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Discovery of the Scombrid *Scomberomorus koreanus* (Kishinouye) in India, with Taxonomic Discussion on the Species

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Abstract The discovery of *Scomberomorus koreanus* (Kishinouye, 1915) in Palk Bay extends its distribution to the Indian Ocean. Day's (1878) *Cybium kuhlii* is considered a misidentification of *S. koreanus*. *S. koreanus* differs significantly from *S. semifasciatus* in many features.

Introduction

According to Jones and Silas (1964), the species of *Scomberomorus* that are at present recognized from the Indian Ocean are: *S. guttatus* (Bloch et Schneider, 1801), *S. lineolatus* (Cuvier, 1831), *S. niphonius* (Cuvier, 1831), *S. queenslandicus* (Munro, 1943), *S. semifasciatus* (Macleay, 1883), and *S. commerson* (Lacepède, 1800).

During February and March 1969 some interesting specimens of seerfishes were landed at Pamban in Rameswaram Island (Fig. 1) by the drift gill net fishermen, from Palk Bay off Neduntivu. They were found to differ from the well known and familiar species of seerfishes of India (*S. commerson*, *S. guttatus*, and *S. lineolatus*) in certain respects. For the fishermen, there is no difficulty with regard to the identity of this fish as they could instantaneously pick it out as Vellura, the local name by which it is known, though it exhibits an apparent resemblance to Kattayan Seela (*S. guttatus*). This fish has been identified as *Scomberomorus koreanus* (Kishinouye, 1915), and is an addition to the list of seerfishes known from India and the Indian Ocean.

The identity of the fish is established by comparison with Kishinouye's descriptions (1915; 1923) of *Cybium koreanum*. Further, it is shown that Day's (1878) *Cybium kuhlii* is not identical with *C. kuhlii*, but a misidentification of *S. koreanus*. The opinion of Jones and Silas (1964) and Silas (1964) that Fraser-Brunner's (1950) synonymizing *C. koreanum* with *S. semifasciatus* as unwarranted, is hereby also confirmed. The study also reveals that *S. koreanus* is distinct from *S. guttatus*, and also not a subspecies of the latter as considered by Silas (1964).

Materials and methods

Specimens of *S. koreanus* and *S. guttatus* caught in the drift gill nets from Palk Bay and the Gulf of Mannar respectively and landed at Pamban (Fig. 1) were utilized for the study. Only stray specimens of *S. koreanus* were available in the fishing grounds in Palk Bay off Neduntivu Island up to Point Calimere and Jaffna. The methodology adopted here for morphometric measurements is after Holt (1959) for the Indian mackerel (*Rastrelliger kanagurta*). The standard length (LS) is the distance from the tip of the snout to the caudal fork depressing the small fleshy flap extending posteriorly to indicate the end of the hypural. This measurement is termed fork length (F. L.) by Silas (1964: 324).

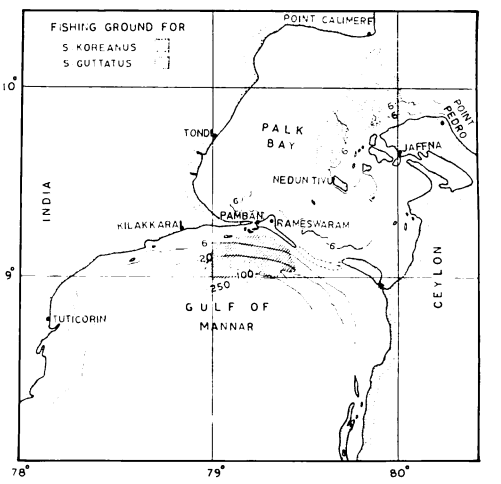

Fig. 1. Areas of capture of specimens of *Scomberomorus koreanus* and *Scomberomorus guttatus* utilized in this study.

The extent of variations between *S. koreanus* and *S. guttatus* has been brought out from the morphometric data by comparison of means, and from the meristic counts by the levels of intergradation and divergence (Ginsburg, 1938). Morphometric and meristic data on *S. semifasciatus* furnished by Munro (1943) have been utilized for comparison with *S. koreanus*.

Comparison of S. guttatus and S. koreanus

For comparison of means 17 morphometric measurements were made from 10 specimens of *S. guttatus* (472～545 mm LS), and 7 *S. koreanus* (499～587 mm). Ranges and means of these characters expressed in thousandths of standard length, and the levels of significance (P) are presented in Table 1. The values indicate that the height of the second dorsal and of the anal fins are very much larger in *S. koreanus* (Figs. 2A; 3B, D) than in *S. guttatus* (Figs. 3A, C); presecond dorsal length and preanal length are shorter in *S. koreanus* than in *S. guttatus*; but, the postsecond dorsal length and postanal length to the end of the caudal keel, are larger in *S. koreanus*; the head is shorter, and the body deeper in *S. koreanus* than in *S. guttatus*. The supraoccipital crest is found to be the highest in *S. koreanus* among *Scomberomorus* (Devaraj, MS). The second dorsal and anal fins also reach the maximum height in *S. koreanus*.

Fin, gill raker, and vertebral counts recorded from about 50 specimens of *S. guttatus* and 8 specimens of *S. koreanus* are shown in Table 1. While the number of first dorsal spines has shown 97% divergence, precaudal, caudal and total vertebral counts have shown 100% divergence

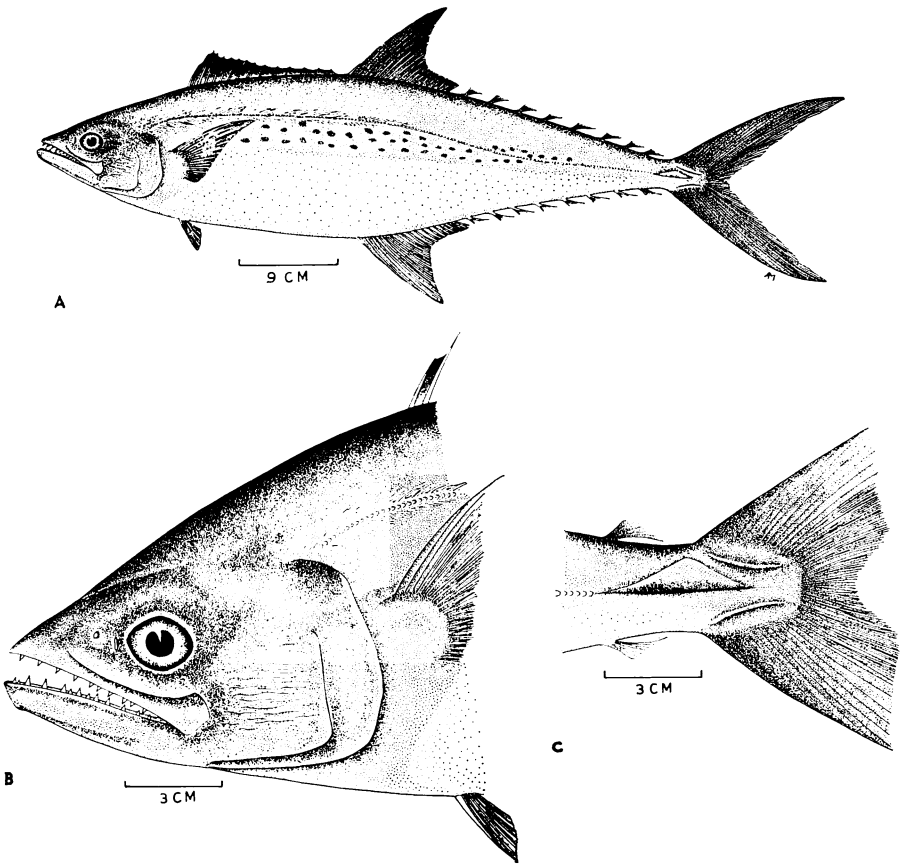

Fig. 2. *Scomberomorus koreanus*, 745 mm in total length, from Pamban, Palk Bay, A. lateral view of whole body; B. head and anterior part of body showing lateral line branchings; C. caudal peduncle showing prominent caudal keel.

Table 1. Biometric data based on body proportions in thousandths of standard length (LS), and meristic characters of *S. guttatus* and *S. koreanus*. (Size of specimens for biometric data: *S. guttatus* LS 472～541 mm in the present sample; FL=LS 242～800 mm in Silas, 1964; *S. koreanus* LS 499～587 mm in the present sample. n. s.=nonsignificant. *=closer to *S. koreanus*. I=intergradation; D=divergence. **=data from Jones and Silas 1964). Values for right side are in parentheses.

Body proportions in thousandths of LS	Present sample							Silas (1964)	
	S. guttatus			*S. koreanus*			P%	*S. guttatus*	
	N	Range	Mean	N	Range	Mean		Range	Mean
Head length	9	201.8～215.2	209.4	7	196.8～204.1	199.8	1	193～216	206
First predorsal distance	10	242.0～254.6	246.2	7	232.0～246.1	241.2	5	233～259	243
Second predorsal distance	10	493.4～519.6	505.2	7	455.0～488.9	475.3	1	450～500	478*
Prepectoral distance	10	205.5～218.9	212.5	7	202.6～212.0	206.6	5	196～218	210
Prepelvic distance	10	217.3～268.0	252.2	7	233.9～245.3	241.8	n. s.	231～271	254
Preanal distance	10	532.1～564.0	546.2	7	479.0～520.0	505.6	1	470～535	514*
Depth at D_1.	9	185.0～207.3	198.4	7	194.5～215.4	204.1	n. s.	—	—
Depth at D_2.	9	227.7～251.5	238.3	7	243.6～266.7	254.8	1	201～236	226
Pectoral length	10	113.7～132.2	121.9	6	130.4～141.3	135.8	1	114～134	124
Eye diameter	10	29.3～ 42.7	36.9	7	34.0～ 36.0	34.9	n. s.	28～ 42	36
Maxilla length	6	109.7～112.6	111.3	7	107.0～113.4	110.0	n. s.	100～116	109
Snout length	5	68.8～ 72.9	71.3	7	61.3～ 76.0	67.9	n. s.	64～77	73
D_1. height	6	66.2～ 74.7	69.0	6	57.8～ 70.1	65.1	n. s.	55～ 76	65
D_2. height	6	130.4～134.3	132.1	7	168.3～194.5	186.5	1	122～165	142
A. height	10	120.7～142.5	133.8	7	161.6～182.0	174.7	1	123～165	143
D_2. origin to keel end	10	480.3～506.5	494.6	7	511.0～544.9	524.5	1	516～548	523*
A. origin to keel end	10	435.9～472.8	453.7	7	480.0～520.0	494.3	1	473～523	491*
Meristic counts							I% D%		
D_1. spines	52	15～17	16.0	7	14～15	14.6	3 97	16～17**	—
D_2. rays	39	19～23	20.9	7	19～23	21.4	28 72	20～21**	—
A. rays	39	20～22	21.1	7	20～24	22.0	21 79	19～20**	—
Dorsal finlets	51	7～ 9	8.5	8	8～ 9	8.3	38 62	7～ 9	8.2
Anal finlets	51	7～9	7.9	8	7～ 9	7.9	46 54	7～ 9	8.0
Pectoral rays	39	19～22	20.4	7	19～23	21.3	26 74	21～23**	—
Gill rakers, upper limb	51	0～2 (1～2)	1.9 (1.8)	8	2～3 (2～3)	2.1 (2.1)	44 56 (41 59)	1～4	2.19
Gill rakers, lower limb	51	6～9 (6～9)	7.8 (7.8)	8 (7)	8～9 (8～9)	8.4 (8.4)	30 70 (38 62)	6～9	8.74
Total gill rakers	51	8～12 (9～12)	10.7 (10.5)	8	11～12 (10～13)	11.5 (11.4)	28 72 (35 65)	8～12	10.93
Precaudal vertebrae	13	21	21.0	6	20	20.0	0 100	—	—
Caudal vertebrae	13	28～29	28.7	6	26	26.0	0 100	—	—
Total vertebrae	13	49～50	49.7	6	46	46.0	0 100	48～49	—

each. The vertebral column of *S. guttatus* is shown in Fig. 4A, and that of *S. koreanus* in Fig. 4B. Presence of 3 or 4 rows of round grey blotches along the lateral median aspect of the body (Fig. 2A), and numerous canals radiating outwards and backwards along both sides of the lateral line of *S. koreanus* (Figs. 2A, B) are characteristic of *S. guttatus* also. Distinguishing characters of *S. guttatus* and *S. koreanus* derived from the comparative study, are summarised in Table 2.

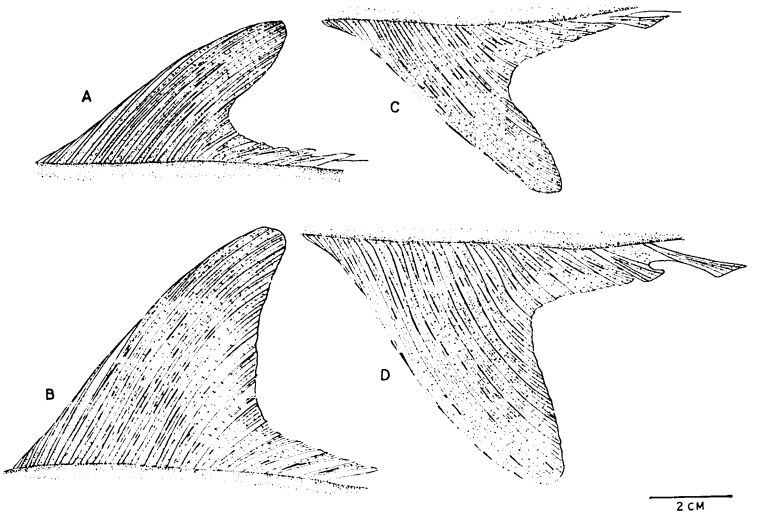

Fig. 3. Second dorsal fin of *Scomberomorus guttatus* (A) and *Scomberomorus koreanus* (B); anal fin of *S. guttatus* (C) and *S. koreanus* (D). Total length of *S. guttatus* 675 mm and of *S. koreanus* 672 mm.

Table 2. Distinguishing characters of *S. guttatus* and *S. koreanus*

Characters	*S. guttatus*	*S. koreanus*
Height of D_2.	Shorter; 130.4 to 134.3 thousandths of standard length to fleshy peduncle (Mean 132.1) (Fig. 3A)	Longer; 168.3 to 194.5 thousandths of standard length to fleshy peduncle (Mean 186.5) (Fig. 3B)
Height of A.	Shorter; 120.7 to 142.5 thousandths of standard length to fleshy peduncle (Mean 133.8) (Fig. 3C)	Longer; 161.6 to 182.0 thousandths of standard length to fleshy peduncle (Mean 174.7) (Fig. 3D)
Colour of D_1.	Black up to eighth spine and the rest white, tipped with black	Uniformly black (Fig. 2A)
Preopercle	Lower limb prominently projecting backwards as a much longer process than the upper (Fig. 5A)	Lower limb as long as or slightly longer than the upper (Fig. 5B)
Vertebrae	21+28=49 or 21+29=50; posterior caudal vertebrae with insignificant mid lateral grooves on the centra (Figs. 4A, C)	20+26=46; posterior caudal vertebrae with very prominent mid lateral grooves on the centra (Figs. 4B, D)
Auxiliary inter-muscular bone on the exoccipital	Absent	Present
Middle lobe of liver	Prominent (Fig. 5C)	Not prominent (Fig. 5D)

Table 3. Comparison of body proportions of *S. koreanus* from different sources with *S. guttatus* from different sources.

A. Body proportions in thousandths of LS	*S. koreanus*			*S. guttatus*			
	Day (1878) as *C. kuhlii*	Kishinouye (1923) as *C. koreanum*	Present sample from Palk Bay	Day (1878) as *C. guttatum*	Kishinouye (1923) as *C. guttatum*	Silas (1964) as *S. guttatus*	Present sample from Gulf of Mannar
	(From the figures)		(Mean)	(From the figures)		(Mean)	(Mean)
1. Second predorsal distance	473.33	462.36	475.3	506.57	493.67	478	506.9
2. Preanal distance	506.66	524.19	505.6	559.21	553.75	514	546.0
3. D_2. height	181.66	166.66	186.5	154.60	118.14	142	135.1
4. A. height	173.33	182.79	174.7	138.15	175.10	143	133.0
B. Other body proportions	(From Day's description)			(From Day's description)			
1. Total length/Head length	5.5~6.0	—	6.36	5.0~5.33	—	—	6.05
2. Total length/Caudal length	3.8~4.0	—	4.14	4.5~5.0	—	—	4.12
3. Total length/Body height	5.0	—	4.99	5.0	—	—	5.32
4. Eye diameter/Head length	0.2	—	0.18	—	—	—	—
5. Snout length/Eye diameter	1.5	—	1.94	2.0	—	—	1.72
6. Anterior height of D_2./Body height below D_2.	0.75	—	0.73	0.57	—	—	0.55

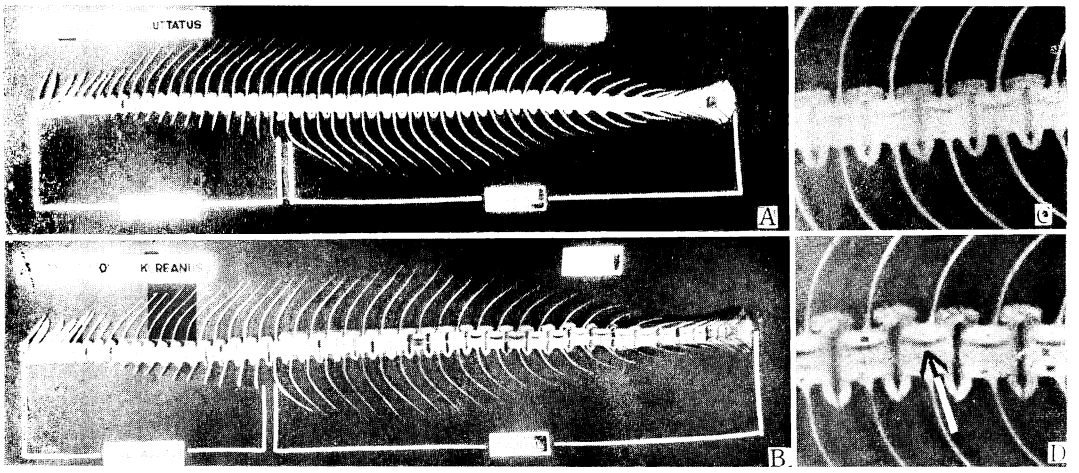

Fig. 4. Vertebral column of *Scomberomorus guttatus* with 21+29=50 vertebrae (A) and *Scomberomorus koreanus* with 20+26=46 vertebrae (B); posterior caudal vertebrae of *S. guttatus* showing the inconspicuous midlateral grooves on the centra (C) and *S. koreanus* showing the prominent midlateral grooves on the centra (D).

Synonymy

For detailed synonymy of *S. guttatus*, reference is invited to de Beaufort and Chapman (1951), Jones and Silas (1961; 1964), Silas (1964), and Smith (1964).

The following are the synonyms of *S. koreanus*:

Scomberomorus koreanus (Kishinouye, 1915)

Cybium kuhlii; Day, 1878 (nec. Cuvier, 1831); Delsman, 1931?

Cybium koreanum; Kishinouye, 1915; Kishinouye, 1923; Park, 1939.

Sawara koreanum; Soldatov and Lindberg, 1930.

Cybium guttatum; Delsman, 1931?

Scomberomorus koreanus; Munro, 1943.

Scomberomorus guttatus; Munro, 1943?

Scomberomorus semifasciatus; Fraser-Brunner, 1950.

Scomberomorus guttatus koreanus; Silas, 1964.

Discussion of synonymy

1. *C. kuhlii* Cuvier, 1831, is a synonym of *S. guttatus* (Bloch and Schneider, 1801).

Before establishing that *C. kuhlii* reported by Day (1878) is a misidentification of *S. koreanus* (Kishinouye, 1915), it is necessary to reiterate the fact that *C. kuhlii* (as given in the original description) is a synonym of *S. guttatus* Günther (1860) for the first time synonymised *C. kuhlii* with *C. guttatum*. After examining the two paralectotypes of *C. kuhlii* in the Leiden Museum, de Beaufort and Chapman (1951) also concluded that both without doubt belong to *S. guttatus*. He also expressed doubt whether Day's *C. kuhlii* is *C. kuhlii* or not.

2. *C. kuhlii* of Day (1878) is referable to *C. koreanum* Kishinouye, 1915.

In the four body proportions expressed in thousandths of LS in Table 3A, Day's *C. kuhlii* closely agrees with the original description of *C. koreanum* and especially with *S. koreanus* from Palk Bay, but differs from *C. guttatum* of Day (1878) and Kishinouye (1923) and specimens of *S. guttatus* from the Gulf of Mannar. The values clearly indicate that the second dorsal of Day's *C. kuhlii* and *S. koreanus* are very much larger, and the second predorsal and preanal lengths of their body shorter than those of *S. guttatus* (present sample) or *C. guttatum* of both Day and Kishinouye. The similarity between Day's *C. kuhlii* and *S. koreanus* in the body proportion: anterior height of D_2/ body height below D_2., is also very striking (Table 3B). The head of Day's *C. kuhlii* is shorter than that of his *C. guttatum* just as the head of *S. koreanus* being shorter than that of *S. guttatus* (Table 3B). All these body proportions have already been shown to be of diagnostic importance in distinguishing *S. koreanus* from *S. guttatus*.

Day's description that the preopercle is emargi-

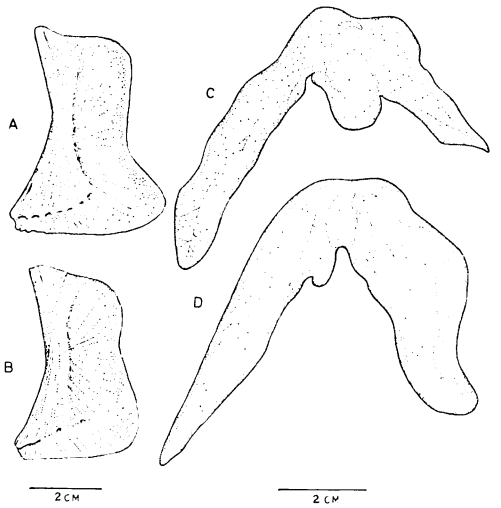

Fig. 5. Preopercle of *Scomberomorus guttatus* (A) and *Scomberomorus koreanus* (B); liver of *S. guttatus* (C) and *S. koreanus* (D).

nate along its vertical border, and the lower limb of the preopercle is almost as long as its hind limb in *C. kuhlii*, suits well the shape of the preopercle of *S. koreanus* (Table 2). It can be seen from the figures of the preopercle of *S. koreanus* (Fig. 5B) and *S. guttatus* (Fig. 5A) that the two limbs are nearly equal in size in the former, but the lower limb more prominently projecting backwards as a long process than the upper in *S. guttatus*.

C. kuhlii of Day lacks spots on the body, either because of the description presumably based on a preserved specimen or due to seasonal variation as observed by Jones and Silas (1961) in *S. guttatus* when it frequents low saline waters off river mouths. It was the absence of the blotches that probably led Day to treat it as *C. kuhlii*, the types of which being juveniles, lacked spots, as has been observed in the case of juveniles of *S. guttatus* too, sometimes.

3. *C. koreanum* Kishinouye, 1915, is not a subspecies of *S. guttatus* (Bloch and Schneider, 1801).

According to Silas (1964), the number of vertebrae, dorsal and anal finlets, and gill rakers of *C. koreanum* fall within their known range for *S. guttatus*, and the only difference of some significance is the height of body which in the former is deeper than in the latter. He treated *S. koreanus* as a subspecies of *S. guttatus*.

The number of vertebrae is 46 (=20+26) in both the Japanese (Kishinouye, 1923) as well as the Indian specimens of *S. koreanus*, and 48 to 51 in *S. guttatus* (Jones and Silas, 1961 and 1964, and Silas, 1964: 48 or 49; present sample: 21+28～29=49～50; Kishinouye, 1923: 21+30=51). However, Munro (1943) and Delseman (1931) record a vertebral count of 20+26=46 for *S. guttatus*, and Delseman (1931) records 20+25=45 for *S. kuhlii*, and therefore, according to Silas (1964), the count for *S. koreanus* lies within the range for *S. guttatus*. It is very likely that the specimens regarded as *S. guttatus* by Munro (1943) and Delsman (1931), and as *S. kuhlii* by Delsman (1931) are *S. koreanus*.

It is very interesting that the mean values 478, 514, 523 and 491 respectively for the second predorsal distance, preanal distance, distance from the origin of second dorsal to the end of caudal keel, and from the origin of anal to caudal keel of *S. guttatus* given in Silas (1964) differ drastically from the values: 506.9, 542.7, 493.3 and 457.1 for the respective characters of the Pamban sample of *S. guttatus*, but surprisingly agree with the values for the corresponding proportions: 475.3, 505.6, 524.5 and 494.3 of *S. koreanus* (Table 1). But the body depth at second dorsal (226) is much less than in *S. koreanus* (254.8) (Table 1).

The fishing ground for the Pamban sample of *S. guttatus* lies in the northernmost part of the Gulf of Mannar, hardly 100～125 miles northeast of Tuticorin (southern part of the same Gulf) from where Silas (1964) obtained most of his material (Fig. 1). It is inferred that the *S. guttatus* in the southern Gulf of Mannar and the contiguous Arabian Sea is a distinct race different from the typical *S. guttatus* by the shortening of the precaudal and the lengthening of the caudal region of the body as observed in *S. koreanus*. A slight reduction has taken place in the number of vertebrae (48～49) of the Tuticorin specimens from the typical *S. guttatus*.

4. *C. koreanum* Kishinouye, 1915, is not a synonym of *S. semifasciatus* (Macleay, 1883).

According to Fraser-Brunner (1950), *C. koreanum* is a Japanese form of *S. semifasciatus*, differing from it only in the possession of round blotches on the body instead of the vertical bars, and hence, should be considered a synonym or at the most a subspecies of *S. semifasciatus*.

Table 4. Comparison of body proportions and meristic characters of *S. semifasciatus* (168～595 mm body length) from Queensland (Munro, 1943) and *S. koreanus* (527～622 mm body length) from Palk Bay. Body length=distance from the tip of the snout to the posterior edge of the central rays of the caudal furca, as defined by Munro, 1943. I=intergradation. D=divergence.

Body proportions	*S. semifasciatus*			*S. koreanus*			P%	
	N	Range	Mean	N	Range	Mean		
Head length/Snout length	9	2.43～2.75	2.55	7	2.56～3.24	2.95	1	
Head length/Eye diameter	9	5.72～8.18	6.98	7	5.53～6.00	5.71	1	
Head length/Maxilla length	8	1.25～1.67	1.45	7	1.74～1.85	1.82	1	
Head length/Pectoral length	9	1.67～1.96	1.81	6	1.40～1.56	1.47	1	
Body length/Head length	9	4.43～50.9	4.95	7	5.17～5.37	5.29	1	
Body length/First predorsal length	9	3.92～4.31	4.12	7	4.26～4.58	4.38	1	
Body length/Second predorsal length	9	2.06～2.16	2.12	7	2.16～2.30	2.22	1	
Body length/Preventral length	8	3.82～4.31	4.07	7	4.20～4.52	4.37	1	
Body length/Height of D_2. & A.+ body height at vent	6	1.90～2.03	1.95	7	1.66～1.79	1.72	1	
Body length/Length of upper & lower caudal lobes	7	2.04～2.76	2.27	7	1.71～1.81	1.75	1	
Meristic counts							I%	D%
D_1. spines	16	13～15	14.3	7	14～15	14.6	43	57
D_2. rays	18	17～20	18.9	7	19～23	21.4	7	93
A. rays	18	20～22	20.9	7	20～24	22.0	20	80
Dorsal finlets	16	8～10	9.1	8	8～9	8.3	19	81
Anal finlets	16	8～10	9.0	8	7～9	7.9	16	84
Pectoral rays	12	22～23	22.8	7	19～23	21.3	16	84
Precaudal vertebrae	4	19	19.0	6	20	20.0	0	100
Caudal vertebrae	4	25～26	25.8	6	26	26.0	38	62
Total vertebrae	4	44～45	44.8	6	46	46.0	0	100

Silas (1964) disagreed with this view citing characters that could easily separate both the species.

The different body proportions, and the number of D_2. rays, precaudal and total vertebrae (Table 4) appear to be of biological significance in separating *S. koreanus* from *S. semifasciatus*. Though the lateral line is gently sloping in both the species, the characteristic branching in *S. koreanus* is absent in *S. semifasciatus*. There are 12 to 20 vertical broad bands on the sides of the body of *S. semifasciatus*, smaller than 500 mm in length, and the bands tend to break into spots or fade out more or less completely in the adults (Munro, 1943), but in *S. koreanus*, the markings remain as round blotches throughout the size-range examined. The middle lobe of the liver is larger in *S. semifasciatus* than in *S. koreanus*.

Acknowledgments

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インドから初めて記録されたヒラサワラについて

Muthiah Devaraj

インドの Palk Bay でヒラサワラが発見され，分布域が日本からインド洋に至ることが確認された．Day が 1878 年に発表した *Cybium kuhlii* はヒラサワラと誤同定したものである．ヒラサワラは *Scomberomorus semifasciatus* とは多くの形質で異なる．