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Echo-Survey of Tuna Fishing Ground*

Minoru NISHIMURA** and Keishi SHIBATA***

Résumé: L'analyse du tracé du sondeur ultra-sonore obtenu à la pêcherie du thon permet d'étudier non seulement ses conditions écologiques mais encore la couche diffusante sonore et la forme de l'appareil de pêche. Dans la présente note sont d'abord précisés les problèmes à résoudre dans ces études et puis se montrent des résultats obtenus par l'analyse des échogrammes que nous avons enregistrées aux océans Pacifique, Atlantique et Indien: Le poisson à grandes dimensions considéré comme thon se trouve entre 250 et 500 m de profondeur pendant le jour et entre 0 et 100 m de profondeur pendant la nuit. Il fait ainsi la navigation verticale diurne. Sa vitesse de nagement est 1 à 2 kt à l'ordinaire et 1 à 8 kt à la fuite. La densité de banc, variable avec la pêcherie, est 0,02 à 200 par 10^5 m^3. L'apparence de la couche diffusante sonore et la variation de la perte de réflexion dépendent de la fréquence d'ultra-sonore.

1. Introduction

Echo-survey is now practically used in tuna fishing. One of the authors (NISHIMURA, 1961) reported the usefulness of the ultrasonic echo-sounder (fish-finder) in the study of tuna behavior. It has been proved to be possible with the use of the fish-finder to observe not only vertical and horizontal distribution of individual tuna, but also to determine the size of the existing population. Moreover, it is possible to define the body-size of tuna by the analysis of echo-trace and in some cases the species can be assumed on the basis of the body size. The location, thickness, expansion and other characteristics of sonic scattering layer can also be traced by the fish-finder. The scattering layer is formed in many cases by the concentration of micronecton which is closely related to the availability of tuna on the fishing ground. The abrupt change of hydrographic circumstance at a depth also causes the scattering of sound.

It is also suggested that fish-finder is useful to detect the position of long-line set in the depth (SHIBATA, 1962).

In the present paper the authors proposed a theoretical treatment of tuna echo-trace for determination of body size, for calculation of swimming depth, school density and swimming speed of individual tuna. Examples of calculation are presented on the basis of data obtained by field observations. Acoustic property of sound scattering layer is analyzed in relation to the oceanographic condition at the layer. Then, catenary shape and the depth of long-line are demonstrated by tracing the results of echo-survey.

The survey has been carried out since 1960, and is being continued. The surveys were made on the occasion of several cruises of the "Banshu-Maru" of Taiyo-Gyogyo Co., Ltd., the "Nagasaki Maru" of the Faculty of Fisheries, Nagasaki University, the "Taisei-Maru" of the Mie Prefectural Fisheries Experimental Station and the "Iwaki-Maru" of the Fukushima Prefectural Fisheries Experimental Station in various localities covering Pacific, Indian and South Atlantic Oceans.

2. Theoretical consideration of echo-trace

1) Sound propagation and identification of fish size

In a vertical fish-finder, the receiving sound pressure p_R from tuna located on the direction of deviation angle θ of a transducer is indicated as follows:

$$20\log p_R=20\log p_{S1}-(40\log x+2\alpha x+L_p)+20\log R_S R_R-120, \qquad (1)$$

where p_{S1} is output sound pressure at unit distance (1 m) from a transmitting transducer, α is vertical absorption coefficient in db/km, L_P

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is reflection loss of tuna in db, x is the depth of tuna in meter, and R_S and R_R are directivity function for transmitting and receiving transducers respectively.

Since p_{S1} is obtained at sea by the standard measurement for the target with known reflection loss (glass ball L_G), if receiving sound preassure p_R is measured for tuna, giving the value of x and α, the value of L_P is calculated from Eq. (1). The size of fish which appears on the record of fish-finder can be indicated because the reflection loss of tuna and the relation between reflection loss and size of tuna is given by experimental equation (HASHIMOTO and MANIWA, 1956) (Figs. 1 and 2). Fig. 3 illustrates a graph derived from Eq. (1), assuming that the tuna is on the acoustic axis ($R_S=R_R=1$). The abscissa indicates depth of fish in meter and the ordinate indicates receiv-

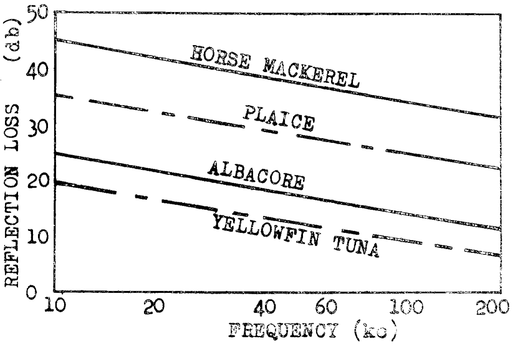


Fig. 1. Reflection loss of fish v.s. ultrasonic frequency. The model fish used are medium in size.

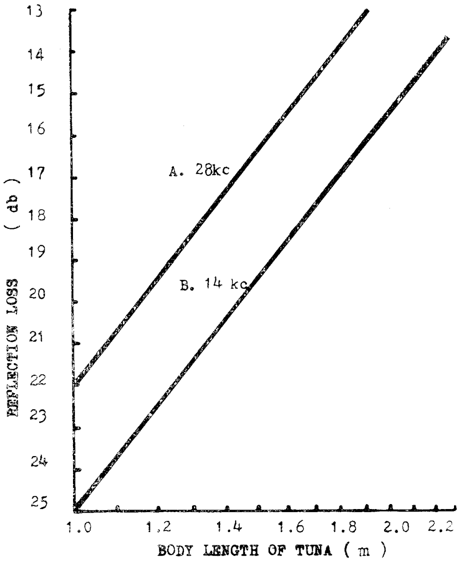


Fig. 2. Body length of tuna v.s. reflection loss. Line A indicates calculated value for 28 kc, and line B for 14 kc.

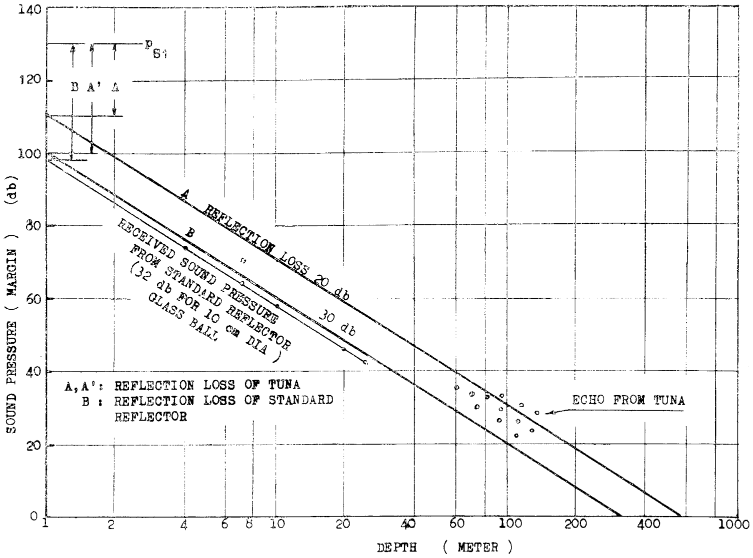


Fig. 3. Graphical identification of fish species. When the margin of fish is measured as sign ∘, the reflection loss will be obtained by the curve A, B....derived from Eq. (1).

ing sound pressure in db.

There is another method measuring the size of fish. The echo-trace of tuna generally shapes like the inversed V as shown in Fig. 4. In this figure, h' is distance between transducers and fish entering in the beam at deviation angle θ, h_0 is vertical distance between transducers and fish on the center of beam. The receiving sound pressure from fish located at "A" in Fig. 4 is presented in the following equation derived from Eq. (1), assuming that R_S and R_R is equal ($R_S=R_R=R$) and that absorption coefficient is negligible.

$$20\log p_R=20\log p_{S1}-(40\log h'+L_P-40\log R) \quad (2)$$

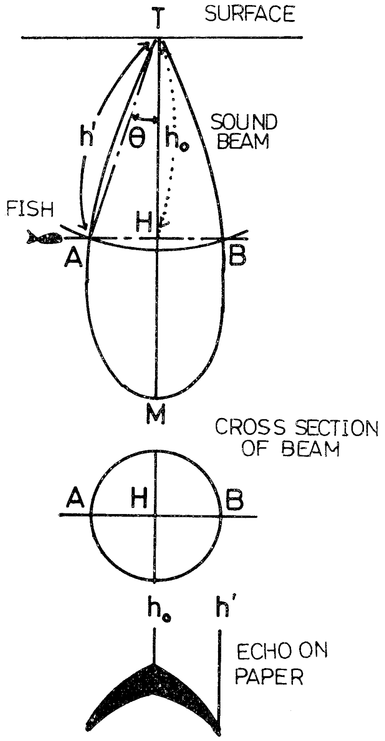


Fig. 4. The shape of sound cone and the echo-trace of tuna appearing on the echo-gram.

On the other hand, the receiving sound pressure from the fish at the center of beam is indicated by the following equation:

$$20\log p_R=20\log p_{S1}-(40\log h_0+L_P) \quad (3)$$

Therefore, the echo-margin M_{h0} for the fish located at the center of beam is obtained by the remainder of Eqs. (2) and (3), thus

$$M_{h0}=-40\log(h_0/h')-40\log R, \quad (4)$$

where R is computed from deviation angle

$$\theta=\cos^{-1}(h_0/h'). \quad (5)$$

In conclusion, M_{h0} is calculated by Eq. (4) when h' and h_0 are measured on the inversed V shape of the echo-trace, and the reflection loss and size of fish are estimated by the margin test.

2) Detectable area of sound beam and density calculation of tuna school

The directivity of transducer is available to decide the covered area by ultrasonic beam from transducer. The maximum sounding range x for a fish located on the direction of deviation angle θ is

$$x=x_m\cdot R, \quad (6)$$

where x_m is maximum axial sounding range, R is directivity function of transmitting or receiving transducer and $R_S=R_R=R$. The directivity characteristics of maximum sounding range obtained from Eq. (6) is shown in Fig. 5, and every point on the closed curve indicates the same receiving sound pressure from tuna. The water mass searched by sound is

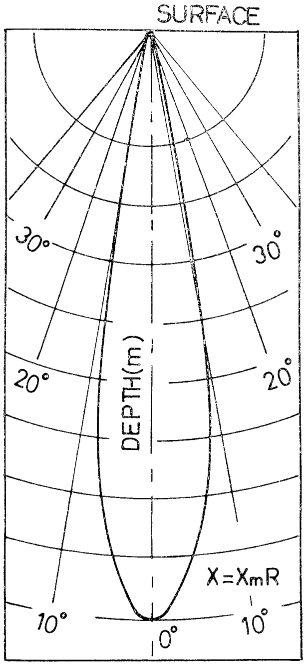


Fig. 5. Main lobe of directional pattern of sound beam. Each point on the curve indicates the same receiving sound pressure from the fish.

equal to the product of running distance of ship and the area of transverse plane of sound cone. The school density of tuna, therefore, is determined with the ratio of size of water mass and amount of tuna trace. The school density is computed fundamentally by the above-mentioned method. However, the difference of the receiving acoustic pressure from tuna located on the axis of sound beam and outside the axis, reaches more than 12 db in some deviation angle, assuming that the all tunas are located at the same depth. There is more than 12 db of allowance in the identification of tuna. Since the difference between the reflection loss of tuna and the other fish smaller than tuna such as mackerel is less than 12 db. For example, the receiving sound pressure from mackerel on the axis may be equal to that from tuna outside the axis. Then, in the practical measurement, it is necessary to assume that some narrow sound beams decrease these errors. Considering again Eq. (4), if the value of 40 $\log R$ is assumed as a constant value K, the difference of acoustic pressure from tuna on the axis and that off axis are presented by the following formula:

$$M=-40\log(h_0/h')-K \qquad (7)$$

thus, the searched area of sound beam becomes triangle as shown in Fig. 6, because the deviation angle becomes constant since $40\log R$ is assumed to be constant. To decrease the error, K must be selected as small value as possible.

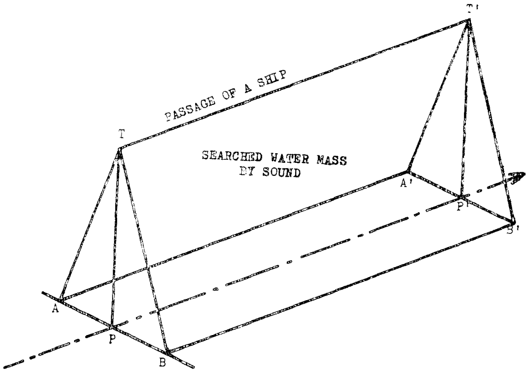


Fig. 6. Water mass searched by sound. The ratio of number of tuna in the volume and the searched water mass indicates the school density of fish.

K is assumed as 5 db in the measurement in this report. The school density of tuna is computed, therefore, by the ratio of account of tuna N and searched volume of water by sound $l \cdot A$,

$$\text{tuna density } D=\frac{N}{l\cdot A}=\frac{N}{l(h_2-h_1)(h_2+h_1)\tan\theta}, \qquad (8)$$

where h_1 is shallower depth and h_2 is deeper depth of the swimming layer of tuna, θ is the deviation angle derived from R, l is underway distance during accounting tuna trace assuming arbitrary K is constant.

The average of reflection loss of tuna which is 142 cm in length is measured as 20 db by the field experiment. If the tuna of 20 db loss located on the axis, the receiving sound pressure is measured corresponding to 20 db loss of tuna, but if this tuna is located off axis, the sound pressure will indicate apparently the same value from fish with reflection loss of 25 db. It is assumed that fish trace with acoustic pressure corresponding to fish of 20 to 25 db loss is that caused by tuna. The echo from fish of 15 db loss is included in this measurement.

3) Calculation of swimming speed of tuna

The swimming speed of tuna is measured from the time required by the tuna to cross the distance AB at sound beam in Fig. 4. When the ship is underway, the speed is indicated approximately by the following equation, assuming that the fish horizontally swims along the longitudinal diameter of the cross section.

$$V_F=\frac{2\sqrt{h'^2-h_0^2}}{t}\pm V_S, \qquad (9)$$

where V_F is the speed of tuna, V_S is that of ship and t is the time required by the tuna to cross. The positive and negative signs of second term in Eq. (9) depend upon the swimming direction of tuna against the ship. When a tuna is swimming vertically its swimming speed is calculated by the following equation:

$$V_F=\left|\frac{-h_0t\pm\sqrt{h_0^2t^2-t^2(h_0^2+V_S^2t^2-h'^2)}}{t^2}\right|$$

3. Practical application of echo-trace

1) Swimming depth of tuna

Record of echo-survey indicates that the

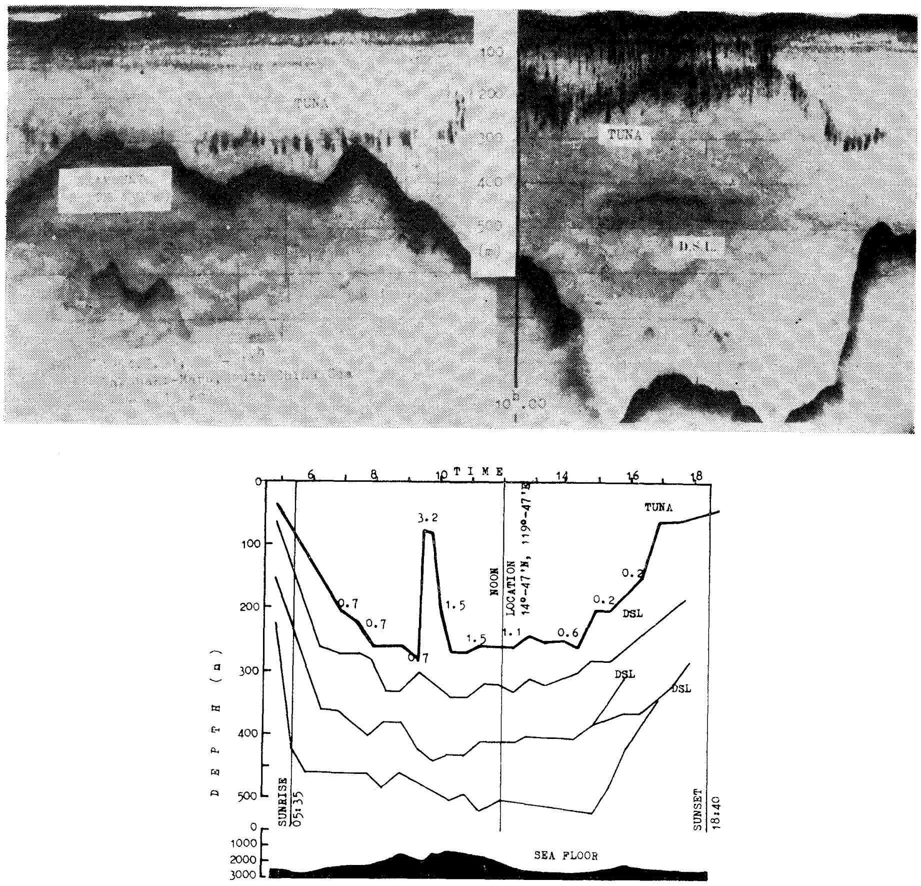


Fig. 7-A. Upper: echo-gram of tuna fishing ground around the seamout, lower: diurnal change of tuna swimming and scattering layer. Sea bottom was recorded by P. D. R. with 14 kc on the "Nagasaki-Maru" in the South China Sea on July 20, 1964. The thick line shows the swimming layer of tuna (numerals on thick line indicate the number of tunas per 10^6 m^3) The lines show the depth of scattering layers.

swimming depth of tuna extends in general from the surface to 400 meters deep or more. It has been shown that albacore is distributed in day time at 60 to 80 meters, that the yellowfin inhabits deeper water than 120 meters in the western South Pacific (NISHIMURA, 1961), and that yellowfin and bigeye tuna inhabit the depth of 200 to 250 meters in the Philippine Sea (SHIBATA, 1963). Later, it has been found that albacore to live at the depth of 300 meters or deeper in the North Pacific (NISHIMURA and SHIBATA, 1965; INOUE, 1965).

The P.D.R. (Precise Depth Recorder) of the "Nagasaki Maru" recorded many tuna like fish at the depth 400 meters or more in the North Pacific Ocean from Tokyo to Honolulu in summer 1965.

Diurnal change of the swimming depth of tuna was observed in the South China Sea on July 21, 1964. It was indicated that the concentration of tuna was located near the surface at $05^h:00^m$, and then shifted gradually toward the deep water after sunrise (05:50) as shown in Fig. 7-A. In the figure, the echo of tuna suddenly rose to the depth as shallow as about 80 meters at about 09:40 when the ship passed the area of a shallow sea floor which is elevated to 1,300 meters from 2,500 meters of the neighbouring sea floor. Tuna school again sunk, descending to about 250 meters at 10:00.

In the afternoon, and then the tuna was gradually rising toward the surface along with the time approach of sunset. Below the tuna echo, there were three distinct scattering layers throughout the daytime. These layers as well as the tuna swimming layer also moved up and down with the time of the day. When the ship passed over the shallow sea floor, scattering layer became fade probably on account of dispersion of animals which was perhaps caused by upwelling of water existing in the area around the elevation of sea floor. This suggests that tuna moved upward and downward along with the change of vertical distribution of food animals which were controlled by the underwater light penetration.

The change of light, of course, would stimulate the tuna itself. Diurnal change of light penetration in the water at various depth measured by CLARKE and BACKUS (1964) in the North Atlantic is inserted in Fig. 7-B to indicate how the movement of scattering layers happend in parallel with the change of underwater light penetration. Sudden rise of tuna at about 09:40 would be induced by the upwelling current of water, rather than by the dispersion of food animals at that time.

2) Density of tuna school

The density of tuna school can be expressed by the ratio between the number of tunas on echo-gram and the volume of water encircled by the sound beams. The unit of density of tuna school is indicated in Table 1 as number of tuna existing in the order of 10^5 cubic meters of water in the area of commercial fishing ground.

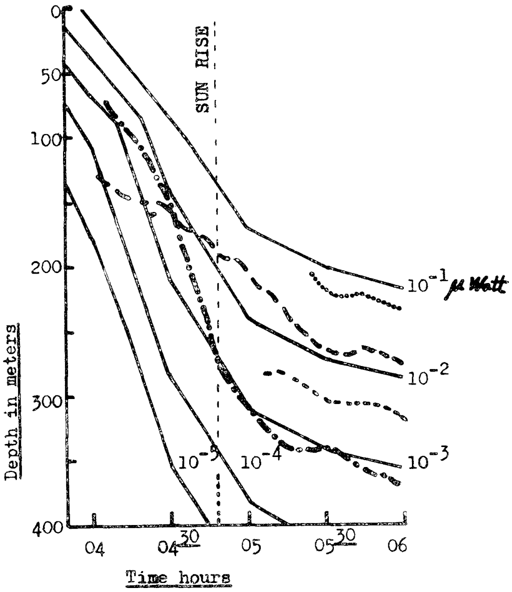


Fig. 7-B. The position of the isolumes for downwelling ambient light (solid lines) and the vertical migrations of scattering layers (broken lines, indicating middle of each layer), during Aug. 14, 1959. (38°40′ N, 68°33′ W, from G. L. CLARKE and R. H. BACKUS, 1964).

3) Swimming speed of tuna

Applying the Eq. (9), the swimming speed of tuna is calculated as shown in Table 2. Albacore swims about 1 to 1.5 knots and yellowfin about 1 knot. Yellowfin swims more actively as fast as 3 to 4 knots, at the time of sunset. The speed of tunas change when they are stimulated by ship born noise, approaching net etc. (Fig. 8: A, B, C).

4) Sonic scattering layer

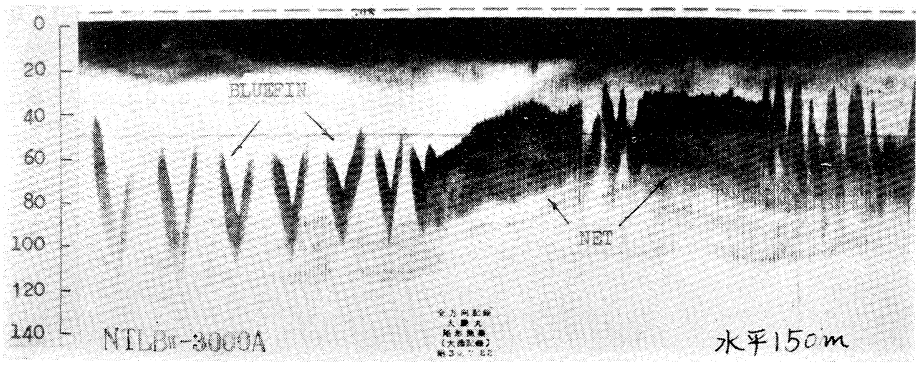
Table 1. School density of tuna.

Fishing ground	Species	School density (tuna/10^5 m^3)	Note
N. E. New Zealand (1960)	albacore	30	NISHIMURA
Philippine Suru Sea (1960)	yellowfin	9	〃
East of Solomon Is. (1961)	〃	90	〃
Tsugaru Straits (1962)	bluefin	200	〃
Philippine Sea (1962)	bigeye & yellowfin	2—16	SHIBATA
North of Tahiti Is. (1964)	yellowfin	1—2	〃
South China Sea (1964)	〃	0.1—1.3	〃
Gibraltar Straits (1960)	〃	30	CABO

Table 2. Swimming speed of tuna obtained by acoustic measurement.

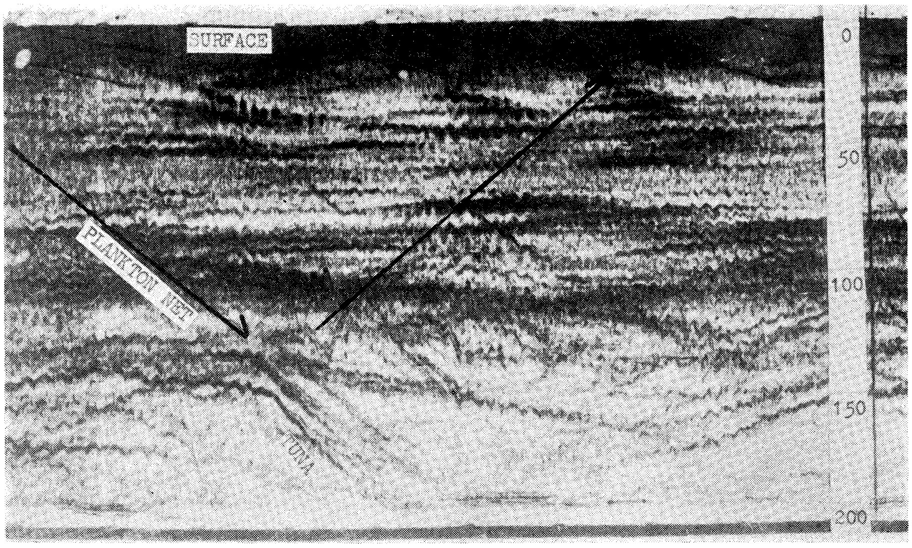
Fishing ground	Species	Swimming depth (m)	Speed (kt)	Note
N. E. New Zealand (1960)	albacore	40—120	1—2	NISHIMURA
Philippine Sea (1962)	yellowfin	100—250	0—0.5	SHIBATA
〃	〃	40—200	1—4	〃
Gibraltar Strs. (1960)	〃	60	7—10	CABO (migrating speed)
Off Hawaii		106	2	MANAR (optical observation)
N. E Solomon Is. (1965)	yellowfin	25—100	3	YAMANAKA (ascending by ship born noise)
Off Choshi (1964)	bluefin	10— 60	7—8	NISHIMURA (in purse-seine)

A. Yellowfin tuna swimming faster and deeper affected by ship-born noise. (1965. 11. 26, 6. PM, 01°S, 162°E, Shunyo-Maru, NTLB-3000, 28 kc H. YAMANAKA).



B. Bluefin tuna surrounded by purse seine in which the speed reached more than 8 knots. (1964. 7. 22, off Choshi, Taikei-Maru, NTLB-3000, 28 kc).

Fig. 8. Echo-gram showing abnormal movement of tuna by the outside threat.



C. Yellowfin tuna dives vertically to deeper than 200 meters at a speed of 1–1.5 kts when a plankton net approaches 6–10 minutes later it came back to that depth and reset again, swimming at a speed of about 0.5 kt. (1962. 11. 19, half an hour before sunset on the Philippine Sea, Nagasaki-Maru, NEC 1620, 14 kc, sea state: smooth, ship's drifting speed; 0.1 kt).

Fig. 8. Echo-gram showing abnormal movement or tuna by the outside threat.

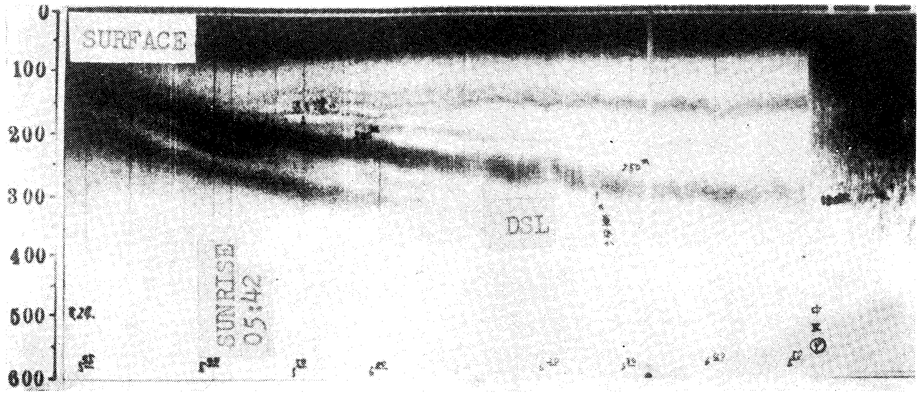


Fig. 9. Typical echo-gram of the migratory scattering layer descending slowly after sunrise. (1964. 7. 29. 16–18 h, 1°N, 97°W, Taisei-Maru NTLB-3000, 28 kc).

It has been stated that a sonic scattering layer is caused by the concentration of some animal plankton, small fish or small nectonic animals, or by the existance of internal wave. The sonic scattering layer can be divided into two categories *i.e.*, 1) migratory scattering layer (deep scattering layer), which migrate diurnally in the range of 100 to 500 meters or more, and 2) non-migratory scattering layer which does not move diurnally, and associated with internal waves, it usually migrates up and down in the range of 10 to 20 meters at a certain interval, but not diurnal.

(1) Migratory scattering layer (D. S. L.) and its acoustic properties

Generally speaking, the deep scattering layer changes its depth in accordance with the changes of underwater light penetration. Fig. 9 shows typical echo-gram of the migratory scattering layer. The scattering layer is located at the depth less than 100 meters in darkness at night, and it reaches 200 to 500 meters one to two hours after sunrise. In daytime the layer is kept at a certain depth, but begins to rise toward the surface at a speed of 2 to 5 meters per minute in the evening. After sunset, the scattering layer is located in the range of 10 to 100 meters. The depth of descending varies according to the penetration of day light as well as to the hydrographic conditions such as the existence of discontinuous layer of temperature and etc. Sometimes scattering layer disperses after sunrise, forming more than several layers at various depths as shown in Fig. 10.

The distribution of tuna is recorded on the echo-gram at the similar zone to that of scattering layer (Fig. 11). It is expected that the depth of tuna may coinside with the scattering layer because the tuna would be preying upon food animals which are the cause of scattering layer. However, it was not successful to prove this by comparing 30 operations of tuna long-line and 42 hauls of Isaacs-Kidd midwater trawl at the depth of scattering layer (SHIBATA, 1965).

Acoustic experiments of scattering layer were carried out from 1963 to 1965. The ultrasonic reflection loss was measured as 50 to 70 db, on the eastern South Pacific by the fish-finder of the "Taisei-Maru" in summer of 1964. It was measured as 42 to 70 db on board the "Nagasaki-Maru" in the Philippine Sea, South China Sea and Indian Ocean from 1936 to 1965: the reflection loss showed the minimum at the depth

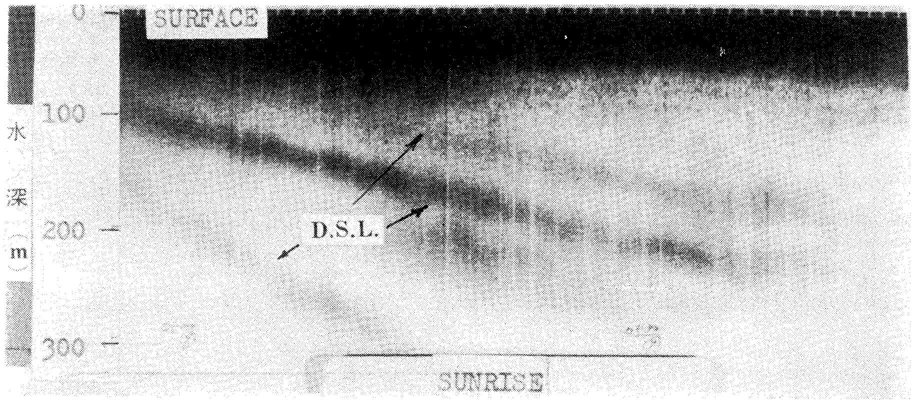


Fig. 10. Dispersed scattering layer forming several layers after sunrise. (1965. 129, 05-06 h, 10°S, 10°W, Iwaki-Maru, 28 kc).

Fig. 11. The echo-trace of tuna appearing at the similar zone to that of migratory scattering layer. (1964, 7. 12, noon, 29°N, 127°E, Nagasaki-Maru, P.D.R. 14 kc).

of 260 and 400 meters at noon. In this series of observation, dense scattering layers were continuously recorded by low frequency (14 kc) but not record by high frequency (200 kc).

During these experiments, some specimens were collected from scattering layer with the Isaacs-Kidd midwater trawl net and Norpac plankton net. The specimens collected were copepods, euphausiids lantern-fish, jellyfish, sergestids, salps, chaetognaths and so on. Sampling with these gears would not efficiently fish large organisms which were taken by tuna (SHIBATA, 1962, 1965).

Another series of experiments was made to check the variation of reflection loss of ascending scattering layer using 29 and 200 kc fish-finders on September 8 to 12, 1965, at 36°N, 167°E in the North Pacific. During those five days, the scattering layer showed remarkable diurnal vertical migration; in the evening, the layer located at 300 meters depth one and half hour before sunset ascended at a speed of 4 meters per minute, and one hour after sunrise it reached 50 or 60 meters in depth. It was kept at this depth during darkness at night. The reflection loss was measured every five minutes by means of oscilloscope with the results shown in Fig. 12. The smooth fitted result of reflection loss by 29 kc increased at the depth of deeper than 100 meters when the depth of layer became shallow, but in case of 200 kc, the loss decreased in the range of 150 to 40 meters.

It is assumed that such a difference in reflection loss is caused by the size of micro-structure in the scattering layer. Accordingly, it is deemed that the acoustic size of micro-structure in the deep scattering layer may be determined by acoustic observations by fish-finder operated

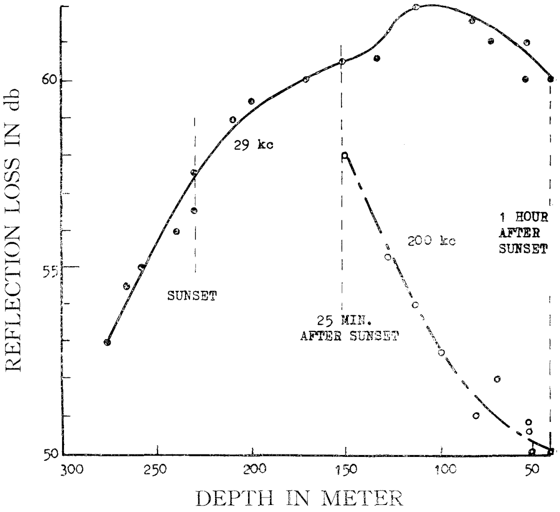


Fig. 12. Changes of reflection loss of ascending scattering layer recorded by 29 kc and 200 kc. (September 8–12, 1965 Central North Pacific, 36°N, 167°E, Hatsushio-Maru No. 3).

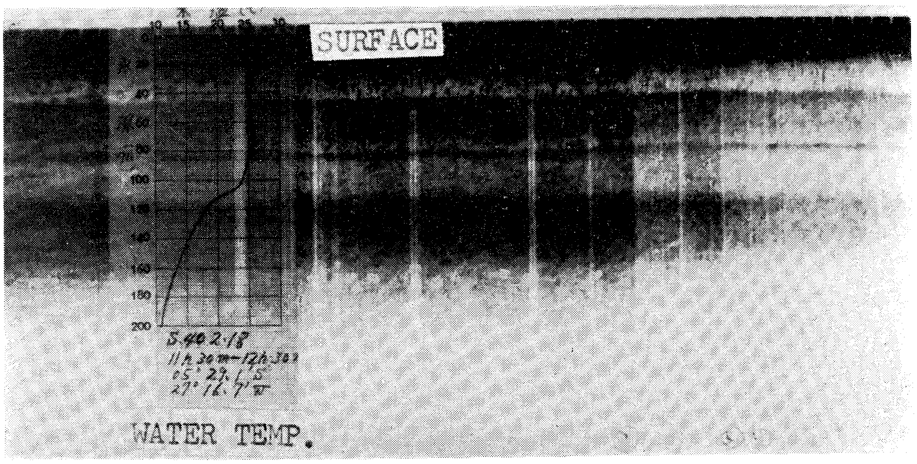


Fig. 13. Echo-gram showing non-migratory scattering layer. The vertical distribution of underwater temperature was measured at the same time. (1965. 2. 22, 05 h, 4°S, 26°W, Iwaki-Maru, 28 kc).

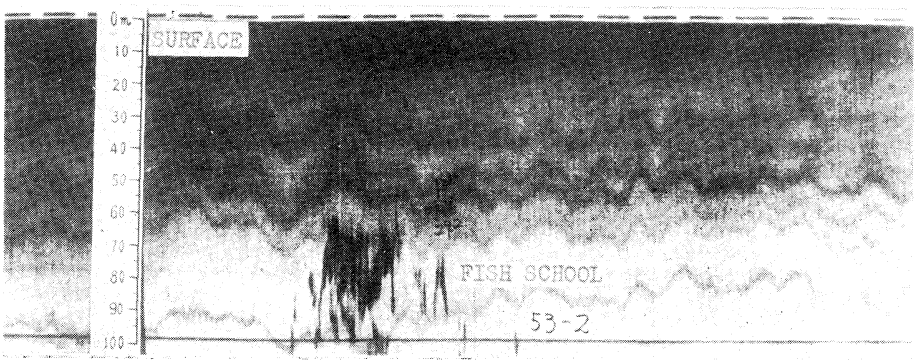


Fig. 14. Echo-gram showing the internal wave. School composed of small fish is distributed below this layer. (1963. 2. 20, 13h, 5°S, 65°E, No. 5 Banshu-Maru. 200 kc.).

at as various frequencies as possible.

(2) Non-migratory scattering layer and its acoustic properties

Non-migratory scattering layer and internal wave were recorded in wide area. Fig. 13 and Fig. 14 show examples of non-migratory scattering layer and observed internal wave. Fig. 15 shows the distribution of the scattering layer on an echo-gram recorded on the "Iwaki-Maru" in the south-eastern Atlantic Ocean in January to March 1965. There are peaks of the depth of scattering layers at about 50 meters and 150 meters respectively. In these cases, the reflection loss was measured higher than 60 db. It has been reported that temperature and density of water affect upon the ultrasonic reflection (HASHIMOTO and MANIWA, 1954). Laboratory experiments show that the reflection loss is as much as 60 db at the boundary layer at which temperature and density vary abruptly by 2.5°C and 0.003 respectively. In the field observation, the temperature gradient never exceeds 0.2°C per meter, so that the observed scattering layer would be rarely caused by the discontinuity of density of water.

Other observation carried out on the "Nagasaki-Maru" along the meridian of 132.5°E from July 15 to 20, 1965, indicated that the scattering layer appeared at the layer where the gradient of water temperature, salinity and oxygen contents were remarkable. Fig. 16 shows the relation between the appearence of scattering layer and the vertical distribution of hydrographic conditions. It is shown that the appearence of scattering layer is closely related to the oxygen content.

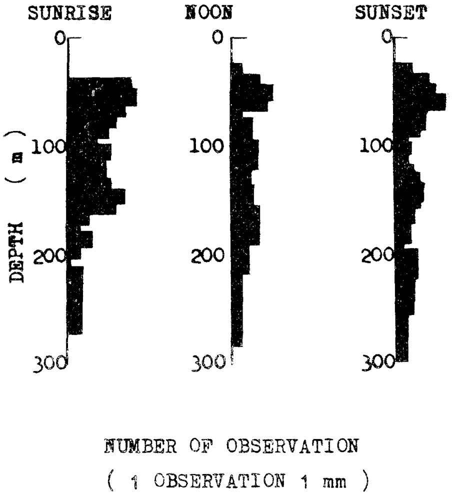


Fig. 15. Vertical distribution of scattering layer observed in the Atlantic Ocean during the period from 20 Jan. to 21 Mar. 1965. (5°–30°W, 5°N–25°S Iwaki-Maru. 200 kc).

(5) Survey of tuna long-line

In tuna long-line fitting hooks with bait should be suspended at the depth of the swimming layer of tuna. There are many methods measuring the position of line and hooks in the water, *i.e.*, chemical tube, pressure gauge, acoustic instruments etc. The depth measured by chemical tube and pressure gauge can only indicates the depth of a point of long-line and depths can be known after hauling the line. Acoustic method is of great advantage to know

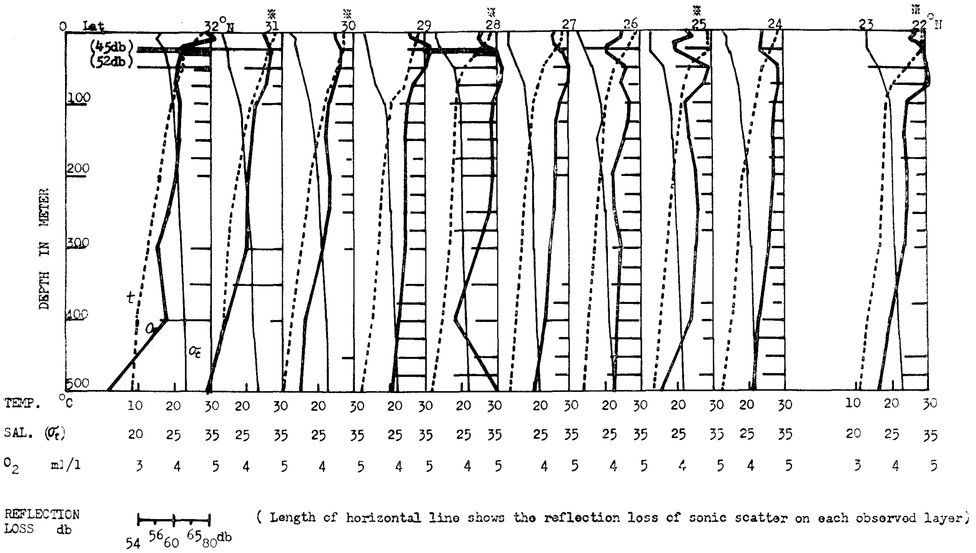


Fig. 16. Relationship between the hydrographic conditions and the reflection loss of the scattering layer on the CSK cruise of the Nagasaki-Maru along the meridian of 132.4°E from 20°N to 32°N on July 15 to 21, 1965 asterisked station; at night.

all over catenary of the long-line, and the suspended branch lines and hooks continuously.

The fundamental experiment proved that frequency of ultrasound as high as 200 kc is available to the long-line detection, better than the lower frequency. (SHIBATA, 1962 and 1963; KAWAGUCHI, HIRANO and NISHIMURA, 1963)

An example of long-line measurement which obtained on board the "Nagasaki-Maru" in the East China Sea and the Philippine Sea on 1961 to 1962, is presented as follows: * bait depth of commercial long-line was positioned in the range of 80 to 150 meters and each main-line drew approximately the catenary curve in sea water. Repeated observation indicated that the long-line sunk at a speed of about 8 m/min, and was balanced 10 to 15 minutes after setting.

(6) Comparison of data between echo-survey and exploratory long-line fishing

The relationship between the catch of tuna by long-line and the existence of distinct scattering layer or of tuna echo was studied by the analysis of echo-gram. The catch of tuna is generally good when the scattering layer is observed at the depth between 80 and 180 meters in daytime (Fig. 17), Fig. 18 suggests that when internal wave occurs the catch of tuna is poor, or at least good catch does not last longer. The data of catch of tuna and number of tuna echo-trace with echo-intensity corresponding to the fish less than 25 db in reflection loss, were obtained in the Philippine Sea in July and November 1962 (Table 3). The correlation

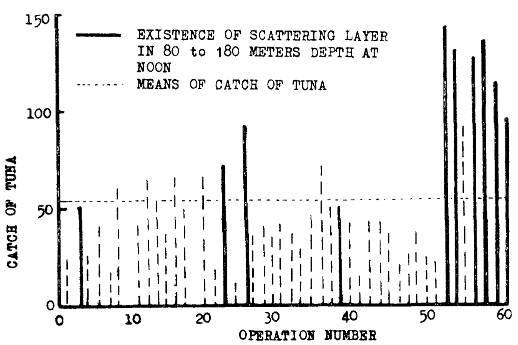


Fig. 17. Relationship between existence of scattering layer and catch of tuna. (July 1964 to Feb. 1965, Eastern Pacific Ocean, Taisei-Maru, Scattering layer was observed by 28 kc fish-finder.).

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* The details of tuna long-line used in this experiment are as follows; material: Klemona, diameter: 56 mm, length of main-line per one unit: 250 m, length of branch-line 23 m, length of float-line 25 m. The sea state: slight sea, current: about 0.3 kt.

Table 3. Relation between the catch rate of tuna by long-line and the density of tuna school (40–200 meters in depth) on the echo-gram in the Philippine Sea on July 13–20 and Nov. 21–25, 1962, and in the equatorial Central Pacific from Jan. 26 to Feb. 6, 1965.

Date	Number of tuna trace	Counting time (min)	Underway speed (knot)	Density of tuna school per 10^5 m^3	Max. depth of hook (m)	Hooked rate	Remark
June 1962 13	9	10	9	0.55	120	0	Location : Off Daito Is. Ship's name; Nagasaki Maru Number of hooks; 600
14	288	60	8	3.44	110—120	0.5	
16	12	10	9	0.76	110	2.3	
17	18	10	9	1.12	120—130	1.7	
18	52	10	9	3.24	100—110	0.7	
19	8	10	9	0.50	100—110	0.7	
20	6	10	9	0.37	100—110	0.3	
				0.95*		0.5*	
Nov. 1962 21	230	36	8	4.56	120—130	0.5	Off Luzon Is. Nagasaki Maru 600 hooks
22	64	20	8	2.13	130	0.8	
23	92	30	8	2.23	120—130	3.3	
25	96	24	8	2.67	110—115	1.8	
				3.14*		1.6*	
Jan. 1965 26	205	54	10.5	1.15		3.4	Equatorial Central Pacific, 5°N, 150°W Kyosho Maru 2,000 hooks determined at the range of 40 to 100 m in depth
27	295	50	10.5	1.75		5.5	
28	519	102	10.5	1.54		4.0	
Feb. 6	639	90	10.5	2.15		3.8	
				1.65*		4.0*	

* Average in each fishing ground.

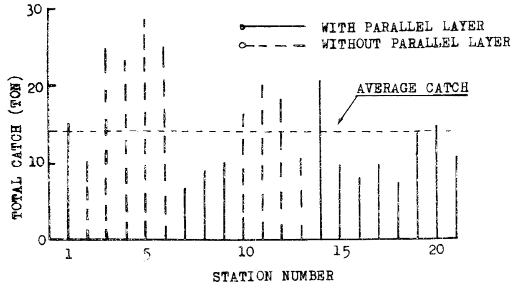

Fig. 18. Relationship between the existence of internal wave and the catch of tuna. (Dec. 1962 to Feb. 1963, North of Mozanbique Strait No. 5 Banshu-Maru, Internal wave was observed by 200 kc fish-finder).

factor was about 0.14 so far as the present data are concerned, namely there is no significant correlation between the number of tuna trace in the range of the depth of 50 to 200 meters and the catch of tuna caught by long-line in the same area.

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マグロ漁場のEcho-Surveyについて

西村　実　　柴田恵司

要旨：マグロ漁場で得られる魚群探知機の記録を解析することにより，マグロ類の生態たとえば魚種，魚体寸法，遊泳速度，深度，群密度の測定のみならず，“Sonic Scattering layer”の調査あるいは漁具の形状などの測定に魚群探知機が実用されることが示されている。

そこで本報告においてはまずこれらの測定を行なう場合に必要な音響学的問題について検討を行ない，特にsonar方程式より魚種別ならびに体長測定法を導くと共に，“距離函数指向性”の考え方を用いて魚群密度の測定法について考察した。

次に筆者らが太平洋，印度洋，大西洋などで得た魚探記録を解析し，マグロの生態，“sonic scattering layer”などについて新たな知見をうることができた。

マグロと推定される大型魚は一般に日出没時を境とし，昼間は250ないし500mの深層に，夜間は0～100mの浅層に分布し，日周上下回遊を行なっていることを示した。マグロの遊泳速度は通常1～2kt，逃避行動の場合には1ないし8kt程度であることも観測された。更にマグロ類はまばらな魚群を構成し，その群密度は漁場によって異なるが，$10^5\,m^3$あたり0.02～200尾という数値が得られた。

一方マグロ類の分布に関係あると思われる“Sonic Scattering layer”についての調査結果の二，三を示したが，マグロ漁場におけるScattering layerは一般に超音波の周波数によってその出現状態が異なっていることがわかった。また日没時上昇するScattering layerにおいては深度が浅くなるにしたがい反射損失が周波数によって異なった変化を示すことが認められた。

“Sonic scattering layer”の存在はマグロの漁獲に影響を与えているという二，三の結果も得られた。

La mer; Bulletin de la Société franco-japonaise d'océanographie
Tome 4, N° 3, Août 1966

Chaetognaths Collected on the Fifth Cruise of the Japanese Expedition of Deep Seas*

Masataka KITOU**

Résumé: Voici un rapport de Chaetognatha obtenu par une levée verticale effectuée par le bateau météorologique «Ryofu Maru» à 34°N à la fosse du Japon au mois de juin 1962: 1°) *S. neodecipiens* vit à la région ouest du Pacifique Nord. 2°) La longueur du corps maturé dépend considérablement de la température d'eau. 3°) La quantité de Chaetognatha est la plus grande à la couche supérieure entre 0 et 500 m. Elle en diminue à 1/8 entre 500 et 1000 m et à 1/100 au-dessous de 2000 m. 4°) Aucune espèce ne se trouve au-dessous de 3000 m. 5°) Les espèces des couches intermédiaire et profonde sont moins abondantes que du côté nord de l'extension du Kuroshio. 6°) Les eaux originaires du Kuroshio sont indiquées par *S. lyra*. 7°) *S. scrippsae* et *S. elegans* sont apparus grâce au transport par les eaux intermédiaires subarctique.

1. Introduction

The Fifth Cruise of the Japanese Expedition of Deep Seas (JEDS-5) was made by the R.V. Ryofu Maru of the Japan Meteorological Agency along the Thirty-fourth Parallel in June 1962. On the present cruise collections of deep-sea plankton were carried out at two stations. In this paper some morphological notes and the vertical distribution of chaetognaths at station F 23, which is situated in the Japan Trench, will given. The approximate location of the sampling position is shown in Figure 1.

The net used in the present expedition is a 130-cm closing net consisted of two parts (MATSUE *et al.*, 1963). The upper part has a mouth ring, 130 cm in diameter, and cylindrical coarse nylon cloth (3.0 mm mesh openings), 165 cm long. The lower one has a trunk ring with the same diameter as the mouth ring and the conical filtering part composed of coarse nylon cloth (3.0 mm mesh openings), 375 cm long and bolting cloth (0.33 mm mesh openings), 140 cm long. Therefore, this net may allow small size chaetognaths to pass through the coarse nylon cloth.

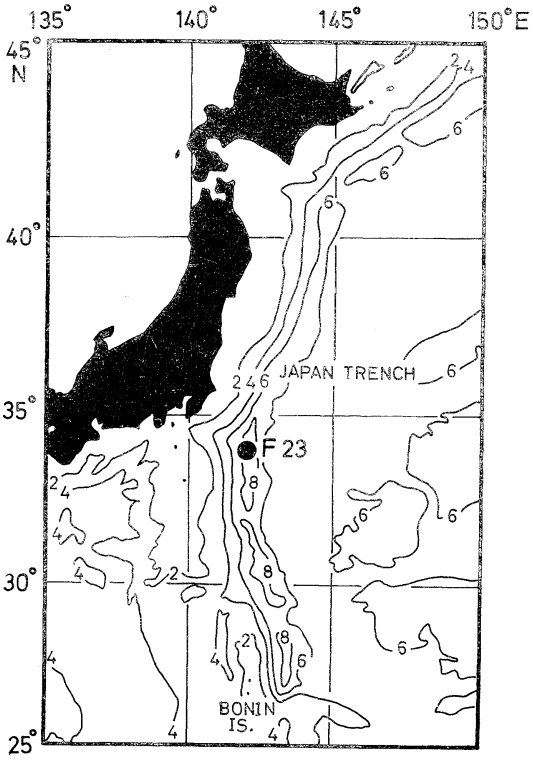

Fig. 1. Approximate location of the sampling position.

The sectional hauls were made vertically in the six layers: 0–500 m, 500–1000 m, 1000–2000 m,

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JEDS Contribution No. 72

** Oceanographical Section, Marine Division, Japan Meteorological Agency

2000–3000 m, 3000–4000 m and 5000–6500 m. Also, the vertical haul of 0–5000 m was made as the closing apparatus did not work.

In processing the samples, all chaetognaths were picked up, and sorted into species. In staining of the specimens, a weak solution of neutal red was used. In the measurement of the body length, the tail fin was excluded.

2. Species identified and some morphological notes

Following nineteen species of chaetognaths were identified from the present materials.

Sagitta hexaptera D'ORBIGNY
S. lyra KROHN
S. scrippsae ALVARIÑO
S. enflata GRASSI
S. elegans VERRILL
S. bipunctata QUOY et GAIMARD
S. serratodentata pacifica TOKIOKA
S. ser. pseudoserratodentata TOKIOKA
S. regularis AIDA
S. minima GRASSI
S. decipiens FOWLER
S. neodecipiens TOKIOKA
S. zetesios FOWLER
S. macrocephala FOWLER
Pterosagitta draco (KROHN)
Eukrohnia hamata (MÖBIUS)
E. bathypelagica ALVARIÑO
E. fowleri RITTER-ZÁHONY
Krohnitta subtilis (GRASSI)

Among these species, most of them have been described repeatedly by many authors. However, *S. scrippsae* and *S. neodecipiens*, which were taken from the Pacifiic, have been described recently by ALVARIÑO (1962) and TOKIOKA (1959), respectively. After that, the two species have not been reported from anywhere. Also, from the materials, the small-sized specimens of *S. zetesios* were found out, in comparison with the specimens obtained at St. E 2 (KITOU, 1963) located in the Transition Area between the Kuroshio and Oyashio waters.

a) *Sagitta scrippsae* (Fig. 2)

The body is bulky, flaccid and transparent as in the related species *S. lyra*. The shape of the body is closely resembles to *S. lyra*, too (Fig. 2). TOKIOKA (1939) reported the young specimens of *S. scrippsae* obtained from the bays of Sagami and Suruga as the *S. lyra* "*gazellae*"-form. ALVARIÑO (1962) distinguished the *S. lyra* "*gazellae*"-form from *S. lyra* as *S. scrippsae* based on the serial study of all the characters at various stages of growth. The apparent distinction easy to see practically lies in the collarette at the neck, the corona ciliata and the nervous system (Fig. 2). The collarette

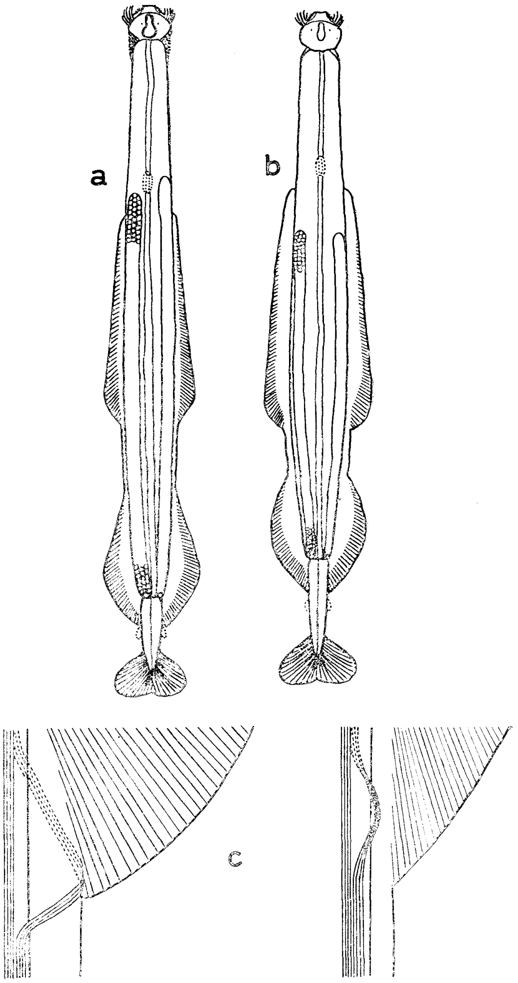

Fig. 2. *Sagitta scrippsae* and *Sagitta lyra*.
a, *S. scrippsae* (47 mm long specimen from St. E 2, JEDS-4);
b, *S. lyra* (35 mm long specimen from St. F 23, JEDS-5);
c, Nervous system at the posterior portion of the anterior fin of *S. lyra* (left) and *S. scrippsae* (right).

is conspicuous in the fully mature specimens which reach to 60 mm in body length, excluding the tail fin. But in *S. lyra*, it is absent throughout all stages of maturity, and body length reaches to about 40 mm in the fully mature specimens. The nervous system is useful to distinguish the two species in younger stages. In *S. lyra*, a nerve branched off from the ventral nerve crosses the lateral field diagonally from the posterior part of the anterior fin, runs the posterior edge of the anterior fin and joins the dorsal nerve behind the anterior fin. In *S. scrippsae*, a nerve branched off from the ventral nerve crosses the lateral field, and joins the dorsal nerve at the level near the posterior end of the anterior fin. The nerve looks like a cord. The corona ciliata is different in both size and shape as shown in Fig. 2.

According to ALVARIÑO (1962), *S. scrippsae* occurs along the southern part of the Subarctic waters, in a band 600 miles wide across the Pacific, roughly north of the Fortieth Parallel. With regard to the distribution of *S. lyra* in the North Pacific, some studies can be referred to (BIERI, 1959; FURUHASHI, 1961; HIDA, 1957; KITOU, 1963; MARUMO *et al.*, 1958; SUND, 1959; TCHINDONOVA, 1955; TOKIOKA, 1959). In these studies, however, *S. scrippsae* seems to be included in *S. lyra*. As the result of the re-examination of *S. lyra* obtained at St. E 2 (JEDS-4), a number of *S. scrippsae* was differenciated from *S. lyra* (Table 4).

b) *Sagitta neodecipiens* (Fig. 3 and Table 1)

S. neodecipiens taken from the Shellback area of the East Pacific described by TOKIOKA (1959). The occurrence of this species is strictly confined there and has never been reported from the western North Pacific.

General appearance of the body (Fig. 3) is closely resembles to that of S. decipiens. Body length is up to 13.2 mm in examined specimens. The tail segment occupies 23.5–27.8% of the body length. This value is somewhat less than that measured by TOKIOKA (1959); perhaps his measurement may include the tail fin. The anterior fins begin at the level of the posterior end of the ventral ganglion. The posterior fins are as long as or slightly shorter than the anterior fiss and divided into halves by the tail

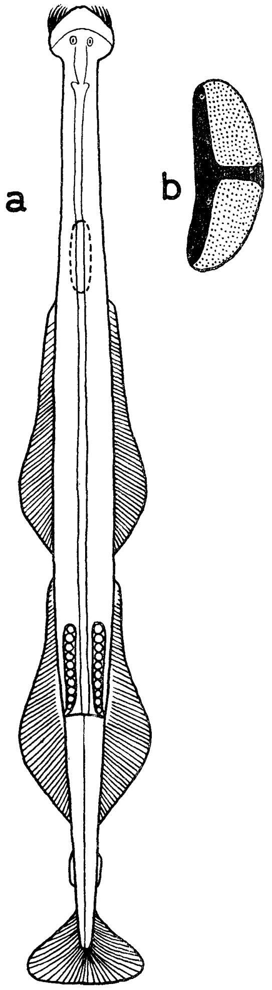

Fig. 3. *Sagitta neodecipiens.*
a, 10.5 mm long specimen from St. F. 23;
b, eye pigment.

Table 1. Body length and the head armature formulae of *Sagitta neodecipiens.*

Body length (mm)	Tail (%)	hook	Anterior teeth	Posterior teeth
13.2	24.0	6	9	17
13.2	23.5	6	9	18
10.6	24.5	6	9	20
8.7	27.1	6	7	16
8.2	26.1	6	8	16
7.9	27.7	6	8	13
7.6	27.8	6	7	13
7.3	27.3	6	8	15

septum. The anterior terminal of both fins is lacking in the fin rays. In the posterior fins, the narrow and short rayless zone runs along the inner edge. There is no constriction at the tail septum. The eye pigments are elongate, but these are fairly shorter than that of the same sized specimens of *S. decipiens*. The head armature formulae are shown in Table 2. The hooks have no serration, and their number is six. The anterior teeth are 7–9, and the posterior teeth 13–20 in number. The corona ciliata was not detected. The intestinal diverticula are present. The seminal vesicles with a elongate shape are situated approximately at the middle of the distance between the posterior end of the posterior fins and the anterior end of the tail fin. The ovaries did not exceed the level of the anterior end of the posterior fins in the examined specimens.

c) *Sagitta zetesios* (Fig. 4 and Table 2)

Three fully mature specimens of *S. zetesios* (Fig. 4) were found from the present materials. They are small in body length in comparison with the typical specimens taken at St. E 2 (Fig. 4). The present author (1963) used the species name "*S. planctonis*" to the specimens of the planctonis-group at St. E 2. This *planctonis* is idnentical with *S. zetesios* Fowler. One specimen was taken by the vertical haul 500–1000 m and other two were taken by the vertical haul 0–5000 m. The characters of these specimens are as follows:

Body length is 22.7–25.5 mm. The tail segment excluding the tail fin occupies 21.7–22.3% of the body length. The body is robust. The anterior fins begin at the level of the posterior one-third of the ventral ganglion, and slightly longer than the posterior fins. The posterior fins are roundly triangular and the broadest at the tail septum. The anterior end of both fins is deveoid of fin rays. The rayless zone runs along the inner edge. The hooks are 6–7 in number. The anterior and posterior teeth are 4–6 and 6–8 in number, respectively. The complete shape of the seminal vesicles was not found. The remnants, however, indicate that these are elongate and in contact with the posterior fins. The ovaries exceed the ventral ganglion. The collarette is prominent and extends from the neck to the tail segment. The corona ciliata was not detected.

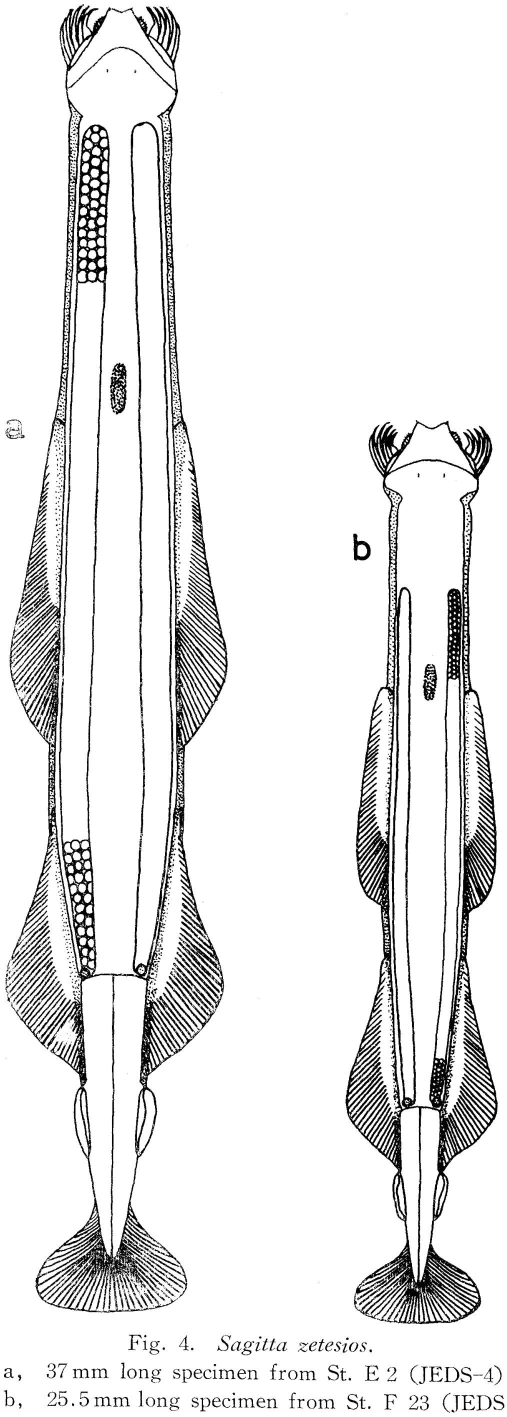

Fig. 4. *Sagitta zetesios*.
a, 37 mm long specimen from St. E 2 (JEDS-4);
b, 25.5 mm long specimen from St. F 23 (JEDS-5).

Table 2. Measurements of *Sagitta zetesios*.

Body length (mm)	Top of ovary	Posterior teeth	Starting point of anterior fin in relation to ventral ganglion
Station F 23 (JEDS-5)			
28.0	?	15	?
27.5	?	17	?
25.5	over ventral ganglion	6	at posterior one-third
24.3	over ventral ganglion	8	at posterior one-third
23.9	at posterior fin	15	behind
22.7	over ventral ganglion	7	at posterior one-third
21.1	at posterior fin	16	at posterior end
18.3	?	16	behind
13.9	?	16	?
12.3	absent	16	at posterior end
Station E 2 (JEDS-4)			
37.0	over ventral ganglion	12	behind
35.0	over ventral ganglion	13	behind
34.3	over ventral ganglion	13	at posterior end
30.3	at posterior fin	17	behind
27.0	over posterior fin	13	behind
23.2	at posterior fin	10	at posterior end
21.4	at anterior fin	8	at posterior end
21.2	over posterior fin	8	at posterior end
20.0	?	15	behind
16.8	absent	13	at posterior end
16.6	at posterior fin	9	at posterior end
15.6	at posterior fin	9	at posterior end

The above-mentioned characters are generally in accordance with that of the type from taken at St. E 2, but there are some different points in details. The present specimens are fully matured in smaller size, while the type form of which the ovaries extend over the ventral ganglion is more than 34.3 mm in body length. DAVID (1956) suggested that *S. zetesios* was not fully matured less than 25 mm long. The starting points of the anterior fins of the three specimens are located at the level of the posterior one-third part of the ventral ganlion, but that of the type form are located behind the ventral ganglion. However, they are not *S. planctonis*, because in *S. plnactonis* the anterior fins reach to the middle of the ventral ganglion. The posterior teeth are less than that of the type form in number (Table 2). Reffering to the David's study (1956), the number of the posterior teeth is less than 14 in *S. planctonis* and more than 14 in *S. zetesios*. In the result of the examination of the samples obtained at two stations (Table 2), the number of the posterior teeth is not always over 14, whereas they have the character of *S. zetesios*. Therefore, the number of the teeth seems to be not so useful to distinguish the two species.

RUSSELL (1932) said that the growth of *Sagitta* and variations in mature specimens were closely related to the water temperature. Then, the present small specimens are recognized a variant form of *S. zetesios* in relation to the water temperature. In fact, the water temperatur of the 500–1000 m layer is higher than that of the St. E 2 (Fig. 6).

d) *Eukrohnia bathypelagica* (Fig. 5)

This species taken from the Pacific has been described recently by ALVARIÑO (1962). The general appearance resembles closely to that of *E. hamata*. Easely distinguishable point lies in ovaries, thickness of the body, collarette and lateral fins. The immature ovaries are coiled, and the coiling becomes less apparent with the development of the ovaries. The fully mature ovaries are long, straight, thick and milky white, and completely fill the body cavity. In *E. hamata*, these are straight and thin. The body is broader than that of *E. hamata*. The collarette is present from the ventral ganglion to the tail fin, but in most cases, it disappeares the preserved specimens. This tissue is absent in *E. hamata*. The posterior parts of the lateral fins are broad and bend toward the dorsal side, but it is not conspicuous in *E. hamata*.

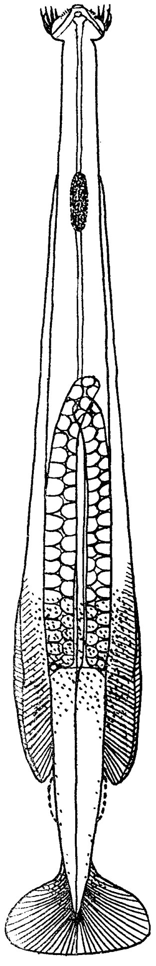

Fig. 5. *Eukrohnia bathypelagica* (23.5 mm long specimen from St. E 2, JEDS-4).

The present author (1963) did not separate the specimens taken at St. E 2 into two species. As a result of the re-examination, the individual number of *E. hamata* was revised in Table 4.

3. **Population** (Table 3)

In the 0–500 m layer, the population was the largest, being 1454 individuals per haul, through the vertical range from 6500 m depth to the surface, and the species number was the largest, being 12 species. The eleven species, excepting *E. hamata*, are warm water forms. Among them, *S. minima*, *P. draco*. *S. hexaptera* and *S. lyra* were dominant.

In the 500–1000 m layer, the population density was reduced conspicuously to one-eighth of that in the 0–500 m layer, and many epiplanktonic species occurred in the 0–500 m layer disappeared. Main components here were *S. lyra* and *E. hamata*.

In the 1000–2000 m layer, the total number of individuals decreased still more and only *E. hamata* prevailed. In the layers below 2000 m, the population density was reduced to less than one-hundredth of that in the 0–500 m layer, and no species was found below 3000 m. In the 3000–4000 m layer, *S. bipunctata*, *S. ser. pseudoserratodentata* and *P. draco* were found, however, these animals did not inhabit there but entered into the net through coarse mesh apertures near the sea surface.

The chaetognath communities obtained by a vertical haul from 5000 m depth to the surface were resemble to that of total amount of the above-mentioned hauls. Here, it is noticeable that the two specimens of *S. elegans* which is a typical indicator species of the Oyashio water were found from this sample.

4. **Vertical distribution of each species** (Tables 3 and 4)

In general, the surface living forms of chaetognaths inhabit in the upper 200 m depth, though some species extend to the 1000 m depth, being small in number (THIEL, 1938). In this study, the warm water and surface living forms,

Table 3. Number of individuals (per haul) of each species collected with 130-cm closing net at St. F 23 (JEDS-5).

Hauling depth (m)	0–500	500–1000	1000–2000	2000–3000	3000–4000	5000–6500	0–5000
Location	34°28′N 142°17′E	34°28′N 142°17′E	34°26′N 142°16′E	34°03′N 142°08′E	34°29′N 142°19′E	34°34′N 142°22′E	34°31′N 142°21′E
Date	June 17	June 17	June 17	June 15	June 17	June 17	June 17
	1962						
Sagitta hexaptera	108	—	—	—	—	—	126
S. lyra	58	89	—	—	—	—	173
S. scrippsae	—	3	1	2	—	—	—
S. enflata	10	—	—	—	—	—	15
S. elegans	—	—	—	—	—	—	2
S. bipunctata	—	—	—	—	(3)	—	—
S. ser. pacifica	15	—	—	—	—	—	6
S. ser. pseudoserratodentata	65	—	—	—	(1)	—	34
S. regularis	1	—	—	—	—	—	—
S. minima	362	—	—	—	—	—	495
S. decipiens	47	—	—	—	—	—	33
S. neodecipiens	17	2	—	—	—	—	2
S. zetesios	—	12	2	2	—	—	7
S. macrocephala	—	—	3	—	—	—	6
Pterosagitta draco	118	1	—	—	(2)	—	101
Eukrohnia hamata	1	26	29	—	—	—	95
E. bathypelagica	—	1	3	—	—	—	14
E. fowleri	—	—	2	—	—	—	21
Krohnitta subtilis	25	3	—	—	—	—	44
Damaged specimens and juv.	587	39	19	27	14	10	375
Total	1454	176	59	31	20	10	1549

such as *S. hexaptera*, *S. enflata*, *S. ser. pacifica*, *S. ser. pseudoserratodentata*, *S. regularis* and *S. minima* were restricted in the upper 500 m. Only two species, *P. draco* and *K. subtilis*, extended to the 500–1000 m layer, but the number of individuals was extremely small. In the warm waters, two species of mesoplanktonic form inhabit; one is *S. decipiens* and the other *S. neodecipiens*. Referring to the previous studies (ALVARIÑO, 1964; DAVID, 1958; FURUHASHI, 1961) on the vertical distribution of *S. decipiens*, the lower limit of this species is the depth of 1000 m, but this animal was restricted in the upper 500 m, being relatively large in number. While, *S. neodecipiens* is less than *S. decipiens* in number but extended to the 500–1000 m layer.

Table 4. Number of individuals (per haul) of the four species of Chaetognatha at St. E 2 (JEDS-4).

Hauling depth (m)	0–580	0–1000	0–3000	0–5000	0–7000
Sagitta lyra	181	70	202	165	68
S. scrippsae	16	3	15	22	27
Eukrohnia hamata	96	172	429	386	367
E. bathypelagica	—	11	208	59	142

It is known that the young chaetognaths live in the more shallow layers than do the adults (FOWLER, 1905; RUSSELL, 1931; ALVARIÑO, 1964). The silmilar behavior of *S. lyra* was apparently observed. *S. lyra* distributed abundantly in both the 0–500 m and 500–1000 m layers. The body length is 7–27 mm in the former layer, while 25–35 mm in the latter one.

S. scrippsae is taken a serious view of the indicator species together with *S. elegans* (KITOU, 1966). This animal was distributed in three layers from 500 m to 2000 m, but the number of individuals was less than that at St. E 2 (Table 1). The body length is 27.6–37.0 mm, and smaller specimens was not found at all.

S. zetesios is one of the mesoplanktonic forms. In the Kurile Kamchatka Trench (TCHINDONOVA, 1955), the lower limit of this species extend to the 6000–8000 m layer. At this station, it was the depth of 3000 m; the largest density of population was present at the 500–1000 m layer.

S. *macrocephala*, *E. fowleri* and *E. bathypelagica* are bathypelagic forms. The first two species occurred in the 1000–2000 m layer, and the third one in the 500–2000 m layer, being small in number, respectively. In comparison with the individual numbers of these species at St. E 2 (KITOU, 1962, Table 1), *E. bathypelagica* and *E. fowleri* were reduced remarkably.

E. hamata is epiplanktonic form in high latitudes and bathypelagic form in low latitudes (THIEL, 1938; ALVARIÑO, 1964). This animal was distributed in the three layers upper 2000 m, but the dense population was present in the 500–1000 m layer. The population density at this station became smaller than that at St. E 2 (Table 4). The body length of these specimens is 6–20 mm.

5. Distribution of some chaetognaths in relation to oceanographical effects

In this study, the close relationship between the distribution of *S. lyra*, *S. scrippsae* and *S. elegans* and watermass was observed. The chlorinity minimum, being 18.88‰, was found at the depth of 1000 m. This minimum layer is recognized as the core of the Subarctic Intermediate Water (Fig. 6). *S. lyra* was the only one species prevailed in the Kuroshio water layered above the Subarctic Intermediate Water. While at St. E 2, the core was found at the depth of 600 m (Fig. 6), and *S. lyra* prevailed in the 0–580 m layer.

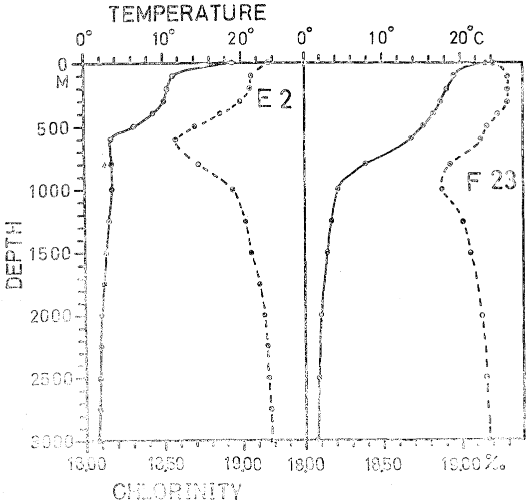

Fig. 6. Vertical distribution of water temperature and chlorinity at Sts. E 2 and F 23.

S. scrippsae is distributed near the Oyashio front in the western side of the North Pacific (ALVARIÑO, 1962; KITOU, 1966). In the far south of the Kuroshio Extension, the occurence of both *S. scrippsae* and *S. elegans* is probably due to this Intermediate Water.

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第5回深海観測で採集された毛顎動物について

鬼頭正隆

要 旨： 1962年6月，気象庁観測船凌風丸は34°Nの日本海溝において，6500m深におよぶプランクトンの鉛直区分採集を行なった。この報告はその際得られた毛顎動物の調査結果である。

1) 生息海域が東部太平洋の Shellback 海域に限られていた *S. neodecipiens* は，北太平洋西部海域にも分布することが明らかになった。2) ある種の毛顎動物の完熟に達する体長は，水温に大きく影響されること，あるいは幼体は浅い層に，成体はより深い層に生息することが知られているが，前者については中層種の *S. zetesios* に，後者については *S. lyra* に，この現象がみられた。3) 毛顎動物の量は0–500mで最も多く，500–1000mでは1/8に，2000m以深では1/100以下に減少した。4) 0–500mでは *S. minima*, *S. hexaptera*, *P. draco*, *S. lyra* の優勢な組成であるが，500–1000mでは *S. lyra*, *E. hamata* の優勢な組成に変り，1000–2000mでは *E. hamata* の優勢な組成である。3000m以深からはいかなる種類も採集されなかった。5) 中・深層種の量は，黒潮続流の北側に比べて減少し，特に *E. hamata*, *E. bathypelagica* が著しい。6) 中層における黒潮系水は *S. lyra* により指標される。7) 北方性の *S. scrippsae*, *S. elegans* が出現したが，これらは1000m層にみられる亜寒帯中層水によって運ばれたものと考えられる。

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A New Species of *Heterokrohnia* (Chaetognatha) from the Western North Pacific*

Ryuzo MARUMO** and Masataka KITOU***

Résumé : Deux échantillons de Chaetognatha *Heterokrohnia* ont été levées, deux à une couche profonde à l'entrée du Golfe de Suruga par "Tansei-maru" et une à une couche profonde à une région sud du Japon par "Ryofu-maru." Une seule espèce *H. mirabilis* s'est reconnue jusqu'à présent à ce genre créé par RITTER-ZÁHONY en 1911. Etant donné qu'il se trouve une différence nette entre *H. mirabilis* et nos échantillons par l'existence de la colerette et la position des nageoires paires, nous les publions ici sous le nom de *Heterokrohnia bathybia* n.sp. Quant à *H. milabilis*, elle a été obtenue deux fois au Pacifique et deux fois à l'océan Antarctique. Toutefois, l'insuffisance de la description de la forme de *H. milabilis* du Pacifique et l'apparition de cette nouvelle espèce mettent en doute que les échantillons précedemment levées à ces deux océans aient été à la même espèce.

1. Introduction

Three specimens of genus *Heterokrohnia* which were found from our deep-sea collection can be clearly distinguished in two respects, namely, in the presence of collarette and in the position of lateral fins, from *Heterokrohnia mirabilis* RITTER-ZÁHONY which has been known as the only one species belonging to this genus. In the present paper we describe a new species, *Heterokrohnia bathybia*.

Two of these specimens (a holotype specimen, 14.6 mm in body length and a paratype specimen-1 of 11.4 mm) were caught by oblique hauls from depths of 2,000 and 1,430 m, respectively, with a 160-cm opening and closing net (ORI-net) (OMORI, 1965) in the southwest of the Izu Peninsula by the research ship Tansei Maru, Ocean Research Institute, University of Tokyo. Another specimen (a paratype specimen-2 of 5.3 mm) was caught by a vertical haul from a depth of 1,000 to 2,000 m with a 130-cm closing net (MATSUE and others, 1963) in the area far south of Japan by the Ryofu Maru, Japan Meteorological Agency. Detaileddata on plankton collection are shown in Table 1.

2. *Heterokrohnia bathybia* n. sp. (Figs. 1 and 2, Tables 1 and 2)

Holotype

Holotype specimen, 14.6 mm in body length, was caught with ORI-C net which was hauled in oblique from the depth of 2,000 m to the surface at station 107, 34°29.3′N, 138°35.5′E, on board the Tansei Maru.

Body proportion: Total length is 14.6 mm, excluding tail fin. Tail segment occupies 34% of total length.

Head armature: Hooks are 12 and 12. Anterior teeth are 7 and 4. Posterior teeth are 7 and 7.

Holotype specimen is deposited in Ocean Research Institute, University of Tokyo.

Paratypes

Two of such specimens were caught, which are respectively 11.4 and 5.3 mm in body length. Data on collection are shown in Table 1, and body proportions and head armature formulae are shown in Table 2.

3. Characters of *Heterokrohnia bathybia* n. sp.

In general appearance, *H. bathybia* resembles closely to *H. mirabilis* RITTER-ZÁHONY. The body is stiff and opaque. Neck is conspicuous. There is no constriction at tail septum.

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* Received August 21, 1966
Contribution No. 75 from the Ocean Research Institute, University of Tokyo
JEDS Contribution No. 73

** Ocean Research Institute, University of Tokyo
*** Marine Division, Japan Meteorological Agency

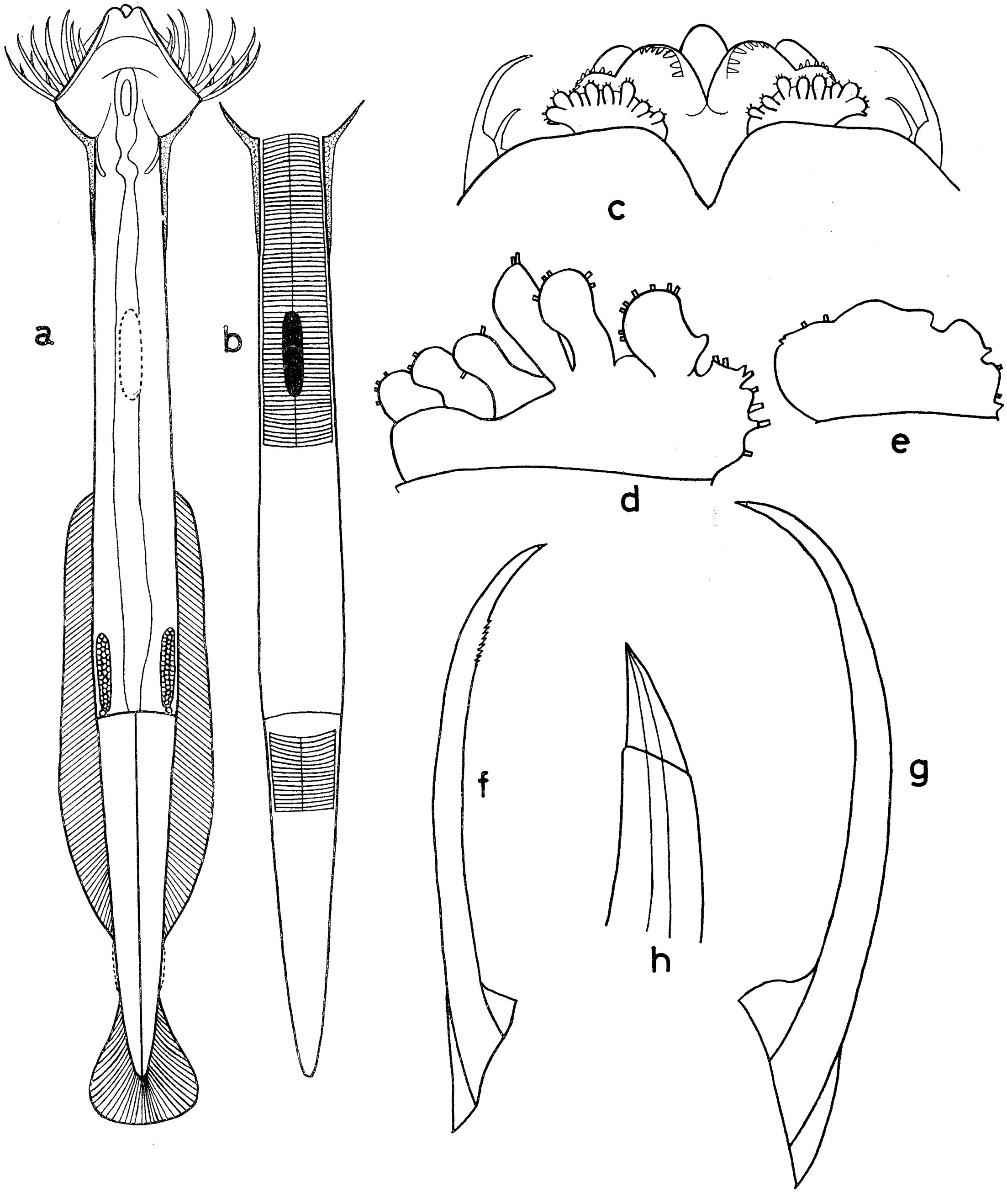

Fig. 1. Illustrations of *Heterokrohnia bathybia* n. sp.

a: body, dorsal; b: body, ventral, showing ventral transverse musculatures in trunk and tail segment; c: anterior portion of head, ventral; d: vestibular organ with processes like prickly pears; e: vestibular organ without process; f and g: hook; h: point of hook.
a, b, c, d, g and h: 14.6-mm specimen, e: 11.4-mm specimen, f: 5.3-mm specimen.

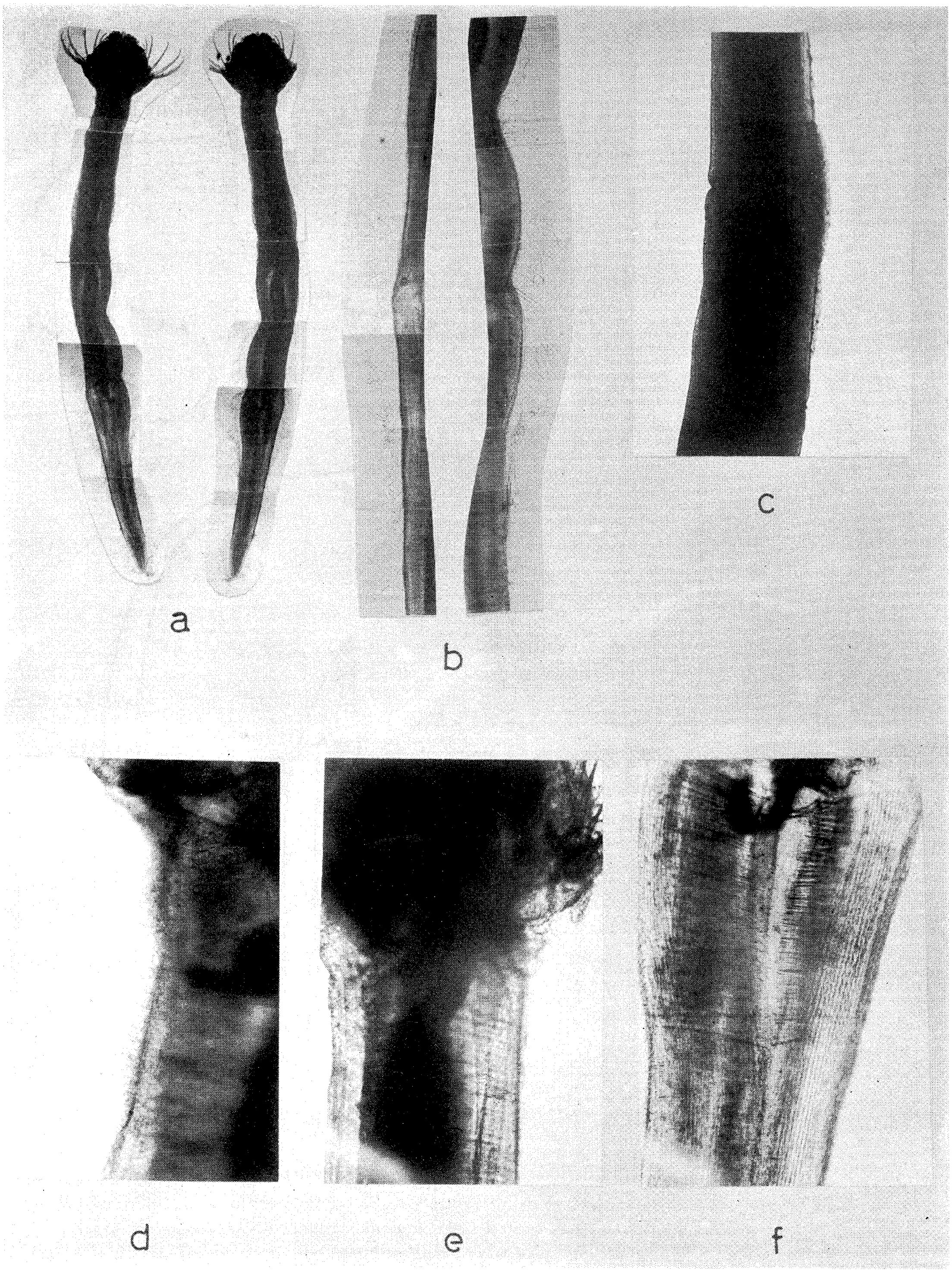

Fig. 2. Photographs of *Heterokrohnia bathybia* n. sp.
a : body, dorsal (left) and ventral (right) (×6); b : lateral fins, dorsal (×14); c : ventral ganglion, lateral (×17); d : collarette, dorsal (×38); e : ventral transverse musculature in trunk, dorsal (×48); f : ventral transverse musculature in tail segment, dorsal (×38).
a, b, d, e and f are of the 14.6-mm specimen, and c is of the 11.4-mm specimen.

Table 1. Data of plankton collection.

Specimen	Station	Date	Location	Net	Hauling	Wire length paid out(m)	Depth estimated (m)
Holotype	107	March 4, 1965	34°29.3′N 138°35.5′E	160-cm opening-closing net (ORI-C)	oblique	0–4,000	0–2,000
Paratype-1	111–2	April 24, 1965	34°27.4′N 138°34.2′E	160-cm opening-closing net (ORI-C)	oblique	0–4,000	0–1,430
Paratype-2	I 23	May 18, 1965	28°01′N 137°52′E	130-cm closing net	vertical	1,000–2,000	1,000–2,000

Table 2. Body length and armature formulae of *Heterokrohnia bathybia* n. sp.

Specimen	Body length* (mm)	Tail segment (%)	Hooks	Anterior teeth	Posterior teeth
Holotype	14.6	34	12/12	7/4	7/7
Paratype-1	11.4	36	12/12	1/2	0/2
Paratype-2	5.3	39	10/10	2/1	3/4

* Measurements were taken from the top of head to the end of tail segment, excluding tail fin.

Trunk is relatively wide and the widest in front of tail septum. Lateral fields are narrow.

Tail segment occupies 34–39 % of the body length.

Head is large.

Eyes are completely absent.

Apical gland cell complex is at the top of the head.

Gland canals are at both sides of the neck as in *Bathyspadella edentata* TOKIOKA.

Corona ciliata is not seen by staining of neutral red.

Vestibular organs are swollen, having some shallow notches at the external margin. Sensory aestelascs are at the ridge. Large processes like prickly pears bearing aestelascs are in the 14.6-mm specimen.

Intestinal diverticula are absent.

Hooks are curved fairly at the anterior portion. The points are not hooked ventrally as in *H. mirabilis*. Hooks are serrated in the 5.3-mm young specimen as in young specimen of *Eukrohnia hamata* (MÖBIUS). Hooks are 10–12.

Teeth are thick and short, being arranged in two sets. Anterior teeth are 1–7. Posterior teeth are 0–7.

Collarette is obviously seen, extending from head to the middle between neck septum and the anterior end of ventral ganglion. Foams are finer and stronger than those of *Pterosagitta draco* (KROHN).

Lateral fins make a pair. They begin at the same interval as length of ventral ganglion behind its posterior end level and are divided into equal halves by tail septum. Shape of lateral fins is restored as shown in Fig. 1–a, though they are partly damaged. Anterior half is narrower than the posterior. Rayless-zone is absent.

Ventral ganglion is considerably large and swollen.

Ventral transverse musculature exists in the anterior half of trunk and in an anterior quarter of tail segment.

Ovaries reach near ventral ganglion in the 11.4-mm specimen, while they are not so developed in the 14.6-mm specimen and not yet formed in the 5.3-mm specimen.

Seminal vesicles are not completely seen. But the remnants indicate that seminal vesicles touch both of the lateral and tail fins. These are not formed in the 5.3-mm specimen.

Intestines show brick red color in the specimens soon after fixation by neutralized formalin.

4. Discussion

The diagnosis of genus *Heterokrohnia* was

Table 3. Comparison of systematically important characters between two species of *Heterokrohnia*.

	Heterokrohnia mirabilis RITTER-ZÁHONY	*Heterokrohnia bathybia* n. sp.
Collarette	absent	present in neck region
Lateral fins	begin just behind the posterior end of ventral ganglion and run longer along trunk than along tail segment	begin at the same interval as length of ventral ganglion behind its posterior end and are divided into equal halves by tail septum

first described by RITTER-ZÁHONY (1911) as follows:

The body is stout and slender. There is a pair of lateral fins that extends from the trunk to the tail segment. The teeth are arranged in two sets. Between the rows of the anterior teeth, there is apical gland cell complex. The ventral transverse musculature is found in the trunk and the tail segment.

Thus, it is doubtless that our specimens belong to this genus. However, *H. bathybia* is, with its presence of collarette and its position of lateral fins, definitely distinct from *H. mirabilis* as shown in Table 3, although these two species resemble closely in their general appearance.

In addition to these distinctions, comparison can be made on further several characters. The costruction of vestibular organs seems to be different from each other, even though it is not so sure, because Ritter-Záhony's description is very brief. By him, vestibular organs of *H. mirabilis* were swollen and in young specimens small papillae were visible. DAVID (1958) also said that vestibular organs were quite smooth in case of *H. mirabilis*, while they have large processes in case of *H. bathybia*. *H. bathybia* has gland canals in neck region, but RITTER-ZÁHONY did never describe them for *H. mirabilis*. Corona ciliata has never been seen for both species. The maximum body length of *H. mirabilis* is 19 mm by RITTER-ZÁHONY (1911), 33 mm by DAVID (1958), and 36 mm by TCHINDONOVA (1955). Specimens of *H. bathybia* are fairly small, less than 14.6 mm, in comparison with the above species.

RITTER-ZÁHONY established genus *Heterokrohnia* and first described *H. mirabilis* on the basis of materials collected by deep hauls from a depth of 2,000–3,423 m to the surface on the Indian Ocean side of the Antarctic. Since then this genus has contained only one species up to now. A few paper can be referred to, with regard to the occurrence of *H. mirabilis*. JAMESON (1914)* and DAVID (1958) reported *H. mirabilis* from the Atlantic side of the Antarctic, while in the Pacific TCHINDONOVA (1955) found it in the Kurile-Kamchatka Trench, and BIERI (1959) off Central America (Fig. 3).

It is doubtful whether *H. mirabilis* collected in the Pacific are identical with that in the

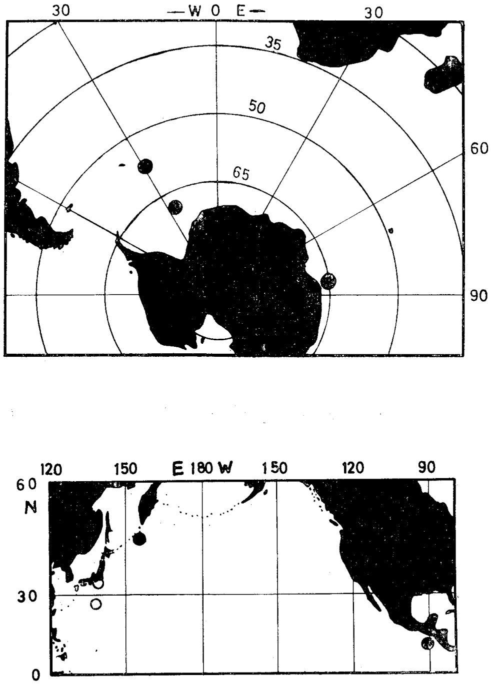

Fig. 3. Distribution of *Heterokrohnia mirabilis* RITTER-ZÁHONY (●) and *H. bathybia* n. sp. (○).

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* DAVID (1958) has a doubt that Jameson's specimen seems to be a damaged one of *Sagitta macrocephala*.

Antarctic or not, because the number of specimens caught is very small and furthermore morphological description is not so complete. We consider that *H. bathybia* must be one of the representative bathypelagic chaetognaths and endemic in the Pacific. Until now we have taken many collections in layers upper than 1,000-m depth, but never caught specimens of *Heterokrohnia*, which were caught only in deeper hauls than 1,000-m depth. We may expect to catch easily even these rare bathypelagic specimens when fishing is done at sufficiently deep layers with sufficiently large plankton net.

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The authors wish to express their hearty thanks to Dr. Tokiharu ABE, Tokai Regional Fisheries Research Laboratory, for his valuable advices on nomenclature and to Dr. Yutaka KAWARADA for his kind criticisms throughout this work. Thanks are also due to research staffs and crews of the research ships Tansei Maru and Ryofu Maru for their sincere assistance in sampling work.

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西部北太平洋より採集された *Heterokrohnia*（毛顎動物）の1新種

丸茂隆三　鬼頭正隆

要旨： 淡青丸（駿河湾冲）および凌風丸（本州南方海）により深層から毛顎動物 *Heterokrohnia* 屬に屬する標本がそれぞれ2および1得られた．この屬は RITTER-ZÁHONY (1911) により設けられ，現在までに *H. mirabilis* の1種が知られているだけである．われわれの標本は泡状組織の存在，側鰭の位置等において明らかに *H. mirabilis* と異なるので，*Heterokrohnia bathybia* n. sp. として発表する．

H. mirabilis は南極洋で2回，太平洋で2回採集されたことが知られている．ただし太平洋のものについては形態の記載が不十分であり，かつここで新種が得られたことから考えて，果して南極洋のものと同一の種であるか否か疑わしい．

資　　料

Electrical Conductivity, Chlorinity and Salinity*

Yoshio SUGIURA**

Résumé : L'auteur passe en revue la recherche précédente sur la détermination de la teneur en substances dissoutes au moyen de la conductivité électrique de l'eau de mer. Les points capitaux sont précisés. Il donne une interpétation physique à la différence entre la chlorinité obtenue par la conductivité électrique et celle obtenue par le titrage et expose ce qu'il pense de la chlorinité, de la salinité et de la conductivité électrique.

Concerning the electrical conductivity of sea water in connection with the chlorinity and salinity problem, a wide-scoped review was already done by K. PARK and W. V. BURT (1965, 1966). So, the present author does not intend to repeat it in the same style, but does intend to concentrate data now available to him onto the limited direction.

Sea water is a mixture of aqueous solution of inorganic and organic electrolyte including a small amount of non-electrolyte. According to HARVEY (1957), 99.5% of the dissolved salts is occupied by nine species of ions. Table 1 shows the major ionic composition of sea water with Cl 19.00 ‰ and ρ_{20} 1.0243.

Table 1. Major constituents of sea water. (Cl 19.00 ‰, ρ_{20} 1.0243)

Ion	g/kg	mg at/l	Ion	g/kg	mg at/l
Na^+	10.56	470.15	Cl^-	18.98	548.30
K^+	0.38	9.96	Br^-	0.065	0.83
Mg^{++}	1.27	53.57	SO_4^{--}	2.65	(S) 28.24
Ca^{++}	0.40	10.24	HCO_3^-	0.14	(C) 2.34
Sr^{++}	0.08	0.09	H_3BO_3	0.026	(B) 0.43

(after Y. MIYAKE, 1965)

Those ions are not all free ions. As far as some kinds of ions are concerned, cations and anions are strongly attracted by means of Coulomb's force. According to GARRELS and THOMPSON (1962), in the case of ions pertaining to Na, free ions occupy less than 99%, $NaSO_4^-$ 1.2% and $NaHCO_3$ 0.01%. Those attracted ions with opposite charge are called "ion pair". Ten percent of all ions pertaining to Ca or Mg are said to constitute ion pairs, most of which are those with sulfate and the remaining constitutes those with HCO_3^- or CO_3^{--}. Table 2 shows each fraction occupied by free ions or several kinds of ion pairs among the major species of ions.

Table 2. Distribution of major cations as ion pairs with sulfate, carbonate and bicarbonate ions in sea water of chlorinity 19 ‰, pH 8.1 at 25°C and 1 atm. (GARRELS and THOMPSON, 1962)

Ion	Molality	Free ion %	Ion pair with (%) sulfate	bicarbonate	carbonate
Ca^{++}	0.0104	91	8	1	0.2
Mg^{++}	0.0540	87	11	1	0.3
Na^+	0.4752	99	1.2	0.01	—
K^+	0.0100	99	1	—	—

Ion	Molality	Free ion %	Ion pair with (%) Ca	Mg	Na	K
SO_4^{--}	0.0284	54	3	21.5	21	0.5
HCO_3^-	0.00238	69	4	19	8	—
CO_3^{--}	0.000269	9	7	67	17	—

The existence of complex ions and undissociated molecules results in the decrease of free ions, although their concentrations are small. It is difficult to get an exact knowledge of the whole concentration of various kinds of ions through the measurement of electric conductivity of sea water, if the ionic composition of sea water and the partial ionic electric con-

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* 1966 年5月16日　日仏会館における例会で講演

** 杉浦吉雄, 気象研究所 Meteorological Research Institute ductance of each component are not clarified with regard to free ions, ion pairs and complex ions. Moreover, considering the existence of non-electrolyte whose nature and quantity are not fully understood, it seems quite difficult to exactly know the total amount of dissolved substances or density of sea water to be determined under the condition of temperature and pressure besides the total amount of dissolved substances.

Chlorinity has hitherto been determined at the precision of 0.01% by argentometry. On the other hand, since 10 years ago it has been determined not only at the precision of 0.0015‰ but also with rapidity as never yet obtained, through the measurement of electric conductivity. At present, the conductometric determination, therefore, has become popular in place of titrimetric determination. For instance, in the Cooperative Study of the Kuroshio and Adjacent Regions (CSK), the use of a conductivity salinometer is recommended in preference to titration by the International Coordination Group for CSK. But, it is noteworthy that nowadays when the precision of 0.001‰ is attainable, the difference must be distinguished between conductometric and titrimetric chlorinities, as later pointed out. This seems to be an interesting point in connection with the controversial problem whether chlorinity or salinity should be preferably employed as a basic amount in the oceanography.

Fig. 1 shows the results cooperatively obtained by COX and CULKIN, NIO and GREENHALGH and RILEY, University of Liverpool (COX, *et al*, 1962). It shows the relationship of electric conductivity to chlorinity. Both were simultaneously determined on surface and deep waters collected at about 300 sites in the world ocean. According to Fig. 1, there is a difference as much as 0.02‰ in chlorinity even for waters with the equal electric conductance. Also, there is another trend indicating that the surface water is higher in chlorinity than the deep as far as the waters with equal electric conductance are concerned.

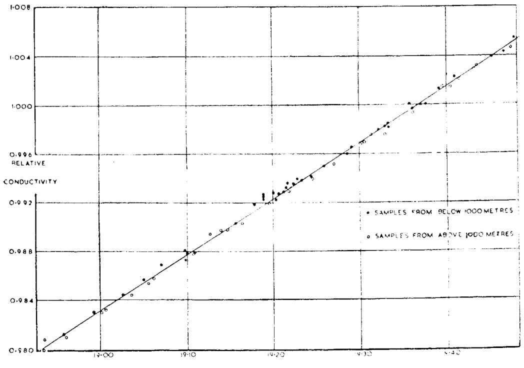

Fig. 1. Relative conductivity *vs.* titrimetric chlorinity. (Unesco, 1962)

Fig. 2 shows the relation between salinity derived from titrimetric chlorinity and observed density (Unesco, 1962). Points in the diagram considerably scatter. On the contrary, a fairly good linearity is, as shown in Fig. 3, found in the relation between salinity derived from conductivity and density. It is noteworthy that electric conductivity of sea water has rather better linearity with density of sea water than with chlorinity.

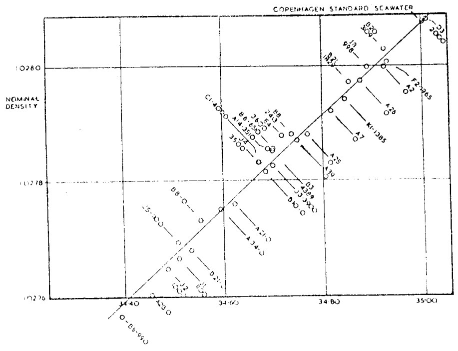

Fig. 2. Density *vs.* titrimetric salinity. (COX, *et al.*, 1962)

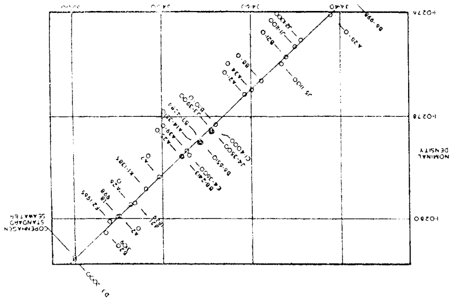

Fig. 3. Density *vs.* conductometric salinity. (COX, *et al.*, 1962)

Density is obtained by a summation of product of molar concentration and a reciprocal of partial molar volume of each component. While, electric conductivity is obtained by a summation of product of each ion concentration and partial ionic conductance. Composition of sea water being assumed nearly constant within a certain range, an average partial molar volume and an average partial ionic conductance can be considered nearly constant. So, the fact that electric conductivity has a linear relationship with density suggests that the total ion concentration has a linearity with the total amount of dissolved substances. In spite of a strong desire to know exactly the total amount of dissolved substances in sea water, there was no way but regard salinity defined by FORCH, KNUDSEN and SøRENSEN (1902) as a measure of the total amount of dissolved substances, which situation was expressed by COX in a term of 'compromise' between theory and practice.

According to the definition by SøRENSEN *et al.*, the salinity is "the weight of dissolved solid found in 1 kilogram of sea water after all the bromine has been replaced by an equivalent quantity of chlorine, all the carbonate converted to oxide and all of the organic matter destroyed."

Now, let us examine the size of the difference between the total amount of dissolved substance and salinity. Among the major constituents of sea water shown in Table 1, concentrations of Br^- and HCO_3^- are multiplied respectively by (Cl/Br) and ($1/2 \cdot O/HCO_3$) (where Cl and Br denote the atomic weights of chlorine and bromine, and HCO_3, the summation of atomic weights of the component atoms) and those products are summed up together with concentrations of the other constituents. Then, the total reaches 34.39 g/kg, which is equal to the value of the salinity defined above. While, the summation of concentrations as shown in Table 1 of the major constituents gives 34.55 g/kg which is the total amount of dissolved substances

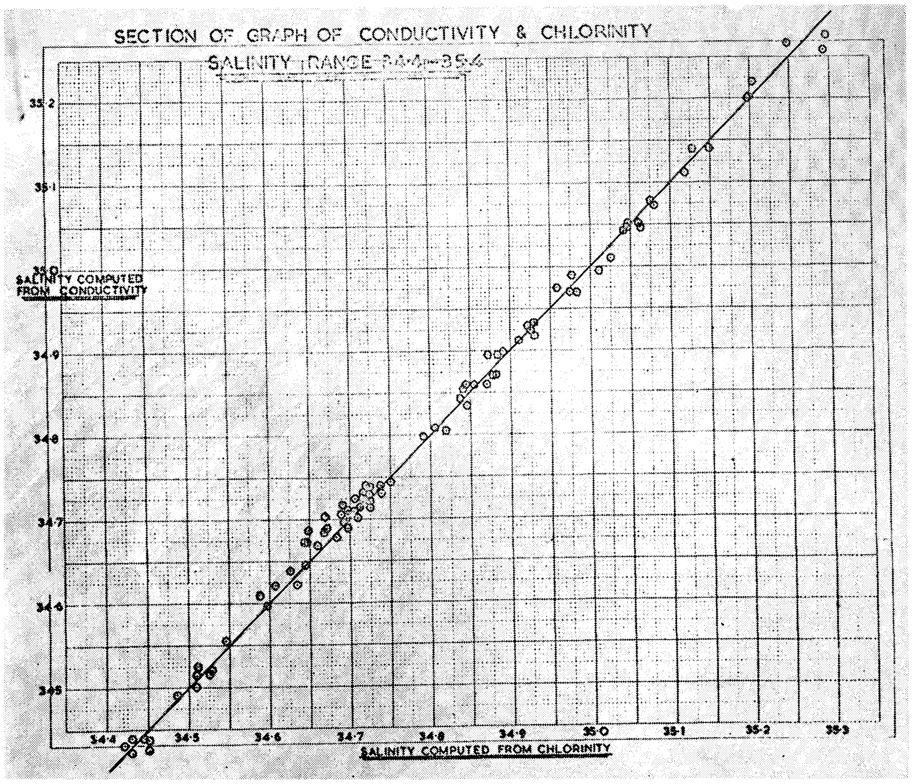

Fig. 4. Conductometric salinity *vs.* titrimetric salinity. (Unesco, 1962)

except organic matter. Even though taking organic matter into account, it amounts at the most to 34.56 g/kg.

Accordingly, the salinity value is equal to 0.9951 to 0.9954 times the total amount of dissolved substances. This coefficient hereafter will be called '*h*'.

Fig. 4 shows the relation between conductometric salinity and titrimetric salinity (salinity derived from titrimetric chlorinity). There is a considerable scatter (Unesco, 1962).

Fig. 5 shows the comparison in the vertical distribution of ($S_{con}-S_{tit}$) and excess Ca ($Ca_{obs}-0.02106\cdot Cl_{obs}$(‰), where 0.02106 is the value of the ratio of Ca/Cl in g/kg/‰) which were observed at Kattegat between Sweden and Denmark (KWIECINSKI, 1965). Those results show us that both variations of ($S_{con}-S_{tit}$) and excess Ca are mutually similar and their aptitudes are just opposite to the aptitude seen in the vertical distribution of salinity.

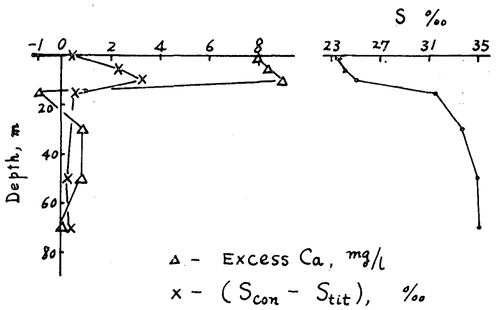

Fig. 5. Vertical distribution of ($S_{con}-S_{tit}$) and excess Ca. (KWIECINSKI, 1965)

Fig. 6 shows the comparison in the vertical distribution of ($Cl_{con}-Cl_{tit}$) and excess total carbon dioxide* determined by the present author (SUGIURA, 1966). Fig. 6 reveals a fairly good correlation between them. Since ($S_{con}-S_{tit}$), as later shown, is eqaul to $a^n(Cl_{con}-Cl_{tit})$ where a^n is a constant, results of Figs. 5 and 6 are considered to suggest that Ca^{--}, HCO_3^- and CO_3^{--} might be an important factor on which the value of ($Cl_{con}-Cl_{tit}$) depends.

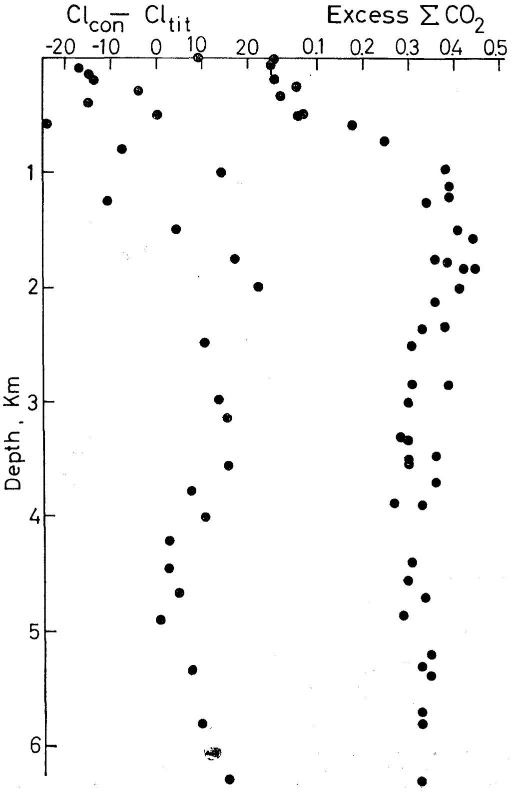

Fig. 6. Vertical distribution of ($Cl_{con}-Cl_{tit}$)(‰) and excess $\sum CO_2$ (mg at/*l*) in the Western North Pacific. (SUGIURA, unpublished)

The chemical procedure for determination of salinity is so tedious and time-consuming that treatment of a great number of samples can not be done in practice. So, after a simple substitute being sought, the method by which to derive the salinity from titrimetric chlorinity has been established, which has a basis on the following formula obtained from the analyses of nine samples:

$$S(‰)=0.030+1.805\cdot Cl(‰) \qquad (1)$$

Since eq. (1) includes a constant term, conservativity con not be strictly maintained. For example, when one liter of water with salinity 40 ‰ is mixed up with one liter of water with salinity 30 ‰, two liters of 35 ‰ water must be obtained. While, when chlorinity is first calculated by eq. (1) to obtain 22.144 and 16.604 ‰, two liters of chlorinity 19.374 ‰ or salinity 34.970 ‰ water must be obtained, which is discordant with the previous result. Taking this point into account, the following equation including no constant term has been proposed

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* which is equal to the amount of ($\sum_{obs} CO_2-(\sum CO_2/Cl)_{surface}\times Cl$).

by the Joint Panel of the Equation of state of Sea Water* in its second draft:

$$S=a\cdot\mathrm{Cl} \qquad (2)$$

In this second draft, moreover, the following point has been discussed: The values of the coefficient 'a' in eq. (2) must be variable depending on an individual water mass, because, strictly speaking, the composition of sea water is not constant. So, to keep 'a' constant, the average value of the ratio of salinity to chlorinity must be employed. *i. e.*,

$$a=(\overline{S/\mathrm{Cl}}) \qquad (3)$$

The value of 'a' can be arbitrarily chosen, but it is desirable to decide it not so as to be discordant with the salinity value which has hitherto been determined in a conventional way. But, the correspondence can not be exact at all salinities. By specifying exact correspondence at a salinity of 35‰,

$$S=a\cdot\mathrm{Cl}=0.030+1.805\cdot\mathrm{Cl}=35$$

Hence,

$$a=1.805\times35/34.97=1.80655.$$

Thus, a new definition of salinity

$$S(‰)=1.80655\cdot\mathrm{Cl}(‰) \qquad (4)$$

is obtained. This formula, can be used at salinity 35‰ or so in the same meaning as the salinity defined by KNUDSEN.

The coefficient 'a' depends on the water mass. But, in an average or to say more concretely, in a ratio of the averaged salinity to the averaged chlorinity determined on the above-mentioned nine samples, 'a' takes a certain value close to 1.80655**. Let us call this constant 'a' a normalizing factor and write a^n. Thus, the relation

$$S^n=a^n\cdot\mathrm{Cl}_{\mathrm{tit}} \qquad (5)$$

is obtained, where $\mathrm{Cl}_{\mathrm{tit}}$ denotes titrimetric chlorinity. Now, the above-mentioned, nine samples will be examined. In Table 3 chlorinity and Dittmar constant values for those nine samples are shown and compared to Dittmar constant values in the Atlantic samples.

As seen in Table 3, the average property of nine samples is different from that of open sea. The value of 'a' for open-sea water will be smaller than a^n which will be expressed by a^r. So, by

$$S^r=a^r\cdot\mathrm{Cl}_{\mathrm{tit}} \qquad (6)$$

another salinity value will be obtained from the same value of titrimetric chlorinity. If salinity is divided by the coefficient 'h' the total amount of dissolved substances $\sum C_i$ will be obtained. Accordingly,

$$\sum^n C_i=f^n\cdot\mathrm{Cl}_{\mathrm{tit}} \qquad (7)$$

$$\sum^r C_i=f^r\cdot\mathrm{Cl}_{\mathrm{tit}} \qquad (8)$$

where the factor f is equal to (a/h) which takes, for instance, the value of 1.8154.

Table 3. The "Dittmar constant" ($\rho_{17.5}/\mathrm{Cl}$) among the nine samples employed by KNUDSEN *et al* and the Atlantic samples of the "Meteor" at depths down to 5,000 m or more. (after J. LYMAN, 1959)

1. Nine samples

Source	Cl ‰	Dittmar constant
Gulf of Finland	1.474	1.425
Gulf of Bothnia	2.927	1.403
Great Belt	8.089	1.3838
Kattegat	10.410	1.3823
Kattegat	12.842	1.3815
Kattegat	16.020	1.3801
Norwegian Sea	19.410	1.3799
Norwegian Sea	19.588	1.3798
Red Sea	22.237	1.3803
Average	12.555	1.3884

2. Atlantic samples of the "Meteor"

Dittmar constant interval	Number of samples
1.3760-69	4
70-79	10
80-89	59
90-99	63
1.3800-09	29
10-19	2
20-29	1

Fig. 7 shows the schematic diagram of the inductive salinometer. 'W' in the figure shows

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* Panel members are D. E. CARRITT (USA), F. HERMANN (Denmark), R. A. COX (UK), G. N. IVANOFF-FRANTZKEVICH (USSR), G. DIETRICH (W. Germany), N. P. FOFONOFF (Canada) and Y. MIYAKE (Japan).

** The averaged chlorinity of nine samples is 12.555‰. So, the exact value of 'a' becomes $\{0.030+(1.805)(12.555)\}(12.555)=1.8074$

a single-turn closed circuit of sample water or standard water. '*S*', '*D*' and '*M*' respectively show the source, the detector, and the measuring, circuit. The polarities of windings '*b*' and '*d*' are made opposite. If the alternative current in the circuit '*S*' is constant, the valtage V_W induced at the end '*a*' of the circuit '*W*' is constant. Current in the circuit '*W*' is expressed by '$K_W V_W$'. In order to counterbalance the current induced in the circuit '*D*' by the current in the circuit '*W*' with the current induced in '*D*' by the current in '*M*', the current in '*M*' must be expressed by $p\cdot K_W\cdot V_W$, where p shows a reciprocal of turns of the winding '*d*'. Denoting the resistance of the circuit '*M*' R, the relation

$$V_m=p\cdot K_W\cdot V_W\cdot R \qquad (9)$$

is satisfied (TOHYAMA and YAMASHITA, 1957).

$$K_W=\bar{\lambda}\cdot\sum C_i$$

and

$$\bar{\lambda}=(\sum\lambda_i\cdot C_i)/\sum C_i$$

where λ_i is zero for an undissociated components.

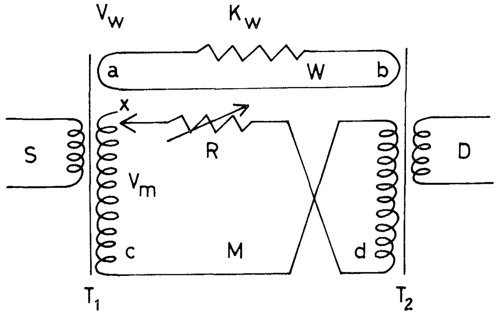

Fig. 7. Schematic diagram of the inductive salinometer.

According to PARK (1964), the partial ionic equivalent conductance (which will hereafter be abbreviated as p.e.c.) of the major ions in sea water is as shown in Table 4 at 23°C.

Following those data, the average p.e.c. value in sea water with salinity 35‰ and temperature 23°C is 41.5.

Table 4. Concentration and partial equivalent conductance of major ions in sea water at 23°C and 35‰ salinity assuming the cation transference number of potassium chloride in sea water is 0.49 (mho cm^2).

(after K. PARK, 1964)

Cation	Equiv./*l*	λ^+	Anion	Equiv./*l*	λ^-
Na^+	0.483	31	Cl^-	0.558	59
K^+	0.010	57	$1/2\cdot SO_4^{--}$	0.057	21
$1/2\cdot Mg^{++}$	0.109	13	HCO_3^-	0.002	15
$1/2\cdot Ca^{++}$	0.021	19	Br^-	0.001	63
$1/2\cdot Sr^{++}$	0.0002	21	$1/2\cdot CO_3^{--}$	0.0002	−8

$\bar{\lambda}$ is constant if the composition of sea water is kept constant. This has been approved by Fig. 8. Fig. 8 indicates that relative conductance at various salinities obtained by dilution of sea water with distilled water has a linear correlation with salinity (BROWN and HAMON, 1961). Accordingly, at the calibration of a salinometer by using sea water diluted with distilled water, the salinity scale can be put on. But, actually, the scale is given in relative conductance and a conversion table from relative conductance to salinity is attached.

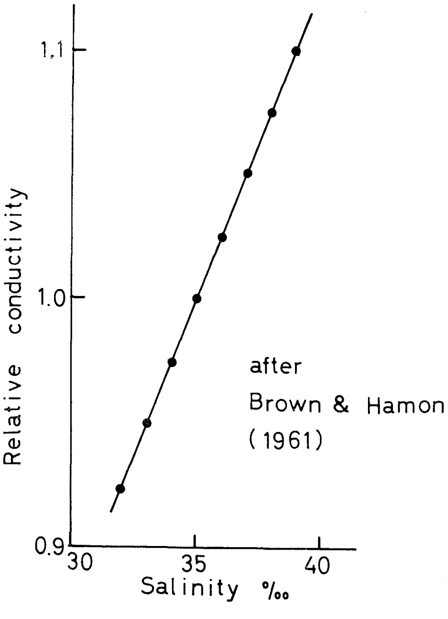

Fig. 8. Relation between relative conductivity and salinity. (BROWN & HAMON, 1961)

Now, let us follow the procedure of an inductive salinometer. First, salinity (S_{st}) of the standard sea water is estimated from chlorinity by use of eq. (5). Then, the corresponding value of relative conductance is obtained from the conversion table, and the balancing controller 'x' is set at the scale equivalent to the determined value of the relative conductance. The induced voltage in the measuring circuit, V_m, under the above-mentioned condition being denoted by V_{st},

$$V_{st}=p\cdot K_{st}\cdot V_W\cdot R^n \qquad (10)$$

where R^n shows the value of the variable resistance, R, which satisfies eq. (10). This equation expresses the procedure of standardization.

$$V_{st}=k\cdot S_{st}=k\cdot a^n\cdot \mathrm{Cl}_{st},$$

where 'k' is a coefficient necessary to adjust the dimension of V and S and takes a constant value. Here is one thing to be noticed. In the conversion table, relative conductance is proportional to salinity only when the sea water whose composition is equal to the composition of the sea water employed for calibration of the instrument is put in a cell of the salinometer. If the composition of the standard sea water is different from that of sea water employed for calibration, relative conductance corresponding not to S_{st} but to $(\bar{\lambda}_{st}/\bar{\lambda}_0)S_{st}$ must be sought in the table, where $\bar{\lambda}_0$ expresses the average p.e.c. value depending on the composition of sea water employed for calibration. Accordingly, a perfect equation equivalent to standardization is

$$k\cdot(\bar{\lambda}^n/\bar{\lambda}_0)\cdot a^n\cdot \mathrm{Cl}_{st}=V^n{}_{st}=p\cdot K_{st}\cdot V_W\cdot R^n \qquad (11)$$

And the equation equivalent to measurement is

$$k\cdot(\bar{\lambda}^n/\bar{\lambda}_0)\cdot a^n\cdot \mathrm{Cl}_{\mathrm{con}}=V^n{}_{sa}=p\cdot K_{sa}\cdot V_W\cdot R^n \qquad (12)$$

where $\mathrm{Cl}_{\mathrm{con}}$ expresses conductometric chlorinity. Equations (11) and (12) describe that the determination of chlorinity by means of a salinometer is based on the assumption that the values of 'a' and 'λ' corresponding to the averaged composition of the nine sea waters are always employed irrespective of standard sea water or sample water to be put in the cell.

(12)÷(11),

$$\mathrm{Cl}_{\mathrm{con}}=(K_{sa}/K_{st})\cdot \mathrm{Cl}_{st}. \qquad (13)$$

Since the composition of the standard sea water generally differs from the average composition of the nine sea waters, as the values of 'a' and 'λ', not a^n but $a^r{}_{st}$ and not $\bar{\lambda}^n$ but $\bar{\lambda}^r{}_{st}$ must be employed, where a superscript 'r' means 'real'. Employing real factors $\bar{\lambda}^r$ and a^r, eq. (11) can be rewritten as follows:

$$k\cdot(\bar{\lambda}^r{}_{st}/\bar{\lambda}_0)\cdot a^r{}_{st}\cdot \mathrm{Cl}_{st}=p\cdot K_{st}\cdot V_W\cdot R^r \qquad (14)$$

and eq. (12) must be

$$k\cdot(\bar{\lambda}^r{}_{sa}/\bar{\lambda}_0)\cdot a^r{}_{sa}\cdot \mathrm{Cl}_{\mathrm{tit}}=p\cdot K_{sa}\cdot V_W\cdot R^r \qquad (15)$$

(14)÷(15),

$$\mathrm{Cl}_{st}=(K_{st}/K_{sa})(\bar{\lambda}^r{}_{sa}/\bar{\lambda}^r{}_{st})(a^r{}_{sa}/a^r{}_{st})\cdot \mathrm{Cl}_{\mathrm{tit}} \qquad (16)$$

From (13) and (16),

$$\mathrm{Cl}_{\mathrm{con}}=(\bar{\lambda}^r{}_{sa}\cdot a^r{}_{sa}/\bar{\lambda}^r{}_{st}\cdot a^r{}_{st})\cdot \mathrm{Cl}_{\mathrm{tit}}$$

Hence,

$$\mathrm{Cl}_{\mathrm{con}}-\mathrm{Cl}_{\mathrm{tit}}=\mathrm{Cl}_{\mathrm{tit}}((\bar{\lambda}^r{}_{sa}\cdot a^r{}_{sa}/\bar{\lambda}^r{}_{st}\cdot a^r{}_{st})-1).$$

So, if $\bar{\lambda}^r{}_{sa}\cdot a^r{}_{sa}>\bar{\lambda}^r{}_{st}\cdot a^r{}_{st}$,

$$\mathrm{Cl}_{\mathrm{con}}-\mathrm{Cl}_{\mathrm{tit}}>0.$$

The value of 'a' is larger as the concentration of ions other than halogen ion is higher as compared to the concentration of halogen ion. There is no direct relation between the values of '$\bar{\lambda}$' and 'a'. In other words, even though the value of 'a' is equal, '$\bar{\lambda}$' is larger as the ions with larger p.e.c. values are richer. The water with higher content of excess total carbon dioxide* and excess calcium* has a larger value of 'a'. In sea water, about 90% of the total carbon dioxide is in the form of bicarbonate. Assuming that the opponent ion is an equivalent quantity of calcium and/or magnesium, the value of $\bar{\lambda}$ for the excess part is approximately constant irrespective of the proportion of calcium and magnesium because p.e.c. of calcium is nearly equal to p.e.c. of magnesium. Accordingly, the larger 'a' brings the larger $(\mathrm{Cl}_{\mathrm{con}}-\mathrm{Cl}_{\mathrm{tit}})$. In other words, the sea water with higher content of excess Ca and excess $\sum \mathrm{CO}_2$ can be expected to have higher $(\mathrm{Cl}_{\mathrm{con}}-\mathrm{Cl}_{\mathrm{tit}})$. Figs. 5 and 6 support this idea. Next, let us treat it quantitatively.

Putting

$$((\mathrm{Cl}_{\mathrm{con}}-\mathrm{Cl}_{\mathrm{tit}})/\mathrm{Cl}_{\mathrm{tit}})_d-((\mathrm{Cl}_{\mathrm{con}}-\mathrm{Cl}_{\mathrm{tit}})/\mathrm{Cl}_{\mathrm{tit}})_s =\varDelta_{d-s},$$

where 'd' and 's' are abbreviates of deep and surface,

$$\varDelta_{d-s}=(\bar{\lambda}_d\cdot a_d-\bar{\lambda}_s\cdot a_s)/\bar{\lambda}_{st}\cdot a_{st}.$$

$$\bar{\lambda}\cdot a=\bar{\lambda}\cdot(S/\mathrm{Cl})=\bar{\lambda}\cdot h\cdot(\textstyle\sum C_i/\mathrm{Cl})$$
$$=h\cdot(\lambda_1\cdot C_1/\mathrm{Cl}+\lambda_2\cdot C_2/\mathrm{Cl}+\cdots+\lambda_n\cdot C_n/\mathrm{Cl}).$$

Hence,

$$\bar{\lambda}_{st}\cdot(a_{st}/h)\cdot\varDelta_{d-s}=(\lambda_1\cdot C_1/\mathrm{Cl}\cdots+\lambda_n\cdot C_n/\mathrm{Cl})_d$$
$$-(\lambda_1\cdot C_1/\mathrm{Cl}+\cdots+\lambda_n\cdot C_n/\mathrm{Cl})_s.$$

Assuming that the major cause arising a definite value of $\varDelta_{d-s}$ is the dissolution of calcium carbonate into calcium bicarbonate, (the incre-

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* For instance in the case of calcium,
excess Ca $=\mathrm{Ca}_{\mathrm{obs}}-(\mathrm{Ca}/\mathrm{Cl})_{\mathrm{reference}}\times \mathrm{Cl}_{\mathrm{obs}}$.

ment in calcium content is associated with the amount of carbon dioxide released at the oxidative breakdown of organic material (See APPENDIX)).

$$\bar{\lambda}_{st}\cdot(a_{st}/h)\cdot\varDelta_{d-s}$$
$$=\lambda_{Ca}\cdot\text{excess Ca/Cl}_d+\lambda_{HCO_3}\cdot\text{excess HCO}_3\text{/Cl}_d.$$
$$\bar{\lambda}_{st}\cdot(a_{st}/h)\cdot\text{Cl}_d\cdot\varDelta_{d-s}$$
$$=(2\cdot\lambda_{Ca}+\lambda_{HCO_3})\cdot\text{excess HCO}_3.$$

Applying the data obtained by PARK and the value of excess $\sum CO_2$ (0.4×10^{-3} at/l) obtained by the present author (SUGIURA, 1966),

$$(41.5)(1.8)(19/35.5)(x/19)=(53)(0.4\times10^{-3}).$$

Hence,

$$x(\fallingdotseq((\text{Cl}_{con}-\text{Cl}_{tit})_d-(\text{Cl}_{con}-\text{Cl}_{tit})_s))=0.01\text{‰}.$$

is obtained. According to Fig. 6,

$$((\text{Cl}_{con}-\text{Cl}_{tit})_d-(\text{Cl}_{con}-\text{Cl}_{tit})_s)\geqslant0.02\text{‰}.$$

So, about half of $((\text{Cl}_{con}-\text{Cl}_{tit})_d-(\text{Cl}_{con}-\text{Cl}_{tit})_s)$ can be explained by the increment in calcium and bicarbonate contents due to the dissolution of calcium carbonate. But another half remains unexplained. This coincides with the results obtained by MIYAKE, SUGIURA and PARK (1965).

As shown in Fig. 6, waters above 1000 m depth in the Western North Pacific have negative values of $(\text{Cl}_{con}-\text{Cl}_{tit})$. This means that in waters above 1000 m in the W. N. Pacific the concentration of ions other than halogen ion is lower than in the Copenhagen Standard Sea Water. Table 5 shows the values of $(\text{Cl}_{con}-\text{Cl}_{tit})$ obtained on the Japanese Standard Sea Waters. What is meant by $(\text{Cl}_{con}-\text{Cl}_{tit})$ is the comparison in the compositions between the Copenhagen, and the Japanese, Standard Sea Waters.

Table 5. Results obtained on the Japanese Standard Sea Waters.

Cl_{tit} ‰	Cl_{con} ‰	$(\text{Cl}_{con}-\text{Cl}_{tit})$ ‰
19.371	19.373	+0.002
19.385	19.384	−0.001
19.387	19.388	+0.001
19.383	19.380	−0.003
19.388	19.391	+0.003

Table 5 reveals that $\bar{\lambda}\cdot a$'s in the Copenhagen, and the Japanese, Standard Sea Water are nearly equal. The original material from which the Japanese Standard Sea Water has been prepared is the surface water collected near the Torishima Island. So, the original sea water must have a negative $(\text{Cl}_{con}-\text{Cl}_{tit})$, despite of which once the Standard Sea Water has been made $(\bar{\lambda}\cdot a)$ increases. It is probably due to the dissolution of elements other than halogen during the processes of preparation of standard sea water*.

Considering from the several findings mentioned above, the provisional conclusion at present seems probable that conductometric chlorinity is one thing; titrimetric chlorinity is another thing. Both can not be mixed up at least as long as the discussion is done at the level of 0.001‰ precision. Electric conductivity is a suitable factor by which to derive density and titrimetric chlorinity is more suitable to trace a water mass.

APPENDIX

Fig. 9 shows the relation between $(\text{Ca}/\rho_{15}\cdot\text{Cl})$ and AOU which is the abbreviate of apparent oxygen utilization, *i.e.* saturation amount minus observed amount of dissolved oxygen. Data were obtained by HIGANO at the CSK cruise of the R. V. "Takuyo", Japan Hydrographic Office in August of 1965. As seen in Fig. 9,

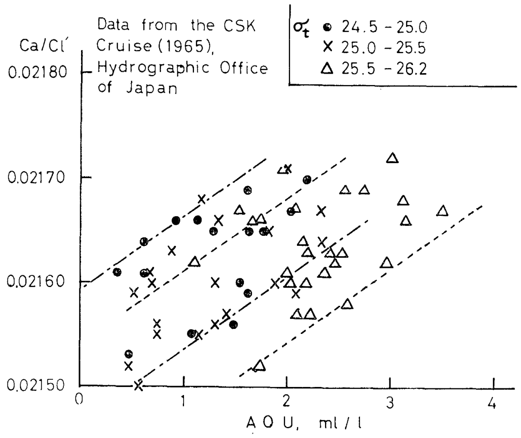

Fig. 9. Relation between $(\text{Ca}/\rho_{15}\cdot\text{Cl})$ and AOU. (SUGIURA and HIGANO, unpublished)

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* The processes preparing the standard sea water include concentration through evaporation of a part of the original sea water, addition of the concentrated to the residual main body, filtration and storage for one year or longer.

waters of *in situ* density, σ_t, 24.5 to 25.5 and waters of σ_t 25.5 to 26.2 are respectively located along straight lines whose slopes are both equal to the slope theoretically given basing on the assumption that calcium carbonate which might be organically bound is dissolved into calcium bicarbonate through the reaction with carbon dioxide set free from the breakdown of organic material. The ratio of the increment in the total carbon dioxide to the consumed oxygen at the breakdown of organic material is, as proved by the present author previously (SUGIURA, 1966), 106/272 in atoms. Also, 0.272 mg-at/l of oxygen is equivalent to 3.04 ml/l. The calcium concentration equivalent to the increment in the total carbon dioxide caused by the oxygen consumption of 3.04 ml/l is

$$(40)\cdot(0.106)=4.24\,\mathrm{mg}/l$$

Therefore, the slope to be given by the ratio of $(\mathrm{Ca}(g/l)/\rho_{15}\cdot\mathrm{Cl}(‰))$ to AOU should be

$$(4.24\times10^{-3}/19.49)/3.04=7.15\times10^{-5}$$
$$\text{when Cl}=19.1‰,$$
$$(4.24\times10^{-3}/19.69)/3.04=7.08\times10^{-3}$$
$$\text{when Cl}=19.2‰,$$
$$(4.24\times10^{-3}/19.80)/3.04=7.04\times10^{-3}$$
$$\text{when Cl}=19.3‰.$$

In Fig. 9, the slope of the straight line is 7.1×10^{-5}. It is a good agreement.

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要 旨: 海水の電気伝導度から溶存物質の全濃度を決定する際に注意すべき点を，従来の諸研究から概説的に述べたのち，電気伝導度測定から求めた塩素量と滴定法によって求めた塩素量との差の物理的意味を明らかにし，塩素量，塩分および電気伝導度に関する筆者の意見を述べる。

討　論

座　長: 増沢譲太郎（気象庁）

増沢: この問題は海洋化学の専門家に限らず，それ以外の海洋学の研究者，技術者にとっても興味があり，重要であると考えられますので，各方面の活発なご意見をうかがいたいと思います。

冨永（学芸大）: 電気伝導度は水温に関係すると思いますが，この点をどう扱っていますか。

答: この話はある固定された温度のところで進められています。実際には，サーモスタットで一定の水温にして測定します。

冨永: 精度をやたらに上げると，ちょっとした原因で測定値が影響を受けることになり，かえってデータ処理がむずかしくなると思いますが，水塊分析などではどの程度の精度まで行けばよいのか，将来はどうすべきなのでしょうか？

答: 現在，電導度から塩分を求める場合，±0.003‰の精度が普通よく言われていますが，これが更に2桁くらい下がると，溶存ガスの影響を受けるようになります。同様に，懸濁粒子の影響も考えられます。また，海水の密度を求める目的で電導度を測る場合には，水素の同位体濃度の変動とか共存有機物の影響も考慮しなければならなくなるでしょう。

佐々木（東水大，理研）: サリノメーターの温度補正はどうなっていますか？

答: 温度補正回路を用いていますが，精確には恒温槽を用いるべきだと思います。

増沢: CKS の際に塩分を採用したのは，それをとることが理想的であるというよりも，むしろあるところでは塩分を採用し他処で塩素量を使っているという現状から来る不便さをなくすための実際的な要請に基づいていると思います。塩分，塩素量の問題は根本的に考えてゆくべきものだと思いますが，一方では，どういうふうにしてこの煩雑さをなくすべきかを考えていただきたいと思います。も一つ重要な点は，今までは常圧の下での話ですが，実際，深海では，密度計算に圧力の項が無視できません。しかも，現在もっともわかっていないものの一つだと思います。この点は，今後是非明らかにしてほしいことです。

秋山（気象庁）: サリノメーターを実際に使っている者の立場から言いますと，実用上，0.00N の桁の精度には，多少，疑問があります。

海洋の生態的区分*

L'étagement biologique dans la mer

高木和徳**

海産生物はその支持水との関係から生態的に底生生物 benthos と遊離生物 pelagos とに，そして後者は浮遊生物 plankton，遊泳生物 nekton，および浮漂生物 neuston などに分けられるが，終局的にはそれが生息する相faciès やそのような生息相の中での個々の生息場所 habitat との関係で表わされる。

そのような生態的区分は海洋域 domaine pélagique と海底域 domaine benthique とに2大別される。各区域それぞれに多くの研究者が細分類を試みているが，従来の成書ではわが国のものを含めてもっぱら EKMAN の体系が広く知られているようである。ここでは近年北太平洋や大西洋などの諸海域の調査結果から得られたこの分野の成果の大要をマルセイユ大学の PÉRÈS 教授らの見解（1961～1963）に基づいて紹介し，この問題に関心をもたれる方のご参考に供したい。

I．海洋域の生態区分

この領域の細分類としては BRUUN (1956) が海底域との対応関係を考慮している点で興味ある成果を挙げているが，ここでもっとも注目すべきは BIERSTEIN, VINOGRADOV および TSCHINDONOVA (1956) の業績である。彼らは千島海溝で表層から 10,382 m 層までの範囲を取扱っている。

a．上洋層 zone épipélagique：深さは海表面から平均約 50 m まで（おそらく 100 m まで）で，いわゆる自生生物（特に硅藻やうず鞭毛虫類）の平均補償深度を限度とする。この水帯はちょうど受光層 zone euphotique に相当する。

b．中洋層 zone mésopélagique：その深さは 50 m（～100 m）から 200 m までで，それは中緯度までの低緯度地方では 10°C の等温線が限度である。この水帯の範囲内では植物プランクトンは発育しないはずである。

BIERSTEIN ら (1956) によれば，これら2層は 0～200 m まで一括して表層 zone superficielle と呼ばれ，彼らの調査した北太平洋海域では，冬季の著しい温度低下が特徴的である。この海域では植物プランクトンや少数の橈脚類によって卓越される動物プランクトンが豊富で，その生物量は 109～1,120 mg/m^3 に達する。

c．下洋層 zone infrapélagique：深さは 200 m から 500～600 m までで，BIERSTEIN らはその調査海域について，この層が冷たい表層水と，より暖かい外洋水との間の推移帯となるとしている。ここではプランクトンの代表種類数はまだ多いけれど，その生物量は著しく少なくなる（165～346 mg/m^3）。バチスカーフからの観測結果（PÉRÈS, 1959）によれば，この水帯は夜間表層水(中洋層）に達するプランクトンの多くが日中待避するところである。このようなプランクトンは次のような種類によって代表される：甲殻十脚類では *Hymenodora frontalis* 幼生，オキアミ類では *Gnathophausia gigas*，端脚類では *Scina borealis* や *S. incerta*，橈脚類では *Scaphocalanus magnus*, *Pseudochirella spinifera*, *Spinocalanus stellatus*, *Haloptilus pseudoxycephalus*, など。

d．亜深洋層 zone bathypélagique (s. str.)：水深 500（～600）m から 2,000（～2,500）m までの水帯で，その下限は，中緯度地方ではおよそ 4°C の等温線に相当するとみられる（BRUUN, 1956：1106, Fig. 1)。ここの生物量（22～56 mg/m^3）はなおほとんど橈脚類で占められるが，外洋性ひも形動物もみられるし，更に一連の特徴的な腔腸類がここで出現する。これらは. *Crossota rufobrunnea*, *Pentachogon haeckeli*, *Halicreas minimum*, *Atolla bairdi*, *Periphylla hiacinthina* などである。そのほか，管クラゲ類（Dimophyidae)，毛顎類の *Eukrohnia fowleri*，オキアミ類の *Eucopia grimaldi*，多くの端脚類：*Koroga megalops*, *Cyclocaris quilelmi*, *Eusirella multicalceola*, *Scina* spp., *Lamceola* spp. など，甲殻十脚類の *Hymenodora frontalis*, *Gennadas borealis*，また *Hymenodora glacialis* の幼生などもこの水帯の出現種である。

e．深洋層 zone abyssopélagique：この水帯は水深 2,000（～2,500）m から 6,000（～7,000）m までの層でここの卓越種は量的にみると，大型プランクトンによっ

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* 1966年8月8日受理

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て代表される。すなわち，この層の主な傾向として，生物量（9.3〜26.4 mg/m³）の大部分はもはや橈脚類ではなくて，毛顎類，甲殻十脚類，オキアミ類などによって占められている。ここの上層部には，なお毛顎類の *Eukrohnia fowleri* が豊富であり，中洋層でごく普通にみられた腔腸類の *Crossota rufobrunnea* はいない。深層部になると，オキアミ類の *Eucopia australis* や *Bentheuphausia amblyops*, *Acanthephyra* 属のエビ類の出現がみられる。なお，この部分では橈脚類がまた現われ，*Cephalophanes* を含む数属のものが認められている。

f. 冥洋層 zone hadopélagique：水深 6,000(〜7,000) m から深海底までをいい，この水帯を特徴づけるのは，少ないものから端脚類，貝形類，および橈脚類などであるが，いずれにしてもこれらは質量ともに極めて乏しい。生物量は 0.01〜1.73 mg/m³ である。

これらの海洋区分は，すでに知られるように，地形的に，沿岸区と外洋区とに大別される。

i. 沿岸区 province néritique：この区域は200 m 等深線を通る垂直面で区切られるとされているが，実際は大陸棚の外縁を限る線，すなわち傾斜の折れ目を通る垂直面で区切られるものとする方が適切である。しかも，沿岸区の範囲は大陸棚そのものの範囲に従って，きわめて変りやすい。

ii. 外洋区 province océanique：海洋の残りの部分を占める区域で，大陸棚の外縁を通る垂直面の沖にある。

II. 海底域の生態区分

底生生物組成の区分は遊離生物組成のそれよりも興味深い問題になっている。PÉRÈS（1957）によれば，この領域についていままでに 20 通りあまりの生態区分が提唱されている。そのうちもっとも広く知られているのが EKMAN（1935）の区分で，この方式は SVERDRUP ら（1960：275）によって踏襲されている。ZERNOV（1949）や ZENKEVITCH（1956）の体系も EKMAN 系のものといえよう。

EKMAN の区分体系の特徴の一つは沿岸と深海の生物組成を区別するのに 200m 等深線を強調していることで

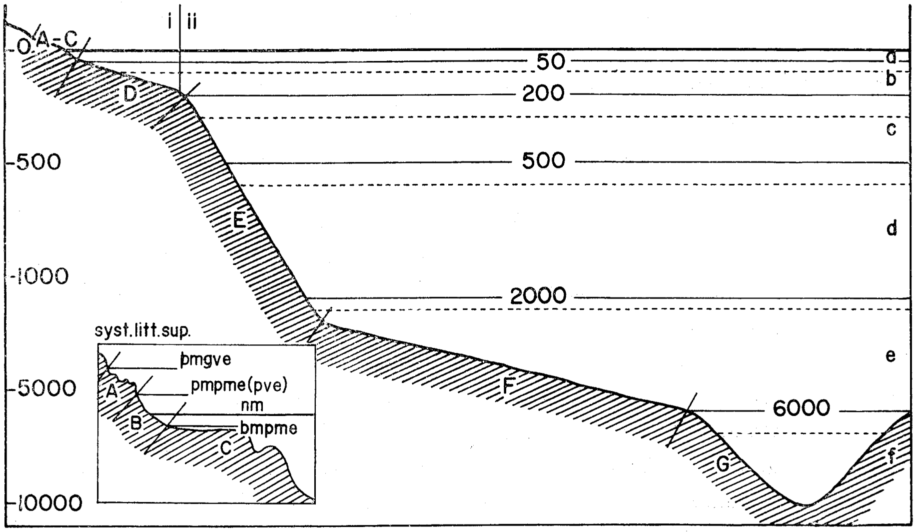

Fig. 1. Division biologique schématique dans la mer.

A–G, étagements benthiques (étages)： A, supralittoral; B, médiolittoral; C, infralittoral; D, circalittoral; E, bathyal; F, abyssal; G, hadal. a–f, étagements pélagiques (zones)： a, épipélagique; b, mésopélagique; c, infrapélagique; d, bathypélagique; e, abyssopélagique; f, hadopélagique. i–ii, subdivisions topographiques dans le domaine pélagique (provinces); i, néritique; ii, océanique. Dans le cadre on voit le système littoral supérieur (syst. litt. sup.) en detail; bm, basse mer; gve, grande vive-eau; nm, niveau moyen; pm, pleine mer; pme, petite morte-eau; pve, petite vive-eau. Le chiffre arabique indique la profondeur en mètre. Pour le domaine pélagique la ligne horizontale pleine signifie la limite principale, et celle de point la limite maximum inférieure. (préparée selon PÉRÈS, 1961, et PÉRÈS et DEVÈZE, 1963)

ある。この等深線はここでは大陸棚の外縁や，光線の透過帯と不透過帯との境界をも表わすものとされているが，実際は全く任意なものである。大陸棚斜面から大陸棚を分つ斜面の折れ目は 200 m のあたりよりも 120 m あたりにあることが多い。一方200m という水深は，多くの海域では藻類の補償深度の上にあることは明らかで生物学的見地からも支持されないようである。EKMAN はまた彼の深海系を 1,000 m 等深線で 2 階層（archibenthique と abyssobenthique）に区別しているが，この深さも任意に選ばれたものである。EKMAN の体系は上下沿岸帯（zone eulittorale et sublittorale）の区別を除けば，生物学的基礎のない，本質的に形式的な体系となってしまった。

各国の海域に亘って底生生物を研究するためには合理的な海底区系について統一された見解をたてる必要を認めた PÉRÈS, PICARD 両教授らの主唱によって，その見解がまずジュネーブ・シンポジウムで，次いでロンドンの第15回国際動物学会議で検討された。PÉRÈS 教授らの海底区系は底生生物組成による区分を基準としているが，世界中のどこでも適用されるように考慮されているから，多くの専門研究者の同意が得られよう。

上記のように，この分類体系は無機要因に基づくものではなくて，すべての環境要因の拮抗，累積あるいは干渉作用の結果としての生物群集によっている。この場合，湿潤度，光度，圧力などの要因はそれに対して不可欠であるか，あるいは不可欠とみられる要因にすぎない。

A．沿岸区系 système littoral（植生区系 système phytal）

a．上沿岸区 étage supralittoral：ある期間引き続き水面上にあるべき生物の占めるところである。つまり，ここは海水で湿っていて，たとえば干満の差の著しい海域で，春（秋）分の大潮時に例外的に全く水面下に沈むようなところである。STEPHENSON (1947) らの潮間帯上層域 supralittoral fringe に相当しよう。

b．中沿岸区 étage médiolittoral：継続的に，あるいはほとんど継続的に水面下にいることはないが，普通の状態ならばそれほど長時間水面上になくてよいような生物によって，この階層が特徴づけられる。ここはおそらく STEPHENSON らの midlittoral zone を主分布域とする潮間帯生物の一部を含むものと考えられる。干満の差の著しい海域では，小潮（極端な場合は大潮）最小高潮面 pleine mer de la petite morte-eau (de la petite vive-eau) から小潮最小低潮面 basse mer de la petite morte-eau まで（後者を含む）の範囲に入るであろう。

c．下沿岸区 étage infralittoral：この階層の上限は生物群集がいつも水面下にあるか，あるいは極くまれに水面上にあるような水準にある。その下限は生物群集がアマモ類（*Zostera*），すなわち好光性藻類と共存するようなところであるが，高緯度地方では水深およそ 15～20 m のところにある。地中海では 30～40 m であり，また熱帯域でリュウキュウスガモ *Thalassia*（トチカガミ科）の生えているようなところでは約 80m まで下るようである。潮間帯の下層域 infralittoral fringe はこの階層に含められる。なお，この区域は地域的に上下 2 層に細分されることがある。

d．漸沿岸区 étage circalittoral：この階層の範囲は海産顕花植物（あるいは好光性藻類）の生活限界から，生物群集が嫌光性藻類の植生と共存できる極限の深さまでである。ただし，海藻の存在はこの区に属するビオトープに対する必須条件ではない。一つの海域内で植生の有無を問わず漸沿岸区ビオトープのそれぞれの大きさを特に支配しているのは，底質，特に堆積物の地域的条件や海域別藻類相の組成などである。

上記の 4 階層は沿岸区系または植生区系として一括される。すでに明記されているように，この生態区分は深さによるものではなくて，生物群集型に基づいている。したがって，上部 2 階層に対する湿潤度，下部 2 階層に対する光度などの基礎要因の垂直変動がかなり大きいところから，生物群集の垂直分布範囲には海域間でかなり著しい違いが生ずる。しかし，ここで述べられている区分は生物群集の分布そのものによってなされているから，垂直分布範囲がどのように変っても，各区分の定義を変えないでよい。たとえば，堅い底質のところでは，上沿岸区の垂直範囲は安定した状態で 50 cm の幅であるが，生物群集組成の多くは同じなのに，不安定な状態では 3～4 m になることがある。また漸沿岸区のほぼ水平に近い底質のところでの嫌光性藻類群集は中程度の濁り度の海域では水深 30 m から見られるが，透明度の高い海域では 60 m からである。

B．深海区系 système profond（非植生区系 système aphytal）

e．亜深海区 étage bathyal：この階層は大陸棚斜面とこの斜面の基部に接してゆるい傾斜をもつその深部とを占める生物群集に対応している。その下限は広底生性漸沿岸種の大部分が占める生息範囲の下限に当り，そこで生物群集組成がかなり徹底的にいれかわるようである。それは 3,000 m をあまりこえないところらしいが，この区域と次の深海区との間を BRUUN (1956) のよう

に4°Cの等温線で区別するよりは，この等温線の深さが緯度によってかなり大きく変る点からみても，むしろ生物的基準で分けるのが望ましいようである。

f.　深海区 étage abyssal：この階層は極くわずかな傾斜のついた大海底平原の生物群集に対応している。この平原は大陸棚斜面の基部のゆるやかな傾斜面にはじまり，次の晦冥区に属する大峡谷（深海溝）のはじまる約6,000～7,000 m のところまでひろがっている。本質的にはこの区域は上に述べたような動物相の，特に Élopsida 類（ナマコ類）にみられるかなり急激な入れ変り，生物群集の総体的な貧困性，および大陸棚起原の広底生種のほとんど完全な消失などによって特徴づけられるようである。

g.　晦冥区 étage hadal：この名称は BRUUN (1956) の提唱したものであるが，これはソ連の研究者たちのいう超深海区 étage ultraabyssal である。この最深部の階層は6,000～7,000 m を超す海谷海溝の底にある。ここを特徴づけるのは，一つは生物群集の質的量的両面の貧困性で，大きな分類単位のうちのいくつかに属する種類はみられないこと，その他には600～700気圧を越す圧力の下で生活できるように適応した，いわゆる好圧性細菌の存在である。

これら3階層は前述の4階層に対して深海区系または非植生区系を構成する。この系の特徴は光線の透過がないので緑色植物が生えていないことと，高圧なこと（特に深さが増すにつれて高くなること）である。

要するに，海洋2領域の生態区分は次のように要約されよう（記号は Fig. 1 に対応）。

I．海洋域 domaine pélagique
（垂直区分 division verticale）
a．上洋層 zone épipélagique　…zone euphotique
b．中洋層 zone mésopélagique
（a, b）表層 zone sperficielle
c．下洋層 zone infrapélagique
（a～c）zone oligophoitque
d．亜深洋層 zone bathypélagique
e．深洋層 zone abyssopélagique
f．冥洋層 zone hadopélagique
（d～f）zone aphotique
（水平区分 division horizontale）
i．沿岸区 province néritique
ii．外洋区 province océanique

II．海底域 domaine benthique
沿岸区系（植生区系）système littoral (phytal)
A．上沿岸区 étage supralittoral
B．中沿岸区 étage mediolittoral
C．下沿岸区 étage infralittoral
D．漸沿岸区 étage circalittoral
深海区系（非植生区系）système profond (aphytal)
E．亜深海区 étage bathyal
F．深海区 étage abyssal
G．晦冥区 étage hadal (ultraabyssal)

付記：Fig. 1 では深度を目安にして生態区分が示されているが，この要因が各区分の本質的な特徴を支配するものではないことは本文で述べられているとおりである。

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マルセイユ大学付属アンドーム海洋実験所報告, **52** (36), 1965

J. PICARD: Recherches qualitatives sur les Biocoenoses marines des substrats meubles dragables de la région marseillaise.....................1-160.
マルセイユ地区で浚渫される移動性下層土の海洋生物群集に関する定性的研究

D. BELLAN-SANTINI: Contribution à l'étude du genre Hippomedon (Crustacea-Amphipoda) en mer Méditerranée. ....161-180.
地中海産ヒポメドン属（甲殻類-端脚類）に関する研究

C. C. EMIG: Contribution à la répartition de Phoronidiens et à la cartographie benthique du golfe de Fos.................................181-183.
Fos 湾の海底地形図と箒虫類の分布に関する研究

L. BLANC-VERNET: Note préliminaire sur quelques dragages effectués au large de Marseille (Canyon de Planier)...........................185-190.
マルセイユ沖（カニヨン・ド・プラニエ）で実施した浚渫に関する予報

L. BLANC-VERNET: Note sur la répartition des Foraminifères au voisinage des côtes de Terre Adélie (Antarctique).........................191-203.
南極テール・アデリー沿岸の有孔虫類の分布

P. ARNAUD: Pelecypodes, Amphineures et Scaphopodes Antarctiques des XI^e et XII^e expéditions françaises en Terre Adélie. ....207-214.
フランス隊のテール・アデリー第11次および第12次探検による南極産斧足類，双神経類および掘足類について

H. CHAMLEY: Observations sur quelques sédiments marins prélevés près des côtes de Terre Adélie (Antarctique).........................215-228.
テール・アデリー（南極）沿岸で採集した数種の海洋性沈積物に関する観察

Cl. FROGET: Les sources thermales sulfureuses de l'anse d'Arnette (W de Cap Couronne, Bouches-du-Rhône), Premières observations......229-235.
アーネット入江（クーロンヌ岬の西，ブーシェ・ド・ローヌ県）の硫黄泉——第1回観察

G. PALAUSI: Hydrogéologie des Iles de Lérins (Alpes Maritimes) ....237-244.
レラン島（アルプ・マリチーム県）の水域地質学

"Recueil des Trav. Station Mar. Endoume, 53 (37), 1965."

同誌, **53** (37), 1965

M. MINAS: Aperçu hydrologique préliminaire sur l'Etang de Berre.........................3-10.
ベール池の水域地質学的予報

M. MINAS: Distribution verticale de la matière organique et de la fraction calcaire dans les sédiments de l'Etang de Berre. ....11-17.
ベール池の沈殿物中の有機物および石灰質性画分の垂直分布

H. J. CECCALDI: Carotenoproteides: **4.** Electrophorèse des Protéines des oeufs du Homard *Homarus gammarus* (L.)...................19-25.
カロチノイド色素蛋白質: 4, *Homarus gammarus* L.（オホツメエビの類）の卵蛋白の電気泳動

H. J. CECCALDI: Carotenoproteides: **5.** Electrophorèse des protéines de la carapace du Homard *Homarus gammarus* (L.) ....27-35.
カロチノイド色素蛋白質: 5, オホツメエビの甲殻の蛋白質の電気泳動

M. LE BOURHIS: Etude biochimique et physiologique des pigments de l'algue *Bangia fuscopurpurea* (Dillwyn) Lyngbye. ....37-149.
Bangia fuscopurpurea (Dillwyn) Lyngbye（紅藻類，ウシケノリの類）の生化学および生理学的研究

C. PATRITI: Contribution à l'étude de Siphonophores Calycophores recueillis dans le Golfe de Gascogne. Note préliminaire 1. Campagne du "Job ha Zélian" (Juillet-Août 1964) ....151-160.
ガスコーニュ湾で採集した管水母の研究．予報 1. "Job ha Zélian" の航海（7～8 月，1964）

M. LEVEAU: Contribution à l'étude des Ostracodes et Cladocères du Golfe de Marseille.....161-246.
マルセーユ湾の介虫類および枝角類の研究

R. HIPEAU-JACQUOTTE: Note de faunistique et de biologie marines de Madagascar. III. Un nouveau Décapode nageur (P*ontoniinae*) associé aux Oursins dans la région de Tuléar; *Tuleariocaris holthuisi* nov. gen. et. nov. sp.................247-260.
マダガスカルの動物相と海洋生物学的記録．Ⅲ．遊泳性の十脚類（トレアー地方のウニとの動物群集）の新属新種，*Tuleariocaris holthuisi*.

J. P. REYS: *Crystallophrisson gutturosum* (Kowalewsky) nouveau représentant des Mollusques Aplacophores en Méditerranée................261-262.
地中海産軟体動物無枝類の新代表*Crystallophrisson gutturosum* (Kowalewsky)

S. REYS: Note préliminaire sur les Ostracodes d'un sable fin organogène. ....263-275.
有機性の細砂粒の介虫類に関する予報

R. GIOVANNINI: Révision des espèces benthiques méditerranéennes du genre Hyale. ......277-340.
地中海産底棲 Hyale 属（カメガイの類）の修正

J. LABOREL: Note préliminaire sur les récifs de grès et récifs de coraux dans le Nord-Est brésilien. ....341-344.
ブラジル北東域の砂岩礁および珊瑚礁に関する予察記録

（野村　正）

名誉会員日高孝次博士

モナコ大公アルベール一世記念メダル受賞さる

1965年度の「モナコ大公アルベール一世記念メダル」が，日仏海洋学会名誉会員日高孝次博士に授与された。まことにおめでたいことである。本学会にとっても名誉なことで，御同慶の至りである。

モナコ大公アルベール一世（1848–1922）は，海洋調査船イロンデル（Hirondelle）I，II 号，プリンセス・アリス（Princess Alice）I，II 号を建造し，これによって赤道から北極圏までの北大西洋や地中海を観測して海洋物理，海洋生物の面において多くの貴重な成果を挙げた。また，モナコに海洋博物館をつくり，そこに多くの研究室を併置した。当時，世界一流の海洋学者がそこに集まり，海洋学者のメッカとなった。さらに，パリに海洋研究所をつくりフランス国民に寄贈した。パリ大学付属海洋研究所がそれである。

大公の没後，1948年に至りモナコ大公アルベール一世記念会が設立され，この記念メダルができた。この記念メダルは，毎年一件づつ原則としてフランスと外国の海洋学者に交互に授与されることになった。

1948年には，モナコ大公ルイ二世とパリ大学海洋研究所に授与された。

1949年に第3号がスエーデンのハンス・ペッテルソン（Hans Pettersson）に授与せられて以来，毎年授与せられている（1961年には授与はなかった）。

そして，1965年に第 18 号が本学会の名誉会員日高孝次博士に授与されたわけである。

この記念メダルは，直径 125 mm，赤銅製で表面にアルベール大公の肖像を刻み，裏面にはミネルバの女神が月桂樹を捧げている像と受賞者の姓名およびメダルの号数が刻んである（写真参照）。

（日仏海洋学会長　佐々木忠義記）

モナコ大公アルベール一世紀念メダル

表　　　　裏

録事

1. 昭和 41 年7月 22 日，理化学研究所において編集委員会が開かれ，第4巻第3号および第4号の編集を行なった。

2. 昭和 41 年7月 25 日，東海大学同窓会望星クラブ（新宿，東海ビル9階）において例会が開かれ約60名の出席者をえて盛会であった。講演題名および講演者は次の通りである。

コンビーナー：高野健三（東大・海洋研）

座長：永田　豊（東大・理）

1．海面上の風の応力　岩田憲幸（防災センター）

2．海洋測器について　岩下光男（東海大・海洋）

座長：宮崎正衛（気象庁）

3．第2回国際海洋学会議（モスコー）について

岩田憲幸（防災センター）
宇田道隆（東水大）
星野通平（東海大・海洋）
猿橋勝子（気象研）

座長：岩下光男（東海大・海洋）

4．第2回海洋科学，海洋工学会議（ワシントン）について　佐々木忠義（東水大，理研）

なお，講演終了後討論が行なわれ，引き続き軽食をとりながら懇談し盛会であった。

3. 下記の諸氏が入会された。

氏名	所属	紹介者
青木　洋	（株）イワキ	佐々木忠義
畑　幸彦	高知大・農	竹田正彦
黒田一紀	神戸海気	大久保勲
篠田厚	東水大	永田正
小池英夫	産経新聞	佐々木忠義
山城宏之	矢島建設	大柴五八郎
吉永勝秀	東水大	佐々木忠義
冨　和一	石川県水試	〃
小林平八郎	東大・地震研	梶浦欣二郎
須賀次郎	東亜潜水(株)	山中鷹之助
鳥羽良明	京大・理	佐々木忠義

4. 会員の住所，所属の変更

氏名	新住所または新所属
神田献二	神奈川県平塚市竜城ケ丘3番 39 号
村田義男	千葉市朝日ケ丘 3168-17
堀口孝男	東京都千代田区霞ケ関 1-2 運輸省港湾局防災課
井上直一	函館市港町　北海道大学北洋水産研究施設
西沢　敏	〃
梶原昌弘	〃
長野泰一	東京都港区芝白金三光町　北里研究所

町名表示変更

氏名	新住所または新所属
星野通平	東京都文京区小日向 1-19-4

5. 佐々木会長は昭和 41 年5月 26 日，ソ連モスコーにて開催された第2回国際海洋学会議並びに米国ワシントンにて開催された第2回海洋科学，海洋工学会議に出席，あわせて関連分野の研究，調査のため渡航され7月4日帰朝された。

日仏海洋学会役員

顧問　ルネ・カピタン　ユベール・ブロッシェ　ジャン・デルサルト

名誉会長　ジャック・ロベール

会長　佐々木忠義

常任幹事　大柴五八郎，永田　正，村上　脩

幹事　今村　豊，岩下光男，川口守一，神田献二，菊地真一，高野健三，高木和徳，西村　実，松尾邦之助，丸茂隆三，溝口哲夫，山中鷹之助

監事　高山重嶺，三宅泰雄

評議員　赤松英雄，阿部友三郎，阿部宗明，新崎盛敏池松政人，石井一美，石野　誠，市村俊英，井上　直一，井上　実，今井丈夫，今村　豊，入江春彦，岩崎秀人，岩下光男，岩田憲幸，上野福三，宇田道隆，内田清一郎，宇野　寛，江上不二夫，大内正夫，大久保勲，大島泰雄，大柴五八郎，大村秀雄，岡部史郎，小沢敬次郎，小野弘平，梶浦欣二郎，金谷太郎，川合英夫，川上太左英，川村輝良，川村文三郎，川口守一，川原田　裕，神田献二，菊地真一，鬼頭正隆，木村喜之助，草下孝也，楠　宏，国司秀明，黒木敏郎，黒沼勝造，久保伊津男，小林　博，小牧勇蔵，近藤　仁，西条八束，斎藤泰一，斎藤行正，坂本市太郎，佐々木忠義，佐々木幸康，猿橋勝子，椎野秀雄，柴田恵司，下村敏正，庄司大太郎，末広恭雄，杉浦吉雄，須藤英雄，関根　隆，高野健三，高橋淳雄，高山重嶺，高木

和徳，田畑忠司，田村　保，千葉卓夫，辻田時美，土屋靖彦，寺本俊彦，冨永政英，鳥居鉄也，中井甚二郎，中野猿人，永田　正，永田　豊，永野泰一，奈須敬二，奈須紀幸，南日俊夫，新野　弘，西村　実，新田忠雄，根本敬久，野村　正，花岡　資，速水頌一郎，半沢正男，半谷高久，菱田耕造，日比谷　京，檜山義夫，平野敏行，深沢文雄，福島久雄，福富孝治，淵　秀隆，藤田亀太郎，星野通平，増沢譲太郎，松江吉行，松尾邦之助，松崎卓一，松平近義，松平康男，丸茂隆三，溝口哲夫，三宅泰雄，宮崎千博，宮崎正衛，向井正幸，村上　脩，元田　茂，森川光郎，森田良美，森安茂雄，安井　正，矢部　博，山路　勇，山中鷹之助，山中一，依田啓二，渡辺貫太郎，渡辺精一，渡辺信雄

（50 音順）

モーリス・アンコントル，アンドレ・エービー，フランソア・グランリー，マルセル・ジュクラリウス，ピエール・ルイ・ブラン，ロジェ・ペリカ，ピエール・サン・ルー

訂正表

うみ 第4巻 第2号

ページ	行	誤	正
101	左 8	Sts. at	at Sts.
105	右 27	Antartic	Antarctic
108	左下より 4	$+\nabla(\eta\nabla u)-fu$	$+\nabla(\eta\nabla v)-fu$
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	〃	$\nabla\left[\eta\left(\int_{-H}^{\zeta}\varpi dz\right)\right]$	$\nabla\left[\eta\nabla\left(\int_{-H}^{\zeta}\varpi dz\right)\right]$
	右下より 6	$\nabla[\eta\Delta\varpi]$	$\nabla[\eta\nabla\varpi]$
109	左 13	$e^{-\alpha^2+\alpha^2}d\alpha d\beta$	$e^{-(\alpha^2+\beta^2)}d\alpha d\beta$
	左下より 11	$\varpi^t\equiv$	$\varpi'\equiv$
	左下より 3	$\int^{+\infty}$	$\int_{-\infty}^{+\infty}$
	右 13	$-\frac{Ky}{f}$	$-\frac{f}{Ky}$
110	Fig. 3	(a) in case of eastern flow.	(a) in case of western flow.
	〃	(b) in case of western flow.	(b) in case of eastern flow.
127	頭註	REPRODUKTION	REPRODUCTION
135	左 3	デザイン	果，デザイン
	左 4	果	削除
	左下より 1	上記のよう	下記のよう
138	左 3	竹村　伸	竹松　伸

英仏和，海洋・水産学用語集 (S~Z)

Vocabulaire anglais-français-japonais de l'océanographie et des pêches (S~Z)

番号	英	仏	和
		S	
1223	S_2 component (constituent)	composante S_2; onde solaire principale semi-diurne	S_2 分潮
1224	salinity	salinité	塩分
1225	salinity determination	dosage de salinité; détermination de la salinité	塩分検定
1226	salinocline	salinocline	塩分躍層
1227	salinometer	salinomètre	塩分計
1228	salt error	erreur de sel	塩誤差
1229	sample water	échantillon d'eau	試水
1230	sampling	récolte; collection; levée; échantillonnage; prélèvement	採集
1231	sand bank	banc de sable	砂たい
1232	sand bar	barr de sable	砂州
1233	sand bottom facies	faciès du fond sableux	砂底相
1234	sand ripple	ride de sable	砂紋
1235	sandy	sableux; sablonneux	砂質の
1236	sandy bottom	fond sableux (de sable)	砂底
1237	saprophytic bacteria	bactérie saprophytique	腐生細菌
1238	saprozoic nutrition	nutrition saprozoïque	腐敗動物栄養
1239	Sarcodina (L.)	Sarcodines	肉質虫類; 仮足類
1240	saturation	saturation	飽和
1241	scale	échelle	尺度，スケール
1242	scale of swell	échelle des houles	うねりの階級
1243	scale of wind wave	échelle des vagues	風浪階級
1244	Scaphopoda (L.)	Scaphopodes	掘足類
1245	scatter; scattering	diffusion	散乱
1246	scattered light	lumière duffusée	散乱光
1247	scatterer	diffuseur	散乱体
1248	scattering coefficient	coefficient de diffusion	散乱係数
1249	scavenger	boueur; balayeur	清掃生物; 補集剤（元素の）
1250	Schizopoda (L.)	Schizopodes	裂脚類
1251	SCUBA (self-contained underwater breathing apparatus)	scaphandre autonome	潜水肺; アクアラング
1252	Scyphomedusae (L.)	Scyphoméduse	はちくらげ類
1253	sea	mer	海洋; 海
1254	sea chart	carte marine	海図
1255	sea ice	glace de mer	海氷
1256	sea (tide) level	niveau de la mer	潮位
1257	sea-level departure	déviation du niveau de la mer	潮位偏差
1258	sea-mount	montagne sous-marine	海山
1259	sea noise	bruit marin	海鳴り
1260	sea salt	sel de mer	海塩

1261	sea surface	surface de mer	海面
1262	sea surface roughness	rugostité de la surface de mer	海面のあらさ
1263	sea wall	digue	防潮壁
1264	sea water	eau de mer	海水
1265	sea weed	algue marine	海藻
1266	seasonal change (variation)	variation saisonnière	季節変化
1267	seasonal (climatic) migration	migration saisonnière	季節回遊
1268	Secchi disc	disque de Secchi	透明度板
1269	section	section	断面
1270	secular variation	variation séculaire	永年変化
1271	sediment	sédiment	たい積物
1272	sedimentary environment	environnement sédimentaire	たい積環境
1273	sedimentary facies	faciès sédimentaire	たい積相
1274	sedimentary petrology	pétrologie sédimentaire	たい石岩岩石学
1275	sedimentary rock	roche sédimentaire	たい積岩
1276	sedimentation	sédimentation	たい積
1277	sedimentology	sédimentologie	たい積学
1278	seiche	seiche	セイシュ
1279	seismic prospecting	prospection séismique	地震探査
1280	seismic zone	zone des séismes	地震帯
1281	self-purification	auto-purification	自浄作用
1282	self-registering thermometer	thermomètre enregistreur	記録温度計
1283	semi-diurnal current	courant semi-diurne	半日周潮流
1284	semi-diurnal tide	marée semi-diurne	半日周潮
1285	semi-range	semi-marnage	半潮差
1286	sessile egg	œuf sessile	付着卵
1287	seston	seston	セストン
1288	sewage	eaux d'égout	下水
1289	shade flora	flore ombrophile; plante d'ombre	陰性植物
1290	shallow water	eau de faible (petite) profondeur; eau peu profonde	浅海水
1291	shallow water wave	onde en eau peu profonde	浅海波（浅水波）
1292	shear; shear line	cisaillement; gradient normal de vitesse ligne de cisaillement	シャー線
1293	shear (friction) velocity	vitesse de frottement	摩擦速度
1294	shear zone	zone de cisaillement	シャー帯
1295	shearing stress	force de cisaillement (dans un écoulement à gradient)	切線応力
1296	shelf edge	rebord du plateau	大陸だな外縁
1297	shelf sediment	sédiment au plateau continental	大陸だなたい積物
1298	shelf seiche	seiche sur plateau continental	たなセイシュ
1299	shell	coquille	貝がら
1300	shell bottom	fond coquiller	貝がら底
1301	shell sand	sable coquillier; débris de coquilles	貝がら砂
1302	sheltering coefficient	coefficient d'abri (c. d'épaulement)	しゃへい係数
1303	ship born wave recorder	enregistreur de houle de bord	船上波浪計
1304	shoal	bas-fond; haut-fond	浅所
1305	shock wave	onde de choque	衝撃波
1306	shore line	ligne côtière	海岸線；てい線

1307	shore ice	glace côtière	沿岸氷
1308	shore process	processus littoral	沿岸過程
1309	shore zone	zone littorale	沿岸域
1310	short-crested wave	onde à courtes crêtes	切れ波(峰の短かい波)
1311	siderite	sidérite	りょう鉄鉱
1312	sieve	tamis; crible	ふるい
1313	sigma-t; σ_t	sigma-t; σ_t	シグマ・ティー
1314	significant wave	onde (houle) significative	有義波
1315	significant wave height	hauteur d'onde significative	有義波高
1316	significant wave period	période d'onde significative	有義波周期
1317	silicate-silicon	silice sous forme de silicate: silicium silicate	ケイ酸塩ケイ素
1318	silicious ooze	vase silicieuse	ケイ質軟でい
1319	silicious sediment	sédiment silicieux	ケイ質たい積物
1320	Silicoflagellata (L.)	Silicoflagellés	ケイ質べん毛虫類
1321	sill	seuil	峠状部
1322	sill depth	profondeur de seuil	しきい深度
1323	sinking	plongée d'eau	沈降
1324	Siphonophora (L.)	Siphonophores	管くらげ類
1325	Sira-plankton	plancton à sira	シラプランクトン
1326	“sirasu” stage	stade “Sirasu” (de la sardine)	しらす期(幼)
1327	skotoplankton	scotoplancton	けん光性プランクトン
1328	slack; slack water	étale de courant	潮だるみ
1329	slope current	courant de pente	傾斜流
1330	sludge	sludge	海綿氷
1331	slush; sludge	bouillie glacée	軟氷
1332	snow-covered ice	glace couverte de neige	載雪氷
1333	S-N ratio	rapport signal-bruit	S-N 比
1334	SOFAR (sound fixing and ranging)	SOFAR	ソーファー
1335	solar annual tide	onde solaire annuelle	太陽年周潮
1336	solar diurnal tide	onde solaire diurne	太陽日周潮
1337	solar semiannual tide	onde solaire semi-annuelle	太陽半年周潮
1338	solar tide	onde solaire	太陽潮
1339	solenoidal field	champ solénoïdal	ソレノイド場
1340	solitary wave	onde solitaire	孤立波
1341	solitical tides	marée solsticale	至点潮
1342	SONAR (sound navigation and ranging)	SONAR	ソーナー
1343	sonic scattering layer	couche diffusante sonore	音波散乱層
1344	sound channel	chenal sonore	音速最小層
1345	sounding	sondage	測深
1346	sounding machine	sondeur; machine à sonder	測深機
1347	sounding tube	perche de sondage	測深管
1348	sounding wire	fil de sonde	測深索
1349	South China Sea	mer de Chine méridionale	南シナ海
1350	spawning ground	frayère	産卵場
1351	spawning migration	migration reproductrice	産卵回遊
1352	species	espèce	種
1353	specific activity	activité spécifique	比放射能

1354	specific alkalinity	alcalinité spécifique	比アルカリ度
1355	specific gravity	gravité spécifique	比重
1356	specific gravity *in situ*	gravité spécifique in situ	現場比重
1357	specific heat	chaleur spécifique	比熱
1358	specific volume	volume spécifique	比容
1359	specific volume anomaly	anomalie de volume spécifique	比容異常
1360	specific volume *in situ*	volume spécifique in situ	現場比容
1361	spherical wave	onde sphérique	球面波
1362	spilling breaker	déferlement à déversement	くずれ波
1363	sponge	éponge	海綿
1364	spray fscia	zone des embruns	しぶき帯（生物）
1365	spring out-burst; spring flowering	prolifération printanière des diatomées; grande poussée printanière	春期大増殖（けい藻類の）
1366	spring range	amplitude en vives-eaux	大潮差
1367	spring rise	hauteur de la pleine mer de vives-eaux	大潮高
1368	spring tides	vives-eaux	大潮
1369	Sprungschicht (Ger.)	couche de transition	躍層
1370	stable isotope	isotope stable	安定同位元素（体）
1371	stagnant water	eau stagnante	停滞水
1372	stagnation	stagnation	停滞
1373	stand of tide	étale de la marée	停潮
1374	standard depths	profondeurs standard	標準深度
1375	standard (reference) port	port de référence	標準港
1376	standard sea level	plan de référence	基本水準面
1377	standard sea water	eau normale (de Copenhague)	標準海水
1378	standard time	heure légale	標準時
1379	standardization	calibrage	無網試験（プランクトンネットの）
1380	standing (stationary) wave	clapotis; onde stationnaire	定常波
1381	state of ice	état de glace	氷況
1382	state of sea	état de la mer	海面状態
1383	station	station	（観）測点
1384	stationary (standing) wave	onde stationnaire; clapotis	定常波
1385	steady (state)	(état) permanent	定常な（状態）
1386	stenohaline	sténohaline	狭塩性の
1387	stenothermal	sténothermique	狭温性の
1388	step resistance wave recorder	perche à contacts électriques	段形抵抗波浪計
1389	stereophotogrammetry	stéréophotogrammétrie	立体写真測量
1390	sterilization	stérilisation	滅菌
1391	still water level	niveau de l'eau en repos	静水面
1392	Stokes wave	onde de Stokes	ストークス波
1393	Stomatopoda (L.)	Stomatopodes	口脚類
1394	stone	pierre; caillou; grès	石
1395	storm surge (tide)	onde de tempête	風津波（高潮）
1396	storm wave	onde de tempête	暴風波
1397	strait	détroit	海峡
1398	strand-line	ligne côtière	てい線
1399	stratosphere	stratosphère	成層圏

1400	stream line	ligne de courant	流線
1401	strobila	strobile	横分体（幼）
1402	styli-plankton	styliplancton	スチリプランクトン
1403	Subantarctic Intermediate Water	eau intermédiaire subantarctique	亜南極中層水
1404	Subarctic Intermediate Water	eau intermédiaire subarctique	亜北極中層水
1405	sublittoral	sublittoral	亜沿岸の
1406	submarine caldera	caldéra sous-marin	海底カルデラ
1407	submarine canyon	canyon sous-marine (sillon)	海底峡谷
1408	submarine explosion	explosion sous-marine	海底爆発
1409	submarine exploration	exploration sous-marine	海底開発
1410	submarine fault	faille sous-marin	海底断層
1411	submarine forest	forêt sous-marin	藻場
1412	submarine geophysics	geophysique sous-marine	海底（地球）物理
1413	submarine illuminance	luminosité sous-marine	海中照度
1414	submarine morphology	morphologie sous-marine	海底形態学
1415	submarine photometer	photomètre sous-marin	海中光度計
1416	submarine radiation	radiation sous-marine	海中放射
1417	submarine resources	ressources sous-marines	海底資源
1418	submarine ridge	seuil sous-marin	海底山脈
1419	submarine technology	génie civil sous-marin	海中工学
1420	submarine terrace	terrace sous-marine	海底段丘
1421	submarine topography	topographie sous-marine	海底地形
1422	submarine valley	vallée sous-marine	海底谷
1423	submarine volcano	volcan sous-marin	海底火山
1424	submarine weathering	efflorescence sous-marine	海底風化
1425	subneritic	subnéritique	亜浅海の
1426	Subpolar Intermediate Water	eau intermédiaire subpolaire	亜極中層水
1427	subspecies	sous-espèce	亜種
1428	subtidal	subtidal	下干潮帯の（生物）
1429	subtropical	subtropical	亜熱帯の
1430	Subtropical Convergence	convergence subtropicale	亜熱帯収束線
1431	Subtropical Subsurface Water	eau sub-superficielle subtropicale	亜熱帯次表層水
1432	succession	succession	遷移（生物）
1433	sulfate reducing bacteria	bactéries sulfato-réductrices; bactéries réductrice de sulfate	硫酸塩還元細菌
1434	sulfur bacteria	bactéries sulfureuses	いおう細菌
1435	surfur-oxidizing bacteria	bactéries thiooxydants; bactérie oxydant le soufre	いおう酸化細菌
1436	sunken rock	récif	暗礁
1437	supersaturation	supersaturation	過飽和
1438	surf	battement de déferlement	いそ波
1439	surf beats	battement de déferlement	サーフ・ビート
1440	surf zone	zone de déferlement	いそ波帯
1441	surface current	courant de surface	表面流
1442	surface layer	couche superficicielle	表層
1443	surface layer current	courant de couche superficielle	表層流
1444	surface layer water	eau de couche superficielle	表層水
1445	surface observation	observation de surface	表面観測

1446	surface temperature	température de surface	表面水温
1447	surface tension	tension superficielle	表面張力
1448	surface water	eau de surface	表面水
1449	surface water sampling	prélèvement (levée) de l'eau de surface	表面採水
1450	surface wave	onde de surface	表面波
1451	surging breaker	déferlement à gonflement	まき波
1452	survival rate	taux de survie; taux de survivance	生存率
1453	suspended material (matter)	matières en suspension	懸濁物
1454	suspended particle	particule non dissoute	懸濁粒子
1455	sawash	courant de houle	打上げ波
1456	swell	houle; houle longue	うねり
1457	synecology	synécologie	群生態学
1458	synoptic chart	carte synoptique	総観図
1459	synoptic wave chart	carte synoptique de houle	（総観）波浪図

T

1460	T-S curve	courbe T-S	T-S 曲線
1461	T-S diagram	diagramme T-S	T-S 図
1462	tabular berg	iceberg tabulaire	卓状氷山
1463	tadpole-larva	têtard-larve; têtard ascidian	おたまじゃくし形幼生
1464	tagging experiment	expérience de marquage	標識放流
1465	tangential stress	tension tangentielle	接線応力
1466	tapered wire	cable conique	先細りワイヤー
1467	temperate	tempéré	温帯の
1468	temperature gradient	gradient de température	温度傾度
1469	temperature measurement (observation)	mesure de température	測温
1470	terdiurnal tide	marée tiers-diurne	三分の一日周潮
1471	terrestrial heat flow through the ocean floor	flux de chaleur terrestre à travers le fond océanique	海底地かく熱流量
1472	terrigenous	terrigène	陸性の
1473	thanatocoenose	thanatocoenose	遺がい群集
1474	thermal (heat) conductivity	conductivité thermique	熱伝導率
1475	thermal equator	équateur thermique	熱赤道
1476	thermocline	couche de transition; thermocline	水温躍層
1477	thermodynamic circulation	circulation thermodynamique	熱力循環
1478	thermograph	thermomètre enregistreur	記録温度計
1479	thermohaline circulation	circulation thermohaline	熱塩循環
1480	thermometer	thermomètre	温度計
1481	thermometric depth	profondeur thermométrique	被圧深度
1482	thermometric sounding	sondage thermométrique	温度測深
1483	thermosteric anomaly	anomalie thermostérique	サーモステリックアノマリー
1484	thick winter-ice	glace hivernale épaisse	厚い一冬氷
1485	tholichthys	stade tholichthys	トリクチス期（幼）
1486	thyotroph	thyotrophe	でい食性
1487	tidal analysis	analyse harmonique des marées	調和分析（潮せきの）
1488	tidal bore	mascaret	ボア
1489	tidal constant	constantes de marée	潮せき定数
1490	tidal current	courant de marée	潮流
1491	tidal current table	table des courants de marée	潮流表

1492	tidal energy	énergie des marées	潮せきのエネルギー
1493	tidal friction	frottement des marées	潮せき摩擦
1494	tidal observation	observation des marées	潮せき観測
1495	tidal period	période des marées	潮せきの周期
1496	tidal power plant (station)	usine marémotrice	潮せき発電所
1497	tidal race	raz	しお波
1498	tidal range	marnage	潮差
1499	tidal stream	courant de marée	潮流
1500	tidal well	puits	検潮井戸
1501	tide	marée	潮せき；潮
1502	tide curve	courbe de marée	潮候曲線
1503	tide gauge	marégraphe	検潮器
1504	tide-generating force; tide-raising force; tide-producing force	force génératrice (productrice) de la marée	起潮力
1505	tide (sea) level	niveau de la mer	潮位
1506	tide pole	échelle de la marée	検潮柱
1507	tide pool	cuvette rocheuse (de la zone des marées)	潮だまり
1508	tide predicting machine; tide predictor	tide-predictor	潮候推算器
1509	tide table	annuaire des marées; table des marées	潮せき表
1510	tide wave	onde de marée	潮せき波
1511	time of high water	heure de la pleine mer	高潮時
1512	time of low water	heure de la basse mer	低潮時
1513	time of turn of tide	heure de renverse du courant	転流時
1514	timer	minuterie; chronométreur	タイマー
1515	Tintinnoinea (L.)	Tintinnides; Tintinnoïdiens	チンチヌス類
1516	tombolo	presqu'île	陸係島
1517	total solid	solide total	全固形物
1518	tow-net	filet remorqué; filet traîné	水平びきネット
1519	tracer	traceur	トレーサー
1520	trajectory	trajectoire	流跡線
1521	transition layer	couche de transition	躍層
1522	transoceanic migration	migration transocéanique	渡洋回遊
1523	transparency	transparence	透明度
1524	transparent layer	couche transparente	透明層
1525	transport	transport	輸送
1526	travel time	temps de propagation	走時
1527	travel time-distance curve	courbe de propagation	走時曲線
1528	trench	fossé; fosse	海こう
1529	triangulation	triangulation	三角測量
1530	trinodal seiche	seiche trinodal	三節セイシュ
1531	tripos-plankton	plancton à tripos; triposplancton	トリポスプランクトン
1532	trochoidal wave	onde trochoïdale	トロコイド波
1533	trochophore	trichophore	トロコフォラ（幼）
1534	trophotropism	trophotropisme; tropisme trophique	食じ走向性
1535	tropic inequality	inégalité tropique	回帰潮不等
1536	tropic tides	marée tropique	回帰潮
1537	tropical	tropical	熱帯の

1538	tropical convergence	convergence tropicale	熱帯収束線
1539	tropical surface water	eau superficielle tropicale	熱帯表層水
1540	tropical waters	eaux tropicales	熱帯水域
1541	tropopause	tropopause	圏界面
1542	troposphere	troposphère	対流圏
1543	trough	dépression; cuvette	舟状海盆
1544	tsunami	tsunami; raz de marée	津波
1545	Tunicata (L.)	Tuniciers	皮のう類
1546	turbid layer	couche turbide	濁り層
1547	turbid water	eau turbide	濁り水
1548	turbidimeter	turbidimètre	濁度計
1549	turbidity	turbidité	濁り度
1550	turbidity current	couraut de turbidité	乱でい流
1551	turbidity factor	facteur de turbidité	濁り係数
1552	turbulence	turbulence	乱れ
1553	turbulent boundary layer	couche limite turbulente	乱流境界層
1554	turbulent flow	écoulement turbulent	乱流
1555	turn of tide	renverse du courant	転流
1556	tychoplankton	tychoplancton	臨時性プランクトン
1557	typhoon	typhon	台風

U

1558	ultrafiltration	ultrafiltration	限外ろ過
1559	ultraplankton	ultraplancton	極微プランクトン
1560	undercurrent	courant sous-marin	潜流
1561	undersaturation; unsaturation	non-saturation; insaturation	不飽和
1562	undertow	courant de compensation près du fond	底引き（波の）
1563	underwater acoustics	acoustique sous-marine	水中音響学
1564	underwater camera	appareil de photo sous-marin	水中写真機
1565	underwater forest	forêt sous-marin	藻場
1566	underwater noise	bruit sous-marin	水中騒音
1567	underwater photometer	photomètre sous-marin	水中光度計
1568	underwater photography	photographie sous-marine	水中写真
1569	underwater sound volocity	vitesse de son sous-marine	水中音速
1570	underwater television	télévision sous-marine	水中テレビジョン
1571	underwater technology	génie civil sous-marin	海中工学
1572	uninodal seiche	seiche uninodal	単節セイシュ
1573	unprotected thermometer	thermomètre non-protégé	被圧温度計
1574	uprush	courant de houle	打上げ波
1575	upwelling	remontée (d'eau); upwelling	上昇流；上昇
1576	urea-splitting bacteria	bactérie clivant l'urée	尿素分解細菌

V

1577	valley	vallée	谷
1578	veliger	vélligère	ベリジャー（幼）
1579	Vertebrata (L.)	Vertébrés	脊つい動物
1580	vertical attenuation coefficient	coefficient d'extinction verticale	鉛直消散係数
1581	vertical distribution	distribution verticale	鉛直分布

1582	vertical migration	migration verticale	鉛直回遊
1583	vertical mixing	échange vertical	鉛直混合
1584	vertical movement	mouvement vertical	鉛直移動
1585	vertical stability	stabilité verticale	垂直安定度
1586	very open pack-ice	pack très lâche	極分離流氷
1587	viscosity	viscosité	粘性
1588	viscous drag	force de viscosité	粘性抵抗
1589	visual observation	observation visuelle	目視観測
1590	vital statistics	biostatistique; biométrie	生物統計法
1591	Vitiaz Deep	fosse titiaz	ビチアージ海えん
1592	viviparous	vivipare	胎生の
1593	volcanic	volcanique	火山の
1594	volcanic mud	vase volcanique	火山でい
1595	volcanic sand	sable volcanique	火山砂
1596	volume scattering function	forme de l'indicatrice de diffusion	体積散乱関数
1597	voluntary migration	migration volontaire	自主的回遊
1598	vortex	remous; tourbillon	うず
1599	vortex (eddy) motion	mouvement tourbillonnaire	うず運動
1600	vorticity	tourbillon	うず度
1601	vorticity equation	équation des tourbillons	うず度方程式

W

1602	warm core	veine chaud	ウォーム・コア
1603	warm current	courant chaud	暖流
1604	warm water	eau chaude	暖水
1605	waste effluent	effluent d'égout	廃水
1606	water bottle (sampler)	bouteille de prélèvement	採水器
1607	water budget	bilan d'eau	水収支
1608	water content	teneur en eau	含水量
1609	water level	niveau marin (de mer)	水位
1610	water mass	masse d'eau	水塊
1611	water phial	bouteille d'échantillon; canette	試水（採水）びん
1612	water pressure	pression d'eau	水圧
1613	water sample	échantillon d'eau	試水
1614	water sampler	bouteille de prise d'eau	採水器
1615	water temperature	température d'eau	水温
1616	water type	eau-type	水型
1617	waterpolluting plankton	planctons pollués	汚濁プランクトン
1618	waters	eaux	海域（水域）
1619	wave age	âge de la houle	波令
1620	wave crest	crête d'onde	波の山（峰）
1621	wave current	courant de houle	波成流
1622	wave diffraction	diffraction de l'onde (houle)	波の回折
1623	wave direction	direction de l'onde	波の向き
1624	wave force	force de houle	波力
1625	wave forecast (forecasting)	prédiction de l'agitation de la mer	波浪予報
1626	wave form (profile)	forme (profil) de l'onde	波形
1627	wave front	front de houle	波面

1628	wave generator (machine)	générateur des ondes	波起し機
1629	wave-height	hauteur d'onde	波高
1630	wave hindcast (hindcasting)	hindcast; prévision a postériori	波の追算
1631	wave meter (recorder)	houlomètre	波浪計
1632	wave of condensation and rarefaction	onde de condensation	粗密波
1633	wave orthogonal	orthogonale de houle	波面と波線
1634	wave period	période d'onde	波の周期
1635	wave pressure	pression d'onde	波圧
1636	wave ray	rayon de houle	波線
1637	wave refraction	réfraction de l'onde (la houle)	波の屈折
1638	wave refraction diagram	plan de vagues	波の屈折図
1639	wave reflection	réflexion de l'onde (la houle)	波の反射
1640	wave spectrum	spectre d'onde	波のスペクトル
1641	wave run-up	assaut des vagues	波のはいあがり
1642	wave staff	perche à houle	波浪柱
1643	wave steepness	cambrure (de la houle)	波形こう配
1644	wave train	train d'ondes	波列
1645	wave through	creux	波の谷
1646	wave velocity	vitesse de phase	波速（波の速度）
1647	wave length	longueur d'onde	波長
1648	wavelet	ride	さざ波
1649	wave number	nombre d'onde	波数
1650	weather forcasting	prévision du temps	天気予報
1651	weight	lest	おもり
1652	westward intensification	intensification des courants sur le bord ouest des océans	西岸強化
1653	white cap (horse)	moutons	白波
1654	winch	treuil	ウインチ
1655	wind-driven current	courant dû au vent; courant de dérive	風成海流
1656	wind-mixed layer	couche superificielle brassée par le vent	風による混合層
1657	wind set up	montée de niveau due au vent	吹き寄せ
1658	wind stress	poussée du vent; tension du vent	風の応力
1659	wind surge	onde de tempête	高潮
1660	wind-up	montée de niveau due au vent	風の吹き寄せ
1661	wind wave	vague; mer du vent	風浪
1662	wire angle	angle du câble	ワイヤーの傾角
1663	wire angle gauge	clinomètre	傾斜計
1664	wire sounding	sondage à la ligne	索測深

X

1665	xerobiose; xerobiont	animaux xérophiles	乾性動物
1666	xerophil	xérophiles	耐乾燥性の

Y

1667	year by year variation; yearly variation	variation an-à-an	年々変化
1668	Yellow Sea	mer Jaune	黄海
1669	yellow substance	substance (pigment) jaune	黄色物質

Z

1700	zoea	zoée	ゾエア（幼）
1701	zonal plankton	mésoplancton	中層プランクトン
1702	zonal wind	vent zonal	帯状風
1703	zooplankton	zooplancton	動物プランクトン
1704	Zostera zone	zone zostère	あまも帯

原稿募集

学会誌“うみ”は会員各位の御協力により，ますますその内容が充実されつつあります。なんといっても学会誌は学会活動の本命であります。

今年からは年間4冊発行いたすことになり，すでに第4巻第3号を発行することができました。これもひとえに会員各位の御協力によるもので御同慶の至りであります。

“うみ”は，毎号約300部をフランスに発送いたしております。フランス水路部の機関誌“Cahiers Océanographiques”は“うみ”を毎号紹介しております。

なお，最近はイギリス，ドイツ，アメリカなどの関係機関から購読あるいは交換図書の申込みがあります。このようにして“うみ”は，広範にわたり関係者の注目をひくようになりました。

つきましては，各位の御研究の発表（和文，欧文）や寄稿，資料欄などに奮って御投稿下さいますよう御願いいたします。

編集委員会

なお，**第5巻**の原稿締切並びに発行予定は下記の通りです。

記

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第2号	42年 3月末	〃 5月末
第3号	〃 6月末	〃 8月末
第4号	〃 9月末	〃 11月末

付記：「うみ」表紙2の投稿規定に従って御投稿願います。

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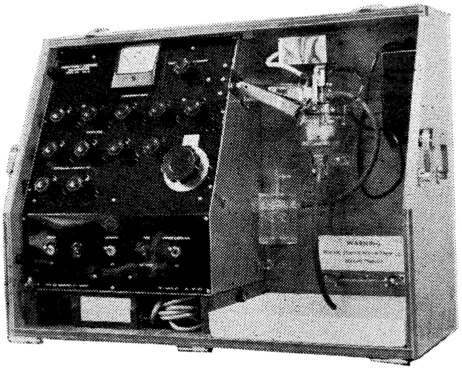
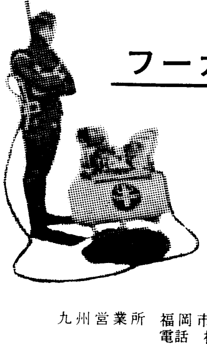
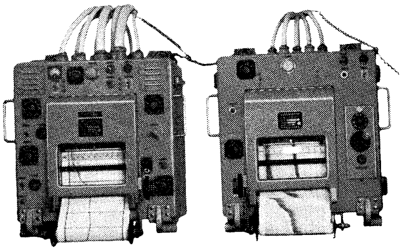




音響測深機　ECHO SOUNDER

精密深海用音響測深機

精密な深海測深を目的としてI. G. Y. 等で使用しているもので測深能力は 13,000m，精度は1／5000 以上の機能を有しています。



PRECISION DEPTH RECORDER

- The main recording apparatus with multiple recording system is able to record the depth of 13,000 meters
- Always keep over 1／5000 of precision because of the crystal controlled recording motor driven by fixed frequency electrical source.

記録レンジ

第一記録機	0 −2000m　0 −2200m　多重記録方式
第二記録機	0 −200m　100m ステップシフト
記録精度	±1／5000
周波数	10KC
記録方式	螺旋状電極線多重記録方式
発振出力	約2KW
増幅方式	ヘテロダイン増幅方式
記録紙	電解式記録紙　紙巾　216mm 有効紙巾 170mm
電源	AC 100 V　60 c/s　1.5KVA

Sounding range

First recorder	0 to 2000m, 0 to 2200m multiple recording system
Second recorder	0 to 200m (100m step shift)

Sounding Precision

Precision of recording pen speed Better than ±1/5000

Frequency	10KC

Recoording system

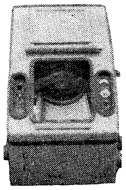
Spiral electrode wire multiple-recording system

Oscillation output	About 2KW
Amplifier system	Heterodyne amplification system First recording channel output 5W second recording channel 10W
Recording paper	Electrolytic recording paper paper width 216mm Effective recording width 170mm
Power source	AC 100V, 60 c/s

極浅海用精密音響測深機

高性能浅海用測深機で、浅海、湖沼、河川、ダム等の精密測深に最適。

記録目盛	0 −10m, 10−20m, ……90−100m 0 −100m　……連続自動記録
精度	± 0.1%
周波数	200K c/s
記録紙	放電破壊記録紙　長サ 10m 巾150m/m
電源	DC 24V　約7.5A



PRECISION ECHO SUNDER FOR SHALLOW

Ideal for surveying shallow seas, harbors, lakes, dame, rivers.

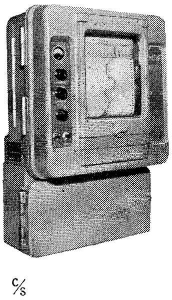
Accurate to 0.1%

Portable and easily removed.

航海用音響測深機

高性能測深機で、客船、貨物船、油槽船、海洋観測船等いづれの船型にも容易に装備でき、操作も簡単で、感度、精度ともすぐれています

記録目盛	0 −120(m)	0 − 720(m)
	100−220(m)	600−1320(m)
	200−320(m)	1200−1920(m)
周波数	23KC	
記録紙	乾式　長サ　10m　巾 150m/m	
電源	AC 100,110,115,200,220,230(V) 60 c/s DC 100,110,115,200,220,230(V)	



ECHO SUNDER FOR NAVIGATION

MARINE GRAPH is most adaptadle to passenger boats cargo boats oceanic observation boats, tankers, etc.

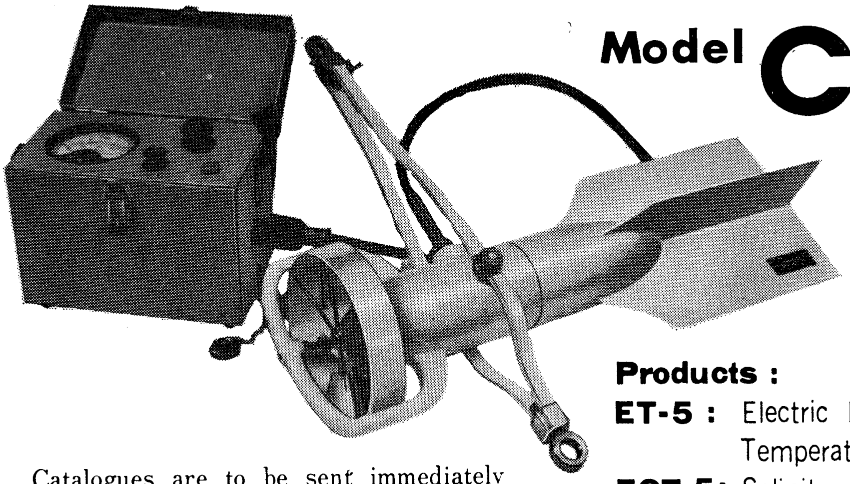
Recoding range	0−120(m)	0− 720(m)
	100−220(m)	600−1320(m)
	200−320(m)	1200−1920(m)
Frequency	23K c/s	
Recording paper	dry type	length 10m width 150m/m
Power source	AC 100,110,115,200,220,230(V) DC 100,110,115,200,220,230(V)	

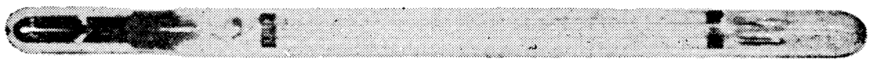
海上電機株式会社

東京都千代田区神田錦町1の19
電話　東京 291局2611−3，8181−3

MARINE INSTRUMENTS CO., LTD.

1〜19 KANDA NISHIKI-CHO, CHIYODA-KU, TOKYO
TEL. TOKYO (291) 2611〜3, 8181〜3
CABLE ADDRESS "MARINEINSTRU" TOKYO





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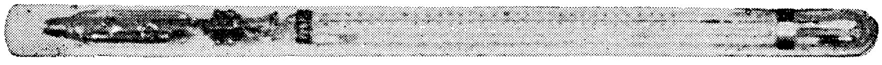


Unprotected

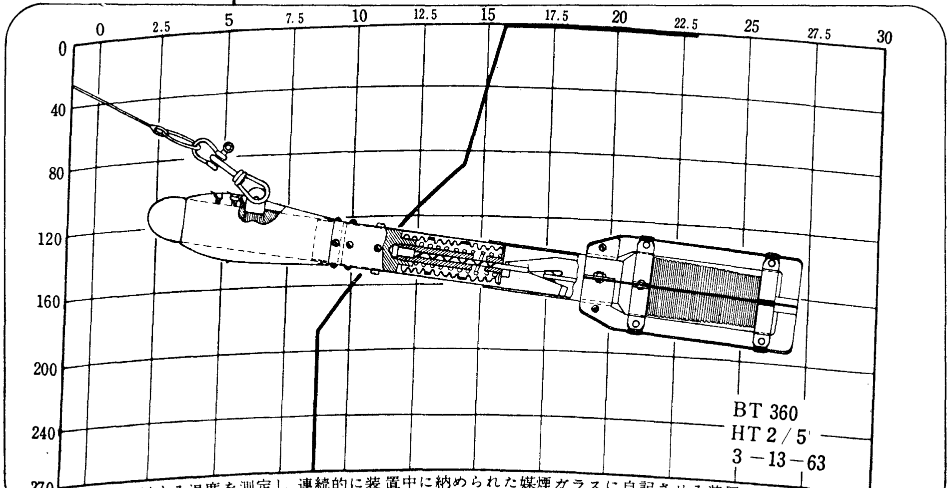
BT BATHYTHERMOGRAPH

NO.2045バシサーモグラフ

（THERMARINE RECORDER）

WALLACE & TIERNAN INC.

NEW JERSEY, U.S.A.



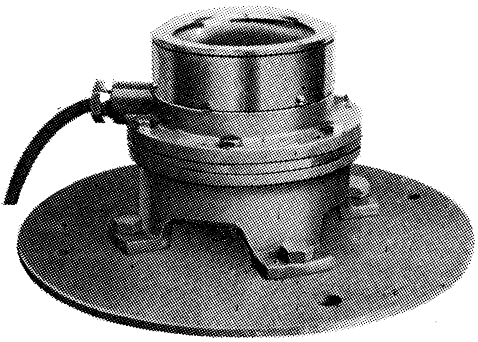
深さに対する温度を測定し、連続的に装置中に納められた媒煙ガラスに自記させる装置。

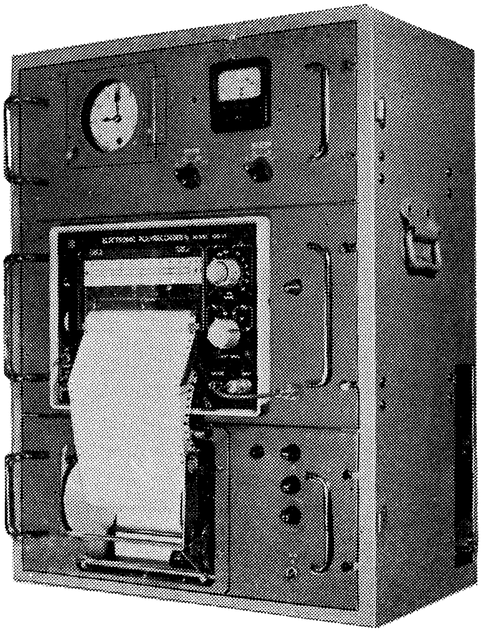
Model	FA－190012	FA－190022	FA－190032
Depth Range	0～60m. （0～200ft.）	0～135m. （0～450ft.）	0～270m. （0～900ft.）
Temp. Range	－1～＋30°C（28～90°F）		

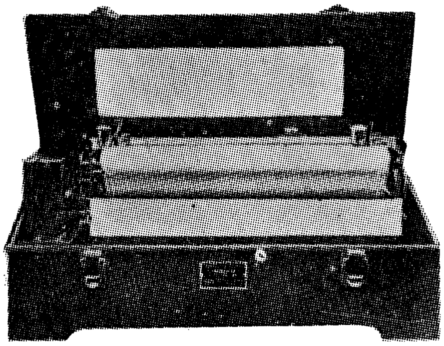
海洋観測器械
日本代理店

株式会社 離合社

本　社　東京都千代田区神田鍛冶町1の2　丸石ビル
電話　東京（252）1511（代表）
大阪営業所　大阪市北区北同心町1の15　電話大阪（351）7346・8019
工　場　東京・浦和







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Matériels et produits pour la soudure
Installations de séparation et de purification de gaz à basse température

Son Département Développement représente au Japon les procédés de nombreuses sociétés, entre autres,

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Société Chimique de la GRANDE PAROISSE
Société d'Electro-chimie, d'Electro-métallurgie et des Aciéries électriques d'UGINE
Compagnie de Filage des Métaux et des Joints Curty (CEFILAC)
Compagnie PECHINEY-SAINT-GOBAIN
Compagnie SAINT-GOBAIN NUCLEAIRE
Compagnie de Produits Chimiques et Electro-métallurgiques PECHINEY
Société KLEBER-COLOMBES
Le Méthane Liquide
Société des Très Basses Températures
Société PRAT-DANIEL
Institut Français du Pétrole
Compagnie Générale de Télégraphie Sans Fil
Compagnie des Compteurs
Société POCLAIN
Société HISPANO-SUIZA
Société NADELLA
Société GURY
Société HYDRO-MECA
Société de Forgeage de Rive de Gier
etc. etc. . . .

22/1 Takamatsu-cho, Hyogo-ku, Kobe, Japan
P. O. BOX No. 522, KOBE PORT JAPAN
(Siège Légal : Nihon Gas Kyokai Bldg. 38, Kotohira-cho, Shiba,
Minato-ku, Tokyo, Japan)


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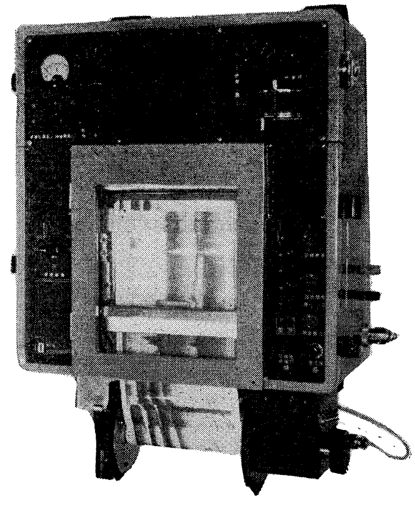

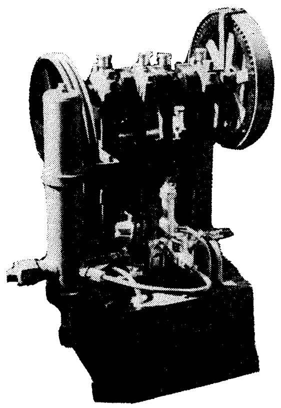

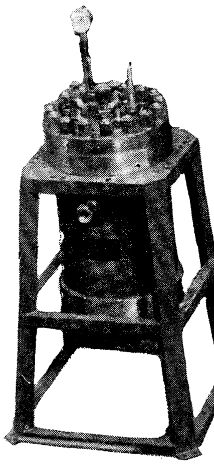

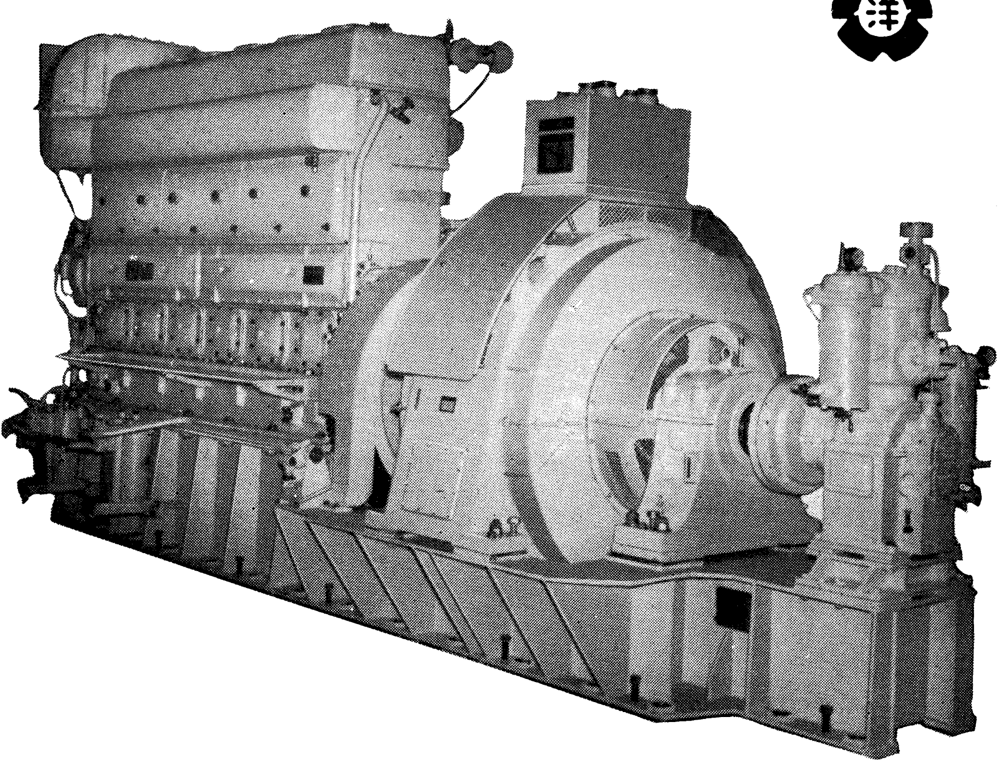

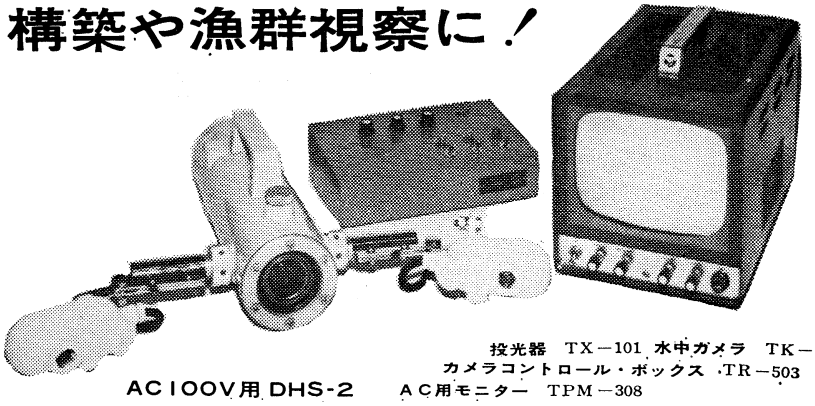

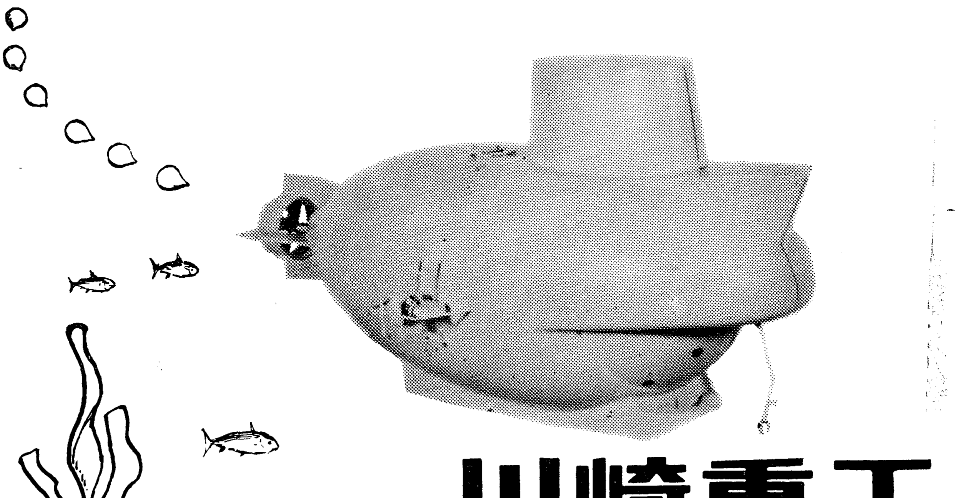

Annonce

Fondation du Prix de la Société franco-japonaise d'océanographie

L'Assemblée générale éventuellement convoquée le 12 Novembre 1965 à la Maison franco-joponaise a reconnu à l'unanimité la fondation du Prix de la Société franco-japonaise d'océanographie. Voici l'essentiel des statuts.

Le Prix est descerné à un (des) membre(s) de la Société franco-japonaise d'océanographie pour ses (leurs) travaux sur l'océanographie ou des pêches, publiés, en principe, dans le Bulletin de la Société franco-japonaise d'océanographie. A cette fin, il est créé le "Comité de recommandation de candidats du Prix de la Société", qui se compose de 13 commissaires élus par le Conseil d'Administration. Le Comité recommande un candidat (des candidats s'il s'agit de travaux en collaboration) au président de la Société. Le président en consulte à son tour le Conseil d'Administration. Le(s) candidat(s) est (sont) admis comme lauréat(s) par la votation du Conseil d'Administration. Le Prix (¥ 30.000) lui (leur) est remis à l'Assemblée générale au mois d'Avril.

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目　　次

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Tome 4　N° 3

SOMMAIRE

Notes originales

Documentations