

A NEW RECORD OF *SARDINELLA AURITA* VALENCIENNES, 1847 (TELEOSTEI:
CLUPEIDAE) FROM THE EASTERN PART OF THE ARABIAN SEA: A POSSIBLE
IMMIGRANT THROUGH THE RED SEA?

Someshwar Dutt and K. Varahala Raju¹
Andhra University
Visakhapatnam, India

"*Sardinella aurita* Valenciennes, 1847, is widely distributed in the tropical Atlantic, the Mediterranean, and the western central Pacific, but in the Indian Ocean seems to be replaced by *Sardinella longiceps* Val., 1847. *S. aurita* has now been recorded from Quilon on the west coast of India. Its occurrence in small numbers in the Arabian Sea and its absence in the Bay of Bengal foster the hypothesis that it might represent an uncommon instance of migration from the eastern Mediterranean through the Suez Canal and Red Sea."

Introduction

In India, clupeoids account for about one-third of the total annual catch of marine fish; the total catch was about 1.4 million metric tons in 1979. The entire fishery is restricted to the inner half of the continental shelf.

Among the clupeoids, sardines of the genus *Sardinella* Valenciennes are the most important. We do not have a reliable picture of the total number of species of this genus represented in the exploited waters off mainland India. According to Nair (1973), there are nine species represented in India. Whitehead (1973) listed ten species from India and indicated that two others are likely to occur there, but not *Sardinella aurita* Valenciennes, 1847. In 1960 Ben-Tuvia (1960a) showed the known distribution of *S. aurita* and its notable absence in the Indian Ocean, where it was replaced by *Sardinella longiceps* (Whitehead, 1973).

We undertook the present study because of the very few in-depth analyses of the taxonomy and spatial distribution of *Sardinella* species represented in India. We recorded the following 10 species: *S. aurita*, *S. longiceps*, *S. dayi*, *S. albella*, *S. fimbriata*, *S. melanura*, *S. gibbosa*, *S. sirm*, *S. clupeoides*, and *S. leiogaster*. Among the 12 species listed by Whitehead (1973), 3 -- *S. jussieui*, *S. brachysoma*, and *S. sindensis* (the latter most probably a synonym of *S. gibbosa*) -- have not been recorded during the present study. *S. aurita* is being recorded for the first time from Quilon on the west coast of India; in fact, this constitutes the first record from the Indian Ocean.

Material and Methods

The taxonomic study of sardines was based on detailed examination of 1931 specimens from 61 random samples from 13 localities from both coasts of India

¹D.N.R. College, Bhimavaram, India.

and reexamination of the registered specimens of *Sardinella* in the Zoological Survey of India. One sample of 131 specimens collected at Quilon on January 3, 1979 included 4 specimens of *S. aurita* (88-94 mm SL), 120 specimens of *S. longiceps* (104-152 mm SL), and 7 specimens of *S. gibbosa* (76-132 mm SL).

Observations

In the course of processing and analyzing the biometric data of 86 specimens that all appeared to be *S. longiceps* from the sample from Quilon, we observed that 4 differed from the others. Instead of true *S. longiceps*, these 4 exhibited the following six characteristics: shorter head, shorter postorbital, shorter predorsal distance, shorter prepelvic length, shorter preanal length, and lower number of gillrakers on lower arm of first gill arch (see Table 1)(Raju, 1981). The four specimens agree with the earlier descriptions of *S. aurita* (Table 2) in regard to the meristic characteristics. Despite these differences, *S. longiceps* and *S. aurita* resemble each other externally so that the latter was misidentified as *S. longiceps*. However, individual specimens of either species can be correctly identified if the number of gillrakers is counted in relation to length of specimen.

Discussion

Day (1878) and Weber and de Beaufort (1913) recognized only *S. longiceps*, and thus did not distinguish it from *S. aurita*. Fowler (1941) and Chan (1965) did recognize them as distinct species, but some of their specimens of "s.

TABLE 1. Comparison of the relevant characteristics of the specimens of *S. longiceps* and *S. aurita* in the sample from Quilon collected on January 3, 1979. (Data from Raju, 1981)

Characteristic	<i>S. longiceps</i> (104-130 mm SL) n = 82	<i>S. aurita</i> (88-94 mm SL) n = 4
Head length	29.8-32.7	25.0-26.8
Postorbital length	15.3-16.8	11.3-12.7
Predorsal distance	46.2-49.0	41.7-44.5
Prepelvic distance	54.6-59.8	49.4-55.3
Preanal distance	76.8-81.8	74.7-77.6
Gillrakers	193-266	127-138

TABLE 2. Comparison of meristic characteristics of *Sardinella aurita* between earlier sources and present data.

Sources	Rays		Scutes		Vertebrae	Gillrakers		
	Dorsal	Anal	Pectoral	Total				
Regin, 1917	16-20	15-19	-	18-20	13-15	47 or 48	110-160	
Fowler, 1941	18	19	-	-	-	-	168	
Ben-Tuvia, 1960	16-20	15-19	16-18	18-21	13-17	32-35	46-49	100-170
Chan, 1965	17-20	15-18	14-16	17-18	12-15	-	-	68-166
Whitehead, 1967	17-19	17-18	16-18	19	15	-	49	83-127
Present data (n = 4)	18-19	17-18	15-17	18-19	15	33-34	46-48	127-138

longiceps" included *S. aurita*, which is further evidence of how closely the two species resemble each other.

Day (1878) placed *Clupea lemuru* Blkr. (= *S. aurita*) in the synonymy of *S. longiceps*. Weber and de Beaufort (1913) gave the number of gillrakers in *S. longiceps* as 120, which suggests that their material also included *S. aurita*; even juveniles of *longiceps* in the 7-cm length group (TL) have more than 150 gillrakers. Further, Roxas' (1934) description of "*S. longiceps*" appears to be *S. aurita*, upon examination of the head length and number of gillrakers.

Fowler (1941) mentioned a specimen of *S. longiceps* from the Philippine Islands (in the National Museum of Natural History, No.56161), measuring 153 mm and having 140 gillrakers on the lower arm. George Van Dyke (in litt.) provided the relevant data and stated that most of the caudal fin rays are now missing and that in all probability its total length may have been 153 mm, a length mentioned by Fowler. Its standard length is 124 mm. Van Dyke stated that the specimen is now identified as *Harengula* (= *Sardinella*) *longiceps*. Obviously, this specimen is not *S. longiceps*, because specimens of *S. longiceps* in the 120-mm length group (SL) (= 150-mm length group [TL]) have a much higher number of gillrakers: 192-255. The following body measurements (expressed as percent of standard length) were obtained from the actual measurements provided by Van Dyke: head length, 26.5 mm; postorbital length (of head), 14.8 mm; predorsal distance, 44.3 mm; prepelvic distance, 52.0 mm; and preanal distance, 75.8 mm. These values (except postorbital length) are within the range now recorded in the four specimens of *S. aurita* (Table 1). The number of gillrakers noted by Chan (1965) on the lower arm (145-258) of *S. longiceps* suggests that his material also included specimens of *S. aurita*.

The original figure of *Sardinella aurita* in Valenciennes (1847, plate 594) reproduced by Whitehead (1967, plate 1b) clearly shows the shorter head (23.8 percent in SL), shorter postorbital length (11.4 percent in SL), and shorter predorsal distance (42.8 percent in SL) that distinguish it from *S. longiceps*. Similarly, the figure of *Clupea lemuru* (= *Sardinella aurita*) in Bleeker (1853, plate 267, figure 1) -- reproduced in Whitehead, Boeseman, and Wheeler (1966, plate 5, figure 2) -- also shows a shorter head (26.0 percent in SL), shorter postorbital (12.0 percent in SL), and shorter predorsal distance (45.0 percent in SL) than in *S. longiceps*.

Chan (1965) also drew attention to the differences between *S. aurita* and *S. longiceps* in regard to these three body measurements, in addition to his own figures of *S. aurita* (p.36, figure 16) and of *S. longiceps* (p.36, figure 17). Although the two figures reveal the distinct difference between the two species in the shape of the interopercle, Chan's figure of *S. aurita* does not depict the shorter head, shorter postorbital, and shorter predorsal distance. The relevant measurements from Chan's figure of *S. aurita* yield the following values (for percent of standard length): head length, 30.4; postorbital length, 16.5; and predorsal distance, 46.0. These fall within the corresponding range of *S. longiceps*. However, in his description of the two species, Chan (1965) gave the following proportions for the two species:

	<i>S. aurita</i>	<i>S. longiceps</i>	from Chan's figure of <i>aurita</i>
Head in standard length	3.66-3.84	2.95-3.44	3.28
Predorsal length in standard length	2.18-2.31	2.04-2.22	2.16
Postorbital length in head length	2.36-2.58	2.20-2.35	2.00

The values derived from Chan's figure in regard to head length and predorsal length of *S. aurita* actually fall within the range given by him for *S. longiceps*, and the value for postorbital length does not fit into either range. Hence, Chan's figure of *S. aurita* is not accurate in regard to these three important diagnostic characteristics.

The present first record of *S. aurita* from the northern tropical part of the Indian Ocean is noteworthy because, although it is the most widespread of all the species of *Sardinella* -- being represented in the tropical Atlantic, the Mediterranean, and the western central Pacific -- it was believed to be replaced by *S. longiceps* in the Indian Ocean. Its occurrence in very small numbers along the west coast of India (the other species of *Sardinella* occur in appreciable quantities, given the multispecies nature of the fishery), and in the context of the earlier view, fosters the hypothesis that it has spread southward from the eastern Mediterranean through the Suez Canal and Red Sea. Furthermore, although in the Eastern Hemisphere this species extends from the central western Pacific into the Indo-Australian Archipelago, it has not spread further west into the Bay of Bengal and is not represented along the east coast of India. This excludes the possibility of its having spread westward from the Indo-Australian Archipelago.

There are quite a few records of the migration of Red Sea fish to the Mediterranean through what has been called Lessepsian migration, a term proposed by F.D. Por, but relatively few records of establishment of Mediterranean species in the Red Sea and further south in the Arabian Sea. Ben-Tuvia (1971, 1976) has shown that fish of Red Sea origin are of increasing importance in the eastern Mediterranean, but that fish migration in the opposite direction -- i.e., into the Red Sea and further south -- is very limited. According to Tortonese (1974), the higher temperatures and the "faunistic pressure" exerted by the very rich fauna in the Red Sea have been the main reasons for the limited migration into it. Ben-Tuvia (1960b) has drawn attention to the fact that the related *S. maderensis* (Lowe) penetrated into the Suez Canal from the eastern Mediterranean, but not further south.

Thus, there is still no record of any fish having established itself in the Arabian Sea after migrating southward from the eastern Mediterranean. Ben-Tuvia (1973) has also discussed the effects of the construction of both the Suez Canal and the Aswan High Dam on the fishery resources of the area.

Literature Cited

- Ben-Tuvia, A. 1960a. Synopsis of biological data on *Sardinella aurita* of the Mediterranean Sea and other waters. Proc. World Sci. Meet. Biol. Sardines Rel. Species. FAO, Rome, 2: 287-312.
- _____. 1960b. Synopsis on the systematics and biology of *Sardinella maderensis* (Lowe). Proc. World. Sci. Meet. Biol. Sardines Rel. Species. FAO, Rome. 2: 497-519.
- _____. 1971. Revised list of the Mediterranean fishes of Israel. Isr. J. Zool. 20: 1-39.
- _____. 1973. Man-made changes in the eastern Mediterranean Sea and their effect on the fishery resources. Mar. Biol. 19: 197-203.
- _____. 1976. Fish Collections from the Eastern Mediterranean, the Red Sea and Inland Waters of Israel, Vols. 1-20. Zoology Museum, Department of Zoology, The Hebrew University of Jerusalem.
- Chan, W.L. 1965. A systematic revision of the Indo-Pacific clupeid fishes of the genus *Sardinella* (Family Clupeidae). Jpn. J. Ichthyol. 12: 104-18; 13: 1-39.
- Day, F. 1878. The Fishes of India. Williams & Norgate, London. Pt.4: 553-778. (Reprinted Wm. Dawson and Sons, 1958.)
- Fowler, H.W. 1941. Contributions to the biology of the Philippine Archipelago and adjacent regions. Bull. U.S. Nat. Mus. 13: 601-620.
- Nair, R.V. 1973. Indian sardines. CSIR Zoological Monographs, New Delhi. No.2: 1-107.
- Raju, K.V. 1981. A taxonomic study of *Sardinella* spp. (Teleostei: Clupeidae) represented in the coastal waters of mainland India and a biometric comparison of *Sardinella longiceps* Valenciennes, 1847 from five localities. Unpublished Ph.D. thesis, Andhra University, Waltair.
- Regan, C.T. 1917. A revision of the clupeoid fishes of the genera *Sardinella*, *Harengula*, etc. Annu. Mag. Nat. Hist. 19: 377-395.
- Roxas, H.A. 1934. A review of the Philippine isospondylous fishes. Philipp. J. Sci. 55: 231-295.
- Tortonese, E. 1974. Mediterranean fishes in the Indian Ocean. J. Mar. Biol. Assoc. India 14: 480-486.
- Weber, M., and L.F. de Beaufort. 1913. Fishes of the Indo-Australian Archipelago. (E.J. Brill, Lieden) 2: 1-404.

- Whitehead, P.J.P. 1967. The clupeoid fishes described by Lacepede, Cuvier and Valenciennes. Bull. Br. Mus. Nat. Hist. (Zool). Suppl. 2: 1-180.
- _____. 1973. A synopsis of the clupeoid fishes of India. J. Mar. Biol. Assoc. India 14: 160-256.
- Whitehead, P.J.P., M. Boeseman, and A.C. Wheeler. 1966. The types of Bleeker's Indo-Pacific elopoid and clupeoid species. Zool. Verhandl. (E.J. Brill, Leiden) 84: 1-159.