It seems reasonable therefore that *S. Stapfii* should find a place in the series *Spontanea* of the Sub-Section *Arundinacea*, of Snowden.

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*September* 17, 1940.

[1] Hooker, J. D., *Flora of British India*, 1897, **7**, 184.
[2] Gamble, J. S., *Flora of Madras*, 1934, **10**, 1735.
[3] Snowden, J. D., *The Cultivated Races of Sorghum*, 1936.

## On the Natural History of *Rastrelliger kanagurta* (Russell) with Special Reference to its Spawning Season and Eggs.*

THE first description of the South Indian mackerel was by Russel in his *Fishes of Vizagapatam*[1] published in 1803. As his name '*Kanagurta*' was an adaptation from the vernacular, many of the subsequent authors adopted Rupell's specific name 'microlepidotus'. Jordon and Dickerson[2] in 1908 distinguished the chub-mackerel *Rastrelliger* with its deeper body, larger scales, feebler dentition and feathery gill-rakers from the typical mackerel and established the genus *Rastrelliger* for it. As the South Indian mackerel presents these characters, it should be included in the genus *Rastrelliger*. As Russell's names have now been generally accepted, we have called the common South Indian mackerel *Scomber microlepidotus* of Day, *Rastrelliger kanagurta* (Russell).

According to H. W. Fowler[3] this species is widely distributed in the Indo-Pacific region. On the West Coast of the Madras Presidency the seasonal fishery of this fish is of great economic value, and ranks next only to that of *Sardinella longiceps*, the Indian oil-sardine. The statistics collected by the Madras Fisheries Department show that, in a good season like that of 1928–29, as much as about 21 lakhs of maunds (= 75,267 tons) of this fish valued approximately at 27 lakhs of rupees is taken on the coasts of the Malabar and South Kanara Districts (250 miles). The fishery usually commence in August and continues to the end of May; it reaches its peak in October, November and December. As the mackerel taints quickly, the quantity consumed in the fresh condition is not considerable; the great bulk of the catches is cured and the product exported to the interior districts in India and to Ceylon and Singapore. The fishery is subject to great fluctuations as the mackerel fisheries elsewhere in the world. In some years the abundance of the mackerel seems to coincide with the scarcity of the oil-sardine and *vice versa*. As both are plankton-feeders, it is obvious that they both compete for food in a mutual struggle for existence and otherwise affect each other's welfare in a manner not yet intelligible. Over 5,000 specimens have been examined from 1934.

*Size*: Specimens of this mackerel less than 10 cm. in length have not been met with in the catches examined. 25 cm. is the maximum length to which this fish grows on the west coast as recorded by Day.[4] The fish attain maturity at about a length of 19 cm. The size forming the bulk of the commercial catches varies from 20 cm. to 23 cm.

*Food*: The diet of this mackerel consists entirely of plankton. The following organisms have been found in its stomach contents.

Zooplankton: (1) Copepods chiefly *Paracalanus* sp., *Euterpina* sp., *Acartia* sp., and *Oithona* sp.; (2) Larval bivalves; (3) Evadne; and (4) Larval prawns.

Phytoplankton: (1) *Conscinodiscus* chiefly *C. jonesianus, C. oculosiridis, C. gigas* var. *dioramma,* and *C. joneschii*; (2) *Peridinians*—*P. depressum* and *P. ovatum;* (3) *Fragilaria*; (4) *Ceratium*—*C. tripos* and *C. massiliense*; (5) *Thalassiothrix nitzschioides*; (6) *Nitzschia* sp.; (7) *Asterionella japonica*; (8) *Rhizosolenia*; (9) *Pleurosigma*; (10) *Dinophysis homunculus*; (11) *Biddulphia sp*; (12) *Planktoniella*; (13) *Ceratulina*; and (14) *Tintinnus.*

Its European relative, *Scomber scombrus* is said to include in its dietary small sprats and pilchards.[5] Till now no vertebrate material has

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been seen in the stomach-contents of the Indian mackerel. Usually copepods preponderate showing that this is its favourite item of food.

*Spawning Season*: Recovering spents are usually met with in September when gonads begin to refill and grow. The maturation of the testis proceeds more rapidly and is much in advance of that of the ovary. Simultaneously with the progress in size of the gonads a corresponding decrease in the catches is noticed, and by the end of May the catches dwindle. As the spawning of this fish synchronizes with the outbreak of the South-West Monsoon and as fishermen don't venture out to sea to fish during the monsoon, any research work on the spawning of the mackerel is bound to be extremely difficult without a sea-going research vessel. The data collected relate to catches which are made occasionally during the breaks in the monsoon. Recovering spents and maturing individuals are abundant enough from September onwards but when they are in a condition preparatory to spawning in May, the mackerel becomes scarce and ultimately disappears under cover of the South-West Monsoon eluding all attempts at research on their eggs and early stages. It is possible that they recede from coastal waters which during this period is much disturbed by the rough winds and rain caused by the onset of the South-West Monsoon. This is favourable to the propagation of the species as ripe individuals which escape the nets go beyond the fishing zone of the fishermen and thereby get a good chance to spawn unmolested by man. Fish in spawning condition are therefore difficult to secure. Besides they appear to spawn at night; but as no spent-fish are found in the day-catches it may be inferred that mackerel either do not spawn in inshore waters exploited by the local fishermen or after spawning at night, they retire beyond their reach. The appearance of spent ones in occasional catches made in August 1937, indicates that the fish after spawning do not permanently retire to the deep sea but seek coastal waters and that their spawning grounds are not very far from the coast.

The above observations roughly show that the spawning of mackerel begins sometime about June and continues till about the end of September, rather a long period.

*Eggs*: According to Delsman[6] the diameter of the eggs of *Rastrelliger kanagurta* varies from 0·85 mm. to 0·95 mm. The diameter of the preserved eggs measured by us varies from 0·54 mm. to 0·70 mm. It is presumed that Delsman measured fresh eggs. The plankton containing the egg is usually preserved in the boat in 5 per cent. sea-water formalin as otherwise the eggs will disintegrate on the return journey of 4 to 5 miles in an open boat under a tropical sky. Delsman had a power-boat fitted with a laboratory and he studied the eggs very often at the spot where they were collected. The somewhat smaller diameter of the eggs noticed by us, in all probability is due to the eggs having shrunk in preservation. The average number of eggs in the South Indian mackerel is nearly 94,000. On one occasion on 1st June 1937, mature and transparent eggs were obtained from fully ripe individuals and artificial hatching was tried but did not meet with success. Delsman remarks as follows:

"A characteristic feature of the '*Kembung*'† eggs is that they are fairly difficult to hatch. When isolated in a glass with clear sea-water a good many of them die in the course of the day and sink to the bottom, becoming opaque. As a rule only a few hatch. This occurs in the course of the evening between 4 and 6 p.m."

In a haul of shore plankton taken at a distance of 5 miles from the shore off Calicut (Chaliyam) on 5th June 1937, at a spot where mackerel were being caught, there were mackerel eggs of the sizes and characteristics of those obtained on 1st June 1937 from full mature specimens. 405 eggs were collected in different stages of development beginning with eggs just fertilized and ending with those with larvæ ready to hatch out. There were also just hatched larvæ. The eggs which were undoubtedly mackerel eggs occurred in a spot where ripe mackerel shoaled and as the fertilised eggs closely resembled in size and

† *Kembung lelaki* is the local vernacular name given by Delsman for *Rastrelliger kanagurta*.

character those obtained from a spawning mackerel, it seems certain that the eggs in the plankton were those of the mackerel. Dr. Delsman also identified mackerel eggs in the plankton in the Malay Archipelago by a process of elimination and inference. In the absence of artificially fertilized eggs, the inference lacks that conclusiveness which was obtained for the eggs of the oil-sardine in 1934 (*vide* paragraph 11 of Administration Report of Department of Fisheries for the year 1934–35). This conclusive proof can only be furnished when spawning fish are secured and artificial fertilization is carried out.

*Internal Parasites*: These are found in the pyloric coecæ, the gut and in the peritonium covering the gut. The parasites in the pyloric coecæ and the gut are numerous and appear to be free scolices of tapeworms or metacestodes. Those found imbedded in the peritonial tissue or sometimes free in the body-cavity are just a few not exceeding two or three in one specimen and are fully developed milk-white tapeworms.

The presence of free scolices in the mackerel indicates that it is the intermediate host of an adult tapeworm or tapeworms and therefore forms the food of predaceous animals such as sharks, perpoises, etc., among whom one should expect the permanent host, whereas the presence of a fully developed tapeworm shows that the scolices must have found their way into the body through the food of the mackerel. In the former case or perhaps in both cases, one might trace possible causes for the natural fluctuations of this mackerel.

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[1] Russell, *Fishes of Vizagapatam*, 1803, **2**, 28, pl. 136.
[2] Jordon and Dickerson, *Proc. United States National Museum*, 1908, **34**, 607.
[3] Fowler, H. W., *The Fishes of Oceania*, 1928, p. 132.
[4] Day, *The Fauna of British India: Fishes*, 1889, **2**.
[5] Cunningham, J. T., *The Natural History of the Marketable Marine Fishes of the British Islands*, 1896.
[6] Delsman, H. C., *Treubua*, 1926, **8**, 395.

## The Apodan Sperm

The Sperms of Amphibia are of two types. The anuran type is very different from the urodelan type and is, curiously, the simpler. In the former, the head is followed by a short but conspicuous neck region in which, in the majority of forms, both the centrioles are lodged. A portion of the base of the flagellum is ensheathed by the mitochondria which are disposed in a spiral manner. This region is usually called the "middle piece" (Wilson, 1928). The structure of the urodele sperm, on the other hand, is highly complex and is very different from that of the Anura. Of the two centrioles, the proximal or head centriole becomes greatly enlarged and conspicuous as a rounded, ovoid or elongated body closely applied to the head of the sperm. Gatenby (1931) finds a clear non-staining space between the head and the proximal centriole in the sperm of *Desmognathus fusca*. The distal centriole, on the other hand, undergoes a curious modification. It becomes converted into a ring which greatly elongates and often extends backwards in the form of a long pessary through a considerable distance along the tail.

Nothing is known of the spermatozoa of the third group of Amphibia, the Apoda. The Sarasins (1890) figured the sperms of *Ichthyophis glutinosus* but their observations are by no means complete and in a review of the subject of the structure and development of the animal sperm, Ballowitz (1913) denies all knowledge of the sperms of Apoda.

In the course of my studies on the spermatogenesis of Apoda, I have had opportunities of examining the sperms of *Ichthyophis, Urœotyphlus* and also *Siphonops* which I describe below.

Figs. 1, 2 and 3 show the ripe sperms of *Ichthyophis glutinosus, Urœotyphlus narayani* and *Siphonops annulatus*. They have been drawn at the same magnification. A variation in the size of the head is noticeable in the three species. The acrosome is spatulate and