highest percentage of the group A among the three groups of Bihar compared and equal to that of the Bagdis of Bengal. The Bagdi blood groups were obtained from South Bengal in the district of 24 Perganas where they live upon agriculture and fishing. The Bagdis have the highest percentage of B and the lowest of O. The Santals also possess a high percentage of B and an almost equal amount of O. The Bihar Aborigines are characterised by a high frequency of the genes R (group O) and B while the Bagdis possess chiefly the genes A and B. The gene A may have come as an intrusive element from the south, but the final solution of all and kindred questions will have to wait till adequate materials have been obtained from all the contiguous territories.

In carrying out this work, I received a great deal of help from Dr. E. W. E. Macfarlane, D.Sc. (Lond.), for which thanks are due to her.

S. S. SARKAR.

Bose Institute,
Calcutta,
December 2, 1937.

[1] Sarkar, S. S., *Curr. Sci.*, 1933, **1**, 318.
[2] (*a*) Macfarlane, E. W. E., *Curr. Sci.*, 1936, **4**, 653.
(*b*) Aiyappan, A., *Man*, 1936, 255.

LAST week Mr. S. S. Sarkar and I visited the villages where he had previously obtained Bagdi bloods. The distribution of the blood groups in the earlier sample of 44 Bagdis showed an unusually high percentage of Group B. We are able to classify the bloods of 20 more in these villages and I have also tested 16 Bagdi bloods at Budge Budge. We now have data from 80 Bagdis of the 24 Perganas District, Bengal, and find that the percentages of the four blood groups and the frequencies of the blood group genes both show a strong resemblance to those found among the Santals by Mr. Sarkar. Mr. Sarkar has asked me to supplement his recent communication to you for the data no doubt give a more correct idea of the following blood group situation in the Bagdis :—

No. of Bagdis 80 ; Group O 25 (31·25%), A 18 (22·5%), B 28 (35·0%), AB 9 (11·25%). Frequencies of the genes: $p = 17·98$, $q = 26·07$, $r = 55·95$.

EILEEN W. E. MACFARLANE.

C/o Burmah Shell, Budge Budge,
Bengal,
December 4, 1937.

Distribution of the Genus *Sagitta* during the Several Months of the Year in the Indian Seas.

IN the March issue of the *Records of the Indian Museum*, I saw a paper by Dr. C. C. John on "Seasonal Variations in the Distribution of *Sagitta* of the Madras Coast" based on collections made by the University Zoological Laboratory, Madras, but worked out independently at Agra. The main conclusion of John is: "The distribution of *Sagitta* is at its minimum when the rainfall 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" (p. 92). As I have not been able to correlate the results of John (1937) with those recorded by Menon (1931) and Aiyar, Menon and Menon (1936), I shall trace the history of the question of the occurrence of *Sagitta* on the Madras Coast and point out the difficulties in the acceptance of the claims of John.

All these results are based on collections made by the Department of Zoology of the University of Madras. In the year 1931 Mr. K. S. Menon published "A Preliminary Account of the Madras Plankton". In page 491 of Menon's paper occurs the statement: "While a few forms such as *Sagitta* and *Pleurobrachia* do not show much variation in numbers throughout the year, and do not have a definite maximal period, most of the organisms exhibit a regular seasonal abundance, and corresponding periods of maxima and minima". Further, under the heading "Chætognatha" the following observation is met with: "*Sagitta bipunctata* (Q and G). Present practically all through the year. Scarce in May and July" (p. 505). Regarding the method of enumeration of numbers, Menon rightly remarks: "The bigger forms, such as *Sagitta*, were picked out and counted. The rest of the sample was spread out and examined on a ruled slide, and the numbers of the separate organisms counted. It must be borne in mind that the counts arrived at by such a process would in no

case represent the number of organisms in any known volume of sea-water. For one thing it is impossible to calculate even approximately the speed of such a crude craft as the catamaran and, likewise we had no knowledge of the currents on the coast. So the amount of water draining through the nets for any given length of time remained an unknown quantity. The graphs given, based on these results, while having no value as showing the numbers of any particular form in unit volume of sea-water, serve, however, to give a very good idea of the intensity of the various maxima" (p. 490). Further, Menon says: "In the neighbourhood of Madras town, however, there are no rivers worth mention, and the two small ones that are present are little more than drainage channels and are dry practically throughout the year, having connection with the sea during the monsoon period only (Mid-October to December). This fact must have considerable importance as far as life in the coastal waters is concerned, since not much of organic and inorganic food material is brought down into the sea, nor is there such a drainage of fresh-water into it as to make any very great variation in the salinity, which varies from 32 in September–November to 34·5–35 in June–August (Sewell, 1929 *b*)" (p. 489).

John examined the collections of Menon (1933) and points out: "The *Sagitta* of the East Coast of India has never been identified before. The only reference to it is found in the *Reports* of the Siboga Expedition (Fowler, 1906). Though that expedition did not investigate the Bay of Bengal, in two of the charts on the distribution of the genus, Fowler shows the occurrence of *S. enflata* and *S. subtilis*. Later when one of the officers of the Madras Fisheries Department proceeded to England, he took with him a few badly preserved specimens, which were doubtfully identified there as *S. bipunctata* and the account of the previous worker was probably based on that" (p. 1). He identifies five species, *S. enflata*, *S. gardineri*, *S. neglecta*, *S. tenuis*, and *Srobusta*, in the collection.

This clarification of the species question has been accepted by Aiyar, Menon and Menon (1936) who record *Sagitta* Sp. occurring throughout the year, including the months of September and October. Leaving alone the maxima of the different species, the fact will have to be admitted that the genus *Sagitta* occurs throughout the year (see Lele and Gae, 1936). This fact is accepted by John partially as the following sentence of his will show: "Menon observed 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" (p. 83). But John's explanation (1937) that it was the mistake in the identification of *Sagitta* by Menon "which was responsible for the misconception that *Sagitta* occurs fairly constantly during all the seasons:..." (p. 83) does not stand to reason. It does not matter whether one species or other has a maximum in a particular month, but the fact that the genus *Sagitta* occurs throughout the year is patent from Menon's paper. In view of the above considerations I find it difficult to accept his conclusion: "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" (p. 86).

Analysing his results further, there are also the following contradictions: In his paper on "*Sagitta* of the Madras Coast" (1933) I find the following remark about the occurrence of the various species: "In the present paper five species *S. enflata*, *S. gardineri*, *S. neglecta*, *S. tenuis* and *S. robusta* have been identified of which *S. enflata*, *S. gardineri* and *S. tenuis* occur abundantly. *S. neglecta* is *very scarce*[1] and I have been able to obtain *only a very few specimens from the entire collections*" (p. 1). From the statement: "Considering the number of species obtained from the Maldive and Laccadive Islands by Doncaster (1902) it is possible that some more species may be obtained from the Bay of Bengal with better methods of collection," it is clear that only five species were obtained by John after a thorough examination of Menon's collections (John, 1933). In his recent paper he states that two more species have been identified. It has to be pointed out here that the paper is only the result of a re-examination of the old material and no better methods of collection have been employed. Yet as John has described two more species and gives as many as 1,953 specimens of *S. planktonis*

and 1,845 specimens of *S. hispida* and describes them also as occurring during the months of June, July and September in 1929, April, May, June, July and August of 1930, a statement how these two species which are represented by so many individuals were missed by him in his previous examination and with what other species they were confused, would have helped to clear the issues. The total number of each species examined by John is given below.

Species	1929	1930	1931–32	Total
S. tenuis ..	39	3689	4791	8519
S. enflata ..	597	2049	2363	5009
S. gardineri ..	652	1815	1922	4499
S. neglecta ..	35	673	2110	2818
S. planktonis ..	455	403	1095	1953
S. hispida ..	318	527	1000	1845
S. robusta ..	..	175	276	451
Doubtful Forms ..	4	18	23	45

One is surprised to note that the terms "*scarce....very few in the entire collection*[1]" of *S. neglecta* is used to mean 2,818 specimens! Tabulating the different totals one finds that *S. neglecta* comes a good fourth leaving *S. robusta* well behind even the "two more species" in point of numbers.

While agreeing with Menon (1931) that the results only give an idea of the various maxima, I have to point out here that the *Sagitta* has been picked out of the collections by John himself in 1932 and 1933. It is quite probable that some of the specimens may have gone into the wrong tubes, and some lost, and it is surprising that the above factor is not taken into consideration in arriving at results which seem to contradict what has been previously said about this aspect by Menon (1931), Aiyar, Menon and Menon (1936). About the latter there is also no reference in John's paper and the curious fact is that while *Sagitta* is recorded by Aiyar, Menon and Menon in September and October, John's examination of the same material shows no *Sagitta* (!!) to which phenomenon great significance is attached by him.

The effect of rain on the salinity of the Bay of Bengal is dealt with fully by Sewell (1929) and in a paper in which the conclusions are drawn entirely from the supposed effect of rain on sea-water, no reference is made to Sewell's paper. Nor is there any information given as to the source from which the amount of rainfall for each month is taken.

An analysis of the sea-water made by me during the years 1932–33, shows that Sewell's conclusions are fairly applicable even to coastal waters and as the variations in salinity from December to August is about 6·43 gm. per litre of sea-water (see p. 179, Subramaniam and Gopal Aiyar, 1936), the fact will be admitted that *Sagitta* can withstand great changes of salinity as John's Tables themselves show *Sagitta* occurring from December to August, for which salinity records of the Bay of Bengal have already been published. It is no doubt well known that the macroplankton is affected by salinity changes but the point at issue is whether similar conclusions could be drawn from the meagre data presented by John.

Coming now to the actual interpretations of the results, one is surprised to find grave misinterpretations of the observations of other workers. Regarding the monsoon John says: "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" (p. 90). Still Lele and Gae (1936) state as follows regarding *S. gardineri*, *S. bedoti* and *S. bombayensis*. "These arrow-worms are usually found throughout the year and although colourless and transparent they attract one's notice by their darting movements" (p. 2). *S. gardineri*. "This species was abundantly found in winter. Although it was not found in the months of March, April and May of 1933 later collections have shown that it is not altogether absent during these months" (p. 4). *S. bedoti*. "This is the most common *Sagitta* of Bombay and is found in fair numbers throughout the year" (p. 6). *S. bombayensis*. "This species is present in the Bombay Harbour throughout the year but it appears *in swarms during the South-West Monsoon*[1]" (p. 9). The table of Seasonal variation in the population observed by them is given below.

Month	*S. gardineri*	*S. bedoti*	*S. bombayensis*
January ..	130	590	567
February ..	20	260	79
March ..	..	7	8
April ..	..	803	688
May ..	..	375	183
June ..	16	105	1,336
July ..	97	428	1,243
August ..	187	753	184
September ..	267	604	378
October ..	60	32	30
November ..	728	110	62
December ..	1,028	203	165

John explains that his conclusion regarding seasonal variation is supported by Lele and Gae's results in the following manner: "Of the three species described by him *S. gardineri* is the only one, in which the body wall is thin, 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" (p. 89). If rain affects the salinity of the sea-water so much as to make the *Sagitta* disappear from the surface plankton, it is surprising that *S. gardineri* of Bombay which is absent during the hottest months of the year, when the salinity should be very high, should appear even though in small numbers during the actual monsoon season! John's explanation that *S. bedoti* and *S. bombayensis* have rigid body walls and that probably this characteristic "enables these two species to withstand certain degree of chemical changes in the sea" does not explain why *S. bombayensis* should appear in "*Swarms*"[1] during the South-West Monsoon. John conveniently omits *S. bombayensis* from any consideration due to the fact that being a new species more details regarding its habit and distribution are necessary. I wonder what the species question has to do with the effect of the environment on an animal.

Doncaster (1902) records that Stanley

Species	Doncaster	John
1. *S. enflata*	Very abundant in both winter and April making up perhaps 50 per cent. of the collection	....
2. *S. magna*	Abundant in winter, but not found in April	....
3. *S. tricuspidata* ..	Scarce in winter and not found in April	Not found in April
4. *S. serratodentata* ..	A moderately common species in winter and spring	Common in winter and spring
5. *S. hispida*	Scarce in winter, abundant in April	Scarce in winter, abundant in April
6. *S. regularis* ..	Small numbers in winter	Small numbers in winter
7. *S. flaccida*	One specimen in April	....
8. *S. robusta*	Abundant in winter, but scarce in April	Abundant in winter, but scarce in April
9. *S. ferox*	Abundant in winter, absent in April	....
10. *S. gardineri* ..	Moderately abundant in winter	Moderately abundant in winter
11. *S. pulchra*	Moderate numbers in both winter and spring	Moderate in winter and spring
12. *S. polyodon* ..	Found in fair abundance in winter and spring	Fairly abundant in winter and spring
13. *S. septata*	Moderately common in winter and spring	Moderately common in winter and spring

Gardiner's Expedition collected 900 *specimens between December 10th*, 1899, and 10th *January* 1900[2] *and 'over 250' in April* 1900. For comparison Doncaster's results are given side by side with John's interpretation of Doncaster's results.

The Laccadive Archipelago forms with the Maldives a long narrow belt and a description of the monsoon and rains in Laccadives will equally apply to Maldives also. Ellis (1924) mentions in the case of Laccadives: "The South-West Monsoon usually becomes definitely set towards the end of May and continues regularly until September" (p. 2). "The greater part of the rain falls during the South-West Monsoon in the months of June and July. During the rest of the year, *except in November and December when the North-East Monsoon brings heavy showers*,[1] there is but little rain" (p. 3). Thus the collections examined by Doncaster are of material townetted *just during*[2] the North-East Monsoon (December to January and *just before* South-West Monsoon (April). The terms "winter" and "spring" used by Doncaster have no other significance than a reference to the climate in England at the time the material was collected in the Maldives and Laccadives. Having shown previously that John's interpretation of Lele and Gae's (1936) result is erroneous, I shall show that a similar mistake is committed by John in the interpretation of that of Doncaster also. John infers that "in the Maldive and Laccadive regions almost all the species reach their maxima during the colder months November to January....." (p. 91). This result does not at all support John's conclusions, for in the quotation cited previously, Ellis definitely mentioned that the North-East Monsoon brings heavy showers during November and December and the collections examined by Doncaster were made from December 10th to January 10th. Thus while Doncaster's results are not strictly comparable to those of John because no collections were made by Gardiner's Expedition in the rainy season (South-West Monsoon) they distinctly contradict John's results, for, during the period of the North-West Monsoon when salinity, according to John's suggestion, should be low, more *Sagitta* was collected by the Expedition (900) than during the summer months before the South-West Monsoon (above 250), when salinity would be the highest for the year.

To one analysing the results of Doncaster (1902), Menon (1931), Aiyar, Menon and Menon (1936) and Lele and Gae (1936), it appears that the genus *Sagitta* occurs throughout the year in the Arabian Sea and the Bay of Bengal, different species having their maxima in different months of the year. As John himself states that *S. enflata* has not a rigid body wall like *S. bedoti* and *S. bombayensis* (p. 90) and as this species is recorded by Doncaster *as occurring abundantly in both December, January and April and forming fifty per cent. of the collections*,[1] John's explanation in the case of *S. bedoti* and *S. bombayensis* that their occurrence throughout the year may be due to the rigid body wall cannot bear a moment's scrutiny.

Only general conclusions could be drawn from collections made with crude crafts such as the catamaran and the fact remains that the genus *Sagitta* occurs throughout the year as evidenced from the results of Doncaster (1902), Lele and Gae (1936) on the Arabian Sea coast and Menon (1931) and Aiyar, Menon and Menon (1936) on the Bay of Bengal coast and that they do not disappear from the surface plankton when the salinity of the sea-water is appreciably altered by the admixture of rain and tributary waters.

I wish to express here my deep sense of gratitude to Professor R. Gopala Aiyar for his advice and criticism.

M. K. SUBRAMANIAM.

Department of Zoology,
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December 1, 1937.

1,2 Italics are mine.

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