Environmental preferences of longlining for yellowfin tuna *(Thunnus albacares)* in the tropical high seas of the Indian Ocean

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Abstract: A survey on yellowfin tuna fishing ground has been carried out on board of the longliners, Huayuanyu No.18 and No.19 in the tropical high seas of the Indian Ocean from September 15th- Dec. 12th, 2005. The depth of the hooks which having tuna caught have been simulated individually by modeling the relationship between the theoretical hook depth and the actual average hook depth measured by TDRs by means of stepwise regression method, and their relevant water temperature, salinity, chlorophyll-a and dissolved oxygen (DTSCO), which indicate environment conditions of yellowfin tuna inhabiting, have also been estimated by the simulated hook depth and the environment profiles. By analyzing the catch rate of yellowfin tuna at different range of depth, temperature, salinities, chlorophyll-a and dissolved oxygen based on sampled yellowfin tuna data, the results indicate that the environmental preferences of yellowfin tuna are as following: the DTSCO range, closely correlated to catch rate, is 100.0～179.9m, 14.0～17.9℃, 35.30～35.69, 0.040～0.099μg/L and 1.00～2.99mg/L respectively. The DTSCO range of the yellowfin tuna's more closely correlated to catch rate, is 120.0～139.9m, 16.0～16.9℃, 35.40～35.49, 0.090～0.099μg/L and 2.00～2.49 mg/L respectively.

Key words: *Thunnus albacares*, depth, temperature, salinity, chlorophyll-a , dissolved oxygen, longline, the Indian Ocean

Indian Ocean Tuna Commission (IOTC) has conducted intensive studies on yellowfin tuna (*Thunnus albacares*) resources assessment (IOTC Secretariat,2001,2004,2005; Tom Nishida and Hiroshi Shono,2002) , biological characteristics (Chitjaroon Tantivala,2000; V. S. Somvanshi,2002; F. Kaymaram,2000; J. Ariz,2005; Praulai Nootmorn,2001; Arrizabalaga,2002; Lumineau Olivier，2002), their distribution (Masahiko Mohri,2000), and the factors affecting hooking rates, such as water temperature, dissolved oxygen and salinity and so on (Lee, P. F.,2002; Francis Marsac,2002). Romena, November A (2001) predicted optimum range for every environment parameter at each respective life stages of yellowfin tuna, using geographic

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information system (GIS) application and simple numerical analyses in order to describe their relationships, the five environment data were temperature, depth of thermocline (at 20°C), salinity, dissolved oxygen concentration and chlorophyll-a concentration, which were taken from the World Ocean Database 98 (WOD98) and World Ocean Atlas 98 (WOA98). Tom Nishida et al (2001) attempted to examine how steep bathymetry affected tuna catch rates by analyzing the digital depth data and hooking rates data of the Japanese longline fisheries in the Indian Ocean. Because yellowfin tuna is the main bycatch species of Chinese tuna longline fishing fleets in the Indian Ocean, it has been studied by Chinese scientists on its biological characteristics (Ye Zhen-jiang,2001a; Zhu Guo-ping,2006; Xu Liu-xiong, 2006), the status of its resources (Shang He-feng,2005; Ye Zhenjiang,2003,2004; Zhu Guo-ping,2006; Miao Zhen-qing,2002,2003), the tuna longline fisheries (Ye Zhenjiang,2001b), longline fishing efficiency at the different depth (Ye Zhenjiang,2001c), longline fishing gear configuration and design (Ye Zhenjiang,1999,2000) and so on . The optimum chlorophyll-a and DO level of yellowfin tuna based on the actual measured data have not been reported.

In this paper, the ranges of depth, temperature, salinity, chlorophyll-a and DO (DTSCO) closely correlated to and more closely correlated to catch rate are discussed based on the observer data , including catch rate of yellowfin tuna , water temperature, salinity, chlorophyll-a content, dissolved oxygen measured by CTD and the Submersible Data Logger, and actual hook depth measured by TDR, obtained during the longline experimental cruises on 2 Chinese longliners from Sep. to Dec. 2005 in the tropical high seas of the Indian Ocean. Results will be referenced to the further study on the habitat of yellowfin tuna (SEAPODYM, and HSI models) and CPUE standardizing.

1 Materials and methods

1.1 Fishing vessels, fishing gear and methods

Longliners *Huayuanyu No.18* and *Huayuanyu No.19* on which data has been collected have super spool and chill sea water equipment. The vessel's particular of the LOA, mould breadth, mould depth, gross tonnage, net tonnage and main engine power is 26.12m, 6.05m, 2.70m, 150.00t, 45.00t and 407.00kW, respectively.

The longline gear consists of 3.6 mm diameter monofilament main line, 360mm diameter hard plastic floats, 5mm diameter nylon float line and 2 types of branch line ending in ring hook or circle hook. The length of main line, float line, branch line is 110km, 22m, 16m, respectively. Two sets of fishing gear have been used in the study, the conventional gear which the vessels used is as reference for comparative. The trial gears were assembled as 16 types of gear with 4 groups of weight (0.5kgs, 1.0kgs, 1.5kgs and 2.5kgs in water). In general, the time of shooting and deploying gear was between 03:00 and 06:00 at local time, and then lasted for 5 hours in fishing. The time of retrieving and handling on the gear was at 12:00 to 15:00, the total operation would be lasted for 10 to 12 hours. During deploying gear, the vessel's speed was about $4.3ms^{-1}$, line shooter speed was about 6.2 to $7.0ms^{-1}$, time interval between fore and after branch lines set out was about 7.8s, the length of main line between two branch lines was 43.5m each and there were 25 hooks per basket (HPB).

The fishing boats were targeting bigeye tuna mainly, and the bycatch including yellowfin tuna (*Thunnus albacares*), swordfish (*Xiphias gladius*), albacore (*Thunnus alalunga*) and billfish (Istiophoridae), and their operating was in 0º47′N～10º16′N，61º40′E～70º40′. The locations, where data collected by means of Submersible Data Logger (XR-620), CTD (SBE37SM) and TDR (2050) are shown in Fig.1. The investigation time was from Sep.15th to Dec.12th, 2005 and each boat fished 54 days.

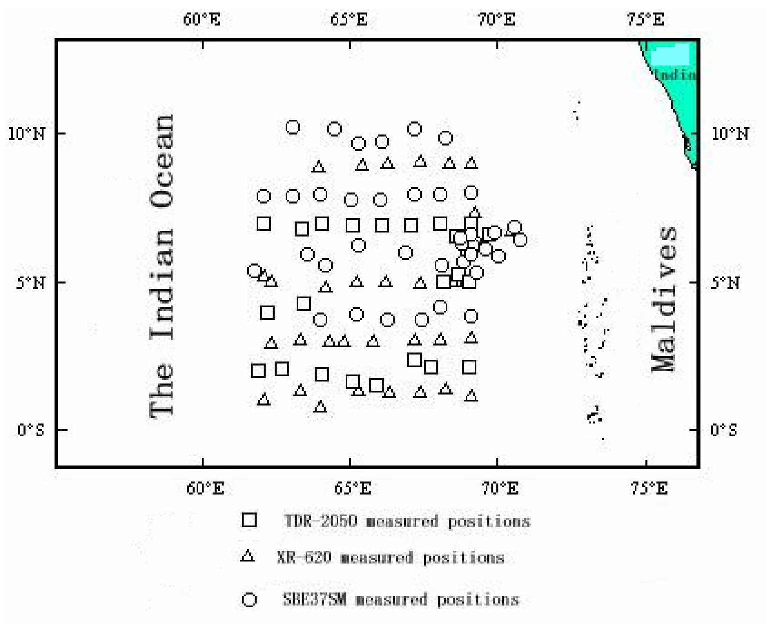

Fig.1 TDR, XR-620, SBE37SM measured locations

1.2 Instrumentation

Investigation instruments include Submersible Data Logger XR-620 and TDR (2050) (RBR Co. Canada) and SBE37SM (CTD, SeaBird Co. USA), each boat has equipped 7 TDRs. The measurement range of temperature, conductivity, DO and chlorophyll-a of XR-620 are 5 to 35□, 0 to 2mS/cm, 0 to 150％, 0.02 to 150μg/L, respectively. The accuracy of data is 0.002□, 0.0003mS/cm, 1％ of DO measurement range, less than 2% of chlorophyll-a measurement range, respectively. The actual depth of hook approached and water temperature measured by TDR, the accuracy on depth measurement is ±0.05% in range 10m-740m, and the accuracy on temperature is ±0.002□, the conductivity of the CTD is 0.0003s/m. Considering the accuracies of data from varied instruments and requirements of the study, the data of depth and temperature have been processed to keep one effective decimal only, and the other items of as salinity, DO and CPUE keep two decimals and chlorophyll-a having three decimals respectively in this paper.

1.3 Investigation methods and items

There were 80 planned positions to be investigated, but the actual investigation positions were lightly inconsistent with the plan. XR-620 (some of positions) had recorded water temperature, salinity, DO and chlorophyll a vertical profiles in some of days after setting gear. SBE37SM (other of positions) had recorded water temperature, salinity vertical profiles and TDR (2050) had also recorded water temperature vertical profiles in some of days after setting gear. The data beyond the measurement range were estimated from vertical profile aided the trend line.

The following data were collected, including setting position and time, course and speed, line shooter speed , number of HPB, the time interval between two hooks, the numbers of hook, the time of retrieving line, hook code which hooked fish, individuals of hooked yellowfin tuna per day, yellowfin tuna hooked positions.

1.4 Methods

By the ranges of depth, temperature, chlorophyll-a and DO, the catch rate and the individuals of hooked yellowfin tuna were analyzed by clustering (Tang Q Y and Feng M G, 2002) to analyze the depth, temperature, chlorophyll-a and DO range closely correlated to and more closely correlated to catch rate.

1.4.1 Theoretical depth

The theoretical hook depth (519) was calculated by the catenary curve equation (Saito S.J, 1992) based on the identified hook code, which was also measured by TDR-2050 to record the actual hook depth.

1.4.2 Modeling the relationship between theoretical depth and actual average hook depth

The relationships between theoretical depth and actual average hook depth (2 types of fishing gear: conventional gear and trial gear) had been modeled by stepwise regression method in DPS software. For the conventional fishing gear, we considered that the actual hook depth was mainly impacted by gear drift velocity (Vg), wind speed (V_w), wind direction (C_w), washing angle (Q_w) and wind angel (γ) in this paper. The actual hook depth changed constantly at a certain range. For the trial fishing gear, we thought of the weight in the water as an additional factor in the model. In the equation, Vg means the fishing gear drift velocity to the ground by the resultant force of wind and current, V_w measured by anemoscope, C_w measured by compass. Q_w means the angle between prevailing course in deploying gear and drifting direction of fishing gear. γ means the angle between wind direction and prevailing course in deploying gear.

For conventional fishing gear, we assume that the following equation fits the relationship between theoretical depth (D_T) and actual average depth ($\overline{D}$).

$$\overline{D} = b_0 + b_1 D_T + b_2 V_w{}^2 + b_3 V_g{}^2 + b_4 \sin\gamma + b_5 \sin Q_w \qquad (1)$$

By DPS，the model is

$$\overline{D} = 0.30 + 0.67 D_T + 1.03 V_w^2 + 47.21 \sin Q_w \quad \text{(R=0.8349, F=187.0649, p=0, S=47.1438)} \qquad (2)$$

For trial fishing gear, we assume that the following equation fits the relationship between theoretical depth (D_T) and actual average depth ($\overline{D}$).

$$\overline{D} = b_0 + b_1 D_T + b_2 W + b_3 V_w{}^2 + b_4 V_g{}^2 + b_5 \sin\gamma + b_6 \sin Q_w \qquad (3)$$

By DPS，the model is

$$\overline{D} = 96.53 + 0.69 D_T - 17.03 W - 19.73 V_g{}^2 \quad \text{(R=0.6593, F= 68.4305, p=0, S= 67.6504)} \qquad (4)$$

By this 2 models, the $\overline{D}$ is defined as simulated hook depth.

1.4.3 Hooking temperature, salinity, chlorophyll-a and DO

Among 516 inds of the hooked fish, 293 inds’ (sample coverage 56.78%) temperature, 231 inds’ salinity (sample coverage 44.77%), 181 inds’ (sample coverage 35.08%) chlorophyll-a, and 181 inds’ (sample coverage 35.08%) DO which indicate environment conditions of yellowfin tuna inhabiting, was calculated from temperature, salinity, chlorophyll-a, and DO vertical profiles measured by XR-620, SEB37SM and TDR-2050 guided by the simulated hook depth.

1.4.4 Data processing

(1) The method of classifying the depth, temperature, salinity, chlorophyll-a and DO

It was classified to the hooked fish that the hook depth ranged from 40.0m to 399.0m with 20m intervals, the water temperature ranged from 10.0 to 28.9℃ with 1℃ intervals, the salinity ranged from 33.80 to 36.79 with 0.1 intervals, the chlorophyll-a ranged from 0.030ug/L to 0.099ug/L with 0.010ug/L intervals and above 0.100ug/L as a range, the dissolved oxygen ranged from 0.5 to 3.99mg/L with 0.5mg/L intervals. There were, in total, 18 ranges in depth, 19 ranges in water temperature, 20 ranges in salinity, 8 ranges in chlorophyll-a and 9 ranges in dissolved oxygen.

(2) The CPUE in the different ranges of depth, temperature, salinity, chlorophyll-a and DO

Individuals of hooked yellowfin tuna whose hook code was identified and the numbers of hook which were sampled in different depth, water temperature, salinity, chlorophyll-a and DO ranges, were calculated by the frequency statistic method, showed in N_{Sij}(indicated in N_{S1j}, N_{S2j}, N_{S3j}, N_{S4j}, N_{S5j}) and H_{Sij} (indicated in H_{S1j}, H_{S2j}, H_{S3j}, H_{S4j}, H_{S5j}) respectively. The percentages of N_{Sij} of the total individuals of hooked yellowfin tuna (indicated in N_S) whose hook code were identified were calculated and they were indicated in P_{ij} (indicated in P_{1j}, P_{2j}, P_{3j}, P_{4j}, P_{5j}, showed in equation 5). The percentages of H_{Sij} of the total sampled hooks (conventional hooks and trial hooks indicated in H_S and H_S' respectively) were calculated and they were indicated in P_{Hij} (conventional hooks indicated in P_{H1j}, P_{H2j}, P_{H3j}, P_{H4j}, P_{H5j}, showed in equation 6, and trial hooks indicated in P_{H1j}', P_{H2j}', P_{H3j}', P_{H4j}', P_{H5j}', showed in equation 7). Individuals of total hooked yellowfin tuna (indicated in N) and hooks which were divided into totally (conventional hooks indicated in H; trial hooks indicated in H′) different depth, water temperature, salinity, chlorophyll-a and DO ranges, were estimated based on the sample data, and they were indicated in N_{ij} (indicated in N_{1j}, N_{2j}, N_{3j}, N_{4j}, N_{5j}, showed in equation 8) and H_{ij} (conventional hooks recorded as H_{1j}, H_{2j}, H_{3j}, H_{4j}, $H_{5j,}$ showed in equation 9 and trial hooks as H_{1j}', H_{2j}', H_{3j}', H_{4j}', H_{5j}', showed in equation 10, $H_{2j,}$ H_{3j}, H_{4j}, $H_{5j,}$ H_{2j}',H_{3j}',H_{4j}',H_{5j}' was estimated based on the water temperature, salinity, chlorophyll-a and DO ranges of 2 types of fishing gear corresponding to the depth range) respectively. The numbers of hook (indicated in H_{Tij}) in different depth, water temperature, salinity, chlorophyll-a and DO ranges was the sum of conventional hooks and trial hooks per day （showed in equation 11）. Yellowfin tuna catch rates in different depth, water temperature, salinity, chlorophyll-a and DO ranges (indicated in $CPUE_{ij}$) were calculated by N_{ij} and H_{ij} (showed in equation 12). They can be indicated in the following equations:

$$P_{ij} = N_{Sij} / N_S \quad (5)$$

$$P_{Hij} = H_{Sij} / H_S \quad (6)$$

$$P_{Hij}' = H_{Sij}' / H_S' \quad (7)$$

$$N_{ij} = P_{ij} \times N \quad (8)$$

$$H_{ij} = P_{Hij} \times H \quad (9)$$

$$H_{ij}' = P_{Hij}' \times H' \quad (10)$$

$$H_{Tij} = \sum_{k=1}^{n} H_{ij} + \sum_{k=1}^{m} H_{ij}' \quad (11)$$

$$\mathrm{CPUE}_{ij} = N_{ij} / H_{Tij} \quad (12)$$

In the equations 5 to 12: k means operating days (n: for conventional hooks, m: for trial hooks) ,i=1,2,3, 4,5, when calculate the data by different depth ranges, water temperature ranges, salinity ranges, chlorophyll-a ranges, DO ranges, j=1,2,3,……18, j=1,2,3,……19, j=1,2,3,……20, j=1,2,3,……8, j=1,2,3,……7, respectively.

2 Results

2.1 The DTSCO range closely correlated to CPUE

The CPUE (inds./1000hooks) at different depth, water temperature, salinity, chlorophyll-a and DO ranges of the tropical high seas of the Indian Ocean shows in figure 2,3,4,5 and 6.

By the figures and the clustering analysis, the DTSCO range of the yellowfin tuna closely correlated to CPUE is 100.0～179.9m, 14.0～17.9℃,35.30～35.69,0.040～0.099μg/L and 1.00～2.99 mg/L respectively.

2.2 The DTSCO range more closely correlated to CPUE

By the figures and the clustering analysis, the DTSCO range of the yellowfin tuna more closely correlated to CPUE is 120.0～139.9m, 16.0～16.9□, 35.40～35. 0.090～0.099μg/L and 2.00～2.49 mg/L in the tropical high seas of the Indian ocean, and the CPUE is 10.10, 12.69, 13.64, 127.06 and 13.16 inds/1000hooks, respectively.

3 Discussions

(1) Keith A. Bigelow (2002) has studied the simulated hook depth at different surface current (only current speed) by Logistic Regression method. Keith A. Bigelow (2006) modeled the

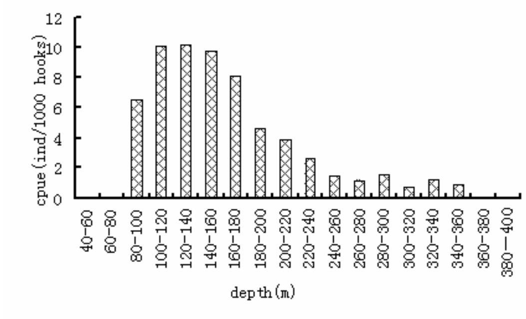

Fig.2 *Thunnus albacares* cpue by depth ranges

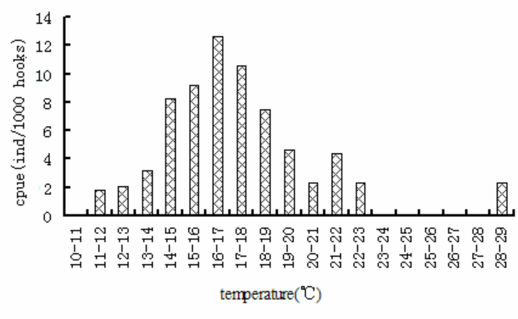

Fig.3 *Thunnus albacares* cpue by temperature ranges

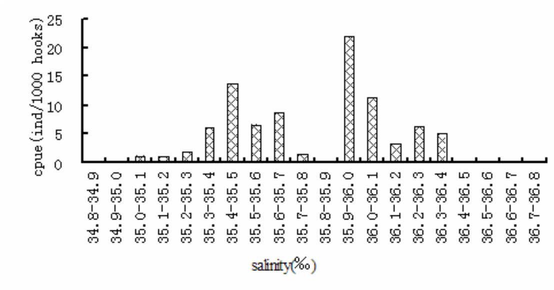

Fig.4 *Thunnus albacares* cpue by salinity ranges

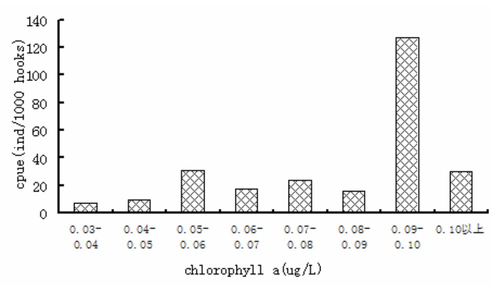

Fig.5 *Thunnus albacares* cpue by chlorophyll-a ranges

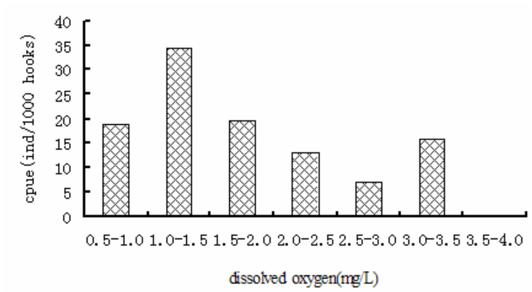

Fig.6 *Thunnus albacares* cpue by dissolved oxygen (DO) ranges

relationship among actual hook depth and theoretical hook depth by catenary curve, wind force, current shear, current speed (data come from OCGM model) by GLM and GAM. Song L M (2006b), analyzed the relationship between actual average hook depth and theoretical hook depth considering the environment factors (fishing gear drift speed, wash angle, wind speed, wind angle) by stepwise regression method. In this paper, the same method was adopted as Song L M (2006b). Actually, fishing gear drift speed and wind angle are the combined indexes which are influenced by current shear at different depth, wind speed and wind direction at different position. Now, we can not compare the accuracy for the simulated hook depth based on those methods because of the limitation of data. We can test the models based on actual measured data and establish new model by using measured 3 dimensions current data from 0m to 400m combined with mechanics analysis to improve the accuracy of the hook depth model.

(2) When the yellowfin tuna as the main targeting species, we suggest deploying the hook depth within the range of depth, water temperature, salinity, chlorophyll-a and DO more closely correlated to catch rate to get higher yellowfin tuna CPUE and to mitigate the bycatch of shark, sea turtle and other species. Sonic tagging has shown that dwelling time of young yellowfin (less than 1.00m FL) is distributed about the maximum temperature gradient, within the thermocline (Cayré & Marsac 1993). Block (1997) revealed that yellowfin tuna with size ranging from approximately 4 kg to 110 kg have strong environment preference whereby tracked specimen were consistently found above the thermocline in the surface mixed layer in waters near California, United States. Brill (1999) also relate temperature to be the limiting factor in his experiment near the Hawaiian Islands. It was also found out that water temperature, dissolved oxygen concentration and thermocline depth influenced the distribution of adult yellowfin tuna, while temperature and dissolve oxygen concentration influenced spawning activities (Romena, N A 2001). If any disparities exist among the depth range, water temperature range, salinity range, chlorophyll-a range, and DO range, the water temperature range should be considered as the main factor since the yellowfin tuna is sensitive to the water temperature’s fluctuation and the water temperature.

(3) We conclude that, in the high seas of the Indian Ocean, optimum swimming depth range of yellowfin tuna is in the depth range of 100.0－179.9m. Masahiko Mohri et al（2000）reported that the optimum depth was around 80m-200m for yellowfin tuna in the equatorial region, which was consistent with the result of this paper. Cayré et al（1993）concluded that young yellowfin tuna mainly distributed within the thermocline and maximum temperature gradients. Based on the results of qualitative analyses, Romena, N A(2001) suggested an association between the

distribution of adult yellowfin tuna and the thermocline depth (at 20℃), especially the observable affinity of dense aggregation within shallow thermocline depth. Numerical analysis, on the other hand, depicted a wide optimum range of the thermocline depth from 75 m to 130 m, with a central tendency around 100 m deep. The area of convergence, with high hooking rate density, lies just above and adjacent to this shallow thermocline depth. We didn't study the impact of thermocline depth (at 20℃) to the distribution of yellowfin tuna, instead we calculated the CPUE in different temperature range using simulated hook depth in this paper. The relationship between the distribution of yellowfin tuna and thermocline depth where the fish hooked should be studied later. According to the comparison of the depth between the simulated hook depth and theoretical depth during the investigation, in general, the former is shallower than the latter. It is suggested that the former can reflect the yellowfin tuna vertical distribution more exactly. Different distribution results may be obtained by different fishing gear configuration, operating depth, ocean environment factors and different data processing method. It is suggested that there are some limitations (the limitation of hook depth reached) to analyze the yellowfin tuna's habitat based on the commercial data, although the commercial data can reflect the fisheries more directly. It is also suggest that we should study it by tagging method further.

(4) This paper shows that in the high seas of the Indian ocean, the temperature range of the yellowfin tuna closely correlated to catch rate is from 14.0℃ to 17.9℃, and more closely correlated to catch rate is from 16.0℃ to 16.9℃. Masahiko Mohri et al(2000) found that, the temperature range where yellowfin tuna was fished was ranging from 11℃ to 28℃, the optimum water temperature catching yellowfin tuna was 13℃－24℃, and the hooking rates peaked at the 15℃ - 17℃, which was quite close to the result of this paper. Based on the results of qualitative analyses, Romena, N A (2001) suggested that the adult yellowfin tuna distribution follow the spatial and seasonal changes of water temperature profile in the Indian Ocean. Combined with numerical analyses, results showed that the preferential water temperature lies within the optimum range from 17°C to 24°C.The results were different to ours because the source data were different, environmental data Romena, N A(2001) used for study were from two databases, World Ocean Database 98 (WOD98) and World Ocean Atlas 98 (WOA98), the entire area was based on 1° by 1° square grid in each standard depth, computed by vertically weighted average, while in this

paper, the data were real measured by investigating equipments.

(5) The salinity range of the yellowfin tuna closely correlated to catch rate is from 35.30 to 35.69, and the range more closely correlated to catch rate is from 35.40 to 35.49. Romena, N A (2001) thought that adult yellowfin tuna was fairly distributed within areas with high salinity, qualitative analysis failed to show clear spatial relationship. Numerical analysis indicated an optimum range from 34.2 to 34.4 and 35 to 35.3. These findings suggest that salinity had less influence on the distribution because no steady salinity range produced high hooking rates. From fig.4 , we can conclude that, the yellowfin tuna hooking rate was higher in the two salinity ranges: 35.30～35.69 and 35.99～36.39. Both source data and processing methods used by Romena, N A(2001) were different to this paper, so we couldn't compare this two results, we could suggest that salinity had less influence on yellowfin tuna's distribution.

(6) The chlorophyll-a range of the yellowfin tuna closely correlated to catch rate is from 0.040μg/L to 0.099μg/L in this paper. Pei-Fen Lee et al(1999) found that the monthly means of chlorophyll-a concentration for yellowfin tuna showed higher values and greater variability than albacore and bigeye tuna, results also indicated that yellowfin tuna occur in more productive regions, but the chlorophyll-a concentration data are derived from the Advanced Very High Resolution Radiometer (AVHRR) carried aboard the NOAA-series polar-orbiting satellites and from the Nimbus-7 Coastal Zone Color Scanner (CZCS), which only contained the sea surface layer data.

(7) Besides water temperature, DO is another important factor impacting the distributing of yellowfin tuna. The DO range of the yellowfin tuna closely correlated to catch rate is from 1.0 mg/L to 2.99mg/L in this paper, and the range more closely correlated to catch rate is from 2.00 mg/L to 2.49 mg/L. Minimum dissolved oxygen at the catching depth was 1 mL/L (0.7mg/L) (Masahiko Mohri et al 2000). Cayré et al (1993) pointed out that gradients of temperature and dissolved oxygen have greater effect on the vertical movement of yellowfin tuna. In western Indian Ocean, oxygen levels ranging from 3.6 to 4.2 mL/L (2.52 to 2.94mg/L) can be considered threshold values that could affect the general activity of the species. Romena,N A(2001) concluded that the overall occurrence of high hooking rates on yellowfin tuna was generally dense in areas where favorable dissolved oxygen concentration ranging form 2.6 mL/L（1.82mg/L）

below to 5 mL/L（3.5mg/L）just above. Numerical analysis indicated an optimum range from minimal concentration of 0.6 mL/L (0.42 mg/L) to 3.8 mL/L (2.66mg/L). The findings imply that yellowfin tuna preferred but were not limited to areas with an optimum dissolved oxygen concentration. This was very close to the yellowfin tuna CPUE distribution in different DO ranges showed in fig. 6, but the data were based on 1° by 1° square grid in each standard depth, computed by vertically weighted average.

(8) The results in this paper are based on the analysis on the relationship between the catch rate (CPUE) and each single environment factor. We should get an integrated factor considering different weight of each single factor, and analyze the relationship between the integrated factor and yellowfin tuna vertical distribution.

(9) The above conclusions were obtained based on this investigation. We will consider the biological factors, food web and water current factors to study the vertical distribution with the larger individuals of sample tuna, hook depth measured by TDR and measured times of Submersible Data Logger.

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