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11 “ 1 ”(H) 8 (O) HH[H(♀)×H(♂)] OO[O(♀)×O(♂)] HO[H(♀)×O(♂)] OH[O(♀)×H(♂)] (GCA) (SCA) 20 F1 58.03% HO OH HH 31.48% 35.80% 360 OH>HO>HH>OO F1 24.65% 46.02% HH OH 23.51% 39.60% F1 E_{HO} E_{OH} 68.31% 40.29% 53.96% 180 GCA “ 1 ” GCA OH SCA HO “ 1 ” OH

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Heterosis and combining ability of reciprocal hybrids between “Haida No.1” strain and orange shell line of the Pacific oyster (*o ppl pob dfl p*)

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(1. *Hb I lo lo lc ofrirob fkfpo lc ar fk L b k kf bopf lc efk Nfkda l* 266003 *efk*;
2. *I lo lo clo ofkbC fzebofppP fbk b ka Cl la Mol ar fk Mol bppbp Nfkda l K fk i I lo lo clo ofkbP fbk b ka Qo ekli ld Nfkda l* 266237 *efk*)
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Abstract The Pacific oyster (*Crassostrea gigas*) which originated from East Asia, has been a dominant commercial species in northern China. However, frequent summer mass mortality in farming areas has severely restricted the development of oyster aquaculture. In order to develop a new strain of *C. gigas* with fast growth and high survival traits, intra-specific hybridization was carried out using the “Haida No. 1” strain (H) and orange shell line (O) which were successively mass selected for 11 and 8 generations, respectively. The heterosis for growth and survival at larval and grow-out stages were assessed among two purebred groups HH[H(♀)×H(♂)] and OO[O(♀)×O(♂)] and two reciprocal hybrids HO[H(♀)×O(♂)] and

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OH[O(♀)×H(♂)]. On day 20, the mid-parent heterosis for survival of hybrid groups was 58.03%. Compared to HH groups, the survival rate of HO and OH increased by 31.48% and 35.80%, respectively. On day 360, the growth among four groups followed the order OH>HO>HH>OO, the mid-parent heterosis for shell height and living weight of reciprocal hybrids were 24.65% and 46.02%, respectively. Compared to HH groups, the shell height and living weight of OH group on day 360 increased by 23.51% and 39.60%, respectively. Two hybrid groups also exhibited high heterosis in survival, the mid-parent heterosis M_{F1} and high-parent heterosis H_{HO}, H_{OH} were 68.31%, 40.29% and 53.96%, respectively. As male parent, the “Haida No.1” strain exhibited negative value for general combining ability in survival on day 180. However, the general combining ability was positive when the “Haida No.1” strain was employed as parent at other stages, which indicated the “Haida No.1” strain can be chosen as an excellent parental strain for crossbreeding with other lines of *C. gigas*. The values of special combining ability for growth and survival of OH group were higher than those of HO group. This suggested the progeny with higher heterosis could be obtained by using the “Haida No.1” strain as male parent and orange shell line as female parent.

o ppd pob d fd p, survival; heterosis; hybridization; combining ability

(*Crassostrea gigas*)

2020 132 t

25%[1]

[2-4] [5]

10%~15%

1.3

Li [14] 1

1 1

50 1

HH[H(♀)×H(♂)] OO[O(♀)×O(♂)] HO[H(♀)×O(♂)] OH[O(♀)×H(♂)]

3 100 L 24

24 h 300 D 100 L 2~3 /mL

2

2.1

1 HO (75.38 μm) > OH (72.40 μm) > HH (69.64 μm) > OO (68.23 μm) HO OO (P<0.05) 1 M_{F1} H_{HO} H_{OH} 7.18% 8.24% 3.96% 10 HO (163.11 μm) (P<0.05) M_{F1} 19.36% 20 (P<0.05) HO (303.66 μm) > OH (298.45 μm) HO HH (284.46 μm) (P<0.05) M_{F1} 6.91% H_{HO} H_{OH} 6.75% 4.92%

5 HO (93.67%) OO (88.00%) (P<0.05) (1) OH (H_{OH} -0.72%) 10 OH (89.00%) HO (86.33%) (P<0.05) M_{F1} H_{HO} H_{OH} 16.37% 15.11% 18.67% 20 HO OH OO HH (HO 71.00% OH 73.33% HH 54.00% OO 37.33%) (P<0.05) M_{F1} 58.03% H_{HO} H_{OH} 31.48% 35.80%

M_{F1} 54.57% (P<0.05)
OH>HO>HH>OO 360 HO(61.17 g) OH(67.65 g) HH(48.46 g) OO(39.76 g)
(P<0.05) H_{HO} 26.23% H_{OH} 39.60%(2 3)
180 (P>0.05)
HH 92.33% HO 93.33% OH 93.00% OO 92.33% M_{F1} H_{HO}
H_{OH} 0.92% 1.08% 0.72% 360 OO (34.67%) (P<0.05)
OH (71.33%) HO (65.00%) (P<0.05) M_{F1} H_{HO} H_{OH}
68.31% 40.29% 53.96%(2 3)

2

Tab. 2 Shell height, living weight and survival rate of four experimental groups at juvenile and adult stage

		/d time			
parameter	group	day 90	day 180	day 270	day 360
/mm shell height	HH	76.00 ± 6.28^{a}	80.38 ± 6.60^{b}	85.58 ± 4.96^{c}	91.95 ±11.93^{c}
	HO	78.12 ± 9.58^{a}	82.11 ± 6.34^{ab}	93.35 ± 6.34^{b}	98.13 ± 9.88^{b}
	OH	78.50 ± 8.61^{a}	86.82 ± 6.04^{a}	97.12 ± 6.04^{a}	113.57 ± 10.92^{a}
	OO	47.20 ± 12.90^{b}	55.06 ± 9.32^{c}	65.83 ± 10.38^{d}	77.88 ± 10.80^{d}
/g living weight	HH	35.22 ± 5.91^{b}	41.85 ± 6.05^{b}	48.35 ± 7.69^{c}	48.46 ± 10.52^{c}
	HO	38.25 ± 5.84^{a}	48.27 ± 5.98^{a}	57.97 ± 6.44^{b}	61.17 ± 10.10^{b}
	OH	38.04 ± 3.84^{a}	51.18 ± 5.92^{a}	62.95 ± 6.86^{a}	67.65 ± 7.01^{a}
	OO	24.06 ± 5.10^{c}	25.88 ± 8.39^{c}	29.88 ± 4.46^{d}	39.76 ± 8.64^{d}
/% survival rate	HH	-	92.33 ± 5.03^{a}	72.67 ± 2.52^{b}	46.33 ± 3.51^{c}
	HO	-	93.33 ± 2.08^{a}	85.67 ± 0.58^{a}	65.00 ± 2.00^{b}
	OH	-	93.00 ± 2.00^{a}	87.67 ± 3.06^{a}	71.33 ± 1.52^{a}
	OO	-	92.33 ± 0.57^{a}	63.33 ± 3.06^{c}	34.67 ± 3.21^{d}

3

Tab. 3 Heterosis for shell height, living weight and survival rate of four experimental groups at juvenile and adult stage

		/d time			
parameter	heterosis	day 90	day 180	day 270	day 360
/mm shell height	F1 E_{HO}	27.12	24.73	25.79	24.65

OH >HO 180 HO 2.80 H
O 8.00 8.00 OH 1.20 270 360
HO OH OH 10.17 16.85

4

Tab. 4 Combining ability for growth-related traits of four experimental groups at juvenile and adult stage

trait	combining ability	parent	group	/d time day 90	day 180	day 270	day 360
/mm shell height	general combining ability	sire	H	1.79	1.07	1.01	1.09
			O	-1.79	-1.07	-1.01	-1.09
		dam	H	1.30	9.71	5.10	5.92
			O	-1.30	-9.71	-5.10	-5.92
	specific combining ability	-	HO	8.05	7.02	7.81	2.70
		-	OH	8.42	9.57	11.54	17.85
/g living weight	general combining ability	sire	H	4.48	1.27	1.04	3.10
			O	-4.48	-1.27	-1.04	-3.10
		dam	H	6.17	3.30	1.78	9.51
			O	-6.17	-3.30	-1.78	-9.51
	specific combining ability	-	HO	4.06	6.40	8.13	6.79
		-	OH	4.27	9.28	13.08	13.15
/% survival rate	general combining ability	sire	H	-	-8.00	7.62	8.94
			O	-	8.00	-7.62	-8.94
		dam	H	-	8.00	4.47	1.72
			O	-	-8.00	-4.47	-1.72
	specific combining ability	-	HO	-	2.80	8.20	10.58
		-	OH	-	1.20	10.17	16.85

2.4

360 500 OH HO
OO
HH 1 000
HO OH 500 684 68.4%
316 31.6% HH
I

I 1

1. 1 2. 3. 1 4~5

Plate I Shell color of the "Haida No.1" line, the orange-shell line and two reciprocal hybrids

1. the “Haida No.1” line of the Pacific oyster; 2. the orange-shell line of the Pacific oyster; 3. the hybrids with the same shell phenotype as the “Haida No.1” line; 4-5. the hybrids with purple shell color

3

3.1

1

11 8

360 OH HH 25% Ma [18]

(*C. sikamea*)

[10]

Han [4] 6 7 3 3

[19]

[10]

[4]

[20]

HO

OH OH OH HO

[12] (*C. angulate*) [21] [10]

[13] [12] [4]

1

[3-4]

3.2

[22] 1

1

[5] GCA 1 HH GCA OO

OH SCA HO

[4] (SCA) [3]

GCA SCA

[23] 1 GCA GCA

OH SCA OH

1

3.3

Zhang [12] Kong [13] lg

4.

1

(360) OH 53.96% 1

GCA OH

SCA HO 1

OH

[1] -2021[M]

2021 23-27

Fisheries and Fisheries Administration Bureau of the Ministry of Agriculture and Rural Areas, National Aquatic Technology Promotion Station, China Society of Fisheries. China Fishery statistical yearbook-2021[M]. Beijing: China Agriculture Press, 2021: 23-27 (in Chinese).

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