Oceanographic Conditions and Zooplanktonic Biomass in Tuna Fishing Grounds of the Central Tropical Atlantic.

By

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Introduction

Oceanographic investigations of the Atlantic Ocean have been carried out in the most detail among the three great oceans. Especially, the investigations by SCHMIDT (1921-'22), and MERZ and DEFANT (1925-'28) are famous. In 1963, international cooperative investigations of the Tropical Atlantic (EQUALANT) were undertaken by U. S. A., U. S. S. R. and other countries.

This survey was made during the period between December 24th, 1965 and

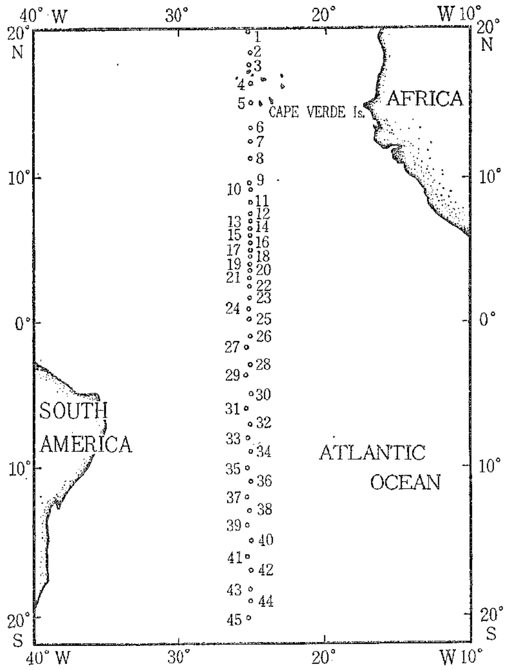

Fig. 1. Positions of oceanographic stations in the central Atlantic.

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January 10th, 1966, in the meridional section along 25°W from 20°N to 20°S (central part of the Atlantic Ocean), and covered 45 stations on 2400 miles.

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Sampling method

The samples were collected at the stations shown in Fig. 1 and Table 1. The most important subject of the investigation was observations of the upper layers of the sea, because the present investigation was carried out to make clear the relationship between oceanographic conditions and tuna fishing. Therefore, at all stations we used B.T. (bathythermograph) and observed the vertical changes of sea water temperature in the upper layer. At the same time water sampling and temperature measurement were done at each layer between the surface and depth of 1200 m. These data are important for the dynamical calculation. These procedures were carried out with reversing thermometers and reversing water bottles. Water salinity was measured with salinometer (Auto-Lab), and dissolved oxygen, phosphate-P and silicate-Si were analyzed on board.

Collections of zooplankton were made with Indian Ocean standard net (mouth diameter 113 cm, length about 5 m, net cloth GG 54) with a flowmeter. Plankton net was vertically hauled up from a depth of 200 m to the surface at the speed of 1 m per second. This net is designed to collect macro-zooplanktons without taking phytoplanktons and to measure their biomass. The samples thus collected were fixed with 5 - 10 % formalin solution as soon as possible. The displacement volume and the wet weight of zooplankton were measured by MOTODA's method (1959). Then, their volumes were converted to volumes per 1000 m^3 to compare with one another.

Result of investigation

Oceanographic stations were located in the waters of the central tropical Atlantic Ocean, which were along the meridian of 25°W from 20°N to 20°S. These stations are distributed in the North Equatorial Current, the Equatorial Countercurrent and the South Equatorial Current, and the northern stations lie in the Canary Current flowing into the North Equatorial Current.

Table 1. Oceanographic conditions in the central tropical Atlantic.

No.	Station Lat.	Station Long. (W.)	Date	Weather	Water temperature (°C) 0 m	10 m	25 m	50 m	75 m	100 m	125 m	150 m	200 m	250 m	300 m	400 m	500 m	600 m	800 m	1,000 m	1,200 m
1	19 48.5 N	25 15.0	1965 Dec. 24	c	22.5	22.70	22.76	22.48	21.05	18.05	16.95	16.04	13.66	13.05	13.09	11.77	10.46	9.16	7.18	6.27	5.76
4	15 00.0	25 00.0	25	b	24.1	24.12	24.24	20.50	16.02	14.55	13.20	12.91	11.76	11.36	10.99	10.14	9.27	8.25	6.76	5.96	5.31
7	12 00.0	25 00.0	26	b c	25.0	24.89	24.34	21.89	15.35	13.63	13.08	12.64	11.69	11.02	10.30	9.22	8.94	7.30	6.30	5.32	5.31
9	09 40.0	25 05.5	27	b c	25.2	25.07	25.36	17.50	15.83	13.55	12.65	12.04	11.69	11.76	10.55	9.61	8.20	7.64	5.94	5.16	4.65
14	07 00.0	25 00.0	28	c	26.3	26.50	26.60	24.55	20.75	16.70	14.05	13.40	12.10	10.80	9.90	8.92	8.12	7.30	5.53	5.01	4.65
17	05 00.0	25 00.0	28	c	27.3	27.19	27.03	27.05	25.25	16.02	14.71	13.70	12.61	11.65	10.00	9.24	7.91	7.10	5.26	4.72	4.56
19	02 56.0	25 00.0	29	b	27.3	27.15	26.95	26.60	15.40	14.40	14.40	13.40	12.56	11.96	11.29	9.78	6.90	5.76	4.81	-	
25	00 15.0	24 59.5	30	b c	26.8	26.81	26.70	25.91	20.70	16.56	14.86	13.51	12.97	11.95	10.41	8.76	6.03	6.13	5.13	4.42	4.44
27	01 57.5 S	25 14.5	31	b c	26.0	26.16	26.15	26.15	25.30	15.95	13.85	12.30	11.49	11.74	10.62	8.50	6.50	5.20	4.63	4.41	4.27
29	03 50.5	25 19.5	1966 Jan. 2	b c	25.9	25.80	25.80	25.20	23.00	14.65	13.15	13.66	11.31	11.84	11.60	9.52	7.76	6.40	4.56	4.37	4.07
31	06 00.0	25 19.2	3	c	25.6	25.69	25.62	25.69	25.50	24.08	18.40	16.50	13.00	10.47	9.49	8.05	6.59	5.86	4.64	4.05	4.05
33	08 01.3	25 12.2	4	b	25.8	26.06	26.04	26.05	25.76	24.75	20.63	17.26	12.35	10.30	9.12	8.10	6.74	5.73	4.47	4.13	4.16
35	10 00.5	25 12.5	5	b	25.9	26.01	26.09	25.99	25.00	23.75	22.00	18.60	14.09	11.50	9.87	8.06	6.80	5.97	4.47	3.92	4.11
36	11 00.0	24 59.7	5	o	26.2	26.07	26.09	25.46	24.11	23.25	22.55	19.63	15.63	12.28	10.53	7.63	6.44	5.56	4.07	4.03	3.97
37	12 03.5	25 17.0	6	o	25.8	25.86	25.87	25.20	23.79	22.72	21.40	18.80	14.70	12.31	10.64	7.67	6.30	5.42	4.42	3.94	3.81
38	13 00.0	25 20.0	6	o	25.5	25.65	25.58	25.00	23.97	23.00	21.56	16.30	14.97	12.31	10.34	8.18	6.55	5.45	4.35	4.07	3.77
39	14 01.4	25 14.0	7	b	25.9	25.75	25.80	25.57	24.11	23.80	23.10	21.87	17.43	14.52	12.29	8.90	6.9	5.62	4.21	3.88	3.85
40	15 05.0	25 01.0	7	b c	24.0	26.09	25.82	25.35	25.20	22.00	22.40	20.04	16.40	13.90	12.29	9.29	6.53	4.95	3.91	3.75	3.76
41	16 00.7	25 23.3	8	b c	25.5	25.50	25.45	25.44	23.75	22.94	22.39	21.10	17.80	14.30	12.74	9.39	7.06	5.46	3.90	3.80	3.67
42	17 00.0	25 00.0	8	c	25.5	25.63	25.60	24.92	23.32	23.29	22.40	19.27	17.21	14.69	13.09	10.00	7.03	6.30	4.30	3.77	3.78
43	18 15.6	25 04.5	9	c	25.3	25.38	25.39	25.14	24.86	23.25	22.57	21.90	18.13	15.90	13.99	10.69	8.01	6.00	4.23	3.7	3.66
44	19 00.0	25 02.6	9	b	25.6	25.63	25.51	24.93	23.64	22.88	22.09	22.06	18.76	15.23	14.16	11.22	8.03	6.10	4.14	3.90	3.46
45	20 07.5	25 11.0	10	c	25.3	25.60	25.60	25.14	23.70	23.03	22.45	21.10	19.15	15.79	14.06	11.08	9.00	6.01	4.32	3.51	3.64

Salinity (‰)																
0 m	10 m	25 m	50 m	75 m	100 m	125 m	150 m	200 m	250 m	300 m	400 m	500 m	600 m	800 m	1,000 m	1,200 m
36.01	36.59	36.46	36.47	36.57	36.16	36.05	36.08	35.93	35.45	35.10	34.96	34.82	34.61	34.94	34.95	35.01
35.57	35.51	35.53	35.70	35.69	35.42	35.29	35.40	35.22	35.08	35.03	35.08	34.95	34.90	35.00	35.00	34.96
[illegible]	35.29	35.28	35.49	35.63	35.44	35.37	35.35	35.29	35.16	35.10	35.04	34.98	34.90	34.84	34.82	34.86
35.25	35.23	35.25	35.74	35.46	35.40	35.59	35.36	35.16	35.11	35.09	35.01	34.94	34.86	34.74	34.77	34.86
35.26	35.27	35.27	35.71	35.73	35.46	35.10	34.98	34.87	34.82	34.73	34.63	34.68	34.58	34.44	34.54	34.67
35.26	35.24	35.32	35.25	35.06	35.35	35.30	35.18	35.06	34.97	34.83	34.73	34.62	34.55	34.44	34.47	34.60
35.15	35.17	35.36	35.60	36.00	35.80	35.58	35.50	35.33	35.28	35.20	34.96	34.75	34.76	34.64	--	
35.50	35.47	35.45	35.59	35.73	35.66	35.48	35.34	35.17	35.04	34.93	34.77	34.54	34.48	34.49	34.56	34.77
35.73	35.71	35.71	35.75	35.93	35.43	35.24	35.12	35.05	34.99	34.87	34.64	34.43	34.36	34.30	34.37	34.44
35.85	35.86	35.86	35.80	35.69	35.37	35.16	35.11	35.03	35.01	34.96	34.72	34.58	34.54	34.44	34.53	34.74
35.71	35.72	35.72	35.74	35.95	35.97	35.63	35.36	34.92	34.71	34.61	34.46	34.36	34.19	34.21	34.41	34.55
36.29	36.27	36.27	36.26	36.25	36.58	36.03	35.86	35.19	34.96	34.80	34.64	34.54	34.48	34.47	34.48	34.40
36.31	36.38	36.39	36.45	36.71	36.81	36.65	36.08	35.38	35.09	34.87	34.67	34.56	34.49	34.47	34.51	34.70
36.74	36.57	36.57	36.91	36.97	36.97	36.69	36.39	35.64	35.22	35.02	34.69	34.59	34.55	34.51	34.54	34.75
36.66	36.69	36.69	36.78	36.72	36.87	36.66	36.27	35.57	35.20	35.05	34.74	34.59	34.54	34.51	34.57	34.76
36.56	36.49	36.49	36.60	36.91	36.67	36.46	35.87	35.35	34.93	34.88	34.54	34.39	34.43	34.27	34.39	34.62
36.65	36.66	36.66	36.64	36.87	36.87	36.80	36.46	35.73	35.23	34.94	34.57	34.39	34.28	34.25	34.37	34.47
36.56	36.59	36.63	36.76	36.68	36.60	36.59	36.19	35.54	35.06	34.80	34.65	34.30	34.14	34.15	34.28	34.40
36.85	36.85	36.85	36.85	36.66	36.62	36.55	36.35	35.62	35.21	34.89	34.63	34.50	34.27	34.14	34.27	34.44
36.99	36.97	36.97	36.87	36.84	36.78	36.55	36.20	35.66	35.27	34.99	34.73	34.38	34.28	34.27	34.39	34.57
36.75	36.75	36.75	36.75	36.74	36.58	36.50	36.30	35.65	35.27	34.91	34.49	34.24	34.11	34.01	34.16	34.34
36.69	36.70	36.69	36.69	36.76	36.67	36.61	36.36	35.70	35.29	34.93	34.52	34.22	34.25	34.03	34.01	34.20
36.93	36.92	36.92	36.87	36.72	36.67	36.61	36.46	35.90	35.31	35.04	34.71	34.47	34.25	34.11	34.19	34.34

Vertical distribution of water temperature and salinity.

Water temperature:

The water temperatures in the upper layer at all stations were measured with bathythermograph, and the results of these measurments were almost similar to the data obtained with reversing thermometer. Therefore data obtained by the bathythermograph are not listed here. The vertical distribution of the water temperature at each station is summarized below:

Station 1 (Fig. 2-A).

The water temperature in a layer between the surface and a depth of 50 m was 22.8 - 22.5°C and was the lowest temperature among those at all stations. The thermocline was found in a layer between 50 m and 100 m and the water temperature decreased at the rate of 0.9°C per 10 m. Below a depth of 100 m, the distribution of the water temperature was similar in trend to that shown in Fig. 2-B, but at a depth of 250 m the water temperature was about 2°C higher and at a depth of 600 m about 1°C higher than that in Fig. 2-B.

Stations 5, 7, 9 and 12 (Fig. 2-B).

Within a layer shallower than 25 m, the water temperature was nearly constant, and according to the shift of the stations to the south, the temperature increased from 24.0°C to 26.5°C. The remarkable thermocline was found in a layer between 25 m and 150 m. The water temperatures in the thermocline converged to about 12.5°C at a depth of 150 m. In this thermocline, the rates of the temperature decrease were arranged in the following order; stations 12, 9, 7, and 5, the water temperature decreased at the rate from 1.12°C to 0.92°C per 10 m. Below a depth of 150 m, the water temperature decreased gradually with the depth, and the temperature converged to about 5°C at a depth of 1200 m.

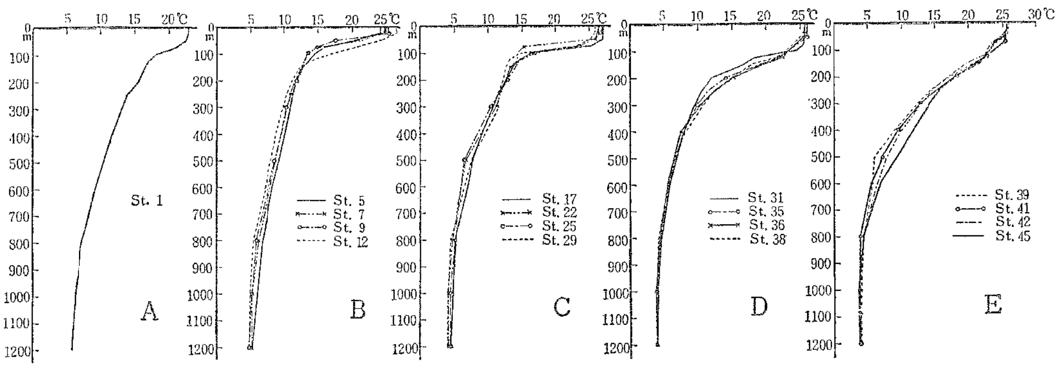

Fig. 2. Vertical distribution of water temperature in the central Atlantic.

Stations 17, 22, 23, 25, 27 and 29 (Fig. 2-C).

These stations are on a line which crosses the equator and ranges from 4°N to 4°S. The surface temperature at the station 22 was 27.5°C which was the highest value among those at all stations. The temperatures at these stations were nearly constant within a layer shallower than a depth of 50 m, but a sudden fall of the temperature was also found in a layer between 50 m and 100 m. The fact may suggest the presence of remarkable thermocline in a layer between 50 m and 100 m, and moreover the thickness of the thermocline was about 50 m. In this thermocline, the water temperature decreased at the rate from 2.48°C to 1.73°C per 10 m. The temperature was about 11.7°C at a depth of 250 m, and gradually decreased with the depth. At a depth of 800 m, the temperature was about 5°C, and was nearly constant below a depth of 800 m.

Stations 31, 33, 35, 36, 37 and 38 (Fig. 2-D).

In a layer between the surface and a depth of 25 m, the water temperature was 25.8°C and nearly constant. The thermocline was found only at stations 31 and 33 in a layer between 100 m and 250 m, but was not remarkable. The temperature converged from 6°C to 7°C at a depth of 500 m and the vertical distribution of the temperature below a depth of 500 m at the stations 31 - 38 and 17 - 29 were similar in general trend.

Stations 39, 40, 41, 42, 43, 44 and 45 (Fig. 2-E).

In a layer between the surface and a depth of 50 m, the water temperature was about 25.5°C and nearly constant. The thermocline was found in a layer between 50 m and 100 m, though this was not remarkable. In a layer between 100 m and 800 m, the water temperature gradually decreased with the depth, but below a depth of 800 m the temperature did not decreased.

Salinity:

In general the salinity attained to the maximum in a layer between a depth of 50 m and that of 100 m, and below a depth of 100 m the salinity decreased with the depth and attained to the minimum at a depth of 800 m except at two or three stations. The patterns of the salinity change with the depth at various stations were classified into three following groups.

Stations 5, 7, 9 and 22 (Fig. 3-A).

The salinity at the surface was 35.2 - 35.6 ‰, and increased 0.7 - 0.5 ‰ in a layer between a depth of 25 m and 50 m except that at station 5. Below a depth of 50 m the salinity decreased with the depth, and attained to the minimum value of 34.8 ‰ at a depth of 800 m.

Stations 12, 17, 25, 27, 29 and 31 (Fig. 3-B).

In the surface layer (above a depth of 75 m) the salinity increased with the depth and attained to the maximum 35.7 - 36.0 ‰ at a depth of 75 m. Below a depth of 75 m the salinity decreased with the depth and the salinity at stations 12, 25 and 31 attained to the minimum at a depth of 600 m. At stations 17 and 31 the salinity attained to the minimum at a depth of 800 m.

Stations 33 - 45 (Fig. 3-C).

These stations are located in the waters from latitude 8°S to 20°S. The salinity at the surface was extremely high, and in the intermediate layer (below a depth of

800 m) the salinity was lower than those of two groups previously mentioned. The surface salinity at station 33 was 36.3 ‰ and was higher than those at stations in the south. The highest salinity, 36.9 ‰, was recorded at station 45. At stations 33 - 39, the

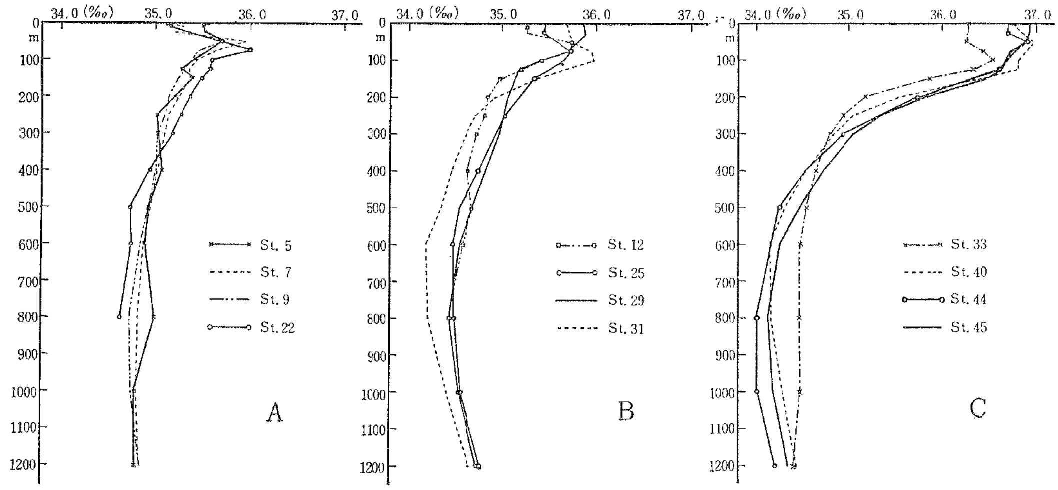

Fig. 3. Vertical distribution of salinity in the central Atlantic.

salinity increased from a depth of 50 m to about 100 m and attained to the maximum in a layer between a depth of 75 m and about 100 m. At stations 40-43, the salinity was nearly constant from the surface to a depth of 50 m. Below a depth of 100 m, the salinity decreased with the depth and attained to the minimum at a depth of 800 m or thereabout. The vertical gradients of salinity at these stations were the steepest of all stations and the minimum salinity at a depth of 800 m at stations 43 and 45 was 34.0 ‰ which was the lowest value of all stations.

Distribution of temperature and salinity in the vertical sections

This section runs from the north to the south along the meridian of 25°W. Distribution of temperature and salinity in the vertical sections is shown in Fig. 4 and Fig. 5. The water of low temperature and low salinity which perhaps originated from the north, occupied the surface layer of the northern part (stations 1 - 12). Between 5°N and the equator, the water of high temperature occupied the surface layer, and following the shift of the stations to the south the surface water temprature gradually decreased. On the other hand, the water of high salinity occupied the surface layer of the southern part (stations 33 - 45). The intermediate water in the southern part was relatively lower in temperature and salinity than those in the northern part. The thermocline along this section was found in the surface layer and the depth of the thermocline differed with latitude. In the thermocline, the water temperature ranged from 25°C to 18°C and the temperature at center of the thermocline was 22°C. At latitude 10°N or thereabout the thermocline was found at a depth of 40 m and the rising of cold water was recognized. With the southward shift of the stations, the depth of the thermocline increased to about 90 m at latitude 5°N and the sinking of the warm water was recognized. In the equatorial part or thereabout the depth of the thermocline decreased, and the isotherms separated into two groups, i.e. the both isotherms of 25°C and 24°C from the north and the south ascended progressively toward the equator to form a ridge, and those of 23°C or less descended progressively toward the equator to form a trough.

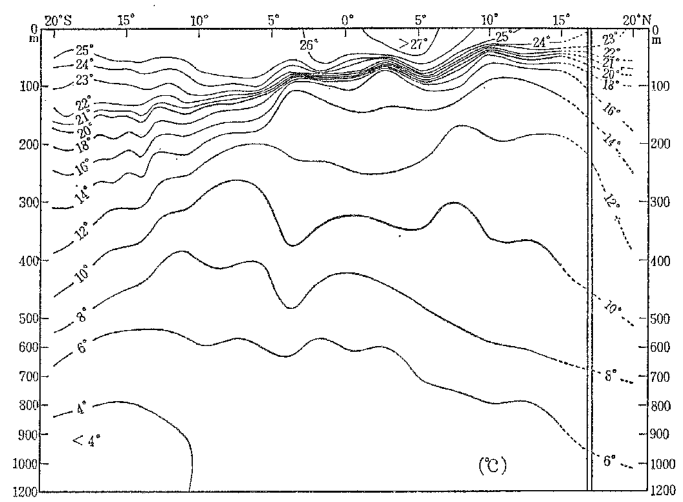

Fig. 4. Distribution of water temperature in the vertical cross section.

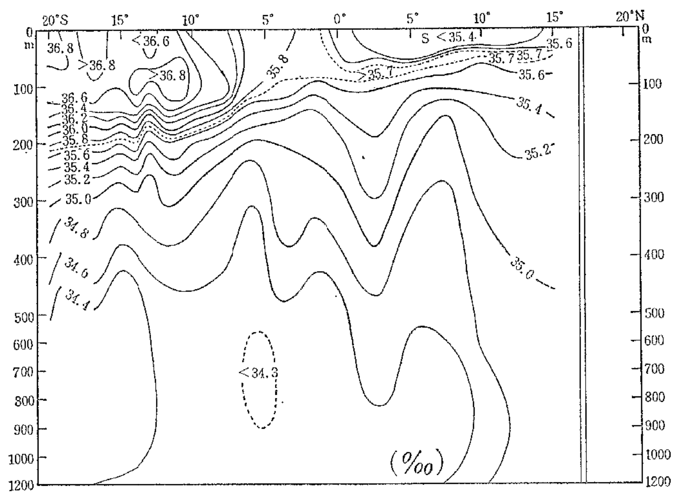

Fig. 5. Distribution of salinity in the vertical cross section.

This phenomenon demonstrated the presence of the Equatorial Undercurrent. In the part south of the equator, with the shift to the south the depth of the thermocline gradually increased. And in the southern part from latitude 10°S to 20°S the thermocline became indefinite. At latitude 13°S or thereabout the convex or concave shape of the isotherms and isohalines were found in a layer between 100 m and 250 m.

Water masses

As suggested by Fig. 6, it appears that there were three water masses in the surface layer (0 - 100 m), a water mass in the surface layer, and three water masses in the intermediate layer (below a depth of 800 m) as follows;

i) Surface layer.

Water mass A : t=25 - 27°C, S=35.3 - 35.5 ‰; this water mass has its core in a layer between 25 m and 50 m and is located in the Northern Hemisphere.

Water mass B : t=25 - 26°C, S=35.7 - 36.0 ‰ ; this water mass occupies a layer shallower than 50 m in depth at stations 27, 29 and 31.

Water mass C : t=23 - 25°C, S=36.5 - 37.0 ‰; this mass is located in alayer between 50 m and 100 m in depth at stations 33 - 45.

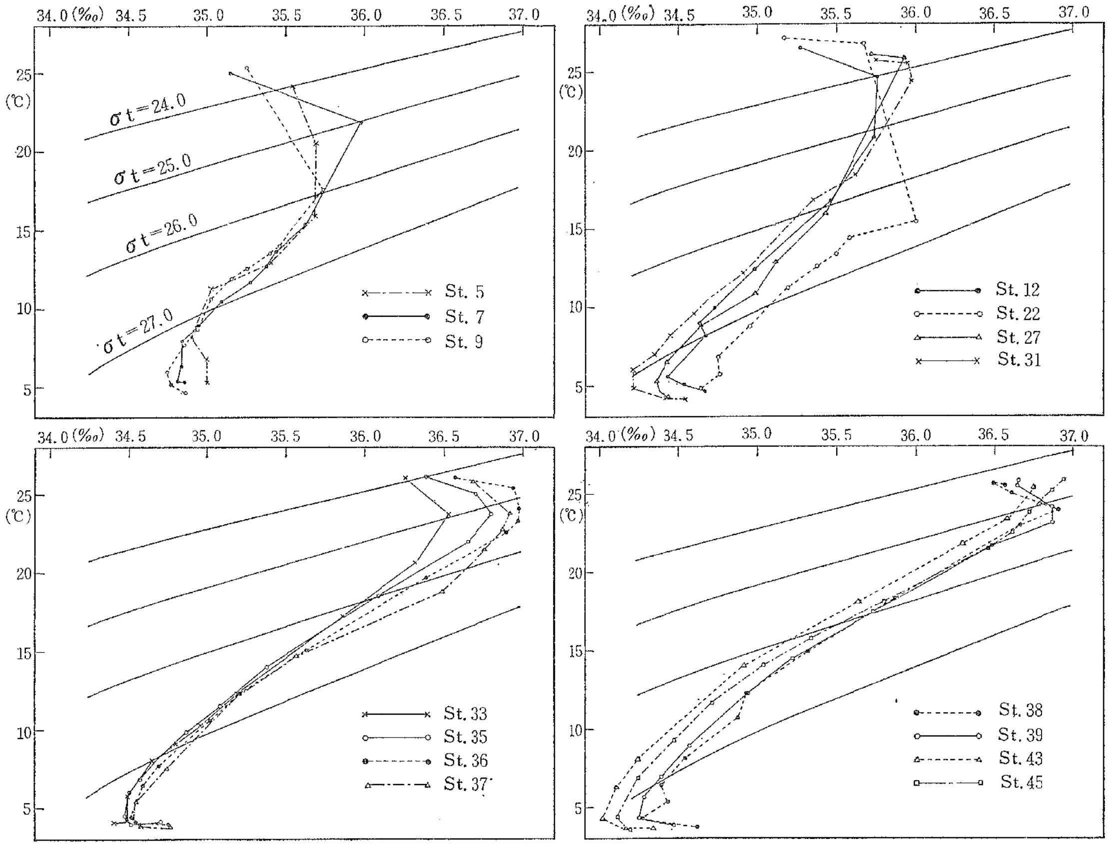

Fig. 6. T-S Diagram at each station in the central Atlantic.

Above-mentioned three water masses are greatly influenced by atmospheric conditions and seasonal fluctuations, so that the locations and the characters of these water masses are also subject to change by the seasons.

ii) Subsurface layer.

Water mass D : It is characterized by a nearly linear T - S relationship between the points t=6°C, S=34.5 ‰ and t=18°C, S=36.0 ‰. This water mass is the South Atlantic Central Water described by SVERDRUP (1952) and originated from the region of the Sutropical Convergence. This water occupies the subsurface layer (800 - 100 m in depth) at all stations. At stations 38-45, in a layer between 300 m and 500 m or thereabout, there is a water mass whose salinity is 0.2-0.4 ‰ lower than that of the water mass D. It is estimated that this water mass was formed by the mixing of the water mass D with other water masses.

iii) Intermediate layer.

Water mass E : t=4.5°C, S=34.0 - 34.1 ‰ ; this water mass occupies a layer at a depth of 800 m or theroabout at stations 43, 44 and 45, and is the Subantarctic Water described by SVERDRUP (1952) and formed in the region between the Antarctic Convergence zone and the Subtropical Convergence zone.

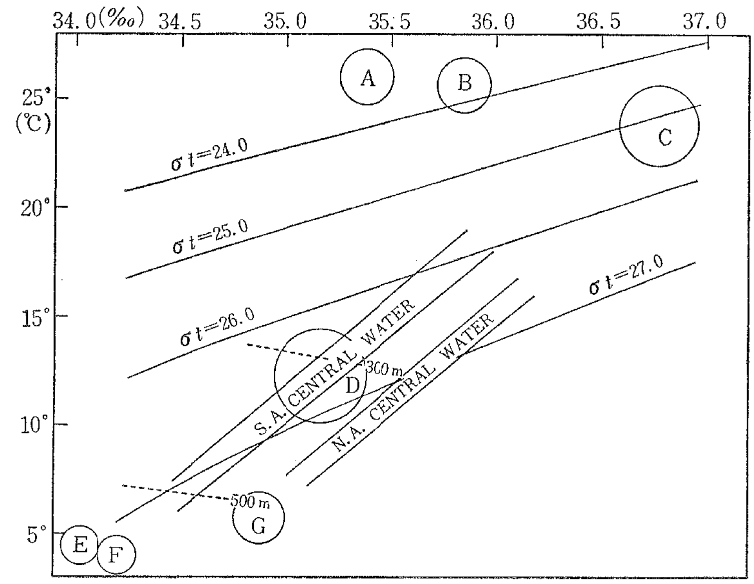

Fig. 7. Water masses shown in T-S diagram.

Water mass F : this is characterized by the temperature of 3.5°C to 5.0°C and the salinity of 34.1‰ to 34.15 ‰. This water mass occupies a layer of 800 m or thereabout in depth at stations 12 - 37 and a layer below 800 m in depth at stations 38 - 45. This water mass is the Antarctic Intermediate Water described by SVERDRUP. According to SVERDRUP, it can be traced to latitude 20°N. Recently V. A. BUBNOV and A. N. KOSAREV (1964) reported that the presence of the Antarctic Intermediate Water is clearly traceable to latitude 18° - 19°N and its traces can be found at further north up to latitude 26°N. But the result of the present investigation indicates that the Antarctic Intermediate Water can be clearly traced to only latitude 7°N.

Water mass G : t=4.5 - 5.5°C. S=34.8 - 35.0 ‰ ; this water mass occupies a layer below 800 m in depth at stations 5, 7 and 9. The character of this water mass is similar to that of the Subarctic Intermediate Water. According to SVERDRUP, the

Subarctic Intermediate Water is found only in the northern region (further north from latitude 45°N) and some portions of the Mediterranean Water turn south and spread continuously below the Antarctic Intermediate Water across the equator. Therefore, it is reasonable to consider that the water mass G was created by the transformation of the Mediterranean Water.

Water type (Water system)

As mentioned above, an analysis of the T-S curves at all stations shows the presence of 7 water masses. And further we can make an assumption that these water masses can be classified into four water types by the process of their formation.

Type I ; this type was formed from water masses A, D and G, located at stations 5, 7 and 9.

Type II ; this type was formed from water masses B, D and F, located at stations 12-31.

Type III ; this type was formed from water masses C, D and F, located at stations 33, 35, 36 and 37.

Type IV ; this type which was formed from water masses C, D, F and G, is located at stations 39-45.

Horizontal distribution of four water types is shownin Fig. 8.

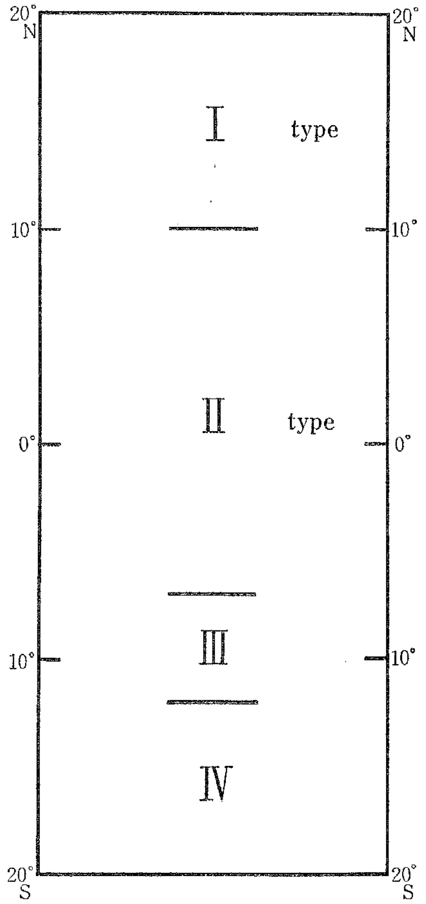

Fig. 8. Schematic representation of the distribution of the principal water masses in the central Atlantic.

Conclusions on oceanographic conditions

The analysis of the vertical distributions of water temperature and salinity and the patterns of the isotherms and isohalines in the vertical cross section leads us to the following conclusions.

The depth of the bottom of layers which have a temperature almost similar to those of the surface water differs by latitude ; that is, at stations 1, 17-29 and 39-45 it is 50 m, and at stations 5-12 and 31-38 it is 25 m.

A remarkable thermocline and a strong correspondency between isotherms and isohalines are recognized. According to the thermocline topography, it is estimated that the northern boundary of the Equatorial Countercurrent is located at latitude 10°N and the southern boundary at latitude 4°N.

In the equatorial region (from latitude 2°N to 2°S) the isotherms are separated into two groups at a depth of 75 m ; i. e. the both isotherms of 25°C and 24°C from the north and the south ascend progressively toward the equator to form a ridge and the isotherms of 23°C and 22°C descend progressively toward the equator to form a trough. This phenomenon is recognized also in the vertical distribution of dissolved oxygen. According to the above-mentioned fact, it is estimated that the Equatorial Undercurrent exists in a layer of 75 m or thereabout in depth. This Undercurrent was reported by WOOSTER and JENNINGS (1955) and was described by WOOSTER and CROMWELL (1958), KNAUSS (1960), MONTGOMERY and STROUP (1962), G. P. PONOMARENKO (1962) and W. D. FORRESTER (1964). According to their reports, the presence of Undercurrent is indicated by the thermocline topography.

At latitude 13°S or thereabout, the convex or concave shape of the isotherms and isohalines are found in a layer between 100 m and 250 m in depth. From this fact it is estimated that there exists a discontinuous line. In the Pacific Ocean, at latitude 10°S or thereabout the presence of discontinuos line was described by H. YAMANAKA (1956).

Analysis of the water masses leads us to the followitng conclusions.

i) Formation of three water masses are recognized in a surface layer. Water mass A is located in the area from latitude 15°N to latitude 1°S. Water mass B is located in the area from latitude 1°S to latitude 7°S. Water mass C is located in the area south of latitude 7°S.

ii) In the subsurface layer only one water mass is formed, i. e, the South Atlantic Central Water described by SVERDRUP. It was ascertained that other water masses are not present in the equatorial Atlantic Ocean.

iii) In the intermediate layer, three water masses are formed, and one of them, the Antarctic Intermediate Water, extends north in a layer of 600 - 1000 m in depth and reaches latitude 7°N.

Zooplankton biomass

The zooplankton components of the sampled biomass in this region were analyzed. The following is a list of zooplanktons arranged in order of abundance : Copepoda, Chaetognatha, pelagic Amphipoda, medusa, Euphausiacea, Gastropoda, appendicularia, Ostracoda, Polychaeta, fish larvae and fish eggs. Copepoda was especially abundant and occupied 60 - 70 % of total numbers.

The distributions of zooplankton biomass at each station are shown in Table 2 and Fig. 9. In general, biomass was abundant in the northern water, and was not abundant in the southern waters. From the results of consideration on the relationship between oceanographic conditions and zooplankton biomass, the present authors recognized that the size of zooplankton biomass was related inversely to the depth of thermocline. The similar fact was recognized by the present authors in the eastern tropcal Pacific Ocean. On the other hand, it is assumed that the species composition

Table 2. Date on standard plankton samplings in the central tropical Atlantic.
(0—200 m vertical hauls with Indian Ocean standard net)

Station			Date	Hour (L. T.)	Angle of wire	Length of wire (m)	Estinonted volume of Water filterd m³	Wet weight g		Displacement volume cc	
No.	Lat.	Long. (W)						observed	per 1,000m³	observed	per 1,000m³
	° ′	° ′		h m							
1	19 48.5N	25 15.0	1965 Dec. 24	09 : 15	55°	200	518.4	2.2	4.24	2.0	3.86
5	15 00.0	25 00.0	25	21 : 30	38°	200	488.2	44.5	91.15	44.0	90.13
7	12 30.0	25 03.0	26	13 : 00	50°	200	475.9	17.6	36.99	15.0	31.52
9	09 40.0	25 04.5	27	09 : 30	50°	200	425.0	13.0	30.59	11.0	25.88
12	07 30.0	25 00.0	28	05 : 10	18°	200	331.0	21.0	63.44	10.0	30.21
17	05 00.0	25 00.0	28	21 : 50	34°	200	380.0	13.0	34.21	11.0	28.95
22	02 30.0	25 00.0	29	15 : 10	52°	200	413.1	10.0	24.21	10.0	16.95
25	00 13.2	24 53.5	30	09 : 05	63°	200	419.2	7.0	16.70	5.0	11.93
27	01 57.5S	24 14.5	31	08 : 20	40°	200	410.9	54.0	131.42	58.0	141.15
29	03 50.8	25 19.5	1966 Jan. 2	09 : 10	56°	200	406.4	14.0	34.45	12.0	29.53
31	06 00.0	25 19.2	3	08 : 55	49°	200	458.5	8.5	18.54	7.0	15.27
33	08 01.2	25 12.2	4	08 : 05	46°	200	430.5	4.0	9.29	2.0	4.16
35	10 03.5	25 12.5	5	07 : 50	42°	300	480.7	2.0	4.16	4.0	9.29
36	11 00.0	24 59.7	5	21 : 20	44°	253	445.0	4.0	8.99	5.0	11.24
37	12 02.5	25 17.0	6	09 : 30	64°	207	483.0	3.0	6.21	4.0	8.28
38	13 00.0	25 00.0	6	21 : 10	55°	240	549.3	4.0	7.28	2.0	3.64
39	14 01.4	25 14.0	7	09 : 50	50°	215	385.1	0.5	1.30	0.5	1.30
40	15 00.0	25 01.0	7	21 : 00	45°	248	452.4	1.5	3.32	1.0	2.21
41	16 05.7	25 12.4	8	09 : 30	50°	200	404.1	4.0	9.90	2.0	4.95
42	17 00.0	25 00.0	8	21 : 05	61°	236	482.0	2.0	4.15	2.0	4.15
43	18 15.6	25 04.5	9	08 : 40	41°	200	355.5	0.5	1.40	1.0	2.81
44	19 00.0	25 02.6	9	20 : 10	48°	200	343.6	2.0	5.82	2.0	5.82
45	20 07.5	25 11.0	10	08 : 45	51°	200	377.7	3.0	7.94	4.0	10.60

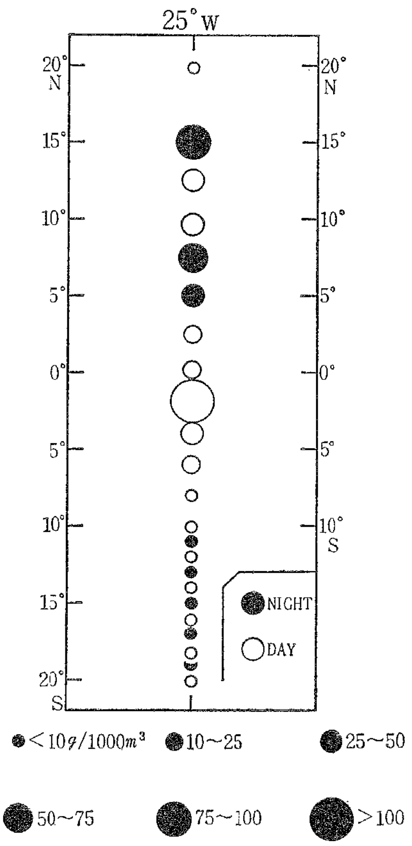

Fig. 9. Distribution of zooplankton biomass. (wet weight g/1000m³)

of zooplankton was different from station to station. But the identification of species is not yet completed, so we cannot discuss here on the relationship of species composition of zooplankton to the latitude. In night time, surface collecting of fish larvae at 15 stations was performed with a larva net. Collections with larva nets were compared with collections with plankton nets. The result shows that both distributions of biomass are similar in trend, but species compositions are different because of different mesh sizes of nets. Specimens collected with larva nets show charactristic differences by region. Leptocephalus of Anguillida (Apodes) (311 specimens), phyllosoma age of Scyllaridae (187 specimens) and alima age of Stomatopoda (3841 specimens) appeared at the stations on the boundary between the North Equatorial Current region and the northern part of the Equatorial Countercurrent region. *Salmariscorona* (29 specimens) appeared only in the South Equatorial Current region.

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