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Research Article

Contribution to the Taxonomy and Distribution of Six Shark Species (Chondrichthyes, Elasmobranchii) from the Gulf of Thailand

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A collection of nine shark specimens from six different species, obtained in 1993 from the Gulf of Thailand, was examined in this study. The sharks were determined, morphometrically and meristically analyzed, photographically documented, and compared with relevant literature. Additionally, further available material from the fish collections of the Zoological Museum Hamburg, the Senckenberg Naturmuseum Frankfurt, and the Muséum national d'Histoire naturelle, Paris, was examined by way of comparison. Contrary to most references, prominent dorsal ridges were detected in several specimens of *Chiloscyllium griseum*. Additionally, one of the specimens had a very unusual big ocellar blotch on the head which had not been reported for this genus before. For *Paragaleus randalli*, it could be proven that the teeth morphologically deviate strongly from those shown in literature due to having much larger cusps. Furthermore, the known distribution area of *Paragaleus randalli* could be extended considerably eastwards by about 2000 km. For a seventh species, *Paragaleus tengi*, differences between the actual morphology of upper lateral teeth and those drawn in the original description were detected.

1. Introduction

About 500 of the more than 1200 globally known species of Chondrichthyes are sharks, including the world's biggest fish species [1]. The highest diversity of Chondrichthyes can be found in the East Indian Ocean [2–4], where the catches of elasmobranch fishes have increased significantly over the last decades from 18 600 t in 1950 to 77 700 t in 1997 [5]. Today Indonesia has the world's largest chondrichthyan fishery [3]. Extensive targeted fishery and bycatch belong to the most important reasons for the recent decline of the populations of many elasmobranch species [6, 7]. Sharks are especially susceptible to population declines because the lifestyle of many species is characterized by late attainment of sexual maturity, slow growth, and low reproductive output [2, 8, 9]. Due to the numerous population declines, it is very important to develop management and protection programs for many elasmobranch species, which require well-founded knowledge about the taxonomy, distribution, and abundance of the species. However, although many new elasmobranch species have been described in recent years [1, 10–13], the knowledge on many known species is still scarce due to the often very old and sketchy original descriptions like those by Müller and Henle [14]. Another reason for the gaps in knowledge is the often insufficient declaration of elasmobranch catches by fishermen, who classify most caught specimens simply as "diverse Elasmobranchii" or "small sharks" instead of making a more detailed determination [5, 15].

In order to make a contribution to the filling of these knowledge gaps, a collection of nine shark specimens from the Gulf of Thailand and many comparative specimens were examined in this study. Thailand was the fifth most important chondrichthyan fishing nation in the East Indian Ocean in 1997 with 5600 t officially landed [5]. The examined Thai specimens belong to the Carcharhinidae species *Carcharhinus dussumieri*, the two Hemigaleidae species *Hemigaleus microstoma* and *Paragaleus randalli*, the Sphyrnidae species *Sphyrna lewini* and the two Hemiscyllidae species *Chiloscyllium griseum* and *C. punctatum*.

The Carcharhinidae is by far the most speciose shark family in Thai and adjacent waters with 30 species [16]. Its members are characterized by two nonspiny dorsal fins, nasoral grooves and barbles, an under, or beyond-the-eyes located mouth and nictitating eyelids [17] as well as a precaudal pit and an intestinal valve of scroll type [18]. The second most speciose family in this region is the family Triakidae with only seven species [16]. The family Hemigaleidae is represented in the region by four species [16]. It is morphologically similar to the family Carcharhinidae, but all of its members have an intestinal valve of spiral type [18]. The Sphyrnidae, represented by four species in Thai and adjacent waters [16], have a cephalofoil, a uniquely formed head with lateral, bladelike expansions [18]. The Hemiscyllidae with four species in the region [16] are—like all Orectolobiformes—characterized by the presence of an anal fin, two equal-sized, nonspiny dorsal fins, barbles, nasoral grooves, and a short mouth that ends in front of the eyes [19]. The species of Hemiscyllidae in particular have a slender, conical body, large spiracles, and short barbles [17].

This study provides extensive morphometrical analyses for six shark species for most of which such detailed morphometrics have not been published before. Additionally, tooth row counts are given for all specimens from the Thailand collection as well as morphological descriptions and comparisons with relevant literature.

A morphologically correct image of upper anterolateral teeth of *Paragaleus randalli* is shown here for the first time. Furthermore, the known distribution area of *Paragaleus randalli* is extended.

2. Material and Methods

The examined Thai collection of nine sharks from six different species was collected by Matthias Stehmann during a Thailand expedition that took place from the 5th to the 11th December 1993 after the fourth Indo-Pacific Fish Conference (IPFC). The specimens were acquired from local fishermen in the two Thai harbors shown in the map in Figure 1: Cha-Am (12°49′N, 100°E) and Pak Phanang (8°20′N, 100°15′E). According to the fishermen, the sharks were caught nearby those harbors. All specimens were fixed in 4% formaldehyde solution soon after the catch and preserved in 70% ethanol afterwards.

The map was generated using ArcMap 9.3.1 by ESRI [20] and based on the Global Relief Model ETOPO 1 of the National Geophysical Data Center (NOAA) [21]. The country borders were visualized by means of the shapefiles supplied by ESRI for the ArcExplorer-Java Edition for Education 2.3.2 (AEJEE) [22]. Land below the sea level was colorized in the color of the lowest land elevation class using Adobe Photoshop CS 4 [23].

Additionally to the nine specimens from the Thai collection, the following material from the fish collections of the Zoological Museum Hamburg (ZMH), the Senckenberg Naturmuseum Frankfurt (SMF) and the Muséum national d'Histoire naturelle, Paris (MNHN) was examined by way of comparison.

2.1. Carcharhinus dussumieri. ZMH 2137: male postembryo, 264 mm total length (TL) and female postembryo, 335 mm TL, China: Futschau, Fokien, 8 Sep. 1911, Cons. G. Siemssen. ZMH 2149: male postembryo, 247 mm TL, male postembryo, 262 mm TL and female postembryo 246 mm TL, China: Futschau, Fokien, 9 Sep. 1904, Cons. G. Siemssen. ZMH 25479: female postembryo, 260 mm TL, Indonesia: Sumatra.

2.2. Carcharhinus sealei. ZMH 103117 (ISH 145-1965): female, 855 mm TL (with two female embryos of 365 and 373 mm TL) and female, 875 mm TL, off Pakistan: 22°10′N, 68°34′E, RV "Meteor" station 230a/65, Indian Ocean Exped., 8 Mar. 1965, 45–56 m deep, Kutter Trawl, uncataloged material: juvenile male, 530 mm TL, Sokotra Islands: 12°39′N, 53°27′E–12°36′N, 53°20′2″E, RV "Vityaz" cruise 17 station 2567, 28 Oct. 1988, 41–43 m deep, BOT 30 m. Adult male, 850 mm TL, Sokotra Islands: 12°04.8′N, 53°12.6′E–12°09.2′N, 53°10.1′E, RV "Vityaz" cruise 17 station 2829, 15 Jan. 1989, 36–40 m deep, 29 m-Shrimp Trawl.

2.3. Hemigaleus microstoma. ZMH 120307 (ISH 57-1982): juvenile male, 540 mm TL, Indonesia: Moyo Island: 8°18′S, 117°35′E, RV "Jurong", Jun. 1981, 150 m deep, Bottom Trawl, T. Gloerfelt-Tarp.

2.4. Paragaleus randalli. Paratype ZMH 103119 (ISH 150-1965): adolescent male, 590 mm TL, Arabian Sea: 22°01-02′N, 68°10-15′E, RV "Meteor" station 229a/65, Indian Ocean Exped., 7 Mar. 1965, 88–94 m deep. Paratype SMF 28109: adult male, 685 mm TL, Arabian Gulf: Kuwait: 28°42.88′N, 48°26.30′E–28°44.07′N, 48°27.64′E, 24 Apr. 1995.

2.5. Sphyrna lewini. ZMH 5326: female postembryo 385 mm TL, female postembryo 410 mm TL, and female postembryo 415 mm TL, Thailand: Kokra, RV "Meteor", 14 May 1966, 25 m deep, Trawl. ZMH 10212: juvenile male, 473 mm TL, China: Prov. Fokien, 18 Dec. 1905, Cons. G. Siemssen. ZMH 22417: head only, width of cephalofoil: 223 mm, Gold Coast: Lahou, 14 Mar. 1929. ZMH 25482: female postembryo, 329 mm TL and female postembryo, 356 mm TL, Tonga, Palze. ZMH 101459 (ISH 139-1962): juvenile female, 510 mm TL, Guinea: 8°50′–9°47′N, 13°38′–14°05′W, fishing boat "Hilda", Oct./Nov. 1962, 13–40 m deep, Bottom Trawl. ZMH 101553 (ISH 201-1963): female embryo 188 mm TL, female embryo 198 mm TL, female embryo 203 mm TL, male embryo 197 mm TL, male embryo 204 mm TL, male embryo 205 mm TL, and male embryo 206 mm TL, Guinea: Conakry: 09°45′N, 14°05′W, fishing boat "Hilda", 4 Feb. 1963, 10–13 m deep, Kutter Trawl. ZMH 104704 (ISH 1019-1966): juvenile male, 563 mm TL, South Brasil: 32°45′S, 51°02′W, RV "Walter Herwig" station 218/66, 10 Jun. 1966, 75 m deep, 140′-Ground Trawl. ZMH 113340 (ISH 266–1975): juvenile male, 1060 mm TL, Pacific: North Mexico: 24°02′N, 111°04′W, RV "Weser" station 187, 6 Jan. 1975, 70 m deep, Bottom Trawl. Uncataloged material: juvenile female, 615 mm TL, without data. juvenile female, 820 mm TL,

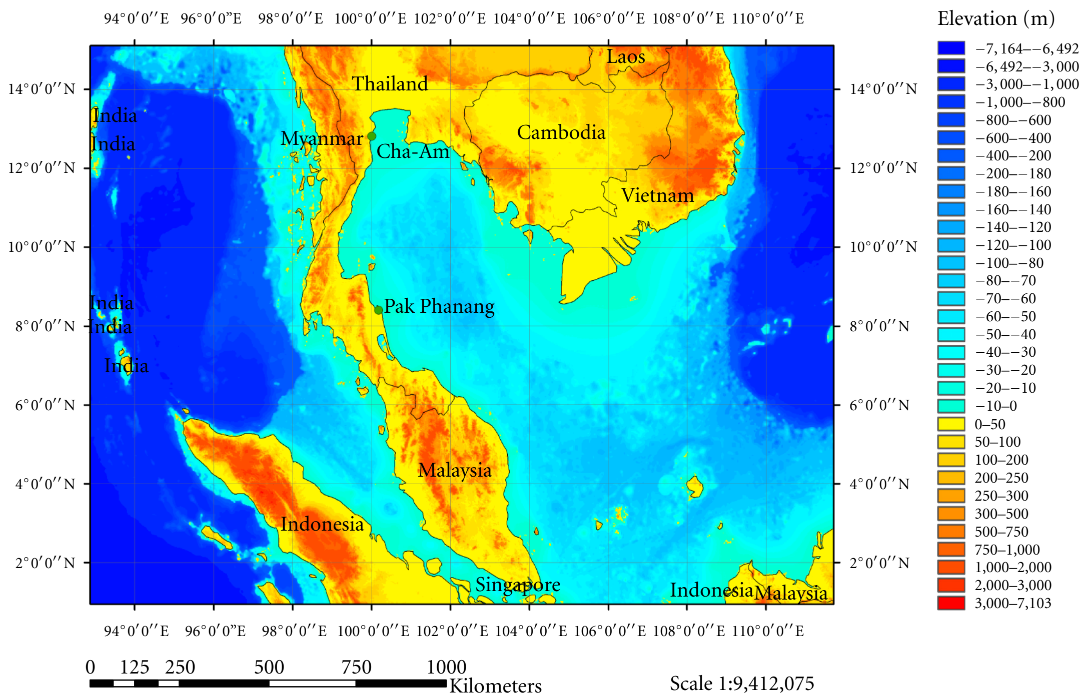

Figure 1: Map of Thailand showing the two harbors Cha-Am and Pak Phanang in which sharks were acquired.

Northwest Madagascar: 12°34′2″S, 48°39′1″E, RV "Vityaz" cruise 17 station 2591, 11 Nov. 1988, 53 m deep, BOT 30 m.

2.6. Chiloscyllium arabicum. ZMH 1370: juvenile male, 361 mm TL, Arabian Sea: India, Maharashtra State, off Alibag, German Indian Ocean Expedition, 25 Nov. 1955, v. Maydell. ZMH 1371: male postembryo, 115 mm TL, Arabian Sea: India, Karnataka State, North Kanara, off Karwar, German Indian Ocean Expedition, 14 Feb. 1956, v. Maydell. ZMH 25397 (ISH 1–1961): juvenile male, 320 mm TL, Arabian Sea: India, Maharashtra State, off Alibag, German Indian Ocean Expedition, 25 Nov. 1955, v. Maydell.

2.7. Chiloscyllium griseum. ZMH 1372: juvenile female, 175 mm TL, Arabian Sea: India, Maharashtra State, off Alibag, German Indian Ocean Expedition, 25 Nov. 1955, v. Maydell. ZMH 1373: juvenile male, 149 mm TL, Arabian Sea: India, Karnataka State, North Kanara, off Karwar, German Indian Ocean Expedition, 14 Feb. 1956, v. Maydell. ZMH 10114: juvenile male, 515 mm TL, Ceylon (Sri Lanka): Colombo, 27 Jul. 1904, John Hagenbeck. ZMH 100420 (ISH 229-1962): juvenile male, 205 mm TL, Arabian Sea: India, Karnataka State, North Kanara, off Karwar, German Indian Ocean Expedition, 14 Feb. 1956, v. Maydell. Paralectotypes MNHN 1009: adult male, 453 mm TL, female, 520 mm TL and adult male, 548 mm TL, India: Kerala State, Malabar, Dussumier. Lectotype MNHN 1010: juvenile male, 374 mm TL, India: Kerala State, Malabar, Dussumier. Paralectotype MNHN 1011: female, 524 mm TL, India: Kerala State, Malabar, Dussumier.

2.8. Chiloscyllium indicum. ZMH 5325: adult male, 415 mm TL, Thailand: Prachuap Khiri Khan, 13 Oct. 1965, 40 m deep, Trawl. ZMH 10121: female, 445 mm TL, Singapore.

2.9. Chiloscyllium plagiosum. ZMH 10115: female, 470 mm TL and female postembryo, 138 mm TL, China: Futschau, Fokien, 1 Jun. 1911, Cons. G. Siemssen. ZMH 10116: female, 555 mm TL (with abnormal caudal, first dorsal, and anal fin) and female, 580 mm TL, China: Futschau, Fokien, 1 Apr. 1905, Cons. G. Siemssen. ZMH 10117: juvenile male, 538 mm TL, China: Futschau, Fokien, 18 Dec. 1905, Cons. G. Siemssen. ZMH 10119: female, 499 mm TL, China: Canton. ZMH 10122: juvenile female, 267 mm TL, Manila, 1878. ZMH 22303: adult male, 650 mm TL, China: Futschau, Fokien, 1906, Cons. G. Siemssen. ZMH 22307: juvenile male, 447 mm TL, Bohol, 1874, Semper.

2.10. Chiloscyllium punctatum. ZMH 5324: juvenile male, 322 mm TL and juvenile female, 335 mm TL, Thailand: Prachuap Khiri Khan, 22 Nov. 1965, 40 m deep, Otter Trawl. ZMH 120168 (ISH 53-1982): semiadult male, 720 mm TL and adult female, 900 mm TL, Indonesia: South Java: 7°28′S, 109°12′E, RV "Jurong", 1981, 45 m deep, Bottom Trawl, T. Gloerfelt-Tarp.

Descriptions in literature were analyzed for a seventh species, *Paragaleus tengi*. Morphometrics and meristics were done following Compagno [24] with very minor modifications. The habitus photographs were taken with a Nikon D90 and a Nikkor 18–105 mm zoom lens and afterwards reworked using Adobe Photoshop CS4 [23]. Detail photographs were taken using a Canon EOS 350D, a Tamron

Table 1: Classifications, numbers, and locations of the examined specimens from the Thai collection.

Class	Subclass	Order	Family	Genus	Species	Number	Harbor
Chondrichthyes							
—	Elasmobranchii						
—	—	Carcharhiniformes					
—	—	—	Carcharhinidae				
—	—	—	—	*Carcharhinus*			
—	—	—	—	—	*dussumieri*	1	PP
—	—	—	Hemigaleidae	—	—	—	—
—	—	—	—	*Hemigaleus*	—	—	—
—	—	—	—	—	*microstoma*	1	PP
—	—	—	—	*Paragaleus*	—	—	—
—	—	—	—	—	*randalli*	1	PP
—	—	—	Sphyrnidae	—	—	—	—
—	—	—	—	*Sphyrna*	—	—	—
—	—	—	—	—	*lewini*	2	PP
—	—	Orectolobiformes	—	—	—	—	—
—	—	—	Hemiscyllidae	—	—	—	—
—	—	—	—	*Chiloscyllium*	—	—	—
—	—	—	—	—	*griseum*	2	CA
—	—	—	—	—	*punctatum*	2	PP

28–200 mm zoom lens, and a Soligor Extension Tube. For verifying the tooth row counts, radiographs were taken of all specimens from the Thai collection with a 1979 launched MG 101 X-ray equipment for radiography by Philips.

3. Results

The nine examined Thai specimens represent six different shark species from two orders, four families, and five genera. Their classifications, numbers of individuals, and catch locations are shown in Table 1.

The abbreviations of the harbors stand for CA: Cha-Am and PP: Pak Phanang.

The following species descriptions refer to the specimens from the Thai collection if not otherwise stated. However, the available comparative specimens were always checked for correspondence in the described characters.

Typical characteristics which proved to be important for the determination are provided, as well as comparisons with relevant literature and—in the case of more complex determination procedures—differences to similar species. Furthermore, comments about aberrations in the examined specimens from the descriptions in literature and possible mistakes or problems in the references including taxonomically problematic cases are given. These themes are not part of the conclusion chapter, but have been included directly in the results chapter to allow direct comparisons with the species descriptions. Three habitus photographs are shown for each of the nine examined specimens from the Thai collection. A distribution map is given for *Paragaleus randalli* due to the newly discovered occurrence. For distribution maps of the other examined species, see for example Compagno et al. [17]. Measurements of all nine specimens from the Thai collection can be found in Tables 2–10. A collection of 24 batoids from the same expedition was described by the author in a previous paper [25].

3.1. Carcharhinus dussumieri (Müller and Henle) [14]. *Carcharhinus dussumieri* is a common, but heavily fished species, which is distributed from the Arabian Sea over the shelf areas of the northern and eastern Indian Ocean until South Japan in the north [17].

The specimen of *Carcharhinus dussumieri* (ZMH 25683) was caught by local fishermen in the Gulf of Thailand near Pak Phanang on the 7th December 1993. It is a 75 cm long male with fully developed claspers (Figure 2(c)) and thus can be considered to be adult. Following Compagno et al. [17], *Carcharhinus dussumieri* reaches a maximal total length of 100 cm.

Three habitus photographs of specimen ZMH 25683 are shown in Figure 2 and its measurements in Table 2.

As described for this species by Last and Stevens [1], it has a conspicuous black tip to the second dorsal fin while all other fins do not have distinct markings (Figures 2(a), 2(b)). Additionally, the species has a low interdorsal and no lateral ridge on the tail stock, the first dorsal-fin origin is over, or slightly anterior to, the free rear tips of the pectoral fins and the second dorsal fin originates over, or usually a little bit behind, the anal fin origin [1].

The most obvious character, the dark tip to the second dorsal fin, is also present in diverse other species of the genus *Carcharhinus*, but there is only one further species, *Carcharhinus sealei* (Pietschmann) [26], in which all fins except the second dorsal fin are plain and without blotches [18].

Figure 2: *Carcharhinus dussumieri*, ZMH 25683: (a) lateral view, (b) dorsal view, (c) ventral view. Scale bar (a)–(c) 5 cm.

However, contrary to *Carcharhinus sealei*, the teeth of the examined specimen have no cusplets and the first dorsal fin is triangular (Figure 2(a)), whereas it is falcate in *Carcharhinus sealei* [18]. Furthermore, the examined specimen has—as described for *Carcharhinus dussumieri* by Compagno [18]—semifalcate pectoral fins (Figure 2(a)), while those of *C. sealei* are strongly falcate. Additionally, the mouth width of the examined specimen is 6.9% of its total length. Following Compagno [18] the mouth width is 6.4 to 8.3% of total length in *Carcharhinus dussumieri*, whereas it is 4.2 to 6.6% in *C. sealei*.

The examined specimen ZMH 25683 has 26 tooth rows each in the upper and lower jaw. Last and Stevens [1] list 25 to 28 (seldom 24–31) tooth rows in the upper and also 25 to 28 (sometimes 22–32) in the lower jaw for *Carcharhinus dussumieri*. Fowler [27] specifies 24 to 25 tooth rows per jaw for this species. *Carcharhinus sealei* usually has 26 tooth rows in the upper and 25 rows in the lower jaw [28].

3.2. Hemigaleus microstoma Bleeker [29]. Despite the intensive commercial use of this species, populations are growing due to rapid reproduction rates. However, the known distribution area is patchy: it consists of the Red Sea, South India, parts of Southeast Asia, and East China [17].

The specimen of *Hemigaleus microstoma* (ZMH 25682) was caught by local fishermen in the Gulf of Thailand near Pak Phanang on the 7th December 1993. It is a mature male of 79 cm total length with fully developed claspers (Figure 3(b)). This corresponds with the description by Compagno et al. [17], after whom this species matures at about 60 cm total length and reaches a maximal length of 94 cm.

Three habitus photographs of specimen ZMH 25682 are shown in Figure 3 and its measurements in Table 3.

Contrary to the genera *Chaenogaleus* and *Hemipristis*, the cusps of the lower anterolateral teeth of all *Hemi-* and *Paragaleus* species do not protrude from the mouth and the gill slits are clearly shorter compared to the eye length [18]. In contrast to the species of the genus *Paragaleus*, both described *Hemigaleus* species have—following Compagno [18]—anterolateral teeth with short cusps in their upper jaws (Figure 4) as well as strongly falcate pelvic and dorsal fins and a falcate ventral lobe of the tail fin (Figure 5(a–d)).

Additionally, the two species of *Hemigaleus* have 6 to 20 tooth rows more in the lower than in the upper jaw, whereas all *Paragaleus* species have between one less and five more.

The examined specimen has 25 tooth rows in the upper and 37 rows in the lower jaw.

Due to the lateral white blotches on its body (Figure 3(c)) and the white margins of the dorsal and pelvic fins as well as the anal fin and the ventral part of the caudal fin (Figure 5(a–d)), the examined specimen was determined as *Hemigaleus microstoma*, which has about 32 tooth rows in the upper jaw according to Fowler [27]. The other species of *Hemigaleus*, *H. australiensis* White, Last and Compagno [30], has a plain body and, instead of the white fin margins, a second dorsal and caudal fin with dark margins and tips [17].

3.3. Paragaleus randalli Compagno, Krupp and Carpenter [31]. *Paragaleus randalli* is an inshore species, which lives in shallow water to 18 m depth on the continental shelf. Abundance and commercial use are unknown. The known distribution area includes only few small regions in the northern Indian Ocean, which partially are far away from each other: the Arabian Gulf, the Gulf of Oman, India, and Sri Lanka [17].

The specimen of *Paragaleus randalli* (ZMH 25681) was caught by local fishermen in the Gulf of Thailand near Pak Phanang on the 7th December 1993. Therefore, this specimen was caught about 2000 km more easterly than the former easternmost record from East India. The fully developed

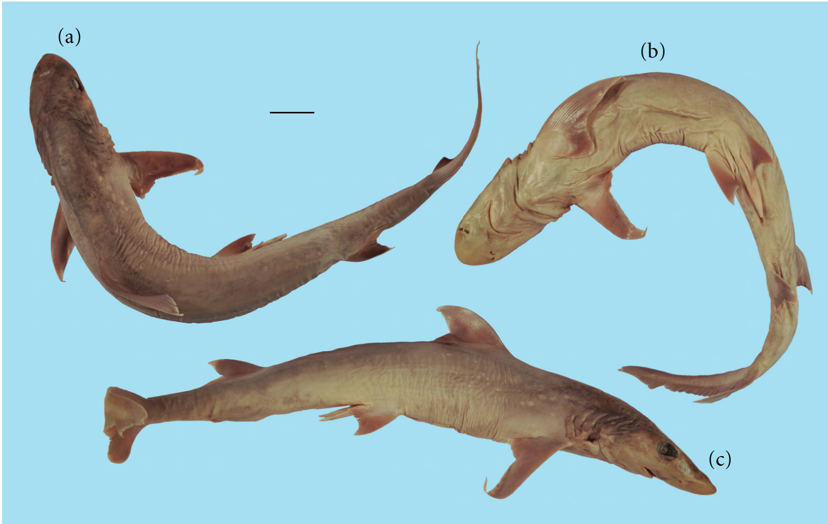

Figure 3: *Hemigaleus microstoma*, ZMH 25682: (a) dorsal view, (b) ventral view, (c) lateral view. Scale bar (a)–(c) 5 cm.

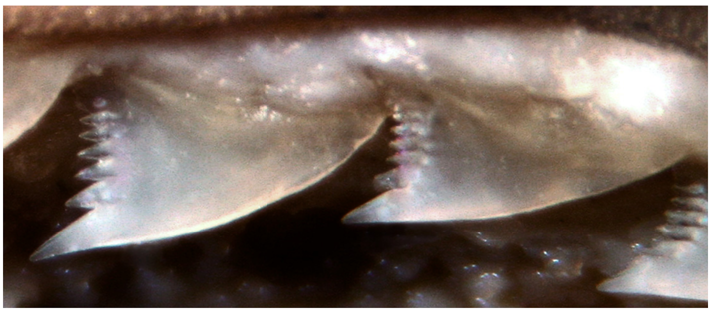

Figure 4: *Hemigaleus microstoma*, ZMH 25682: anterolateral teeth from the right upper jaw.

claspers (Figure 6(a)) of the 75 cm long specimen show that it is mature, which corresponds with the total length of at least 81 cm and maturing size of 60–70 cm, which are mentioned by Compagno et al. [17].

Three habitus photographs of specimen ZMH 25681 are shown in Figure 6. A distribution map for *Paragaleus randalli* is pictured in Figure 7, in which the distribution area after Compagno et al. [17] is marked in red and white stripes and the catch location of specimen ZMH 25681 as a blue spot. Its measurements can be found in Table 4.

The distribution map for *Paragaleus randalli* was generated using ArcMap 9.3.1 [20] and based on the shapefiles supplied by ESRI for the ArcExplorer-Java Edition for Education 2.3.2 (AEJEE) [22]. The distribution area and catch location were drawn with Adobe Photoshop CS4 [23].

Contrary to the genera *Chaenogaleus* and *Hemipristis*, the cusps of the lower anterolateral teeth of all *Para*-and *Hemigaleus* species do not protrude from the mouth (Figure 6(c)), and the gill slits are clearly shorter compared to the eye length [18]. The examined specimen differs from the genus *Hemigaleus*—following Compagno [18]—in having anterolateral upper teeth with long cusps (Figure 8(a)), whereas they have short cusps in both *Hemigaleus* species. Additionally, the pelvic and dorsal fins and the ventral lobe of the caudal fin are not falcate in the examined specimen (Figure 6(c)), while these fins are falcate in *Hemigaleus* [18]. A further character that classifies the examined individual clearly to the genus *Para*-and not *Hemigaleus* is the number of tooth rows: the examined specimen has 29 tooth rows each in the upper and lower jaw. According to Compagno [18], the genus *Paragaleus* possesses one less to five more tooth rows in the upper than in the lower jaw, whereas there are 6 to 20 tooth rows more in the upper than in the lower jaw in *Hemigaleus*.

The examined specimen was determined as *Paragaleus randalli* because its second dorsal fin and the dorsal lobe of the caudal fin have light margins (Figure 6(b)), which is not present in any other species of the genus following Compagno et al. [17]. Furthermore, the examined specimen has two narrow black lines ventrally on the snout (Figure 6(a)). According to Compagno et al. [17], the only *Paragaleus* species that have such lines are *P. randalli* and *P. tengi* (Chen) [32]. The studied specimen was not determined as *Paragaleus tengi* because it has—like described for *P. randalli* by Compagno et al. [31]—a long and narrowly rounded prenarial snout, whereas it is rounded in *P. tengi* and has clearly larger pectoral fins than those described for *P. tengi* (Figure 6(a)).

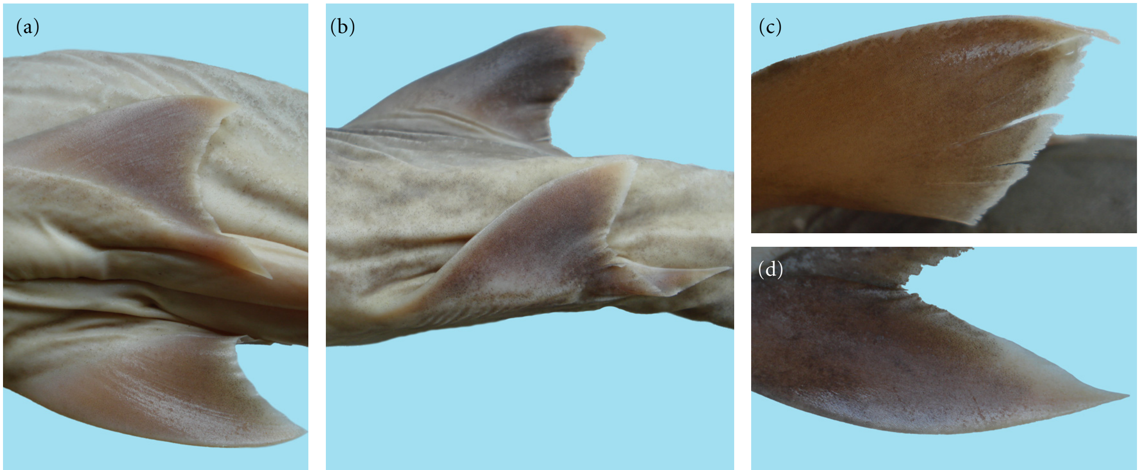

Figure 5: *Hemigaleus microstoma*, ZMH 25682: (a) pelvic fins, (b) second dorsal and anal fin, (c) first dorsal fin, (d) ventral lobe of caudal fin.

Figure 6: *Paragaleus randalli*, ZMH 25681: (a) ventral view, (b) dorsal view, (c) lateral view. Scale bar (a)–(c) 5 cm.

The ratio length of the longest gill slit to the eye length is 1.2 in the examined specimen. According to Compagno et al. [17], this ratio would be suggestive of *Paragaleus tengi*, because they specify a ratio of 1.2 to 1.3 for *P. tengi* and about 1 for *P. randalli*. However, when analyzing the original description of *Paragaleus randalli* [31], one can see that already in only 14 measured specimens the longest gill slit is between 0.9 and 1.3 times as long as the eye of the respective animal. Accordingly, the specimen ZMH 25681 is in line with *Paragaleus randalli* even in this character and the information in Compagno et al. [17] should be extended correspondingly.

The fact that male *Paragaleus tengi* specimens mature not until 78–88 cm total length [17] is another criterion for the exclusion of *P. tengi* in the determination of the 75 cm long mature Thai specimen.

As already mentioned, the examined specimen of *Paragaleus randalli* (ZMH 25681) has 29 tooth rows per jaw. Following Compagno et al. [31], this species has 28–30 rows in the upper and 28–33 in the lower jaw. *Paragaleus tengi*, in contrast, has 26 tooth rows in the upper and 27 in the lower jaw [32].

It appears that the drawing of a left, anterolateral tooth from the upper jaw of the paratype SMF 28109 of *Paragaleus randalli* (Figure 8(b), white arrow) in the original description [31] and, therefore, also in Compagno et al. [17] is inaccurate: the drawn tooth looks similar to the anterolateral teeth of *Hemigaleus microstoma* (Figure 4) due to its short cusp, which is much shorter than in the examined specimen ZMH 25681 (Figure 8(a), white arrow). The examination of paratype SMF 28109 proved that the cusps are not really

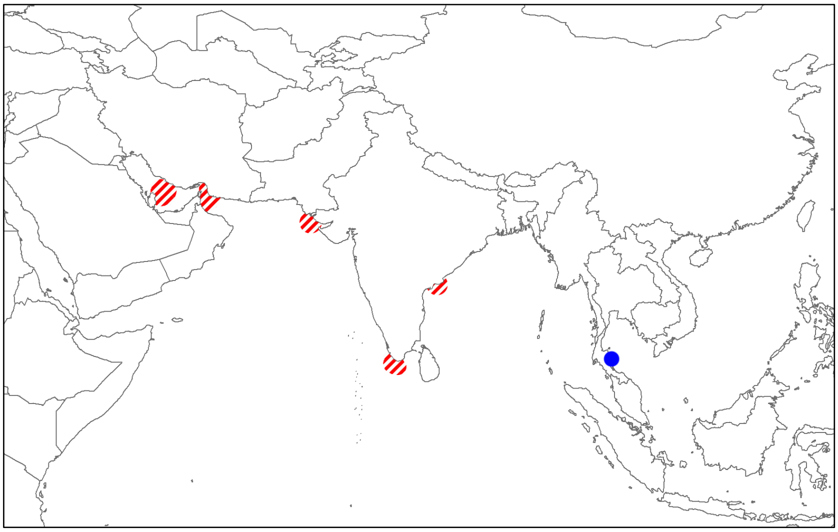

Figure 7: *Paragaleus randalli.* Distribution area after Compagno et al. [17] as well as the catch location of specimen ZMH 25681 marked as a blue spot.

shorter than in specimen ZMH 25681. Possibly a blunt tooth was drawn by Compagno et al. [31], because the intact teeth have clearly longer cusps than in their drawing. Hence, their morphology is very similar to that of the teeth of the examined specimen ZMH 25681 (Figure 8(a)) as well as to that of the teeth of paratype ZMH 103119 (ISH 150-1965), which was also examined by way of comparison.

A comparison of the upper teeth of the mentioned *Paragaleus randalli* specimens with the tooth drawings in the original description of *P. tengi* [32] reveals conspicuous morphological differences because the drawn upper teeth of *P. tengi* hardly bear cusplets (Figure 9). However, the photograph of upper teeth of *Paragaleus tengi* in Compagno [33] indicates that the drawing of Chen [32] is apparently imprecise, because the teeth pictured in Compagno [33] do have distinct cusplets (Figure 10) and, hence, look very similar to those of *P. randalli*.

3.4. Sphyrna lewini (Griffith and Smith) [34]. *Sphyrna lewini* can be found in shelf regions as well as adjacent deep water areas to over 275 m depth. However, this species lives mainly inshore. It is found worldwide in all warm temperate and tropical seas. Although it is still common and widespread, it is extremely heavily fished in most regions [17] so that, without catch limitations, strong population decreases can be expected.

The two specimens of *Sphyrna lewini* (ZMH 25679 and ZMH 25680) were caught by local fishermen in the Gulf of Thailand near Pak Phanang on the 7th December 1993. Considering the maximal total length of 420 cm and the size at birth of 42 to 55 cm of this species [17], the two examined specimens with total lengths of 51.3 cm and 58 cm, respectively, are young juveniles caught shortly after birth.

Three habitus photographs of each of the specimens ZMH 25679 and ZMH 25680 are shown in Figures 11 and 12 and their measurements in Tables 5 and 6.

The posterior margins of the lateral blades of head are arching posterolaterally in the examined specimens as described for *Sphyrna lewini* by Compagno [18]. As typical for this species following Compagno et al. [17], the broadly arched and narrow-bladed head of the examined specimens has a central notch and two smaller lateral indentations (Figures 11(a), 11(c), 11(d), and 12(b)). Further characteristics according to Compagno et al. [17] are the only moderately high first dorsal fin and the dark-tipped lower caudal fin lobe, second dorsal fin, and pectoral fins (Figures 11(b), 11(d)).

Both examined specimens (ZMH 25679 and ZMH 25680) have 33 tooth rows each in their upper and in their lower jaws. Last and Stevens [1] list 32 to 33 (seldom 32 to 36) for the upper and 31 to 33 (sometimes 30 to 34) for the lower jaw of *Sphyrna lewini*. Following Bass et al. [35], this species has 32 tooth rows in the upper and 31–33 rows in the lower jaw.

3.5. Chiloscyllium griseum Müller and Henle [14]. *Chiloscyllium griseum* is an inshore and quite common shark species that lives on rocks and in lagoons from 5 to 80 m depth. Its distribution area ranges from Pakistan and India over most parts of Southeast Asia to Papua New Guinea in the south and East China and South Japan in the north [17].

The two specimens of *Chiloscyllium griseum* (ZMH 25675 and ZMH 25676) were caught by local fishermen in the Gulf of Thailand near Cha-Am in about 30 m depth on the 5th December 1993. The maximal total length of *Chiloscyllium griseum* is about 77 cm, and the males mature at a total length of about 45 cm [17]. Hence, the two examined specimens with total lengths of 56 cm and 59.5 cm, respectively, are probably adult.

Three habitus photographs of each of the specimens ZMH 25675 and ZMH 25676 are shown in Figure 13 and their measurements in Tables 7 and 8.

Contrary to the similar species *Chiloscyllium arabicum* Gubanov [36], the two examined specimens have faded

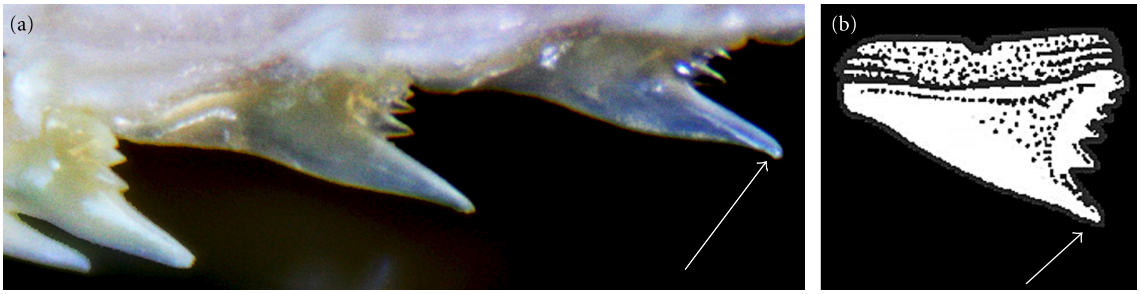

Figure 8: (a) *Paragaleus randalli*, ZMH 25681: anterolateral teeth from the left upper jaw, (b) anterolateral tooth from the left upper jaw of *Paragaleus randalli*, SMF 28109 after Compagno et al. [31].

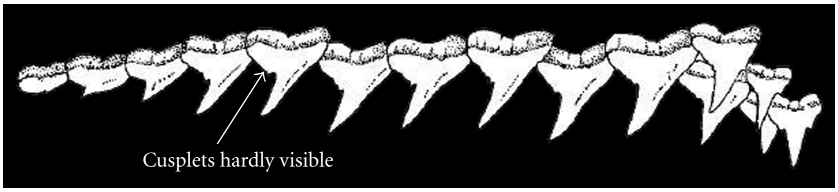

Figure 9: *Paragaleus tengi*. Teeth from the right upper jaw after Chen [32].

stripes on their caudal fin and the base of the second dorsal fin is not longer than that of the first dorsal fin (Figures 13(b), 13(c), and 13(f)). The rudimentary dark and light bands clearly show that the two examined specimens do not belong to *Chiloscyllium arabicum* because this species is plain-colored in all stages without any color patterns. Additionally, *Chiloscyllium arabicum* has only been reported from the northwestern Indian Ocean, from the Persian Gulf to the western coast of India [17]. A striped pattern of alternating dark and light bands (which is very distinct in juveniles but pales almost completely into plain brown or gray when maturing) is only present in three species of *Chiloscyllium*: *C. griseum*, *C. hasseltii* Bleeker [29], and *C. punctatum* Müller and Henle [14]. Of these species *Chiloscyllium punctatum* can be excluded from the determination of the two examined specimens because in this species the posterior margins of the dorsal fins are concave and the free rear tips are elongated [37], whereas in the specimens ZMH 25675 and ZMH 25676 the dorsal fins have convex posterior margins and not elongated free rear tips (Figures 13(c), 13(d)).

The two examined specimens differ from *Chiloscyllium hasseltii* in having only pale dark bands compared to the light bands as well as broader and, therefore, fewer light bands. In *Chiloscyllium hasseltii* the dark bands are more distinct and black edged and there are more and narrower light bands [19]. Furthermore, the height of the first dorsal fin is 7.8% of total length in specimen ZMH 25675 and 7.2% in ZMH 25676. Following Dingerkus and DeFino [37] and Gloerfelt-Tarp and Kailola [38], this ratio is over 6.6% in *Chiloscyllium griseum* and less than that in *C. hasseltii*. Additionally, the height of the second dorsal fin compared to the total length is 6.3% in ZMH 25675 and 6.1% in ZMH 25676. This ratio is over 5.8% in *Chiloscyllium griseum* and less than 5.8% in *C. hasseltii* [37, 38]. The same values for these two ratios are given by Compagno [19] in his key to species. However, in his detailed descriptions of both species the values for the first and second dorsal fins are interchanged in each species because the height of the first dorsal fin is specified as being smaller than that of the second one. In the Thai and comparative specimens as well as following Compagno et al. [17], Compagno [24] and Dingerkus and DeFino [37], the first dorsal fins are higher than the second ones in both species.

The third proportion mentioned by Compagno [19] is the ratio between the interdorsal space and the total length. In specimen ZMH 25675 this ratio is 7.3% and in ZMH 25676 it is 7.9%. Compagno [19] lists a ratio of 8.7–11.5% for *Chiloscyllium griseum* and 6.6–11.1% for *C. hasseltii*. Therefore, both examined specimens are rather accord with the description of *Chiloscyllium hasseltii* than with that of *C. griseum* regarding this ratio. However, this proportion seems to be rather insignificant due to its high margin of variation.

In contrast to Compagno [19], who indicates that the base of the first dorsal fin is longer than that of the second one in *Chiloscyllium griseum*, the bases of both fins are about equal in length in each of the two examined specimens. The only species of *Chiloscyllium*, in which the first dorsal fin base is not longer than the second one, are *C. arabicum* and *C. punctatum*, which can be excluded from the determination due to the earlier mentioned differences. In *Chiloscyllium arabicum* the base of the second dorsal fin is even longer than that of the first one [17, 19, 24].

Although the dorsal ridges of *Chiloscyllium griseum* are not prominent following Compagno [19, 24] or even absent after Compagno et al. [17], both examined specimens have distinct pre—and interdorsal ridges. The *Chiloscyllium griseum* specimens which were examined by way of comparison also have quite prominent to prominent ridges pre—and interdorsally. According to Compagno [19, 24]

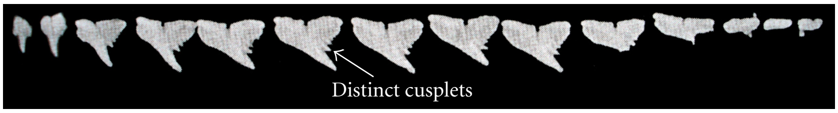

Figure 10: *Paragaleus tengi*. Teeth from the left upper jaw after Compagno [33].

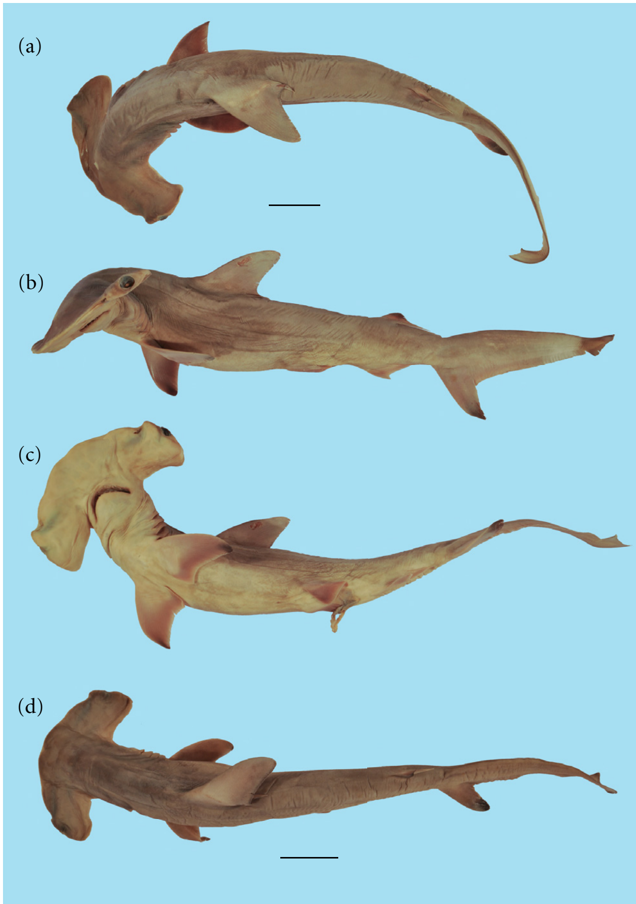

Figure 11: *Sphyrna lewini* (a)–(c) ZMH 25679: (a) dorsal view, (b) lateral view, (c) ventral view. Scale bar (a)–(c) 5 cm. (d) ZMH 25680: dorsal view. Scale bar (d) 5 cm.

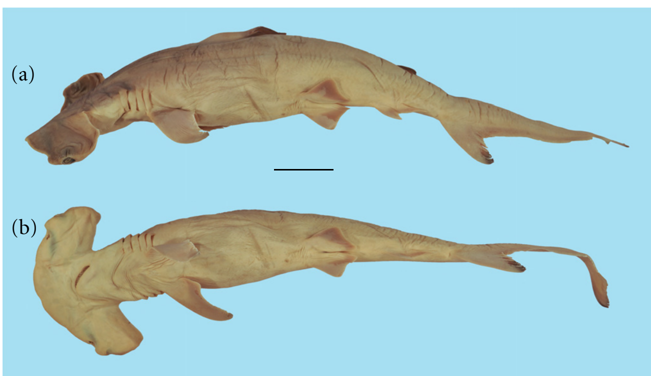

Figure 12: *Sphyrna lewini*, ZMH 25680: (a) lateral view, (b) ventral view. Scale bar (a)–(b) 5 cm.

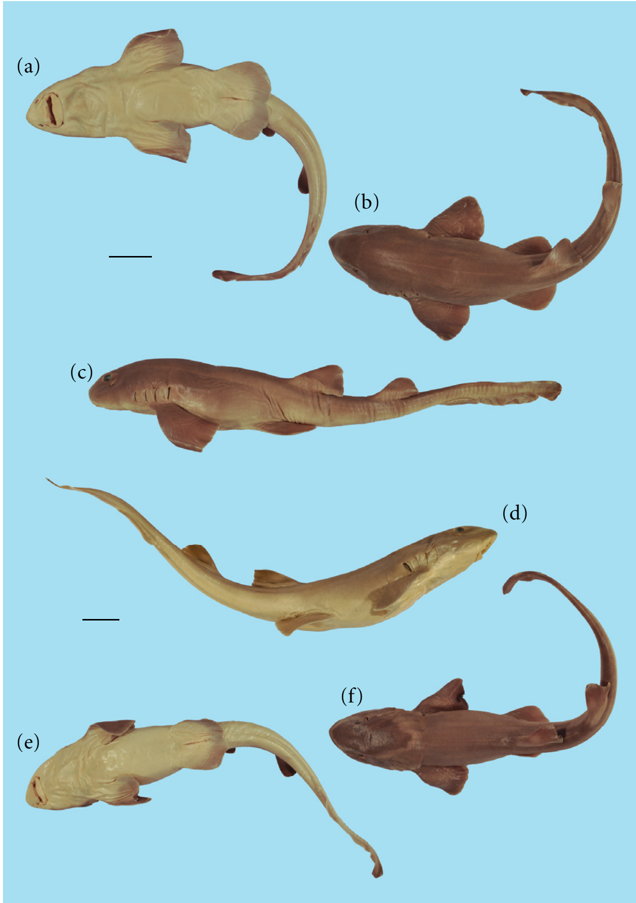

Figure 13: *Chiloscyllium griseum*: (a)–(c) ZMH 25675: (a) ventral view, (b) dorsal view, (c) lateral view. Scale bar (a)–(c) 5 cm. (d)–(f) ZMH 25676: (d) lateral view, (e) ventral view, (f) dorsal view. Scale bar (d)–(f) 5 cm.

and Compagno et al. [17], only *Chiloscyllium arabicum, C. indicum,* and *C. plagiosum* have prominent dorsal ridges but these species can be excluded from the determination of the examined Thai specimens by means of other, unambiguous differences. Dingerkus and DeFino [37] specify the dorsal ridges of *Chiloscyllium griseum* at least as quite prominent, but slightly less pronounced than in *C. arabicum*.

One highly unusual character can be found in the specimen ZMH 25676, which has a very big ocellar blotch on the head (Figure 13(f)). Such a blotch has not been described before for a species of the genus *Chiloscyllium* and is probably the remains of an untypical juvenile color pattern.

Specimen ZMH 25675 has 29 tooth rows in the upper and 27 rows in the lower jaw, specimen ZMH 25676 has 31 and 27 tooth rows. Fowler [27] lists 30 to 32 tooth rows per jaw for *Chiloscyllium griseum*.

3.6. Chiloscyllium punctatum Müller and Henle [14]. *Chiloscyllium punctatum* lives in coral reefs and, possibly, also in offshore soft bottoms to at least 85 m depth. Its distribution area ranges from East India over most parts of Southeast Asia to the whole northern coast of Australia in the south and East China and South Japan in the north [17].

The two specimens of *Chiloscyllium punctatum* (ZMH 25677 and ZMH 25678) were caught by local fishermen in the Gulf of Thailand near Pak Phanang on the 7th December 1993. Last and Stevens [1] list a maximal total length of at least 132 cm (144 cm in captivity) with the males maturing at 82 cm and the females at 87 cm total length. Accordingly, both examined specimens with total lengths of 56 cm and 61.7 cm, respectively, have to be considered as juveniles. This is also evidenced by the not-yet-well-developed claspers of the male specimen ZMH 25678 (Figure 14(f)).

Three habitus photographs of each of the specimens ZMH 25677 and ZMH 25678 are shown in Figure 14 and their measurements in Tables 9 and 10.

As described for *Chiloscyllium punctatum* by Last and Stevens [1]—and contrary to all other species of the genus—the examined specimens have dorsal fins with concave posterior margins and elongated free rear tips (Figures 14(b), 14(e)). Additionally, following Last and Stevens [1], the origin of the first dorsal fin is situated far anteriorly (over the anterior base of the pelvic fins), the bases of both dorsal fins are about equal in length, there are no lateral ridges on the body and the origin of the anal fin is situated about under or slightly behind the free rear tip of the second dorsal fin (Figures 14(b), 14(e)).

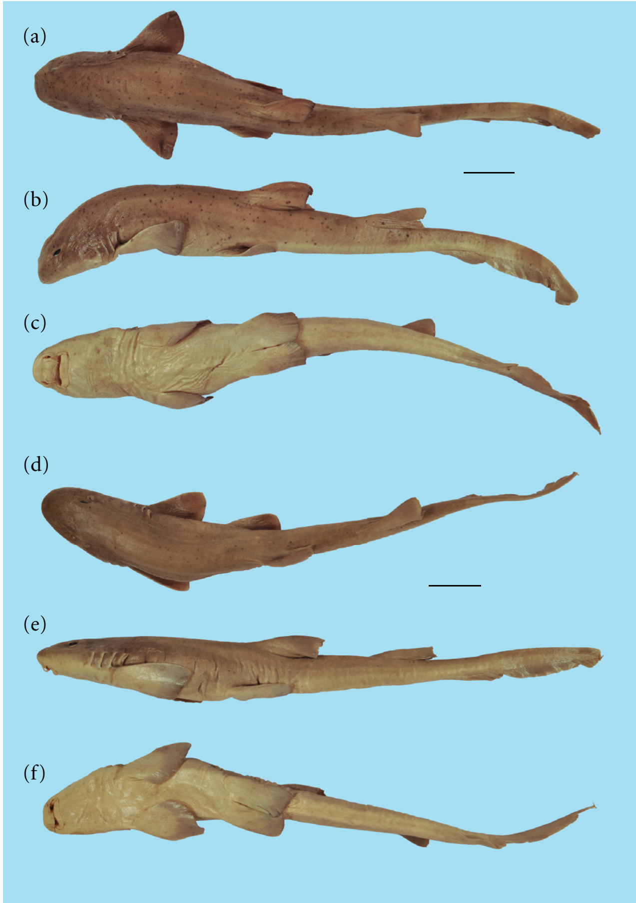

Figure 14: *Chiloscyllium punctatum*: (a)–(c) ZMH 25677: (a) dorsal view, (b) lateral view, (c) ventral view. Scale bar (a)–(c) 5 cm. (d)–(f) ZMH 25678: (d) dorsal view, (e) lateral view, (f) ventral view. Scale bar (d)–(f) 5 cm.

Both examined specimens show faded alternating dark and bright bands, which are remains of the distinct juvenile color pattern of this species (Figures 14(a), 14(b), 14(d), and 14(e)). Additionally, both specimens—especially specimen ZMH 25677—have black spots on the body (Figures 14(a), 14(b), 14(d), and 14(e)) as typical for older juveniles of the species following Dingerkus and DeFino [37]. Adult specimens of *Chiloscyllium punctatum* are almost plain brown, similar to those of *C. arabicum*, *C. griseum*, and *C. hasseltii* [37].

Specimen ZMH 25677 has 32 tooth rows in the upper and 31 in the lower jaw, and specimen ZMH 25678 has 31 and 30 tooth rows. Last and Stevens [1] specify between 31 and 33 tooth rows for the upper and 30 to 33 for the lower jaw of *Chiloscyllium punctatum*. Fowler [27] lists 30 tooth rows for the upper and 28 rows for the lower jaw of this species.

4. Conclusion

The results provide several new findings regarding the taxonomy and distribution of the examined species. Additionally, inaccuracies and errors from different references are described and clarified. As 26 to 73 million sharks get caught in commercial fishery each year [39], it is very important to improve our knowledge about these animals. In order to find out which species are particularly used commercially, it is very important to be able to identify the species quickly and accurately. A reliable determination is essential for effective protection and management programs. As mentioned before, detailed morphological information is scarce for several species due to the partially sketchy original descriptions like those by Müller and Henle [14]. Detailed morphological, morphometrical, and meristical descriptions as well as meaningful and detailed drawings are usually missing in their descriptions. Additionally, the margin of variation of a character or ratio in one species is often not fully known, as detected for example in *Paragaleus randalli*. Furthermore, extensive data about the abundance and the conservation status are not available for almost half of all Elasmobranchii [40]. The disagreement about the exact number of known cartilaginous fish species (1168 according to Fowler et al. [2], 1115 after Camhi et al. [40], over 1200 following Last and Stevens [1]) as well as the many newly described species in recent years [1, 10–13] also shows that there is still a huge need for further taxonomic and systematic research in sharks.

The knowledge deficits revealed in this study are, at least partially, based on short and imprecise original descriptions.

Table 2: Measurements of *Carcharhinus dussumieri*, ZMH 25683. Weight: 1831 g, sex: male.

Measurement	[mm]	[%TL]
TL, total length	750	100.0
FOR, fork length	614	81.9
PRC, precaudal length	555	74.0
PD2, pre-D2-length	458	61.1
PD1, pre-D1-length	250	33.3
HDL, head length	160	21.3
PG1, prebranchial length	121	16.1
PDP, prespiracular length	—	—
POB, preorbital length	59	7.9
PP1, prepectoral length	147	19.6
PP2, prepelvic length	325	43.3
SVL, snout—anterior vent length	343	45.7
PAL, preanal fin length	457	60.9
IDS, interdorsal space	181	24.1
DCS, dorsal (D2)—caudal space	62	8.3
PPS, pectoral—pelvic space	152	20.3
PAS, pelvic—anal space	82	10.9
ACS, anal—caudal space	59	7.9
PCA, pelvic—caudal space	193	25.7
VCL, anterior vent—caudal tip l.	400	53.3
PRN, prenarial length	22	2.9
POR, preoral length	45	6.0
EYL, eye length	16.4	2.2
EYH, eye height	13.6	1.8
ING, intergill length 1st to last slit	38	5.1
GS1, 1st gill slit height (unspread)	17	2.3
GS2, 2nd gill slit height	20	2.7
GS3, 3rd gill slit height	21	2.8
GS4, 4th gill slit height	20.3	2.7
GS5, 5th gill slit height	14	1.9
P1A, pectoral anterior margin l.	118	15.7
P1B, pectoral base length	41	5.5
P1I, pectoral inner margin length	44	5.9
P1P, pectoral posterior margin length	90	12.0
P1H, pectoral height (base end to tip)	99	13.2
P1L, pec. length (ant. base to post. tip)	79	10.5
SOD, subocular pocket depth	6	0.8
CDM, dorsal caudal margin length	190	25.3
CPV, preventral caudal margin length	92.5	12.3
CPU, upper postventral C margin l.	88	11.7
CPL, lower postventral C margin l.	40	5.3
CFW, caudal fork width	54	7.2
CFL, caudal fork length	59	7.9
CST, subterminal C margin length	19	2.5
CSW, subterminal caudal width	18	2.4
CTR, terminal caudal margin length	41	5.5
CTL, terminal caudal lobe length	53	7.1
D1L, D1 total length	118	15.7

Table 2: Continued.

Measurement	[mm]	[%TL]
D1A, D1 anterior margin length	120	16.0
D1B, D1 base length	78	10.4
D1H, D1 vertical height	73	9.7
D1I, D1 inner margin length	39	5.2
D1P, D1 posterior margin length	74	9.9
D2L, D2 total length	76	10.1
D2A, D2 anterior margin length	47	6.3
D2B, D2 base length	44	5.9
D2H, D2 vertical height	26	3.5
D2I, D2 inner margin length	31	4.1
D2P, D2 posterior margin length	42	5.6
P2L, pelvic total length	70	9.3
P2A, pelvic anterior margin length	51.5	6.9
P2B, pelvic base length	39	5.2
P2H, pelvic height = max. width	34	4.5
P2I, pelvic inner margin length	22	2.9
P2P, pelvic posterior margin length	39	5.2
ANL, anal fin total length	73	9.7
ANA, anal fin anterior margin length	46	6.1
ANB, anal fin base length	41	5.5
ANH, anal fin vertical height	24	3.2
ANI, anal fin inner margin length	33	4.4
ANP, anal fin posterior margin l.	39.5	5.3
HDH, head height at P origin	80	10.7
TRH, trunk height at P base end	87	11.6
ABH, abdomen height at D1B end	100	13.3
TAH, tail height at pelvic base end	68	9.1
CPH, caudal peduncle height	29	3.9
DPI, D1 midpoint—pectoral base end	70	9.3
DPO, D1 midpoint—pelvic origin	70	9.3
PDI, pelvic midpoint—D1 base end	70	9.3
PDO, pelvic midpoint—D2 origin	110	14.7
DAO, D2 origin—anal fin origin	3	0.4
DAI, D2 base end—anal base end	5	0.7
MOL, mouth length (arc radius)	35	4.7
MOW, mouth width	50	6.7
ULA, upper labial furrow length	—	—
LLA, lower labial furrow length	—	—
NOW, nostril width	12	1.6
INW, internarial width	30.5	4.1
ANF, anterior nasal flap length	3.5	0.5
INO, interorbital space, “bony”	60	8.0
SPL, spiracle length	—	—
ESL, eye—spiracle space	—	—
HDW, head width at middle gill slits	79	10.5
TRW, trunk width at P base ends	76	10.1
ABW, abdomen width at D1B end	67	8.9
TAW, tail width at pelvic base ends	54	7.2
CPW, C peduncle width at C origin	25	3.3
CLO, clasper outer margin length	73	9.7
CLI, clasper inner margin length	78	10.4
CLB, clasper base width	10	1.3
Barbel length	—	—
Width of cephalofoil	—	—

Table 3: Measurements of *Hemigaleus microstoma*, ZMH 25682. Weight: 1490 g, sex: male.

Measurement	[mm]	[%TL]
TL, total length	790	100.0
FOR, fork length	660	83.5
PRC, precaudal length	605	76.6
PD2, pre-D2-length	475	60.1
PD1, pre-D1-length	220	27.8
HDL, head length	155	19.6
PG1, prebranchial length	119	15.1
PDP, prespiracular length	80	10.1
POB, preorbital length	56	7.1
PP1, prepectoral length	146	18.5
PP2, prepelvic length	340	43.0
SVL, snout—anterior vent length	355	44.9
PAL, preanal fin length	490	62.0
IDS, interdorsal space	205	25.9
DCS, dorsal (D2)—caudal space	76	9.6
PPS, pectoral—pelvic space	190	24.1
PAS, pelvic—anal space	120	15.2
ACS, anal—caudal space	72	9.1
PCA, pelvic—caudal space	220	27.8
VCL, anterior vent—caudal tip l.	435	55.1
PRN, prenarial length	25	3.2
POR, preoral length	54	6.8
EYL, eye length	20	2.5
EYH, eye height	16	2.0
ING, intergill length 1st to last slit	37	4.7
GS1, 1st gill slit height (unspread)	22	2.8
GS2, 2nd gill slit height	25	3.2
GS3, 3rd gill slit height	24	3.0
GS4, 4th gill slit height	23	2.9
GS5, 5th gill slit height	17	2.2
P1A, pectoral anterior margin l.	119	15.1
P1B, pectoral base length	34	4.3
P1I, pectoral inner margin length	37	4.7
P1P, pectoral posterior margin length	82	10.4
P1H, pectoral height (base end to tip)	100	12.7
P1L, pec. length (ant. base to post. tip)	68	8.6
SOD, subocular pocket depth	6	0.8
CDM, dorsal caudal margin length	178	22.5
CPV, preventral caudal margin length	84	10.6
CPU, upper postventral C margin l.	79.5	10.1
CPL, lower postventral C margin l.	33	4.2
CFW, caudal fork width	42	5.3
CFL, caudal fork length	54	6.8
CST, subterminal C margin length	21	2.7
CSW, subterminal caudal width	16	2.0
CTR, terminal caudal margin length	44	5.6
CTL, terminal caudal lobe length	58	7.3
D1L, D1 total length	110	13.9
D1A, D1 anterior margin length	118	14.9
D1B, D1 base length	82	10.4
D1H, D1 vertical height	60	7.6
D1I, D1 inner margin length	25.5	3.2
D1P, D1 posterior margin length	55	7.0
D2L, D2 total length	78	9.9
D2A, D2 anterior margin length	67	8.5
D2B, D2 base length	56	7.1
D2H, D2 vertical height	38	4.8
D2I, D2 inner margin length	22	2.8
D2P, D2 posterior margin length	41	5.2
P2L, pelvic total length	68	8.6
P2A, pelvic anterior margin length	65	8.2
P2B, pelvic base length	43	5.4
P2H, pelvic height = max. width	41	5.2
P2I, pelvic inner margin length	27	3.4
P2P, pelvic posterior margin length	40	5.1
ANL, anal fin total length	62	7.8
ANA, anal fin anterior margin length	52	6.6
ANB, anal fin base length	44	5.6
ANH, anal fin vertical height	29	3.7
ANI, anal fin inner margin length	19	2.4
ANP, anal fin posterior margin l.	30	3.8
HDH, head height at P origin	69	8.7
TRH, trunk height at P base end	79	10.0
ABH, abdomen height at D1B end	86	10.9
TAH, tail height at pelvic base end	56	7.1
CPH, caudal peduncle height	22.5	2.8
DPI, D1 midpoint—pectoral base end	90	11.4
DPO, D1 midpoint—pelvic origin	78	9.9
PDI, pelvic midpoint—D1 base end	85	10.8
PDO, pelvic midpoint—D2 origin	112	14.2
DAO, D2 origin—anal fin origin	10	1.3
DAI, D2 base end—anal base end	2	0.3
MOL, mouth length (arc radius)	16	2.0
MOW, mouth width	44	5.6
ULA, upper labial furrow length	12	1.5
LLA, lower labial furrow length	7.8	1.0
NOW, nostril width	14.5	1.8
INW, internarial width	29	3.7
ANF, anterior nasal flap length	5.3	0.7
INO, interorbital space, “bony”	48	6.1
SPL, spiracle length	2	0.3
ESL, eye—spiracle space	8	1.0
HDW, head width at middle gill slits	63	8.0
TRW, trunk width at P base ends	68	8.6
ABW, abdomen width at D1B end	61	7.7
TAW, tail width at pelvic base ends	52	6.6
CPW, C peduncle width at C origin	17.5	2.2
CLO, clasper outer margin length	56	7.1
CLI, clasper inner margin length	63	8.0
CLB, clasper base width	8	1.0
Barbel length	—	—
Width of cephalofoil	—	—

Table 4: Measurements of *Paragaleus randalli*, ZMH 25681. Weight: 1026 g, sex: male.

Measurement	[mm]	[%TL]
TL, total length	750	100.0
FOR, fork length	620	82.7
PRC, precaudal length	570	76.0
PD2, pre-D2-length	450	60.0
PD1, pre-D1-length	215	28.7
HDL, head length	150	20.0
PG1, prebranchial length	111	14.8
PDP, prespiracular length	75	10.0
POB, preorbital length	52.5	7.0
PP1, prepectoral length	140	18.7
PP2, prepelvic length	320	42.7
SVL, snout—anterior vent length	335	44.7
PAL, preanal fin length	470	62.7
IDS, interdorsal space	195	26.0
DCS, dorsal (D2)—caudal space	85	11.3
PPS, pectoral—pelvic space	160	21.3
PAS, pelvic—anal space	110	14.7
ACS, anal—caudal space	75	10.0
PCA, pelvic—caudal space	225	30.0
VCL, anterior vent—caudal tip l.	430	57.3
PRN, prenarial length	32	4.3
POR, preoral length	46.5	6.2
EYL, eye length	17	2.3
EYH, eye height	9.5	1.3
ING, intergill length 1st to last slit	38	5.1
GS1, 1st gill slit height (unspread)	17.5	2.3
GS2, 2nd gill slit height	18.5	2.5
GS3, 3rd gill slit height	21	2.8
GS4, 4th gill slit height	21.5	2.9
GS5, 5th gill slit height	17	2.3
P1A, pectoral anterior margin l.	93	12.4
P1B, pectoral base length	30	4.0
P1I, pectoral inner margin length	38	5.1
P1P, pectoral posterior margin length	55	7.3
P1H, pectoral height (base end to tip)	78	10.4
P1L, pec. length (ant. base to post. tip)	67	8.9
SOD, subocular pocket depth	8.5	1.1
CDM, dorsal caudal margin length	165	22.0
CPV, preventral caudal margin length	66	8.8
CPU, upper postventral C margin l.	77	10.3
CPL, lower postventral C margin l.	20	2.7
CFW, caudal fork width	39	5.2
CFL, caudal fork length	49.5	6.6
CST, subterminal C margin length	24	3.2
CSW, subterminal caudal width	15.7	2.1
CTR, terminal caudal margin length	39	5.2
CTL, terminal caudal lobe length	53	7.1
D1L, D1 total length	89	11.9
D1A, D1 anterior margin length	83	11.1
D1B, D1 base length	67	8.9
D1H, D1 vertical height	50	6.7
D1I, D1 inner margin length	25	3.3
D1P, D1 posterior margin length	59	7.9
D2L, D2 total length	66	8.8
D2A, D2 anterior margin length	52	6.9
D2B, D2 base length	50	6.7
D2H, D2 vertical height	32	4.3
D2I, D2 inner margin length	21	2.8
D2P, D2 posterior margin length	43.5	5.8
P2L, pelvic total length	65	8.7
P2A, pelvic anterior margin length	56	7.5
P2B, pelvic base length	37	4.9
P2H, pelvic height = max. width	32	4.3
P2I, pelvic inner margin length	17	2.3
P2P, pelvic posterior margin length	31	4.1
ANL, anal fin total length	57	7.6
ANA, anal fin anterior margin length	44	5.9
ANB, anal fin base length	40.5	5.4
ANH, anal fin vertical height	22	2.9
ANI, anal fin inner margin length	18	2.4
ANP, anal fin posterior margin l.	25.5	3.4
HDH, head height at P origin	63	8.4
TRH, trunk height at P base end	72	9.6
ABH, abdomen height at D1B end	71	9.5
TAH, tail height at pelvic base end	54	7.2
CPH, caudal peduncle height	21	2.8
DPI, D1 midpoint—pectoral base end	75	10.0
DPO, D1 midpoint—pelvic origin	73	9.7
PDI, pelvic midpoint—D1 base end	70	9.3
PDO, pelvic midpoint—D2 origin	122	16.3
DAO, D2 origin—anal fin origin	8	1.1
DAI, D2 base end—anal base end	1	0.1
MOL, mouth length (arc radius)	18	2.4
MOW, mouth width	32	4.3
ULA, upper labial furrow length	12	1.6
LLA, lower labial furrow length	8	1.1
NOW, nostril width	9	1.2
INW, internarial width	23.5	3.1
ANF, anterior nasal flap length	3.5	0.5
INO, interorbital space, “bony”	42	5.6
SPL, spiracle length	1	0.1
ESL, eye—spiracle space	7	0.9
HDW, head width at middle gill slits	52	6.9
TRW, trunk width at P base ends	58	7.7
ABW, abdomen width at D1B end	51	6.8
TAW, tail width at pelvic base ends	43	5.7
CPW, C peduncle width at C origin	16	2.1
CLO, clasper outer margin length	55	7.3
CLI, clasper inner margin length	61	8.1
CLB, clasper base width	9	1.2
Barbel length	—	—
Width of cephalofoil	—	—

Table 5: Measurements of *Sphyrna lewini*, ZMH 25679. Weight: 766 g, sex: female.

Measurement	[mm]	[%TL]
TL, total length	580	100.0
FOR, fork length	425	73.3
PRC, precaudal length	385	66.4
PD2, pre-D2-length	325	56.0
PD1, pre-D1-length	140	24.1
HDL, head length	135	23.3
PG1, prebranchial length	101	17.4
PDP, prespiracular length	—	—
POB, preorbital length	38	6.6
PP1, prepectoral length	125	21.6
PP2, prepelvic length	253	43.6
SVL, snout—anterior vent length	265	45.7
PAL, preanal fin length	315	54.3
IDS, interdorsal space	119	20.5
DCS, dorsal (D2)—caudal space	40	6.9
PPS, pectoral—pelvic space	116	20.0
PAS, pelvic—anal space	44	7.6
ACS, anal—caudal space	34	5.9
PCA, pelvic—caudal space	110	19.0
VCL, anterior vent—caudal tip l.	318	54.8
PRN, prenarial length	26	4.5
POR, preoral length	39	6.7
EYL, eye length	13	2.2
EYH, eye height	11	1.9
ING, intergill length 1st to last slit	38	6.6
GS1, 1st gill slit height (unspread)	16	2.8
GS2, 2nd gill slit height	19	3.3
GS3, 3rd gill slit height	21	3.6
GS4, 4th gill slit height	19.4	3.3
GS5, 5th gill slit height	15	2.6
P1A, pectoral anterior margin l.	73.5	12.7
P1B, pectoral base length	32	5.5
P1I, pectoral inner margin length	26	4.5
P1P, pectoral posterior margin length	46	7.9
P1H, pectoral height (base end to tip)	60.5	10.4
P1L, pec. length (ant. base to post. tip)	55	9.5
SOD, subocular pocket depth	5	0.9
CDM, dorsal caudal margin length	185	31.9
CPV, preventral caudal margin length	69.5	12.0
CPU, upper postventral C margin l.	122	21.0
CPL, lower postventral C margin l.	33.5	5.8
CFW, caudal fork width	49	8.4
CFL, caudal fork length	46	7.9
CST, subterminal C margin length	16	2.8
CSW, subterminal caudal width	13	2.2
CTR, terminal caudal margin length	25.5	4.4
CTL, terminal caudal lobe length	34	5.9
D1L, D1 total length	87	15.0

Table 5: Continued.

Measurement	[mm]	[%TL]
D1A, D1 anterior margin length	99	17.1
D1B, D1 base length	63	10.9
D1H, D1 vertical height	68	11.7
D1I, D1 inner margin length	23	4.0
D1P, D1 posterior margin length	62	10.7
D2L, D2 total length	51	8.8
D2A, D2 anterior margin length	27	4.7
D2B, D2 base length	22	3.8
D2H, D2 vertical height	15	2.6
D2I, D2 inner margin length	30	5.2
D2P, D2 posterior margin length	31	5.3
P2L, pelvic total length	47	8.1
P2A, pelvic anterior margin length	33	5.7
P2B, pelvic base length	31	5.3
P2H, pelvic height = max. width	29	5.0
P2I, pelvic inner margin length	31	5.3
P2P, pelvic posterior margin length	34	5.9
ANL, anal fin total length	54	9.3
ANA, anal fin anterior margin length	32	5.5
ANB, anal fin base length	33	5.7
ANH, anal fin vertical height	17	2.9
ANI, anal fin inner margin length	23	4.0
ANP, anal fin posterior margin l.	32	5.5
HDH, head height at P origin	69	11.9
TRH, trunk height at P base end	73	12.6
ABH, abdomen height at D1B end	66.5	11.5
TAH, tail height at pelvic base end	59	10.2
CPH, caudal peduncle height	28.5	4.9
DPI, D1 midpoint—pectoral base end	42	7.2
DPO, D1 midpoint—pelvic origin	72	12.4
PDI, pelvic midpoint—D1 base end	53	9.1
PDO, pelvic midpoint—D2 origin	68	11.7
DAO, D2 origin—anal fin origin	10	1.7
DAI, D2 base end—anal base end	3	0.5
MOL, mouth length (arc radius)	20	3.4
MOW, mouth width	40	6.9
ULA, upper labial furrow length	—	—
LLA, lower labial furrow length	1.5	0.3
NOW, nostril width	11.8	2.0
INW, internarial width	109.5	18.9
ANF, anterior nasal flap length	—	—
INO, interorbital space, “bony”	147	25.3
SPL, spiracle length	—	—
ESL, eye—spiracle space	—	—
HDW, head width at middle gill slits	54	9.3
TRW, trunk width at P base ends	55	9.5
ABW, abdomen width at D1B end	48	8.3
TAW, tail width at pelvic base ends	40	6.9
CPW, C peduncle width at C origin	17	2.9
CLO, clasper outer margin length	—	—
CLI, clasper inner margin length	—	—
CLB, clasper base width	—	—
Barbel length	—	—
Width of cephalofoil	153	26.4

Table 6: Measurements of *Sphyrna lewini*, ZMH 25680. Weight: 500 g, sex: female.

Measurement	[mm]	[%TL]
TL, total length	513	100.0
FOR, fork length	384	74.9
PRC, precaudal length	345	67.3
PD2, pre-D2-length	300	58.5
PD1, pre-D1-length	140	27.3
HDL, head length	118	23.0
PG1, prebranchial length	91	17.7
PDP, prespiracular length	—	—
POB, preorbital length	30	5.8
PP1, prepectoral length	112	21.8
PP2, prepelvic length	230	44.8
SVL, snout—anterior vent length	240	46.8
PAL, preanal fin length	285	55.6
IDS, interdorsal space	115	22.4
DCS, dorsal (D2)—caudal space	37	7.2
PPS, pectoral—pelvic space	98	19.1
PAS, pelvic—anal space	33	6.4
ACS, anal—caudal space	31	6.0
PCA, pelvic—caudal space	87	17.0
VCL, anterior vent—caudal tip l.	271	52.8
PRN, prenarial length	23	4.5
POR, preoral length	36	7.0
EYL, eye length	11.5	2.2
EYH, eye height	12.5	2.4
ING, intergill length 1st to last slit	29	5.7
GS1, 1st gill slit height (unspread)	14	2.7
GS2, 2nd gill slit height	15	2.9
GS3, 3rd gill slit height	17	3.3
GS4, 4th gill slit height	15	2.9
GS5, 5th gill slit height	13	2.5
P1A, pectoral anterior margin l.	63	12.3
P1B, pectoral base length	25	4.9
P1I, pectoral inner margin length	21	4.1
P1P, pectoral posterior margin length	39	7.6
P1H, pectoral height (base end to tip)	52	10.1
P1L, pec. length (ant. base to post. tip)	44	8.6
SOD, subocular pocket depth	3	0.6
CDM, dorsal caudal margin length	164	32.0
CPV, preventral caudal margin length	60	11.7
CPU, upper postventral C margin l.	99	19.3
CPL, lower postventral C margin l.	22	4.3
CFW, caudal fork width	39	7.6
CFL, caudal fork length	40	7.8
CST, subterminal C margin length	15	2.9
CSW, subterminal caudal width	12.5	2.4
CTR, terminal caudal margin length	21.5	4.2
CTL, terminal caudal lobe length	30	5.8
D1L, D1 total length	73	14.2
D1A, D1 anterior margin length	88	17.2
D1B, D1 base length	57.5	11.2
D1H, D1 vertical height	56	10.9
D1I, D1 inner margin length	18	3.5
D1P, D1 posterior margin length	45	8.8
D2L, D2 total length	46	9.0
D2A, D2 anterior margin length	24	4.7
D2B, D2 base length	21	4.1
D2H, D2 vertical height	11.5	2.2
D2I, D2 inner margin length	25	4.9
D2P, D2 posterior margin length	25	4.9
P2L, pelvic total length	42	8.2
P2A, pelvic anterior margin length	33	6.4
P2B, pelvic base length	27	5.3
P2H, pelvic height = max. width	25.5	5.0
P2I, pelvic inner margin length	16.5	3.2
P2P, pelvic posterior margin length	25	4.9
ANL, anal fin total length	49	9.6
ANA, anal fin anterior margin length	31	6.0
ANB, anal fin base length	29.5	5.8
ANH, anal fin vertical height	18	3.5
ANI, anal fin inner margin length	21	4.1
ANP, anal fin posterior margin l.	24	4.7
HDH, head height at P origin	52	10.1
TRH, trunk height at P base end	60	11.7
ABH, abdomen height at D1B end	67	13.1
TAH, tail height at pelvic base end	49	9.6
CPH, caudal peduncle height	23	4.5
DPI, D1 midpoint—pectoral base end	20	3.9
DPO, D1 midpoint—pelvic origin	58	11.3
PDI, pelvic midpoint—D1 base end	47	9.2
PDO, pelvic midpoint—D2 origin	57	11.1
DAO, D2 origin—anal fin origin	14	2.7
DAI, D2 base end—anal base end	2	0.4
MOL, mouth length (arc radius)	17	3.3
MOW, mouth width	31.5	6.1
ULA, upper labial furrow length	—	—
LLA, lower labial furrow length	2	0.4
NOW, nostril width	11	2.1
INW, internarial width	93	18.1
ANF, anterior nasal flap length	—	—
INO, interorbital space, “bony”	125	24.4
SPL, spiracle length	—	—
ESL, eye—spiracle space	—	—
HDW, head width at middle gill slits	43	8.4
TRW, trunk width at P base ends	47	9.2
ABW, abdomen width at D1B end	38	7.4
TAW, tail width at pelvic base ends	33	6.4
CPW, C peduncle width at C origin	17	3.3
CLO, clasper outer margin length	—	—
CLI, clasper inner margin length	—	—
CLB, clasper base width	—	—
Barbel length	—	—
Width of cephalofoil	132	25.7

Table 7: Measurements of *Chiloscyllium griseum*, ZMH 25675. Weight: 704 g, sex: female.

Measurement	[mm]	[%TL]
TL, total length	560	100.0
FOR, fork length	—	—
PRC, precaudal length	425	75.9
PD2, pre-D2-length	320	57.1
PD1, pre-D1-length	220	39.3
HDL, head length	125	22.3
PG1, prebranchial length	90	16.1
PDP, prespiracular length	51.5	9.2
POB, preorbital length	43.5	7.8
PP1, prepectoral length	97	17.3
PP2, prepelvic length	205	36.6
SVL, snout—anterior vent length	211	37.7
PAL, preanal fin length	400	71.4
IDS, interdorsal space	41	7.3
DCS, dorsal (D2)—caudal space	52	9.3
PPS, pectoral—pelvic space	67	12.0
PAS, pelvic—anal space	160.5	28.7
ACS, anal—caudal space	0	0.0
PCA, pelvic—caudal space	214.5	38.3
VCL, anterior vent—caudal tip l.	353	63.0
PRN, prenarial length	13.3	2.4
POR, preoral length	27	4.8
EYL, eye length	11.4	2.0
EYH, eye height	6	1.1
ING, intergill length 1st to last slit	34.5	6.2
GS1, 1st gill slit height (unspread)	12.5	2.2
GS2, 2nd gill slit height	14.5	2.6
GS3, 3rd gill slit height	15.7	2.8
GS4, 4th gill slit height	13.5	2.4
GS5, 5th gill slit height	14	2.5
P1A, pectoral anterior margin l.	77.5	13.8
P1B, pectoral base length	40	7.1
P1I, pectoral inner margin length	37	6.6
P1P, pectoral posterior margin length	55	9.8
P1H, pectoral height (base end to tip)	67	12.0
P1L, pec. length (ant. base to post. tip)	74.5	13.3
SOD, subocular pocket depth	—	—
CDM, dorsal caudal margin length	136	24.3
CPV, preventral caudal margin length	—	—
CPU, upper postventral C margin l.	—	—
CPL, lower postventral C margin l.	—	—
CFW, caudal fork width	—	—
CFL, caudal fork length	—	—
CST, subterminal C margin length	20	3.6
CSW, subterminal caudal width	17	3.0
CTR, terminal caudal margin length	23	4.1
CTL, terminal caudal lobe length	31	5.5
D1L, D1 total length	66.5	11.9

Table 7: Continued.

Measurement	[mm]	[%TL]
D1A, D1 anterior margin length	63	11.3
D1B, D1 base length	50.5	9.0
D1H, D1 vertical height	43.5	7.8
D1I, D1 inner margin length	20	3.6
D1P, D1 posterior margin length	34.5	6.2
D2L, D2 total length	69	12.3
D2A, D2 anterior margin length	64	11.4
D2B, D2 base length	51	9.1
D2H, D2 vertical height	35.5	6.3
D2I, D2 inner margin length	17	3.0
D2P, D2 posterior margin length	29.5	5.3
P2L, pelvic total length	70.5	12.6
P2A, pelvic anterior margin length	54	9.6
P2B, pelvic base length	28	5.0
P2H, pelvic height = max. width	44.5	7.9
P2I, pelvic inner margin length	24	4.3
P2P, pelvic posterior margin length	42	7.5
ANL, anal fin total length	59	10.5
ANA, anal fin anterior margin length	—	—
ANB, anal fin base length	54.5	9.7
ANH, anal fin vertical height	14.5	2.6
ANI, anal fin inner margin length	6.5	1.2
ANP, anal fin posterior margin l.	—	—
HDH, head height at P origin	59	10.5
TRH, trunk height at P base end	64	11.4
ABH, abdomen height at D1B end	35.5	6.3
TAH, tail height at pelvic base end	39	7.0
CPH, caudal peduncle height	17	3.0
DPI, D1 midpoint—pectoral base end	117	20.9
DPO, D1 midpoint—pelvic origin	50	8.9
PDI, pelvic midpoint—D1 base end	48	8.6
PDO, pelvic midpoint—D2 origin	94.5	16.9
DAO, D2 origin—anal fin origin	85	15.2
DAI, D2 base end—anal base end	87	15.5
MOL, mouth length (arc radius)	—	—
MOW, mouth width	35.5	6.3
ULA, upper labial furrow length	12	2.1
LLA, lower labial furrow length	8	1.4
NOW, nostril width	3	0.5
INW, internarial width	22.5	4.0
ANF, anterior nasal flap length	—	—
INO, interorbital space, “bony”	25	4.5
SPL, spiracle length	9.5	1.7
ESL, eye—spiracle space	—	—
HDW, head width at middle gill slits	74	13.2
TRW, trunk width at P base ends	68	12.1
ABW, abdomen width at D1B end	32	5.7
TAW, tail width at pelvic base ends	36	6.4
CPW, C peduncle width at C origin	13	2.3
CLO, clasper outer margin length	—	—
CLI, clasper inner margin length	—	—
CLB, clasper base width	—	—
Barbel length	13	2.3
Width of cephalofoil	—	—

Table 8: Measurements of *Chiloscyllium griseum*, ZMH 25676. Weight: 774 g, sex: female.

Measurement	[mm]	[%TL]
TL, total length	595	100.0
FOR, fork length	—	—
PRC, precaudal length	450	75.6
PD2, pre-D2-length	340	57.1
PD1, pre-D1-length	225	37.8
HDL, head length	130	21.8
PG1, prebranchial length	94.5	15.9
PDP, prespiracular length	52	8.7
POB, preorbital length	44	7.4
PP1, prepectoral length	109	18.3
PP2, prepelvic length	220	37.0
SVL, snout—anterior vent length	232	39.0
PAL, preanal fin length	420	70.6
IDS, interdorsal space	47	7.9
DCS, dorsal (D2)—caudal space	58	9.7
PPS, pectoral—pelvic space	80	13.4
PAS, pelvic—anal space	171	28.7
ACS, anal—caudal space	0	0.0
PCA, pelvic—caudal space	245	41.2
VCL, anterior vent—caudal tip l.	380	63.9
PRN, prenarial length	14.5	2.4
POR, preoral length	27	4.5
EYL, eye length	11	1.8
EYH, eye height	6.6	1.1
ING, intergill length 1st to last slit	38	6.4
GS1, 1st gill slit height (unspread)	14.3	2.4
GS2, 2nd gill slit height	15	2.5
GS3, 3rd gill slit height	16	2.7
GS4, 4th gill slit height	14	2.4
GS5, 5th gill slit height	14	2.4
P1A, pectoral anterior margin l.	81.5	13.7
P1B, pectoral base length	41.5	7.0
P1I, pectoral inner margin length	37	6.2
P1P, pectoral posterior margin length	59	9.9
P1H, pectoral height (base end to tip)	69	11.6
P1L, pec. length (ant. base to post. tip)	76	12.8
SOD, subocular pocket depth	—	—
CDM, dorsal caudal margin length	145	24.4
CPV, preventral caudal margin length	—	—
CPU, upper postventral C margin l.	—	—
CPL, lower postventral C margin l.	—	—
CFW, caudal fork width	—	—
CFL, caudal fork length	—	—
CST, subterminal C margin length	18	3.0
CSW, subterminal caudal width	16	2.7
CTR, terminal caudal margin length	21	3.5
CTL, terminal caudal lobe length	22.5	3.8
D1L, D1 total length	74.5	12.5

Table 8: Continued.

Measurement	[mm]	[%TL]
D1A, D1 anterior margin length	70	11.8
D1B, D1 base length	55	9.2
D1H, D1 vertical height	43	7.2
D1I, D1 inner margin length	19	3.2
D1P, D1 posterior margin length	37	6.2
D2L, D2 total length	70.5	11.8
D2A, D2 anterior margin length	66	11.1
D2B, D2 base length	55	9.2
D2H, D2 vertical height	36	6.1
D2I, D2 inner margin length	17	2.9
D2P, D2 posterior margin length	33	5.5
P2L, pelvic total length	70	11.8
P2A, pelvic anterior margin length	56	9.4
P2B, pelvic base length	27	4.5
P2H, pelvic height = max. width	45	7.6
P2I, pelvic inner margin length	29	4.9
P2P, pelvic posterior margin length	40	6.7
ANL, anal fin total length	66	11.1
ANA, anal fin anterior margin length	—	—
ANB, anal fin base length	61	10.3
ANH, anal fin vertical height	14	2.4
ANI, anal fin inner margin length	5.4	0.9
ANP, anal fin posterior margin l.	—	—
HDH, head height at P origin	58	9.7
TRH, trunk height at P base end	70	11.8
ABH, abdomen height at D1B end	37.5	6.3
TAH, tail height at pelvic base end	38	6.4
CPH, caudal peduncle height	16.5	2.8
DPI, D1 midpoint—pectoral base end	125	21.0
DPO, D1 midpoint—pelvic origin	59	9.9
PDI, pelvic midpoint—D1 base end	52	8.7
PDO, pelvic midpoint—D2 origin	103	17.3
DAO, D2 origin—anal fin origin	90	15.1
DAI, D2 base end—anal base end	99	16.6
MOL, mouth length (arc radius)	—	—
MOW, mouth width	38	6.4
ULA, upper labial furrow length	12	2.0
LLA, lower labial furrow length	9	1.5
NOW, nostril width	2.5	0.4
INW, internarial width	24	4.0
ANF, anterior nasal flap length	—	—
INO, interorbital space, “bony”	20.5	3.4
SPL, spiracle length	7.5	1.3
ESL, eye—spiracle space	—	—
HDW, head width at middle gill slits	73	12.3
TRW, trunk width at P base ends	70	11.8
ABW, abdomen width at D1B end	35	5.9
TAW, tail width at pelvic base ends	40	6.7
CPW, C peduncle width at C origin	12.5	2.1
CLO, clasper outer margin length	—	—
CLI, clasper inner margin length	—	—
CLB, clasper base width	—	—
Barbel length	13	2.2
Width of cephalofoil	—	—

Table 9: Measurements of *Chiloscyllium punctatum*, ZMH 25677. Weight: 599 g, sex: female.

Measurement	[mm]	[%TL]
TL, total length	560	100.0
FOR, fork length	—	—
PRC, precaudal length	422	75.4
PD2, pre-D2-length	310	55.4
PD1, pre-D1-length	210	37.5
HDL, head length	115	20.5
PG1, prebranchial length	85	15.2
PDP, prespiracular length	49	8.8
POB, preorbital length	43	7.7
PP1, prepectoral length	89	15.9
PP2, prepelvic length	183	32.7
SVL, snout—anterior vent length	195	34.8
PAL, preanal fin length	395	70.5
IDS, interdorsal space	57	10.2
DCS, dorsal (D2)—caudal space	57	10.2
PPS, pectoral—pelvic space	64	11.4
PAS, pelvic—anal space	172	30.7
ACS, anal—caudal space	0	0.0
PCA, pelvic—caudal space	230	41.1
VCL, anterior vent—caudal tip l.	363	64.8
PRN, prenarial length	7	1.3
POR, preoral length	19	3.4
EYL, eye length	10	1.8
EYH, eye height	4	0.7
ING, intergill length 1st to last slit	27	4.8
GS1, 1st gill slit height (unspread)	13	2.3
GS2, 2nd gill slit height	15	2.7
GS3, 3rd gill slit height	16	2.9
GS4, 4th gill slit height	16	2.9
GS5, 5th gill slit height	13.5	2.4
P1A, pectoral anterior margin l.	73	13.0
P1B, pectoral base length	30	5.4
P1I, pectoral inner margin length	35	6.3
P1P, pectoral posterior margin length	40	7.1
P1H, pectoral height (base end to tip)	64	11.4
P1L, pec. length (ant. base to post. tip)	61	10.9
SOD, subocular pocket depth	—	—
CDM, dorsal caudal margin length	113	20.2
CPV, preventral caudal margin length	—	—
CPU, upper postventral C margin l.	—	—
CPL, lower postventral C margin l.	—	—
CFW, caudal fork width	—	—
CFL, caudal fork length	—	—
CST, subterminal C margin length	19	3.4
CSW, subterminal caudal width	15	2.7
CTR, terminal caudal margin length	25	4.5
CTL, terminal caudal lobe length	30	5.4
D1L, D1 total length	79	14.1

Table 9: Continued.

Measurement	[mm]	[%TL]
D1A, D1 anterior margin length	74	13.2
D1B, D1 base length	54	9.6
D1H, D1 vertical height	47	8.4
D1I, D1 inner margin length	24.5	4.4
D1P, D1 posterior margin length	48	8.6
D2L, D2 total length	79.5	14.2
D2A, D2 anterior margin length	69	12.3
D2B, D2 base length	62	11.1
D2H, D2 vertical height	39.5	7.1
D2I, D2 inner margin length	20	3.6
D2P, D2 posterior margin length	42	7.5
P2L, pelvic total length	57	10.2
P2A, pelvic anterior margin length	55	9.8
P2B, pelvic base length	23	4.1
P2H, pelvic height = max. width	37	6.6
P2I, pelvic inner margin length	22	3.9
P2P, pelvic posterior margin length	35	6.3
ANL, anal fin total length	59	10.5
ANA, anal fin anterior margin length	—	—
ANB, anal fin base length	53	9.5
ANH, anal fin vertical height	15.5	2.8
ANI, anal fin inner margin length	9	1.6
ANP, anal fin posterior margin l.	—	—
HDH, head height at P origin	55.5	9.9
TRH, trunk height at P base end	62.5	11.2
ABH, abdomen height at D1B end	42	7.5
TAH, tail height at pelvic base end	42	7.5
CPH, caudal peduncle height	20.5	3.7
DPI, D1 midpoint—pectoral base end	110	19.6
DPO, D1 midpoint—pelvic origin	45	8.0
PDI, pelvic midpoint—D1 base end	44	7.9
PDO, pelvic midpoint—D2 origin	88	15.7
DAO, D2 origin—anal fin origin	79	14.1
DAI, D2 base end—anal base end	75	13.4
MOL, mouth length (arc radius)	—	—
MOW, mouth width	34	6.1
ULA, upper labial furrow length	9	1.6
LLA, lower labial furrow length	6	1.1
NOW, nostril width	2	0.4
INW, internarial width	21	3.8
ANF, anterior nasal flap length	—	—
INO, interorbital space, "bony"	22	3.9
SPL, spiracle length	8	1.4
ESL, eye—spiracle space	—	—
HDW, head width at middle gill slits	62	11.1
TRW, trunk width at P base ends	65	11.6
ABW, abdomen width at D1B end	35.5	6.3
TAW, tail width at pelvic base ends	39	7.0
CPW, C peduncle width at C origin	14	2.5
CLO, clasper outer margin length	—	—
CLI, clasper inner margin length	—	—
CLB, clasper base width	—	—
Barbel length	11	2.0
Width of cephalofoil	—	—

Table 10: Measurements of *Chiloscyllium punctatum*, ZMH 25678. Weight: 670 g, sex: male.

Measurement	[mm]	[%TL]
TL, total length	617	100.0
FOR, fork length	—	—
PRC, precaudal length	495	80.2
PD2, pre-D2-length	352	57.1
PD1, pre-D1-length	225	36.5
HDL, head length	121	19.6
PG1, prebranchial length	91	14.7
PDP, prespiracular length	52	8.4
POB, preorbital length	45	7.3
PP1, prepectoral length	108	17.5
PP2, prepelvic length	210	34.0
SVL, snout—anterior vent length	220	35.7
PAL, preanal fin length	440	71.3
IDS, interdorsal space	71	11.5
DCS, dorsal (D2)—caudal space	58	9.4
PPS, pectoral—pelvic space	68	11.0
PAS, pelvic—anal space	200	32.4
ACS, anal—caudal space	0	0.0
PCA, pelvic—caudal space	255	41.3
VCL, anterior vent—caudal tip l.	399	64.7
PRN, prenarial length	12	1.9
POR, preoral length	23	3.7
EYL, eye length	11.5	1.9
EYH, eye height	5	0.8
ING, intergill length 1st to last slit	31	5.0
GS1, 1st gill slit height (unspread)	14.3	2.3
GS2, 2nd gill slit height	16.4	2.7
GS3, 3rd gill slit height	17.2	2.8
GS4, 4th gill slit height	16.8	2.7
GS5, 5th gill slit height	17	2.8
P1A, pectoral anterior margin l.	81	13.1
P1B, pectoral base length	28	4.5
P1I, pectoral inner margin length	40	6.5
P1P, pectoral posterior margin length	46	7.5
P1H, pectoral height (base end to tip)	70	11.3
P1L, pec. length (ant. base to post. tip)	64	10.4
SOD, subocular pocket depth	—	—
CDM, dorsal caudal margin length	140	22.7
CPV, preventral caudal margin length	—	—
CPU, upper postventral C margin l.	—	—
CPL, lower postventral C margin l.	—	—
CFW, caudal fork width	—	—
CFL, caudal fork length	—	—
CST, subterminal C margin length	17	2.8
CSW, subterminal caudal width	17	2.8
CTR, terminal caudal margin length	20.5	3.3
CTL, terminal caudal lobe length	28	4.5
D1L, D1 total length	89	14.4

Table 10: Continued.

Measurement	[mm]	[%TL]
D1A, D1 anterior margin length	89	14.4
D1B, D1 base length	65	10.5
D1H, D1 vertical height	44	7.1
D1I, D1 inner margin length	23.5	3.8
D1P, D1 posterior margin length	50	8.1
D2L, D2 total length	76	12.3
D2A, D2 anterior margin length	73	11.8
D2B, D2 base length	59	9.6
D2H, D2 vertical height	40	6.5
D2I, D2 inner margin length	18.5	3.0
D2P, D2 posterior margin length	39	6.3
P2L, pelvic total length	62	10.0
P2A, pelvic anterior margin length	62	10.0
P2B, pelvic base length	45	7.3
P2H, pelvic height = max. width	38	6.2
P2I, pelvic inner margin length	19	3.1
P2P, pelvic posterior margin length	39	6.3
ANL, anal fin total length	65	10.5
ANA, anal fin anterior margin length	—	—
ANB, anal fin base length	55	8.9
ANH, anal fin vertical height	17	2.8
ANI, anal fin inner margin length	9	1.5
ANP, anal fin posterior margin l.	—	—
HDH, head height at P origin	54	8.8
TRH, trunk height at P base end	58	9.4
ABH, abdomen height at D1B end	40	6.5
TAH, tail height at pelvic base end	40	6.5
CPH, caudal peduncle height	17	2.8
DPI, D1 midpoint—pectoral base end	132	21.4
DPO, D1 midpoint—pelvic origin	48	7.8
PDI, pelvic midpoint—D1 base end	61	9.9
PDO, pelvic midpoint—D2 origin	123	19.9
DAO, D2 origin—anal fin origin	88	14.3
DAI, D2 base end—anal base end	78	12.6
MOL, mouth length (arc radius)	—	—
MOW, mouth width	28	4.5
ULA, upper labial furrow length	9.7	1.6
LLA, lower labial furrow length	4.5	0.7
NOW, nostril width	2.5	0.4
INW, internarial width	22	3.6
ANF, anterior nasal flap length	—	—
INO, interorbital space, "bony"	22	3.6
SPL, spiracle length	9	1.5
ESL, eye—spiracle space	—	—
HDW, head width at middle gill slits	62	10.0
TRW, trunk width at P base ends	61	9.9
ABW, abdomen width at D1B end	29.5	4.8
TAW, tail width at pelvic base ends	36	5.8
CPW, C peduncle width at C origin	13.5	2.2
CLO, clasper outer margin length	15	2.4
CLI, clasper inner margin length	27	4.4
CLB, clasper base width	5	0.8
Barbel length	13	2.1
Width of cephalofoil	—	—

Additionally, due to the many newly described species, data about similar, earlier described species have to be revalidated because they might include not only the intended, but also the newly described species.

More knowledge deficits become apparent in the not exactly known or patchy distribution areas of some species as well as the fact that the known distribution area for *Paragaleus randalli* could be extended eastwards significantly due to the examined Thai specimen. A similar extension could be found recently for another elasmobranch species, *Rhinobatos formosensis* Norman [41], the Taiwan Guitarfish [25].

Important information about distribution areas could eventually be provided by the observations of fishermen, but as mentioned before they are often not able to determine the exact species and simply declare most of their catches as "diverse Elasmobranchii" or "small sharks" [5, 15]. Easy- and fast-to-use identification keys like those by White et al. [3] or Daley et al. [42] could be very helpful for the determination. However, the exact determination of species from genera with many superficially similar species like, for example, most reef shark species (family Carcharhinidae) would still remain very difficult and time-consuming for nonscientists.

Additionally to the comments on literature in the results chapter of this paper, the author suggests to use another distinguishing feature for the differentiation of Carcharhinidae and Hemigaleidae in identification keys: Compagno [18] uses only the folding of the intestinal valve for the differentiation. However, the author suggests using the presence or absence of spiracles instead or additionally as distinctive feature for identification keys because the folding of the intestinal valve is difficult to check. The presence or absence of spiracles, in contrast, can easily be used because all Carcharhinidae with the exception of the unmistakable Tiger Shark *Galeocerdo cuvier* (Péron & Lesueur) [43] lack spiracles, whereas all Hemigaleidae do have spiracles.

When determining juvenile sharks, caution is advised in matters of possible ontogenetic changes in morphology or morphometrics. In this study the well-known morphological changes in the Hemiscyllidae species *Chiloscyllium griseum* and *C. punctatum* were found. However, some deviations from literature that were found in this study might result from ontogenetic changes, also. In an extreme case, ontogenetic changes can even lead to describing a different stage of life of a known species accidentally as a new species. This happened due to strong differences in terms of color in the Zebra Shark *Stegostoma fasciatum* (Hermann) [44]: Seba [45] described the banded juvenile stage of this species as *Squalus varius* and Gmelin [46] described the spotted adult form as *Squalus longicaudatus*.

The results indicate that differences in tooth morphology, which have commonly been used for the distinction of *Paragaleus randalli* and *P. tengi*, are probably based on imprecise or inaccurate drawings in Compagno et al. [31] and Chen [32], respectively. Actually, both species have a very similar tooth morphology. Due to these new results, *Paragaleus randalli* and *P. tengi* should not be differentiated by means of their teeth only.

In *Chiloscyllium griseum,* variability in the size of the dorsal ridges between different references and the examined specimens was detected. Unfortunately there is no information about the dorsal ridges in the original description of *Chiloscyllium griseum* [14], but only a drawing in which no dorsal ridges are shown. This drawing is probably simply inexact or not generally appropriate as Müller and Henle [14] only examined seven individuals. It might be possible that Compagno [19, 24] and Compagno et al. [17] refer to this drawing in their description of the dorsal ridges. However, the drawing in Müller and Henle [14] actually shows a specimen of *Chiloscyllium punctatum* and not *C. griseum*, which is evidenced by the pronounced concave posterior margins and elongated free rear tips of the dorsal fins. Dingerkus and DeFino [37] guess that the specimen drawn by Müller and Henle [14] is the *Chiloscyllium punctatum* specimen RMNH 4178 due to similarities in body proportions and color pattern. In Compagno et al. [17] a similar mistake was made in the black and white drawing of *Chiloscyllium griseum* because its dorsal fins were erroneously drawn with concave posterior margins and elongated free rear tips like those of *C. punctatum*. However, the corresponding textual description is correct and describes straight to convex posterior margins as well as not elongated free rear tips. The color painting of *Chiloscyllium griseum* in Compagno et al. [17] is correct, also.

Altogether, it remains unclear if the size of the dorsal ridges is very variable in this species from not present to prominent or if some sources are imprecise about this character. Generally, *Chiloscyllium griseum* is considered a taxonomically complex species and the differentiation of several species of *Chiloscyllium* remains difficult due to strong ontogenetic changes and a high margin of variation in some morphometric ratios [19, 47].

In the future the pit organs might possibly be used in support of the determination of sharks, because the abundance and distribution of these free neuromasts vary widely among species according to Budker [48], Tester and Nelson [49] and Peach [50]. However, further research including the examination of more species is needed to verify if there are species-specific patterns of pit organs and, if so, to characterize the different typal patterns.

Due to the flourishing fin trade, further research is also desirable on the identification of shark species by means of their fins. Although good progress has been made in recent years, for example, by Clarke et al. [51] and Wong et al. [52] related to the genetic and by Deynat [53] regarding the morphological distinguishing, further research is still needed.

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