

A new species of the genus *Sagitta* (Phylum Chaetognatha) from the Agatti lagoon (Laccadive Archipelago, Indian Ocean) with comments on endemism

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A new chaetognath *Sagitta madhupratapi* from the Agatti atoll, Laccadive Archipelago is described. The species belongs to the "hispid" group. Though collections were made from other atolls the species was found restricted to the Agatti suggesting that the species is endemic to this lagoon. It appears that isolated waters of lagoons promote speciation as this as well as another species dwelling in the area were found to be new to science. Isolation from surrounding neritic populations of chaetognaths is probably one of the reasons for endemism.

There are a number of studies on zooplankton of coral reef areas in the Indian Ocean, most of them are in relation with biological cycles and diet of polyps. Some of these are from the lagoons of the Laccadive Archipelago¹⁻⁶ located off the southwest coast of India (0-12°N, 69-78°E). Most of the atolls of the Laccadive have luxuriant coral fauna.

It has been emphasized that the surrounding waters entering the lagoons enhance the quantity and

diversity of plankton through transportation from the open-sea, and also that some species might be resident. Emery⁷ was the first to mention endemics in the reef plankton communities and the existence of such species is now generally admitted. The study of the chaetognaths of Agatti atoll, one of the numerous small atolls constituting the Laccadive Archipelago, seems to confirm this view. Indeed the two species of *Sagitta* inhabiting the lagoon are undescribed and the

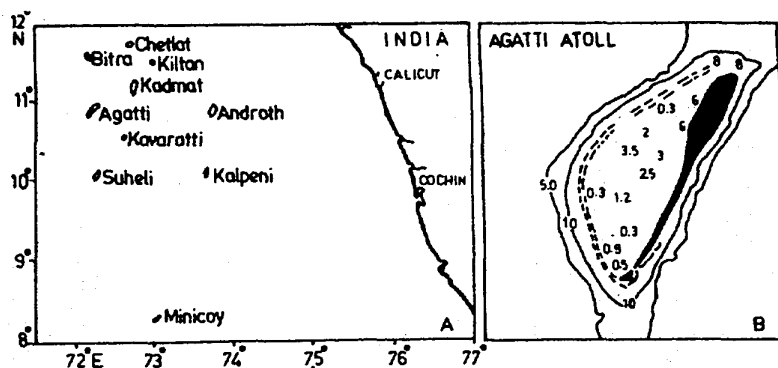


Fig. 1—Agatti Atoll: (A) Location among some other atolls of the Laccadive Archipelago north of 8°N; (B) Configuration.

larger one of them, *Sagitta madhupratapi* sp. nov. is described here.

Materials and Methods

Agatti atoll is a typical representative of the atolls of the Laccadives. It is situated at about 11°N-72°E in the Arabian Sea, off southwest coast of India (Fig. 1). It is oriented along the north-south axis, the lagoon lying west of the island. In the channel the depth is ~6 m, but inside the lagoon it is only between 0.3 and 3.5 m, with a mean of 1.5 m.

The specimens were collected (9 and 10 December 1998) from surface plankton tows made for 10 minutes with a square net (mouth area=0.25 m², mesh size=200 µm) and were preserved in 4% buffered formalin. Chaetognaths were very rare or absent in day time collections. In night collections, they ranged from 48 to 99 specimens/m³ which included the two new species.

Sagitta madhupratapi sp. nov.

Description—A total of 28 specimens were available for systematics studies. Length varied from 6.6 to 9.5 mm. The body is firm and the head elongated, resembling that of a snake. The tail consists 24.5 to 28.8% of the total body length excluding tail fin (Fig. 2). The anterior teeth, 4-6 at each side, are less numerous than the posterior ones, 8-10 (Fig. 3A, B). Both anterior and posterior teeth are ornamented with ridges. The hooks, 6-7, bent at their tip, are smooth (Fig. 3A). The vestibular organs are regularly festooned (Fig. 3B). The eyes are rounded with pigment cell constituted of three branches (Fig. 3C): the internal one is shorter and the two others end as a small fork. Some sensory cells, coloured - grey, are in contact with the internal side of the pigment cell. An original feature is the presence of three external patches of sensory cells, one elongated and two rounded, situated respectively in front of the two axis and forked parts of the larger branches of the pigment cell. The collarette extends from neck to beginning of ventral ganglion and reappears on the anterior part of the tail fin. The corona ciliata stretches from the end of cerebral ganglion to slightly anterior to the extremity of the ventral ganglion (Fig. 2). A pair of conspicuous intestinal diverticula are seen in the neck region. Both lateral and caudal fins are wholly covered with rays. The anterior fins begin slightly after the posterior end of the ventral ganglion. The posterior-

fins are roughly equal to the anterior ones and do not touch the seminal vesicles (Figs 2, 3D). The posterior fins extend more on the tail than on the trunk and the ratio of T/C (part on trunk/part on caudal segment or tail)=0.46 to 0.65. Space between anterior and posterior fins varied between 8.2 and 9.8% of body length.

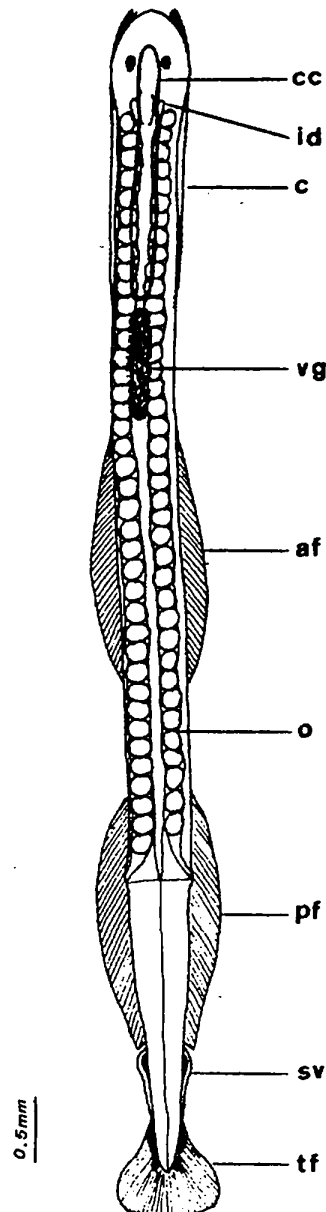


Fig. 2.—Habitus of *Sagitta madhupratapi* sp. nov. (dorsal view). af=anterior fins, c=collarette, cc=corona ciliata, id=intestinal diverticula, o=ovaries, pf=posterior fins, sv=seminal vesicles, tf=tail fin, vg=ventral ganglion.

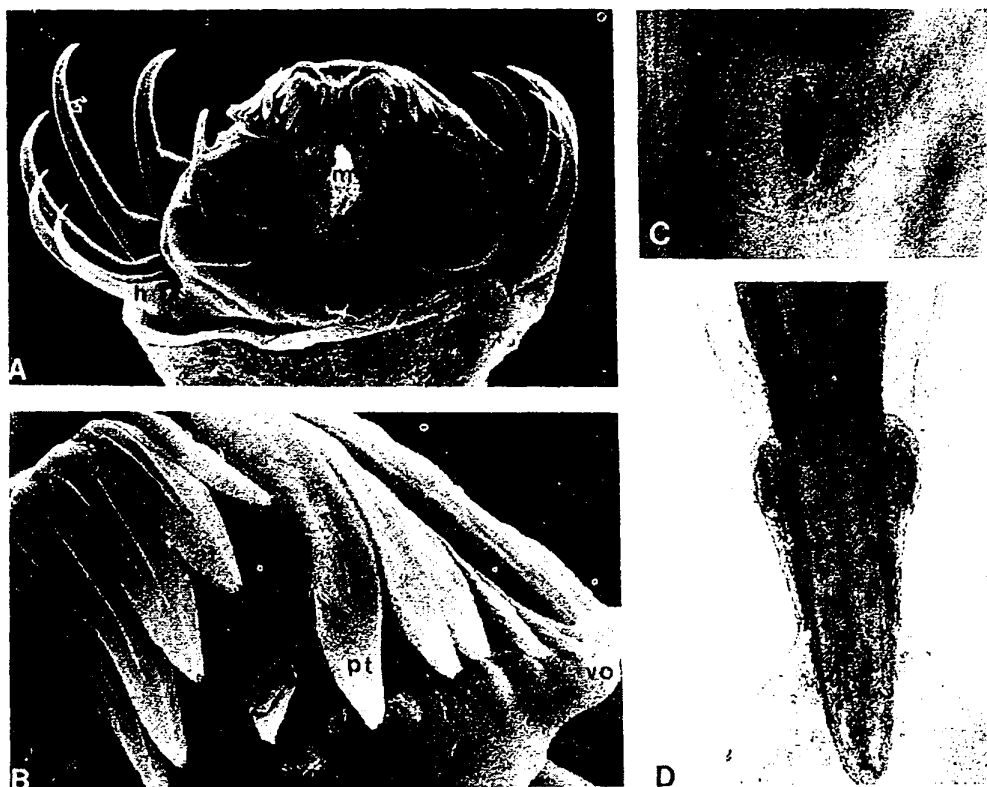


Fig. 3—*Sagitta madhupratapi* sp. nov. A-B: SEM photographs of ventral side of head (A) and details of teeth (B). C-D: light photographs of the right eye (C) and seminal vesicles (D). at=anterior teeth, h=hooks, m=mouth, pt =posterior teeth, vo =vestibular organs* [Magnification: A×100, B×560, C×250 and D×50]

Ovaries are long, reaching the level of neck, with ova arranged dorsoventrally in one row (Fig. 2). The seminal vesicles are slightly separated from the posterior fins and touch the tail fin (Fig. 3D). Each vesicle consists of a swollen subrectangular anterior part and a narrower but longer posterior sperm reservoir. Some specimens were fully mature: ovaries reaching up to neck, containing large ova, and tail segment filled with sperm.

Types—The holotype, a mature individual, 7.3 mm long, and one paratype are deposited in the National Institute of Oceanography, Regional Centre, Cochin, India (IOBC-0502-14-66-98). Two other paratypes are presented to the Museum national d'Histoire naturelle, Paris (UE 909)

Etymology—The choice of the species' name (*S. madhupratapi*) expresses our acknowledgement to Dr M. Madhupratap (National Institute of Oceanography, Dona Paula, Goa, India), who collected the zooplankton samples from Agatti lagoon and also in recognition of his contributions to zooplankton studies from lagoons of the Indian Ocean.

Comparisons with related species—The morphological characteristics of *S. madhupratapi* sp. nov show that it belongs to the "hispidia" group of Alvarino^{8,9}, which thus comprises the following species: *S. hispidia* Conant, 1895, *S. ferox* Doncaster, 1903, *S. robusta* Doncaster, 1903, *S. tokiokai* Alvarino, 1967, *S. americana* (Tokioaka, 1959), *S. galerita* Dallot, 1971, *S. erythraea* Casanova, 1985, *S. siamensis* Casanova and Goto, 1997 and *S. madhupratapi* sp. nov. A specific character which allows to recognize the new species immediately among the others of the group is its large eyes externally bordered with patches of sensory cells. The main characteristic features of all the species of the group have been recently reviewed at length¹¹. Owing to the shape of the seminal vesicles, *S. madhupratapi* sp. nov. is more particularly related to *S. americana*, *S. erythraea* and *S. siamensis*. But small differences are noticeable from most of them. In *S. galerita* and *S. americana*, they are surmounted by a swelling of epidermis. This swelling is absent in *S. madhupratapi*, *S. siamensis*, *S. erythraea*, but in

S. erythraea the seminal vesicles are small and well apart from the tail fin by a length equal to their own length. As for *S. siamensis*, it is characterized by a square pigment cell and thick and rigid fins.

Habitat and speciation

The presence of *S. madhupratapi* sp. nov in the very shallow waters of the lagoon is not surprising. Indeed, a trend of speciation towards a neritic waters has been emphasized in the species of the "hispidia" group¹¹. *Sagitta ferox* and *S. robusta* are oceanic species^{11,12} but all other species of this group are more or less coastal species. *Sagitta americana* has been sampled from 300 to 0 m between California and Peru¹³. *Sagitta galerita* has its maximal abundance above 100 m depth north of Madagascar¹⁴, above 50 m in the Gulf of Suez¹⁵ and was only accidentally observed in the open sea north of the Red Sea¹⁶. The fact that the single known specimen of *S. erythraea* has been found in the middle of the Red Sea probably indicates it is a neritic species¹⁶. *Sagitta siamensis* living on seagrass meadows in the coastal waters of Phuket Island (Thailand) in the Andaman Sea is considered as benthoplanktonic¹⁰. Lastly, *S. hispidia*, which occurs in neritic waters on both sides of the warm Atlantic Ocean⁸, has a near bottom distribution on its west side, particularly in areas with marine meadows. Isolated populations of this species have been recently discovered in a tropical lagoon system in the Mexican coast of the Caribbean; one of these *S. hispidia* populations, characterized by smaller adults, would be evolving because of its isolation¹⁷.

It appears that sometimes confinement to nearshore waters promote speciation. This appears to be the case for the Agatti lagoon since the two species of *Sagitta* dwelling in the area are new, the second one (to be described later) being totally original in the genus owing to long anterior teeth looking like flattened stumpy arrows.

Lagoon and endemism

Similar to other atolls of the Laccadives, Agatti atoll is always warm and humid. In spite of the shallowness of its lagoon (~1.5m), the salinity and temperature do not vary much since exchanges with the neighbouring seawater are constant during tidal movements, even during the rainy season. At the time of sampling, temperature and salinity around the atoll were 28-29°C and 35.5 to 36.5‰ respectively.

Biodiversity is considerably lower in Agatti lagoon and the three other ones studied during the same

period by Madhupratap *et al.*⁶ than in the surrounding open seawater. Indeed, for the chaetognath fauna, only two new *Sagitta* species and the benthic *Spadella angulata* Tokioka, 1951 occurred. This is in contrast with previous observations by Nair & Rao¹⁸ for Kavaratti and Kalpeni lagoons of the same Archipelago. Although they reported an impoverishment in the chaetognath fauna within these two lagoons as compared to that found outside the atolls. The number of species they listed was considerably higher than those occurring in Agatti lagoon, as they identified 12 pelagic species and a benthic chaetognath *Spadella angulata*. They attributed the low density of chaetognaths inside the lagoons to the result of predation by corals. A few years before, Tranter & George¹ also reported the decrease in density of zooplankton in these lagoons due to utilization by the reef community.

Endemism has already been mentioned in Agatti lagoon for other organisms⁶. Madhupratap *et al.*⁶ stated that most of the zooplankton organisms which contribute to these lagoon fauna are resident in the lagoons and rarely occurred in the surrounding sea. Earlier the copepod *Acartia dweepei* was reported as endemic to Kalpeni and Agatti atolls⁵. Isolation from surrounding neritic populations is probably one reason, as suggested for a population of *Sagitta hispidia* in a Caribbean lagoon¹⁷.

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