CHAPTER

1.5

Systematics of Butidae and Eleotridae

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Eleotridae and Butidae are two clades of gobioid fishes, both differing from relatives Gobiidae and Gobionellidae in that they are generally less morphologically simplified, without joined pelvic fins but with separate spinous and rayed dorsal fins. Eleotridae and Butidae share with Rhyacichthyidae and Odontobutidae the presence of six (rather than five) branchiostegal rays, a character commonly used to separate Gobiidae and Gobionellidae (with five rays) from the remainder of Gobioidei (Hoese, 1984; Hoese and Gill, 1993). Species of Eleotridae and Butidae tend to attain a larger size than most other gobioids (most are 10 – 25 cm in length, with some smaller and a few much larger), and also generally exhibit heavier scalation. Most species are known from fresh or brackish water, with exceptions in Eleotridae (*Calumia*, *Gobiomorphus*, *Grahamichthys*, *Thalasseleotris* and former xenisthmid genera *Allomicrodesmus*, *Paraxenisthmus*, *Rotuma*, *Tyson*, and *Xenisthmus*). Eleotridae also has a wider distribution than

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Butidae, found circumglobally in tropical and some temperate waters, while Butidae is restricted to the Old World tropics (Africa, Asia, Australia, and Oceania). Species of Butidae and Eleotridae tend to be robust and heavy bodied, particularly as compared to Gobiidae and Gobionellidae. In shape they range from stout and cylindrical (benthic) to laterally compressed (nektonic). Currently, 39 species of Butidae and 130 species of Eleotridae are described (data from Eschmeyer, 2008). Valid genera for Butidae and Eleotridae as well as other six-branchiostegal rayed gobioid families Rhyacichthyidae and Odontobutidae are listed in Table 1.5.1. As with other gobioids, new species of Butidae and Eleotridae continue to be discovered and identified (Hoese and Allen, 1983, 1987; Allen and Hoese, 1991; Allen and Jenkins, 1999a, 1999b; Allen, 2003; Hoese and Reader, 2006; Thacker *et al*., 2006; Larson, 2007), and both butid and eleotrid systematics are active areas of research. In both families, just one or two genera contain the bulk of the species. The biggest fraction of the species in Butidae are *Oxyeleotris* (16 of 39) and similarly, the two largest genera in Eleotridae are *Eleotris* (31) and *Mogurnda* (26). Most of the remaining genera in both families have seven or fewer species, and many are monotypic.

Eleotrids and butids comprise a small but interesting portion of the coastal and occasionally inland freshwater fauna on all continents except Europe and Antarctica, but are particularly notable for their radiations in and Australia, New Guinea, and New Zealand (Butidae: *Oxyeleotris*, and Eleotridae including *Hypseleotris*, *Philypnodon*, *Allomogurnda*, *Mogurnda*, and *Gobiomorphus*). In those ecosystems, Ostariophysi, which are often dominent in freshwater, are mostly not present. Instead, endemic species and genera have evolved with a unique complement of freshwater fishes, many of which have secondarily invaded freshwater from marine environments (Allen, 1991; Allen *et al*., 2002). Some of these eleotrid species exhibit vibrant breeding coloration in males, in conjunction with specific mating behaviors (Unmack, 2000); and the population genetics of some Australian species has been used to investigate the evolution of both the rivers they inhabit, as well as the species themselves (Hurwood and Hughes, 1998; Bertozzi *et al*., 2000; Thacker *et al*., 2007, 2008). Species-level phylogeny has also been investigated for one of these genera, *Hypseleotris* (Thacker and Unmack, 2005). Instances of dwarfism are scattered throughout both Eleotridae and Butidae, including freshwater taxa from Africa (*Kribia*), Australia (*Philypnodon macrostomus* and "*Oxyeleotris*" *nullipora*, a dwarf species not closely related to other *Oxyeleotris*, Thacker and Hardman, 2005), and the neotropics (*Microphilypnus* and *Leptophilypnus*) as well as the marine eleotrid genera *Allomicrodesmus*, *Calumia*, *Grahamichthys*,

Table 1.5.1 Valid genera of Rhyacichthyidae, Odontobutidae, Butidae and Eleotridae.

Rhyacichthyidae	***Odontobutidae***	***Butidae***	***Eleotridae***
Protogobius	*Micropercops*	*Bostrychus*	*Allomicrodesmus*
Rhyacichthys	*Milyeringa*	*Butis*	*Allomogurnda*
Terateleotris	*Odontobutis*	*Incara*	*Belobranchus*
	Percottus	*Kribia*	*Bunaka*
		Ophiocara	*Calumia*
		Oxyeleotris	*Dormitator*
		Prionobutis	*Eleotris*
		Typhleotris	*Erotelis*
			Gobiomorphus
			Gobiomorus
			Grahamichthys
			Guavina
			Hemieleotris
			Hypseleotris
			Kimberlyeleotris
			Leptophilypnus
			Microphilypnus
			Mogurnda
			Ophieleotris
			Paraxenisthmus
			Philypnodon
			Ratsirakea
			Rotuma
			Tateurndina
			Thalasseleotris
			Tyson
			Xenisthmus

Paraxenisthmus, *Rotuma*, *Thalasseleotris, Tyson,* and *Xenisthmus* (Allen *et al*., 2002; Thacker and Hardman, 2005; Thacker *et al*., 2006; Hoese and Reader, 2006).

Phylogenetic relationships of Butidae and Eleotridae, and of groups within those families, have rarely been assessed with morphological data. Hoese and Gill (1993) provided diagnostic characters for Eleotridae (then Eleotrinae), but not Butidae (then Butinae), and they did not include the former xenisthmid genera in their survey of eleotrid characters. Morphology and evolution of those genera has been most comprehensively documented by Springer (1983, 1988), and a phylogeny was provided by Gill and Hoese (1993). Butidae and Eleotridae have historically been grouped together as subfamilies within Eleotridae (Hoese, 1984; Hoese and Gill, 1993), but

recent molecular phylogenetic analyses (Thacker, 2009) have demonstrated that Butidae is sister to a clade containing Gobiidae and Gobionellidae, with Eleotridae sister to that clade of three families. Thus, recognition of a group consisting of Butidae and Eleotridae would be paraphyletic, and they are recognized separately at the family level. Similarly, the five genera in the former family Xenisthmidae are included in Eleotridae so as not to render Eleotridae paraphyletic (Thacker and Hardman, 2005; Thacker, 2009). These five genera are all marine, small and elongate with little pigmentation and some reductions in the skeletal system, but with six branchiostegal rays (Gill and Hoese, 1993; Springer, 1983, 1988).

Within Eleotridae and Butidae, Birdsong *et al*. (1988) considered axial skeletal configuration as well as other morphological characters for several genera, placing most butids in their *Butis* group (which also contained the eleotrid *Gobiomorus*) except *Bostrychus* and *Kribia*, which were placed in their *Dormitator* group. The remaining eleotrids considered were classified into the *Eleotris*, *Gobiomorphus*, or *Hypseleotris* groups, with a separate *Xenisthmus* group for the former xenisthmid genera. These groups each share combinations of characters, but only in the case of the *Eleotris* group are the groupings confirmed with molecular phylogenetic analysis. Thacker (2009) did not recover any of Birdsong's groupings with the exception of demonstration of a close relationship between *Eleotris*/*Erotelis* and *Calumia*, a small, reef-dwelling eleotrid. However, molecular phylogenetic studies do confirm monophyly of most genera in both families; the most prominent exception is the butid genus *Oxyeleotris*, in which one species, the tiny *O. nullipora*, is recovered apart from the remainder of the genus (Thacker and Hardman, 2005; Thacker, 2009).

Miller (1998) and Pezold and Cage (2002) both considered the systematics of *Eleotris* and *Erotelis*. From surveys of morphology including sensory pores and papillae and scalation, Miller (1998) concluded that *Eleotris* and *Erotelis* were not distinct enough to warrant separate recognition. In contrast, Pezold and Cage (2002) documented additional morphological characters such as the caudal and median fin configurations, shape, and coloration, and postulated that *Eleotris* and *Erotelis* should both be recognized. Molecular phylogenetic hypotheses (Thacker and Hardman, 2005; Thacker, 2009) support the contention of Miller (1998) that *Erotelis* is nested within *Eleotris*. Not all *Eleotris* species were examined in those molecular studies, but of the species considered, the neotropical *Erotelis* were most closely related to two Pacific *Eleotris* species.

In Eleotridae, some genera (and some species within cosmopolitan genera) have invaded North and South America. These include some species of *Eleotris* (including all *Erotelis*), all species of *Dormitator* except one known from West Africa, and all species of *Gobiomorus*, *Guavina*, *Hemieleotris*, *Leptophilypnus*, and *Microphilypnus*. Invasion of the neotropics has occurred at least twice among these taxa; once in the neotropical *Eleotris* species, and as a separate event in the other genera (Thacker, 2009). Eleotridae also includes several instances of Neotropical transisthmian species pairs, in which the sister taxa inhabit different coasts of the isthmus of Panama. These species pairs exhibit different levels of genetic divergence, consistent with various ages for interruption of gene flow by uplift of the isthmus, with drainages becoming isolated from one another gradually (Thacker and Hardman, 2005). Taken together, morphological and molecular data have provided a range of complementary insights into the systematics, evolution, biogeography, and population-level processes in both Butidae and Eleotridae.

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