Intraspecific variation of *Scorpaenopsis possi* Randall et Eschmeyer, 2002 (Pisces: Scorpaenidae)

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Abstract

The genus *Scorpaenopsis* has been intensively studied in recent decades. Sixteen species were known before the revision by Randall and Eschmeyer, who described 8 new species in 2002, and nowadays 29 species are known. Two specimens of *Scorpaenopsis* from the collection of the Zoological Institute of the Russian Academy of Sciences are intermediate in a number of parameters between *Scorpaenopsis possi* Randall et Eschmeyer 2002 and *Scorpaenopsis eschmeyeri* Randall et Greenfield 2004. The range of *S. possi* extends from the Indian Ocean coast of Africa and the Red Sea to the Marquesas Islands in the Pacific Ocean, the latitude of the range lies between the 30th latitudes of both hemispheres. The species *S. eschmeyeri* inhabits a much smaller range from the east coast of Australia to the island of Fiji. The aim of this work is to explain the appearance of *S. possi*, similar to *S. eschmeyeri* in some morphological diagnostic characters, almost 12,000 km apart from its range. The number of soft rays in the dorsal fin, which is unusual for the genus *Scorpaenopsis*, is described. Due to the lack of persistent distinguishing characters between *S. possi* and *S. eschmeyeri*, it is highly probable that both are conspecific; in that case *S. eschmeyeri* would be a junior synonym of *S. possi*.

Keywords: biodiversity, distribution, Indian Ocean, morphology, Scorpionfishes, taxonomy.

Introduction

The scorpionfish family Scorpaenidae is a group of fishes living worldwide in tropical and warm temperate marine and brackish waters (rarely in freshwater) (Nelson, Grande, and Wilson, 2016). They usually inhabit rocky substrate bottoms in coastal waters of the continental shelf and continental slope. Most species are found at shallow depths, while a few occur down to 600 m (Eschmeyer, 1969; Randall and Eschmeyer, 2002; Motomura and Causse, 2011). The family includes 381 species in 36 genera, which are widely distributed in temperate and all tropical seas and are especially abundant around the coral reefs of the Indo-Pacific region (Fricke, Eschmeyer, and Van der Laan, 2023).

The genus *Scorpaenopsis* was revised by Randall and Eschmeyer (2002), who recognised 24 valid species. The genus is mainly characterised by the absence of palatine teeth in combination of 12 dorsal-fin spines (vs 13 in the similar genus *Scorpaenodes*) (Randall and Eschmeyer, 2002). Motomura (2004) added *Scorpaenopsis insperatus* from New South Wales, Australia; Randall and Greenfield (2004) described *S. eschmeyeri* from the southwestern Pacific Ocean. Motomura (2008) demonstrated that *Scorpaenopsis stigma* Fowler, 1938 was a junior synonym of *Phenacoscorpius megalops* Fowler, 1938. Motomura and Causse (2011) described a deepwater species, *S. crenulata*, from Wallis and Futuna. Motomura, Béarez, and Causse (2011) revised Indo-Pacific specimens in the MNHN collection. Fricke,

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Competing interests: The authors have declared that no competing interests exist.

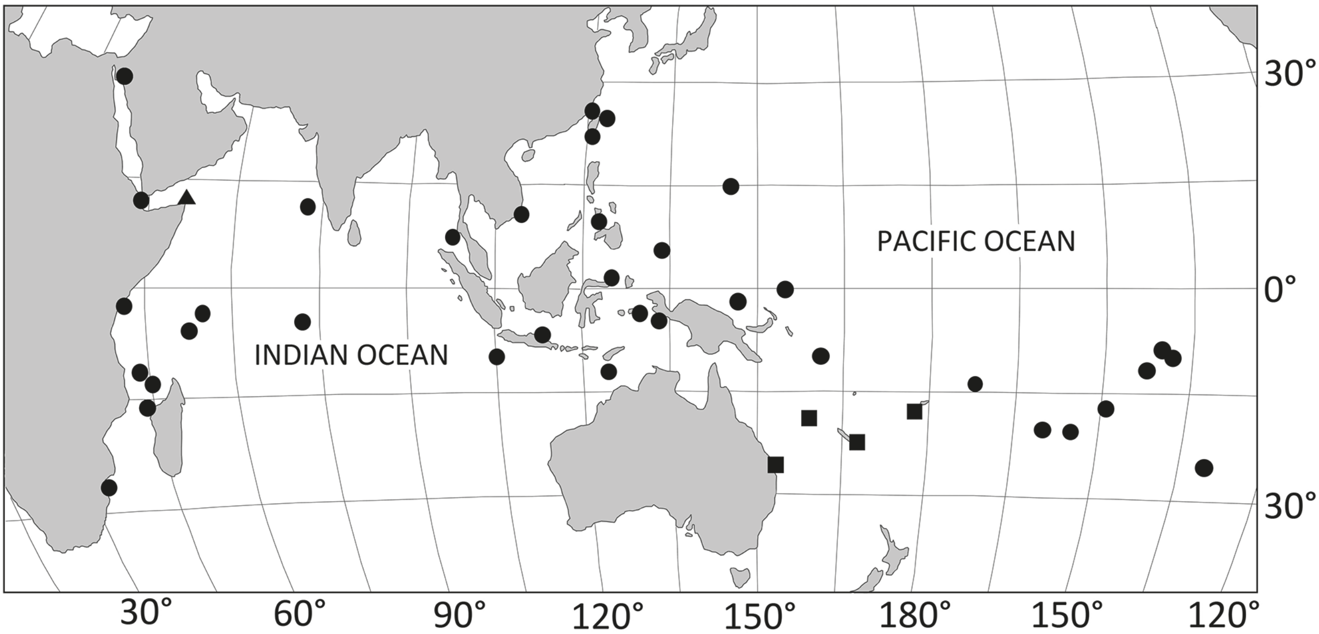

Fig. 1. Geographical distribution: ● — *Scorpaenopsis possi* type series, ▲ — *S. possi* ZIN 37655, ■ — *S. eschmeyeri* type series.

Durville, and Mulochau (2013) described *S. rubrimarginatus* from La Réunion. Thus, the genus *Scorpaenopsis* currently comprises a total of 28 valid species (Fricke, Eschmeyer, and Van der Laan, 2023).

Scorpaenopsis possi Randall et Eschmeyer, 2002 was originally described and based on a holotype from Pitcairn Island, by Randall and Eschmeyer (2002). The authors found the species to be widely distributed from the Red Sea and East Africa east to the Pitcairn Group, north to southern Japan, south to northern Australia (Fig. 1).

During the studies on scorpaenid fishes in the collection of Zoological Institute of Russian Academy of Sciences (St. Petersburg), the authors found two unusual specimens of this species from East Africa, lacking the pretympanic spines. They are reported and described in the present paper.

Materials and methods

Material examined: *Scorpaenopsis possi*: ZIN 37655, 2 specimens, SL 177–188 mm, Indian Ocean, near Cape Guardafui, Somalia, 11°42’ N 51°23’ E, depth 50 m, RV *Ob’*, St. 150, June 8, 1956, collectors Andriashev A. P. and Tokarev A. K. (Fig. 2). Preserved in alcohol.

Comparative material: *S. possi*: SMNS 25417, 1 specimen, New Caledonia, île des Pins; SMNS 2069, 1 specimen, Red Sea, Egypt.

Measurements and counts follow Randall and Eschmeyer (2002): SL — distance between front of the upper lip to the distal end of the caudal plate, last dorsal (and anal) ray branched to base and counted as one, etc. Scales in longitudinal series and pectoral fin rays were counted on both sides (left/right). Urostyle was counted as last vertebra. Terminology of head spines follows Randall and Eschmeyer (2002) and Motomura, Yoshino, and Takamura (2004). The genus and species classification follows Fricke, Eschmeyer, and Van der Laan (2023). Key to the species follows Fricke, Durville, and Mulochau (2013). The skeleton was studied under X-ray images obtained on a PRDU-02 X-ray diffractometer. Abreviations used: ZIN — Zoological Institute RAS, St. Petersburg, Russia; SMNS — State Museum of Natural History Stuttgart; SL — standard length; TL — total length.

Fig. 2. *Scorpaenopsis possi* ZIN 37655–2. Scale bar 10 mm.

Results

The lengths of the examined fish are close to the known maximum SL of *S. possi* (Table), the largest known is 194 mm SL off Cook Islands, Rarotonga (Randall and Eschmeyer, 2002), and significantly exceed the known size for *S. eschmeyeri*: 177.0–188.0 vs 45.5–115 mm. For the first time after the description of *S. eschmeyeri*, the absence of pretympanic spines for *S. possi* was noted — only one of the four was present (Fig. 3). Number, form and posi-

Table. Proportional measurements of *S. possi* compared with the published data of type material of *S. possi* and *S. eschmeyeri*

	S. possi ZIN 37655–1	*S. possi* ZIN 37655–2	*S. possi* type series, n = 74	*S. possi* SMNS 25417	*S. possi* SMNS 2069	*S. eschmeyeri* type series, n = 18
TL, mm	242	227				
SL, mm	188.0	177.0	59.4–188.0	94.5	134.5	45.5–115.0
longitudinal scale series	44/48	53/50	43–50	45	44	44–48
dorsal rays	XII, 8	XII, 9	XII, 9	XII, 9	XII, 9	XII, 9
anal rays	III, 5	III, 5	III, 5	III, 5	III, 5	III, 5
pectoral rays	18/18	18/17	17–18	17	17	17–18
vertebrae	24	24	24	24	24	24
predorsal length in SL	2.75	2.7	2.5–2.7			2.3–2.5
height of the largest dorsal spine in head length	2.5	2.4	2.2–2.9			2.2–2.65
height of the first dorsal spine in second	1.85	2.55	1.9–2.5			1.9–2.4
height of the first dorsal spine in head length	5.75	6.15	5.85–7.2			6.2–7.35
height of the second dorsal spine in head length	3.15	3.3	2.5–3.25			2.6–3.4
length of eleventh dorsal spine in twelfth spine	1.95	1.9	1.4–1.8			1.55–2.0
length of second anal spine in head length	2.5	2.45	1.65–2.0			1.65–1.9
body depth in SL	3.15	2.95	2.6–3.05			2.55–3.05
body width in body depth	1.3	1.25	1.2–1.4			1.25–1.6
head length in SL	2.5	2.4	2.3–2.35			2.2–2.3
snout length in head length	3.6	3.35	2.95–3.2			3.0–3.05
orbit diameter in snout length	1.15	1.25	1.5–1.95			1.5–1.7
orbit diameter in head length	4.2	4.3	4.7–5.8			4.65–5.2
caudal peduncle length in head length	2.95	3.1	3.05–3.3			2.95–3.6
caudal peduncle depth in head length	3.75	3.7	3.45–3.6			3.7–3.95
interorbital width in head	7.0	7.5	5.8–7.1			6.75–7.2
preanal length in SL	1.35	1.4	1.3–1.4			1.35–1.4
length of third anal spine in head	2.55	2.45	2.05–2.5			2.0–2.4
pretympanic spine	present/absent	absent	present	present	present	absent
gill rakers on first arch	5+9	5+10	4–5 + 9–10	5 + 10		5+9

tion of head spines (except pretympanic) coincide with the description in Randall and Eschmeyer (2002). In all fish, both counted and published data (Randall and Eschmeyer, 2002; Randall and Greenfield, 2004; Tsuno, Yuki, Motomura, and Endo, 2022), the number of vertebrae and rays in the anal fin does not vary and is 24 and III, 5, respectively. There are no differences between the two species in the number of pectoral rays as well as in the number of gill rakers on the first arch, and the data obtained do not go beyond this range. In one examined fish, the number of soft rays of the dorsal fin turned out to be 8, while 9 soft rays are considered specific for the entire genus (Fig. 4). The longitudinal scale series number range in *S. eschmeyeri* is within the range of *S. possi*: 44–48 and 43–50, respectively. The number of longitudinal scale series on one examined fish corresponds well to the range of *S. possi*, but on the second fish on the right side the number is the maximum known for this species, and on the left side it even

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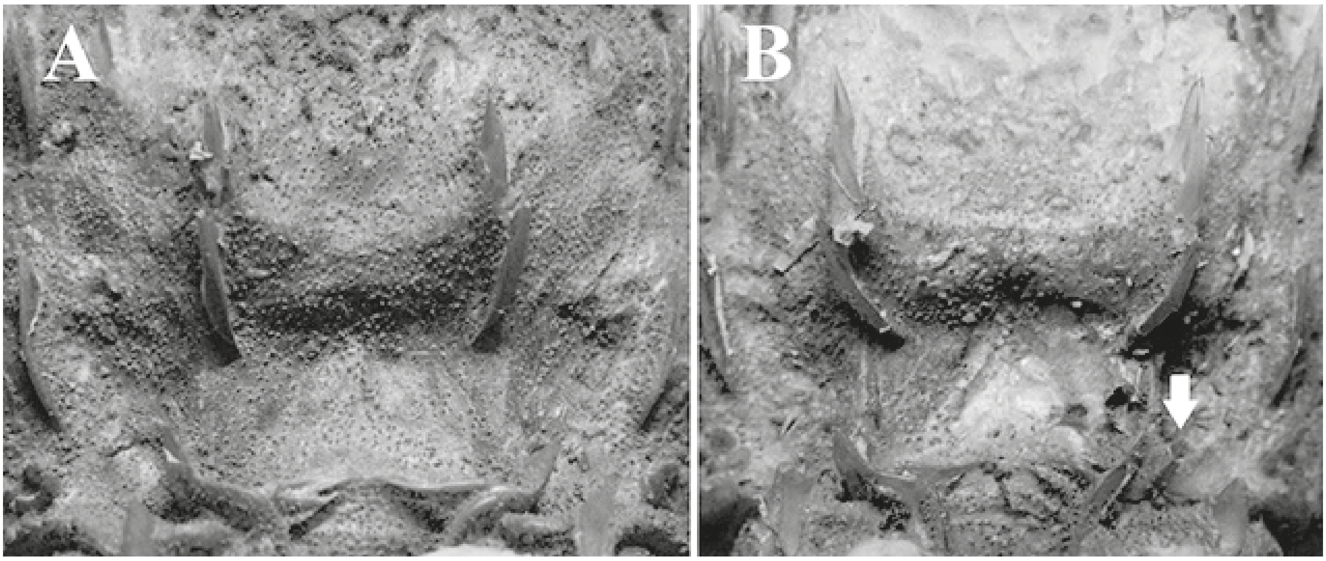

Fig. 3. *Scorpaenopsis possi*, dorsal view on spines around occipital pit, A — ZIN 37655–1, B — ZIN 37655–2. Pretympanic spine is indicated by an arrow.

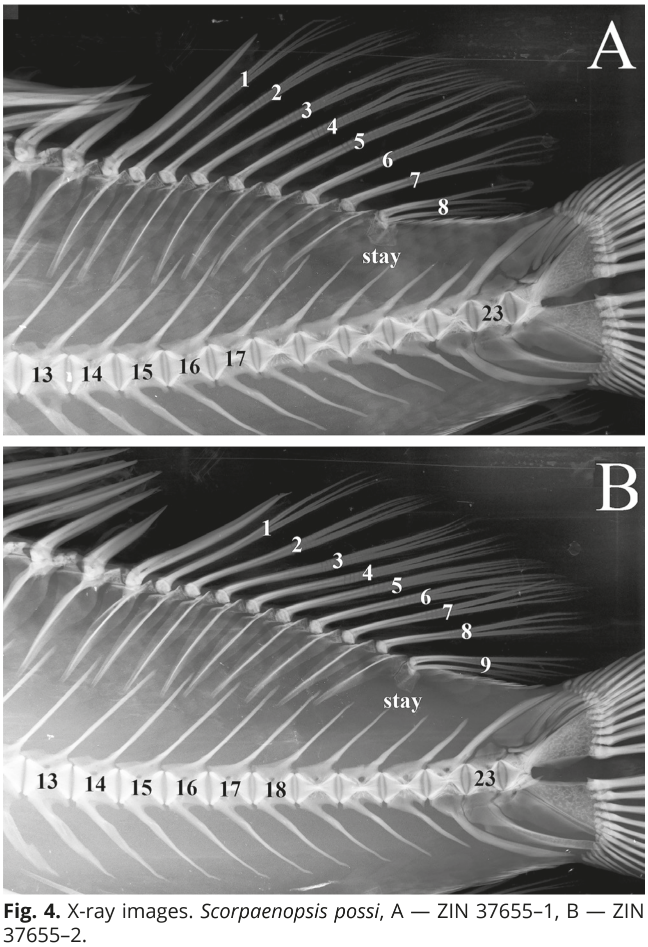

Fig. 4. X-ray images. *Scorpaenopsis possi*, A — ZIN 37655–1, B — ZIN 37655–2.

slightly exceeds it (50–53 vs 43–50). The following coefficients correspond to the ranges of both *S. possi* and *S. eschmeyeri*: height of the largest dorsal spine in head length, body width in body depth and preanal length in SL. The smaller head length in SL than of *S. possi* and *S. eschmeyeri* (2.4–2.5 vs 2.3–2.35 and 2.2–2.3, respectively) affected the predorsal length in SL coefficient, which slightly exceeded the known values on one specimen, as well as the height of the first dorsal spine in head length, whose coefficient is below the lower bounds of *S. possi* and *S. eschmeyeri*, i. e. the spine is larger in one of the measured specimens (ZIN 37655–1). In the same way it affects the orbit diameter in head length (4.2–4.3 vs previously registered 4.7–5.8). The smaller head length is due to the smaller snout, as indicated by the snout length in the head length ratio, which is outside the known values of *S. possi* (3.35–3.6 vs 2.95–3.2). But the other coefficient was not affected by the smaller head length, moreover, the length of the second (largest) anal spine in head length is significantly larger than that of *S. possi*, which indicates a much shorter spine than in both species *S. possi* and *S. eschmeyeri* (2.45–2.5 vs 1.65–2.0 and 1.65–1.9, respectively). The length of the third anal spine in head has a similar value in the studied material 2.45–2.55, the previously known range for *S. possi* was 2.05–2.5. The height of the first dorsal spine in the second coefficient slightly expands the previously known range of 1.85–2.55 vs 1.9–2.5. As well as the length of the eleventh dorsal spine in the twelfth spine (1.9–1.95 vs 1.4–1.8), but here the coefficient fits perfectly into the range of *S. eschmeyeri* (1.55–2.0). The height of the second dorsal spine in head length coefficient has a similar value, the obtained measurements give a range of 3.15–3.3, which slightly expands the known range for *S. possi* (2.5–3.25), but fits well into the range of *S. eschmeyeri* (2.6–3.4). Body depth in SL 2.95–3.15 slightly expands the known range of *S. possi* 2.6–3.05. Shorter snout length affects the ratio orbit diameter in snout length 1.15–1.25, while previously known values were 1.5–1.95. The value of one following coefficient caudal peduncle length in head length is outside the known values for *S. possi*, but within the range of *S. eschmeyeri* (2.95–3.1 vs 3.05–3.3 and 2.95–3.6, respectively). Another factor eliminates the previously known hiatus between

S. possi and *S. eschmeyeri*. The obtained values of caudal peduncle depth in head length 3.7–3.75 expand the range of *S. possi* values (previously known as 3.45–3.6) to overlap the values of *S. eschmeyeri* (3.7–3.95). Interorbital width in head coefficient of the examined specimens 7.0–7.5 slightly expands previously known for *S. possi* 5.8–7.1.

Discussion

In the original description of *Scorpaenopsis possi*, Randall and Eschmeyer (2002) indicated the presence within the range of representatives of the species that fit into the diagnosis, but did not report a unique parameter for *S. possi* — the presence of pretympanic spines. Later (Randall and Greenfield, 2004) a new species was described mainly based on the presence of these spines. The latter authors indicated that there are no meristic differences that distinguish *S. eschmeyeri* from *S. possi*. At the same time, the presence of four measurements was indicated for which there is a different average value for the species: head length, snout length, upper-jaw length, and predorsal length. Moreover, authors declared the necessity to compare only fish of the same size. This would be justified to eliminate the influence of allometry if sexual maturity occurred at about the same size. But a much smaller body size was one of the two most important diagnostic parameters for distinguishing *S. eschmeyeri*. Therefore, already adult *S. eschmeyeri* were compared with juvenile *S. possi*, which still have different proportions. The maximum SL of *S. eschmeyeri* is 115 mm (Randall and Greenfield, 2004), while *S. possi* reaches 194 mm. Thus, according to the characters provided by Randall and Greenfield (2004), in this work we cannot directly compare the proportions of the two species because there is no one of that size of *S. eschmeyeri*. Anyway, the data we obtained bring the morphometry of the two species even closer. We conclude that the only objective (besides the maximum length) parameter that allows to unequivocally assign the caught fish to one of the two species is the presence or absence of pretympanic spines.

Prior to this work, the presence of pretympanic spines was considered a unique diagnostic parameter for *S. possi*, allowing it to be unambiguously identified. This article describes the two fish in one of which this spine is completely absent, and the second fish is, as it were, a transitional variant and has a spine only on the left side. It could be assumed that this is *S. eschmeyeri*, but the very large size casts doubt on this. Moreover, Cape Guardafui is almost 12,000 km away from the closest known occurence of *S. eschmeyeri*. It could be assumed, according to Andriyashev (1988), that generalized species are forced out to the boundaries of the range of the genus, where competitive pressure is less, and thus two isolated populations of *S. eschmeyeri* have formed. Apparently, the absence of pretympanic spines is indeed a generalized state. But the presence of this spine in one of the fish on only one side shows its probable plasticity. The authors have no doubt that the examined material belongs to the species *S. possi*. Moreover, the reduced number of soft rays in the dorsal fin of one specimen shows the evolutionary advancement of these fish, and not ancestrality.

One of the main evolutionary trends in animals is a decrease in the homologous series, for example, the number of vertebrae, pterygiophores and their corresponding rays (Dogel, 1954; Andriashev, 1988), reduction of the sensory system (Mandritsa, 2001). From this point of view, comparing *S. possi* and *S. rubrimarginatus*, we can say that the number of rays in the anal fin in III, 5 in the first is an apomorphic state, while III, 6 in the second is plesiomorphic state. A decrease in the number of rays is not something anomalous, but is in the main evolutionary trend. There is no indication that the loss of one ray was the result of a developmental error. Both fish have the same number of vertebrae, which is normal for the genus — 24. They both have 12 spiny rays in dorsal fin, which is also normal. Consequently, the beginning of the soft part of the fin in both fish falls between the 12^{th} and 13^{th} vertebrae. In both cases there are two pairs of pterygiophores in the dorsal fin, in the first case these are 1 + 2 and 5 + 6, in the second — 1 + 2 and 4 + 5. Here is no evidence that some pterygiophore and ray did not develop in ontogenesis. The stay is also well developed with a characteristic ray on it, branched to base. So, we can postulate that 8 rays is an apomorphic state of the number of soft dorsal rays of *S. possi*.

Most likely, the generalized state of the parameter of the pretympanic spines is not constant in the population, but indicates the possibility of reversion for this character to the ancestral state. For some reason, such a reversion can occur in the species of *S. possi*, therefore, it is no longer necessary to take the state of this parameter as unambiguously diagnostic.

Due to the lack of persistent distinguishing characters between *S. possi* and *S. eschmeyeri*, it is highly probable that both are conspecific; in that case *S. eschmeyeri* would be a junior synonym of *S. possi*. Additional research is required to determine the identity (and possible conspecificity) of *S. eschmeyeri*.

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