Capture environmental conditions of *Pteroplatytrygon violacea* in waters near Gilbert Islands

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Introduction

•*P. violacea* is widely distributed in tropical and subtropical waters of the three Oceans. It is the only currently known pelagic species in the family of dasyatidae.

• *P. violacea* has a highly developed non-visual senses, especially the sense of smell to find their prey (Compagno 1990).

•Hook size and shape significantly affect the catch rate of *P. violacea*.

The larger circle hooks turn out more efficient in reducing bycatch rate of *P. violacea* than small circle hooks (Kerstetter and Graves 2006).

Domingo et al (2005) found that a higher **SST** help to increase catches of *P. violacea*.

They were discarded at sea, but the survival rate was very low (Domingo et al. 2005, Piovano et al. 2008).

Therefore, the mitigation measures should be implemented to reduce the bycatch rate of *P. violacea*.

The purpose of this study

（1）To find which fishing gear could effectively reduce the bycatch rate of *P. violacea*.

（2）To propose the mitigation measures were .

Materials and Methods

Materials

Sampling duration

From October to December , 2009

From November , 2010 to January,2011

Survey vessel

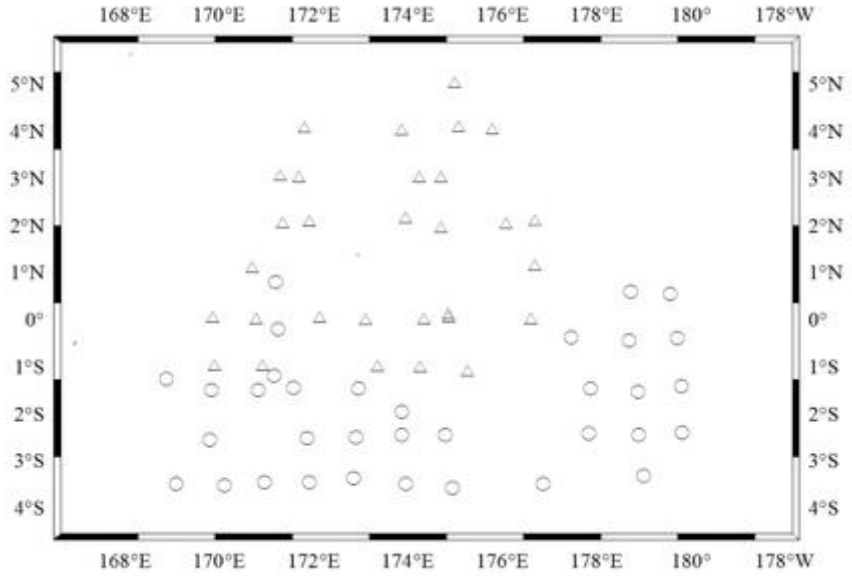
Shenliancheng No.719 in 2009

Shenliancheng No.901 in 2010

Pteroplatytrygon violacea :

186

Survey area and sites



Data collection

(1) deployment position and time;
(2) depth of the hook;
(4) number of hooks;
(5) number of *Pteroplatytrygon violacea;*
(6) Temperature, salinity, chlorophyll-a concentration, and DO

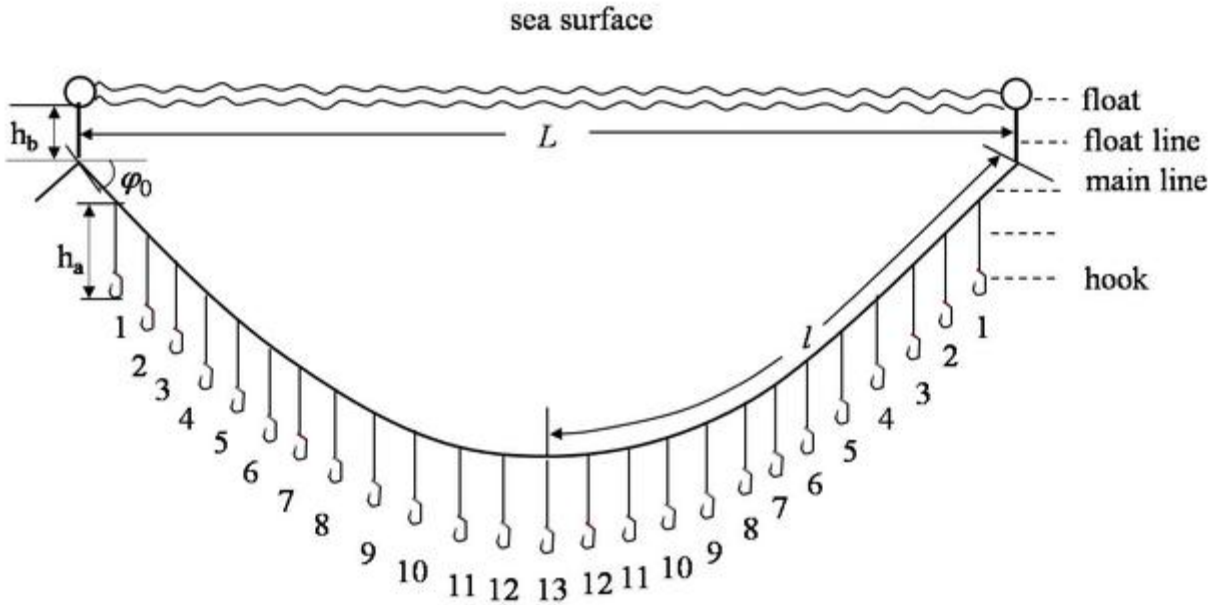
Instrumentation

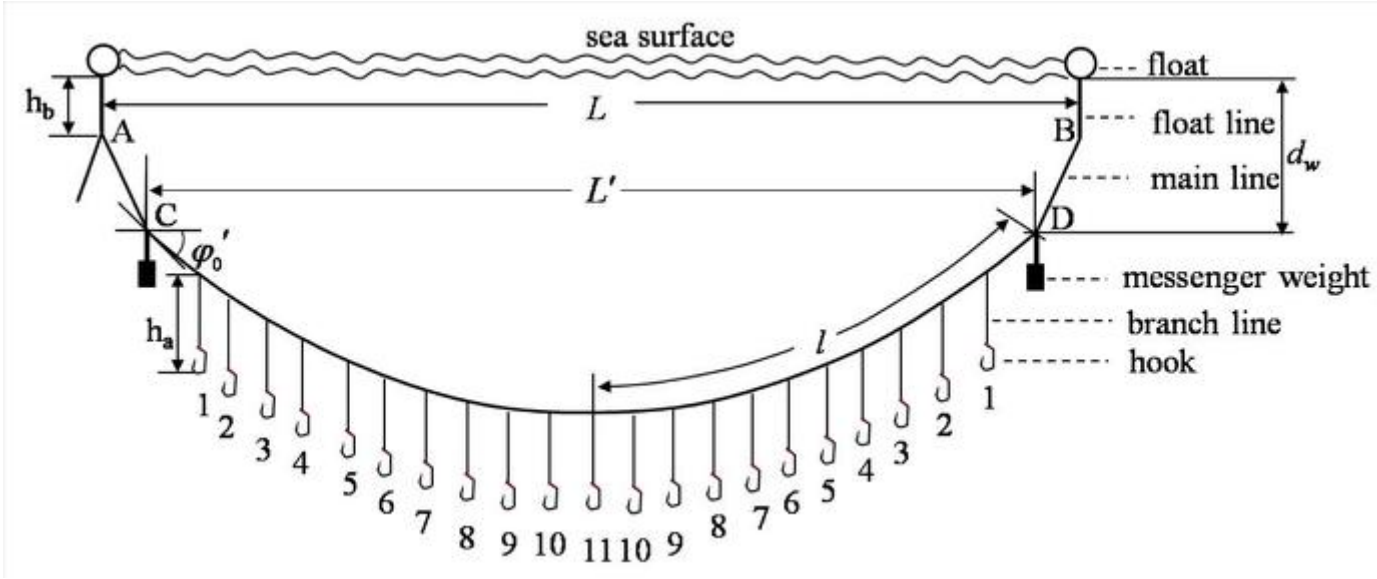
The hook depth was measured and recorded by 14 TDRs .

TDR

The 3D current at different depths was measured by ADCP

XR-620


sea surface
float
float line
main line
hook
L
l
h_b
h_a
φ_0


sea surface
float
float line
main line
messenger weight
branch line
hook
L
L′
l
A
B
C
D
h_b
h_a
φ_0'
d_w

HBF=25 or 21

Table.1 Configuration of experimental gears in 2009 and 2010

No.	Message weight (kg)	Lead swivel (g)	Lead sinker(g)	Plastic fluorescent tube
1	2	75	3.75	with
2	2	60	3.75	with
3	2	45	11.25	without
4	2	10	11.25	without
5	3	75	3.75	without
6	3	60	3.75	without
7	3	45	11.25	with
8	3	10	11.25	with
9	4	75	11.25	with
10	4	60	11.25	with
11	4	45	3.75	without
12	4	10	3.75	without
13	5	75	11.25	without
14	5	60	11.25	without
15	5	45	3.75	with
16	5	10	3.75	with

Data analysis methods

Based on the operation parameters and theoretical hook depth, the calculation model of the hook depth was built by the stepwise regression method.

There were 807 hooks measured by TDR and were used to develop the hook depth calculation models.

For the conventional fishing gear, it was assumed that the hook depth was influenced mainly by current shear coefficient (denoted as τ) calculated by equation

$$= log \frac{\bullet_{n=1}^{N} \left(\frac{u_{n+1} - u_n}{z_{n+1} - z_n} \right)^2 + \left(\frac{v_{n+1} - v_n}{z_{n+1} - z_n} \right)^2 \frac{1}{2} (z_{n+1} - z_n)}{\bullet_{n=1}^{N} (z_{n+1} - z_n)}$$

For traditional **and** experimental fishing gear in 2009, the hook depth prediction models are:

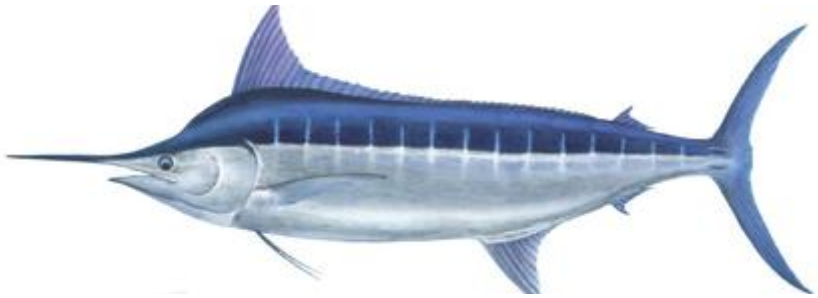
$$D_{f1} = D_{T1}\ 10^{\text{-0.311-0.258lg}(y)\text{-0.121}\ \ \text{+0.038lg}(\sin\ )}, (n = 236, r = 0.66)$$

$$D_{f1} = D_{T1}\ 10^{\text{-0.437-0.427lg}(y)\text{-0.224}}, (n = 102, r = 0.78)$$

For traditional and experimental fishing gear in 2010, the hook depth prediction models are

$$D_{f2} = D_{T2}\ 10^{-0.825-0.239\lg(y)-0.342\ -0.012\lg(\sin\ )},(n=316,r=0.75)$$

$$D_{f2} = D_{T2}\ 10^{-0.837-0.367\lg(y)-0.413},(n=153,r=0.66)$$



2.4.2 Data processing method

The hooked *P. violacea* were grouped into various environmental variable ranges in the defined intervals.

Bycatch rates in different ranges of depth, water temperature, salinity, Chlorophyll-*a* , and DO were calculated as Song et al.(2008 , 2009),and Cao et al. (2011).

Each grouping of depth, temperature, salinity, Chlorophyll-*a*, and DO was analyzed to identify how each was correlated to catch rates, number of hooked *P. violacea* and hooks using hierarchical cluster analysis (Song et al. 2008 , 2009, Cao et al. 2011).

The nominal bycatch rate :

$$R = N \quad H^{1}$$

Bycatch rates in different ranges of depth, water temperature, salinity, Chlorophyll-*a* , and DO (denoted as R_{ij}) were calculated from N_{ij} and H_{Tij} as Song et al.(2008 , 2009), and Cao et al. (2011):

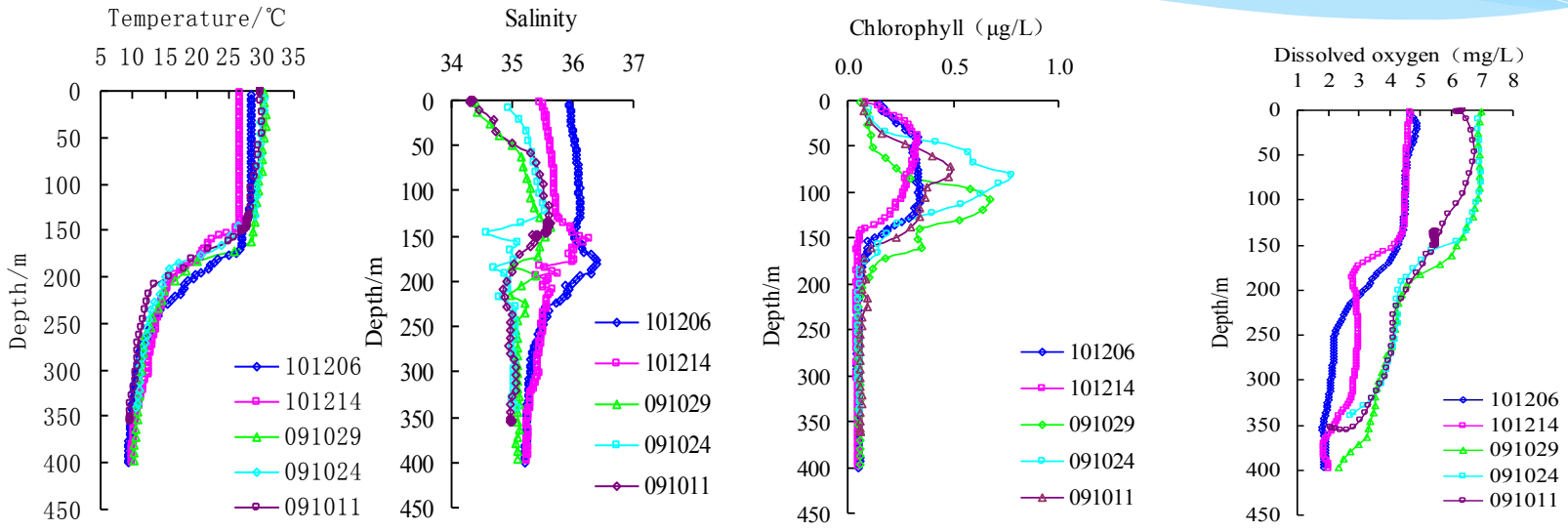
$$R_{ij} = N_{ij} \quad H_{Tij}^{1}$$

Table.2 Ranges of depth, temperature, salinity, chlorophyll-a, and DO of the hooked *P. violacea* with "interval" of observation

Environmental Factor (*i*)	Starting point	Final point	Interval	Total ranges (*j*)
Depth	40.0 m	239.9 m	40 m	5
Temperature	17.0 ℃	29.9 ℃	1 ℃	13
Salinity	35.40	36.29	0.2	5
Chlorophyll *a*	0.040 μg/ L	0.499 μg/ L	0.040 μg/L	12
DO	1.5 mg/L	4.99 mg/ L	0.5 mg/L	7

RESULTS

Temperature, salinity, chlorophyll-*a* concentration, and DO vertical profiles varied with latitude



Note: 101206: December 6, 2010 (S3°21′, N179°00′); 101214: December 14, 2010 (S1°33′, E178°53′); 091029: October 29, 2009 (N1°08′, E176°42′); 091024: October 24, 2009 (N3°01′, E176°05′); 091011: October 11, 2009 (N5°0′, E172°51′)

Table.3 The *P. violacea* bycatch rates of traditional gear, experimental gear, 16/0 circle hook and 18/0 circle hook

	Traditional	Experi	16/0	18/0
Fish (indis)	146	28	10	2
number of hooks (piece)	68212	24594	7733	7733
Bycatch rate (indis/ 1000 hooks)	2.14	1.138	1.293	0.259

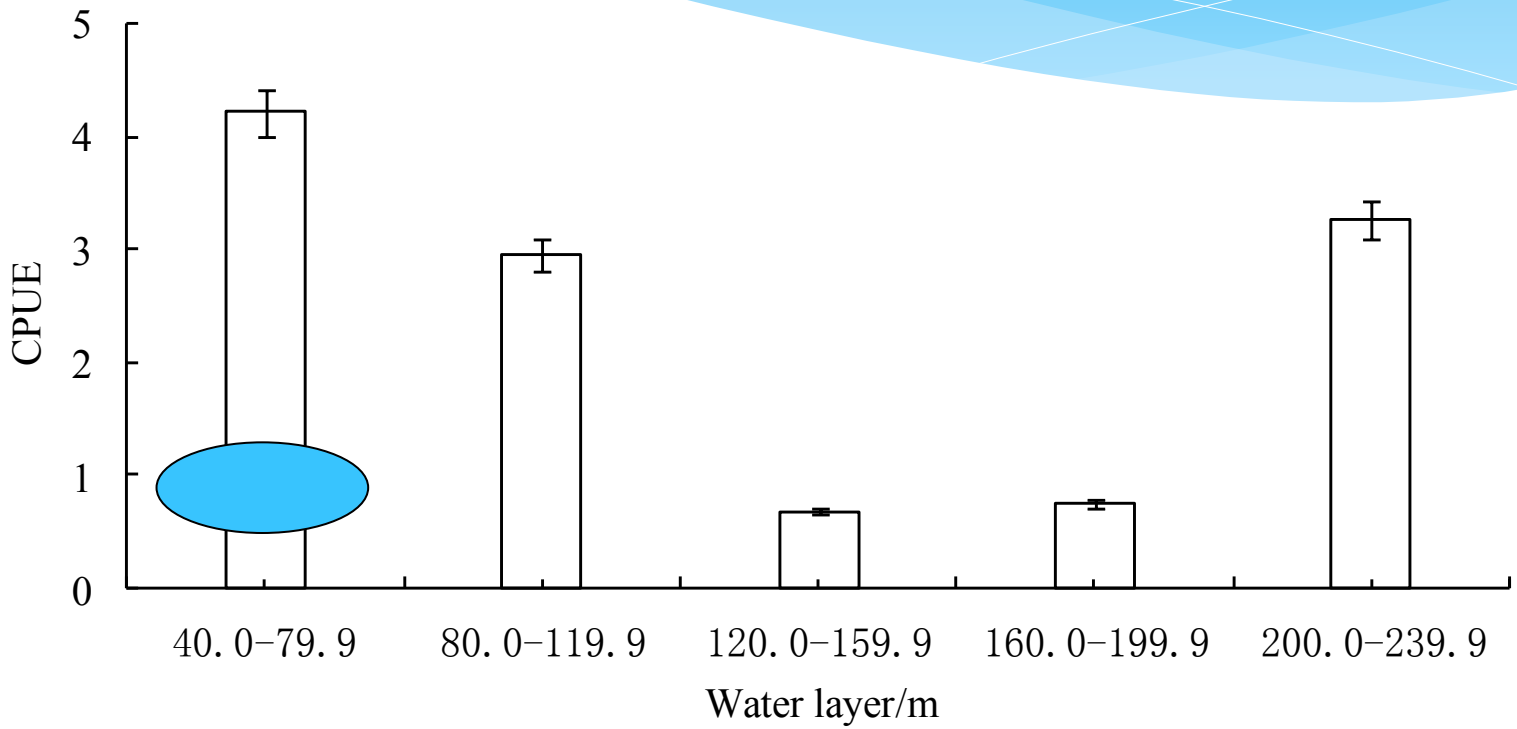
Table.4 The t - test results of *P. violacea* bycatch rates for traditional gear, experimental gear, 16/0 circle hook, and 18/0 circle hook

	Traditional gear	Experi gear	Traditional gear	16/0 circle hook	Traditional gear	18/0 circle gear
average	3.790	1.522	3.790	2.174	3.790	0.435
variance	7.635	5.966	7.635	48.502	7.365	8.696
observations	46	46	46	46	46	46
df	45		45		45	
t Stat	5.028		1.472		7.295	
P(T<=t) two-tail	8.39E-06		0.148		3.73E-09	

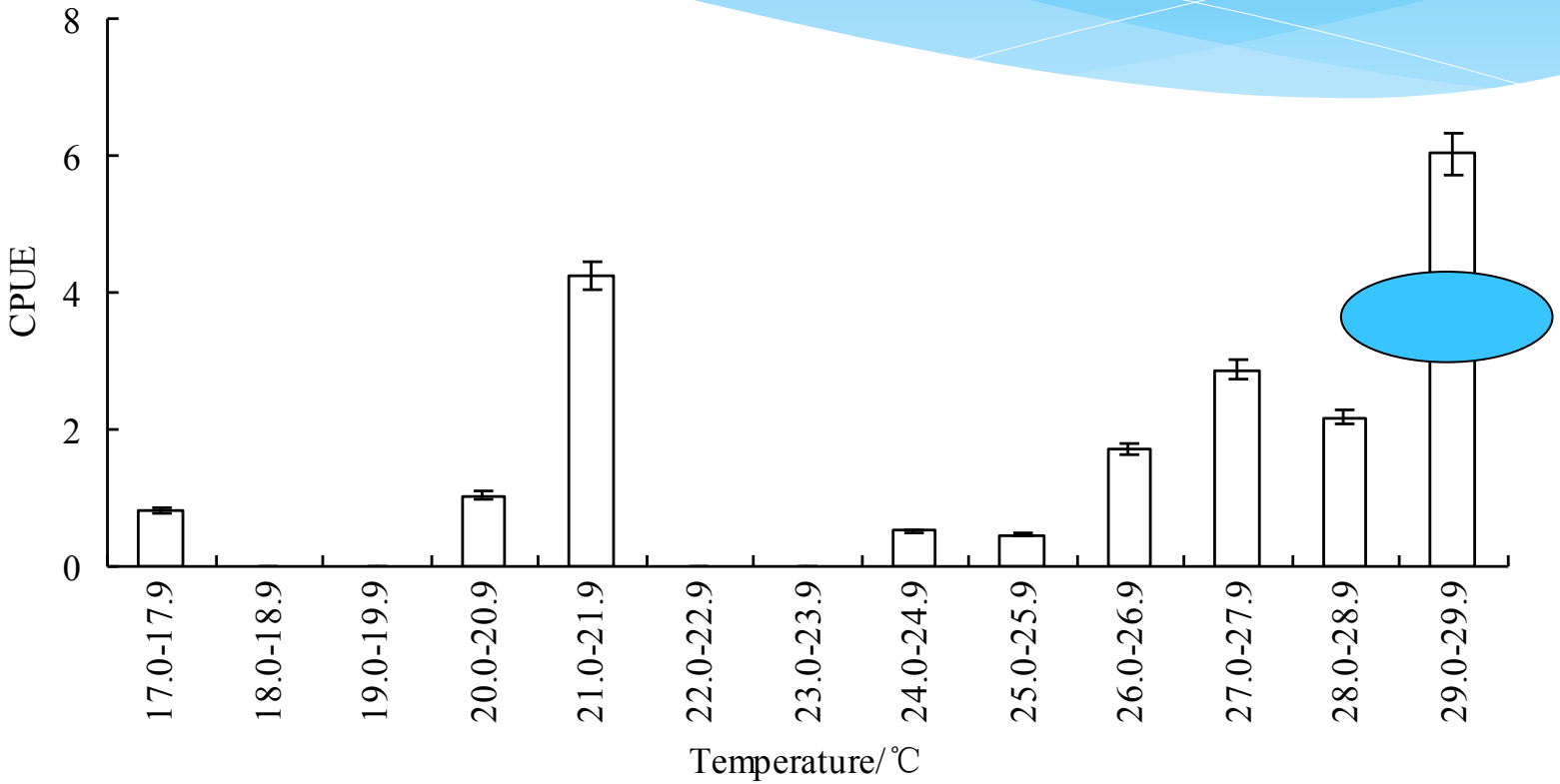
(continued) The t - test results of *P. violacea* bycatch rates for traditional gear, experimental gear, 16/0 circle hook, and 18/0 circle hook

	Experimental gear	16/0 circle hook	Experimental gear	18/0 circle hook	16/0 circle hook	18/0 circle hook
average	1.522	2.174	1.522	0.435	2.174	0.435
variance	5.966	48.502	5.966	8.696	48.502	8.696
observations	46	46	46	46	46	46
df	45		45		45	
t Stat	-0.581		2.762		1.534	
P(T<=t) two-tail	0.564		0.008		0.132	

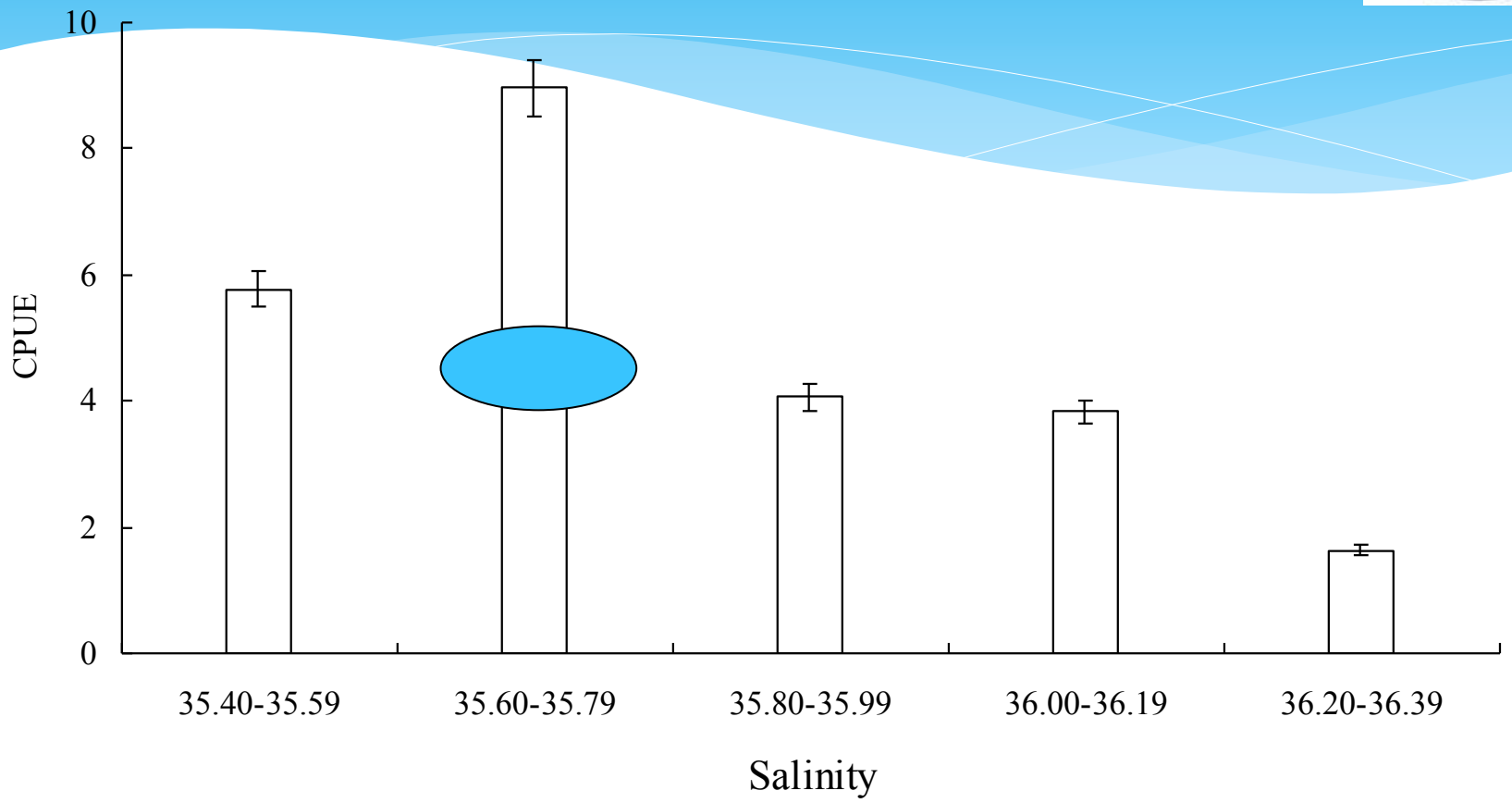
Fig.4(a-d) The bycatch rate of each environmental variable range



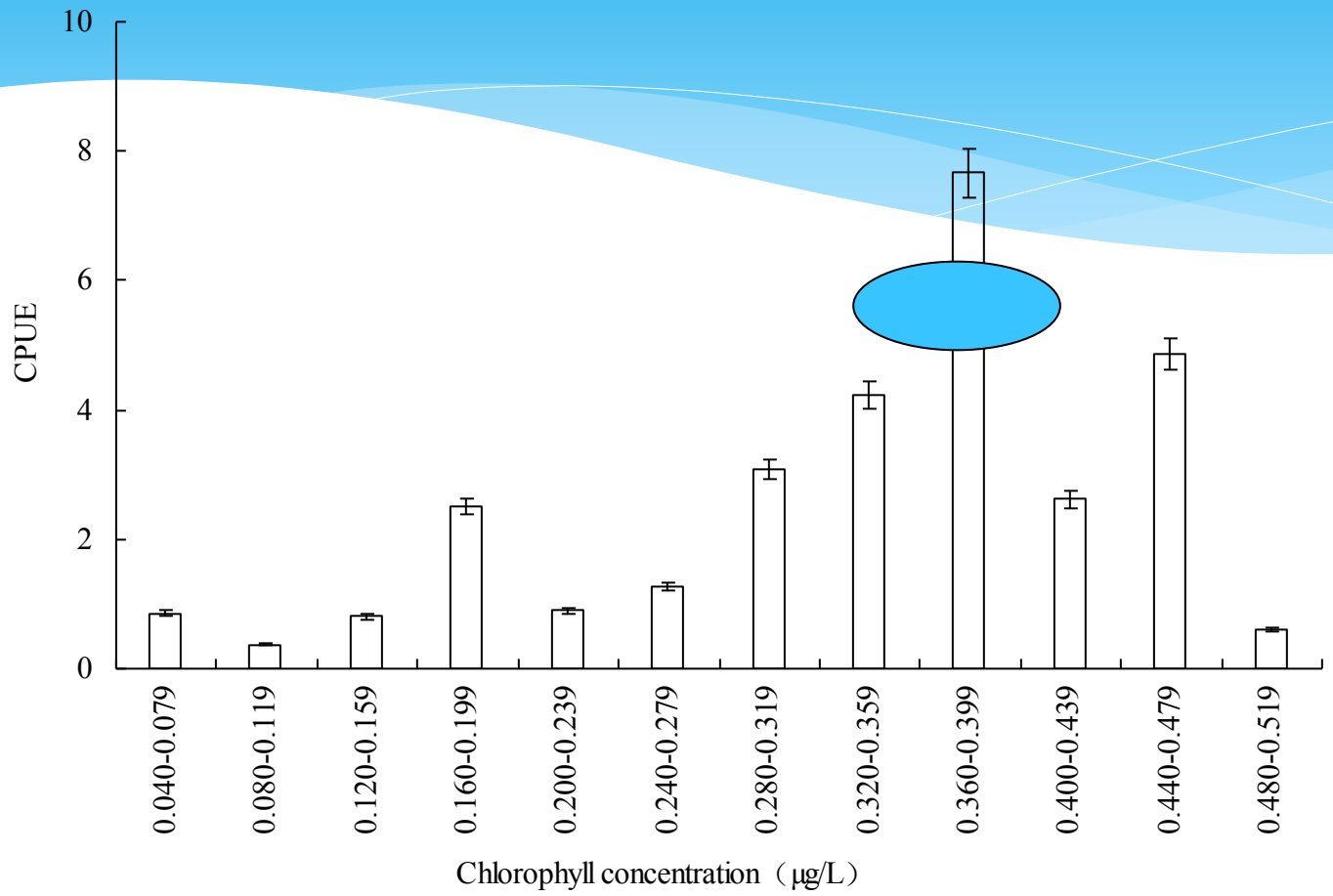
a


8
6
4
2
0
CPUE
17.0-17.9
18.0-18.9
19.0-19.9
20.0-20.9
21.0-21.9
22.0-22.9
23.0-23.9
24.0-24.9
25.0-25.9
26.0-26.9
27.0-27.9
28.0-28.9
29.0-29.9
Temperature/℃

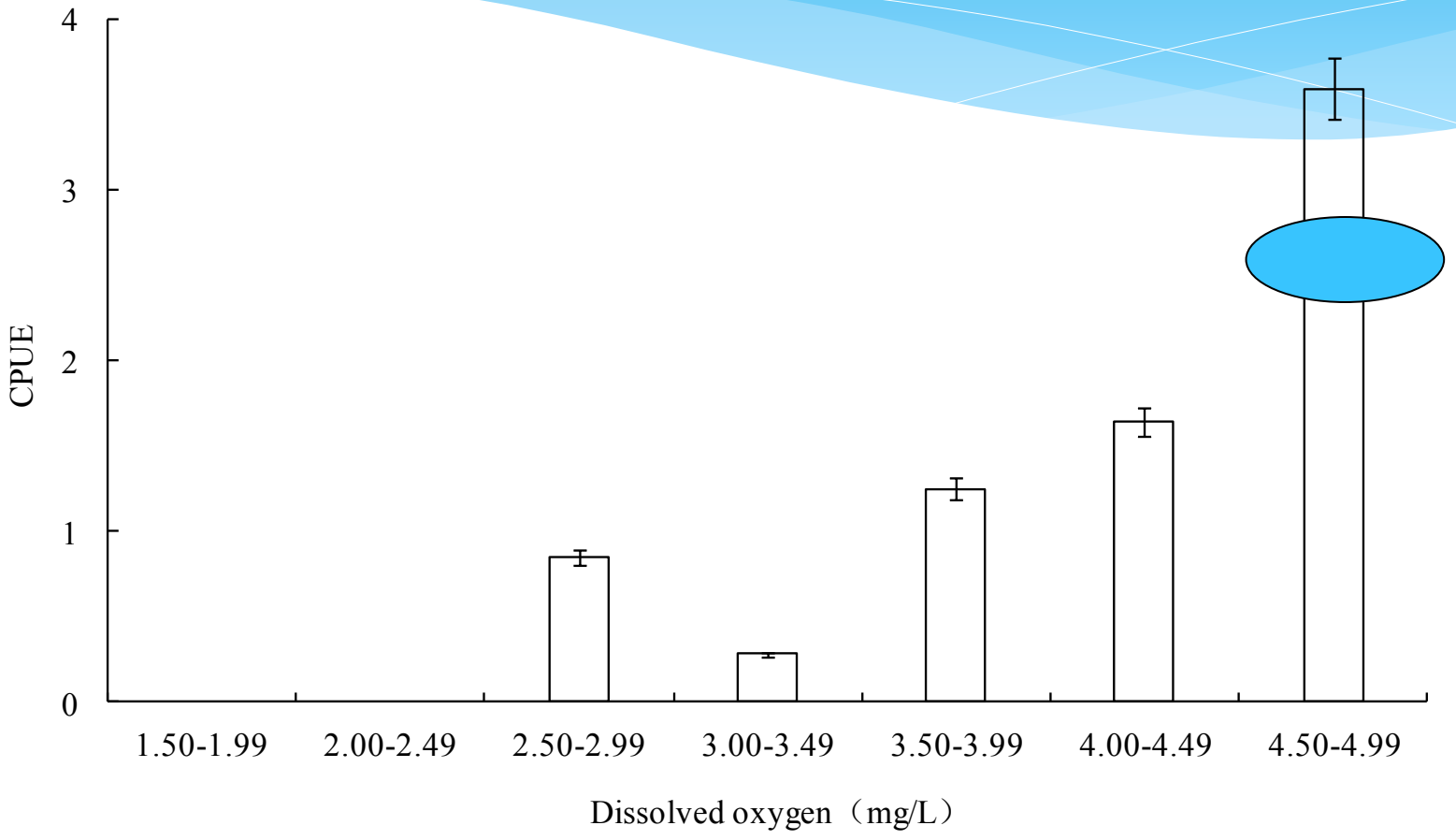
b


10
8
6
4
2
0
CPUE
35.40-35.59
35.60-35.79
35.80-35.99
36.00-36.19
36.20-36.39
Salinity

c

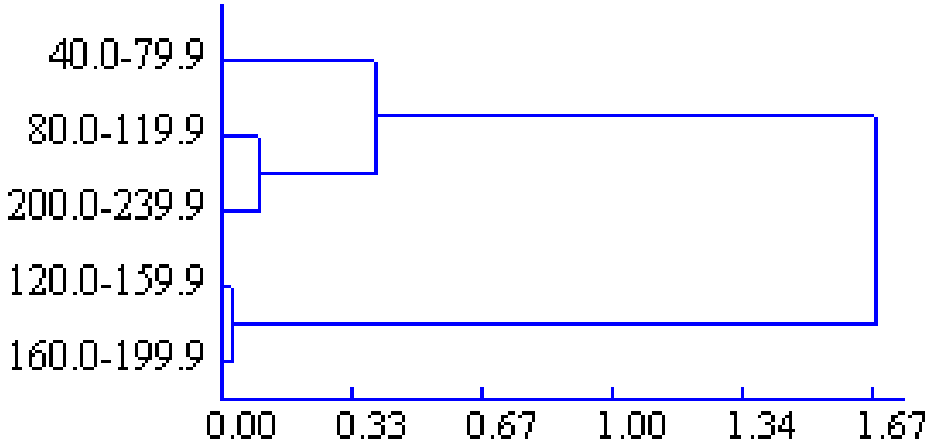

10
8
6
4
2
0
CPUE
0.040-0.079
0.080-0.119
0.120-0.159
0.160-0.199
0.200-0.239
0.240-0.279
0.280-0.319
0.320-0.359
0.360-0.399
0.400-0.439
0.440-0.479
0.480-0.519
Chlorophyll concentration（μg/L）

d

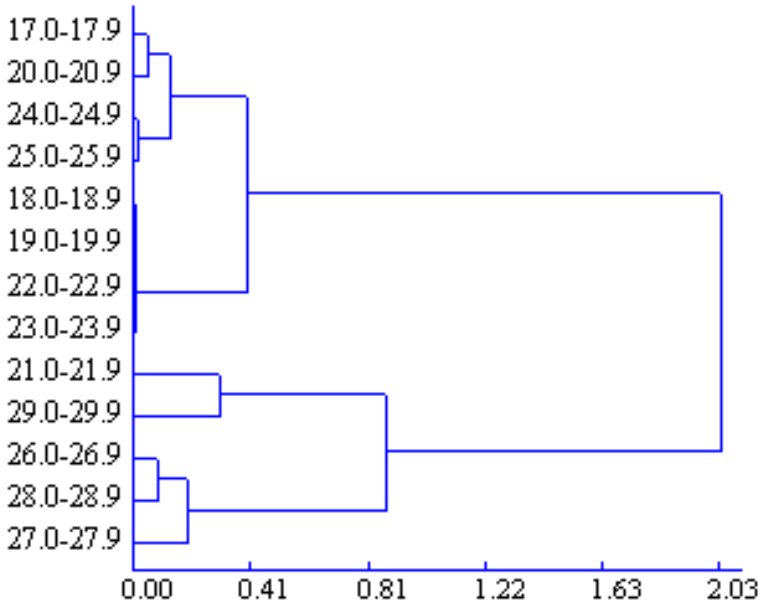

4
3
2
1
0
CPUE
1.50-1.99
2.00-2.49
2.50-2.99
3.00-3.49
3.50-3.99
4.00-4.49
4.50-4.99
Dissolved oxygen（mg/L）

e

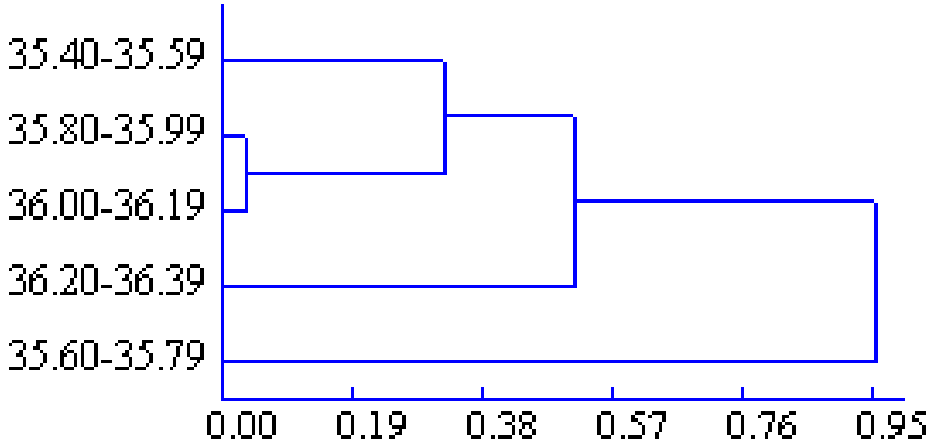
Fig.5 The correlation between bycatch rate and environment variables



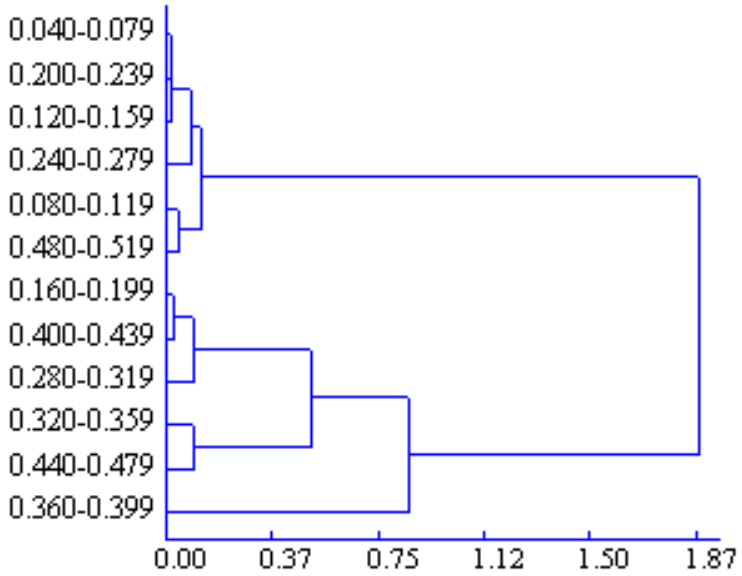
Depth



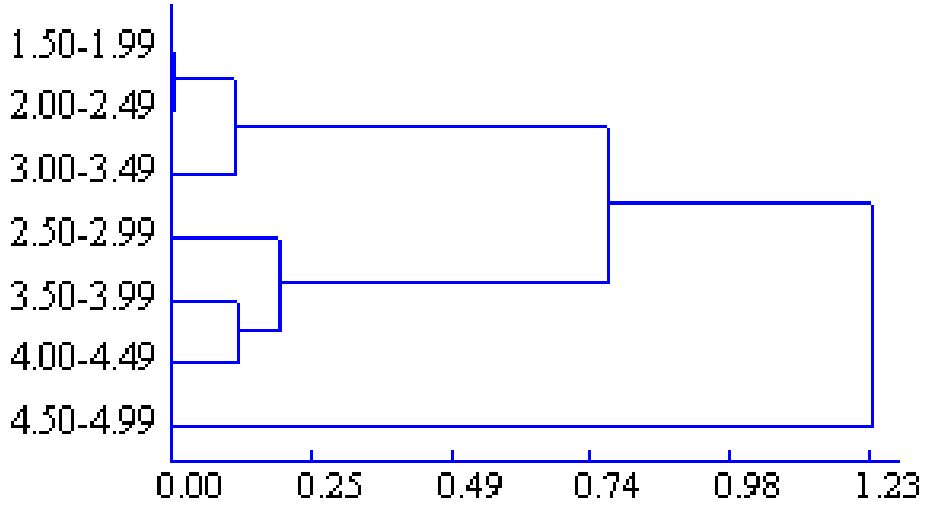
Temperature


35.40-35.59
35.80-35.99
36.00-36.19
36.20-36.39
35.60-35.79
0.00
0.19
0.38
0.57
0.76
0.95

Salinity



Chlorophyll-***a***


1.50-1.99
2.00-2.49
3.00-3.49
2.50-2.99
3.50-3.99
4.00-4.49
4.50-4.99
0.00
0.25
0.49
0.74
0.98
1.23

DO

Table.5 *P. violacea* preferred range of environmental variables, and the corresponding bycatch rate

Variables	Variable range	CPUE (indis/1000 hooks)
Depth（m）	40.0-79.9	4.22
Temperature（℃）	29.0-29.9	6.02
Salinity	35.60-35.79	8.96
Dissolved Oxygen（mg/L）	4.50-4.99	3.60
Chlorophyll（μg/L）	0.360-0.399	7.66

DISCUSSION

1 **Hook depth, size, and shape impact the bycatch rates of *P. violacea* significantly**

Experimental gear and 18/0 circle hook can significantly reduce bycatch rates of *P. violacea*.

Due to the overall depth of experimental gear deepening, the number of experimental gear deployed within the range of the *P. violacea* preferred depth was reduced. The experimental gear can significantly reduce the bycatch rate of *P. violacea*.

2 Proposed mitigation measures

This study suggested that the following mitigation measures could be used to reduce the *P. violacea* bycatch rate:

(1)using of 18/0 circle hook;

(2) setting the hook to depth deeper than 120 m, water temperature lower than 26 ℃, salinity range higher than 35.80, chlorophyll-*a* lower than 0.280 μg/L, and DO lower than 3.50 mg/L, respectively.

The findings of this study could be used to reduce the bycatch rate of *P. violacea*, **and as a reference for** *P. violacea* **stock assessment.**

Prospect

Pteroplatrtrygon violacea's **behavior is influenced by many factors.**

Other marine environmental and ecological factors, such as ocean currents, thermocline depth, plankton and food web, are also important to the distribution and activities of *P. violacea*.

THANK YOU !