

A New Species of Cuttlefish, *Sepia vecchioni* (Cephalopoda, Sepiidae) from Colachal Coast, South India

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Abstract: A new species of cuttlefish *Sepia vecchioni* sp. nov. hitherto wrongly treated as *S. prashadi* Winckworth, 1936, collected from the Colachal fish landing centre (8°10' N, 77°15'E) of South India is described. The dorsal mantle of *S. vecchioni* sp. nov. has distinct white stripes facing upwards in contrast to transverse zebra type stripes with the ends facing downward in the closely related species, *S. prashadi*. Unlike *S. prashadi*, a well-defined sexual dimorphism with respect to shape and length of arm is also seen in *S. vecchioni* sp. nov. In matured males of this species, the first and fourth pair of arms are greatly extended and the first pair is whip like. Males of this species also differ from that of *S. prashadi* with regard to sucker arrangement on hectocotylized arm. Though both the species can be classified under *Acanthosepion* species complex of Rochebrune (1984) based on cuttle bone characteristics, *Sepia vecchioni* sp. nov. also shares the characters of the *Rhombosepion* species complex of Rochebrune (1984) by having weakly and incompletely calcified cuttlebone. The comparison of morphological characters, meristic characters and cuttlebone characteristics of *S. vecchioni* sp. nov. with that of other five closely related species of the genus *Sepia* of world waters are also discussed. [Journal of American Science 2010;6(4):12-21] (ISSN:1545-1003)

Keywords: *Sepia vecchioni* sp. nov.; *Sepia prashadi*; *Acanthosepion* species complex; *Rhombosepion* species complex; Hectocotylization

1. Introduction

Out of the 14 species of cuttlefishes so far recorded from Indian waters, 13 species belong to the genus *Sepia*, Linnaeus, 1758 and one species belongs to the genus *Sepiella*, Grey, 1849 namely *Sepiella inermis*. Based on the shape of cuttlebone, Khromov *et al.* (1998) have classified the cuttlefishes of the genus *Sepia* into 6 species complexes. According to their classification, the 13 species of cuttlefishes of the genus *Sepia* of Indian waters can be classified under three different species complexes namely, *Acanthosepion* (Rocheburne, 1884), *Sepia sensu stricto* (Linnaeus, 1758) and *Doratosepion* (Rocheburne, 1884). Seven species *viz.* *Sepia aculeata* Orbigny, 1848, *S. brevimana* Stestrup, 1875, *S. thurstoni* Adam & Rees, 1966, *S. prashadi* Winckworth, 1936, *S. stellifea*, Homenko and Khromov, 1984, *S. elliptica* Hoyle, 1885 and *S. prabahari* Neethiselvan and Venkataramani, 2002 (Neethiselvan and Venkataramani, 2002) can be classified under the species complex *Acanthosepion*. Three species such as *Sepia pharaonis* Ehrenberg, 1831, *S. latimanus* Quoy and Gaimard, 1832, and *Sepia ramani* Neethiselvan, 2001 (Neethiselvan, 2001) belong to *Sepia sensu stricto* species complex. The three species *viz.* *Sepia arabica* Massy, 1916, *S. trygonia* Rochebrune, 1884, and *Sepia kobeensis*, Hoyle 1885 which are found distributed in Indian coast have been classified under *Doratosepion* species complex of Rochebrune, 1884 (Khromov *et al.* 1998). The present study deals with the taxonomic description of a new species of cuttle fish belonging to the genus *Sepia* with the comparison of its

closely related species *S. prashadi* Winckworth, 1936 and five other closely related species of world waters

Etymology

Dr. Michael Vecchione, is a renowned cephalopod taxonomist working as Director in National Marine Fisheries Service, National Systematic Laboratory of National Museum of Natural History, Smithsonian Institution, Washington DC, USA. In honor of his excellent contribution to the field of Cephalopod taxonomy, the newly described species is named after him.

2. Materials and methods

The present work is based on 50 live specimens collected from the catches of trawls operated at a depth range of 70-100m off Colachal (8°10' N, 77°15'E) coast on 15th December 2006. Three specimens were also collected from Pazhayar (11°23.5' N, 79°41.5' E) coastal waters at depth of about 10m on 5th January 2007.

The fifty live specimens of *Sepia vecchioni* sp. nov. collected from Colachal fish landing centre included 25 males and 25 females representing a wide length group. Fifty live specimens of its closely related species, *S. prashadi*, Winckworth, 1936 were collected on 25th December 2006 covering 25 males and 25 females from the catches of trawls operated off Thoothukudi (8°48' N, 78°9'E) coast at a depth of range of 70-100 m.

Twenty morphometric measurements, two meristic characters and six cuttlebone measurements were recorded for each specimen of both the species. The morphometric and cuttlebone measurements were taken nearest to the millimeter with the help of a divider and a scale. As clear-cut sexual dimorphism was observed in *S.vecchioni* sp.nov, with respect to length of arms and cuttlebone characteristics, the sexes were separately treated with regard to length of arms and cuttle bone characteristics. However for other characters, the data were pooled irrespective of sexes. In the case of *S.prashadi*, care was taken to include both juveniles and matured specimens. Since Silas *et al* (1985) have reported that the length at first maturity of this species vary from 6.7 to 7.2 cm, specimens with the Dorsal Mantle Length (DML) ranging from 6.0 to 8.9 cm were used for the study for reasonable comparison. Though no notable sexual dimorphism with respect to any of the body proportions has been observed for *S.prashadi* in the studies carried out along Chennai coast (13°5.6' N, 80°18.1'E) of India which is type locality of *S.prashadi* (Jothinayagam, 1987), the morphometric measurements with respect to length of arms and cuttlebone were separately recorded for comparison with that of *S.vecchioni* sp.nov. The morphometric measurements were expressed as percentage of DML and those of cuttlebone were expressed as the percentage of Cuttle Bone Length (CBL). The percentage overlapping of body proportions of *S. vecchioni* sp.nov. with that of *S. prashadi* were worked out as per the method of Hubs and Hubs (1953).

3. Results

Type locality Colachal, (8°10' N, 77°15'E) South India

Distribution

Sepia vecchioni sp.nov. is found to have distribution mainly in the extreme coast of India in Arabian sea, mainly in offshore fishing grounds with the depth ranging from 70 to 100m. Its sporadic occurrences was recorded in Bay of Bengal along Northern Tamil Nadu coast (South east coast of India) in coastal waters with the depth as low as 10m .

Materials.Holotype

LA 5 and LA 6 (DML 126mm male; DML108 mm female) in Fisheries College and Research Institute Reference Museum (FCRIRM), Thoothukudi, Tamil Nadu, India, 15th December 2006 coll. by N.Neethiselvan.

Paratypes

(i) 50 specimens with DML 65 to 140 mm with same details as above. (ii) 2 specimens deposited in Fisheries college and Research Institute Reference Museum (LA 7 and LA 8: DML 116 mm male and 104 mm female) (iii) 2 specimens deposited in Marine Biological Station Reference Museum (MBSRM) at Parangipettai (Porto-Novo), Annamalai University, Tamil Nadu, India. (DML 116 mm male and 105 mm female)

Other materials

Two male (110 & 140 mm DML) and one female (115 mm DML) in coastal waters of Pazhayar (11°23.5' N, 79°41.5'E) at a depth of about 10m coll. by N. Neethiselvan, 5th January 2007.

Diagnosis

Sepia vecchioni sp. nov. can be well identified with the following diagnostic characters: (i) distinct white stripes with ends facing upwards on dorsal mantle, white patches and dots on lateral sides of dorsal mantle head and arms, white patches and dots on lateral sides of dorsal mantle arranged vertically (Figure 1a Figure 1b);

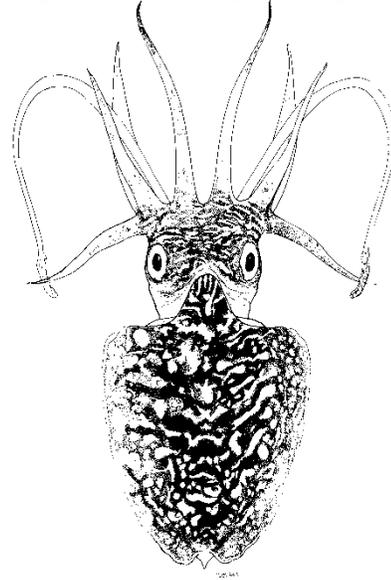


Figure 1a. Dorsal view of *Sepia vecchioni* sp. nov.

(Male) (Illustration by D'Antony Manuela, FAO copy right, 2007)

(ii) well defined sexual dimorphism noticeable with respect to length of arms, matured males with first and fourth arms much extended, first pair whip like, arm formula being 1.4.3.2 (Figure 1a), arms in female not notably extended although with the same formula (Figure 1b);

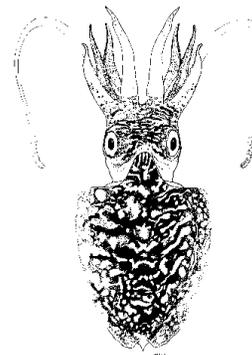


Figure 1b. Dorsal view of *Sepia vecchioni* sp. nov.

(Female) (Illustration by D'Antony Manuela, FAO copy right, 2007)

(iii) left ventral arm in male hectocotylyzed, two middle series of suckers in hectocotylyzed arm completely absent even from basal portion, basal region with 2-3 rows of bi-serially arranged normal suckers proximally followed by a ventral and dorsal series, each series with 18-20 reduced minute suckers in hectocotylyzed portion, hectocotylyzed portion follows 8 to 10 normal quadriserial minute suckers, there after suckers very minute up to arm tip (Figure 2);

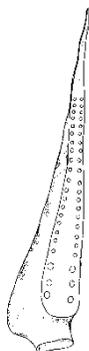


Figure 2. Hectocotylyzed arm of *Sepia vecchioni* sp. nov. (Male) (Illustration by D'Antony Manuela, FAO copy right, 2007)

(iv) tentacle slender; tentacular club elongate with four extremely enlarged median suckers, the middle two being very much enlarged (Figure 3)

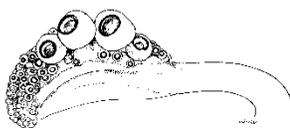


Figure 3. Tentacular club of *Sepia vecchioni* sp. nov. (Illustration by D'Antony Manuela, FAO copy right, 2007)

Common names

Sepia vecchioni sp. nov. is popularly called by fishermen as 'Paper cuttle fish' because of its translucent and thin mantle tissue and is also called as 'Kuttan' by vernacular name. It is also called as 'dotted cuttle fish' as the dorsal mantle has white patches and dots.

Fishery

Sepia vecchioni sp. nov. forms commercial fishery off Kanyamumari coast from August to November in trawlers operated at a depth of ranging from 70 – 100 m. It constitutes mono species fishery during peak fishing season and form sporadic fishery in the motorized traditional fishing in hook and lines along with other cuttlefish species.

Description

The morphometric measurements of *S. vecchioni* sp. nov. and *S. prashadi* are given in Table 1 and the

<http://www.americanscience.org>

percentage overlapping of body proportions of *S. vecchioni* sp. nov. with that of *S. prashadi* are given in Table 2. The description of various body parts of *S. vecchioni* sp. nov. are given below.

Mantle

Mantle elongate, ovate, broadest at anterior end, mid dorsal part in anterior end produced into a triangular lobe, mantle so soft that the ridges of cuttlebone visible through dorsal mantle and can be felt by hand, dorsal mantle pinkish brown with distinct white stripes and spots in fresh condition and persist even after death, stripes with undulations on mid dorsal mantle, stripes discontinuous, stripes on anterior triangular lobe very much curved and facing upwards, white patches and spots on lateral sides of dorsal mantle arranged almost vertically, (Figure 1a, Figure 1b); ventral mantle with numerous minute pinkish brown spots and 12 distinct luminescent streaks, 6 on each side, adjacent and parallel to fin base, maximum width 63.34% (55.81-84.53%) of DML

Fins

Fins very soft, narrow, fin breadth not uniform, wider near posterior end, a narrow white line runs along fin base on dorsal mantle demarcating mantle and fin; fin starts slightly below the anterior margin of mantle with the distance of 5.84% (2.29-20%) of DML, fin width 7.65% (2.94- 13.05) of DML.

Head

Head prominent, short and as long as inter orbital width, dorsal side with numerous white spots, patches, inter orbital width 30.46 (20.94 – 43.06) of DML; eye prominent and its diameter 16.30% (10.78—30.00) of DML.

Funnel

Funnel large, thin walled, reaches almost base of fourth ventral arm, funnel length 36.09% (30.00 -- 46.14) of DML

Arms

Arms generally elongate, dorsal side of arm with white patches and dots, arms soft with pointed end, I pair slender, II and III pair slightly flattened and ventral arms (IV pair) long with well developed keels and tapering ends, arms in matured male I and IV pair notably elongated, I pair very elongate and whip like, arm formula being 1.4.3.2 (Figure 1a), arms in female not remarkably extended though general arm formula being the same (Figure 1b), lateral sides of arms with numerous minute pinkish brown spots, arms with quadriserial suckers arranged in oblique rows throughout; suckers with horny rings with vertical sides, basal rows of suckers large and get gradually reduced towards distal end, those at tips very minute; left dorsal arm in males (I) 69.92 (51.20-83.33%) of DML, left dorsal lateral arm (II) 48.99% (40.00-61.52%) of DML; left ventral lateral arm (III) 49.76% (33.32-65.25%) of DML and left ventral arm

(IV)62.35 (45.21-80.04%) of DML, in females left dorsal arm (I) 61.26%(49.31-81.51 %) of DML, left dorsal lateral arm (II) 47.24% (33.32-68.62%)of DML, left ventral lateral arm (III) 47.85% (36.86-61.00%) of DML and left ventral arm IV 59.47% (46.66-76.16%) of DML

Hectocotylus

Left ventral arm in male hectocotylized, two middle series of suckers completely absent even from basal portion, basal portion with 3 rows of biserial normal suckers proximally followed by a ventral and a dorsal series of minute suckers each consisting of 18-20 suckers in hectocotylized portion, two series of suckers of the hectocotylised portion widely separated from each other with distinct gap, hectocotylized portion follows 7 to 8 rows of minute quadri serial suckers and there after suckers very minute up to arm tip (Figure 2).

Tentacles

Tentacles long, slender, longer than body 178.04%(150.78-256.85%) of DML, tentacular stem rounded in cross section; tentacular club slender and elongate 17.21%(13.05-27.68%) of DML, club with four enlarged median suckers , two middle suckers being extremely enlarged (Figure 3), distal end of club with about 20 minute suckers, swimming membrane at anterior end broad which gradually tapers towards posterior end, protective membranes on ventral side narrow with 1 or 2 suckers , on contrary dorsal protective membrane broad with 4 to 6 minute suckers on its boarder, protective membranes do not extend beyond corpus and united at base.

Buccal membrane

Buccal membrane thick, rostrum of horny beak dark in colour, embedded in buccal mass seen in middle.

Colour

Body pinkish brown with white dots and conspicuous white stripes on dorsal mantle; 12 luminescent vertical streaks 6 on each side of the ventral mantle persist even after death and preservation in ice.

Cuttlebone

Cuttlebone fragile, elongate, elliptical, acuminate on both anterior and posterior ends, color pale pink, dorsal surface mostly flat, slightly convex and highly granulose, cuttlebone of female slightly broader than that of male, mid dorsal side of the cuttlebone weakly calcified, covered with a peelable smooth chitinous membrane, 3/4th of anterior lateral edges calcareous, polished and yellowish in color, dorsal surface with one median and two longitudinal lateral ribs which can be felt through dorsal mantle of animal, lateral ribs diverge slightly towards

distal end; ventral surface with one medial longitudinal groove and two lateral grooves one on each side, running along entire length of cuttlebone , lateral grooves fades towards the distal end and become less distinct, medial groove also becomes shallow and get widened towards distal end of loculus; loculus slightly convex, upper margin of striated zone inverted 'V' shaped, inner cone short with pocket like cavity, limbs of inner cone narrow; sulcus deep; outer cone translucent with poorly developed wings; spine short, prominent and curved upward.

As per the classification of the genus *Sepia* by Khromov *et al* (1998) into six different species complexes, *Sepia vecchioni* sp.nov can be classified under *Acanthosepion* species complex of Rochebrune (1984) due to distinct pocket like cavity of the inner cone (Figure 4a, Figure 4b). However, it also shares some of the characters of *Rhombosepion* species complex of Rochebrune (1984) by having weakly calcified cuttlebone and partially calcified dorsal surface at the distal end. Cuttlebone in female relatively broader than that of males, in males, width of cuttlebone 27.06% (24.60-29.88) of CBL, length of loculus 28.33%(24.61-31.98%) of CBL, indicating that the length of loculus is almost equal or slightly higher than width ; length of striated zone 64.49% (60.44-71.45) of CBL, inner cone length about 2.06% (1.30-3.28%) of CBL.

In females, width of cuttlebone 28.91% (25.97-31.82) of CBL, length of loculus 28.06%(23.91-31.26%)of CBL, indicating that the length of loculus is almost equal or little less than width, length of striated zone 63.37% (55.86-70.90) of CBL, inner cone length about 1.89%(1.09-2.22%) of CBL

Affinity

Sepia vecchioni sp. nov. is closely related to *S. prashadi* by having 4 extremely enlarged median suckers on the tentacular club (Figure 3 , Figure 5a).

The ventral mantle of both the species has 12 distinct luminescent vertical lines 6 on each side, adjacent and parallel to fin base, Both the species are found matured in the size range of 7.0 to 7.5 cm. They also resemble each other in body proportions as evidenced from the high percentage of overlapping (Table.2). The cuttle bone of both the species is also pale pink in color. Apart from *S. prashadi*, other five species of *Sepia* such as *S. omani* Adam and Rees, 1966, *Sepia vossi*, Khromov, 1996, *Sepia papillata* Quoy and Gaimard, 1832, *Sepia chirostrema* Berry, 1918 and *Sepia opipara* Iredale, 1926 also show resemblances with *Sepia vecchioni* sp. nov. by having 3 to 5 extremely enlarged suckers on tentacular club occupying majority of the club surface (Khromo *et al.*,1998; Lu, 1998 & Jereb and Roper,2005).

Table1. Morphometric measurements of *Sepia vecchioni* sp.nov. and *Sepia prashadi* (in cm)

Characters	<i>Sepia vecchioni</i> sp.nov.			<i>Sepia prashadi</i>		
	Mean	SD	Range	Mean	SD	Range
Maximum width of mantle	6.6429	0.6711	5.5 – 8.4	4.8352	0.3312	4.0 – 5.8
Fin width	0.8175	0.3364	0.3 - 1.5	0.3130	0.1139	0.2 – 0.7
Fin length	9.1048	1.4601	6.0 – 13.0	5.6944	0.6172	4.5 - 7.4
Maximum width including fin	7.6429	1.0899	5.8 – 10.7	5.2815	0.3781	4.2 – 6.5
Eye diameter	1.7175	0.3701	1.0 – 3.0	1.211	0.1560	1.0 – 1.5
Inter orbital width	3.1921	0.4480	2.2 – 4.0	2.6185	0.3086	2.0 – 3.5
Free height	0.6143	0.2878	0.3 – 1.8	0.6630	0.1725	0.3 – 1.0
Length of funnel	3.7937	0.4886	2.6 – 5.0	2.7444	0.2910	2.2 – 3.5
Tentacle length	18.6460	1.8892	15.0– 23.5	16.3389	1.6308	12.0-21.0
Tentacular club length	1.8095	0.2964	1.4 – 2.5	1.3944	0.1446	1.0 – 2.0
Male						
Left first arm length	8.2593	1.7041	5.2 – 11.5	3.6487	0.5926	2.5 – 5.5
Left second arm length	5.5852	1.1323	3.6 – 8.0	3.4000	0.5588	2.4 – 4.5
Left third arm length	5.6519	1.1777	3.3 – 7.9	3.3538	0.4997	2.5 – 4.9
Left fourth arm length	7.0741	1.3424	4.7 – 10.1	3.6590	0.5895	2.6 – 5.9
Female						
Left first arm length	6.0833	0.942	4.2 – 8.0	3.2133	0.7455	2.5 – 5.3
Left second arm length	4.6389	0.7088	3.0 – 6.2	3.0267	0.6361	1.9 – 4.6
Left third arm length	4.7639	0.7739	3.4 - 6.0	3.0867	0.6054	2.2 – 4.5
Left fourth arm length	5.9250	1.1302	4.0 – 8.0	3.6000	0.4980	2.6 – 4.8
Male						
Cuttle bone length	10.5000	1.4958	7.7 – 12.6	7.2308	0.5630	6.0 – 8.9
Cuttle bone width	2.8750	0.2861	2.3 – 3.2	2.3897	0.1410	2.1 – 2.6
Length of loculus	3.0250	0.4521	2.3 – 3.9	2.8359	0.3000	2.2 – 3.3
Striated zone length	6.7125	0.7574	5.5 – 8.0	3.9744	0.4419	3.3 – 5.3
Inner cone length	0.2250	0.0829	0.1 – 0.3	0.2641	0.0480	0.2 – 0.3
Spine length	0.2875	0.0331	0.2 - 0.3	0.3605	0.0630	0.3 - 0.5
Female						
Cuttle bone length	10.2263	0.8252	9.0 – 12.5	6.9933	0.7672	6.0 – 8.8
Cuttle bone width	3.0158	0.2661	2.6 – 3.5	2.4600	0.2154	2.1 – 2.9
Length of loculus	2.9263	0.2988	2.2 – 3.5	2.9467	0.5352	2.2 – 3.7
Striated zone length	6.6105	0.7040	5.7 – 8.3	3.6800	0.5062	3.1 – 4.6
Inner cone length	0.1947	0.0223	0.1 – 0.2	0.2333	0.0471	0.2 – 0.3
Spine length	0.2684	0.0567	0.2 - 0.4	0.3400	0.0611	0.2 - 0.4

Table 2. Percentage overlapping of body proportions of *Sepia vecchioni* sp.nov. with that of *Sepia prashadi*

Characters	Overlapping range	Overlapping ratio	Extreme range	Extreme ratio	Percentage of overlapping
Maximum width of mantle	59.81 - 76.68	16.87	55.81 – 84.59	28.78	58.62
Fin width	2.94 - 9.23	6.29	2.67 - 13.05	10.38	60.60
Fin length	72.42 - 85.74	13.32	71.45 - 96.00	24.55	54.26
Maximum width including fin	67.95 - 88.35	20.40	58.31-92.28	33.97	60.05
Eye diameter	14.08 - 20.23	6.15	10.78 - 30.00	19.22	32.00
Inter orbital width	25.00 - 43.06	18.06	20.94 - 44.60	23.66	76.33
Free height	4.29 - 12.67	8.38	2.29 - 20.00	17.71	47.32
Length of funnel	31.25 - 46.14	14.89	30.00 - 49.22	19.22	77.47
Tentacle length	192.92 -256.85	63.93	150.78 - 284.53	133.75	47.80
Tentacular club length	16.18 - 27.68	11.50	13.05 - 28.98	15.93	72.19
Male					
Left first arm length	51.20 - 61.82	10.62	34.25 – 95.80	61.55	17.25
Left second arm length	40.00 - 59.14	19.14	36.36 – 62.48	26.12	73.28
Left third arm length	37.88 – 56.32	18.44	33.32 – 65.25	31.93	57.75
Left fourth arm length	45.21 – 68.99	23.78	40.91 – 80.04	39.13	60.77
Female					
Left first arm length	46.66 – 64.66	18.00	37.67 – 76.16	38.49	46.77
Left second arm length	36.86 – 56.12	19.26	30.15 – 61.00	30.85	62.43
Left third arm length	35.49 – 54.90	19.41	33.32 – 68.62	35.30	54.99
Left fourth arm length	49.31 – 63.06	13.75	41.94 – 81.51	39.57	34.75
Male					
Cuttle bone width	29.22 – 29.88	0.66	24.60 – 36.36	11.76	5.61
Length of locus	28.16 – 31.98	3.82	24.61 – 46.37	21.76	17.56
Striated zone length	60.44 – 65.15	4.71	47.23 – 71.45	24.22	19.45
Inner cone length	2.56 – 3.28	0.72	1.30 – 5.48	4.18	17.22
Spine length	0	0	2.38 – 7.69	5.31	0
Female					
Cuttle bone width	30.50 – 31.82	1.32	25.97 – 38.16	12.19	10.83
Length of locus	0	0	23.91 – 49.22	25.31	0
Striated zone length	55.86 – 62.71	6.85	45.93 – 70.90	24.97	27.43
Inner cone length	0	0	1.09 – 4.61	3.52	0
Spine length	3.41 – 3.60	0.19	1.79 – 6.67	4.88	3.89



Figure 4a. Ventral view of Cuttle bone of *Sepia vecchioni* sp. nov. (Male)

(Illustration by D'Antony Manuela, FAO copy right,2007)



Figure 4b. Ventral view of Cuttle bone of *Sepia vecchioni* sp. nov. (Female)

Illustration by D'Antony Manuela, FAO copy right,2007)

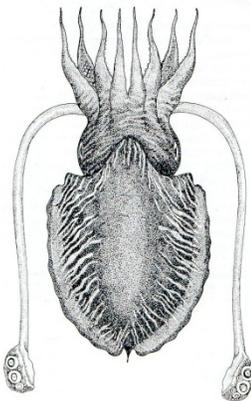


Figure 5a. Dorsal view of *Sepia prashadi*
after Jereb and Roper (2005)



Figure 5b. Ventral view of Cuttle bone of *Sepia prashadi*

4. Discussions

Despite the similarities in body proportions as revealed by the high percentage of overlapping (Table 2), *S. vecchioni* sp.nov. can easily be distinguished from *S. prashadi* based on the stripe pattern. While the dorsal mantle of *S. Prashadi* has 'transverse zebra type stripe pattern' with the ends facing downward (Figure 5a), the stripes of *S. vecchioni* sp.nov are not of 'zebra type' and with the ends generally facing upward (Figure 1a, Figure 1b). Another important diagnostic character of *S. vecchioni* sp.nov is the existence of sexual dimorphism with respect to length of arms in matured animals (Figure 1a). The first pair of arms in male are notably long and whip like in contrast to sub equal in both the sexes of *S. prashadi* (Jereb and Roper,2005). This is also evidenced from the relatively low percentage of overlapping (17.25%) with respect to first arm length between the males of *S. vecchioni* sp.nov and *S. prashadi* (Table.2).

The hectocotylization pattern is yet another important character which can be used to distinguish males of *S. vecchioni* from that of *S. prashadi*. In *S. vecchioni* sp.nov, the suckers are biserial both on the basal as well as on the hectocotylized portion. They are quadriserial only beyond the hectocotylized portion near the arm tip. However in the case of *S. prashadi*, the suckers are quadri-serial through out the hectocotylised arm, despite their reduction in size in the hectocotylized portion. Further, there exists difference with respect to number of reduced suckers on the hectocotylized portion also. The hectocotylized portion of *S. vecchioni* sp.nov has a ventral and a dorsal series of suckers each with 18-20 reduced minute suckers, however in the case of *S. prashadi*, there are 12 to 14 rows of reduced suckers. (Jereb and Roper, 2005). The distinctly wide gap between the two series of suckers in the hectocotylized portion in the case of *S. vecchioni* sp.nov is due to the complete absence of two middle series of suckers.

In the case of tentacular club, though there are four enlarged median suckers with the two middle suckers being extremely large in both the species, the club is short in *S. prashadi* (Jereb and Roper, 2005) and is elongate in *S. vecchioni* sp.nov. (Figure 3). Further, the protective membranes are not united at base in *S. prashadi*. However, in the case of *S. vecchioni* sp.nov., the protective

membranes are united at base. Regarding cuttle bone characteristics of *S. vecchioni* sp.nov., cuttle bone is fragile with weakly calcified portion on dorsal side especially at the distal end. However, the cuttlebone of *S. prashadi* is rigid with complete calcification. Further, the anterior striations in the striated zone of *S. vecchioni* sp.nov. are inverted 'V' shaped (Figure 4a&4b) while they are shallow 'M' shaped in *S. prashadi* (Figure 5b).

The analysis of percentage overlapping of body proportion of *S. vecchioni* sp.nov. with that of *S. prashadi* clearly indicates that both the species resemble each other in many of their body proportion. However, four valid diagnostic characters can be derived based on cuttle bone characteristics which showed nil / low percentage of overlapping viz (i) cuttlebone width, (ii) length of loculus, (iii) inner cone length and (iv) spine length. These morphometric measurements as the percentage of CBL are lower for *S. vecchioni* sp.nov. than that of *S. prashadi*. This may be attributed to relatively elongated nature of cuttle bone of *S. vecchioni* sp.nov.

Since the cuttle bone of *S. vecchioni* sp.nov. shares the characters of both *Acanthosepion* species complex and *Rhombosepion* species complex, it appears that this kind of mixed character has some evolutionary significance. Khromov (1998) viewed the emergence of *Rhombosepion*

species complex followed by *Acanthosepion* species complex during the course of evolution. This species might be probably a link in the evolutionary process of *Rhombosepion* species complex followed by the *Acanthosepion* species complex as viewed by Khromov (1998).

Apart from *S. prashadi*, *S. vecchioni* sp.nov. can easily be distinguished from the other closely related species such as *S. omani*, *S. vossi*, *S. papillata*, *S. chirotrema* and *S. opipara* based on the differences in characteristics of tentacular club, hectocotylyzation pattern and cuttlebone characteristics (Table 4). Though *Sepia vecchioni* sp.nov. resembles *S. chirotrema*, by having tentacular club with protective membranes united at the base, it can be differentiated based on the cuttle bone characteristics, as *S. chirotrema* belongs to *Sepia sensu stricto* species complex (Khromov *et al.* 1998). *Sepia vecchioni* sp.nov. has some resemblances with *S. omani* and *S. vossi* regarding hectocotylyzation in males. However, it distinctly differs from these two species with respect to cuttle bone characteristics (Table.4). Further, *S. vecchioni* sp.nov. notably deviates also from *S. papillata* and *S. opipara* as each of them belongs to different species complex based on the cuttle bone characteristics.

Table 3. Distinguishing morphological and meristic characters of closely related species of *Sepia vecchioni* sp.nov.

Species	Characters		
	Tentacular club	Hectocotylyzation	Cuttle bone
<i>Sepia vecchioni</i> sp.nov.	4 median suckers greatly enlarged, of which two middle sucker extremely enlarged; protective membranes are united at base	3 rows of biserial normal suckers proximally followed by 18-20 rows of reduced suckers in a ventral series and a dorsal series separated by a wide gap, then 7 to 8 rows of minute quadriserial suckers	Fragile, weakly calcified, elliptically oval shaped; median and lateral ribs distinct, anterior striae inverted 'V' shaped; inner cone
<i>Sepia prashadi</i> ^{2,4}	4 median suckers greatly enlarged, of which two middle suckers extremely enlarged; protective membranes not united at base	4 rows of quadri serial normal suckers proximally, followed by 12-14 rows of reduced suckers medially, then normal suckers up to arm tip	Thick, fully calcified, oblong in outline; median and lateral ribs distinct, anterior striae shallow 'M' shaped, inner cone forms distinct cup like cavity; spine long pointed and straight; belongs to <i>Acanthosepion</i> species complex
<i>Sepia omani</i> ^{2,4}	5 median suckers greatly enlarged, of which three middle suckers extremely enlarged; protective membranes not united at base	2 or 3 rows of quadri serial normal size suckers proximally, followed by reduced suckers medially up to 40% of arm with 2 dorsal and 2 ventral series of suckers displaced laterally	Thick fully calcified acuminate; dorsal median and lateral ribs distinct; anterior striae shallow 'M' shaped; inner cone 'U' shaped; spine long and straight; belongs to <i>Rhombosepion</i> species complex

		with a gap	complex
<i>Sepia vossi</i> ²	5 median suckers greatly enlarged, of which three middle suckers extremely enlarged; protective membranes not united at base	3 rows of normal quadri serial suckers proximally, followed by reduced suckers in 2 dorsal and 2 ventral series of suckers displaced laterally with gap followed by normal suckers up to arm tip.	Blunt-pointed anteriorly ; median rib distinct ,lateral ribs indistinct; anterior striae inverted 'U' shaped; inner cone forms 'V' shaped posterior ledge ; spine long pointed straight; spine with dorsal and ventral keel
<i>Sepia papillata</i> ⁴	4 median suckers greatly enlarged, of which 2 middle suckers extremely enlarged; protective membranes not united at base	-----	Broadly oval; ventral surface with median furrow; anterior striae 'L' shaped innercone without spine; belongs to <i>Sepia sensu stricto</i> species complex
<i>Sepia chirostoma</i> ^{4,6}	3 median suckers greatly enlarged, of which middle sucker extremely enlarged; protective membranes united at base	Distal end attenuated, narrow, and compressed laterally, bearing microscopic suckers.	Anterior end acuminate, posterior end broadly rounded; median rib distinct, lateral ribs less distinct; anterior striae inverted 'V' shaped; Inner cone lateral limbs fused with outer cone; spine strong, not pointed and curved with out keel; belongs to <i>Sepia sensu stricto</i> species complex
<i>Sepia opipara</i> ^{2,4}	4 or 5 median greatly enlarged suckers, of which 2nd proximal sucker extremely enlarged; protective membranes not united at base,	5 or 6 rows of normal quadri serial suckers proximally followed by 6 or 7 rows of reduced suckers medially, ventral suckers smaller than dorsal suckers, then normal suckers up to arm tip	Thick, irregularly calcified; elongate oval; median and lateral ribs distinct; anterior striae inverted 'U' shaped; innercone narrow 'U' shaped; spine short; belongs to <i>Rhomposepion</i> species complex

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