SEASONAL VARIATIONS IN THE DISTRIBUTION OF *SAGITTA* OF THE MADRAS COAST

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INTRODUCTION.

A preliminary account of the Plankton of the Madras coast was published five years ago (K. S. Menon, 1931) in which was recorded for the first time the occurrence of *Sagitta* along this coast. Menon observes that *S. bipunctata* occurs in the plankton collections fairly regularly and uniformly during all seasons. In a review of this paper published in '*Nature*' (1932) the conclusion was drawn that this uniform distribution is probably due to the tropical condition of the sea. As I have discussed in a later part of this paper, wherever the distribution of *Sagitta* was studied it has been definitely shown that seasonal variations of most of the species is a marked feature of its occurrence, hence the statement of Menon about the uniformity of its distribution was naturally noted with some interest.

Since the Plankton of the Madras coast had never been studied before Menon's work was of the nature of a pioneer attempt and as such was accompanied with all those unavoidable obstacles which necessarily beset works of that type. He identified *Sagitta* of the Madras coast as *S. bipunctata* and recognised only one species. It may now safely be affirmed that this species is not found in Indian waters. From the west coast of India Doncaster (1902) collected thirteen species of *Sagitta* including a number of new forms and from the Bombay coast Lele (1936) obtained three species including one which was recorded for the first time. The only reference to *Sagitta* in the Bay of Bengal is found in the reports of the "Siboga" Expedition (Fowler, 1906). Though that Expedition did not investigate the Bay of Bengal two of the distribution charts of the Reports of the Expedition make note of the occurrence of *S. enflata* and *S. subtilis*. From Menon's collections, which were carefully preserved in the Zoological Laboratory of the Madras University, the author identified five species (John, 1933) and two more species, *S. planktonis* and *S. hispida* have since been identified and included in this paper, but so far no specimen of *S. bipunctata* has been observed either in the Bay of Bengal or in the West coast. It was probably this mistake in identification which was responsible for the misconception that *Sagitta* occur fairly constantly during all the seasons: some species or other always occurs during most of the months, though not always showing the same degree of abundance.

A few years after the publication of Menon's paper the Madras University kindly awarded me a fellowship, which enabled me to carry on some investigations in the University Laboratory. During this time I made a thorough examination of the entire material collected by Menon and through the kindness of the Director of the laboratory was

able to collect some new material as well, but before long I had to leave Madras. The publication of my results was withheld with the hope that I may be able to carry out some more analysis with fresh material. However, since time and circumstances never permitted me to realize this object, I am now venturing to publish these results, which though fairly complete and conclusive are not entirely based on material collected under my personal supervision. The fact that I have used the very material which formed the basis of Menon's work has the added advantage of eliminating the possibility of all exceptions regarding dates and time of catch.

From the captures of Burfield and Harvey of the "Sealark" Expedition (1926) Aida for Japan (1897) Michael for Philippines (1919), Fowler for "Siboga" (1906), Doncaster for the Maldive and Laccadive Islands (1902) and Lele for Bombay (1936) it is evident that the Indo-Pacific region is very rich in Chaetognatha. So far some thirty valid species of *Sagitta* are recognised, out of these no less than twenty one are found in these collections. The great uniformity of *Sagitta* fauna over this vast region is also clearly brought out when these collections are compared. Eight species are found in common in five of the collections, extending from Japan to the Western Indian Ocean and no fewer than thirteen species are found from Philippines to the coast of Africa. Out of these *S. enflata*, *S. tricuspidata*, *S. serratodentata*, *S. hispida* and *S. regularis* have been recorded from the Arabian sea. The Maldive and Laccadive collections have also brought to light a number of new forms, e.g., *S. septata*, *S. polydon*, *S. pulchera*, *S. gardineri*, *S. ferox* and *S. robusta*, to this must be added *S. bombayensis*, sp. nov. and *S. bedoti*, recorded from Bombay. Taking all these into consideration it will be seen that the Arabian Sea has yielded fifteen species of *Sagitta*, out of which seven species are common in the rest of the Indian Ocean. From the Bay of Bengal only eight species have been so far recorded, of these four are found in the Arabian Sea and six species, i.e., *S. hispida*, *S. enflata*, *S. subtilis* *S. neglecta*, *S. tenuis* and *S. planktonis* are common to the rest of the Indian Ocean. Two of the new species of the Maldive and Laccadive regions have been obtained from Madras also, but *S. tenuis*, *S. neglecta*, *S. planktonis* and *S. subtilis* have not so far been observed in the Arabian Sea.

The plankton collections described in this paper were made under conditions quite different from those employed at other Marine Biological Laboratories. On days when a collection was to be made a local fisherman was engaged. Early in the morning before sunrise he sets out into the sea in the common fishing craft called 'catamaran', which is made by yolking together three to five cylindrical logs of light wood into a shape remotely resembling a flat boat. The crudeness of its construction hardly enables it to gather a speed of more than three miles an hour even when under full sail. Collections were made with a simple tow net made of No. 6 standard silk bolting cloth (74 meshes to the inch). The fisherman was always given strict instructions to use more or less the same locality for towing and to drag the tow net always a definite number of times. By these instructions it was hoped to confine the collections to one definite area and to keep the duration of the drag constant as far as possible under such conditions.

Owing to the simple nature of the methods employed it may be argued that no definite and positive conclusions could be drawn from the analysis of such collections, but in spite of its simplicity, the collections have been fairly regular and systematic and give an accurate idea of the distribution of the plankton fauna during all the months of the year. Further as the collections extended over a period of four years they give great scope for comparison and confirmation of results.

Tables 1—4 represent an analytical study of the distribution of *Sagitta* from 1929-1932. It was probably in 1929 that the Madras University first decided to study the Plankton fauna of the Madras coast. During this year collections were not quite regular. I was not able to find any material of collections made in March, April, May and August. Even during the other months the collections were not rich in *Sagitta*. The collections for 1930 were the most regular and systematic and these yielded a complete set of results for the present study. In 1931 captures were made during January, March, April, May, June, July, August and September, and out of the collections of 1932 I was able to study only part of the materials collected during March, April, May, June and July.

In the present work I take the collections of 1930 as typical and those of 1929, 1931 and 1932 are included only for comparison. The 1930 collections of Madras has one great advantage over any other collections made elsewhere in that they yield a complete record of the distribution of *Sagitta* during all the months of the year.

As I have already pointed out seven species of *Sagitta* have so far been recorded from the Madras coast. In certain cases some specimens have been regarded as ' doubtful ' These do not represent unidentified species but are mostly specimens of one or other of the definite species which are partly damaged or mutilated.

During January *S. enflata* was most numerous though their number was not comparatively high. *S. gardineri*, *S. tenuis* and *S. neglecta* were also found ; of these *S. neglecta* was only represented by a very few specimens. *S. planktonis*, *S. robusta* and *S. hispida* were not present during this month. In February *S. enflata* and *S. gardineri* became much scarcer, while *S. tenuis* becomes the most dominant species and *S. neglecta* still continues to be represented only by a few specimens. As in January *S. robusta*, *S. planktonis* and *S. hispida* are totally absent.

In March though *S. enflata* is still represented by a few specimens *S. gardineri* is totally absent and while *S. tenuis* maintains its predominance *S. neglecta* is scarcer than during the preceding month, being represented only by three specimens for the whole month. During this month *S. robusta* first begins to make its appearance and is represented by three specimens, while *S. planktonis* and *S. hispida* still continue to be conspicuous by their total absence.

April shows the same scarcity for *S. enflata* as in the preceding month but *S. gardineri* begins to reappear. *S. tenuis* which had been showing a progressive tendency towards increase in numbers, reaches its maximum intensity and is represented by a quantity which is not surpassed by any other species during any other month. *S. neglecta*

and *S. robusta* are still very scarce. In June *S. enflata* becomes comparatively more numerous and *S. gardineri* also increases in number, while *S. tenuis* shows a sudden fall. The most dominant species during this month is *S. neglecta*, which seems to have increased suddenly. *S. robusta* is also fairly well represented and *S. planktonis* begins to appear for the first time in the year.

S. tenuis is totally absent in July and from now onwards till the end of the year it is not found in the tow net water at all. During this month *S. enflata* is more numerous than *S. gardineri*. However the most conspicuous species of the month is *S. neglecta*. *S. robusta* also reaches its maximum, while *S. planktonis* is fairly well represented. *S. hispida*, which was totally absent from January to June, appears suddenly in the beginning of July and catches made during this month show its maximum for the whole year. *S. planktonis* also reaches its maximum. *S. enflata*, which has been steadily increasing in numbers from the middle of February, now reaches a state of abundance. After the 9th July though three collections were made there were no traces of even stray specimens of *Sagitta*. However they reappear again on the 10th August. The collection of this date gives the maximum for *S. enflata* and *S. gardineri*. *S. hispida* and *S. planktonis* are also fairly well represented, but three species *S. tenuis*, *S. neglecta* and *S. robusta* are totally absent and continued to be so till the end of the year.

The quantity of *Sagitta* in the plankton dwindles considerably by the beginning of September. In the collection of 12th September though *S. enflata* and *S. gardineri* are dominant *S. planktonis* and *S. hispida* are only represented by stray specimens. During this month a second collection was made on the 19th, but *Sagitta* was totally absent, and in October though six collections were made not a single specimen of *Sagitta* could be found in them. It may therefore be concluded that from the middle of September till the beginning of November *Sagitta* are not found in the surface plankton fauna of the Madras coast. In November though they reappear they are only represented by stray specimens and this continues on till the end of December.

Comparing the above analysis for 1930 with those of 1929, 1931 and 1932 we find a great deal of uniformity in the distribution of the various species during the different seasons, for example in 1929 the collections of February, July and August show very close similarity. During January and February *S. robusta*, *S. planktonis* and *S. hispida* are totally absent. In July *S. enflata* is numerous as in 1930 and in the same month *S. planktonis* and *S. hispida* reach their maximum. From June *S. tenuis* is totally absent and though ten collections were made from the 26th September to 28th October not a single specimen of *Sagitta* was observed, thus supporting the condition of October 1930.

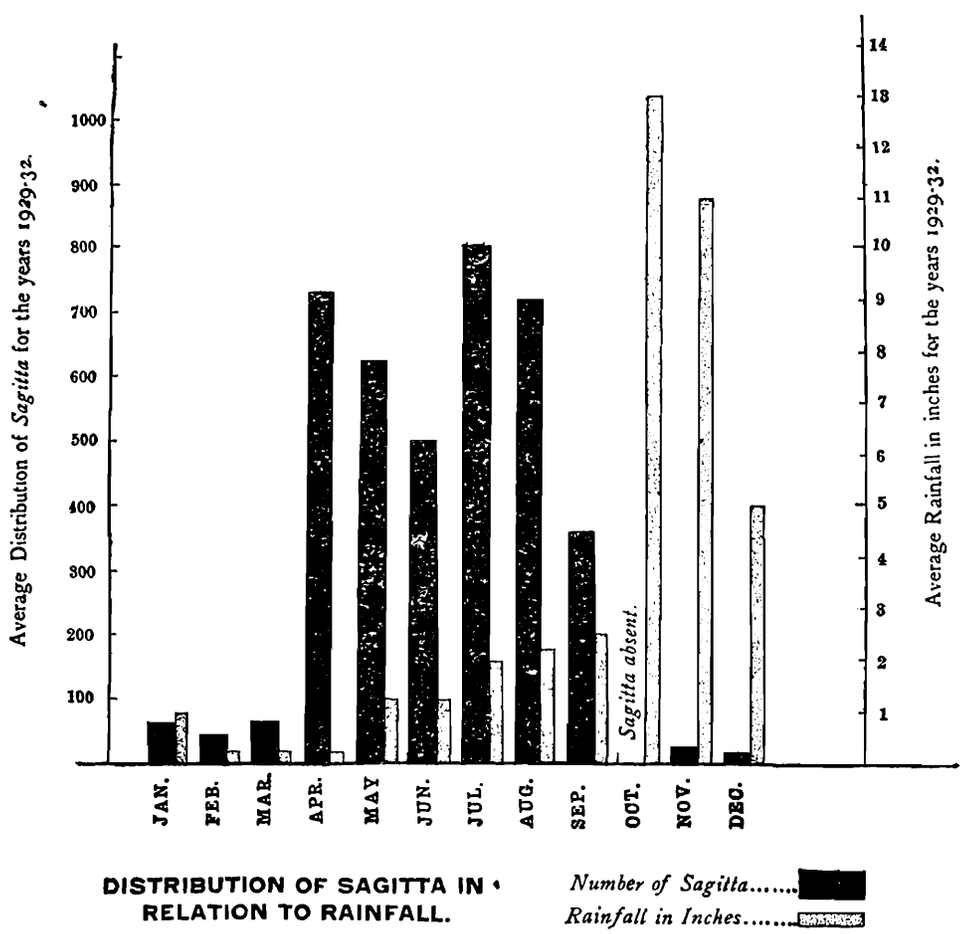
The April collections of 1931 are very similar to those of 1930. *S. tenuis* reaches its maximum but unlike 1930 *S. enflata* is totally absent. This does not, however, alter the general conclusions regarding the distribution of *S. enflata* since in April 1930 only a few stray specimens of that species were recorded, *i.e.*, one to eight specimens in each catch. *S. neglecta* and *S. planktonis* reach their maxima on 3rd June, while in 1930 *S. planktonis* shows its greatest intensity only on the 9th August.

Out of the 1932 collections I was not able to examine the entire lot. So I selected those collections which showed the largest number of *Sagitta* and only analysed them. Out of the March collections only one was examined. Comparing this with the one made on 14th March 1930, it was found that in both cases *S. tenuis* is the most predominant species, though the latter was much richer in numbers. In both cases a few specimens *S. enflata* and *S. neglecta* were also obtained. The April collections of 1932 compare very well with similar collections of 1930. In both cases *S. tenuis* reaches its maximum, while *S. enflata*, *S. gardineri*, *S. neglecta*, *S. robusta* and *S. planktonis* only show evidence of their occurrence by the presence of a few stray specimens only.

The collections of May 1932 are rich in *S. enflata*, *S. gardineri*, *S. tenuis* and *S. robusta*, while *S. planktonis* is represented by only a few specimens. With regard to most of the species mentioned above the numbers are much higher than those of 1930. However, in both cases it is evident that during this month *S. neglecta* reaches its maximum. This month is also interesting because it is during this time of the year that the maximum number of species is found.

In July *S. enflata* and *S. planktonis* reach their maximum and the collection of 25th July 1932, was the richest for all the four years for *S. enflata* and *S. hispida*.

Table No. 5 and the accompanying graph show the variations in the intensity of Distribution during the different months. This table



represents the aggregate average for each month taking the collections of all the four years into consideration. Thus for instance in January

1929 two collections were made in the same month. In 1930 though five collections are on record only three of them showed the occurrence of *Sagitta* and in 1931 only one collection has been recorded. In calculating the aggregate average all the dates in January for all the years are taken together excluding those dates, on which there were no traces of *Sagitta*.

From table 5 it will be seen that in October *Sagitta* are totally absent from the surface plankton. In 1929 this absence was first noticed towards the beginning of the last week of September, in 1930 from the 19th and in 1931 few specimens were found even on the 30th.

Before attempting to explain the causes for these conspicuous differences in the intensity of periodic distribution of *Sagitta* in the Indian waters it is necessary to consider certain general principles. It has been stated by Johnstone (1908) that the nature of plankton distribution will depend on the hydrographic and meteorological conditions or in other words on variations in wind, rain, light, barometric pressure, heat, etc. Along the coast these factors change rapidly and are governed by seasonal changes of the locality. It may also be said that the intensity of any type of plankton will depend also on the intensity of other planktonic organisms which constitute the food of the former and these in turn will depend for their abundance either on the physical conditions of the sea or on their life cycles. This is very well illustrated by the work of Herdman, Scott and Dakin (1910) on an intensive study of the Marine plankton around the south end of the Isle of Man. They have observed that certain planktonic organisms show a remarkable regularity in their time of appearance. For example the nauplii of *Balanus* began to appear on February 22nd in 1907, February 13th in 1908, and February 6th in 1909. This is one of the cases where the regular periodic occurrence depends on the sequence of events in life cycle, which constitutes the dominant factor in determining the composition of the plankton at a given place and time. The occurrence of fish eggs and larvae and the crab zoea is also due to such sequence in life cycles which fall at definite times.

In the case of *Sagitta* it has been definitely established that they do not have any particular breeding seasons. During all the months of the year and at all times the mature specimens carry ripe eggs. In the case of *Spadella cephaloptera* it has been shown that the eggs are shed at intervals of eight to ten days (John, 1933). In *Sagitta* the condition may be more or less the same, considering that the two are very closely allied, so that it may be safely asserted that increase during certain seasons does not depend on the breeding habits of the animal.

During my stay at Plymouth I reared considerable numbers of *Sagitta* and *Spadella* in the Laboratory of the Marine Biological Association and both types were found to thrive on Harpacticids ; these and similar small Crustaceans, which form the food of these animals are invariably found in the plankton during all the months, in the tropical waters. Therefore the postulate that the abundance of *Sagitta* during certain seasons may depend on the abundance of certain other planktonic organisms, which constitute their food, may be dismissed with equal certainty.

The only other factor therefore which remains is change in hydrographic conditions. Concerning this Kofoid (1903) says 'Somewhat regular alternations of growth and rest, of fission and spore formation or parthenogenesis and sexual reproduction are fundamentally the basis of cyclic movements in plankton production. The amplitude and to some extent the location and duration of the pulses are plainly affected by various factors of the environment—light, temperature, vegetation, tributary waters, various hydrographic factors, food supply and possibly also by chemical conditions, not directly concerned with nutrition but available data fail completely to afford any satisfactory environmental factor or groups of factors which stand in correlation with the cyclic movements in production.' However, when considering the cyclic movements of *Sagitta* we find that the periods of seasonal rains along the Madras coast seems to coincide with the periods of scarcity or absence of *Sagitta* in the surface plankton. During the greater part of the year the River Coovum, which reaches the coast close to the Northern side of the University is separated from the sea by a narrow bar of drift sand, but during the rainy season this bar is broken up and the rain water which accumulates in the river forces its way into the sea loaded with mud and dirt of the city. The direction of the coastal currents and the wind cause this muddy water to spread along the coast as a broad patch of reddish brown, clearly distinguishable from the sea water beyond. During this season tow netting is not usually conducted but during certain years when it was desired to obtain a complete record for all the months the fisherman was instructed to drag the net beyond this patch of muddy water. Even then *Sagitta* was not obtained. During the rainy season owing to the admixture of rain water there is bound to be a reduction in the percentage of salinity in the surface layers of the sea.

In 1931 I conducted some experiments with living specimens of *Sagitta* at Plymouth, to investigate their reactions to change of salinity and it was observed that even the slightest change makes them dormant. If the salinity is only altered in superficial layer they sink lower down. The hydrogen-ion concentration of the body fluids of marine animals bears a close relation to the hydrogen-ion concentration of the sea water. Since in the majority of species of *Sagitta* the body wall is thin and flabby any change in the hydrogen-ion concentration of the surface sea water will be felt by the animal which will consequently sink to the lower depths. It seems therefore very probable that the cause of the total absence or scarcity of *Sagitta* during the rainy months is the change of salinity brought about by the admixture of rain water in the superficial layer of the sea.

This conclusion seems to be very well supported by independent observations of Lele (1936) in the Bombay harbour. Of the three species described by him *S. gardineri* is the only one, in which the body wall is thin and flabby and from the table of surface distribution which he has given it will be seen that during March, April and May *S. gardineri* is totally absent from the Bombay coast. In June it is very scarce but from that time onwards there is a steady increase till September. In October the number again falls but rapidly rises again till it reaches

its maximum in December. It will be seen from his table that *S. gardineri* shows two maxima, one in September and the other in December. Alternating with these two periods of maxima are the rainy seasons of Bombay during which times they either become scarce or totally absent. The two other species recorded from Bombay also show seasonal variations in their intensity. For example *S. bedoti* shows three maxima during January, April and August. *S. bombayensis* shows four maxima during the year. It will be noticed that in the case of *S. bedoti* also the season of minimum distribution coincides with the rainy months as in the case of *S. gardineri*.

Species of Chaetognatha in which the body wall is tough and rigid such as *Spadella cephaloptera* are capable of withstanding considerable changes in salinity. *Spadella cephaloptera* is unaffected even when the salinity is reduced to 80 per cent of the normal (John, 1933). I have examined specimens of *S. bedoti* and I have also seen a few specimens of *S. bombayensis*, which Dr. Lele kindly showed me in 1934. In both these cases the body wall is rigid and though not very thick is capable of maintaining the shape of the body unlike *S. gardineri* or *S. enflata*. This characteristic probably enables these two species to withstand certain degree of chemical changes in the sea brought about by the addition of rain water and this probably explains why they do not become totally absent during the rainy seasons.

The south-west monsoon commences on the west coast of India somewhere about the middle of May and its vigour continues on till the end of June. During October Bombay again gets a fair share of rain from northerly winds.

On the East coast the south-west monsoon reaches very late and it passes northwards with only a few light showers along the Madras coast. Madras experiences its heaviest rainfall during the north-east monsoon. This wind, which collects some moisture during its progress across the Bay of Bengal, strikes the Madras coast towards the end of September and gives a considerable amount of rainfall during October, with moderate showers during November and December. Madras therefore has only one rainy season extending from October to December.

The distribution of *Sagitta* during the various months in relation to the average rainfall for each month is shown in the accompanying graph (*vide* text-fig. p. 87).

This graph shows that only in those months when the rainfall is very great the distribution of *Sagitta* is affected. For example at Madras though there are occasional showers in January, July, August and September these do not seem to have any effect on the itensity of distribution of *Sagitta* for it is only natural to infer that such showers cannot alter the salinity of the sea and further, the river Coovum does not empty itself into the sea during these months. But from October to December, when the rain fall is heavy and when there is a considerable rush of tributary waters the salinity is bound to change to such an extent as to make it unsuitable for these delicate organisms to survive in the surface waters.

Out of the three species recorded from Bombay I have only taken two of the well established species into consideration, since the third

is a new species, which appears to behave quite differently from other types. I shall not attempt to comment on this peculiarity till we know some more details regarding its habits and distribution.

Doncaster (1902) in his work on the Chaetognatha of the Maldive and Laccadive Islands does not go into statistical details regarding intensity of distribution. However, the following general idea may be gathered from a study of his paper :—

S. tricuspidata	Not found in April.
S. serratodentata	Common in winter and spring.
S. hispida	Scarce in winter but abundant in April.
S. regularis	Small numbers in winter.
S. robusta	Abundant in winter but scarce in April.
S. gardineri	Moderately abundant in winter.
S. pulchra	Moderate in winter and spring.
S. polydon	Fairly abundant in winter and spring.
S. septata	Moderately common in winter and spring.

From this it may be safely inferred that in the Maldive and Laccadive regions almost all the species reach their maxima during the colder months November to January, the only exception being *S. hispida* which seems to reach its maximum in Summer, just before the commencement of the rains. The rainy seasons in these regions are very much similar to those of Bombay, hence the distributions in these two places are more or less similar. In Bombay also *S. gardineri* reaches its highest maximum in December, while *S. bedoti* is scarce in winter but abundant in April, like *S. hispida* in the Maldive and Laccadive regions. It is therefore evident that on the Indian coast the seasonal fluctuations in the surface distribution of *Sagitta* is mainly governed by the seasons of local rainfall. As the rainy season varies from place to place the seasonal distribution of *Sagitta* is also bound to vary from place to place.

All the seven species recorded from Madras reach their maxima during the hot months April to August. For example *S. tenuis* reaches its maximum in April, *S. neglecta* in May, *S. robusta* in June, *S. enflata*, *S. planktonis* and *S. hispida* in July and *S. gardineri* in August. Of the seven species *S. enflata*, *S. gardineri* and *S. neglecta* occur during all the months of the year except October. The remaining four species *S. tenuis*, *S. robusta*, *S. planktonis* and *S. hispida* are only found during the summer months. We know very little about the vertical distribution of *Sagitta* in these waters and therefore it will be hazardous to venture upon any speculative suggestions before sufficient data are available. In the San Diego region of California where the periodic distribution of *Sagitta* has been recorded (Michael, 1911) the same condition is noticeable. For example *S. bipunctata* seems to be present during all the months, while *S. enflata*, *S. hexaptera*, *S. lyra*, *S. neglecta*, *S. planktonis* and *S. serratodentata* are found only during certain months. Michael makes no attempt to explain this phenomenon. Are they carried away by the surface current of the sea or do they sink to the lower depths during those months when they are not found in surface hauls. These questions can be answered only after a more intensive study of the vertical distribution of the various species during the different seasons of the year.

In conclusion I wish to express my deep sense of gratitude to the authorities of the Madras University and to Mr. R. Gopala Ayyar, Director of the University Zoological Department, for all the facilities they provided me for carrying on this work in their laboratory. My thanks are also due to Dr. Baini Prashad, Director of the Zoological Survey of India, for the loan of periodicals from the Zoological Survey Library.

SUMMARY AND CONCLUSIONS.

1. *Sagitta* does not show a uniform distribution throughout the year in the surface plankton. Out of the seven species recorded from Madras only two are found during most of the months. The other five appear only during the summer months.
2. Each species reaches its maximum only once in the year on the Madras coast and the periods of maxima are different for different species.
3. The distribution of *Sagitta* is at its minimum when the rain fall is very heavy, but it cannot be applied as a general rule that the distribution of *Sagitta* is inversely proportional to the rainfall, because slight occasional showers or irregular rains do not affect their intensity. From these observations the conclusion is drawn that *Sagitta* disappears from the surface plankton when the salinity of the sea water is appreciably altered by the admixture of rain and tributary waters.
4. The periods of maxima do not depend on the breeding habits or the abundance of any particular type of food of the animal.
5. The periods of maxima and scarcity vary from place to place always depending on the nature of the local rainfall. This is supported by recent work carried out at Bombay.

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Table No. 1.

Surface Distribution of Sagitta *for the year 1929.*

Date.	*S. enflata.*	*S. gardineri.*	*S. tenuis.*	*S. neglecta.*	*S. robusta.*	*S. planktonis.*	*S. hispida.*	Doubtful forms.
10th Jan. 1929	12	29	..	3	..	..	..	..
27th Jan. 1929	57	28	1	2	..	..	..	..
11th Feb. 1929	2	4	11	2	..	..	..	..
19th Feb. 1929	7	2	27	4	..	..	..	..
12th June 1929	82	124	..	..	..	85	62	..
2nd July 1929	176	85	..	..	..	187	149	..
12th Sept. 1929	82	124	..	..	..	85	62	..
16th Sept. 1929	143	217	..	8	..	98	31	..
26th Sept. 1929	..	..	..	..	..	..	..	..
28th Sept. 1929	..	..	..	..	..	..	..	..
4th Oct. 1929	..	..	..	..	..	..	..	..
5th Oct. 1929	..	..	..	..	..	..	..	..
13th Oct. 1929	..	..	..	..	..	..	..	..
18th Oct. 1929	..	..	..	..	..	..	..	..
20th Oct. 1929	..	..	..	..	..	..	..	..
21st Oct. 1929	..	..	..	..	..	..	..	..
25th Oct. 1929	..	..		..	..	..	..	..
28th Oct. 1929	..	..	..	..	..	..	..	..
6th Nov. 1929	4	2	..	2	..	..	5	..
12th Nov. 1929	..	..	..	..	..	..	7	2
18th Nov. 1929	8	5	..	5	..	..	2	..
29th Nov. 1929	..	..	..	..	..	..	..	..
30th Nov. 1929	..	..	..	..	..	..	..	..
6th Dec. 1929	3	7	..	3	..	..	..	..
8th Dec. 1929	..	..	..	..	..	..	..	..
9th Dec. 1929	5	8	..	1	..	..	..	..
13th Dec. 1929	1	7	..	1	..	..	..	2
18th Dec. 1929	..	..	..	..	..	..	..	..
20th Dec. 1929	15	10	..	4	..	..	..	..

TABLE No. 2.

Surface Distribution of Sagitta *for the year 1930.*

Date.	*S. enflata.*	*S. gardineri.*	*S. tenuis.*	*S. neglecta.*	*S. robusta.*	*S. planktonis.*	*S. hispida.*	Doubtful forms.
13th Jan. 1930.	55	37	33	9	..	..	..	..
20th Jan. 1930.	60	19	14	4	..	..	..	..
21st Jan. 1930.	3	1	14	3	..	..	..	..
23rd Jan. 1930.	..	..	..	..	..	..	..	..
30th Jan. 1930.	..	..	..	..	..	..	..	..
5th Feb. 1930.	..	..	..	..	..	..	..	..
7th Feb. 1930.	..	6	12	4	..	..	..	13
10th Feb. 1930.	..	2	27	3	..	..	..	..
15th Feb. 1930.	4	5	131	5	..	..	..	..
19th Feb. 1930.	6	3	14	..	..	..	..	..
26th Feb. 1930.	..	..	..	..	..	..	..	..
3rd Mar. 1930.	2	..	23	1	1	..	..	..
8th Mar. 1930.	3	..	126	1	..	..	..	..
14th Mar. 1930.	2	..	119	1	2	..	..	..
22nd Mar. 1930	1	..	8	..	..	..	..	5
29th Mar. 1930.	..	..	..	..	..	..	..	..
1st April 1930	..	..	..	..	..	..	..	..
2nd April 1930	1	..	30	1	1	..	..	..
16th April 1930	..	..	875	..	..	..	..	..
18th April 1930	5	..	1986	..	3	1	..	..
23rd April 1930	8	16	148	2	..	..	..	..
29th April 1930	..	..	..	..	..	..	..	..
1st May 1930.	..	..	..	..	..	..	..	..
5th May 1930.	..	..	..	..	..	..	..	..
15th May 1930.	161	62	124	187	40	5	..	..
29th May 1930.	42	29	5	..	..	..	..	..
4th June 1930.	7	3	..	2	1	3	..	..
12th June 1930.	129	51	..	344	72	38	..	..
14th June 1930.	114	7	..	103	55	49	..	..
16th June 1930.	..	..	..	..	..	..	..	..
9th July 1930.	347	143	..	..	..	154	231	..
21st July 1930.	..	..	..	..	..	..	..	..
23rd July 1930.	..	..	..	..	..	..	..	..
25th July 1930.	..	..	..	..	..	..	..	..
6th Aug. 1930.	..	..	..	..	..	..	..	..
10th Aug. 1930.	387	562	..	..	..	59	165	..
11th Aug. 1930.	316	418	..	..	..	67	114	..
15th Aug. 1930.	118	135	..	..	..	27	17	..
20th Aug. 1930.	..	..	..	..	..	..	..	..
12th Sept. 1930	184	237	..	..	..	..	..	..
19th Sept. 1930	..	..	..	..	..	..	..	..
4th Oct. 1930.	..	..	..	..	..	..	..	..
5th Oct. 1930.	..	..	..	..	..	..	..	..
13th Oct. 1930.	..	..	..	..	..	..	..	..
18th Oct. 1930.	..	..	..	..	..	..	..	..
20th Oct. 1930.	..	..	..	..	..	..	..	..
25th Oct. 1930.	..	..	..	..	..	..	..	..
4th Nov. 1930.	18	13	..	3	..	..	..	..
5th Nov. 1930.	35	28	..	..	..	..	..	..
13th Nov. 1930.	14	12	..	..	..	..	..	..
2nd Dec. 1930.	15	12	..	..	..	..	..	..
9th Dec. 1930.	12	14	..	..	..	..	..	..

TABLES NO. 3 & 4.

Surface Distribution of Sagitta *for the years 1931 & 1932.*

Date.	*S. enflata.*	*S. gardineri.*	*S. tenuis.*	*S. neglecta.*	*S. robusta.*	*S. plankt-onis.*	*S. hispida.*	Doubtful forms.
21st Jan. 1931	4	7	2	4	..	..	..	5
5th Mar. 1931	12	..	87	3	7	..	..	..
26th Mar. 1931	..	..	21	..	..	..	..	..
3rd April 1931	..	17	1248	1	..	3	..	..
6th April 1931	..	4	457	3	..	2	..	..
8th April 1931	..	..	..	..	..	..	..	..
9th April 1931	..	15	168	1	..	..	..	1
10th April 1931	..	6	47	..	..	..	..	..
13th April 1931	..	..	..	..	..	..	..	..
15th April 1931	..	..	..	..	..	..	..	..
12th May 1931	83	21	14	293	26	2	..	17
21st May 1931	..	..	..	..	..	..	..	..
22nd May 1931	94	53	31	326	7	..	..	..
10th June 1931	14	38	..	91	4	3	13	..
12th June 1931	156	72	..	183	51	23	97	..
30th June 1931	169	287	..	376	69	485	180	..
1st July 1931	294	34	..	..	..	246	314	..
6th July 1931	173	183	..	21	13	..	..	..
7th Aug. 1931	263	477	..	4	1	89	63	..
9th Aug. 1931	114	211	..	1	..	1	4	..
13th Sept. 1931	..	..	..	..	..	..	..	..
30th Sept. 1931	24	4	..	..	..	..	..	..
16th Mar. 1932	1	..	56	1	1	..	..	..
18th April 1932	27	8	1642	22	1	..	6	..
27th April 1932	10	5	573	7	1	..	2	..
8th May 1932	48	52	186	252	12	2	..	..
17th May 1932	231	78	259	345	64	6	..	..
15th June 1932	147	96	..	176	19	47	..	..
25th July 1932	499	254	..	..		186	321	..

TABLE No. 5.

Average monthly distribution of Sagitta *for the years 1929-1932.*

Name of Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
S. enflata .	32	3	3	5	109	98	300	240	134	×	16	7
S. gardineri	20	4	×	7	48	71	140	361	146	×	12	10
S. tenuis	11	37	63	717	108	×	×	×	×	×	×	×
S. neglecta	4	3	1	4	234	181	4	1	2	×	2	2
S. robusta	×	×	2	1	25	34	2	1	×	×	×	×
S. planktonis	×	×	×	×	2	81	155	49	49	×	×	×
S. hispida .	×	×	×	1	×	36	203	73	25	×	×	×

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