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长牡蛎壳黑和壳白选育群体生长性状的选择效应

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摘要: 为了培育壳色性状优良且生长性状良好的长牡蛎(*Crassostrea gigas*)新品系, 本研究以 5 个壳黑第四代家系和 5 个壳白第四代家系的成贝为基础群体, 利用截头法对壳高进行选择, 构建了壳黑和壳白快速生长系第一代群体, 分析了两个选育群体的壳高和活体体重的选择反应、遗传获得和现实遗传力等遗传参数。结果表明, 在长牡蛎收获的 490 日龄, 壳黑群体和壳白群体选择组壳高较对照组壳高分别提高(9.83±1.68)%和(9.97±1.87)%, 体重分别提高(10.16±3.64)%和(11.36±1.96)%。两选育群体壳高的平均现实遗传力分别为(0.353±0.09)和(0.405±0.111), 体重的平均现实遗传力为(0.192±0.080)和(0.244±0.123)。本研究表明壳黑群体和壳白群体具有较大的遗传方差, 在对壳高生长速度直接选择的同时实现了对活体体重的间接选育, 可继续通过群体选育提高生长速度。本研究结果可以为培育出壳色美观、生长性状良好的长牡蛎优良品种提供科学依据。

关键词: 长牡蛎; 壳黑; 壳白; 选择反应; 生长性状; 遗传力
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长牡蛎(*Crassostrea gigas*)又称太平洋牡蛎, 自然分布于西北太平洋海域, 是世界上养殖范围最广, 产量最高的经济贝类。2014 年我国牡蛎养殖产量超过 435.2 万 t, 占全国贝类总养殖产量的 33.1%[1]。然而, 养殖种质主要来自未经遗传改良的群体, 存在生长慢、死亡率高、外观差等问题[2], 开展长牡蛎的选择育种是解决这些问题的有效途径。贝类壳色影响着消费者的喜好和选择, 受整个产业的关注[3−4], 而生长速度直接影响经济效益, 因此培育壳色性状优良、生长速度良好的新品系对于长牡蛎产业有着重要意义。

海洋贝类的壳色具有多态性并普遍存在, 近年来, 越来越多的研究表明贝类的壳色由遗传因素决定[5−8]。壳色作为一个重要的育种性状, 已经成为海产贝类遗传育种研究的一个热点。目前国内外很多研究根据壳色这一性状开展了选择育种工作, 并取得一定进展, 获得了一些壳色新品系, 如白壳珍珠贝(*Pinctadafucata martensis*)品系[9], 皱纹盘鲍(*Haliotis discushannai*)的‘中国红’品系[10], 虾夷扇贝(*Patinopecten yessoensis*)的‘象牙白’品系[11], 菲律宾蛤仔(*Ruditapes philippinanm*)的‘白斑马’、‘两道红’等品系[12]和海湾扇贝(*Argopecten irradians*)的‘中科红’新品种[13]等。2010 年本课题组在长牡蛎养殖群体中筛选出了白壳色、黑壳色、金壳色和紫壳色 4 种壳色类型, 并构建了第一代壳色家系, 通过比较不同壳色品系的生长情况, 结果发现长牡蛎壳色与生长和存活存在显著相关[14]。2011—2013 年在第一代家系选育的基础上继续对壳色进行纯化, 获得了第二代至第四代壳色家系。

本研究在连续四代壳色家系选育的基础上, 分别以第四代壳黑家系和壳白家系为基础群体, 开展了长牡蛎壳黑和壳白品系生长性状的群体选育。通过对基础群体壳高性状的截头选择, 分析长牡蛎壳黑和壳白选育群体的选择反应、遗传获

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得和现实遗传力，旨在为培育出壳色美观、生长性能良好的长牡蛎优良品种提供科学依据。

1 材料和方法

1.1 亲贝来源

2014 年 6 月，以 5 个壳黑第四代家系(B1−B5)和 5 个壳白第四代家系(W1−W5)的成贝为基础群体，利用截头法对壳高进行选择。选择前，测量所有亲本的壳高和体重等生长性状。选择前从壳黑和壳白两个基础群体分别随机挑选 80 个亲贝作为对照组亲本。然后再从中挑选 100 个壳高最大的个体作为选择组亲本，构建选择组群体。

1.2 人工受精与产卵孵化

采用人工受精方式分别构建了壳黑和壳白两个选育群体的选择组(壳黑选育系：BS1；壳白选育系：WS1)和对照组(壳黑对照群体：BC1；壳白对照群体 WC1)。采用解剖法移除牡蛎的右壳，辨别雌雄后，收集雌性配子于容器内，显微镜估算密度，确保各亲本卵子使用量相同，将所有卵子混合于同一容器内，同时收集雄性配子，整个过程严防污染。人工授精前对卵子进行镜检，在未发生意外受精的前提下，将精子与熟化好的卵子按照精卵 30∶1~50∶1 的比例进行人工授精。静置 30 min 后倒掉多余精子并洗卵，然后将各组受精卵分别置于水温 24℃、微量充气的 20 m^3 水泥培育池中孵化。

1.3 幼苗培育与采苗

经过约 24 h，受精卵孵化至 D 形幼虫。对各组的幼体进行定量后，将幼体移入新的 20 m^3 的水泥池中培养，幼体初始密度设为 5 个/mL，随幼虫生长定期调整，至眼点幼虫时调整到 1 个/mL，并确保选择组和对照组幼虫密度相同。幼体的前期饵料为球等鞭金藻(*Isochrysis galbana*)和小球藻(*Chlorella vulgaris*)，幼虫壳高生长至 130 μm 后加投扁藻(*Platymonas* sp.)，每日投喂 4~6 次，每次投饵量根据幼虫摄食情况而定。每天换水 1~2 次，每次换水量为水体的 1/2，每隔 7~10 d 倒池 1 次。培育期间保证各组幼体培养条件相同，包括密度、饵料、水温(24℃)和盐度(30)等。当幼体壳高生长至约 350 μm，有 20%~30%幼虫出现眼点时，将用每 500 片栉孔扇贝壳串成一串制成的附着基垂悬于培育池中，供幼虫附着变态，当每片附着基附着约 20 个长牡蛎稚贝时结束采苗。

1.4 养成

稚贝附着后于室外沉淀池暂养约 3 周，确定稚贝充分变态且适应海区环境后，转移至山东省刘公岛海区(37.3ºN, 122.1ºE)，采用筏式吊绳养殖方式进行养成。长牡蛎吊绳养殖所用的夹苗绳为长度 3~4 m、直径 0.6~0.8 cm 的聚乙烯绳，将附有 10~20 个稚贝的附着基夹入苗绳，附着基间距 15~20 cm，每绳夹 15~20 片，苗绳间距 30~40 cm。夹苗绳底部挂重 0.2~0.3 kg 的石块，以避免其因风浪相互缠绕。各组夹片密度、水层深度及海域分布等环境条件均保持一致。

1.5 采样与生长观测

养成期分别在 60 d、120 d、210 d、240 d、300 d、350 d、420 d 和 490 d 时取样，每组随机取样 3 条苗绳，每条苗绳取样 30 个体，用电子游标卡尺(精度 0.01 mm)测量壳高，用电子天平测量个体的总重(精度 0.1 g，由于牡蛎在生长早期个体较小、壳比较脆弱无法剥离成单体，因此个体总重从 120 d 开始测量)。

1.6 选择反应、遗传获得与遗传力估测

参照 Hadley 等[15]和 Zheng 等[16]的方法计算标准选择反应(SR)、现实遗传力(h_R^2)和遗传获得(GG)。

$$SR = \frac{X_S - X_C}{\sigma_C}\text{；}\ h_R^2 = \frac{X_S - X_C}{i\sigma_C}\text{；}$$

$$GG(\%) = \frac{X_S - X_C}{X_C} \times 100$$

式中，X_S 和 X_C 分别是选择组和对照组壳高或体重的平均值，σ_C 是对照组的标准差，i 是选择强度。

利用 SPSS 22.0 统计软件的独立样本 t 检验分析选择组和对照组的表型差异，显著性水平为 0.05。

2 结果与分析

2.1 亲本选择

基础群体所采用的壳黑和壳白家系个体的壳高大小和分布频率如图 1 所示，其中 5 个壳黑家

系个体数分别为 350、329、347、365、277; 5 个壳白家系的个体数分别为 350、300、376、305、345。以 6.0%的选择压, 壳黑 5 个家系选择的个体数分别为 20、19、21、22、18; 壳白 5 个家系选择的个体数分别为 21、18、22、18、21。再选取其中壳型规则、双壳颜色均为黑色的个体 60 个和白色的个体 50 个作为群体选育的亲贝。选择组和对照组的亲本信息如表 1 和表 2 所示。

表 1　长牡蛎壳黑选育群体选择组和对照组亲本信息

Tab. 1　Information of the parents of selected and control strains of the black-shell *Crassostrea gigas*

家系 family	家系大小 family size	对照组亲本 broodstock of control strain			截点 truncation	选择组亲本 broodstock of selected strain		
		雌亲数 N_f	雄亲数 N_m	平均壳高/mm ($\bar{x}\pm SD$) mean shell height		雌亲数 N_f	雄亲数 N_m	平均壳高/mm ($\bar{x}\pm SD$) mean shell height
B1	350	10	7	52.35±9.26	60.31	7	4	63.50±3.58
B2	329	6	8	49.56±8.94	61.09	6	9	64.88±2.99
B3	347	6	8	48.67±8.56	62.27	5	6	65.74±3.00
B4	365	9	7	55.32±8.99	61.17	8	6	64.48±2.67
B5	277	9	8	51.32±9.57	61.77	4	5	64.86±3.21
合计 total		40	35	49.79±8.89		30	30	64.67±3.71

表 2　长牡蛎壳白选育群体选择组和对照组亲本信息

Tab. 2　Information of the parents of selected and control strains of the white-shell *Crassostrea gigas*

家系 family	家系大小 family size	对照组亲本 broodstock of control strain			截点 truncation	选择组亲本 broodstock of selected strain		
		雌亲数 N_f	雄亲数 N_m	平均壳高/mm ($\bar{x}\pm SD$) mean shell height		雌亲数 N_f	雄亲数 N_m	平均壳高/mm ($\bar{x}\pm SD$) mean shell height
W1	350	8	9	49.89±8.69	60.56	6	4	62.70±3.30
W2	300	7	6	46.52±9.21	62.79	5	4	66.38±2.52
W3	376	7	5	52.36±8.59	60.05	6	5	63.11±3.11
W4	305	11	8	50.89±9.36	61.02	8	4	65.86±3.62
W5	345	9	6	49.75±9.74	60.48	5	3	63.98±3.61
合计 total		42	34	49.79±9.15		30	20	64.38±4.56

2.2　生长性状的比较

长牡蛎壳黑和壳白选育群体与对照组在不同日龄的壳高和总重见表 3 和表 4。从 120 日龄起, 壳黑和壳白选育群体和对照组壳高和总重均有显著性差异, 在牡蛎收获的 490 日龄, BS1 和 WS1 的平均壳高分别为(102.06±10.46) mm 和(102.84±14.90) mm, BC1 和 WC1 的平均壳高分别为(93.60±12.86) mm 和(94.17±9.34) mm; BS1 和 WS1 平均体重为(83.14±18.85) g 和(84.46±16.98) g, BC1 和 WC1 的平均体重分别为(76.04±20.62) g 和(76.44±20.58) g。

2.3　遗传参数

壳黑和壳白选育群体壳高性状的选择反应的均值分别为(0.545±0.143)和(0.625±0.171); 遗传获得的均值分别为(9.83±1.68)%和(9.97±1.87)%; 现实遗传力的均值分别为(0.353±0.093)和(0.405±0.111)(表 5)。

壳黑和壳白选育群体总重性状的选择反应的均值分别为(0.297±0.12)和(0.377±0.190); 遗传获得的均值分别为(10.16±3.64)%和(11.34±1.94)%; 现实遗传力的均值分别为(0.192±0.080)和(0.244±0.123)(表 6)。

3　讨论

贝类具有繁殖力高、世代间隔短, 野生群体遗传变异水平高的特点, 尤其适宜开展选择育种

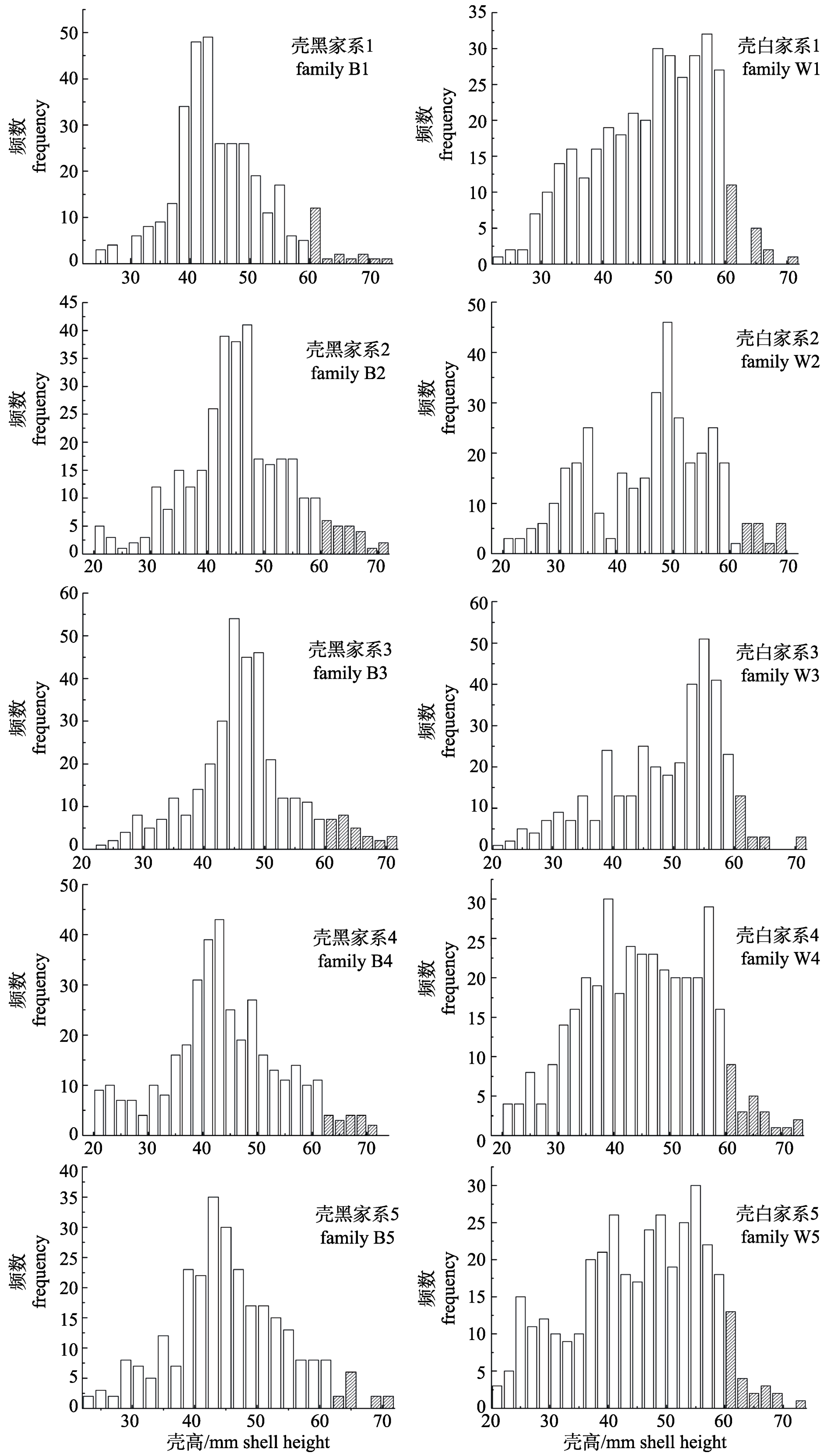

图 1 本研究选取的长牡蛎壳黑和壳白第四代家系以及被截头选择的亲本(斜纹部分)的壳高分布

Fig. 1 Shell height distribution of the black-shell and white-shell *Crassostrea gigas* families of the fourth generation and parents selected for truncation selection (diagonal stripes)

表 3　长牡蛎壳黑和壳白选育群体选择组与对照组不同日龄的壳高

Tab. 3　Mean shell height of the selected and control strains of the black-shell and white-shell *Crassostrea gigas* breeding lines at different ages

$\overline{x}$ ±SD; mm

日龄/d age	壳黑选育群体壳高 black-shell breeding line		壳白选育群体壳高 white-shell breeding line	
	选择组 BS1	对照组 BC1	选择组 WS1	对照组 WC1
60	7.48±1.37[a]	7.04±1.62[a]	7.98±1.59[a]	7.34±1.71[a]
120	24.40±7.37[a]	22.01±5.76[b]	25.00±4.23[a]	22.39±5.42[b]
210	39.58±9.78[a]	35.38±8.27[b]	40.43±6.12[a]	37.18±5.73[b]
240	48.21±6.02[a]	44.08±6.22[b]	46.04±6.16[a]	40.97±7.85[b]
300	52.83±10.67[a]	48.11±7.13[b]	52.48±8.51[a]	47.96±7.33[b]
360	58.13±7.93[a]	52.47±10.77[b]	59.62±10.15[a]	55.53±6.75[b]
420	88.10±9.14[a]	79.71±12.94[b]	87.87±11.09[a]	78.36±12.26[b]
490	102.06±10.46[a]	93.60±12.86[b]	102.84±14.90[a]	94.17±9.34[b]

注: 不同字母代表同一群体中不同处理组之间差异显著(P< 0.05).
Note: different superscript letters indicate significant difference (P<0.05) between two crosses within each breeding line.

表 4　长牡蛎壳黑和壳白选育群体选择组与对照组不同日龄的总重

Tab. 4　Mean total weight of the selected and control strains of the black-shell and white-shell *Crassostrea gigas* breeding lines at different ages

$\overline{x}$ ±SD; g

日龄/d age	壳黑选育群体总重 black-shell breeding line		壳白选育群体总重 white-shell breeding line	
	选择组 BS1	对照组 BC1	选择组 WS1	对照组 WC1
120	3.16±1.54[a]	2.93±1.10[b]	3.22±1.67[a]	2.85±1.26[b]
210	8.70±4.23[a]	7.82±3.92[b]	8.36±3.20[a]	7.39±3.11[b]
240	15.84±4.43[a]	14.93±3.81[b]	13.85±6.67[a]	12.13±4.08[b]
300	17.03±7.08[a]	15.07±5.64[b]	20.34±7.52[a]	18.32±7.03[b]
360	25.07±7.93[a]	23.36±9.40[b]	22.82±9.81[a]	21.04±9.35[b]
420	40.30±8.54[a]	34.61±10.60[b]	41.13±7.04[a]	36.65±5.81[b]
490	83.14±18.85[a]	76.04±20.62[b]	84.46±16.98[a]	76.44±20.58[b]

注: 不同字母代表同一群体中不同处理组之间差异显著(P< 0.05).
Note: different superscript letters indicate significant difference between two crosses within each breeding line(P<0.05).

表 5　长牡蛎壳黑和壳白选育群体不同日龄壳高的遗传获得、选择反应和现实遗传力

Tab. 5　Standardized response to selection (SR), current genetic gains (GG) and realized heritability (h_R^2) of shell height from the black-shell and white-shell *Crassostrea gigas* strains at different ages

日龄/d age	壳黑选育群体 BS1			壳白选育群体 WS1		
	遗传获得/% GG	选择反应 SR	现实遗传力 h_R^2	遗传获得/% GG	选择反应 SR	现实遗传力 h_R^2
60	6.32	0.275	0.178	8.74	0.375	0.243
120	10.88	0.416	0.269	11.63	0.480	0.311
210	11.89	0.509	0.330	8.74	0.567	0.368
240	9.38	0.665	0.431	12.38	0.646	0.419
300	9.82	0.663	0.429	9.41	0.615	0.399
360	10.78	0.525	0.340	7.37	0.606	0.392
420	10.52	0.648	0.420	12.26	0.783	0.508
490	9.04	0.658	0.426	9.21	0.928	0.602
平均值 mean	9.83	0.545	0.353	9.97	0.625	0.405
标准差 SD	6.32	0.143	0.093	1.87	0.171	0.111

表 6　长牡蛎壳黑和壳白选育群体不同日龄总重的遗传获得、选择反应和现实遗传力

Tab. 6　Standardized response to selection (SR), current genetic gains (GG) and realized heritability (h_R^2) of total weight from the black-shell and white-shell *Crassostrea gigas* strains at different ages

日龄/d age	壳黑选育群体 BS1			壳白选育群体 WS1		
	遗传获得/% GG	选择反应 SR	现实遗传力 h_R^2	遗传获得/% GG	选择反应 SR	现实遗传力 h_R^2
120	7.74	0.206	0.134	10.01	0.267	0.173
210	11.25	0.225	0.146	12.98	0.312	0.202
240	6.09	0.239	0.155	14.21	0.423	0.274
300	12.95	0.346	0.224	10.98	0.286	0.185
360	7.31	0.182	0.118	8.46	0.190	0.123
420	16.42	0.536	0.347	12.22	0.771	0.500
490	9.33	0.344	0.223	10.50	0.390	0.253
平均值 mean	10.16	0.297	0.192	11.34	0.377	0.244
标准差 SD	3.64	0.124	0.080	1.94	0.190	0.123

工作[17]。群体选育操作简单易行, 且容易取得成功, 尤其适用于容易获得较快的选择反应的性状, 因此被广泛应用于动物育种中。对于很多水产动物来说, 群体选择是唯一的选择育种方法[18]。多年来群体选育在水产动物的遗传改良中得到了广泛应用, 除了少量的研究未获得积极的结果[19–20], 大部分研究都取得了令人鼓舞的结果[21–24]。本研究分别以 5 个第四代长牡蛎壳黑和壳白家系为基础群体, 利用群体选择构建了第一代快速生长选育群体, 实验结果表明, 通过家系内个体选育提高长牡蛎壳黑和壳白群体的生长速度是有效的。经过一代选择, 两个选育群体获得了类似的选择反应, 其中壳高性状选择反应的均值分别为(0.545±0.143)和(0.625±0.171), 总重性状选择反应

的均值分别为(0.297±0.124)和(0.377±0.190)。从 120 日龄开始, 两选育群体选择组壳高和总重均显著高于对照组, 选择组和对照组自幼体培育至成贝养成阶段所有环境条件均保持一致, 可以推断两组在生长性状上的差异可以归因于选择反应。壳白选育群体壳高和总重性状的选择反应、遗传获得和现实遗传力的均值均大于壳黑选育群体, 两选育群体选择反应不一致的原因可能包括随机遗传漂变、母本效应、近交衰退、主效基因效应等[25]。

490 日龄时壳黑和壳白选育群体选择组平均壳高分别比对照组提高 9.04%和 9.21%, 平均体重较对照组提高 9.33%和 10.50%, 两选育群体壳高性状遗传获得的均值分别为 9.83%和 9.97%, 总重性状遗传获得的均值分别为 10.16%和 11.34%, 这与国内外对牡蛎生长进行群体选育的研究结果相似。在长牡蛎连续三代的群体选育研究中, 中国、日本和韩国三个地理群体选择组的壳高每代平均增长 10%左右[26–28]。Newkirk 等[17]对欧洲牡蛎(*Ostrea edulis*)经过一代的群体选育后, 与对照组相比, 选择组总重提高幅度可达 8%~38%。Nell 等[29]用群体选育方法对悉尼岩牡蛎(*Saccostrea commercialis*)的体重进行了连续二代的选育, 选择组较对照组的活体体重增加 4%~17.8%。Dégremont 等[30]通过四代群体选育来增加长牡蛎对 OsHV-1 抗病能力, 发现在产量上选择组(13.3 kg)比对照组(1.2 kg)有显著的提升。

遗传力是选择育种中的一个重要参数, 遗传力的估算对育种工作具有重要意义, 是制定育种方案的重要依据。在长牡蛎遗传参数估测的研究中, Lannan[31]利用全同胞家系首次估测的 18 月龄长牡蛎壳高和总重的广义遗传力分别为 0.15 和 0.33。Hedgecock 等[32]报道了达到成品规格的长牡蛎肉重的狭义遗传力为 0.2。Langdon 等[33]报道了 3 个不同海区养殖的长牡蛎产量的现实遗传力为 0.01~0.50。Evans 等[34]构建了 34 个全同胞家系并养殖于不同海区, 在不同日龄时估测长牡蛎产量的广义遗传力为 0.22~0.54。王庆志等[35]采用约束性最大似然法(REML)估计 360 日龄长牡蛎壳高的遗传力为(0.35±0.15)。Kong 等[36]利用家系混养后微卫星标记重建系谱信息, 排除共同环境效应, 估算长牡蛎壳高和总重的狭义遗传力分别为(0.49±0.25)和(0.35±0.17)。本研究中, 壳黑和壳白选育群体选择组壳高性状的现实遗传力分别为(0.353±0.093)和(0.405±0.111), 总重的现实遗传力分别为(0.192±0.080)和(0.244±0.123), 与已报道的长牡蛎生长性状遗传力相似。这两个群体有较大的遗传方差, 可继续通过群体选育获得较大的遗传反应。然而, 不同日龄的现实遗传力比现实遗传力的均值更具说服力, 从 120 日龄起, 两选育群体壳高性状的现实遗传力均大于 0.2, 表明通过人工选择, 两选育群体可以很容易获得选择反应。

选择育种过程中不同性状之间存在不同程度的遗传相关性, 遗传相关被认为是基因联锁或基因多效性的结果, 可以利用性状间的遗传相关对不易度量的性状进行间接选育。王庆志等[35]对长牡蛎生长性状遗传力估测的结果表明, 长牡蛎的壳高与总重、肉重和出肉率的遗传相关均为正相关, 推测对成体阶段某一性状进行选择时, 其他性状获得了间接选育。Toro 等[37]在对欧洲牡蛎(*Ostrea edulis*)的体重进行选择时, 发现壳高生长速度也得到显著提高, 体重与壳高的遗传相关高达 0.9。He 等[22]在对珠母贝壳高进行选择的同时, 发现壳高和体重的生长速度均得到显著提高。本研究中, 壳黑和壳白两个选育群体选择组活体体重在不同日龄均高于对照组, 活体体重遗传获得的均值分别为(10.16±3.64)%和(11.34±1.94)%, 表明对两选育群体进行壳高选择的同时, 实现了对活体体重的间接选择。

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Evaluation of mass selective breeding lines of black-shell and white-shell Pacific oyster (*Crassostrea gigas*) for fast growth

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Abstract: Pacific oyster, *Crassostrea gigas*, is the most widely cultured oyster in the world. China produces more than 4.35 million tons of oysters annually. However, nearly all of the oyster broodstock in China remains unselected. This leads to many problems such as low growth rate, high mortality rate, and irregular shell shape. A selective breeding program is an effective way to resolve these problems, and Pacific oyster culturing would undoubtedly benefit from selective breeding for productivity traits such as rapid growth and high yield. Growth-related traits are of particular interest to farmers because of their economic importance. Color polymorphisms are relatively common in marine shellfish including *C. gigas*, and consumers are willing to pay more for seafood with specific colors. During the period of 2010–2013, four successive generations of four shell-color families (white, black, golden, purple) were produced. None of the specifically colored lines showed superior productivity, and so truncation selections for shell height were initiated based on five fourth-generation black-shell and five fourth-generation white-shell families in 2014. Applying the same intensity of selection in the upward direction, two selected and two control lines were created. These lines were reared under the same environmental conditions at the larvae, spat, and grow-out stages. The progeny of the mass-selected lines were compared to those of controls in a 490-day farming experiment. Mean shell height and mean wet weight of the selected lines were significantly greater than those of the controls from day 120 onwards ($P<0.05$). At harvest on day 490, the black-shell and white-shell oysters had mean shell height of (102.06±10.46) mm and (102.84±14.90) mm, respectively, and mean wet weight of (83.14±18.85) g and (84.46±16.98) g, respectively. The increase in shell height for selected black-shell oysters and white-shell oysters compared with that of the control was 9.04% and 9.01%, respectively, and the increase in wet weight was 9.33% and 10.50%, respectively. The estimated gain was consistent with the expected gain for mollusk species (10%–20% per generation). In the black-shell and white-shell mass-selected lines, the realized heritability of shell height was 0.353±0.093 and 0.405±0.111, respectively, the realized heritability of total weight was 0.297±0.12 and 0.377±0.190, respectively, the average selection response of shell height was 0.545± 0.143 and 0.625±0.171, respectively, and the average selection response of total weight was 0.297± 0.124 and 0.377±0.190, respectively. The total genetic gain of total weight for the black-shell and white-shell lines was (10.16±3.64)% and (11.34±1.94)%, respectively, indicating that total weight had improved markedly during selection for shell height. In conclusion, growth improvement for the two mass selected lines can be achieved by selecting the individuals with the greatest shell height. The relatively high realized heritability estimates obtained for the two mass-selected lines indicate that there is genetic variation in the two stocks, and that mass selection could be used to select for rapid growth in the next generations.

Key words: *Crassostrea gigas*; black-shell; white-shell; heritability; selection response; growth trait

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