specimen collected in the South China Sea. Santini (2006) described *Bathyphylax pruvosti* based on 25 specimens collected from the Marquesas Islands. In addition to these contributions, papers and books on taxonomic and zoo-geographical studies of spikefishes were published by authors from various countries including Australia, China, Japan, Korea, Russia, Taiwan, Ukraine, and the USA.

Amaoka (1982) reported *Halimochirurgus alcocki* Weber 1913, *Macrorhamphosodes uradoi* (Kamohara 1933), and *Paratriacanthodes retrospinis* Fowler 1934 with detailed descriptions and color photographs of fresh specimens collected from the Kyushu-Palau Ridge. Matsuura (1984) provided brief accounts and color photographs of tetraodontiform fishes found in the Japanese Archipelago, including *Atrophacanthus japonicus* Kamohara 1941, *Halimochirurgus alcocki*, *Macrorhamphosodes uradoi*, *Triacanthodes anomalus* (Temminck and Schlegel 1850), and *Triacanthodes ethiops* Alcock 1894. In the following year, Matsuura (1985) provided detailed accounts and a color photograph of *Triacanthodes anomalus* collected from the Okinawa Trough. Matsuura (1987) and Stewart and Clark (1988) recorded *Macrorhamphosodes uradoi* from New Zealand, a species previously known only from Japan (Kamohara 1933; Tyler 1968; Matsuura 1984), Kenya (Tyler 1983) and South Africa (Hulley 1972). Matsuura and Tyler (1997) reported *Bathyphylax bombifrons* Myers 1934, *Halimochirurgus alcocki*, *Macrorhamphosodes uradoi*, *Paratriacanthodes retrospinis*, *Triacanthodes ethiops*, and *Triacanthodes intermedius* based on many specimens collected from New Caledonia. Except for *Triacanthodes intermedius*, these are the first records for the species from New Caledonia. Chen et al. (1997) recorded *Triacanthodes anomalus* from the South China Sea. Matsuura (2000) compiled a checklist of Tetraodontiformes from the South China Sea including eight species of spikefishes: *A. japonicus*, *B. bombifrons*, *Halimochirurgus alcocki*, *Macrorhamphosodes platycheilus* Fowler 1934, *Paratriacanthodes retrospinis*, *Triacanthodes anomalus*, *Triacanthodes ethiops*, and *Tydemania navigatoris* Weber 1913.

Myers and Donaldson (2003) published a checklist of fishes from the Mariana Islands including a record of *Halimochirurgus alcocki*. Kim et al. (2005) provided brief accounts and color photographs of *Triacanthodes anomalus* and *Macrorhamphosodes uradoi* from Korea. Hoese et al. (2006) recorded eight species of spikefishes for the first time from Australia: *B. bombifrons* (New South Wales and Queensland), *Halimochirurgus alcocki* (New South Wales, Queensland and Western Australia), *Halimochirurgus centriscoides* (Western Australia), *Macrorhamphosodes platycheilus* (Northern Territory and Western Australia), *Macrorhamphosodes uradoi* (New South Wales and Queensland), *Paratriacanthodes retrospinis* (New

South Wales and Western Australia), *Triacanthodes ethiops* (Northern Territory, Queensland, Western Australia), and *Tydemania navigatoris* (Western Australia). Shao et al. (2008) recorded seven species of spikefishes from off southern Taiwan in the South China Sea: *B. bombifrons*, *Halimochirurgus alcocki*, *Halimochirurgus centriscoides*, *Macrorhamphosodes uradoi* (first record from the South China Sea), *Paratriacanthodes retrospinis*, *Triacanthodes anomalus*, and *Tydemania navigatoris*. All species records of Shao et al. (2008) were based on specimens deposited at museums and institutions in Taiwan and the USA. Larson et al. (2013) published an annotated checklist of the fishes of the Northern Territory, Australia, in which they recorded *Halimochirurgus centriscoides*, *Macrorhamphosodes platycheilus*, *Triacanthodes ethiops*, and *Tydemania navigatoris*.

Tyler (1983) reported four spikefishes from off Kenya in the western Indian Ocean: *B. bombifrons*, *Bathyphylax omen* Tyler 1966c, *Macrorhamphosodes uradoi*, and *Macrorhamphosodes platycheilus*. When Tyler (1968) compared *B. bombifrons* and *B. omen*, the main differences were that *B. bombifrons* has a narrower pelvis, a shorter postorbital length, a less distinctly supraterminal mouth, and a more concave snout profile. Because the holotype of *B. omen* (37.5 mm in standard length, SL) from the western Indian Ocean is much smaller than that of *B. bombifrons* (77.6 mm SL) from off Hong Kong in the South China Sea, some of these differences were considered to be due in part to the size differences of the holotypes (Tyler 1968). Based on four additional, newly collected specimens of *B. bombifrons* (80.9–84.0 mm SL) and two specimens of *B. omen* (67.0–93.5 mm SL), Tyler (1983) concluded that the most reliable character separating the two species is the degree of concavity of the snout. The depth of the snout in the middle of its length is 10.8–13.4 % SL (average 12.0) in *B. bombifrons* and 12.5–15.5 % SL (average 13.9) in *B. omen*. Matsuura and Tyler (1997) confirmed this difference in three specimens (86.2–93.0 mm SL) of *B. bombifrons* collected off New Caledonia.

Tyler (1986) provided keys to the genera and species of spikefishes known from South and East Africa. He recognized 11 species in this region: *A. japonicus*, *B. bombifrons*, *B. omen*, *Halimochirurgus alcocki*, *Halimochirurgus centriscoides*, *Macrorhamphosodes platycheilus*, *Macrorhamphosodes uradoi*, *Mephisto fraserbrunneri*, *Paratriacanthodes retrospinis*, *Triacanthodes ethiops*, and *Tydemania navigatoris*. Adam et al. (1998) recorded *A. japonicus* and *Triacanthodes ethiops* for the first time from the Maldive Islands in the central Indian Ocean. *Atrophacanthus japonicus* had previously been recorded only from southern Japan, the Celebes Sea, and off Tanzania (Kamohara 1941; Fraser-Brunner 1950; Tyler 1968; Matsuura 1984). Although *T. ethiops* is relatively common

Table 2 A list of 7 species of the Triacanthidae in the world

Species	Distribution
Pseudotriacanthus strigilifer (Cantor 1849)	Persian Gulf, Gulf of Oman, Arabian Sea, Bay of Bengal, Philippines, South China Sea including Gulf of Thailand, Indonesia, and northern Australia
Triacanthus biaculeatus (Bloch 1786)	Persian Gulf, Gulf of Oman, Arabian Sea, Bay of Bengal, and Japan (north to central Honshu), China, South China Sea including Gulf of Thailand, Indonesia, northern Australia
Triacanthus nieuhofii Bleeker 1852b	Arabian Sea, Bay of Bengal, Andaman Sea, Indonesia, South China Sea, northern Australia
Tripodichthys angustifrons (Hollard 1854)	Indonesia and northern Australia
Tripodichthys blochii (Bleeker 1852b)	Arabian Sea, Japan (stray), China (stray), South China Sea including Gulf of Thailand, and Indonesia
Tripodichthys oxycephalus (Bleeker 1851c)	Bay of Bengal, South China Sea including Gulf of Thailand, and Arafura Sea
Trixiphichthys weberi (Chaudhuri 1910)	Bay of Bengal, South China Sea including Gulf of Thailand, and Indonesia

in the West Pacific and New Caledonia (Tyler 1968; Matsuura and Tyler 1997), it had previously been known only from East Africa in the Indian Ocean (Tyler 1968, 1986). Manilo and Bogorodsky (2003) studied coastal fishes of the Arabian Sea based on specimens collected by research vessels of Russia and Ukraine from 1967 to 1991. They also examined specimens collected by the German *RV Meteor*, which are deposited at the Zoological Museum of Hamburg University. The two authors recorded *Halimochirurgus centriscoides* and *Mephisto fraserbrunneri* Tyler 1966b (previously known only from the holotype, 52.2 mm SL from the Andaman Sea and a non-type specimen, 66.0 mm SL from off Somalia in the western Indian Ocean), but did not provide descriptions of the two species. The specimens they studied are deposited at the National Museum of Natural History, National Academy of Sciences, Ukraine, the Zoological Museum of the Russian Academy of Sciences, and the Zoological Museum of Moscow State University. In addition to these, Venkataramanujam et al. (1993) erroneously described a new solenostomid species, *Solenostomus tuticoriensis* based on a specimen of *Macrorhamphosodes platycheilus* from southern India (see Orr and Fritzsche 1997).

This brief historical review clearly shows that there are many collection lacunae with respect to the distribution and diversity of spikefishes in the world oceans. New Caledonia is one example of how collection efforts could provide us with better understanding of spikefish diversity. When Matsuura and Fourmanoir (1984) described *Triacanthodes intermedius* from New Caledonia, only two type specimens were available for their study. Long-term deep-water surveys by ORSTOM around New Caledonia added six species of spikefishes including 16 specimens of *Triacanthodes intermedius* to a taxonomic study on tetraodontiform fishes of this region by Matsuura and Tyler (1997). Many regions of the world oceans need to be surveyed, but the most promising areas would be waters in French Polynesia and the Indian Ocean coast of Sumatra and Java in Indonesia. Japanese and Indonesian fisheries

agencies have recently implemented a joint survey along the Indian Ocean coast of Sumatra and Java. Their surveys have resulted in many interesting spikefishes, including two undescribed species and several rarely collected species, which will be published elsewhere (Matsuura and Kawai in preparation).

Triacanthidae (Triplespines, Fig. 1b; Table 2)

Triplespines of the family Triacanthidae are found on continental shelves in the Indo-West Pacific, usually just below the sea surface to 60 m depth (Tyler 1968). They clearly differ from other families of the order Tetraodontiformes in having the following combination of characters: moderately elongate, strongly compressed body; skin moderately thick with numerous scales not easily discernible to the unaided eye, with each scale bearing upright spinules and having a rough, shagreen-like appearance; two separate dorsal fins, six spines (usually only five spines visible, the sixth rudimentary) in the first dorsal fin and 20–26 soft rays in the second dorsal fin; pelvic fin with a large spine and no visible soft rays; mouth small and usually terminal; teeth in jaws with an outer series of about 10 heavy incisors and an internal series of several molars, usually four in the upper jaw and two in the lower jaw; caudal fin deeply forked; caudal peduncle distinctly tapering to a narrow transversely indented region just in front of the caudal-fin base where the peduncle is wider than deep (Matsuura 2001).

In his monograph of the superfamily Triacanthoidea, Tyler (1968) recognized seven species (Table 2): *Pseudotriacanthus strigilifer* (Cantor 1849), *Triacanthus biaculeatus* (Bloch 1786), *Triacanthus nieuhofii* Bleeker 1852b, *Tripodichthys blochii* (Bleeker 1852a), *Tripodichthys angustifrons* (Hollard 1854), *Tripodichthys oxycephalus* (Bleeker 1851c), and *Trixiphichthys weberi* (Chaudhuri 1910). He appeared to have resolved all taxonomic problems in the Triacanthidae, except for two unusual

Table 3 A list of 37 species of the Balistidae in the world

Species	Distribution
Abalistes filamentosus Matsuura and Yoshino 2004	Ryukyu Islands, North West Shelf of Australia, and Timor Sea
Abalistes stellatus (Anonymous 1798)	Red Sea, East Africa eastward through northern Australia to Fiji, northward to southern Japan
Balistapus undulates (Park 1797)	Red Sea, East Africa eastward through northern Australia to Tuamotu Islands, northward to southern Japan
Balistes capriscus Gmelin 1789	Tropical western and eastern Atlantic
Balistes polylepis Steindachner 1876	Eastern Pacific from northern California to Chile and Hawaiian Islands
Balistes punctatus Gmelin 1789	Eastern Atlantic from Madeira to Angola
Balistes vetula Linnaeus 1758	Tropical western and eastern Atlantic
Balistoides conspicillum (Bloch and Schneider 1801)	East Africa eastward through northern Australia to Samoa, northward to southern Japan
Balistoides viridescens (Bloch and Scneider 1801)	Red Sea, East Africa eastward through northern Australia to Line and Tuamotu islands, northward to southern Japan
Canthidermis macrolepis (Boulenger 1888)	Red Sea, Gulf of Oman, and Arabian Sea
Canthidermis maculata (Bloch 1786)	Circumgloba in warm and tropical seas
Canthidermis sufflamen (Mitchill 1815)	Western Atlantic from Massachusetts through Gulf of Mexico to Lesser Antilles, Bermuda
Melichthys indicus (Randall and Klausewitz 1973)	Red Sea, East Africa eastward to western Thailand and Sumatra, southern Java, and Bali
Melichthys niger (Bloch 1786)	Circumglobal in tropical seas
Melichthys vidua (Richardson 1845)	East Africa eastward through northern Australia to Hawaiian and Tuamotu islands, northward to southern Japan
Odonus niger (Rüppell 1836)	Red Sea, East Africa eastward through northern Australia to Line, Marquesas and Society islands, northward to southern Japan
Pseudobalistes flavimarginatus (Rüppell 1829)	Red Sea, East Africa eastward through northern Australia to Tuamotu Islands, northward to southern Japan
Pseudobalistes fuscus (Bloch and Schneider 1801)	Red Sea, East Africa eastward through northern Australia to Society Islands, northward to southern Japan
Pseudobaliste naufragium (Jordan and Starks 1895)	Eastern Pacific from Baja California to Ecuador
Rhinecanthus abyssus Matsuura and Shiobara 1989	Known only from Kume-jima Island, Ryukyu Islands
Rhinecanthus aculeatus (Linnaeus 1758)	East Africa eastward through northern Australia to Hawaiian, Marquesas and Tuamotu islands, northward to southern Japan
Rhinecanthus assasi (Forsskål 1775)	Red Sea and Gulf of Oman
Rhinecanthus cinereus (Bonnaterre 1788)	Mauritius and Reunion
Rhinecanthus lunula Randall and Steene 1983	Queensland to Pitcairn Islands
Rhiencanthus rectangulus (Bloch and Schneider 1801)	Red Sea, East Africa eastward through northern Australia to Hawaiian and Pitcairn islands, northward to southern Japan
Rhinecanthus verrucosus (Linnaeus 1758)	Seychelles, Chagos Archipelago eastward through northern Australia to Vanuatu, northward to southern Japan
Sufflamen albicaudatum (Rüppell 1829)	Red Sea, Gulf of Oman, and Arabian Sea
Sufflamen bursa (Bloch and Schneider 1801)	East Africa eastward through northern Australia to Hawaiian, Marquesas and Pitcairn islands, northward to southern Japan
Sufflamen chrysopterum (Bloch and Schneider 1801)	East Africa eastward through northern Australia to Samoa, northward to southern Japan
Sufflamen fraenatum (Latreille 1804)	Red Sea, East Africa eastward through northern Australia to Hawaiian, Marquesas and Tuamotu islands, northward to southern Japan
Sufflamen verres (Gilbert and Starks 1904)	Eastern pacific from Baja California to Ecuador
Xanthichthys auromarginatus (Bennett 1832)	Mauritius eastward through northern Australia to Hawaiian and Society islands, northward to southern Japan
Xanthichthys caeruleolineatus Randall, Matsuura and Zama 1978	Angela Islands in western Indian Ocean eastward through Indonesia to Galapagos Islands, northward to southern Japan

120

Table 3 continued

Species	Distribution
Xanthichthys lineopunctatus (Hollard 1854)	South Africa eastward through northern Australia to New Guinea, northward to southern Japan
Xanthichthys mento (Jordan and Gilbert 1882)	Antitropical in Pacific, southern Japan, Hawaiian Islands, Clipperton Island, Revillagigedo Islands, southern California, Easter Island, and Pitcairn Islands
Xanthichthys ringens (Linnaeus 1758)	Western Atlantic from South Carolina through Gulf of Mexico to Lesser Antilles
Xenobalistes punctatus Heemstra and Smith 1983	South Africa
Xenobalistes tumidipectoris Matsuura 1981	Mariana Islands

specimens of *Triacanthus biaculeatus* collected from the Gulf of Thailand. Tyler (1968) reported that four specimens from the Gulf of Thailand near Paknam have differences in eye size and the width of the interorbital space. Two of these specimens (111.5 mm SL and 113.9 mm SL) have exceptionally large eyes (10.4 % SL) and the other two (105.6 mm SL and 107.9 mm SL) have a normal eye size (7.8 and 8.5 % SL). The two large-eye specimens have eyes that are also larger than those of any other specimens of equivalent size. The large-eye specimens have a wider interorbital space (10.2–10.5 % SL vs. 6.3–10.0 % SL in many other specimens). Tyler (1968) stated that they could be an undescribed species, but tentatively considered them as abnormal *Tiracanthus biaculeatus*. Although I have been to the Gulf of Thailand many times and examined local collections in Thailand, I have not seen specimens of *Triacanthus* with such large eyes.

Tyler (1968) provided color descriptions of *P. strigilifer*, *Triacanthus biaculeatus*, and *Trixiphichthys weberi* based on color notes or color photographs of fresh specimens, but neither was available for the other species. Matsuura (2009) included a color photograph of a juvenile specimen (50 mm SL) of *Triacanthus nieuhofii* collected from Phuket in the Andaman Sea: body silvery white with light brown tinge on dorsal half of body; first dorsal spine silvery white with a black membrane between the first and third dorsal spines; second dorsal, anal, and pectoral fins with light yellowish rays; caudal fin dark yellow. Matsuura (2013) provided brief accounts and a color photograph of *Tripodichthys blochii* collected from the northern Gulf of Thailand: body silvery white with several irregular golden brownish markings on head and body; basal half of first dorsal spine silvery white and proximal half black with yellowish orange first dorsal fin membrane; second dorsal, anal, and pectoral fins with light yellowish rays; caudal fin dusky yellow.

Distribution ranges of triplespines were well documented by Tyler (1968). After his monograph appeared, many publications on fish faunas, field guides and checklists have provided additional information on triplespine

distributions (e.g., Matsuura 1984, 2003a, 2009, 2011, 2013; Allen and Swainston 1988; Talwar and Jhingran 1991; Kottelat et al. 1993; Randall 1995; Allen 1997; Chen et al. 1997; Fricke 1999; Johnson 1999; Matsuura and Peristiwady 2000; Hutchins 2001b; Hoese et al. 2006; Kottelat 2013; Larson et al 2013). Although most of these publications did not greatly extend the previously reported distributions of triplespines, Fricke (1999) recorded *Triacanthus biaculeatus* from the Mascarene Islands and Kottelat et al. (1993) reported a 60-mm SL specimen of this species from freshwater in Indonesia.

Balistidae (Triggerfishes, Fig. 1c; Table 3)

Triggerfishes of the family Balistidae occur in shallow waters, mainly on coral reefs around the world usually from just below the sea surface to 50 m depth. They differ externally from other families of the order Tetraodontiformes by the following combination of characters: body deep, moderately compressed, encased in very thick, tough skin with large scales easily discernible as individual units; scales above pectoral-fin base in many species enlarged, forming a flexible tympanum; mouth small and terminal, or almost terminal; teeth strong, eight in the outer series of both jaws; gill opening, a moderately short, vertical to oblique slit in front of pectoral-fin base; two dorsal fins, first dorsal fin with three visible spines, the second spine more than 1/2 length of first spine; first spine capable of being locked in an erect position by second spine; second dorsal and anal fin similar in shape; most dorsal-, anal-, and pectoral-fin rays branched; pelvic fins rudimentary, represented by a series of four pairs of enlarged scales encasing posterior end of pelvis (Matsuura 2001).

Triggerfishes of the Balistidae have not yet been comprehensively reviewed, but Matsuura (1979) described the osteology of family and its generic relationships, and Matsuura (1980) diagnosed and illustrated the 20 species of 10 genera found in Japanese waters. His latter paper covered many of the 25 species that were known from the

Indo-Pacific before 1980. Prior to this publication two papers reviewed triggerfishes in the eastern Pacific (Berry and Baldwin 1966) and those of the western Atlantic (Moore 1967a). In addition, Randall and Klausewitz (1973) reviewed *Melichthys* Swainson 1839, with a description of *Melichthys indicus*, and Randall et al. (1978) revised *Xanthichthys* Kaup *in* Richardson 1856 with a description of *Xanthichthys caeruleolineatus*. These were important contributions about the taxonomy of triggerfishes up to and including 1980. A brief historical review of triggerfish taxonomy follows.

Fraser-Brunner (1935a) published a review of the Balistidae, one of his series of taxonomic studies of tetraodontiform fishes. He recognized 13 genera in the Balistidae and provided a platform for triggerfish taxonomy. Although de Beaufort and Briggs (1962) lumped Fraser-Brunner's 11 genera into the single genus *Balistes* Linnaeus 1758, they relegated all 11 genera to subgenera. Berry and Baldwin (1966) reviewed triggerfishes of the eastern Pacific with comments on Fraser-Brunner's classification. They pointed out that Fraser-Brunner (1935a) recognized *Nematobalistes* Fraser-Brunner 1935a and *Verrunculus* Jordan 1924 on trivial differences of squamation and the anterior few soft rays of the dorsal fin. Berry and Baldwin (1966) examined many individuals of the eastern Pacific triggerfishes, which diminished differences among *Balistes*, *Nematobalistes*, and *Verrunculus*. It led Berry and Baldwin (1966) to conclude that the latter two are junior synonyms of *Balistes*. They partially accepted Fraser-Brunner's system by recognizing six genera: *Balistes*, *Canthidermis* Swainson 1839, *Melichthys*, *Pseudobalistes* Bleeker 1865–1869, *Sufflamen* Jordan 1916, and *Xanthichthys*, but they left the other five genera, *Abalistes* Jordan and Seale 1906, *Balistapus* Tilesius 1820, *Balistoides* Fraser-Brunner 1935a, *Odonus* Gistel 1848, and *Rhinecanthus* Swainson 1839 to the deliberations of subsequent authors. Just after Berry and Baldwin's (1966) paper appeared, Moore (1967a) published a review of the triggerfishes of the western Atlantic and recognized four genera, *Balistes*, *Canthidermis*, *Melichthys*, and *Xanthichthys* (i.e., triggerfishes of other genera not occurring in the western Atlantic). Just after his review of the western Atlantic triggerfishes, Moore (1967b) clarified the taxonomic status of *Balistes punctatus* Gmelin 1789, stating that it occurs only in the eastern Atlantic.

Matsuura (1980) provided keys to genera and species, and taxonomic accounts of 20 Japanese species that he classified in 10 genera, *Abalistes*, *Balistapus*, *Balistoides*, *Canthidermis*, *Melichthys*, *Odonus*, *Pseudobalistes*, *Rhinecanthus*, *Sufflamen*, and *Xanthichthys*. He also addressed a taxonomic problem in the genus *Hemibalistes*. *Hemibalistes* as proposed by Fraser-Brunner (1935a) was not an available name because two species, *Sufflamen bursa*

(Bloch and Schneider 1801) and *Sufflamen chrysopterum* (Bloch and Schneider 1801), were included and neither was designated type species. Smith (1949b) subsequently designated *Balistes bursa* Bloch and Schneider 1801 as the type species of the genus *Hemibalistes*. However, the diagnostic character of *Hemibalistes*, all scales on cheek smaller than those on body, is not adequate to differentiate it from other triggerfish genera because squamation on the cheek of *Sufflamen* and *Hemibalistes* is variable (Matsuura 1980). As stated above, the papers of Berry and Baldwin (1966), Moore (1967a), Randall and Klausewitz (1973), Randall et al. (1978), and Matsuura (1980) contributed to the proper recognition of 11 genera, *Abalistes*, *Balistapus*, *Balistes*, Balistoides, *Canthidermis*, *Melichthys*, *Odonus*, *Pseudobalistes*, *Rhinecanthus*, *Sufflamen*, and *Xanthichthys*. Tyler (1980) also accepted these 11 genera in his phylogenetic study on tetraodontiform fishes. The osteologically based phylogenies of balistoids given by Matsuura (1979) and Tyler (1980) were largely in agreement, as were the majority of their morphological description; the few conflicts between their respective accounts were clarified by Tyler and Matsuura (1981) as an aid to subsequent workers.

Matsuura (1981) described *Xenobalistes tumidipectoris* as a new genus and species based on a small juvenile collected from stomach contents of a marlinfish, *Makaira mazara* (Jordan and Snyder 1901), captured in the Mariana Islands. Although the holotype of *Xenobalistes tumidipectoris* was partially damaged by digestion, it differs clearly from other triggerfishes by its possession of a number of unique characters, such as there is a large lateral expansion protruding laterally just below the pectoral fin, the supraorbital ridge is well developed and convex dorsolaterally, and the mid-lateral portion of the coracoid is greatly expanded to form a disk-like bone. Two years later, Heemstra and Smith (1983) described *Xenobalistes punctatus* as a new species, based on a small juvenile washed up on a beach at the mouth of the Van Stadens River, South Africa.

Randall and Steene (1983) described *Rhinecanthus lunula* and provided brief comments about the other five species, *Rhinecanthus aculeatus* (Linnaeus 1758), *Rhinecanthus assasi* (Forsskål 1775), *Rhinecanthus cinereus* (Bonnaterre 1788), *Rhinecanthus rectangulus* (Bloch and Schneider 1801), and *Rhinecanthus verrucosus* (Linnaeus 1758). Matsuura and Shiobara (1989) described *Rhinecanthus abyssus* on the basis of two specimens collected off the northeast coast of Kume-jima in the Ryukyu Islands, at depths of 120–150 m, which is quite deep for triggerfishes. Matsuura and Yoshino (2004) studied the monotypic genus *Abalistes* and recognized two species, *Abalistes stellatus* (Anonymous 1798) and a new species, *Abalistes filamentosus*.

Taxonomic studies of triggerfishes continued during the period from Berry and Baldwin (1966) to Matsuura and Yoshino (2004), resulting in the classification shown in Table 3, which recognizes 37 species of triggerfishes in 11 genera. In addition to the above contributions, many checklists and illustrated books on shallow-water fishes also provided taxonomic and zoogeographical information of the Balistidae and other tetraodontiforms (Böhlke and Chaplin 1968; Jones and Kumaran 1980; Kyushin et al. 1982; Gloerfelt-Tarp and Kailola 1984; Matsuura 1984, 2000, 2001, 2002, 2003a, 2009, 2011, 2013; Sainsbury et al. 1984; Smith and Heemstra 1986; Tortonese 1986; Allen and Swainston 1988; Winterbottom et al. 1989; Kuiter 1993; Allen and Robertson 1994; Randall 1995, 1996, 2005, 2010; Kyushin et al. 1977; Randall et al. 1997, 2004; Fricke 1999; Myers 1999; Manilo and Bogorodsky 2003; Munday 2005; Shao et al. 2008; Fricke et al. 2009; Allen and Erdman 2012). Still, taxonomic challenges remain. *Sufflamen verres* (Gilbert and Starks 1904) in the eastern Pacific is said to be different from the Indo-West Pacific species, *Sufflamen fraenatum* (Latreille 1804), in having higher counts of fin rays of the second dorsal and anal fins (Berry and Baldwin 1966). According to their study, *S. verres* has 30–33 dorsal rays and 27–30 anal rays, while *S. fraenatum* has 28–30 dorsal rays and 24–26 anal rays. However, Berry and Baldwin (1966) also noted that a specimen of *S. fraenatum* from South Africa with 31 dorsal rays and 27 anal rays, overlapping the counts of *S. verres*. Matsuura (1980) showed on the basis of 22 specimens of *S. fraenatum* from Japan that dorsal rays range from 27 to 30 and anal rays from 24 to 27. Randall (2010) stated that the Hawaiian population of *S. fraenatum* has 27–31 dorsal rays and 24–28 anal rays. These data strongly suggest that *S. verres* is a junior synonym of *S. fraenatum*. Molecular comparisons of *S. verres* and *S. fraenatum* may help clarify their relationships. Fricke (1999) stated that *Xanthichthys lineopunctatus* (Hollard 1854) is a synonym of *Xanthichthys lima* (Bennett 1832). However, the original description of *Balistes lima* by Bennett (1832) comprised only 50 words with fin ray counts "D. 1?, A. 26, P. 13." Because the poor original description fits several species of the Balistidae, it is impossible to verify that *Balistes lima* is conspecific with *Xanthichthys lineopunctatus*. As no type specimens are known for *Balistes lima*, I conclude that *Balistes lima* should be treated as a nomen dubium.

Santini et al. (2013a) showed *Xenobalistes tumidipectoris* to be deeply nested among five species of *Xanthichthys* in a phylogenetic tree of the Balistidae based on molecular analysis. Their molecular analysis suggests that *Xenobalistes* is a junior synonym of *Xanthichthys*. I am currently comparing larger specimens of *Xenobalistes tumidipectoris* and *Xenobalistes punctatus* with those of *Xanthichthys* to clarify the relationships of the two species of *Xenobalistes* with the five species of *Xanthichthys*. This study will be published elsewhere to resolve the taxonomic status of *Xenobalistes*. Santini et al. (2013a) also mentioned that *Balistoides* and *Pseudobalistes* are not monophyletic: *Balistoides conspicillum* (Bloch and Schneider 1801) is sister to *Melichthys*, and *Pseudobalistes flavimarginatus* (Rüppell 1829) forms a clade with *Balistoides viridescens* (Bloch and Schneider 1801), whereas *Pseudobalistes fuscus* (Bloch and Schneider 1801) and *Pseudobalistes naufragium* (Jordan and Starks *in* Jordan 1895) represent a single clade. These species should be revisited with detailed morphological examinations.

Monacanthidae (Filefishes, Fig. 1d; Table 4)

Filefishes of the family Monacanthidae occur on coral and rocky reefs and in sea grass beds, shallower than 200 m, but some species are found at depths reaching almost 300 m (Matsuura and Tyler 1997; Hutchins 2001b). They differ externally from other families of the order Tetraodontiformes by the following combination of characters: body usually deep, strongly compressed, body shape varying from oblong to almost circular; skin smooth to rough, shagreen-like, with minute to small scales armed with one to many fine spinules, spinules enlarged in some species forming bristles or spines on the posterior portion of the body; scales on head of some species with strong flattened spinules; mouth small, generally terminal, nonprotractile; teeth pointed and not fused together, central pair usually the largest in each jaw; gill opening, a short vertical to oblique slit in front of, or above, pectoral-fin base; two dorsal fins, first dorsal fin consisting of a prominent spine, which can be locked upright by a second very small spine, second dorsal fin with 22 to 52 simple (unbranched) soft rays; anal fin with 20 to 62 simple soft rays; pelvic fin and spines rudimentary or absent, represented by a series of three or fewer pairs of enlarged scales encasing the pelvic terminus, or segments of indeterminate number, or entirely absent; pelvis usually capable of vertical movement giving rise to a ventral flap (Hutchins 2001b; Matsuura 2003b).

There are no comprehensive reviews of the Monacanthidae, although in 1988 Barry Hutchins provided taxonomic, morphological, and phylogenetic data for all monacanthid species in the world in his doctoral dissertation. Some parts of his dissertation were published, however, the taxonomic accounts of many species and genera and the phylogenetic analysis of the genera remain unpublished. Hutchins published a series of articles on the Monacanthidae between 1977 and 2002. His first article on Australian filefishes recognized 28 genera in Australia

Table 4 A list of 102 species of the Monacanthidae in the world

Species	Distribution
Acanthaluteres brownii (Richardson 1848)	Southern Western Australia and South Australia
Acanthaluteres spilomelanurus (Quoy and Gaimard 1824)	Southern Western Australia, South Australia, Victoria, Tasmania, and southern New South Wales
Acanthaluteres vittiger (Castelnau 1873)	Southern Western Australia, South Australia, Victoria, Tasmania and southern New South Wales
Acreichtys hajam (Bleeker 1851a)	Indonesia to Papua New Guinea, northward to southern Japan
Acreichthys radiatus (Popta 1900)	Indonesia to Papua New Guinea, northward to southern Japan
Acreichthys tomentosus (Linnaeus 1758)	Sri Lanka eastward thorough Indonesia to New Caledonia, northward to southern Japan
Aluterus heudelotii Hollard 1855	Both sides of Atlantic: in the western Atlantic from Massachusetts and Bermuda to Brazil, in the eastern Atlantic Mauritania to Angola
Aluterus monoceros (Linnaeus 1758)	Circumglobal in warm and tropical seas
Aluterus schoepfii (Walbaum 1792)	Nova Scotia and Bermuda to Brazil
Aluterus scriptus (Osbeck 1765)	Circumglobal in warm and tropical seas
Amanses scopas (Cuvier 1829)	Red Sea, East Africa eastward through northern Australia to Tuamotu Islands, northward to southern Japan
Anacanthus barbatus Gray 1831	India eastward to northern Australia
Artrolepis filicauda (Günther 1880)	Northern Western Australia, Northern Territory, Queensland, New South Wales, eastern Victoria, northern Tasmania, and southern Papua New Guinea
Brachaluteres fahaqa Clark and Gohar 1953	Red Sea
Brachaluteres jacksonianus (Quoy and Gaimard 1824)	Southern Western Australia, South Australia, Victoria, Tasmania, and New South Wales
Brachaluteres taylori Woods in Schultz et al. 1966	Indonesia eastward to Papua New Guinea and eastern Australia, northward to Philippines
Brachaluteres ulvarum Jordan and Fowler 1902	Japan
Cantherhines cerinus Randall 2011	Philippines
Cantherhines dumerilii (Hollard 1854)	East Africa, Mozambique Channel, Comores and Mascarenes, north to southern Japan, Ogasawara Islands and Hawaiian Islands, south to New Caledonia, Lord Howe Island, Rapa and Ducie (Pitcairn Group). East to Central America
Cantherhines fronticinctus (Günther in Playfair and Günther 1867)	East Africa eastward through Indonesia to New Caledonia, northward to southern Japan
Cantherhines longicaudus Hutchins and Randall 1982	Tahiti, Cook Islands, New Caledonia, and Tuamotu Islands
Cantherhines macroceros (Hollard in Guichenot 1853)	Western Atlantic and St. Paul's Rocks, Cape Verde Islands
Cantherhines multilineatus (Tanaka 1918)	Eastern Indian Ocean, South China Sea, and Japan
Cantherhines nukuhiva Randall 2011	Marquesas Islands and Tuamotu Archipelago
Cantherhines pardalis (Rüppell 1837)	Red Sea, East Africa eastward through northern Australia to Marquesas and Pitcairn islands, northward to southern Japan
Cantherhines pullus (Ranzani 1842)	Massachusetts and Bermuda to Brazil, also recorded from West Africa
Cantherhines rapanui (de Buen 1963)	Easter Island
Cantherhines sandwichiensis (Quoy and Gaimard 1824)	Hawaiian Islands, Johnston Island, and Cook Islands
Cantherhines verecundus Jordan 1925	Hawaiian Islands
Cantheschenia grandisquamis Hutchins 1977	Western Australia, New South Wales, and Lor Howe Island
Cantheschenia longipinnis (Fraser-Brunner 1941c)	Southern Western Australia and northern New South Wales
Chaetodermis penicilligerus (Cuvier 1816)	Indonesia east ward to northern Australia, northward to southern Japan
Colurodontis paxmani Hutchins 1977	Northern Australia
Enigmacanthus filamentosus Hutchins 2002	Seychelles and Marshall Islands
Eubalichthys bucephalus (Whitley 1931)	Southern Western Australia, South Australia, Tasmania, and southern New South Wales

Table 4 continued

Species	Distribution
Eubalichthys caeruleoguttatus Hutchins 1977	Northern Western Australia
Eubalichthys cyanoura Hutchins 1987	Southern Western Australia and South Australia
Eubalichthys gunnii (Günther 1870)	Eastern South Australia, Victoria, and Tasmania
Eubalichthys mosaicus (Ramsay and Ogilby 1886)	Southern Western Australia, South Australia, Victoria, Tasmania, New South Wales, and southern Queensland
Eubalichthys quadrispinis Hutchins 1977	Southern Western Australia and South Australia
Lalmohania velutina Hutchins 1994b	Southeastern India
Meuschenia australis (Donovan 1824)	Eastern South Australia, Victoria, and Tasmania
Meuschenia flavolineata Hutchins 1977	Southern Western Australia, South Australia, Victoria, Tasmania, and southern New South Wales
Meuschenia freycineti (Quoy and Gaimard 1824)	Southern Western Australia, South Australia, Tasmania, and southern New South Wales
Meuschenia galii (Waite 1905)	Southern Western Australia, South Australia, and western Victoria
Meuschenia hippocrepis (Quoy and Gaimard 1824)	Southern Western Australia, South Australia, Victoria, and northeastern Tasmania
Meuschenia scaber (Forster in Bloch and Schneider 1801)	Southern Western Australia, South Australia, Tasmania, and southern New South Wales
Meuschenia trachylepis (Günther 1870)	New South Wales and Queensland
Meuschenia venusta Hutchins 1977	Southern Western Australia, South Australia, Tasmania, and southern New South Wales
Monacanthus chinensis (Osbeck 1765)	West Pacific northward to southern Japan and southward to Victoria
Monacanthus ciliates (Mitchill 1818)	Newfoundland and Bermuda to the Antilles
Nelusetta ayraud (Quoy and Gaimard 1824)	Southern Western Australia, South Australia, Victoria, northern Tasmania, New South Wale, and southern Queensland
Oxymonacanthus halli Marshall 1952	Red Sea
Oxymonacanthus longirostris (Bloch and Schneider 1801)	East Africa eastward through northern Australia to Samoa, northward to southern Japan
Paraluteres arqat Clark and Gohar 1953	Red Sea
Paraluteres prionurus (Bleeker 1851b)	East Africa eastward through Indonesia to Nieu, northward to southern Japan
Paramonacanthus arabicus Hutchins 1997	Arabian Gulf
Paramonacanthus choirocephalus (Bleeker 1853)	Thailand eastward through Indonesia to Papua New Guinea
Paramonacanthus frenatus (Peters 1855)	East Africa and Seychelles
Paramonacanthuys lowei Hutchins 1997	Eastern Australia
Paramonacanthus matsuurai Hutchins 1997	Ogasawara Islands
Paramonacanthus nematophorus (Günther 1870)	Red Sea, East Africa, and Seychelles
Paramonacanthus oblongus (Temminck and Schlegel 1850)	Indonesia through northern Australia to New Caledonia, northward to southern Japan
Paramonacanthus otisensis Whitley 1931	Eastern Australia
Paramonacanthus pusillus (Rüppell 1828)	Red Sea, East Africa eastward through Indonesia to northern Australia, northward to southern Japan
Paramonacanthus sulcatus (Hollard 1854)	Malaysia, Indonesia, Thailand, Taiwan, and China
Paramonacanthus tricuspis (Hollard 1854)	India eastward to west coast of Thailand
Pervagor alternans (Ogilby 1899)	Eastern Australia, Lord Howe Island, New Caledonia, and Marshall Islands
Pervagor aspricaudus (Hollard 1854)	Mauritius eastward to Marshall Islands, Hawaiian Islands, and New Caledonia, northward to southern Japan
Pervagor janthinosoma (Bleeker 1854)	East Africa eastward through Indonesia to Fiji and Tonga, northward to southern Japan
Pervagor marginalis Hutchins 1986a	Marquesas Islands and Line Islands
Pervagor melanocephalus (Bleeker 1853)	Indonesia eastward through northern Australia to Samoa, northward to southern Japan
Pervagor nigrolineatus (Herre 1927)	Indonesia eastward through Papua New Guinea to Solomon Islands, northward to southern Japan
Pervagor randalli Hutchins 1986a	Red Sea

Table 4 continued

Species	Distribution
Pervagor spilosoma (Lay and Bennett 1839)	Hawaiian Islands
Pseudalutarius nasicornis (Temminck and Schlegel 1850)	East Africa eastward through northern Australia to New Caledonia, northward to southern Japan
Pseudomonacanthus elongatus Fraser-Brunner 1940	Australia
Pseudomonacanthus macruru (Bleeker 1856)	Singapore, Malaysia, Brunei, Indonesia, Philippines, and Japan
Pseudomonacanthus peroni (Hollard 1854)	Australia and New Guinea
Pseudomonacanthus tweediei Fraser-Brunner 1940	Singapore
Rudarius ercodes Jordan and Fowler 1902	Japan, Korea, and China
Rudarius excelsus Hutchins 1977	Malaysia (Sabah), Papua New Guinea, Queensland, and Ryukyu Islands
Rudarius minutus Tyler 1970	Malaysia (Sabah), Indonesia, Palau, and Great Barrier Reef
Scobinichthys granulatus (Shaw in White 1790)	Southern Western Australia, South Australia, Victoria, northern Tasmania, New South Wale, and southern Queensland
Stephanolepis auratus (Castelnau 1861)	Eastern Western Australia, South Australia, Victoria, and Tasmania
Stephanolepis cirrhifer (Temminck and Schlegel 1850)	Japan, Korea, Taiwan, China, and northern Philippines
Stephanolepis diaspros Fraser-Brunner 1940	Red Sea, Gulf of Oman, and Persian Gulf
Stephanolepis hispidus (Linnaeus 1766)	Both sides of Atlantic: western Atlantic from Nova Scotia and Bermuda to Brazil; eastern Atlantic from Canary Islands to Angola
Stephanolepis setifer (Bennett 1831)	North Carolina and Bermuda to northern South America
Thamnaconus analis (Waite 1904)	Southwestern Pacific
Thamnaconus arenaceus (Barnard 1927)	Western Indian Ocean
Thamnaconus degeni (Regan 1903)	Tasmania, Victoria and South Australia
Thamnaconus fajardoi Smith 1953	Mozambique Channel, Madagascar, western Mascarenes
Thamnaconus fijiensis Hutchins and Matsuura 1984	Fiji
Thamnaconus garretti (Fowler 1928)	Hawaiian Islands
Thamnaconus hypargyreus (Cope 1871)	Western Pacific and southeastern Indian Ocean
Thamnaconus melanoproctes (Boulenger 1889)	Muscat, Oman, Gulf of Oman, Arabian Sea, northwestern Indian Ocean
Thamnaconus modestoides (Barnard 1927)	Red Sea, Indo-West Pacific: East Africa, South Africa, Seychelles, Madagascar and Réunion (Mascarenes) east to Indonesia, north to southern Japan, south to northwestern Australia
Thamnaconus modestus (Günther 1877)	Japan, Korea, China
Thamnaconus paschalis (Regan 1913)	Easter Island and southeastern Pacific
Thamnaconus septentrionalis (Günther 1874)	China, East China Sea, and Japan
Thamnaconus tessellatus (Günther 1880)	Western Pacific and southeastern Indian Ocean

(Hutchins 1977) where the greatest diversity of filefishes is found (Hutchins 2001a).

Before Hutchins' (1977) review of Australian filefishes appeared, Fraser-Brunner (1941a) published a review paper on the Monacanthidae (his Aluteridae), recognizing 22 genera. Although de Beaufort and Briggs (1962) lumped *Amanses* Gray 1835, *Chaetodermis* Swainson 1839, *Paramonacanthus* Bleeker 1865–1869, *Pervagor* Whitley 1930a, and *Pseudomonacanthus* Bleeker 1865 into a single genus, *Monacanthus* Linnaeus 1758, they recognized *Aluterus* Cloquet 1816, *Anacanthus* Gray 1830 (their

Psilocephalus Swainson 1839), *Paraluteres* Bleeker 1865, and *Pseudalutarius* Bleeker 1865 as distinctive genera. Berry and Vogele (1961) reviewed nine species of the Monacanthidae of the western North Atlantic with detailed accounts of *Amanses pullus* (Ranzani 1842), *Aluterus monoceros* (Linnaeus 1758), *Aluterus heudelotii* Hollard 1855, *Aluterus schoepfi* (Walbaum 1792), *Aluterus scriptus* (Osbeck 1765), *Monacanthus ciliatus* (Mitchill 1818), *Monacanthus tuckeri* Bean 1906, *Stephanolepis hispidus* (Linnaeus 1758), and *Stephanolepis setifer* (Bennett 1831). Although Berry and Vogele (1961) placed *Monacanthus*

pullus in the genus *Amanses*, they also pointed out that *M. pullus* should be classified in the subgenus *Cantherhines* Swainson 1839 because *M. pullus* does not have a patch of long spines on the mid-side of the body between the dorsal and anal fins, which is a diagnostic character of *Amanses*. When Randall (1964) reviewed the filefish genera *Amanses* (monotypic) and *Cantherhines*, he recognized 11 species of *Cantherhines* in the tropical seas of the world. He showed that *Amanses* possesses a patch of long stout spines (male) or a dense brushlike mass of long setae (female) on the mid-side of the body, whereas all species of *Cantherhines* lack long spines or long setae on the mid-side of the body. Randall (1964) described *Cantherhines tiki* as a new species based on a single specimen collected from Easter Island. *Cantherhines tiki* was said to be distinguishable from other species of *Cantherhines* by its strongly produced snout (Randall 1964). However, Caldwell and Randall (1967) showed *Cantherhines tiki* to be a junior synonym of *Cantherhines rapanui* (de Buen 1963) because of the considerable variation in the snout shape of *Cantherhines rapanui*.

Hutchins (1977) described three new genera, *Bigener*, *Cantheschenia* and *Colurodontis*, and eight new species from Australia. However, Hutchins (1994a) subsequently placed *Aleuterius brownii* Richardson 1848, the type species of *Bigener*, in *Acanthaluteres* Bleeker 1865, making *Bigener* a junior synonym of *Acanthaluteres*. Hutchins and Randall (1982) reviewed the *Cantherhines fronticinctus* complex and described *Cantherhines longicaudus* as a new species from Tahiti and Rarotonga. Matsuura (1984) provided brief accounts and color photographs of 26 monacanthids found in Japanese waters. Hutchins and Matsuura (1984) described *Thamnaconus fijiensis* from Fiji. In the following year, Hutchins (1985) reviewed the genus *Brachaluteres* Bleeker 1865 and recognized four species with comments on their ability to inflate the abdomen. Hutchins (1986a) published a revision of the genus *Pervagor* and recognized eight species including two new species, *Pervagor randalli* and *Pervagor marginalis*. Hutchins (1986b) provided a key and brief taxonomic accounts for 16 species of filefishes found along South Africa. Hutchins (1987) published *Eubalichthys cyanoura* as a new species from South Australia. Hutchins (1994b) described and illustrated *Lalmohania velutina* from India as a new genus and species. Hutchins (2002) reported another new genus and species, *Enigmacanthus filamentosus*, from the Seychelles and Marshall Islands. *Enigmacanthus filamentosus* is a very small filefish, 27–36 mm SL, resembling in size species of the genus *Rudarius*. Randall (2011) again reviewed the genus *Cantherhines*, recognizing 11 species, including two new species, *Cantherhines cerinus* from the Philippines and *Cantherhines nukuhiva* from the Marquesas Islands.

Based on the contributions shown above, I recognize 102 species in 27 genera worldwide (Table 4). I provisionally place *Pseudomonacanthus multilineatus* Tanaka 1918 in the genus *Cantherhines* following previous authors (Matsuura 1984; Kyushin et al. 1977; Lindberg et al. 1997). Although Randall (1964) placed *Pseudomonacanthus multilineatus* in *Cantherhines*, Hutchins and Randall (1982) said that *Cantherhines multilineatus* should be classified in the genus *Thamnaconus* Smith 1949b. However, they did not provide characters to justify the transfer from *Cantherhines* to *Thamnaconus*. To resolve the taxonomic status of *Cantherhines multilineatus*, a detailed study of diagnostic characters, including encasing scales of the posterior end of the pelvis, is needed. Hutchins suggested in his dissertation that *Thamnaconus melanoproctes* (Boulenger 1889) is a senior synonym of *Pseudomonacanthus multilineatus*. However, an examination of specimens from various localities in the Indo-West Pacific is necessary to properly access the relationships of the two nominal species. Although Barry Hutchins made great contributions to the better understanding of taxonomy and diversity of filefishes, in particular Australian filefishes, taxonomic problems in several genera such as *Acreichthys* Fraser-Brunner 1941c, *Pseudomonacanthus*, and *Thamnaconus* remain. As in the case of triggerfishes, many checklists and illustrated guidebooks have provided much useful information on the taxonomy, distribution, and biology of filefishes (see the section on the Balistidae).

Aracanidae (Trunkfishes, Fig. 1e; Table 5)

Trunkfishes of the family Aracanidae occur in shallow to relatively deep waters in depths from 5 m to 300 m. The species of *Aracana* Gray 1833, *Anoplocapros* Kaup 1855, *Caprichthys* McCulloch and Waite 1915, *Capropygia* Kaup 1855 and *Polyplacapros* Fuji and Uyeno 1979 are found in temperate seas of southern Australia, whereas species of *Kentrocapros* Kaup 1855 are known from deep waters in the warm, tropical regions of the Indo-Pacific (Matsuura and Yamakawa 1982; Matsuura and Tyler 1997; Matsuura 2006, 2008).

Trunkfishes differ externally from other families of Tetraodontiformes by the following combination of characters: body almost completely encased in a bony shell or carapace formed of enlarged, thickened scale plates, usually hexagonal in shape and firmly sutured to one another; isolated bony plates on caudal peduncle; carapace triangular or hexagonal in cross section, with openings for mouth, eyes, gill slit, pectoral, dorsal, and anal fins, and for the flexible caudal peduncle; scale plates often with surface granulations and prolonged in some species into prominent

Table 5 Distributions of 13 species of the Aracanidae in the world

Species	Distribution
Anoplocapros amygdaloides Fraser-Brunner 1941d	Western Australia and South Australia
Anoplocapros inermis (Fraser-Brunner 1935b)	Southern Queensland, New South Wales and Victoria
Anoplocapros lenticularis (Richardson 1841)	Western Australia, South Australia and Victoria
Aracana aurtia (Shaw in Shaw and Nodder 1798)	Western Australia, South Australia, Victoria, Tasmania, and New South Wales
Aracana ornata (Gray 1838)	Western Australia, South Australia, Victoria, and Tasmania
Caprichthys gymnura McCulloch and Waite 1915	Western Australia and South Australia
Capropyguia unistriata (Kaup 1855)	Western Australia, South Australia, and Victoria
Kentrocapros aculeatus (Houttuyn 1782)	Japan, Korea, China, and Hawaiian Islands
Kentrocapros eco Phillipps 1932	New Zealand
Kentrocapros flavofasciatus (Kamohara 1938)	Japan, New South Wales, Queensland, and New Caledonia
Kentrocapros rosapinto (Smith 1949a)	Western Indian Ocean
Kentrocapros spilonota (Gilbert 1905)	Hawaiian Islands
Polyplacapros tyleri Fujii and Uyeno 1979	New South Wales and Norfolk Ridge

carapace spines over the eyes or along ventrolateral or dorsolateral angles of the body; mouth small, terminal, with fleshy lips; teeth of moderate size, conical, usually fewer than 15 in each jaw; gill opening moderately short, a vertical to oblique slit in front of pectoral-fin base; spinous dorsal fin absent; most dorsal-, anal-, and pectoral-fin rays branched; caudal fin with nine branched rays; pelvic fins absent (Matsuura 2001).

The Aracanidae and Ostraciidae have been placed in separate families by some authors (e.g., Winterbottom 1974; Tyler 1980; Matsuura 1984, 2001), but they have also been treated as two subfamilies of the family Ostraciidae by others (e.g., Winterbottom and Tyler 1983; Klassen 1995; Allen et al. 2006; Nelson 2006; Matsuura 2008). All the above authors recognized the two groups as closely related phylogenetic clades (sister groups), but placed them at different taxonomic ranks. Santini and Tyler (2003) studied fossils and extant members of the Tetraodontiformes extensively and recognized familial groupings for the Aracanidae and Ostraciidae. Recently, Santini et al. (2013a) investigated the phylogenetic relationships of the Aracanidae and Ostraciidae based on molecular analysis of many taxa (nine species of five genera of Aracanidae and 17 species of six genera of Ostraciidae). They demonstrated that the species examined in their studies (Santini and Tyler 2003; Santini et al. 2013a) have adequate characteristics to recognize two separate groups at the family level.

A problem exists with the spelling of the genus *Aracana*. When Gray (1833) published his article on Indian zoology, he used two different spellings for a species of trunkfish. At the beginning of the article, a section titled "Directions for arranging the plates" provided the name of animals in the plates where he presented the name of

the trunkfish as "Many Spined Coffin Fish. *Ostracion (Acerana) auritus*"; however, the legend of plate 98 spelled the name as "*Ostracion (Acarana) auritus*." Plate 98 provided a good illustration of the species showing appropriate characters to identify the species. It is the type species of the subgenus by monotypy. However, in 1838 John E. Gray published another paper in which he described three species, *Ostracion (Aracana) ornata, Ostracion (Aracana) flavigaster,* and *Ostracion (Aracana) lineata*. The second species is a junior synonym of *Aracana ornata* and the third *Aracana aurita* (Shaw *in* Shaw and Nodder 1798). Gray (1838) stated for his three species that "I have formed a subgenus under the name of *Aracana*" indicating his intention to establish the group at the subgeneric level. Although the name *Aracana* has long been used for the trunkfish genus, the two names *Acerana* and *Acarana* were published earlier than *Aracana,* thus creating a nomenclatural problem. If one follows the priority rule of the Code (ICZN 1999), the family name should be Aceranidae or Acaranidae. As *Aracana* has been used almost universally in the literature, with *Acerana* or *Acarana* virtually ignored by taxonomists, *Aracana* should be preserved under Article 33.3.1 of the Code, making the spelling of the family group name Aracanidae preserved under Article 35.4.1.

Trunkfishes have not yet been comprehensively reviewed. Although Fraser-Brunner (1935b, 1941d) provided brief reviews of the family, his accounts of genera and species were cursory as they were based on few specimens and did not provide adequate characteristics for the species treated. Kuiter (1994) and Matsuura (2008) diagnosed and illustrated seven species in four genera of Australian aracanids, covering many representatives of the family except for the genera *Kentrocapros* and

Fig. 2 *Kentrocapros eco*
(NMNZ P.903, 102 mm TL,
from Pahia, Bay of Islands, New
Zealand; **a** lateral view; **b** dorsal
view) and an undescribed
species of *Kentrocapros*
(**c** NSMT-P 43344, 104 mm SL)
collected from New Zealand
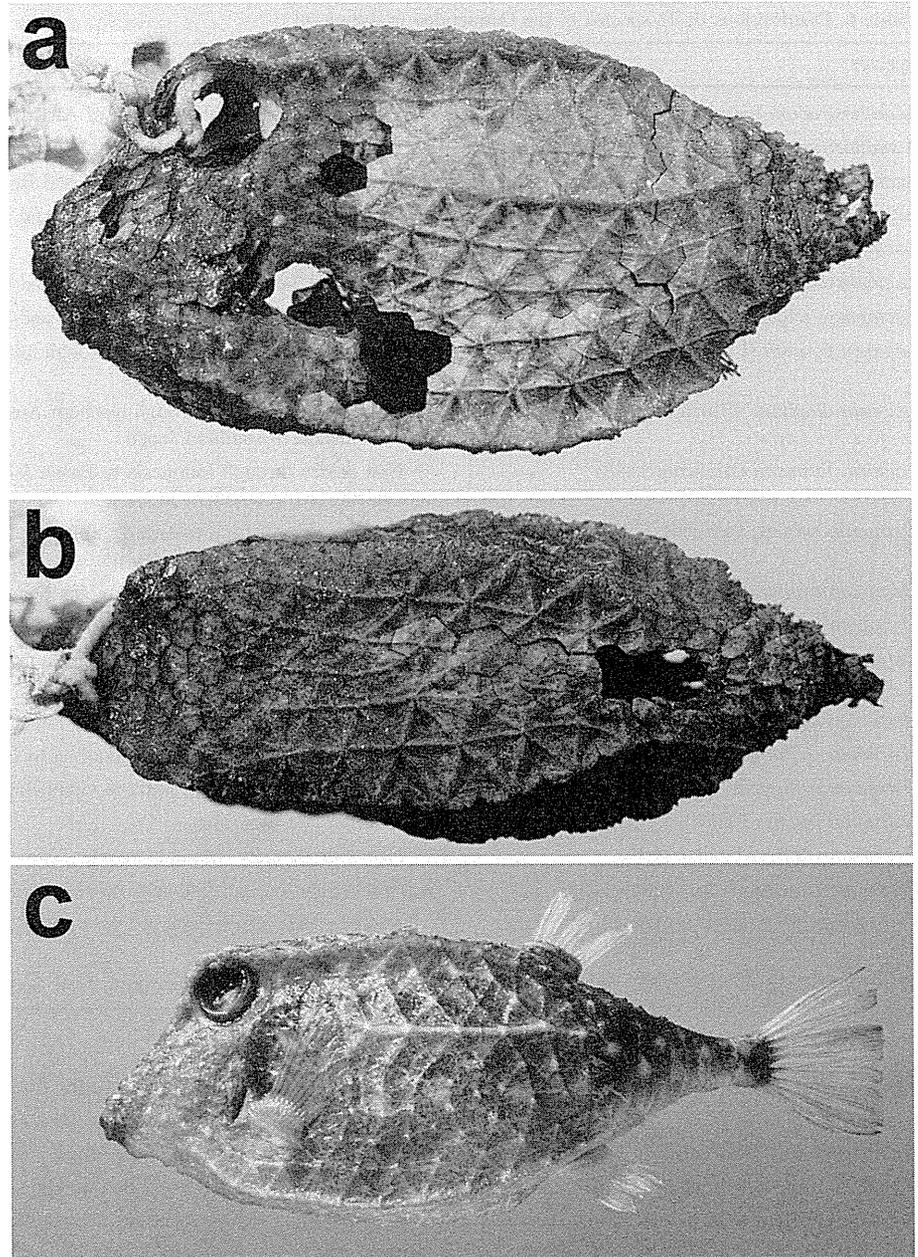
Polyplacapros. *Polyplacapros tyleri* Fujii and Uyeno 1979 is unique in having a fusiform body and the caudal peduncle nearly completely covered by discrete bony plates. In addition to Australian genera of Aracanidae, detailed descriptions and illustrations of all four known species of *Kentrocapros* were provided by Matsuura and Yamakawa (1982), Matsuura and Tyler (1997), and Matsuura (2006). Matsuura (1990) provided brief accounts and a color photograph of a species of *Kentrocapros* collected from the Tasman Sea (32°43′S, 167°30′E) under the name *Kentrocapros eco* (Phillipps 1932). However, an examination of the holotype (102 mm TL) of *Ostracion eco*

(NMNZ P. 903) revealed Matsuura's (1990) Tasman Sea material to be an undescribed species (Fig. 2). This undescribed species has a spine on the dorsolateral ridge midway between the eye and the dorsal-fin origin, whereas the holotype of *O. eco* lacks this spine. This new species will be described and published elsewhere.

As discussed above, no major taxonomic problems remain in the Aracanidae. However, there still remains a need to clarify the nomenclature of some species of *Anoplocapros* as well as the intraspecific variation of morphological characters related to ontogenetic development of *Kentrocapros*.

**Table 6** Distributions of 22 species of the Ostraciidae in the world

Species	Distribution
Acanthostracion guineensis Bleeker 1865	Eastern Atlantic on West Coast of Africa from Guinea to Gabon
Acanthostracion notacanthus Bleeker 1863	Eastern Atlantic from St. Helena, Ascension and Azores islands, Ghana and Angola
Acanthostracion polygonius Poey 1876	Western Atlantic from New Jersey and Bermuda to Brazil
Acanthostracion quadricornis (Linnaeus 1758)	Western Atlantic from Massachusetts and Bermuda to Brazil
Lactophrys bicaudalis (Linnaeus 1758)	Western Atlantic from Florida to Brazil
Lactophrys trigonus (Linnaeus 1758)	Western Atlantic from Massachusetts and Bermuda to Brazil
Lactophrys triqueter (Linnaeus 1758)	Western Atlantic from Massachusetts and Bermuda to Brazil
Lactoria cornuta (Linnaeus 1758)	Red Sea, East Africa eastward through northern Australia to Marquesas Islands, northward to southern Japan
Lactoria diaphana (Bloch and Schneider 1801)	East Africa eastward through northern Australia to Hawaiian and Marquesas islands, northward to southern Japan
Lactoria fornasini (Bianconi 1846)	East Africa through Indonesia to Easter Island, southward to New South Wales, northward to southern Japan
Ostracion cubicus Linnaeus 1758	Red Sea, East Africa eastward through northern Australia to Tuamotu Islands (stray found in Hawaiian Islands), northward to southern Japan
Ostracion cyanurus Rüppell 1828	Red Sea, Gulf of Oman, and Arabian Sea
Ostracion immaculatus Temminck and Schelgel 1850	Japan, Korea, China, and East China Sea
Ostracion meleagris Shaw in Shaw and Nodder 1796	East Africa eastward through Indonesia to Hawaiian and Pitcairn islands, northward to southern Japan
Ostracion nasus Bloch 1785	India eastward through Indonesia to Papua New Guinea, northward to Philippines
Ostracion rhinorhynchos Bleeker 1851a	Sri Lanka eastward through Indonesia to Queensland, northward to southern Japan
Ostracion solorensis Bleeker 1853	Philippines through Indonesia to Great Barrier Reef
Ostracion trachys Randall 1975	Réunion and Mauritius
Ostracion whitleyi Fowler 1931	Hawaiian, Society, Marquesas, and Tuamotu islands
Tetrosomus concatenatus (Bloch 1785)	East Africa through Indonesia to New South Wales, northward to southern Japan
Tetrosomus gibbosus (Linnaeus 1758)	Red Sea, East Africa eastward through northern Australia to New Caledonia, northward to southern Japan
Tetrosomus reipublicae (Ogilby 1913)	East Africa through Indonesia to New South Wales, northward to southern Japan

Ostraciidae (Boxfishes, Fig. 1f; Table 6)

Boxfishes of the family Ostraciidae occur in shallow tropical and warm seas of the world. Boxfishes differ externally from other families of Tetraodontiformes by the following combination of characters: body almost completely encased in a bony shell or carapace formed of enlarged, thickened scale plates, usually hexagonal in shape and firmly sutured to one another; no isolated bony plates on caudal peduncle; carapace triangular, rectangular, or pentangular in cross section, with openings for mouth, eyes, gill slits, pectoral, dorsal, and anal fins, and for the flexible caudal peduncle; scale-plates often with surface granulations, which are prolonged in some species into prominent carapace spines over the eye or along the ventrolateral or dorsal angles of the body; mouth small, terminal, with fleshy lips; teeth moderate, conical, usually fewer than 15 in each jaw; gill opening, a moderately short, vertical to oblique slit in front of pectoral-fin base; spinous dorsal fin absent; most dorsal-, anal-, and pectoral-fin rays

branched; caudal fin with eight branched rays; pelvic fins absent (Matsuura 2001).

Fraser-Brunner (1935b) published a brief review of the Aracanidae and Ostraciidae, recognizing six genera in the Ostraciidae: *Acanthostracion* Bleeker 1865, *Lactophrys* Swainson 1839, *Lactoria* Jordan and Fowler 1902, *Ostracion* Linnaeus 1758, *Rhinesomus* Swainson 1839, and *Rhynchostracion* Fraser-Brunner 1935b. Boxfishes found in the Indo-Australian Archipelago were studied by de Beaufort and Briggs (1962) who lumped Fraser-Brunner's (1935b) Indo-Pacific genera into the genus *Ostracion*. However, they recognized five subgenera in *Ostracion*: *Lactoria*, *Ostracion*, *Rhynchostracion*, *Tetrosomus* Swainson 1839, and *Triorus* Jordan and Hubbs 1925. *Triorus* is a junior synonym of *Tetrosomus* because the type species of the former, *Lactophrys tritropis* Snyder 1911, is a junior synonym of *Tetrosomus concatenatus* (Bloch 1786) (see Randall et al. 1997). Although *Ostracion nasus* Bloch 1785 and *Ostracion rhinorhynchos* Bleeker 1851a have been placed in the genus *Rhynchostracion* by some authors

Acanthostracion bucephalus
HOLOTYPE

IB. 6355   15 mm
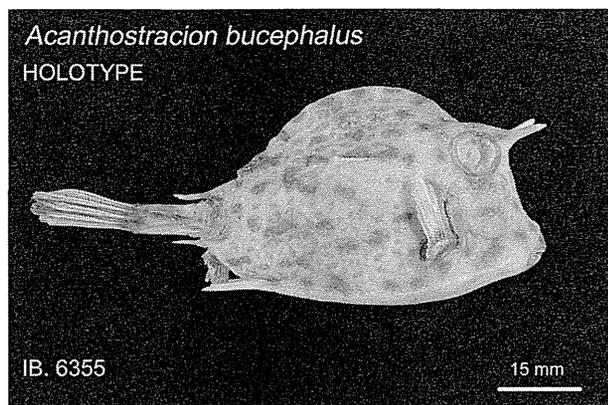
Fig. 3 Holotype of *Acanthostracion bucephalus* (AMS IB.6355) collected from Queensland, Australia. Photograph provided by Mark McGrouther

(Kyushin et al. 1982; Gloerfelt-Tarp and Kailola 1984; Sainsbury et al. 1984; Mohsin and Ambak 1996; Randall et al. 1997; Allen et al. 2006), they were classified in the genus *Ostracion* by other authors (Klassen 1995; Matsuura 2001; Hayashi and Hagiwara 2013). When Fraser-Brunner (1935b) established *Rhynchostracion*, he differentiated it from other ostraciid genera by the degree of the development of the dorsal ridge, the convexity of the dorsal surface of the carapace, and the projection of the snout anterior to the mouth. However, the two characters involving the carapace do not clearly differentiate *Rhynchostracion* from other ostraciids and the snout of *Ostracion nasus*, the type species of *Rhynchostracion*, protrudes anteriorly beyond the mouth in adults but not juveniles. In addition, large adults of *Ostracion cubicus* Linnaeus 1758 have a snout protruding to some extent beyond the mouth. These factors led Matsuura (2001) to place *O. nasus* and *O. rhinorhynchos* in their own genus in his key and brief accounts of ostraciids found in the western central Pacific. Klassen (1995) studied osteological characters of many species of the Ostraciidae extensively and provided evidence that *Rhynchostracion* is a junior synonym of *Ostracion*. Klassen (1995) also regarded *Tetrosomus* as a junior synonym of *Lactoria* because all species of *Lactoria* and *Tetrosomus* examined by him formed a single clade. If Klassen's (1995) proposal is accepted, *Lactoria* should be a junior synonym of *Tetrosomus* because the latter has priority over the former. However, it seems premature to accept his proposal because there are species-level taxonomic problems in several species of *Tetrosomus* (Allen and Erdman 2012).

Tyler (1965) revised the genus *Acanthostracion* in the Atlantic and recognized four species, *Acanthostracion guineensis* Bleeker 1865, *Acanthostracion notacanthus* (Bleeker 1863), *Acanthostracion polygonus* Poey 1876, and *Acanthostracion quadricornis* (Linnaeus 1758).

Böhlke and Chaplin (1968) provided keys and accounts accompanied by illustrations to boxfishes found in the western Atlantic. They recognized five species, *A. polygonus*, *A. quadricornis*, *Lactophrys bicaudalis* (Linnaeus 1758), *Lactophrys trigonus* (Linnaeus 1758), *Lactophrys triqueter* (Linnaeus 1758). *Lactophrys bicaudalis* and *L. triqueter* were placed in the genus *Rhinesomus* by Matsuura (2003b) and McEachran and Fechhelm (2005). However, Klassen (1995) argued that *L. bicaudalis*, *L. triqueter*, and *L. trigonus* are nested in a single clade on the basis of his extensive osteological analysis; I agree with this. *Acanthostracion quadricornis* is common in the western Atlantic, but strays were recorded from waters off South Africa (Tyler 1965). Whitley (1965) described *Acanthostracion bucephalus* on the basis of a specimen from Queensland, Australia. However, there seems little doubt that it is actually *A. quadricornis* (Fig. 3). The record of *A. quadricornis* from Australia may suggest that the specimen was transferred by ballast water from a ship or released from an aquarium. As with the Balistidae, many checklists and illustrated guidebooks have provided a great deal of information on the taxonomy, distribution, and biology of boxfishes (see the section on the Balistidae). On the basis of the above overview, I recognize 22 species in the Ostraciidae (Table 6). However the relationships of *T. concatenatus* and *T. reipublicae* need to be examined in detail based on a comparison of a large selection of specimens including the types from various localities of the Indo-West Pacific to better understand the morphological variations observed in *T. reipublicae* (Fig. 4).

Triodontidae (Threetooth puffer, Fig. 1g)

The family Triodontidae is represented by a single extant species, *Triodon macropterus* Lesson 1831, but several fossil taxa referred to this genus date back to the Eocene (see Tyler and Patterson 1991). The family differs externally from others of the order Tetraodontiformes by the following combination of characters: body moderately elongate and moderately compressed, with a very large ventral flap that may be extended downward by a rotation of the long, shaft-like pelvis; jaws modified to form a beak of three heavy, massive teeth, two on the upper jaw and one on the lower jaw; two rudimentary dorsal-fin spines present or absent; and caudal fin deeply forked (Matsuura 2001).

Triodon macropterus is rare in museum collections and poorly known. It is a deep-water species collected at depths of 50–377 m (Kyushin et al. 1977; Matsuura and Tyler 1997). When Tyler (1967) redescribed *T. macropterus* in detail, only 20 specimens were available for his study: five from the Indian Ocean (Mauritius, Reunion and India) and 15 from the West Pacific (Indonesia, Philippines and

Fig. 4 Two forms of
Tetrosomus reipublicae
collected from the Ryukyu
Islands (**a**, **b**) and Kochi, Japan
(**c**). **a** Deep body with no blue
lines (BSKU 29663); **b**,
c slender body with wavy blue
lines (**b** BSKU 29697; **c** BSKU
59588)
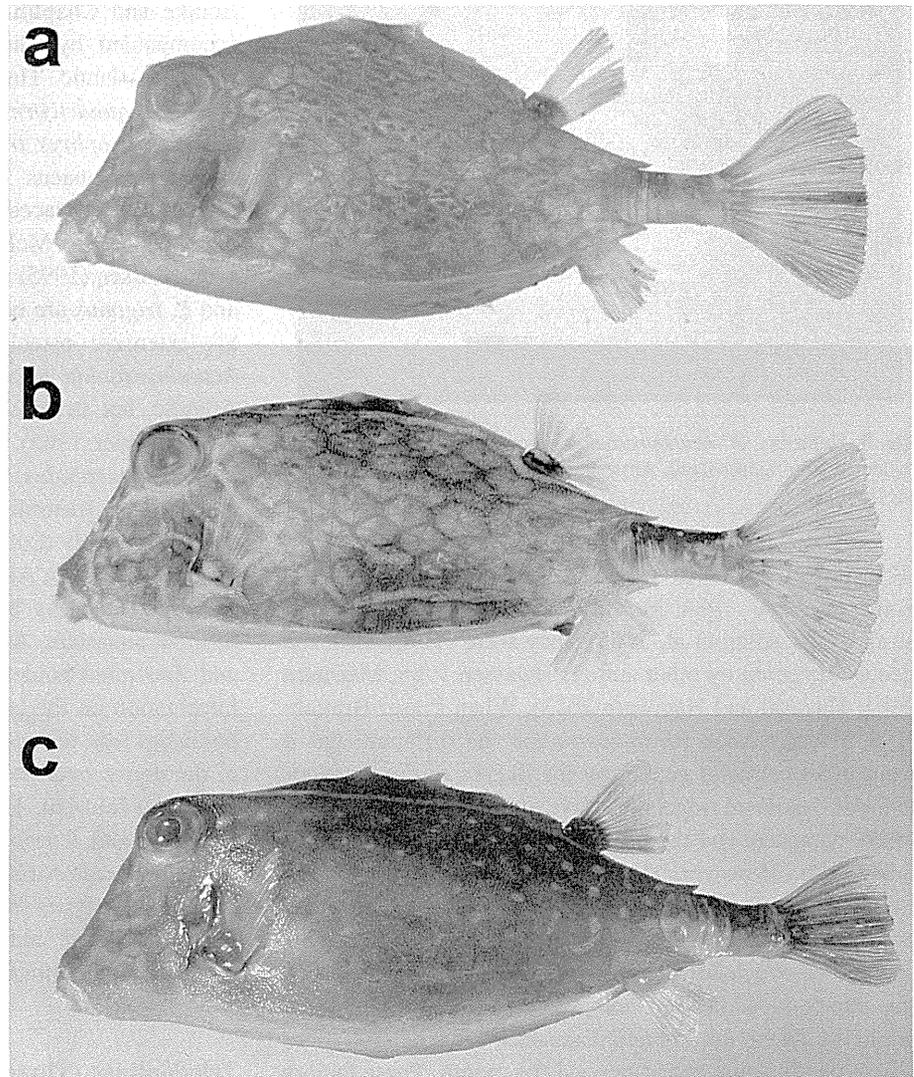
Japan). Due to the poor condition of two specimens, Tyler (1967) used 18 specimens to determine whether the first dorsal fin, composed of one or two spines, is present or absent. His examination revealed 12 specimens from the West Pacific to have a first dorsal fin, and five Indian Ocean specimens and a specimen from the West Pacific to lack a

first dorsal fin (Table 7). However, he did not find other differences between the Indian Ocean specimens and those from the West Pacific. This led him to recognize the two groups as being conspecific. I have recently had the opportunity of examining 28 specimens of *T. macropterus*, nine from the Indian Ocean and 19 from the West Pacific (see Appendix). My examination revealed that the first dorsal fin to be absent in the nine specimens from the Indian Ocean, and present in the 19 specimens from the West Pacific (Table 7). Tyler (1967) also provided frequency distributions of fin-ray counts. My examination of 28 specimens produced almost the same frequency distributions of fin-ray counts as those of Tyler (1967), except for a count of 17 fin rays on the right side pectoral fin in a single specimen (Table 8).

Since Tyler's (1967) redescription was published, *T. macropterus* was reported (with color photographs) from several areas in the Indo-West Pacific: the Chagos

Table 7 Presence or absence of first dorsal fin (two spines) in *Triodon macropterus*. Tyler (1967) showed that a specimen (448.3 mm SL) collected from the Volcano Islands, south of the Ogasawara Islands, had a single spine

First dorsal fin		
	Present	Absent
Indian Ocean		9 + 5* = 14
West-Pacific	19 + 12* = 31	1*

* Data from Tyler (1967)

Table 8 Frequency distributions of fin-ray counts in *Triodon macropterus*. Counts of fin rays of damaged or abnormal fins are excluded. Counts of pectoral-fin rays were obtained from fins on both sides

Dorsal-fin rays

	10	11	12
This study	3	24	1
Tyler (1967)	2	14	1
Total	5	38	2

Anal-fin rays

	9	10
This study	8	19
Tyler (1967)	3	12
Total	11	31

Pectoral-fin rays

	14	15	16	17
This study	1	12	41	1
Tyler (1967)	2	7	17	
Total	3	19	58	1

Archipelago (Kyushin et al. 1977), the South China Sea (Kyushin et al. 1982), the Kyushu-Palau Ridge (Okamura et al. 1985), the Timor Sea (Gloerfelt-Tarp and Kailola 1984), and the Japanese Archipelago (Matsuura 1984). Color photographs taken by research staff of the National Museum of Nature and Science show *T. macropterus* to have the following coloration: body yellowish brown dorsally, becoming white ventrally; ventral flap yellow in the ventral four-fifths and white in the proximal one-fifth; a large black ocellus with a narrow white edge in the proximal part of the ventral flap; second dorsal, anal, pectoral, and caudal fins yellow or yellowish brown; when present, membrane of first dorsal fin black (Fig. 1g). In addition to the above reports, *T. macropterus* has been recorded in checklists of fishes from several areas in the West Pacific: the Mariana Islands (Myers and Donaldson 2003), Tonga (Randall et al. 2004), off southern Taiwan (Shao et al. 2008), Northern Territory of Australia (Larson et al. 2013), and northern half of Australia (Hoese et al. 2006). Kim et al. (2005) provided a brief account and a color illustration of *T. macropterus* from Korea.

Johnson and Britz (2005b) reported the smallest known *T. macropterus* (20 mm SL), collected at Wallis and Futuna at a depth of 245–440 m. They provided detailed characters and the visceral anatomy of the early juvenile that differs from adults in having a huge head (45 % SL vs 28.5–32.7 % SL in adults), no ventral flap, and different scale structure. Juveniles also differ from adults in having a very large distended stomach.

Table 9 A list of 27 genera of the Tetraodontidae in the world

Genus	Number of species
Amblyrhynchote Bibron in Duméril 1855	1
Arothron Müller 1841	11
Auriglobus Kottelat 1999	5
Canthigaster Swainson 1839	36
Carinotetraodon Benl 1957	5
Chelonodontops Smith 1958	2
Colomesus Gill 1884	3
Contusus Whitley 1947	2
Dichotomyctere Duméril 1855	6
Ephippion Bibron in Duméril 1855	1
Feroxodon Su, Hardy and Tyler 1986	1
Guentheridia Gilbert and Starks 1904	1
Javichthys Hardy 1985	1
Lagocephalus Swainson 1839	11
Leiodon Swainson 1839	1
Marilyna Hardy 1982a	3
Omegophora Whitley 1934	2
Pao Kottelat 2013	14
Pelagocephalus Tyler and Paxton 1979	2
Polyspina Hardy 1983a	1
Reicheltia Hardy 1982a	1
Sphoeroides Anonymous 1798	20
Takifugu Abe 1949c	25
Tetractenos Hardy 1983a	2
Tetraodon Linnaeus 1758	6
Torquigener Whitley 1930a	20
Tylerius Hardy 1984a	1
Total number of species	184

Tetraodontidae (Pufferfishes, Fig. 1h, Table 9)

Pufferfishes of the family Tetraodontidae usually occur in shallow warm, tropical seas, and freshwaters of the world, although some species may be found at depths over 350 m (Matsuura 1982; Tyler and Matsuura 1997). They differ externally from other families of the order Tetraodontiformes by the following combination of characters: head large and blunt; jaws modified to form a beak of four heavy, powerful teeth, two above and two below; eyes high on head; gill opening, a simple slit in front of pectoral fins; dorsal and anal fins located far posteriorly, containing seven to 15 soft rays; caudal fin truncate, rounded, or emarginate to somewhat lunate; pelvic fins absent; lateral line (when present) often indistinct, forming an interconnected pattern on sides of the head and body, but quite distinct in some genera (e.g., *Lagocephalus* and *Torquigener* Whitley 1930c); typical scales absent, but many spinules often present on back and/or belly, and sometimes on sides (Matsuura 2001).

The Tetraodontidae is the most speciose family in the Tetraodontiformes, including 184 species (Table 9). Because pufferfishes possess very few external characters useful for taxonomy and specimens are easily distorted when they are fixed in formalin and preserved in ethanol, it is often not easy for ichthyologists to recognize species limits and classify them into natural groups. Consequently, they have been poorly studied and taxonomic confusion remains. Although the Tetraodontidae has never been comprehensively reviewed, the taxonomy of pufferfishes has progressed since Fraser-Brunner's (1943) brief review of tetraodontid genera. He classified pufferfishes into 11 genera, *Canthigaster* Swainson 1839, *Lagocephalus*, *Sphoeroides* Anonymous 1798, *Amblyrhynchote* Bibron in Duméril 1855, *Torquigener*, *Colomesus* Gill 1884, *Ephippion* Bibron *in* Duméril 1855, *Tetraodon* Linnaeus 1758, *Arothron* Müller 1841, *Chonerhinos* Bleeker 1854, *Xenoptere* Bibron *in* Duméril 1855, based on osteological characters of the skull, the lateral-line system on the head and body, a skin fold on the ventrolateral side of the body, and spinule distributions on the body. Although Fraser-Brunner (1943) used the spellings *Amblyrhynchotes* and *Xenopterus*, I follow Kottelat's (2001, 2013) *Amblyrhynchote* and *Xenoptere* because Kottelat (2001) showed that *Amblyrhynchotes* and *Xenopterus* of Troschel (1856) are incorrect spellings.

When Alec Fraser-Brunner studied pufferfishes during World War II, Abe (1939, 1942, 1944, 1949a, b, c, 1950, 1952, 1954) independently studied pufferfishes found in Japan and adjacent regions. Abe (1949c) provided keys and accounts of pufferfishes in the seas around Japan. Subsequently, Abe (1952) proposed *Fugu* as a new genus to include five subgenera *Akamefugu*, *Higanfugu*, *Shosaifugu*, *Takifugu*, and *Torafugu,* which had been previously proposed and made available by Abe (1949c, 1950). However, the genus *Fugu* is an objective synonym of the subgenus *Torafugu* Abe 1950, because the type species of these genus group names is *Tetraodon rubripes* Temminck and Schlegel 1850. Matsuura (1990) clarified the nomenclatural problems concerning the genus group names proposed by Abe (1949c, 1950, 1952) and showed that *Takifugu* Abe 1949c is the appropriate generic name for warmwater pufferfishes found mainly around Japan, Korea, and China. As with other tetraodontiform families, de Beaufort and Briggs (1962) lumped Fraser-Brunner's (1943) Indo-Pacific genera, *Amblyrhynchote*, *Lagocephalus*, and *Torquigener* into the genus *Sphoeroides* although they recognized *Canthigaster*, *Chelonodon* Müller 1841, *Chonerhinos*, and *Tetraodon*. As shown by subsequent authors, *Amblyrhynchote*, *Lagocephalus*, and *Torquigener* are distinctive genera.

Marine pufferfishes occurring in warm and tropical regions of the world were studied by many authors from the 1970s to present. Allen and Randall (1977) reviewed *Canthigaster* and described seven new species, bringing the total number of species to 22. Since Allen and Randall's (1977) revisionary study was published, six Indo-Pacific species have been described as new as follows: *Canthigaster leoparda* Lubbock and Allen 1979 from the Indo-West Pacific, *Canthigaster flavoreticulata* Matsuura 1986 from the Tonga Submarine Ridge, South Pacific, *Canthigaster cyanetron* Randall and Cea-Egaña 1989 from Easter Island, *Canthigaster punctata* Matsuura 1992 from the Mascarene Submarine Ridge in the western Indian Ocean, *Canthigaster cyanospilota* Randall, Williams and Rocha 2008 from the Red Sea, and *Canthigaster criobe* Williams, Delrieu-Trottin, Planes 2012 from the Gambier Archipelago in French Polynesia. In addition, Randall et al. (2008) reviewed *Canthigaster coronata* (Vaillant and Sauvage 1875) and recognized *Canthigaster axiologa* Whitley 1931 as a separate species. Although Allen and Randall (1977) synonymized *Canthigaster papua* (Bleeker 1848) with *Canthigaster solandri* (Richardson 1845), Randall (1995) and Allen and Erdman (2012) recognized it as a distinctive species. Moura and Castro (2002) reviewed *Canthigaster* in the Atlantic where many authors recognized only a single species *Canthigaster rostrata* (Bloch 1786). Moura and Castro (2002) extensively studied specimens collected from various localities from both sides of the Atlantic and recognized six species, three of which they described as new: *Canthigaster figueiredoi* from the east coast of South America, *Canthigaster jamestyleri* from the southeast coast of the United States and the Gulf of Mexico, and *Canthigaster supramacula* from the west coast of Africa. The above studies bring the total number of species of *Canthigaster* to 36, making it the largest genus in the Tetraodontidae.

Shipp (1974) reviewed pufferfishes of the Atlantic belonging to *Canthigaster*, *Colomesus* Gill 1884, *Ephippion* Bibron in Duméril 1855, *Lagocephalus*, and *Sphoeroide*. Prior to Shipp's (1974) publication, Tyler (1964) reviewed two species of *Colomesus*, *Colomesus asellus* (Müller and Troschel 1848), and *Colomesus psittacus* (Bloch and Schnedier 1801) in detail. Amaral et al. (2013) described *Colomesus tocantinensis* from the Tocantins River, Brazil. Shipp (1974) recognized 13 species of *Sphoeroides* in the Atlantic and provided a key to the species, along with detailed accounts of all Atlantic species. Walker and Bussing (1996) described the eastern Pacific *Sphoeroides lispus* Walker *in* Walker and Bussing 1996 and *Sphoeroides rosenblatti* Bussing *in* Walker and Bussing 1996 as new species. Prior to Shipp (1974) and Walker and Bussing (1996), five species of *Sphoeroides* had already been reported from the eastern Pacific. With 20 species, *Sphoeroides* is the third largest genus in the Tetraodontidae. Most species of *Sphoeroides* occur in shallow waters of the Atlantic and the eastern Pacific, but *Sphoeroides pachygaster* (Müller and

Troschel *in* Schomburgk 1848) is found in deep waters exceeding 350 m in all oceans.

Shipp (1974) also provided detailed accounts and photographs of *Lagocephalus laevigatus* (Linnaeus 1766) and *Lagocephalus lagocephalus* (Linnaeus 1758). The former is endemic to the Atlantic and the latter is distributed in tropical and other warm seas of the world. Abe and Tabeta (1983) described *Lagocephalus gloveri* as a new species from Japan. Abe et al. (1984) described another new species, *Lagocephalus wheeleri*, from Japan, but Matsuura (2010) showed it to be a junior synonym of *Lagocephalus spadiceus* (Richardson 1845). Matsuura et al. (2011) redescribed *Lagocephalus guentheri* (Miranda Ribeiro 1915) based on an examination of the holotype and many specimens from the Red Sea. Although the genus *Lagocephalus* has not been comprehensively reviewed, an ongoing study by the author has revealed 11 valid species in the genus. This study will be published elsewhere.

Although Abe (1949a, b, c, 1950, 1952, 1954) made progress on the taxonomy of *Takifugu*, many species found along the coast of China were not included in his articles. Cheng et al. (1975) reviewed pufferfishes found in Chinese waters and described *Takifugu flavidus* (Li, Wang and Wang *in* Cheng et al. 1975) and *Takifugu reticularis* (Tian, Cheng and Wang *in* Cheng et al. 1975). Subsequently, Chinese authors described four species of *Takifugu* from China: *Takifugu orbimaculatus* Kuang, Li and Liang 1984 from a creek in Lianhuashan, Guangdong; *Takifugu coronoides* Ni and Li 1992 from an estuary of Chang Jiang; *Takifugu plagiocellatus* Li *in* Su and Li 2002 from the coast of Hainan Island; and *Takifugu variomaculatus* Li *in* Su and Li 2002 from brackish waters of Modaomen Zhuhai, Guangdong. These Chinese and Japanese authors increased the number of *Takifugu* species making it the second largest genus in the Tetraodontidae, with 25 species. However, taxonomic problems still remain in *Takifugu*, such as *Takifugu basilevskianus* (Basilewsky 1855) and *Takifugu pseudommus* (Chu 1935), which show significant variation in morphological features including ontogenetic color changes.

Benl (1957) described *Carinotetraodon chlupatyi* as a new genus and species from Thailand. However, Dekkers (1975) synonymized *Carinotetraodon chlupatyi* with *Carinotetraodon lorteti* (Tirant 1885), making that species the type of the genus. *Carinotetraodon* is similar to *Canthigaster* in having a laterally compressed body and several derived osteological features, as well as a shared derived behavioral peculiarity in their skin ridge-lifting along the midline of the body (Tyler 1978, 1980). Additional new species of *Carinotetraodon* were described: *Carinotetraodon salivator* Lim and Kottelat 1995 from Sarawak, *Carinotetraodon irrubesco* Tan 1999 from Sumatra, and *Carinotetraodon imitator* Britz and Kottelat 1999 from India.

Tyler and Paxton (1979) described *Pelagocephalus coheni* as a new genus and species based on a single specimen collected at Norfolk Island. *Pelagocephalus* is externally distinguished from other pufferfishes by its nasal apparatus in the form of an open, flat, and relatively unornamented disk. Heemstra and Smith (1981) described a second species of *Pelagocephalus*, *Pelagocephalus marki* from South Africa. Hardy (1982b) recorded *P. marki* from New Zealand.

In the period from 1980 to 1989, Graham S. Hardy published a series of papers on the taxonomy of pufferfishes that are distributed mainly in the Southern Hemisphere. Hardy (1980) reviewed the antitropical species *Arothron firmamentum* (Temminck and Schlegel 1850) indicating that it should be classified in *Arothron*, whereas it had previously been classified in *Boesemanichthys* by Abe (1952). The monotypic genus *Contusus* Whitley 1947 was reviewed by Hardy (1981), who described a second species *Contusus brevicaudus* restricted to southern Australia. Hardy and Hutchins (1981) recognized the validity of *Omegophora* Whitley 1934 with the description of *Omegophora cyanopunctata* from the southwestern part of Australia. Hardy (1982a) erected two new genera, *Marilyna* and *Reicheltia*, based on detailed morphological comparisons including skull osteology. Hardy (1983a) reviewed the Australian species of *Torquigener* and established two new generic names, *Polyspina* with one species and *Tetractenos* with two species. He recognized 12 species of *Torquigener*, including five new species from Australia. Hardy and Randall (1983) described *Torquigener flavomaculosus* as a new species from the Red Sea. Hardy described *Torquigener randalli* Hardy 1983b from the Hawaiian Islands and *Torquigener gloerfelti* Hardy 1984b from Indonesia. Hardy (1989) described *Torquigener balteus* as a new species from South Africa and provided a key to 19 species of *Torquigener*, although he overlooked *Sphoeroides marleyi* Fowler 1929, which is a member of *Torquigener*. My examination of the holotypes of *Torquigener balteus* and *S. marleyi* from South Africa revealed them to be conspecific, making the former a junior synonym of the latter. Matsuura (2014) recently described *Torquigener albomaculosus* as a new species from Amamioshima Island, Ryukyu Islands. *Torquigener albomaculosus* is unique in building large spawning nests, called "mystery circles" by local SCUBA divers. Thus, the above studies of *Torquigener* bring the total number of species of *Torquigener* to 20, the co-equal third largest genus in the Tetraodontidae along with *Sphoeroides*. Hardy (1984a) recognized *Sphoeroides spinosissimus* Regan 1908 as being distinctive from other genera of the Tetraodontidae and established a new genus *Tylerius* for it. Hardy (1985) described *Javichthys kailolae* as a new genus and species from Indonesia. Su et al. (1986) established a new genus,

Feroxodon, for *Anchisomus multistriatus* Richardson 1854 from Australia.

The taxonomy of freshwater pufferfishes in Asia was in a confused state until Dekkers (1975) reviewed the genus *Tetraodon*. Subsequently, Sontirat and Soonthornsatit (1985) described *Tetraodon suvattii* as a new species from Thailand, and Roberts (1988) described *Tetraodon abei* as a new species from Laos. Roberts (1982) reviewed the genus *Chonerhinos* Bleeker 1854 and described three species from Borneo, *Chonerhinos amabilis*, *Chonerhinos nefastus*, and *Chonerhinos silus*. Still, complex nomenclatural problems involving *Chonerhinos* and *Xenoptere* remained until Kottelat (1999) proposed the new genus, *Auriglobus*, to rectify these problems. Kottelat (2013) discussed nomenclatural issues of the Tetraodontidae found in Southeast Asia in detail. He established the new genus *Pao* (type species, *Tetraodon leiurus* Bleeker 1850a) that includes 13 species previously placed in *Tetraodon* and *Monotrete*, but differentiated from other pufferfishes by their unique color pattern and a very elongate premaxillary pedicel that creates a greatly enlarged open space between their dorsomedial edges. Thus, the generic name *Tetraodon* is now applied to only six species of African freshwater pufferfishes. Kottelat (2013) also recognized *Leiodon* Swainson 1839 as a valid genus that includes *Tetrodon cutcutia* Hamilton 1822 distributed in freshwaters of southern Asia. Kottelat (2013) recognized *Dichotomyctere* Duméril 1855 for six species: *Dichotomyctere erythrotaenia* (Bleeker 1853), *Dichotomyctere fluviatilis* (Hamilton 1822), *Dichotomyctere kretamensis* (Inger 1953), *Dichotomyctere nigroviridis* (Marion de Procé 1822), *Dichotomyctere ocellatus* (Steindachner 1870), and *Dichotomyctere sabahensis* (Dekkers 1975). Saenjudaeng et al. (2013) described *Tetraodon palustris* as a new species from the Mekong basin of Thailand. Because of its publication date, July 2013, the authors were unaware of Kottelat's (2013) article proposing the genus *Pao*. However, it is clear from the original description of *Tetraodon palustris*, that it is a species of *Pao,* bringing the total number of species in that genus to 14.

Kottelat (2013) also commented on genera of marine pufferfishes. Although *Tetrodon patoca* Hamilton 1822 has long been placed in *Chelonodon* Müller 1841, Kottelat (2013) pointed out that *Tetrodon cutcutia* Hamilton 1822, the type species of *Chelonodon*, had been placed in the same genus as *Tetraodon fluviatilis* Hamilton 1822 and related species by Tyler (1980). Tyler (1980) called this group *Chelonodon* but Kottelat (2013) stated that the oldest available name for a genus including *Tetraodon fluviatilis* is *Dichotomyctere*. *Tetrodon patoca* and *Tetraodon fluviatilis* have a sufficient number of character differences to warrant being placed in separate genera. The type species of *Chelonodontops* Smith 1958 is *Chelonodontops pulchellus* Smith 1958, a junior synonym of *Chelonodon*

pleurospilus (Regan 1919) and congeneric with *Tetraodon patoca* (see Smith 1986). Thus, *Tetraodon patoca* is a species of *Chelonodontops* (Kottelat 2013). Matsuura (2002) reviewed two species of *Chelonodon*, *Chelonodon laticeps* Smith 1948, and *Chelonodon patoca*, both of which belong in *Chelonodontops*. Kottelat (2013) showed that *Gastrophysus* Müller 1843 is an objective synonym of *Takifugu* Abe 1949, as the type species of both genus group names is *Tetrodon oblongus* Bloch 1786. However, this is likely to cause confusion not only in pufferfish taxonomy, but also in the fisheries of East Asia where pufferfishes are treated as important and expensive fishes (e.g., several species of *Takifugu* cost about US$100 per kilogram at fish markets). In addition, because pufferfishes have fatal poison in their viscera, scientific names are very important for food security management in East Asia. As suggested by Kottelat (2013), *Gastrophysus* can be suppressed under the International Code of Zoological Nomenclature (ICZN 1999). I will ask the International Commission on Zoological Nomenclature to suppress *Gastrophysus*.

Matsuura and Okuno (1991) redescribed a rare pufferfish, *Arothron carduus* (Cantor 1849), on the basis of the holotype from Penang and two additional specimens from the West Pacific. Matsuura (1994) described *Arothron caeruleopunctatus* as a new species from the tropical region of the Indo-West Pacific. Matsuura (1999) briefly reviewed *Arothron* with a key to species and accounts of all members of the genus including two undescribed species.

As indicated above, there has been a great deal of progress in taxonomy of the Tetraodontidae during the past several decades, especially in the period from the mid-1970s to the present. However, there remain taxonomic problems in genera such as *Arothron*, *Chelonodontops*, *Lagocephalus*, *Pao*, *Takifugu*, and *Torquigener* where many species await description and detailed morphological and molecular comparisons to classify them into appropriate groups. The taxonomy of pufferfishes in Southeast Asia is important not only for the understanding of fish diversity of the region, but also for the welfare and food management for humans. Dao et al. (2012) reported that the number of victims of food poisoning by eating pufferfishes reached 737, with 127 mortalities from 1999 to 2003. Due to the lack of knowledge about pufferfishes and their toxicity, pufferfishes are still found in Southeast Asian fish markets (Fig. 5), although local and state governments in countries around the South China Sea have prohibited the sale of pufferfishes for food.

Diodontidae (Porcupinefishes, Fig. 1i)

Many species of the family Diodontidae are benthic inhabitants around coral or rocky reefs, but some occur

Fig. 5 Pufferfishes found in a fish landing place 60 km north of Nha Trang in southern Vietnam (**a**) and a fish market in Sabah, Malaysia (**b**): **a** many small pufferfishes of *Lagocephalus* and a large specimen of *L. inermis* in the center; **b** large specimens of *Arothron hispidus*, *A. reticularis*, and *A. stellatus*
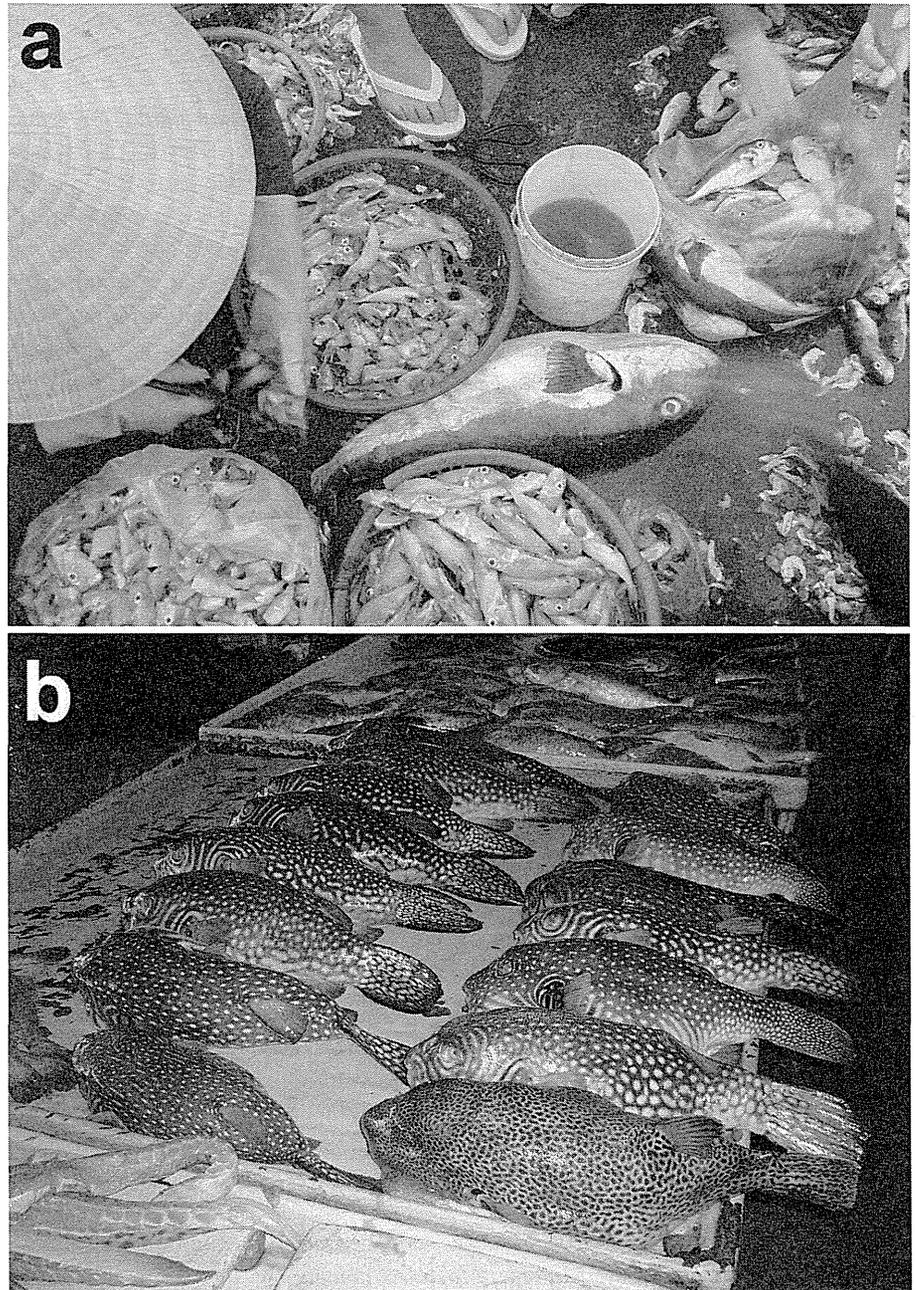
frequently in seagrass beds and on sand or mud bottom to depths of 150 m, with one species being found in pelagic waters. They differ externally from other families of the order Tetraodontiformes by the following combination of characters: body wide and capable of great inflation, covered with massive spines, which may be quite long; spines with large bases or roots, which are beneath the skin; long spines that are usually erectile and double-rooted, or short spines fixed in an erect position by their triple-rooted bases; head broad and blunt; nasal organ usually appearing as small tentacles located in front of the large eyes; mouth large, wide, and terminal, teeth fused to

form a strong, beak-like crushing structure without a median suture dividing the upper and lower jaws into left and right halves; gill opening, a relatively small, vertical slit immediately preceding the pectoral-fin base; short-based dorsal and anal fins with soft rays, set far back on body, and like caudal fin, generally rounded; most fin rays branched; bases of fins often thick and fleshy; no pelvic fins (Leis 2001).

Porcupinefishes were well studied by Leis (1978, 1986, 2001, 2003, 2006). Leis (1978) reviewed *Diodon* Linnaeus 1758 and provided detailed accounts of five species: *Diodon eydouxii* Brisout de Barneville 1846, *Diodon*

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137