

product of some improvements made on the original Clarke Bumpus sampler described by Clarke and Bumpus (1940).

Changes and modifications were made on the Clarke-Bumpus sampler by Paquette and Frolander (1957) and later to assure more reliability, strength and precision modifications were again made by Tranter (1965). Subsequently Tranter made further modifications on the sampler used at IOBC. They are the following:-

1. A flaring collar is attached to the tube of the after section behind the propeller to reduce the velocity of the water flow. The length of the collar is  $4\frac{1}{2}$ " and increases in diameter from 5" to 6".
2. Two large fins were attached to the tail frame (length 31") on a lateral plane to assure more stability.
3. The original Australian Clarke-Bumpus sampler had a net 20" long and here it was reduced to  $17\frac{1}{2}$ " due to the addition of flaring collar.

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#### 7. Simple underway sampler and its performance — M. Sakthivel.

A simple underway sampler was fabricated locally to make plankton collections from a regular passenger vessel, "M. V. Laccadives" which was not equipped for Oceanographic research. The instrument was made of mild steel plate. It has a total length of 66 cm and three main parts. They are Nose cone, Speed Reduction Chamber and Net Chamber.

The cone (length 25 cm Fig. 1 C5) is the front part of the instrument. The anterior opening has a diameter of 4 cm. This gradually widens at an angle of  $7^\circ$  inclination to the axis towards the posterior end. As a result the diameter of the posterior end of the nose cone is  $2\frac{1}{2}$  times greater than the anterior opening. The gradual increase in diameter tends to reduce the speed of flow of water. As a result the damage caused to plankton organisms is reduced. There are two fins attached to the upper side of the nose cone with two holes for attaching bridles. Two rectangular weights are attached to the lower side of the nose cone. A small phytoplankton sampler with a total length of 17 cm (having a nose cone in front with a mouth opening of 1.3 cm diameter and a net chamber behind) was fitted to the bottom of the main sampler.

The Speed reduction chamber (length 11.0 cm Fig. 1. C6) is cylindrical in shape with 12 cm diameter. The front end is welded on to the nose cone and the joint is sloped. The posterior end has flanges on four sides with four holes for nuts and bolts by

which the net chamber is attached to it. As the diameter of this chamber is three times greater than the mouth opening, the velocity of water gets reduced still further. As this chamber functions to reduce the speed and turbulence of the stream of incoming water, it gets its name of speed-reduction chamber.

The net chamber (length 30 cm, Fig. 1 C7) is the posterior most part of the sampler and consists of a cylindrical cover which is intended to protect the net from the outer stream of water. The anterior end of the cover has four corresponding flanges to fit against the flanges of the speed reduction chamber in front. The posterior end is open. Two fins each 5 cm broad were fitted to the top over the entire length of the cover to act as stabilizers.

The rim of the net (length 20 cm) was attached to a brass ring (11.5 cm diameter) which had four flat prolongations with holes corresponding to the four nuts of the net chamber. The net was slightly conical in shape made of nylon with a mesh width of  $330\mu$ . A bucket with a diameter of 5 cm and a length of 10 cm was used.

The instrument was tested on board "M. V. Laccadives" during one of its regular cruises from Cochin to the Laccadive Islands. The average speed of the ship was 9 kts. The deck of the ship was about twelve feet above the water level. The sampler was towed by two bridles which in turn were connected to a nylon rope of 20 m length. The sampler was lowered into the sea by hand. No depressor was used. The net weight of the instrument was 11.5 kg.

While the instrument was towed fast at the speed of 9 kts the length of 20 m nylon rope was found insufficient because of high degree of wire angle. As no depressor was used the instrument could not stay down uniformly below the surface. The rolling and pulling effect of the ship brought the sampler up from one meter depth to the surface with a jerking motion once every ten seconds. When more length of rope (45 m) was paid out, the sampler surfaced less frequently. On two occasions only, out of twenty three hauls, the sampler remained stable without surfacing.

The first sample was removed after one hour of towing. A lot of damage to the catch was noticed, because the sampler occupied a position in the disturbed water close to the propeller. The jerking and side to side movement of the sampler might have caused damage to the catch. As the posterior end of the bucket was closed by a screw cap fitted with wire gauze, this could have increased damage to the catch. The third factor was perhaps most important; the entire catch was found to be jammed inside the lid. When a closed lid was used (without wire gauze) the damage was considerably reduced.

Two main problems have to be solved for success in underway sampling. They are ensuring stability of the sampler when towed fast and reducing damage to the catch. The first problem can be solved only by trial and error to determine correct fin size, fin number and fin position (Tanaka *et al* 1968). A diving plane or weight could be used as a depressor to keep the sampler down below the surface. For sampling at a particular depth the length of wire to be paid out would have to be nearly five times the depth of sampling when the speed of the ship is 6 kts. The damage to the catch could be reduced by reducing the velocity of water as discussed earlier.

There are great advantages in using a simple underway sampler for making regular collections of plankton. The sampler could be operated from any type of vessel. It needs less money, less additional items of equipment and less man-power for operation. It enables

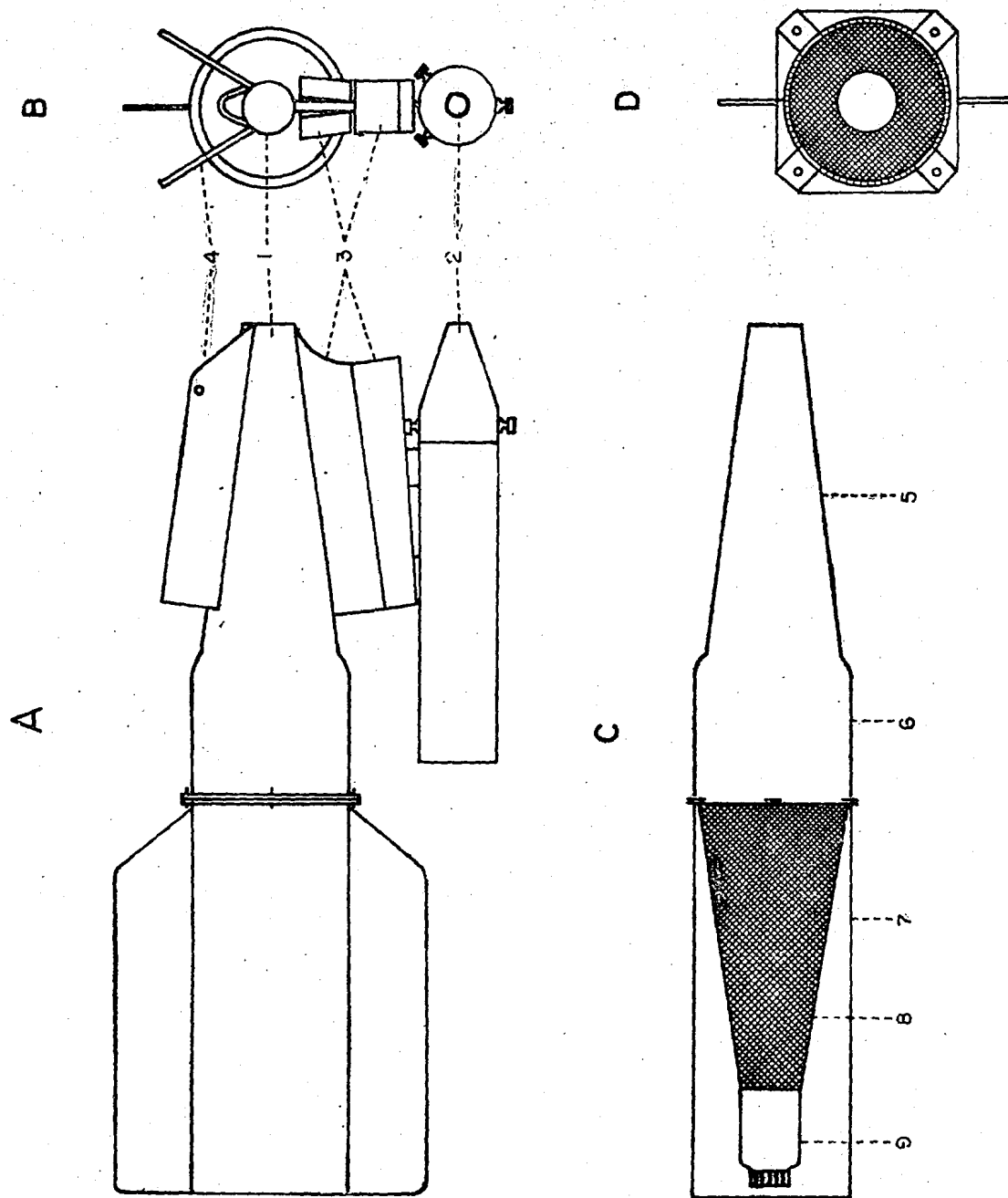


Fig. 1 A Simple underway sampler.

- |  |                                  |
|--|----------------------------------|
| A. Lateral view                        | B. Front view                    |
| C. Longitudinal section of the sampler | D. Front view of the net chamber |
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- |   |                            |
|---|----------------------------|
| 1. Mouth opening of the zooplankton sampler   | 6. Speed reduction chamber |
| 2. Mouth opening of the phytoplankton sampler | 7. Net chamber             |
| 3. Attached weight                            | 8. Net                     |
| 4. Lateral fins                               | 9. Bucket                  |
| 5. Nose cone                                  |                            |

CRUISE TRACK OF M.V. LACCADIVES

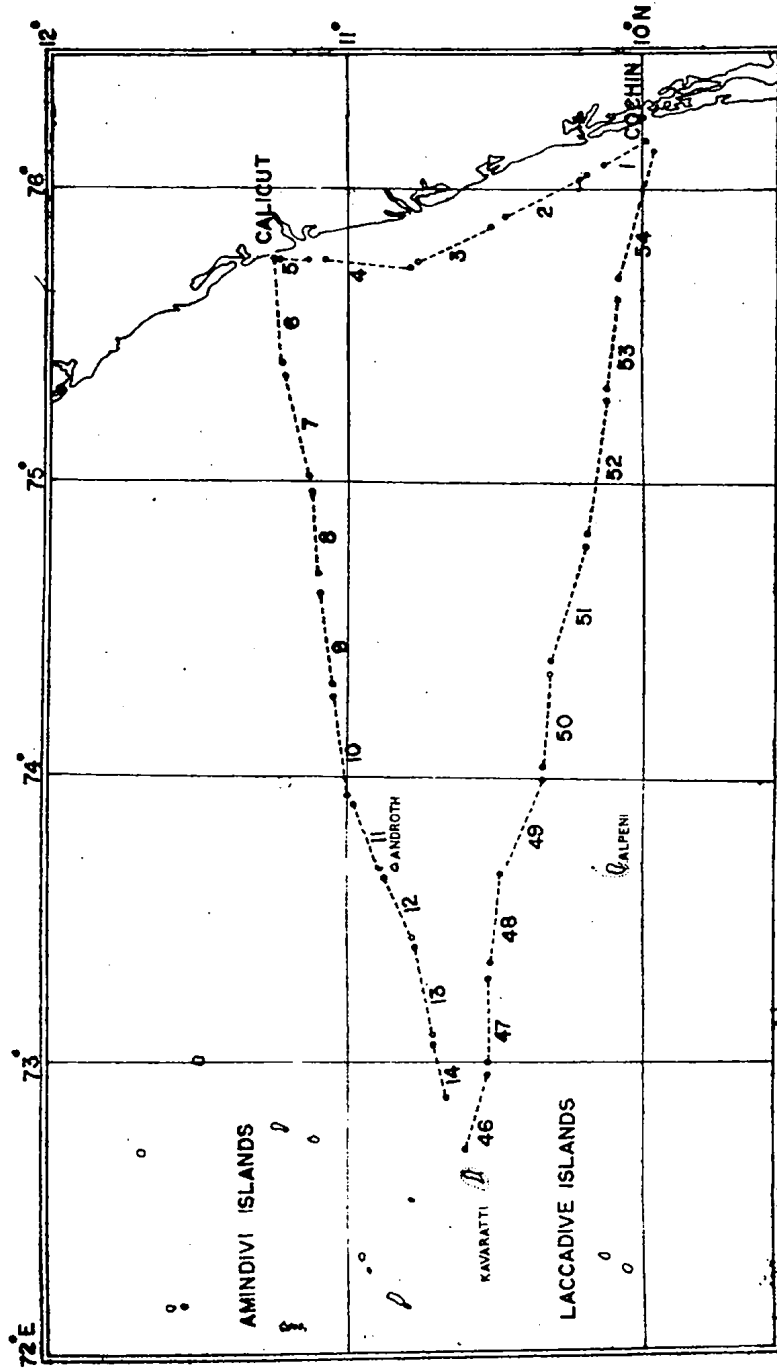


Fig. 2 Cruise track of M. V. Laccadives with station numbers.

larger areas to be sampled. By repeated sampling, seasonal and diurnal changes can be studied in detail. The underway sampler, probably succeeds in trapping organisms that elude the more slow moving plankton net. The use of the underway sampler has two unavoidable disadvantages, namely that a certain degree of damage to the organisms has to be accepted and the sampling is done at one depth only, the scope for varying the depth being limited. The advantages seem to outweigh the disadvantages and the underway sampler deserves to come into wider use in India in future programmes of marine investigations.

Twenty three zooplankton samples were collected from "M. V. Laccadives" by a simple underway sampler during a trial cruise to test the performance of the sampler. The cruise track with station numbers are depicted in Fig. 2 while the details about the collections are given in table 1 (Station list). The duration of the haul varied from one hour to three hours.

Thirteen phytoplankton samples were also collected by a small sampler attached beneath the main zooplankton sampler. The samples were analysed to study the qualitative and quantitative distribution of zooplankton between the Kerala Coast and the Laccadive Islands.

The entire analysis of zooplankton was carried out according to the method devised by Hansen (1966). The volume of zooplankton was measured by displacement method. According to the size of the catch an aliquot of 6.25% to 100% was taken for preliminary sorting. The components were sorted out for further identification by specialists. The number of organisms of each taxon in the aliquot was counted and the number present in the total was estimated. As siphonophores and medusae were damaged the counts for these taxa should be treated with reservation. From the accounts obtained it is clear that the volume of zooplankton is greater in the neritic zone than in the oceanic zone. The neritic zone may be broadly classified (Hedgpeth 1957) into "inner neritic" and "outer neritic". Stations 1 to 5 fall within the inner neritic zone and five stations (6, 7, 8, 53 and 54) in the outer neritic zone and slightly beyond. Outer neritic waters were observed to be more productive in zooplankton than inner neritic waters. This is clear from the high volumes of zooplankton from stations, 7, 8 and 53. This perhaps has a relation to the phenomenon of offshore upwelling.

The volumes given in Table 1 column 9 have not been compared as such, but only the calculated volumes per hour of haul.

Copepods were the dominant group of zooplankton in all the samples except at one station (51). High numbers of copepods were observed at stations 1 to 7 and 53 and 54, which are within the limits of the neritic zone. The numbers of copepods were found to decline towards the oceanic zone from stations 8 to 14 and 46 to 52. Stations 12 and 48 showed somewhat high values which perhaps might be consequent on the closeness of the stations to Androth Island and Kalpeni Island respectively. Copepods were found to be particularly abundant at four stations (1, 6, 7 and 53) which were in the vicinity of Cochin and Calicut.

Ostracods were next to copepods in abundance. Their distribution appeared to be subjected to a high degree of patchiness. They were more abundant than even copepods at one station (51). High numbers of ostracods were seen in stations 1, 2, 7, 8, 9, 51 and 53. However the highest number was observed at station 8, situated close to Calicut.

In most of the samples *Cypridina* sp. was dominant. Similar observations were reported by Tranter and George (1969) in the Laccadive Archipelago.

Cladocera were found to be present in 12 collections out of 23. The highest number was observed near Calicut (St. 6). *Penilia* sp., *Podon* sp., and *Evadne* sp. were present.

*Lucifer* sp. was found to be common from stations 1 to 7. From stations 8 to 47 the genus was not observed. It appeared again from station 48 onwards. *Lucifer* sp. occurred in greatest numbers at station 4.

Brachyura larvae were found to be very common in the neritic zone at stations 1 to 5 between Cochin and Calicut and rare in the oceanic zone, stations 8 to 14 and 46 to 52. The highest number of Brachyura larvae was observed near Cochin in the inshore waters (St. 1).

Other Decapod larvae were found to be more common in neritic waters. However it is interesting to note that a good number of larvae occurred at station 12 which is close to Androth Island and far away from the mainland. The second instance of abundance was observed near Cochin at station 53.

Stomatopod larvae were present at eight stations out of 23. They were not present at stations beyond the continental shelf. Their occurrence was noticed from 1 to 6 and again from 52 to 54. The highest number of these larvae was observed near Cochin. This is to be related to the known high catch of *Squilla* sp. in this area by trawlers.

Mysidacea were found at five stations only and most of them near to Cochin. A large number of mysids was found at station 52.

Euphausiacea were one of the most common groups of crustacea present in most of the samples. They were abundant at two stations viz. station 6 near Calicut and station 53 near Cochin.

Amphipoda were common, quite abundant at station 2 near Cochin.

Chaetognatha were observed in large numbers near Cochin and Calicut.

Copepods were abundant in a few isolated instances most of them in the route from Cochin to Kavaratti Island. The highest number was seen near Calicut at station 6.

Swarms of salps were recorded in two instances (St. 4 & 8). Doliolids were very few as compared to salps in most of the stations.

Postlarval stages of *Branchiostoma* were observed at six stations and most of them were located on the cruise track between Kavaratti Is. and Cochin. They were not observed in the neritic stations (1-5) between Cochin and Calicut. A good number of larvae were recorded at station 52.

Fish eggs were found to be abundant in the neritic waters near Cochin and Calicut. Fish larvae were observed at five stations of which three are nearer to Cochin.

Medusae and siphonophores were more often found in large numbers in the neritic zone. Siphonophores were very abundant at station 6 near Calicut.

Four species of Thecosomata were present. They were:-

1. *Limacina inflata*, 2. *Limacina trochiformes*, 3. *Creseis virgula*, and 4. *Creseis acicula*. *L. inflata* (d' Orbigny) was the dominant among the four species. This species is known to be abundant in areas of upwelling in the Pacific (McGowan 1960) and in the Indian Ocean (Sakthivel 1969). It was observed to be very common in the waters away from the coast. A good number of this species was found at stations 6, 7, 8, 9, 48, 52 and 53. The maximum abundance was noticed at station 53. *L. trochiformes* (d' Orbigny) was not very common. *C. acicula* (Rang) *C. virgula* (Rang) were recorded only at three stations.

Gastropod larvae were found to be very common in the neritic zone between Cochin and Calicut and the maximum number was noticed at Station 53 near Cochin.

Atlantidae occurred at 14 stations and at three of them, they were present in high numbers.

Lamellibranch larvae were present at nine stations, most of them coastal. Two stations (4 & 5) near Calicut were noticeable for the high numbers present.

Brachiopod larvae were rare and found only at two stations (5 & 54). On the west coast of India brachiopod larvae have been earlier recorded by Menon, (1945) near Trivandrum, Sudarsan (1968) near Karwar, and Dall (1921) near Bombay. This is the first record near Cochin and Calicut. This finding suggests that brachiopods may have continuous distribution along the west coast of India.

Pelagic polychaetes were found only at five stations and were very few in numbers.

Sipunculida larvae were observed at four stations, in large number at station 7.

Cyphonautes were found to occur at four stations.

Protozoa were not regularly recorded because of the coarse mesh used. They were found to be present at eight stations only and most of them were radiolarians and foraminiferans. Colonial Radiolaria were observed at station 48.

A few samples (St. 5 & 8) were notable for diatoms, dinoflagellates and crustacean eggs. Of the 23 collections that have been analysed, 2 were particularly rich. St. 6 near Calicut showed very high number of several groups like copepods, cladocerans, euphausiids, chaetognaths, copelates, medusae and siphonophores. Similarly St. 53 near Cochin had large number of copepods, Lucifers, euphausiids, decapod larvae, stomatopod larvae, chaetognaths, copelates and gastropod larvae. Neither of the above mentioned stations is very close to the coast. As the total volume of zooplankton is also comparatively high in these two stations, it appears that the environment at these places is very favourable for sustaining a large zooplankton stock. Meroplanktonic larvae were observed to be more common in the neritic zone and rare or absent in the oceanic zone. A comparison of stations 1 to 5 of the inner neritic zone with the stations 6, 7, 8 and 53 of the outer neritic zone showed that meroplanktonic larvae were more abundant in the former zone.

The collections at different stations were made at different times of the day. Of the 23 collections, 15 were during the night and 8 during day time. As the constituents of zooplankton are known to exhibit varying degrees of nocturnal vertical migration the foregoing remarks must be qualified by the possible operation of this migratory movement.

# STATION LIST OF THE UNDERWAY SAMPLES

Ship	Cruise	Station	Time (HRS)		Date	POSITION				Depth of Haul	Speed of the Ship (Kt.)	Zooplankton Volume (ml)	Phytoplankton Observation	
			From	To		Duration (Minutes)	From Lat.	From Long.	To Lat.					To Long.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
*LA	4/68	1	30.11.68	2205	2305	60	09°59'N	76°09'E	10°70'N	76°04'E	1 m	9	1.0	+
LA	4/68	2	30.11.68	2325	0125	120	10°11'N	76°02'E	10°27'N	75°54'E	1 m	9	1.1	+
LA	4/68	3	1.12.68	0145	0345	120	10°30'N	75°52'E	10°46'N	75°44'E	1 m	9	0.8	+
LA	4/68	4	1.12.68	0400	0600	120	10°48.5'N	75°42'E	11°04'N	75°40'E	1 m	9	1.5	+
LA	4/68	5	1.12.68	0615	0750	95	11°07'N	75°40'E	11°15'N	75°45'E	1 m	-	0.6	+
LA	4/68	6	1.12.68	1520	1720	120	11°15'N	75°49'E	11°12'N	75°23'E	1 m	9	2.0	+
LA	4/68	7	1.12.68	1742	1942	120	11°11'N	75°19.5'E	11°08.5'N	75°01'E	1 m	9	2.3	+
LA	4/68	8	1.12.68	2000	2200	120	11°07.5'N	74°58'E	11°05'N	74°40'E	1 m	9	2.3	+
LA	4/68	9	1.12.68	2215	0015	120	11°05'N	74°37'E	11°02'N	74°17.5'E	1 m	9	0.6	+
LA	4/68	10	2.12.68	0030	0230	120	11°02'N	74°16'E	11°00'N	73°57'E	1 m	9	0.1	+
LA	4/68	11	2.12.68	0245	0435	110	10°59'N	73°55.5'E	10°53'N	73°41'E	1 m	9	0.1	+
LA	4/68	12	2.12.68	0450	0650	120	10°52'N	73°40'E	10°46.5'N	73°24'E	1 m	9	0.7	+
LA	4/68	13	2.12.68	0750	0905	120	10°48'N	73°22'E	10°43'N	73°05'E	1 m	9	Neg	-
LA	4/68	14	2.12.68	0920	1020	60	10°43'N	73°03.5'E	10°40'N	72°53'E	1 m	9	Neg	-
LA	4/68	46	12.12.68	1015	1215	120	10°35'N	72°41'E	10°32'N	72°58'E	1 m	9	Neg	-
LA	4/68	47	12.12.68	1240	1440	120	10°31'N	73°00'E	10°28'N	73°17'E	1 m	9	Neg	-
LA	4/68	48	12.12.68	1455	1655	120	10°27.5'N	73°20'E	10°24'N	73°38'E	1 m	9	0.6	-
LA	4/68	49	12.12.68	1720	1920	120	10°23'N	73°41.5'E	10°20'N	74°09'E	1 m	9	0.3	-
LA	4/68	50	12.12.68	1940	2140	120	10°20'N	74°02'E	10°16.5'N	74°20'E	1 m	9	0.1	-
LA	4/68	51	12.12.68	2200	0100	180	10°16'N	74°23'E	10°12.5'N	74°48'E	1 m	9	1.0	-
LA	4/68	52	13.12.68	0115	0415	180	10°12'N	74°50'E	10°07'N	75°16.5'E	1 m	9	1.2	-
LA	4/68	53	13.12.68	0435	0635	120	10°07'N	75°18.5'E	09°58'N	75°07'E	1 m	9	2.0	-
LA	4/68	54	13.12.68	0715	1015	180	10°03'N	75°41'E	09°58'N	76°07'E	1 m	-	2.8	-

\*LA — Stands for M. V. Laccadives which is a passenger vessel plying between Cochin, Calicut and Laccadive Islands

Neg = Negligible

Table—1





## References

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### 8. *Newly designed Neuston samplers* — K. J. Peter.

This paper deals with the three newly-designed samplers specially made for sampling the uppermost strata of the ocean. Apart from the simple and unscientific techniques of collecting surface fauna using hand nets and buckets, since the pre-Challenger era of oceanography, this subject received special attention only in recent years. Scientific approach to this problem was made since 1956 by Savilev (1958), Zaitsev (1962), Sund and Richards (1965) and David (1965). In most of these cases the samplers were either meant for operating from fast moving vessels or with complicated accessories. Of all the three samplers, the third one is more or less a modified miniature form of the samplers designed by David (1965) and Sund and Richards (1965).