

On the Fluctuation of Mackerel-long-line Catch under the Influence of the Solar-eclipse

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Introduction

Undoubtedly it is very important to have any researches on the catch-fluctuations in the various types of fishery under the influence of the Solar-eclipse, but that is not the way things are now.

On April 19, 1958, under the annular eclipse of the sun, some investigations were done both on the fluctuation of the Mackerel-long-line Catch and on some oceanographical conditions at the sea, 10 miles south-east off Cape Sata.

In this paper some records were described about the relationships, ascertained to have existed, between the extraneous phenomena observed in the fishing-rate and the environment-factors.

Methods and Results

The results of the observation at Nishino-omote Harbour, "Tane" Island, lying near the fishing ground tell us that the observation of the solar-eclipse was carried out at the lapse of time from 11h 03m* to 14h 43m, and it reached its maximum at about 12h 53m.

It was possible for us to see the eclipse for about 6 minutes, its starting time being 12h 49m 59s.

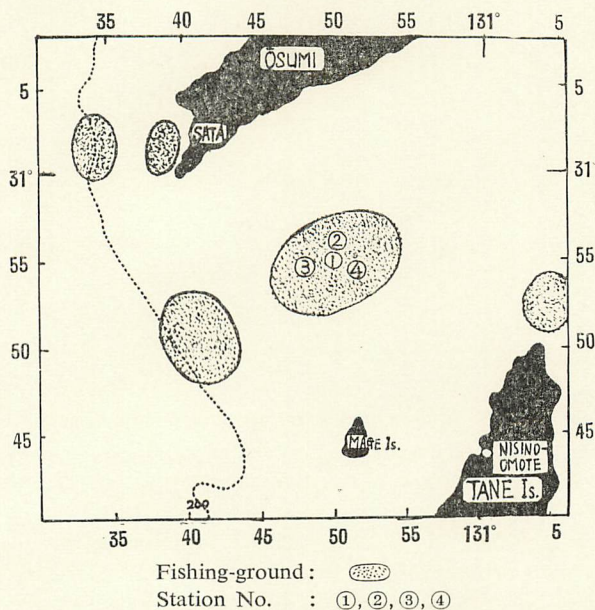


Fig. 1. Fishing-grounds and the stations of observation.

* Japan Standard Time.

The investigations at the fishing ground were performed with the results shown in Table 1 on board of the Training Ship "Shiroyama" 18 tons 60 H. P. of the Faculty of Fisheries, Kagoshima University.

Table 1. Items and Times of investigation at the fishing ground

Date	Ship's position	Time	Item of investigation
April-19	30°—55.6'N 130°—49.5'E	h m h m 11.45 ~ 12.05	Sea conditions
		12.10 ~ 13.30	fluctuation of long-line catch
		12.30 ~ 12.50	larvae, plankton
	30°—56.0'N 130°—50.0'E	14.10 ~ 14.25 14.45 ~ 15.00 15.00 ~ 16.00	Sea conditions, plankton larvae, plankton fluctuation of long-line catch
April-20	30°—54.5'N 130°—48.5'E	h m h m 07.10 ~ 10.00	fluctuation of long-line catch
		10.30 ~ 11.20	" "
	30°—54.7'N 130°—51.0'E	11.25 ~ 11.40	Sea conditions, plankton
		12.20 ~ 13.20	fluctuation of long-line catch
		13.25 ~ 13.45 13.45 ~ 14.15	Sea conditions, plankton larvae, plankton

The fixed Stations of the observation are shown in Fig. 1.

The observation of water-temperature was made at different layers from the surface to the depth of 100 meters, with the use of the reversing thermometer attached to Nansen's reversing-water-bottle: the surface water temperature being measured every half an hour, with the rod-mercurial-thermometer.

The determination of salinity was done through Chlorine titration method, using Normal sea water and Knudsen's Pipette.

Surface water-temperature: The observation-results of the surface water temperature are shown in Fig. 2.

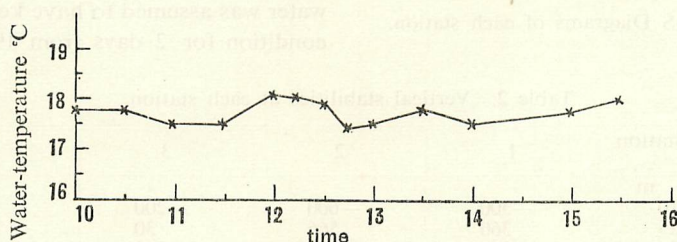


Fig. 2. Change of the surface water temperature.

The surface water temperature was within the scope from 17.5~18.1°C, but there were some considerable irregular variations—though there was nothing particular which enabled us to attribute these variations to the influence of solar eclipse.

Water mass: The vertical distributions of water temperature and of salinity are shown in T—S diagram (Fig. 3). Judging from Fig. 3 it was confirmed that at each layer of the 4 Stations there was little or no difference in water temperature. At the surface layer, the water mass (A) was observed, which was confined within the range of water-temperature about 17~18°C, and that of salinity 34.70~34.90‰. At the bottom

layer, water mass (B) was observed, which was confined within the water temperature

about 14°C, Salinity 34.50~34.65 ‰. At the middle layer, a discontinuous layer was discovered, too.

Vertical stability: Vertical stability at each station was calculated by the next formula :

$$10^8 E = \frac{d\rho}{dZ} 10^8 - 500$$

$$\rho = \rho_s + \Delta s, \quad t + \Delta t, \quad D + \Delta D$$

The data are shown in Table 2.

The vertical stabilities of 25~50m. layers and of 50~75m. layers were found to be larger than those of others; and the mixture of surface water with the bottom one was found to be quite difficult.

The water mass (A) was regarded as a branch of Warm Current (Kuroshio).

Transparency: The transparency was measured with Secchi disc painted in white having 30 cm length in diameter. And the transparencies of water at each station were found out to be 19, 17, 17, and 18m. respectively.

Current direction: The determination of current direction was due to the flowing-direction of long-line. As the result of four times experiments, it was fixed to be north-east.

Judging from these results, the sea-water was assumed to have kept a constant condition for 2 days from 19th to 20th.

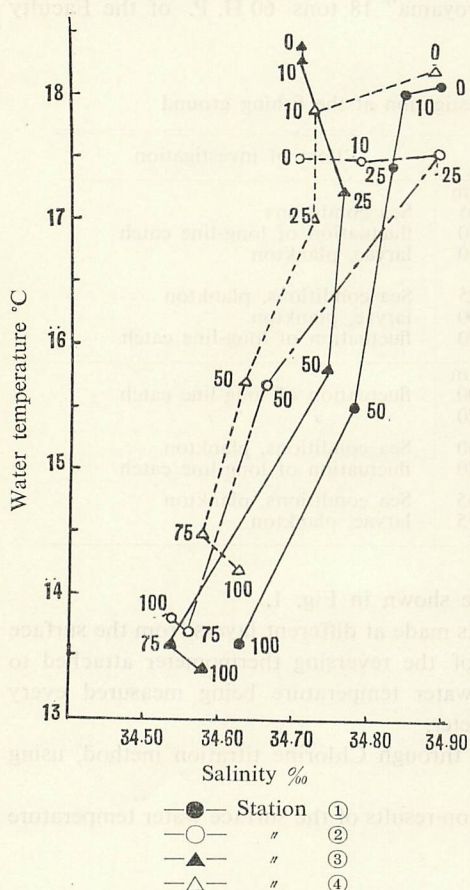


Fig. 3. T-S Diagrams of each station.

Table 2. Vertical stabilities at each station

Station	1	2	3	4
Depth				
m				
0~10	-300	-600	-200	100
10~25	360	566	30	1030
25~50	1340	1300	1340	740
50~75	—	1260	2380	500
75~100	340	-460	-420	-260

Catch condition: The sea off Cape Sata is famous for a good catch of Mackerel. Every year, in these sea-fronts, the appearance of Mackerel-school begins in spring, is kept continuous from April to June, and then is cut out completely.

Judging from the location of catches, it is at the sea-fronts lying about 10~15 miles off Cape Sata that Mackerel-school appears early in March. Their closer approach may be seen after that, and in May and June it is possible for us to see them at the sea-fronts westward off the Light-house.

In March and April, it is with the long-line, that they are caught, and in May and June, it is with "Hanezuri" (a fishing method carried with pole line) or with "Tembinzuri" (a fishing method with hand line). In our experiment, this long line consisted of a drifting-line. This year, during the term from April~May it was with this type of long-line that their catch was done.

The construction of a basket of long-line gear is shown in Table 3.

Table 3. Construction of basket of long-line gear

main line		branch line		hook		float (borden)		float line	
materials	length	materials	length	length	number	pole	float	materials	length
cotton		cotton				banboo (dia.-4cm)	glass	cotton	
20'S, No.20: 250m		20'S, No.4: 1.5 m		1.6 sun	80	3m	dia.-33 cm	7 monme	60m

Fishing method: It was in the early morning that the fishing-boat arrived at the fishing ground. The attachment of main line to the floating line was followed by the throwing-in of the line together with its baited hooks and branches, and in this handling the main line was payed out in good-order from the stern deck of the fishing-vessel, 10 sets of basket being put in at a time.

Immediately after the finish of the throwing-in of the ten baskets, those gears were taken up by hands, and the fish were transferred into the fish-hold.

It took 7 minutes for ten baskets of long-line to be thrown into the sea, and 50 minutes for the gear to be taken up on board of the vessel. The bait used was Saury.

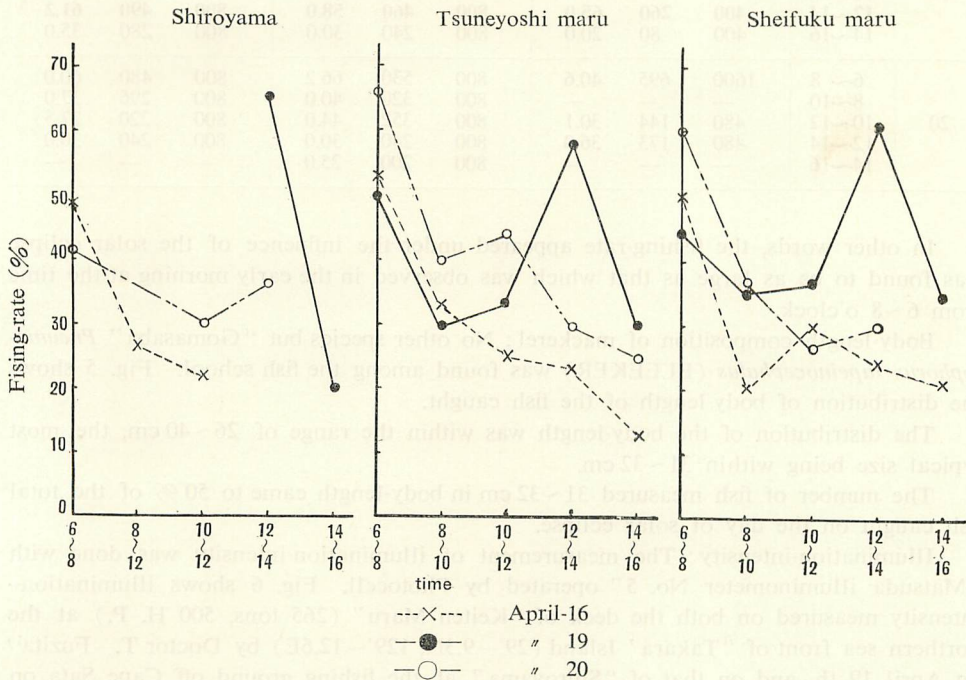


Fig. 4. Change of fishing-rate of Mackerel in every two hours.

Catch ratio: Several fishing-boats engaged in fishing at this fishing-ground in April. During the term from April 16th to 20th the writer investigated the fluctuations in the catch of three vessels; "Shiroyama" (18 tons, 60 H. P.) "Tsuneyoshi-maru" (19 tons, 52 H. P.) "Sheifuku-maru" (17.3 tons, 50 H. P.).

The catches and the fishing-rate $\left(\frac{\text{fish number caught}}{\text{total hooks}} 100 \right)$ of Mackerel are shown in Table 4 and Fig. 4.

As may be seen in Fig. 4 and Table 4, the fishing-rate of each fishing-boat for the lapse of time from 6 to 8 o'clock came to 40~66 % of the total hooks, while that done at other time came down to 20~40 %. And the fishing-rate seen for the 2 hours from 12 to 14 o'clock of the 19th day showed the rate of 58~65 % which was the highest one among the times before or after that.

Table 4. Catches and fishing-rate of Mackerel

Date	Time	Shiroyama			Tsuneyoshi maru			Sheifuku maru		
		total fishing hooks	catches	rate(%)	total fishing hooks	catches	rate(%)	total fishing hooks	catches	rate(%)
April 16	6~8	1200	580	48.3	800	425	53.1	960	480	50.0
	8~10	400	105	26.2	800	266	33.2	800	180	20.3
	10~12	400	88	22.0	800	200	25.0	800	240	30.0
	12~14	—	—	—	800	190	23.7	800	190	24.0
	14~16	—	—	—	800	100	12.5	800	170	21.2
19	6~8	—	—	—	800	400	50.0	800	350	43.7
	8~10	—	—	—	800	240	30.0	800	290	35.0
	10~12	—	—	—	800	270	33.8	800	294	36.7
	12~14	400	260	65.0	800	460	58.0	800	490	61.2
	14~16	400	80	20.0	800	240	30.0	800	280	35.0
20	6~8	1600	695	40.6	800	530	66.2	800	480	60.0
	8~10	—	—	—	800	320	40.0	800	296	37.0
	10~12	480	144	30.1	800	352	44.0	800	220	27.5
	12~14	480	173	36.0	800	240	30.0	800	240	30.0
	14~16	—	—	—	800	200	25.0	—	—	—

In other words, the fishing-rate appeared under the influence of the solar eclipse was found to be as large as that which was observed in the early morning at the time from 6~8 o'clock.

Body-length composition of mackerel: No other species but "Gomasaba" *Pneumatophorus tapeinocephalus* (BLEEKER) was found among the fish school. Fig. 5 shows the distribution of body-length of the fish caught.

The distribution of the body-length was within the range of 26~40 cm, the most typical size being within 31~32 cm.

The number of fish measured 31~32 cm in body-length came to 50 % of the total fish caught on the day of solar eclipse.

Illumination-intensity: The measurement of illumination-intensity was done with "Matsuda illuminometer No. 5" operated by Photocell. Fig. 6 shows illumination-intensity measured on both the deck of "Keiten Maru" (265 tons, 500 H. P.) at the northern sea front of "Takara" Island (29°-9.3N, 129°-12.6E) by Doctor T. Fuzita¹⁾ on April 19 th, and on that of "Shiroyama" at the fishing ground off Cape Sata on June 5th by the writer.

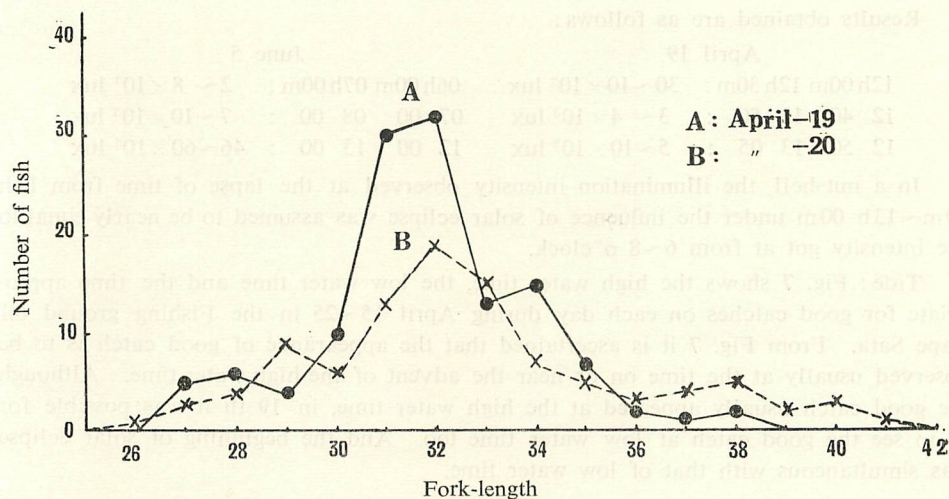


Fig. 5. Body length distribution of Mackerel.

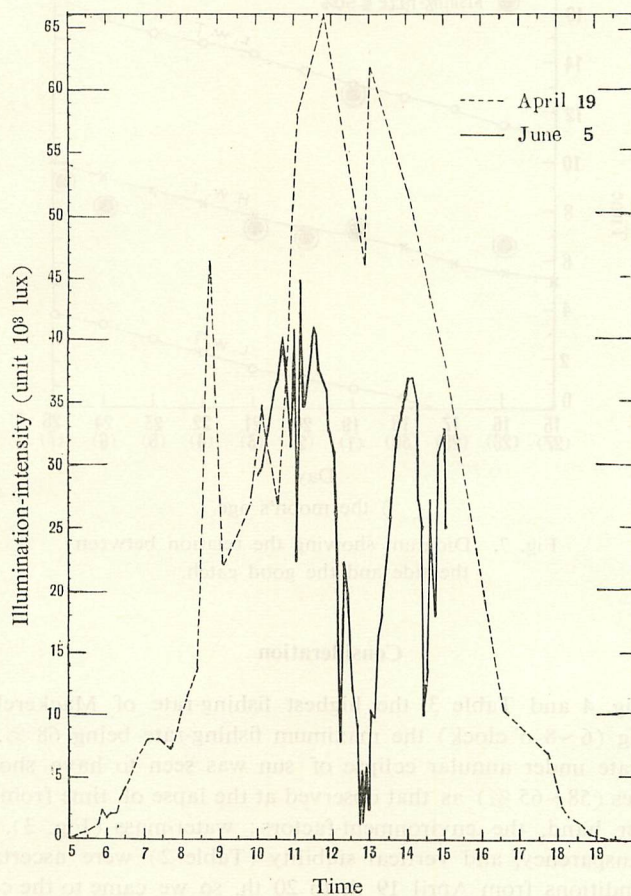


Fig. 6. Change of illumination-intensity.

Results obtained are as follows:

April 19			June 5		
12h 00m	12h 30m :	$30 \sim 10 \times 10^3$ lux	06h 00m	07h 00m :	$2 \sim 8 \times 10^3$ lux
12 40	12 50 :	$3 \sim 4 \times 10^3$ lux	07 00	08 00 :	$7 \sim 10 \times 10^3$ lux
12 50	13 05 :	$5 \sim 10 \times 10^3$ lux	12 00	13 00 :	$46 \sim 60 \times 10^3$ lux

In a nutshell, the illumination-intensity observed at the lapse of time from 12h 30m~13h 00m under the influence of solar eclipse was assumed to be nearly equal to the intensity got at from 6~8 o'clock.

Tide: Fig. 7 shows the high water time, the low water time and the time appropriate for good catches on each day during April 15~25 in the Fishing ground off Cape Sata. From Fig. 7 it is ascertained that the appearance of good catch is to be observed usually at the time on or near the advent of the high water time. Although the good catch usually appeared at the high water time, in 19 th it was possible for us to see the good catch at low water time too. And the beginning of solar eclipse was simultaneous with that of low water time.

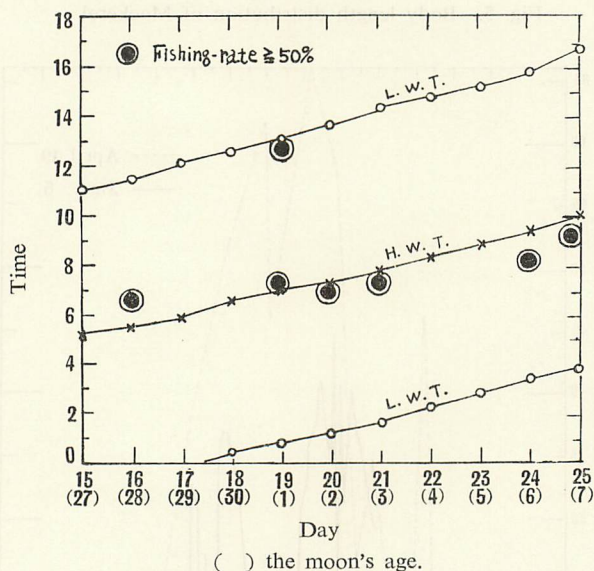


Fig. 7. Didgram showing the relation between the tide and the good catch.

Consideration

As shown Fig. 4 and Table 3, the highest fishing-rate of Mackerel was seen in the early morning (6~8 o'clock) the maximum fishing-rate being 68 %.

The fishing-rate under annular eclipse of sun was seen to have showed the same amount of catches (58~65 %) as that observed at the lapse of time from 6~8 o'clock.

On the other hand, the environment-factors; water-mass (Fig. 3), the Current-direction, the transparency, and vertical stability (Table 2) were ascertained to have kept constant conditions from April 19 th to 20 th, so we came to the conclusion that no considerable change occurred in the sea-conditions.

The illumination-intensity at 6~8 o'clock lay within the range of $2\sim 10\times 10^3$ lux, and which was the same as the one got at 12h 30m~13h 00m under the influence of solar eclipse.

Generally speaking, good catch appeared at high tide time, but in spite of the fact that it was at the low tide time that the solar eclipse occurred, the higher fishing rate than those observed at before or after that time was clearly got.

Judging from these results it might be relevantly conjectured that the changes in the illumination-intensity was one of the important causes for the good catch under the eclipse of sun.

The fishing-depth (depth of hooks) calculated with Yoshihara's method²⁾ was within the range of 60~80 meters; the water temperature appropriate for catch being within 14~16°C.

In other words, it was ascertained that the water-temperature appropriate for catch by the long-line was somewhat smaller than that of "Hanezuri"^{3,4,5)} and "Tembinzuri". This point shall be confirmed in future study.

The number of fish, measured 31~32 cm in body-length, caught under the solar eclipse came to 50% of the total and this was higher in ratio than that caught on April-20.

This may be attributed to the fact that on 20 th it was at different locations in this fishing ground that the catching was done.

Resume

The writer made some researches on the fluctuation of mackerel long-line catch both at the solar eclipse time and before or after that time at the fishing grounds off Cape Sata.

The results were summarized in Table 1~4 and Fig. 1~7.

with the aid of these results the following items were ascertained.

- (1) The highest fishing-rate of mackerel was to be fixed at the time passed from 6~8 o'clock in the morning, it maximum being 68%.
- (2) The fishing-rate got under the influence of the solar eclipse showed the same ratio as that got at 6~8 o'clock in the morning.
- (3) It was brought into consideration that the difference in the illumination-intensity must have been one of the important factors to cause the good catch under the eclipse.
- (4) The body-length-distribution of Mackerel was within the range from 26~40 cm, and the number of the fish measured from 31~32 cm in fork-length was most numerous.
- (5) The water temperature and salinity appropriate for the good catch was within 14~16°C; 34.60~34.80‰ respectively.

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References

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