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Population Biological Parameters of *Ambassis vachellii* (Perciformes: Ambassidae) Caught from Bay Hap and Cua Lon Estuaries, Ca Mau Province, Vietnam

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ABSTRACT

The present study has been estimated the population biological parameters of *Ambassis vachellii* living in Bay Hap (BH) and Cua Lon (CL) estuarine regions. By analyzing the results of length-frequency distribution of 6,922 individuals (4,388 individuals in BH and 2,534 individuals in CL), collected from August 2017 to June 2019, it was concluded that L_∞ of these two populations was 7.4 cm and K value of BH population (0.58 yr^{-1}) was higher than that of CL population (0.52 yr^{-1}). Moreover, the t_0 value of the CL population (-0.44 yr^{-1}) was higher than that in the BH population (-0.39 yr^{-1}). The fishing (1,38 yr^{-1}), natural (1,76 yr^{-}1), and total mortalities (3.14 yr^{-}1) of the BH population were lower than those of the CL population, which were 1.90 yr^{-1}, 3.08 yr^{-1}, and 4.98 yr^{-1}, respectively. Accordingly, the longevity of the former population (t_{max}=5.17 yr) was lower than the later one (t_{max}=5.77 yr). Likewise, the population growth performance was 1.50 in BH and 1.46 in CL. The CL population's recruitment time (mid-May and mid-August) was a month later than the BH one (mid-April and early July). The exploitation rate (0.440 in BH and 0.620 in CL) was higher than $E_{0.5}$ (0.353 in BH and 0.355 in CL). Results suggested that these two populations were subjected to overfishing. The length at first capture was 3.3 cm in BH and 3.4 in CL. Consequently, it is recommended to avoid catching *A. vachellii* during the recruitment period for sustainable fishery management.

INTRODUCTION

Fishery management, which is strongly related to the exploitation rate, estimated from the yield-per-recruit analysis **(Al-Husaini *et al.*, 2002)**. The fish population biology assessment is dependent on the growth parameters and mortality rates **(Amezcua *et al.*, 2006)**. Fish growth rate variations between locations are usually related to the growth performance retrieved from growth and asymptotic length relationship **(Pauly and Munro, 1984)**. However, the knowledge about fish population biology, especially Ambassidae species, in the Mekong Delta **(Tran *et al.*, 2013)** is littel.

Vachelli's glass perchlet *Ambassis vachellii* Richardson, 1846 (Perciformes: Ambassidae) is one of 20 species belonging to the genus *Ambassis* in the world **(Froese and Pauly, 2019)** and six in Vietnam **(Nguyen *et al.*, 2011; Tong and Nguyen, 2011; Nguyen *et al.*, 2015)**. This species widely distributed Indo-West Pacific **(Froese and Pauly, 2019)** and along the coastal and marine regions from northern to southern Vietnam **(Nguyen *et al.*, 2011; Nguyen *et al.*, 2015)** e.g., Dau Tieng Lake in Tay Nay province, southern of Vietnam **(Tong and Nguyen, 2010; Tong and Nguyen, 2011)**. However, *A. vachellii* is the only recorded species in the Mekong Delta **(Tran *et al.*, 2013)**. It lives in the marine to brackish and to the Mekong Delta's freshwater region **(Nguyen, 2005; Tran *et al.*, 2013; Nguyen and Pham, 2017; Tong *et al.*, 2019; Tran and Hong, 2019)**. Although this species could used as agood food supply, there is no information about its population biology especially in the Mekong Delta, where the CPUE of this species is decreasing **(Van Tho, 2016)**. Therefore, this study aims to provide evidence on the population's biological parameters of this fish to improve its stock and fishery management.

MATERIALS AND METHODS

Study site

This study was conducted along the Bay Hap and Cua Lon riverine system, which ranging from estuary to midstream in Ca Mau Province of Vietnam. This study extended from August 2017 to June 2019. The dry season at this area occured between December–May and the wet season is from June to November, with a heavy rain(~400 mm of precipitation per month). The mean annual temperature in these regions is ~27 °C, representing the typical natural environment in Mekong Delta **(Le *et al.*, 2006)**.

Fish collection and analysis

Fish specimens were collected every two months using the push net (6.0 m in width, 1.2 m in height, and 1.8 cm in mesh size) at 12 sampling sites in BH and CL (Fig.

1). Samples were collected during the spring tide from Cha La (1; 8°55'59.7"N 105°05'52.4"E), Dam Cung (2; 8°51'26.8"N 105°01'25.9"E), Rach Cheo (3; 8°47'58.5"N 104°53'54.7"E), Bay Hap (4; 08°47'28"N 104°52'20.9"E), Right bank of Bay Hap (5; 08°46'47.5"N 104°50'35.1"E), Left bank of Bay Hap (6; 8°45'31.7"N 104°50'44.6"E) in BH. Likewise, fish specimens were also caught from Right bank of Ong Trang (7; 8°43'44.4"N 104°49'12.3"E), Left bank of Ong Trang (8; 8°42'39.6"N 104°49'24.4"E), Mui Ong Trang (9; 8°41'45.9"N 104°50'53.3"E), Ong Trang (10; 8°41'36.8"N 104°51'23.6"E), Nhung Mien (11; 8°41'37.8"N 104°55'28"E), and Sa Pho (12; 8°44'27.7"N 104°58'18.8"E) in CL.

Water depth was recorded using Portable Depth Sounder (HONDEX PS7), while temperature and pH were recorded using pH Meter (HI 98107). Salinity at the surface and bottom was recorded by a Refractometer (ATC) and water transparency was recorded using 20cm diameter Secchi Disc. These parameters were then used to examine the relationship between them and the population biological parameters of two fish populations in BH and CL. The fish was measured with the standard length (SL) of 0.1 cm for length-frequency data in the laboratory.

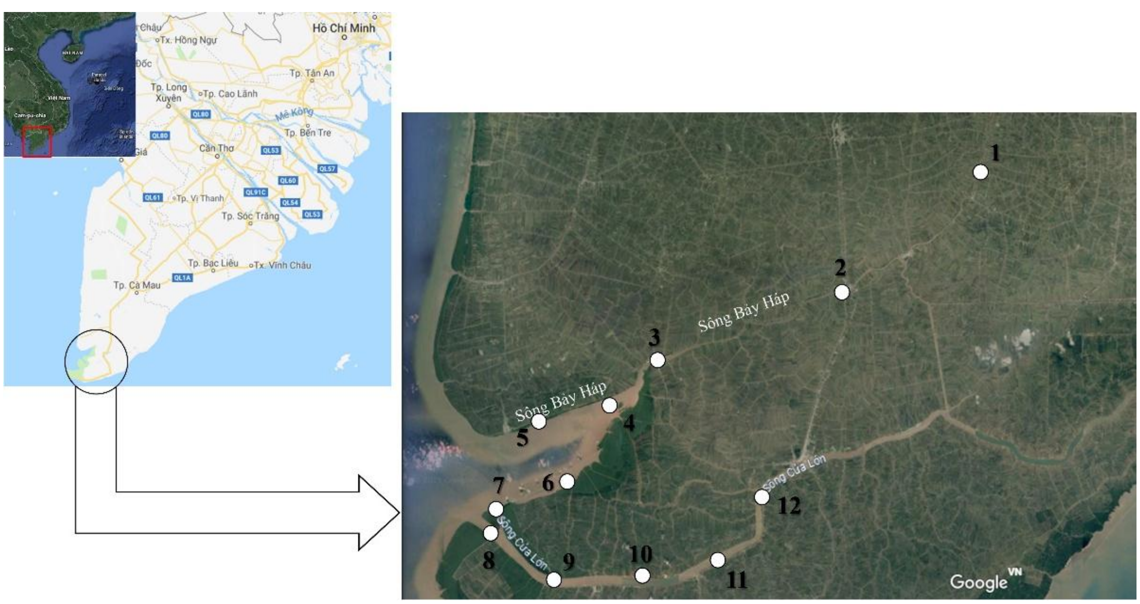

Fig. 1. The map of 12 sampling sites (1: Cha La; 2: Dam Cung; 3: Rach Cheo; 4: Bay Hap; 5: Right bank of Bay Hap; 6: Left bank of Bay Hap; 7: Right bank of Ong Trang; 8: Left bank of Ong Trang; 9: Mui Ong Trang; 10: Ong Trang; 11: Nhung Mien; 12: Sa Pho) (Source: Google map)

Data analysis

The differences in water surface temperature, pH, salinity, water depth, water clarity and water current velocity between two ecological regions (BH and CL) during the two studied seasons (dry and wet) were confirmed by t-test. One-way ANOVA performed the variation of these parameters among sampling months. The interaction of the ecological regions and seasons that influenced by temperature, pH, salinity, water depth, water clarity, and the flow rate was confirmed by two-way ANOVA. All tests were set at a meaningful value of 5%, and were perform using the SPSS v.21.

This fish's length-frequency data was analyzed using FiSAT II software for estimating the population biological parameters **(Gayanilo *et al.*, 2005)**. By using the ELEFAN I the procedure was performed to determine the asymptotic length (L_∞) and the growth parameter (K) **(Pauly and David, 1981; Pauly, 1982; Pauly, 1987)**. The length-converted capture curve was applied to estimate the total mortality rate (Z) **(Beverton and Holt, 1957; Ricker, 1975)**. The theoretical age parameter (t_0) when the fish was zero in length was calculated from the equation:

$$\log_{10}(-t_0) = -0.3922 - 0.2752\log_{10} L_\infty - 1.038\log_{10} K$$ **(Pauly, 1979)**.

The equation $\text{Log}M = -0.0066 - 0.279\text{Log}L_\infty + 0.6543\text{Log}K + 0.463\text{Log}T$, where L_∞ and K were achieved from the ELEFAN I, and T is the mean annual water temperature (^{o}C).

In this study, the above equation was obtained to estimate the natural mortality rate (M) **(Pauly, 1980)**. Therefore, the fishing mortality (F) was calculated as $F = Z - M$, and the exploitation rate (E) was determined using equation $E = F/Z$ **(Ricker, 1975)**. The probability of capturing for each class size as well as the seasonal recruitment pattern were estimated using the length-converted catch and the fish length entry, respectively.

The population for catching (L_c) was computed by plotting the cumulative probability of capture against the class mid-length **(Pauly, 1987)**. The fish stock and yield were estimated from the yield-per-recruit model of **Beverton and Holt (1957) (Sparre and Venema, 1992)**. The knife-edge selection was performed to estimate the maximum yield exploitation rate (E_{max}) with a minimal increase of 10% of Y'/R ($E_{0.1}$) and reduction of stock to 50% ($E_{0.5}$) **(Beverton and Holt, 1966)**. The combined analysis of E and isopleth ratio (L_c/L_∞) was used to determine the fishing status based on **Pauly and Soriano (1986)** method. The growth performance ($\Phi' = \text{Log}K + 2\text{Log}L_\infty$, where K and L_∞ are two parameters of the von Bertalanffy curve) was compared to the von Bertalanffy growth parameters of *A. vachellii* and other fishes dwelling in the same habitat **(Pauly and Munro, 1984)**. The longevity (t_{max}) of *A. vachellii* was calculated using $t_{\max} = \frac{3}{K}$ where K is the growth coefficient **(Taylor, 1958; Pauly, 1980)**

RESULTS

Environmental factors

The temperature in BH (29.60±0.25 SE ^{o}C, n=72) was similar to that in CL (29.36±0.26 SE ^{o}C, n=72, t-test, t=0.91, df=142, P>0.05). For BH, the pH (8.05±0.05, n=72) of the water current velocity (20.53±5.96 SE, n=72) and water clarity (19.89±1.35 SE, n=72) are close to those in CL which were 8.04±0.05 SE (n=72), 27.52±13.26 SE (n=72), 22.48±1.43 SE (n=72), respectively (df=142, P>0,05 for all cases). Contrastly, in BH, the salinity (25.89±0.47 SE, n=72) and water depth (2.53±0.18 m, n=72) were significantly higher than those in CL which were 23.31±0.74 (n=72) and 1.13±0.12 (n=72) respectively (df=142, P<0.05 for all cases). The change of salinity in BH and CL was regulated by dry and wet seasons (two-way ANOVA, F=5.54, P<0.05), whereas the variations of temperature, pH, water current velocity, water clarity, and water depth between BH and CL were not regulated by season variable (P>0.05 for all cases).

The variations of salinity, pH, temperature, water current velocity, water clarity, and depth were presented in Table 2. According to the table, the salinity peaked during the dry season, especially in the late dry season (April 2018 and April 2019). While the pH, temperature, and water clarity showed a reverse trend with high values record in months of the wet season. The water flow rate reached the highest point in October 2017 (231.14±61.70 SE) compared to other months, while the water depth showed a similar trend across the 12 collection sites.

Population parameters

The length-frequency analysis of 6,922 individuals (4,388 individuals in BH and 2,534 individuals in CL, Table 1) showed that 93% of the fish caught (at 2.0-4.0 cm) were from SL in BH (4,095 individuals) and 71% was caught at that SL in CL (1,611 individuals, Fig. 2). A small number of fish that were caught outside of SL<1-2 cm and SL>5 cm. Most of *A. vachellii* was caught during the wet season in BH and CL regions (Fig. 3). During the study, there were six *A. vachellii* size groups from BH populations and five *A. vachellii* size groups in CL populations, i.e., growth curves represented by the blue lines (Fig. 2). The growth increment data analysis obtained from ELEFAN I procedure showed that the von Bertalanffy growth curve of *A. vachellii* was $L_t = 7.4\left(1-e^{-0.58(t+0.39)}\right)$ for BH and $L_t = 7.4\left(1-e^{-0.52(t+0.44)}\right)$ for CL (Fig. 4).

The total (Z), natural (M), and fishing mortalities of *A. vachellii* were 3.14, 1.76, and 1.38 in BH; and 4.98, 1.90, and 3.08 in CL, respectively. This was based on the length-converted catch curve analysis (Fig. 5). Although both BH and CL populations had two recruitment peaks, the CL population's recruitment time (mid-May and mid-August) was a month later compared to BH (mid-March and early July, Fig. 6). The fish was firstly caught (L_c or L_{50}) at 3.3 cm (SL) in BH and 3.4 cm in CL, and they were estimated from the capture probability analysis (Fig. 7).

Table 1. Length frequency data of *A. vachellii* was collected from the study site

Fish size (SL, cm)	Aug-17		Oct-17		Dec-17		Feb-18		Apr-18		Jun-18		Aug-18		Oct-18		Dec-18		Feb-19		Apr-19		Jun-19	
	BH	CL	BH	CL	BH	CL	BH	CL	BH	CL	BH	CL	BH	CL	BH	CL	BH	CL	BH	CL	BH	CL	BH	CL
0-1										1	22	67									5	370		
1-2			23	3	3		46	7	1	6	28	17		6	2				3		39	152		1
2-3	1370	188	75	2	36	9	119	74	14	142	299	69	30	51	10	32	2		4		194	50	14	31
3-4	820	209	2		236	82	265	211	15	205	160	49	44	32	49	97	19	41	4	8	304	212	10	17
4-5	2	2			25	9	47	31	2	4	10	5	11	1	1	7	1	1		1	20	19		1
5-6					1	1	1									4		6						
6-7								1																
Total	2,192	399	100	5	301	101	478	324	32	358	519	207	85	90	62	140	22	48	11	9	562	803	24	50

BH: Bay Hap river, CL: Cua Lon river

Table 2. The variations of environmental factors between sampling times based on one-way ANOVA

Environmental factors	Aug-17	Oct-17	Dec-17	Feb-18	Apr-18	Jun-18	Aug-18	Oct-18	Dec-18	Feb-19	Apr-19	Jun-19
n	12	12	12	12	12	12	12	12	12	12	12	12
Salinity (F=16.21, *P*<0.001)	26.92±1.60^{d,e}	16.92±2.04^{a}	21.08±0.92^{a,b,c}	27.58±0.53^{e}	28.500.53±^{e}	28.00±0.54^{e}	22.00±1.68^{b,c,d}	17.25±0.63^{a,b}	26.67±0.89^{d,e}	25.83±0.68^{c,d,e}	28.83±0.58^{e}	25.67±0.33^{c,d,e}
pH (F=29.82, *P*<0.001)	7.97±0.05^{c,d}	7.54±0.03^{a}	7.62±0.04^{a,b}	7.95±0.03^{c,d}	7.94±0.05^{b,c,d}	7.70±0.07^{a,b,c}	8.13±0.06^{d}	8.00±0.19^{c,d}	7.99±0.04^{c,d}	8.22±0.04^{d}	8.65±0.03^{e}	8.83±0.03^{e}
Temperature (F=11.00, *P*<0.001)	29.62±0.25^{b,c,d}	30.40±0.66^{c,d,e}	28.68±0.27^{a,b,c}	26.73±0.21^{a}	28.38±0.27^{a,b,c}	28.88±0.53^{a,b,c}	29.32±0.46^{b,c,d}	28.08±0.77^{a,b}	30.00±0.26	30.13±0.41^{b,c,d}	31.46±0.70^{d,e}	32.57±0.40^{e}
Water current velocity (F=13.34, *P*<0.001)	2.73±1.36^{a}	231.14±61.70^{b}	19.17±4.83^{a}	24.3±7.04^{a}	0.67±0.20^{a}	0.57±0.13^{a}	2.38±0.59^{a}	1.81±0.49^{a}	1.08±0.51^{a}	2.86±0.60^{a}	1.40±0.46^{a}	0.22±0.14^{a}
Water clarity (F=2.77, *P*<0.05)	25.21±3.02^{a,b}	18.05±2.87^{a,b}	19.63±4.65^{a,b}	12.38±2.88^{a}	19.00±2.88^{a,b}	17.79±2.35^{a}	17.08±2.06^{a}	20.00±1.85^{a,b}	24.04±2.67^{a,b}	22.81±4.68^{a,b}	24.94±4.26^{a,b}	33.33±2.72^{b}
Water depth (F=0.34, *P*>0.05)	2.03±0.52^{a}	1.50±0.32^{a}	2.09±0.44^{a}	1.60±0.31^{a}	1.91±0.43^{a}	1.86±0.35^{a}	1.43±0.30^{a}	1.55±0.35^{a}	1.87±0.53^{a}	2.23±0.50^{a}	1.92±0.47^{a}	1.97±0.61^{a}

Different letters (a, b, c, d, and e) in each environmental factor showed a significant difference between sampling times.

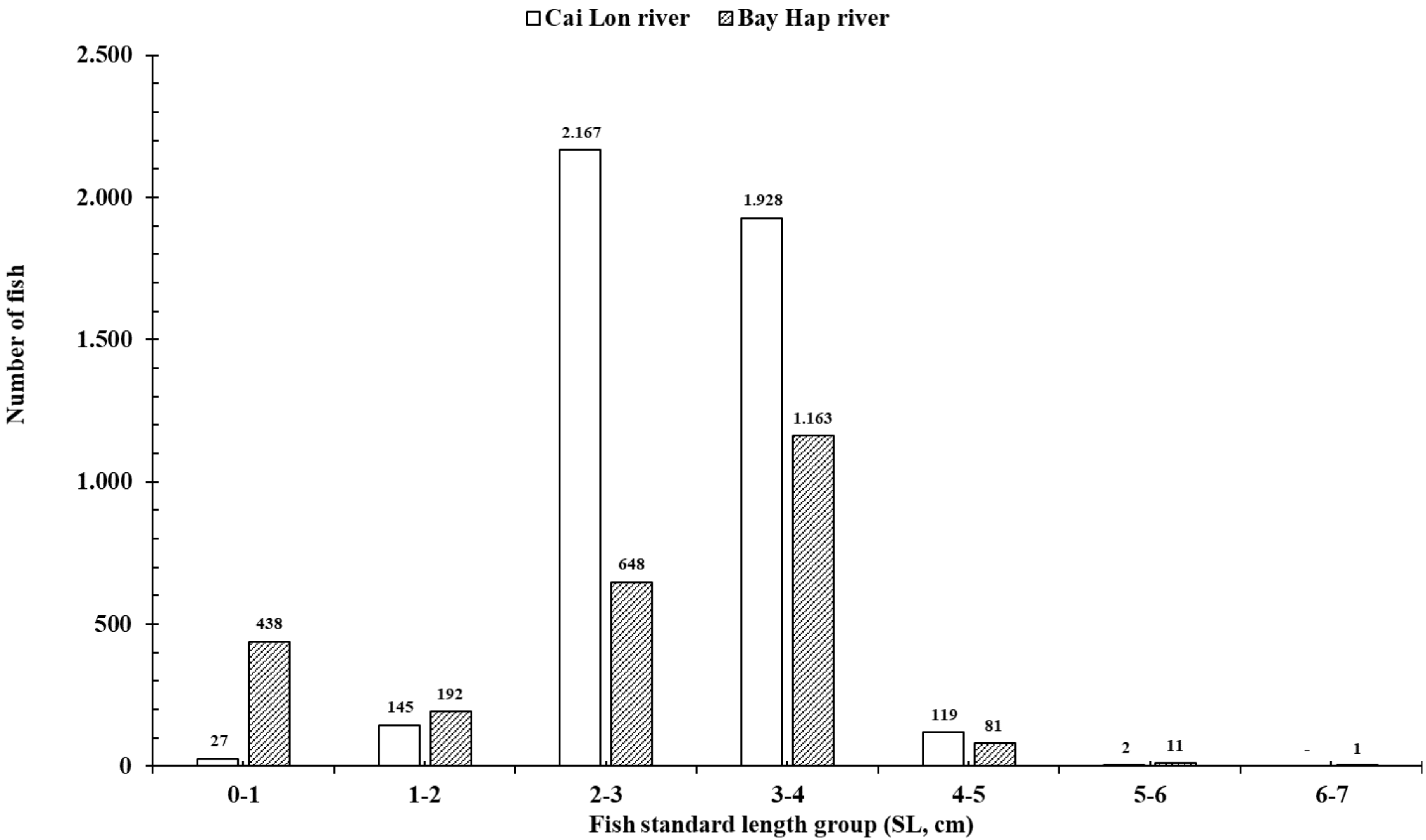

Fig. 2. Number of *A. vachellii* were caught at two ecological regions according to fish size

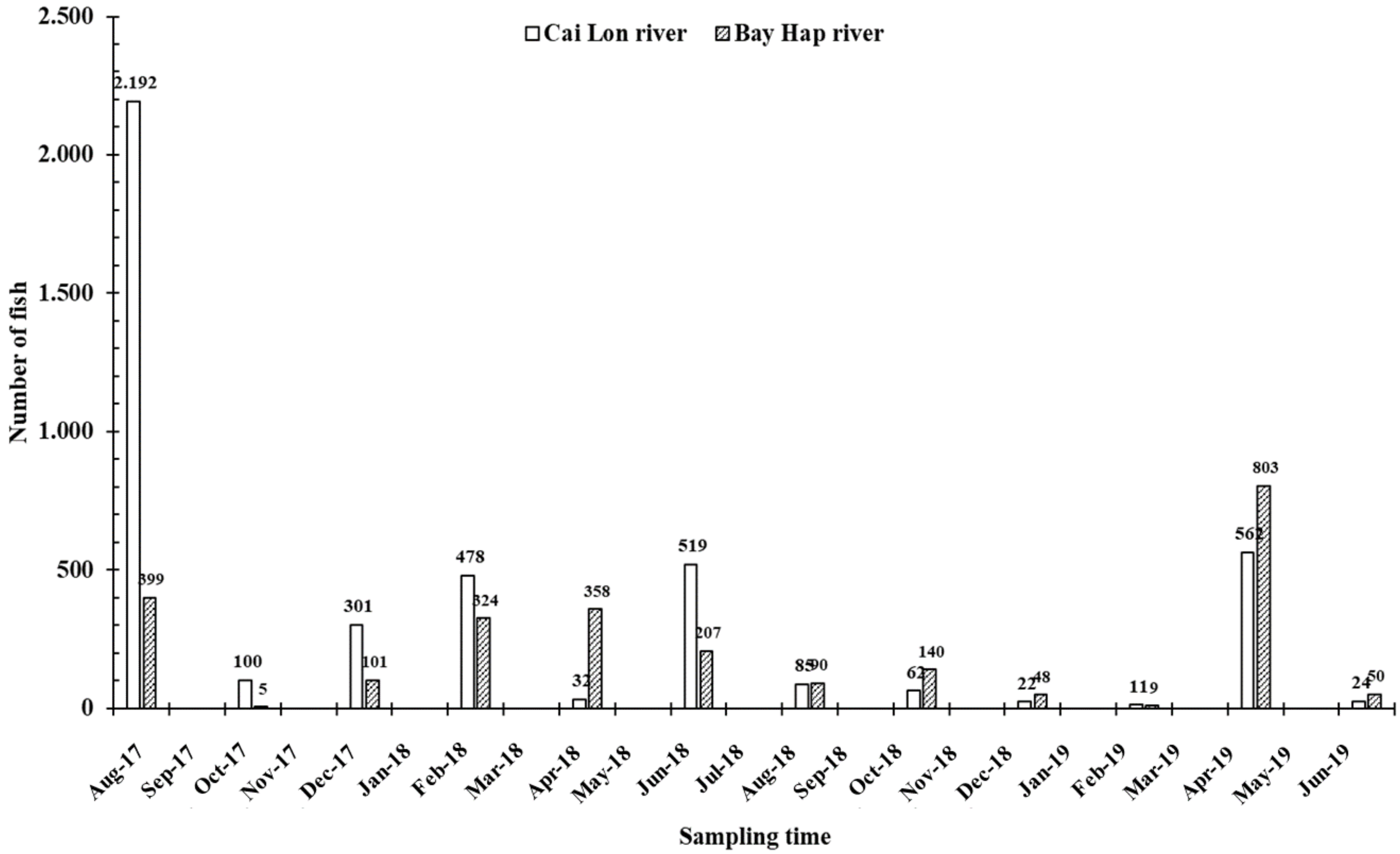

Fig. 3. Number of *A. vachellii* were caught at two ecological regions according to sampling times

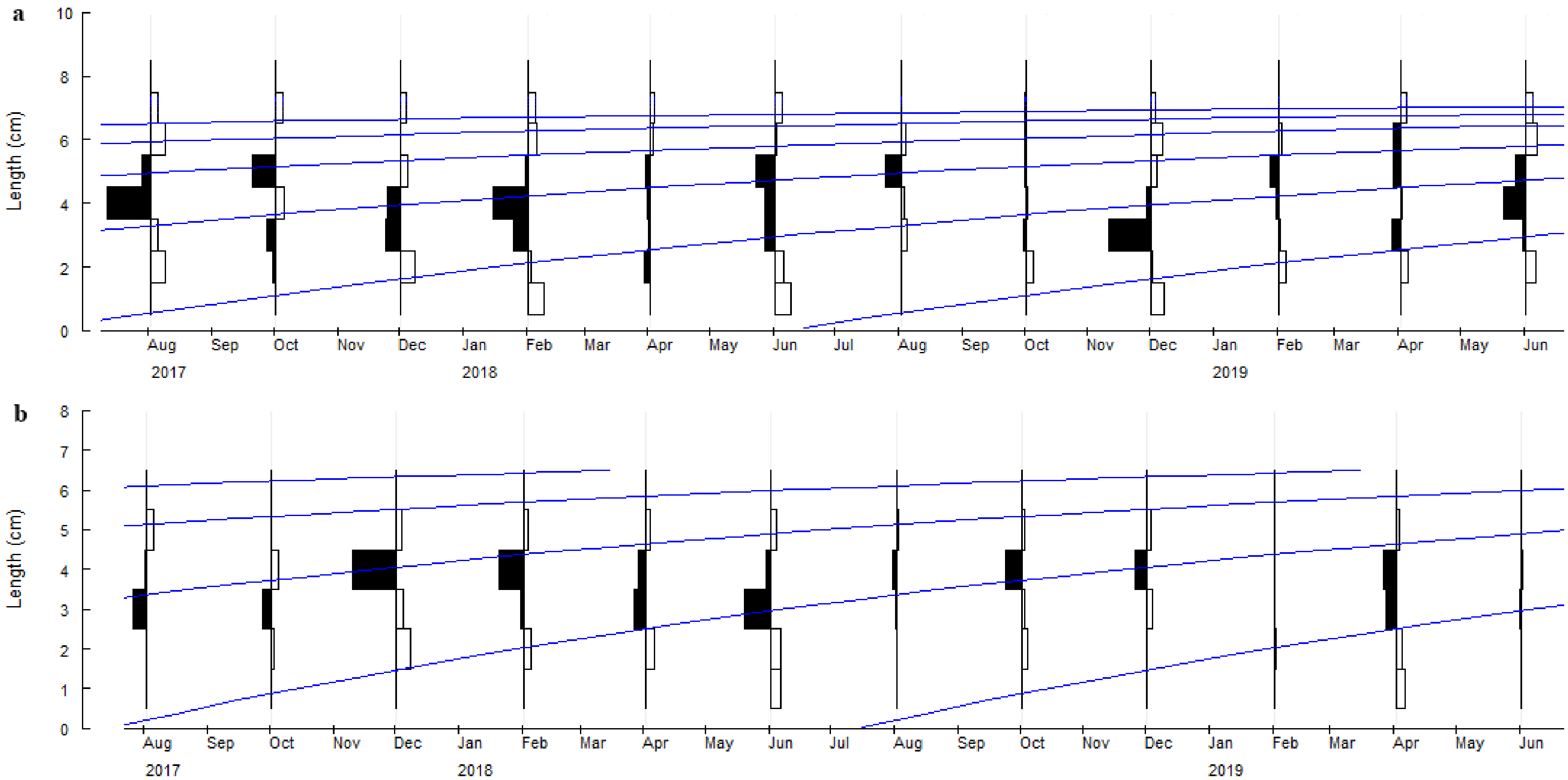

Fig. 4. Length-frequency distribution of *A. vachellii* in Bay Hap (a, n = 4,388) and in Cua Lon (b, n = 2,534). The curves show the increase of fish length over time.

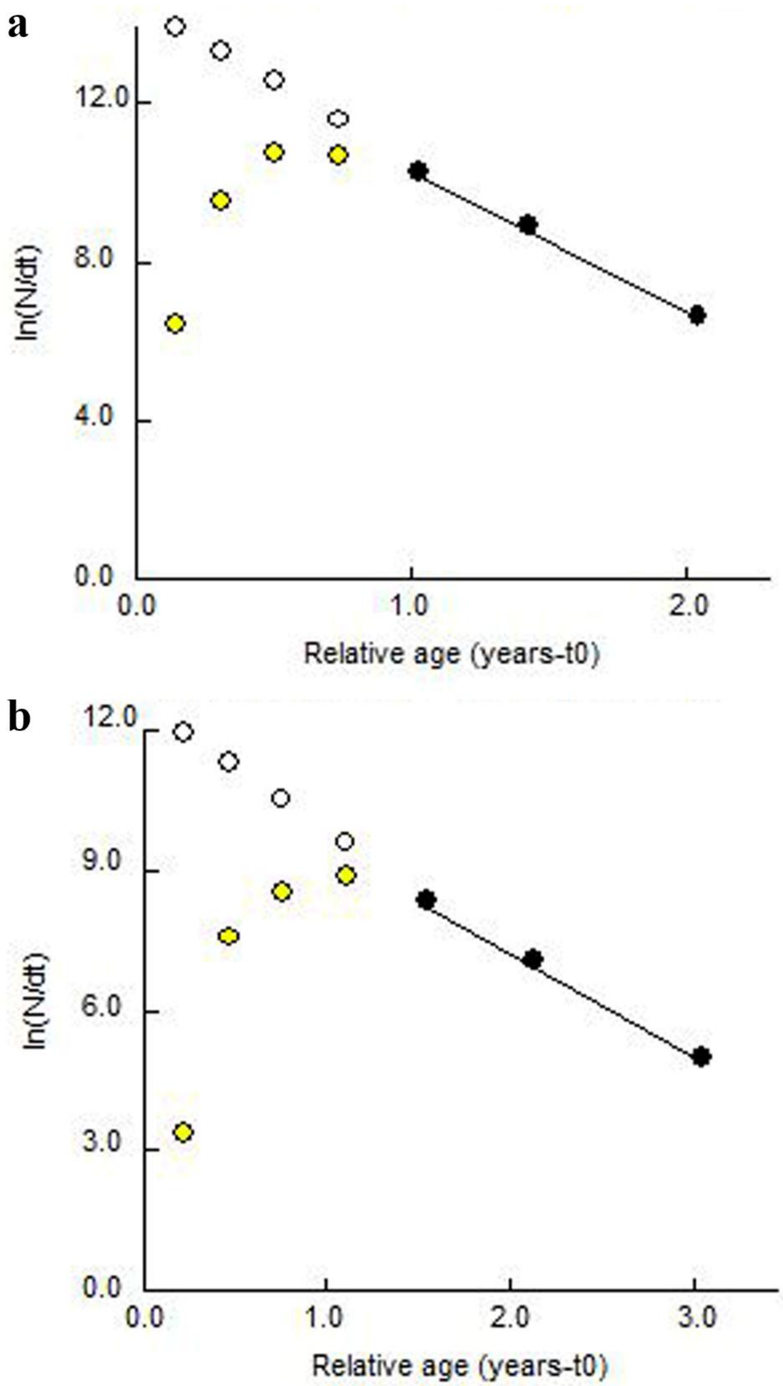

Fig. 5. Length-frequency distribution of *A. vachellii* in Bay Hap (a, n = 4,388) and in Cua Lon (b, n = 2,534). The curves show the increase of fish length over time.

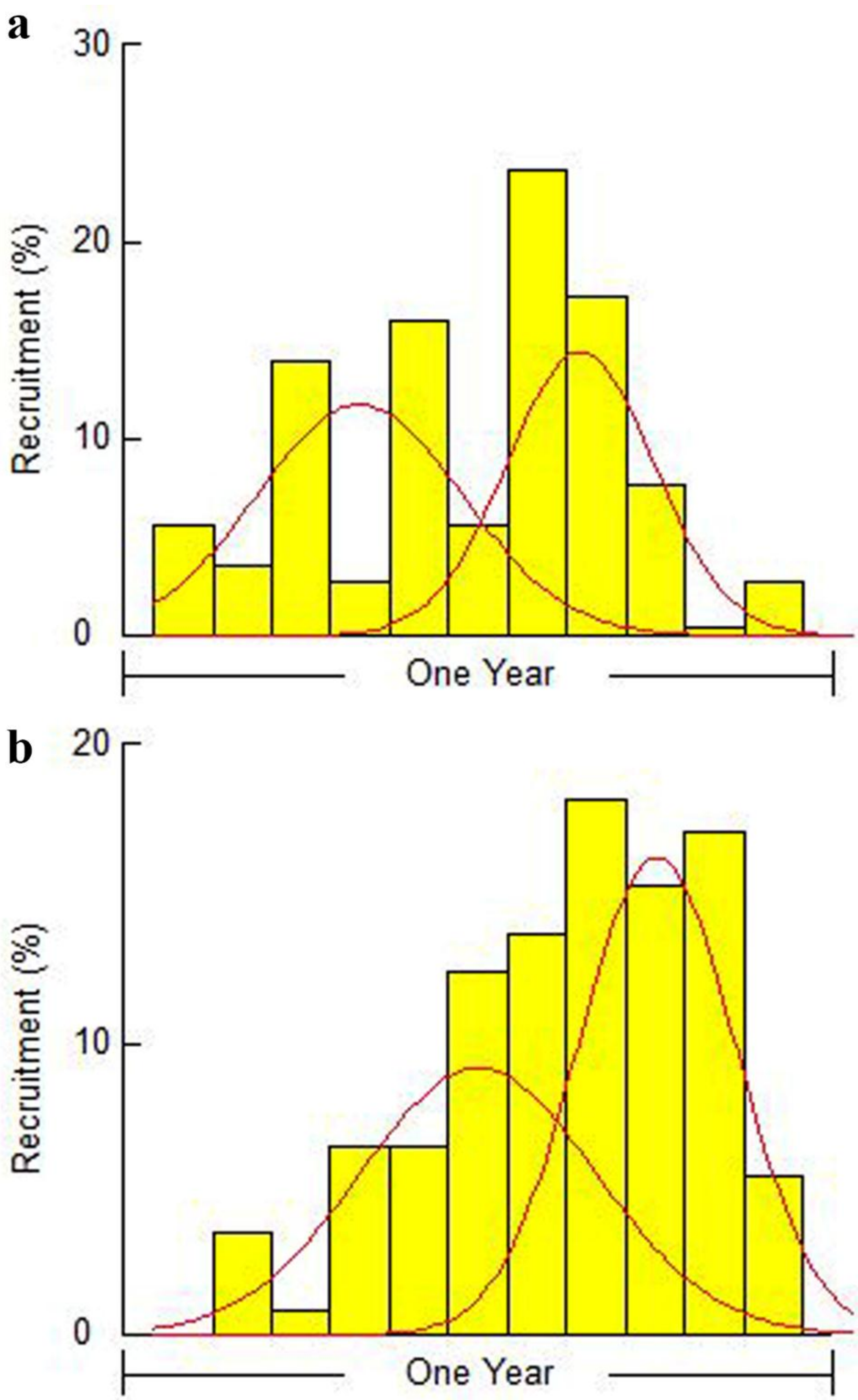

Fig. 6. The recruitment pattern of *A. vachellii* with two peaks in BH (a, main peak in early July and another one in mid-March) and in CL (b, main peak in mid-August and another one in mid-May)

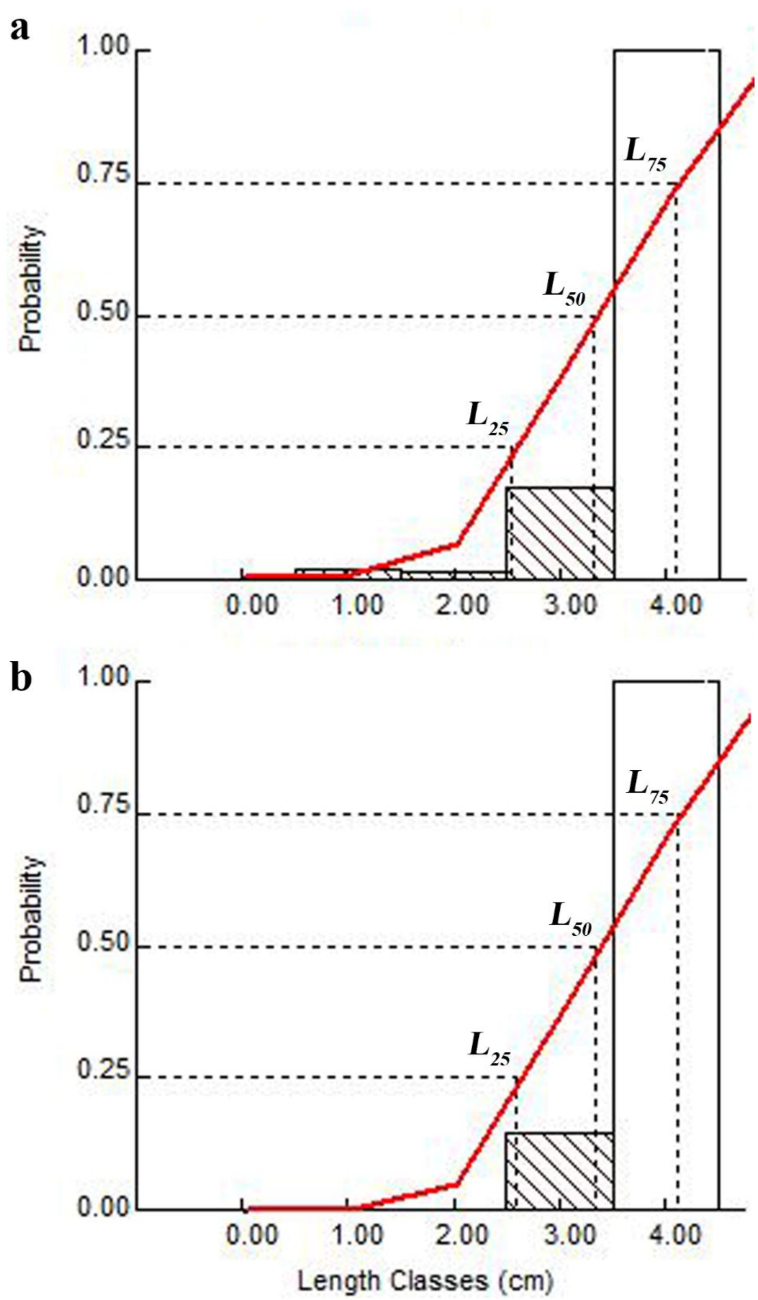

Fig. 7. The probability of capture of *A. vachellii* in BH (a, L_{25} = 2.6, L_{50} = 3.3 and L_{75} = 4.1 cm) and CL (b, L_{25} = 2.6, L_{50} = 3.4 and L_{75} = 4.1 cm) that was estimated from the logistic transform curve, e.g., red line.

The exploitation rate of *A. vachellii* in BH (E=0.44) was 2/3 that was found in CL (0.62). these results indicated an overfishing activity as these values were higher than that of the yield at the stock reduction of 50% (E_{50}). It showed in the analyses of the yield-per-recruit and biomass-per-recruit of *A. vachellii* for; the optimum yield ($E_{0.1}$ was 0.551 in CL and 0.501 in BH), the yield at the stock reduction of 50% ($E_{0.5}$ was 0.355 in CL and 0.353 in BH) and the maximum sustainable yield (E_{max} was 0.626 in CL and 0.621 in

BH, Fig. 8). The ratio between the length at first capture and the asymptotic length (e.g., the yield isopleths) of this fish was 0.45 in BH and 0.46 in CL; its growth performance (*Φ'*) was 1.50 in BH and 1.45 in CL, and the longevity was 5.17 yr in BH and 5.77 yr in CL.

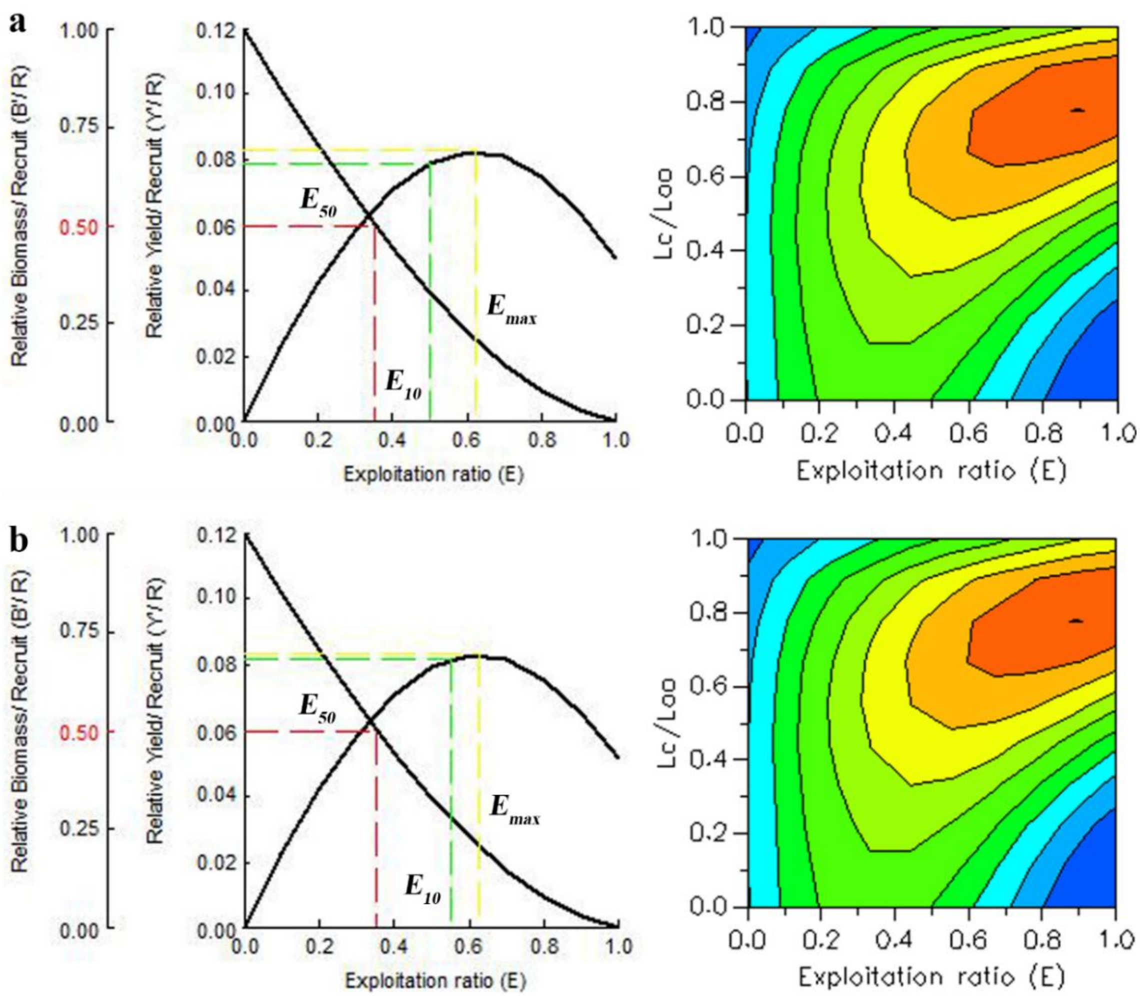

Fig. 8. The exploitation rate of *A. vachellii* in BH (a, E_{10}=0.501, E_{50}=0.353 and E_{max}=0.621) and CL (b, E_{10}=0.551, E_{50}=0.355 and E_{max}=0.626)

DISCUSSION

The higher values of pH, salinity, and water depth in BH compared to CL could lead to a higher number of fishs collected from BH. Most of *A. vachellii* were caught at February in BH and August in CL, showed that it is the migration period of *A. vachellii*, which could caused by the differences in the two populations' main recruited time. The environmental conditions in BH may be more suitable for *A. vachellii* than that in CL. As the *K* recorded a higher value in BL, this could communicated the differences in the number of cohorts in these two populations. **Moreau *et al.* (1986)** during their study on tilapia populations, reported that the growth performance index (*Φ'*) is the best growth index compared to $\omega = K \times L_\infty$, due to its small variation degree. **Moreau *et al.* (1986)** also indicated that *Φ'* was usually similar within the related taxa and has narrow normal distributions. By studying the population structure of *Parapocryptes serperaster,* **Dinh *et al.* (2015)** showed that the difference in growth performance between some fishes resulted from the variation of growth parameter (*K*) and asymptotic length (L_∞). The variation of environmental factors led to the difference of *Φ'* and *K* of *A. vachellii* between BH and CL. The *Φ'* of *A. vachellii* was lower than that of other fish species in the Mekong Delta such as *Pseudapocryptes elongatus* **(Tran *et al.*, 2007)**, *Parapocryptes serperaster* **(Dinh *et al.*, 2015)**, *Boleophthalmous boddarti* **(Dinh, 2017)**, *Glossogobius giuris* **(Dinh *et al.*, 2017)**, *Butis butis* **(Dinh, 2018a)**, *Trypauchen vagina* **(Dinh, 2018b)** and *Stimatogobius pleurostigma* **(Dinh and Nguyen, 2018)** and *Periophthalmodon septemradiatus* **(Tran and Dinh, 2020)** (Table 3). Likewise, the *Φ'* of *A. vachellii* was also lower than that of its relative fish *A. kopsi* living in the Pagbilao, Philippines **(Pinto, 1988)** (Table 3). The difference in *Φ'* of *A. vachellii* and other fish species living in the Mekong Delta, Vietnam, and outside Vietnam indicated that *A. vachellii* is a unique species.

Comparing of L_∞ and L_c of *A. vachellii with* those of other fish species, we found that L_∞ and L_c of *A. vachellii* were significantly shorter. The isopleths parameter (L_c/L_∞) was equal to that of some other fish species or even higher than other species (Table 3). For example, L_∞ and L_c of *A. vachellii* in BH were roughly 1/3 of *Ps. elongatus* **(Tran *et al.*, 2007)**, *G. giuris* **(Dinh *et al.*, 2017)**, and *B. butis* **(Dinh, 2018a)** and a half of *Pn. septemradiatus* **(Tran and Dinh, 2020)**. These two values of *A. vachellii* were 1.2 cm shorter than those of *S. pleurostigma* **(Dinh and Nguyen, 2018)**. However, its isopleths parameter was higher than that of these species. Thus, the fraction of L_c/L_∞ should be used when comparing L_∞ and L_c instead of making individual comparisons.

Ambassis vachellii could spawn many times during its life cycle due to the high value of longevity. This fish has the potential for artificial spawning compared to other fish species living in the Mekong Delta such as *Ps. elongatus* **(Tran *et al.*, 2007)**, *P. serperaster* **(Dinh *et al.*, 2015)**, *Bo. boddarti* **(Dinh, 2017)**, *G. giuris* **(Dinh *et al.*, 2017)**, *B. butis* **(Dinh, 2018a)**, *T. vagina* **(Dinh, 2018b)**, and *S. pleurostigma* **(Dinh and Nguyen, 2018)**, as its t_{max} was higher than that of others. From Table 3, it is noticed that the longevity of *A. vachellii* was higher than that of the other species, however, its growth performance was lower than that of *Ps. elongatus* **(Tran *et al.*, 2007)**, *P. serperaster* **(Dinh *et al.*, 2015)**, *Bo. boddarti* **(Dinh, 2017)**, *G. giuris* **(Dinh *et al.*, 2017)**, *Butis butis* **(Dinh, 2018a)**, *T. vagina* **(Dinh, 2018b)**, *S. pleurostigma* **(Dinh and Nguyen, 2018)** and *Pn. septemradiatus* **(Tran and Dinh, 2020)**.

Both populations of *A. vachellii* in BH and CL had two recruitment peaks. CL's recruitment time appeared to be later compared to BH and the main peak was also different. This is may be due to the difference in environmental factors between BH and CL. The two peaks of the cohort contribution were found in *Ps. elongatus* **(Tran *et al.*, 2007)**, *P. serperaster* **(Dinh *et al.*, 2015)**, *Bo. boddarti* **(Dinh, 2017)**, *G. giuris* **(Dinh *et al.*, 2017)**, *B. butis* **(Dinh, 2018a)**, *T. vagina* **(Dinh, 2018b)**, and *S. pleurostigma* **(Dinh and Nguyen, 2018)**, at a different time interval. This showed that recruitment was influenced by environmental factors even though it was a specific-species.

Table 3. Population parameters of various fish species.

Species	L_∞	K	t_{max}	Z	F	M	L_c	L_c/L_∞	E	Φ'	Place	Sources
Ambassis kopsi	10.9	0.73	-	2.88	0.91	1.96	-	-	-	2.09	1	**Pinto (1988)**
Pseudapocryptes elongatus	26.0	0.65	4.35	2.91	1.47	1.44	11.75	0.45	0.51	2.64	2	**Tran *et al.* (2007)**
Parapocryptes serperaster	25.5	0.74	4.05	3.07	1.57	1.51	14.6	0.57	0.49	2.67	2	**Dinh *et al.* (2015)**
Boleophthalmus boddarti	16.8	0.79	3.55	2.13	0.30	1.83	13.0	0.77	0.14	3.55	2	**Dinh (2017)**
Glossogobius giurris	20.5	0.56	5.36	3.17	1.77	1.40	7.4	0.36	0.56	2.37	2	**Dinh *et al.* (2017)**
Butis butis	24.0	0.61	4.92	3.40	1.98	1.42	10.5	0.44	0.58	2.55	2	**Dinh (2018a)**
Trypauchen vagina	24.2	0.56	5.56	2.73	1.29	1.44	13.8	0.57	0.53	2.50	2	**Dinh (2018b)**
Stigmatogobius pleurostigma	8.6	0.83	3.61	3.48	2.31	1.17	3.8	0.44	0.34	1.79	2	**Dinh and Nguyen (2018)**
Periophthalmodon septemradiatus	12.6	1.60	1.88	4.11	0.97	3.14	9.2	0.73	0.24	2.41	2	**Tran and Dinh (2020)**
Ambassis vachellii	7.4	0.58	5.17	3.14	1.76	1.38	3.3	0.45	0.44	1.50	2	Present study in Bay Hap River
Ambassis vachellii	7.4	0.52	5.77	4.98	1.90	3.08	3.4	0.46	0.62	1.46	2	Present study in Cua Lon River

1: Pagbilao, Philippines; 2: The Mekong Delta, Vietnam

This fish stock of *Ambassis vachellii* had been subjected to overfishing in both BH and CL regions in the present study, as the exploitation rate was higher than that of E_{50}. Moreover, the combination of yield isopleths (L_c/L_∞) and exploitation rate (E) analysis showed that the fish species were overfishing, since its L_c/L_∞ (0.45 in BH and 0.46 in CL) and E (0.44 in BH and 0.62 in CL) failed to be classified into the overfishing category (quadrant D) as described by **Pauly and Soriano (1986)**. A short length supported this assumption at the first capture of this species. Likewise, the population of *G. giuris* **(Dinh *et al.*, 2017)**, *B. butis* **(Dinh, 2018a)**, and *T. vagina* **(Dinh, 2018b)** were overharvesting. In contrast, the population of *Ps. elongatus* **(Tran *et al.*, 2007)**, *P. serperaster* **(Dinh *et al.*, 2015)**, *Bo. boddarti* **(Dinh, 2017)**, and *S. pleurostigma* **(Dinh and Nguyen, 2018)** have not been subjected to overfishing. The fishing gears' mesh size should increase to avoid fishing collection during the recruitment period for sustainable fishery management as *A. vachellii* populations indicated overfishing.

CONCLUSION

The fish stocks had been subjected to overexploitation in the studied regions, so the push net's mesh size should be increased. Also, the fishery should not be operated during the recruitment period as a recommendation for future sustainable fishery management. Besides, *A. vachellii* was high in population recruitment, this species could be potential for future aquaculture due to their high growth constant.

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