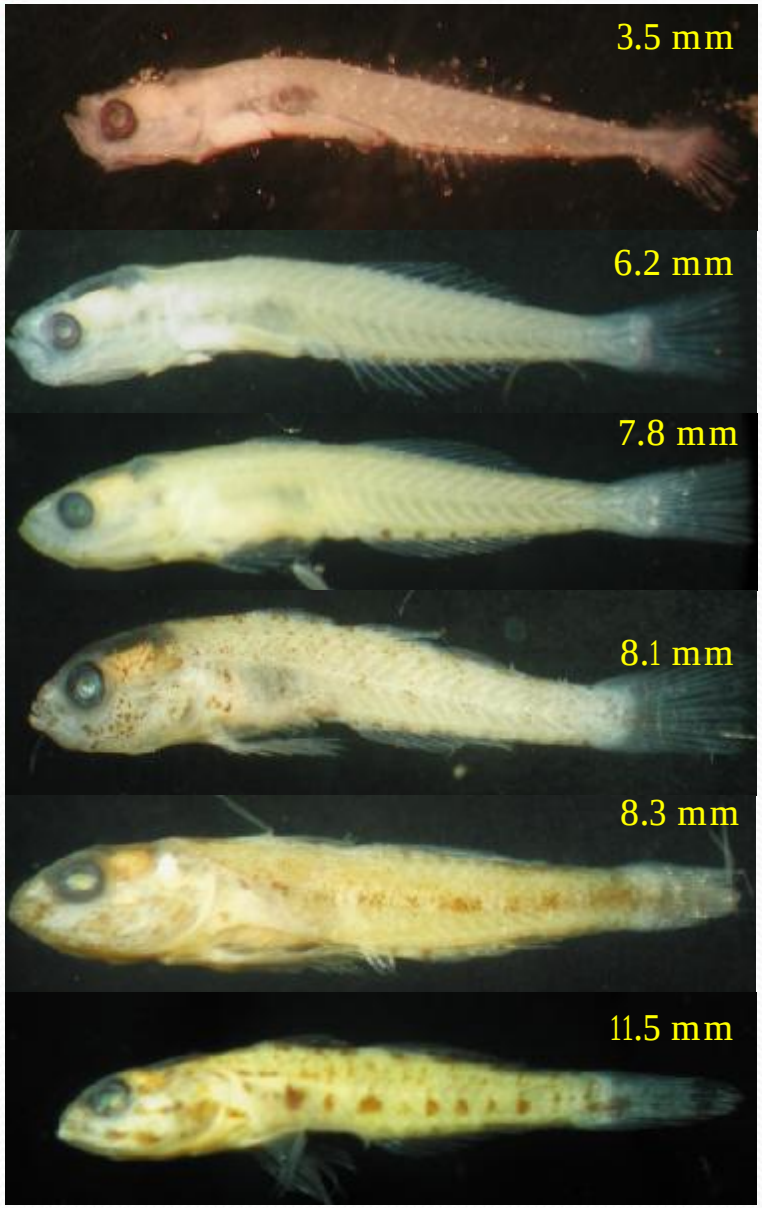
Paedogobius kimurai



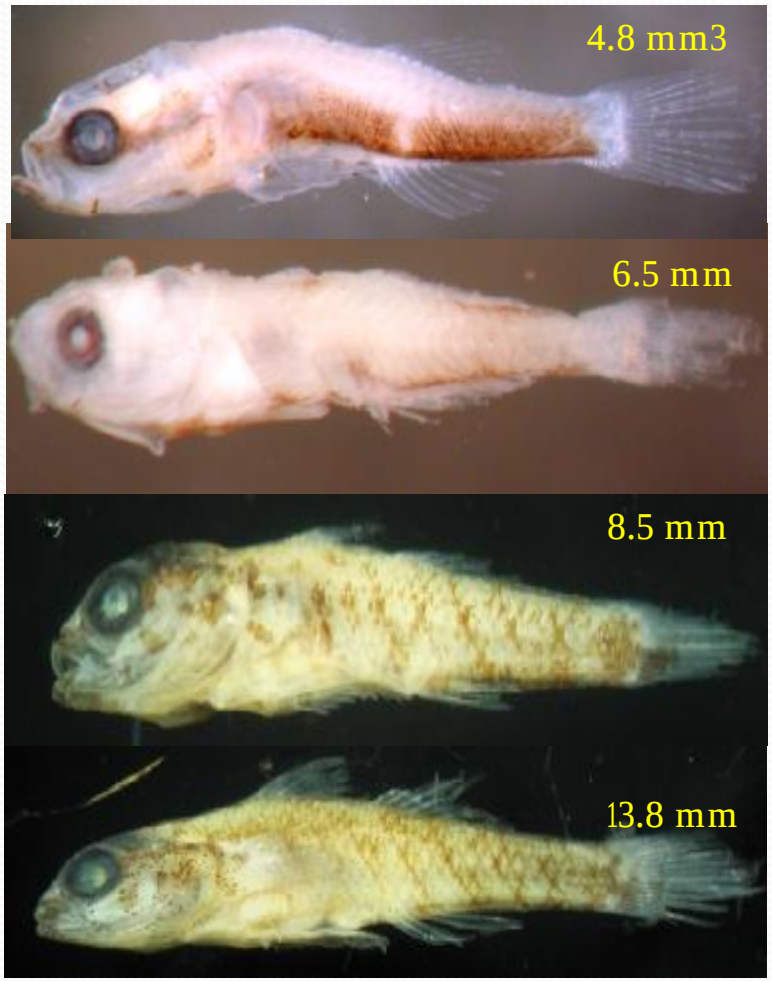
Favonogobius exquisitus

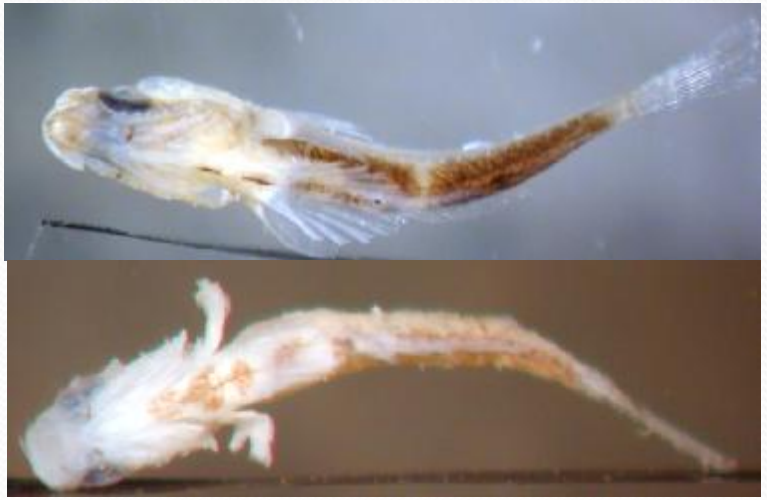


Arenigobius spp.

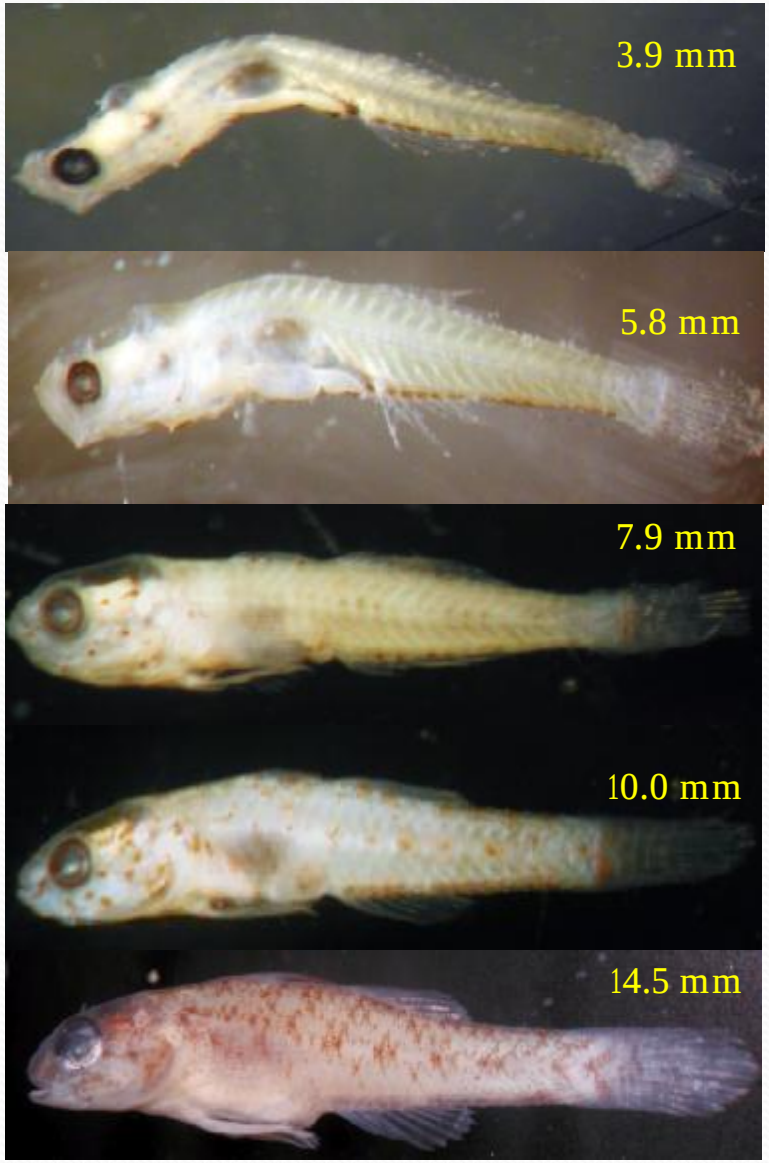


Redigobius macrostoma

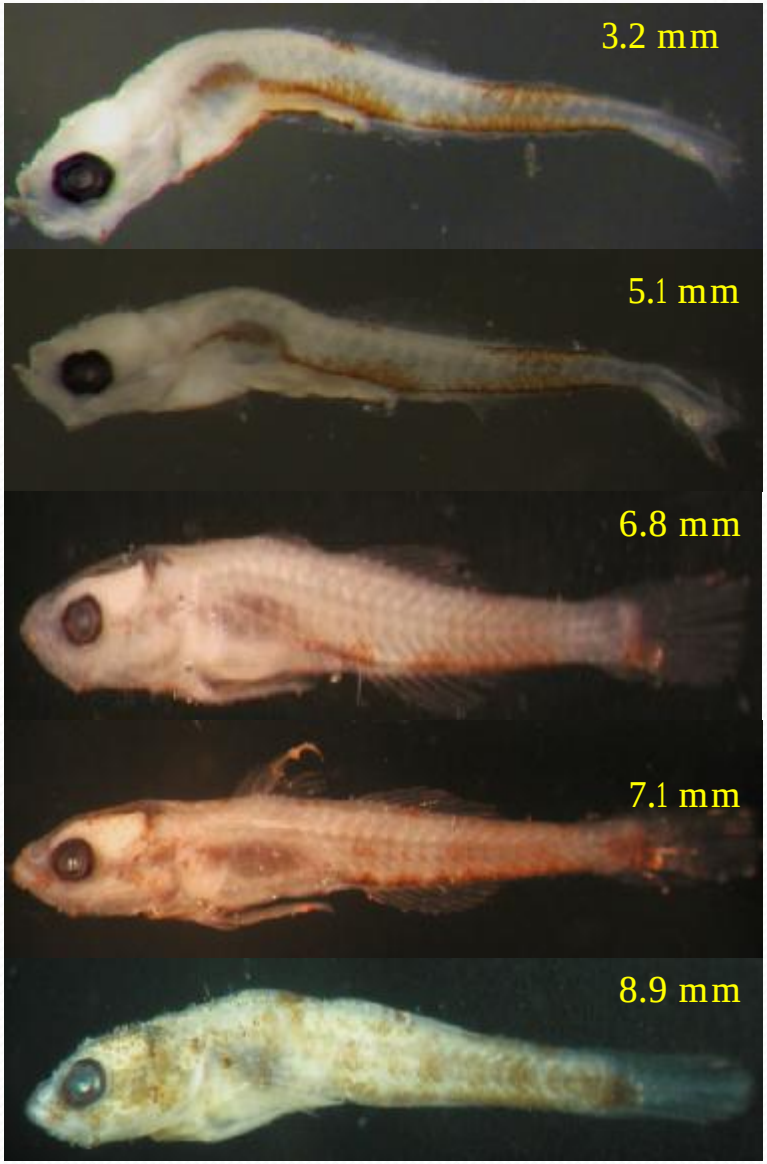


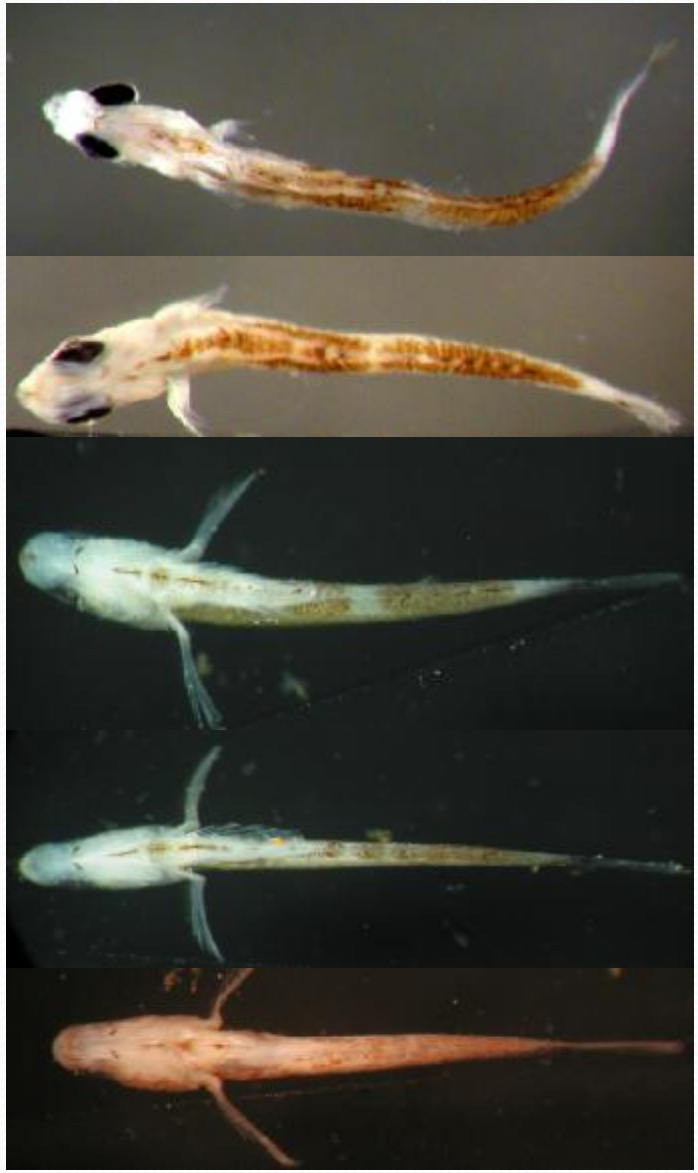


Psuedogobius sp.

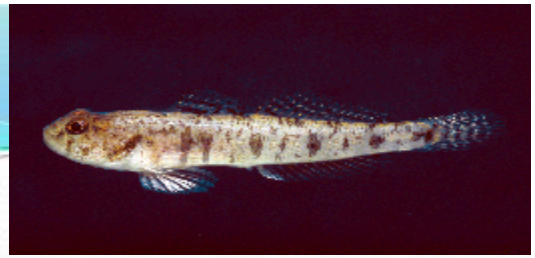


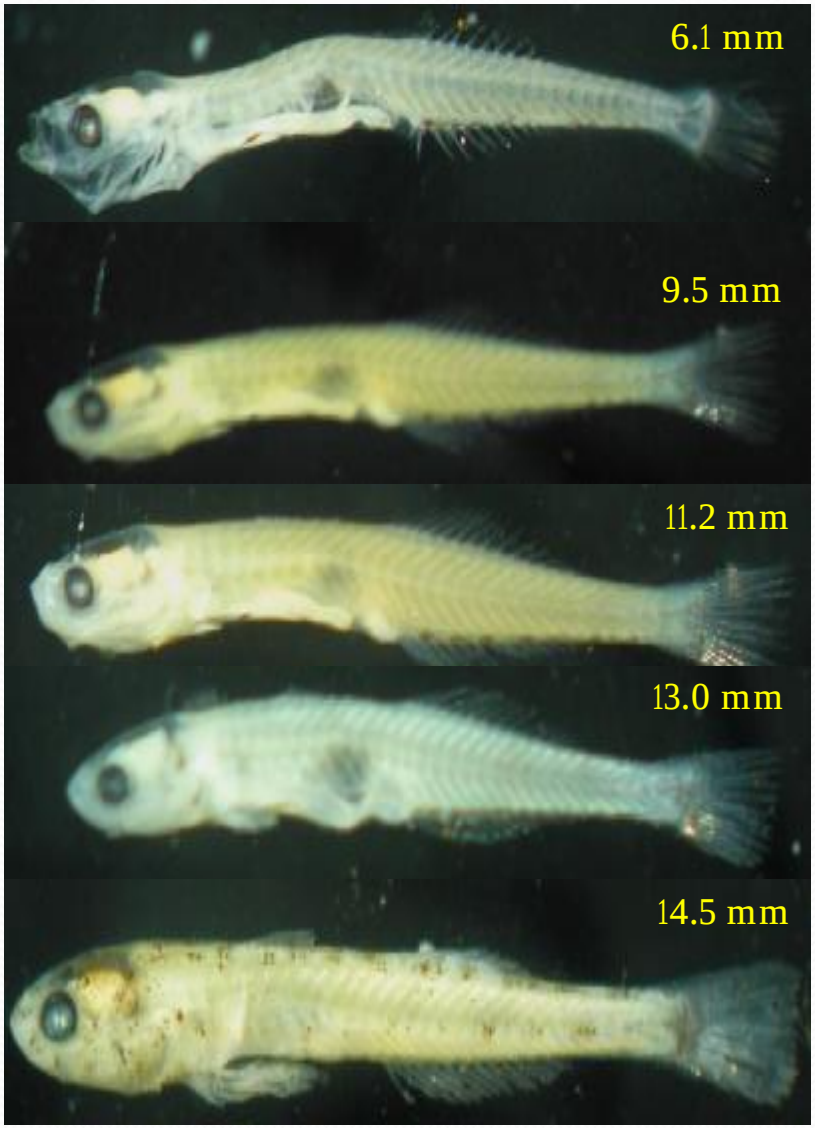
Afurcagobius tamarensis

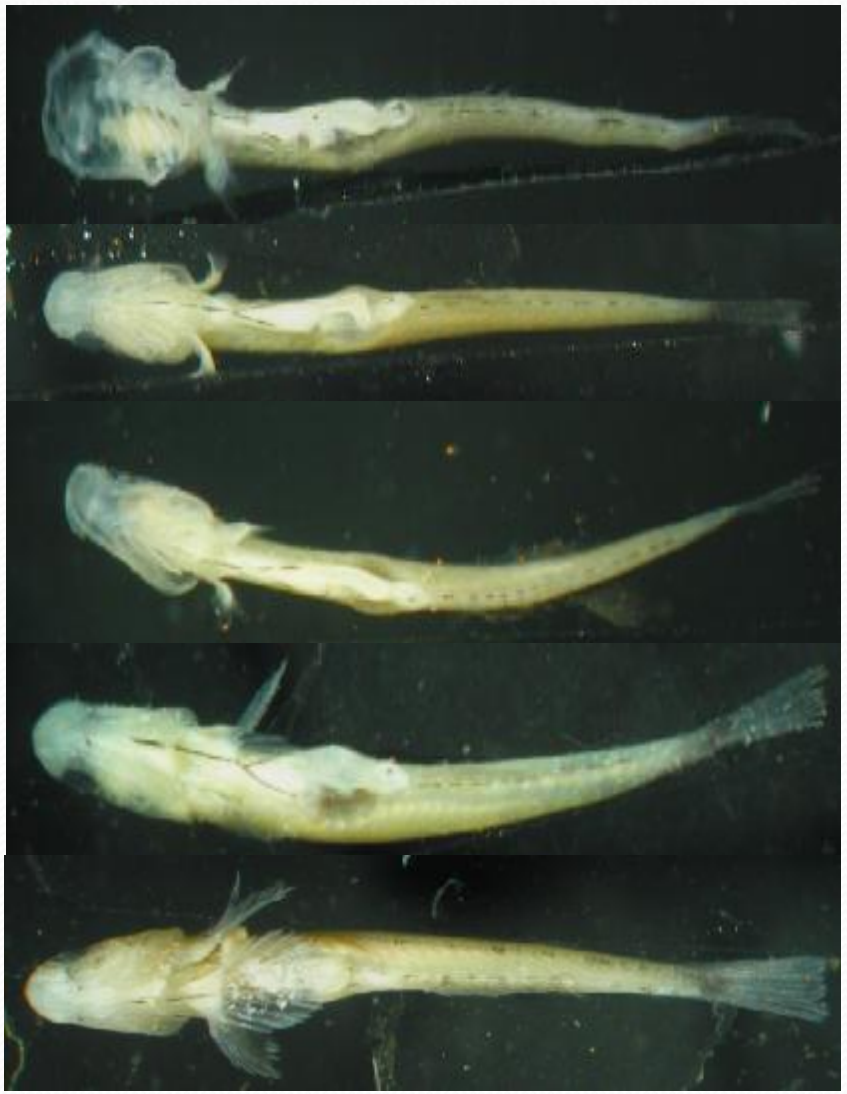




Tasmangobius sp.



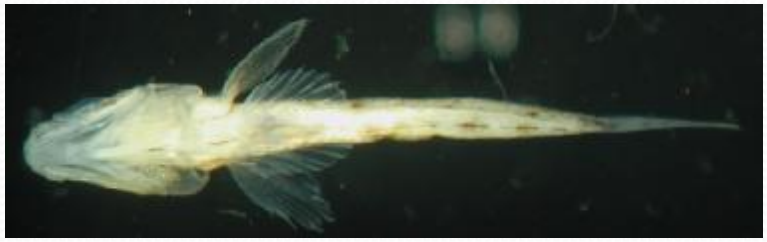




Features separating Eleotrid and Gobiid larvae

- Eleotridae
  - Less morphologically simplified
  - Separated pelvic fins
  - Six branchiostegal rays
  - Usually freshwater/estuarine

- Gobiidae
  - Pelvic fused into a disc
  - Five branchiostegal rays
  - Usually estuarine/marine



Features of Eleotrid larvae

- Lightly pigmented throughout larval development
- Elongate/slender body in early larvae and deeper with growth
- PAL = 45-60% SL
- Large size at flexion (5.5- 8.0 mm SL)
- Series of elongate melanophores on ventral surface of cleithrum and gut
- Series of small melanophores postanally on ventral surface of tail

Phylogeny of gobiids and gobiid lineages

Thacker and Roje (2011)

Tiny Banded Gobies
- *Gobiopterus*
- *Paedogobius*

Lagoon Gobies
- *Afurcagobius*
- *Favonogobius*
- *Arenigobius*

Larson (2001) Pezold (2011)

Mugilogobius group

- *Gobiopterus*
- *Paedogobius*
- *Psuedogobius*
- *Redigobius*
- *Tasmanogobius*

Comparison of larval characters to phylogeny

Thacker and Roje (2011), Larson (2001) Pezold (2011) propose different groupings among Gobiid genera

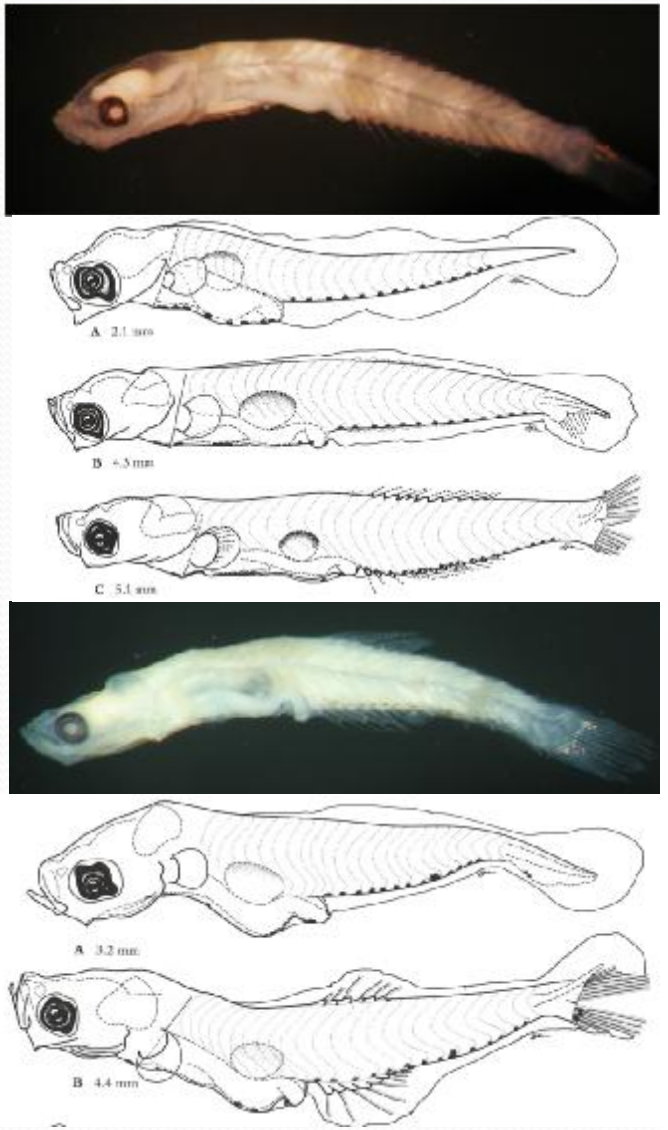
Relationships of *Gobiopterus* and *Paedogobius*

Thacker and Roje (2011) based on genetics propose *Favonogobius* and *Afurcagobius* as sister groups

Gill (1994) based on morphological characters suggests no close relationship between these two genera

Features of Tiny Banded Gobies- Thacker and Roje (2011)

- *Gobiopterus* and *Paedogobius*
- Paedomorphic (sexually mature at 12-15 mm)
- Sexually dimorphic
- Eye bulge in preflexion larvae
- Lightly pigmented throughout larval development
- Elongate/slender body in early larvae and deeper with growth
- PAL = 46-61% SL
- Elongate melanophores on ventral surface of cleithrum and gut
- Series of small melanophores postanally on ventral surface of tail – one enlarged in *Gobiopterus*



Comparison between *Afurcagobius* and *Favonogobius* larval development

Favonogobius

- Lightly pigmented
- Series of small and one large melanophores ventrally along tail
- One to four small dorsal melanophores posteriorly
- Series of melanophores on ventral surface of cleithrum and gut
- No melanophore ventrally on tip of lower jaw
- One melanophore at angle of jaw
- PAL = 46-53% SL
- BD = 13-17% SL
- Flexion 3.0-4.0 mm SL

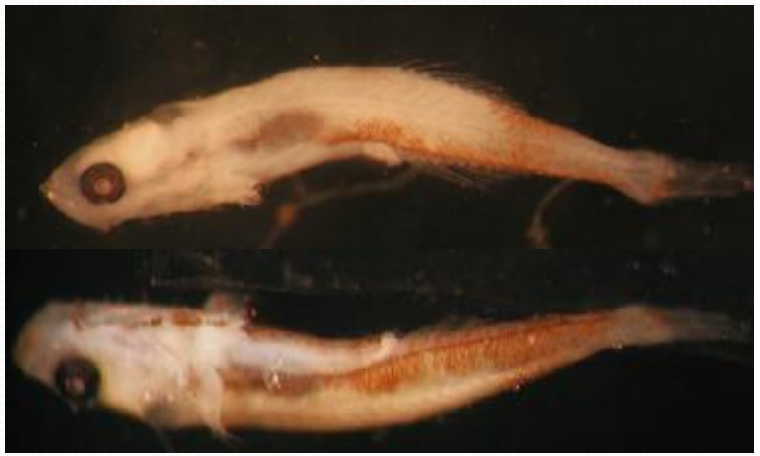
Afurcagobius

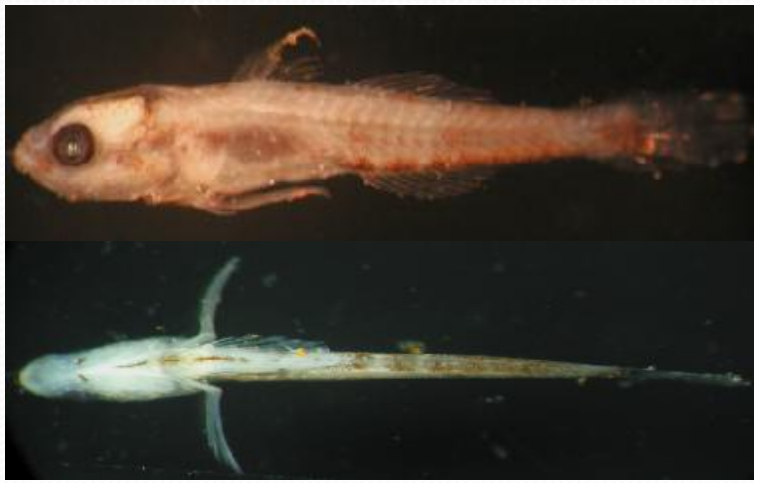
- Heavily pigmented
- Series of large melanophores ventrally along trunk and tail
- Two large dorsal melanophores anteriorly and posteriorly
- Series of melanophores on ventral surface of cleithrum and gut
- One large melanophore ventrally on tip of lower jaw
- One melanophore at angle of jaw
- PAL = 51-61% SL
- BD = 16-26% SL
- Flexion 3.5-4.0 mm SL

Comparison between *Afurcagobius* and *Favonogobius* larval development

Favonogobius

Afurcagobius





Conclusions

- Identification of Eleotrid and Gobiid larvae is difficult but not impossible
- Requires
  - Time
  - Patience
  - Good developmental series, especially transforming larvae
- Gobiid larvae often comprise large proportion of estuarine samples and identification is important for ecological studies and identification of invasive species

Acknowledgements

- Matt Taylor: NSW Primary Industries – Clarence River samples
- Ben Roenfeldt: Deakin University- Hopkins River samples
- Andrew McKinley: University of NSW – six site study samples
- Mark McGrouther and Amanda Hay – Australian Museum
- Di Bray – Museum Victoria
- Adult fish photos from Australian Museum and Museum Victoria websites