

中华绒螯蟹白化症、正常肝胰腺组织结构及脂肪酸组成的比较研究

常国亮^{1,2} 成永旭¹ 吴旭干¹ 杨筱珍¹ 王宗凯¹ 沈 竑³

(1. 上海海洋大学, 农业部水产种质资源与养殖生态重点开放实验室, 上海 200090; 2. 江苏省环洪泽湖生态农业生物技术重点实验室, 淮安 223300; 3. 上海沐雨生态农业有限公司, 上海 202157)

摘要:采用气相色谱、组织学及电镜技术分别对中华绒螯蟹雄蟹白化症肝胰腺与正常肝胰腺脂类和脂肪酸组成、显微及超微结构进行了比较研究, 结果表明: 正常肝胰腺的总脂含量 (31.54%肝胰腺湿重) 显著高于白化症肝胰腺 (19.07%肝胰腺湿重), 两种蟹肝胰腺的脂类组成没有显著差异, 但脂肪酸组成存在一定的差异, 白化症肝胰腺中 C18:1 的含量显著高于正常肝胰腺, 中性脂和极性脂 HUFA 正常蟹肝胰腺含量都高于白化症蟹, 但没有显著差异。组织学结果和超微结构观察表明: 白化症肝胰腺肝小管的上皮细胞壁结构紊乱, 微绒毛及微绒毛黏膜大部分脱落, 细胞内仅见有零星的线粒体、脂肪滴分布, R 细胞呈现空泡化。

关键词:中华绒螯蟹; 肝胰腺; 脂肪酸; 结构

中图分类号: Q493.5; S945 **文献标识码:** A **文章编号:** 1000-3207(2008)05-0687-07

中华绒螯蟹 (*Eriocheir sinensis*) 是我国主要的养殖蟹类, 其肉质鲜美, 营养丰富。10 月份上市时, 发育良好的正常蟹肝胰腺呈黄色 (正常肝胰腺), 近年来发现, 有部分雄蟹肝胰腺呈白色, 严重时呈糜烂状, 无法食用, 使蟹的经济价值降低。宋学宏等^[1,2] 称此种现象为肝胰腺白化症 (Hepatopancreas albinism), 且患此症的蟹 (白化症蟹) 在离水后或气温骤变时很快死亡, 给河蟹养殖带来了巨大的经济损失。目前仅见宋学宏^[1,2]、孙红^[3] 对白化症发生的原因进行了初步研究。

已知肝胰腺对蟹等甲壳动物的生长、发育及生殖具有十分重要的作用^[4,5], 是脂类储存和加工的主要器官^[6-9], 是脂类的代谢中心, 肝胰腺脂类和脂肪组成影响脂溶性维生素、色素的积累, 进而影响肝胰腺的颜色, 所以本论文拟通过对白化症肝胰腺与正常肝胰腺脂类和脂肪酸组成、显微结构及超微结构的研究, 探讨白化症发生的原因, 以期为高品质蟹的培育提供理论指导。

1 材料与方法

1.1 实验材料 2004 年 12 月取自阳澄湖不同围栏养殖区, 正常蟹取自未见白化症蟹围栏养殖区,

体重 (178.2 ± 16.7) g, 体长 (6.8 ± 0.3) cm; 白化症蟹取自多见此类蟹围栏养殖区, 体重 (178.9 ± 37.1) g, 体长 (6.8 ± 0.4) cm, 实验用蟹取回后立即取样。

1.2 试验方法

1.2.1 水分测定 取新鲜的肝胰腺组织 1g 左右至称量皿中, 60℃ 恒温烘至恒重, 测定水分含量。

1.2.2 脂类及脂肪酸组成分析 总脂及脂肪酸组成测定参照文献 [9] 的方法, 混合型标准脂肪酸甲酯购于 Sigma 公司; 脂类分析利用棒状薄层色谱扫描仪 (ATROSCAN™ MK-5 TLC-FD) 进行分析并参考文献 [10] 的方法略有改动, 展开剂为正己烷-乙醚-甲酸溶液 (42:28:0.3, V/V/V)。

1.2.3 显微结构 分别取两种蟹各 3 只, 解剖后立即取出肝胰腺, Bouin's 液固定, 常规石蜡连续切片, H.E 染色, Olympus 显微镜观察拍照。

1.2.4 超微结构样品制备及观察 分别取两种蟹各 3 只, 解剖后立即取出肝胰腺, 经 2.5% 戊二醛和 1% 锇酸双固定, 酒精转换, 梯度丙酮脱水, 国产 618 树脂包埋, 醋酸铀和柠檬酸铅双重染色, JEM-100CX 透射电镜观察, 加速电压 60kV。

收稿日期: 2007-08-28; 修订日期: 2007-11-01

基金项目: 国家自然科学基金 (30471349); 上海市科委项目 (073219N12); 国家“十一五”科技支撑计划 (2006BAD03B07) 资助

作者简介: 常国亮 (1974—), 男, 河南濮阳人; 博士; 专业方向为水产动物营养与繁殖。E-mail: changguoliang888@sohu.com

通讯作者: 成永旭, Tel: 021-65711346, E-mail: yxcheng@shou.edu.cn

2 结 果

2.1 HSI(肝胰腺指数)、总脂含量及脂类组成

两种蟹 HSI、肝胰腺水分含量和总脂含量存在显著差异(表 1)。正常蟹的 HSI 为 6.36%,显著高于白化症蟹的 5.27% ($p < 0.05$);白化症肝胰腺水分含量高达 60.46%,显著高于正常肝胰腺 ($p < 0.01$);肝总脂/肝胰腺湿重的值,白化症肝胰腺仅

有 19.07%,正常肝胰腺为 31.54%,二者差异显著 ($p < 0.05$);肝总脂/体重的值在两种蟹之间差异极显著 ($p < 0.01$),正常蟹约为白化症蟹的 2 倍;脂类组成中,两种肝胰腺的中性脂含量均接近 90%,其主要成分是甘油三酯,占总脂比例在 80% 左右,极性脂含量也较接近,皆在 10%以上,并且各脂类含量在两种肝胰腺之间并无显著差异 ($p > 0.05$)。

表 1 正常、白化症蟹的肝胰腺脂类组成及含量

Tab. 1 Lipid content of normal and albino hepatopancreas of Chinese mitten crab *Eriocheir sinensis* (%)

指标 Index	正常蟹 (Mean $\pm$ SD, $n=6$)	白化症蟹 (Mean $\pm$ SD, $n=8$)
	Normal crab ¹	Albino crab ²
肝胰腺指数 Hepatosomatic index	6.36 $\pm$ 0.55 ^a	5.27 $\pm$ 1.03 ^b
肝胰腺水分 Hepatopancreas moisture	44.92 $\pm$ 0.62 ^B	60.46 $\pm$ 7.65 ^A
肝总脂/肝湿重 Hepatopancreas total lipid/ hepatopancreas wet weight	31.54 $\pm$ 7.69 ^a	19.07 $\pm$ 5.10 ^b
肝总脂/体重 Hepatopancreas total lipid/ body wet weight	2.01 $\pm$ 0.52 ^A	1.01 $\pm$ 0.44 ^B
肝胰腺脂类组成 (%总脂) Hepatopancreas lipid classes (% total lipid)		
中性脂 Neutral lipid	86.45 $\pm$ 8.67	89.30 $\pm$ 6.67
甘油三酯 Triacylglycerides	77.93 $\pm$ 7.20	83.74 $\pm$ 6.67
胆固醇 Cholesterols	1.19 $\pm$ 0.34	1.58 $\pm$ 1.33
游离脂肪酸 Free fatty acids	4.17 $\pm$ 1.85	3.57 $\pm$ 2.58
极性脂 Polar lipid	13.55 $\pm$ 8.67	10.70 $\pm$ 6.67

注: t 检验, n 为样本数;同一行数据右上肩,大写字母 A、B 表示各组间有极显著差别 ($p < 0.01$),小写字母 a、b 表示各组间有显著差异 ($p < 0.05$);表 2 同

Note: t -test, n : number of samples. In one row, the numbers with different superscript capital letters means that there are very significant difference ($p < 0.01$), with different superscript small letters means that there are significant difference ($p < 0.05$). The same as Tab. 2

2.2 肝胰腺中性脂和极性脂脂肪酸组成

两种肝胰腺中性脂和极性脂脂肪酸组成基本相同,其中含量最高的均为 C18:1(油酸),其次为 C18:2(亚油酸)、C16:0(棕榈酸)和 C16:1(棕榈油酸);在两种肝胰腺之间,白化症肝胰腺的 C18:1 含量都显著高于正常肝胰腺 ($p < 0.05$ 或 $p < 0.01$)。而 C20:5(二十碳五烯酸, EPA)的含量正常肝胰腺无论极性脂和中性脂中都显著高于白化

症肝胰腺 ($p < 0.01$)。此外,正常肝胰腺的 C15:0(十五烷酸)、C16:1、C20:1(二十碳烯酸)也高于白化症肝胰腺,其余多数种类脂肪酸及 SFA(饱和脂肪酸)、MUFA(单不饱和脂肪酸)、PUFA(多不饱和脂肪酸)含量均无显著差异 ($p > 0.05$),正常肝胰腺的 HUFA(高度不饱和脂肪酸)的含量虽略高于白化症肝胰腺,但差异并不显著 ($p > 0.05$) (表 2)。

表 2 正常、白化症肝胰腺脂肪酸组成

Tab. 2 Fatty acid composition of normal and albino hepatopancreas of Chinese crab *Eriocheir sinensis* (%)

脂肪酸 Fatty acid	中性脂 Neutral lipid		极性脂 Polar lipid	
	正常肝胰腺 ($n=6$)	白化症肝胰腺 ($n=8$)	正常肝胰腺 ($n=6$)	白化症肝胰腺 ($n=8$)
	Normal hepatopancreas	Albino hepatopancreas	Normal hepatopancreas	Albino hepatopancreas
C14:0	0.94 $\pm$ 0.15	0.74 $\pm$ 0.22	0.80 $\pm$ 0.15 ^a	0.64 $\pm$ 0.12 ^b
C15:0	0.97 $\pm$ 0.24 ^A	0.38 $\pm$ 0.09 ^B	0.86 $\pm$ 0.23 ^A	0.42 $\pm$ 0.15 ^B
C16:0	17.00 $\pm$ 1.11 ^B	19.21 $\pm$ 1.34 ^A	15.89 $\pm$ 0.77	16.88 $\pm$ 1.19
C16:1	9.95 $\pm$ 1.55 ^A	6.36 $\pm$ 1.31 ^B	9.24 $\pm$ 2.08 ^a	6.32 $\pm$ 1.49 ^b
C17:0	0.76 $\pm$ 0.12 ^b	1.33 $\pm$ 0.45 ^a	0.67 $\pm$ 0.13	0.66 $\pm$ 0.26
C17:1	0.70 $\pm$ 0.26	0.60 $\pm$ 0.16	0.75 $\pm$ 0.24	0.82 $\pm$ 0.16

续表

脂肪酸 Fatty acid	中性脂 Neutral lipid		极性脂 Polar lipid	
	正常肝胰腺 (n = 6)	白化症肝胰腺 (n = 8)	正常肝胰腺 (n = 6)	白化症肝胰腺 (n = 8)
	Normal hepatopancreas	Albino hepatopancreas	Normal hepatopancreas	Albino hepatopancreas
C18 0	2.46 ±0.29	2.45 ±0.54	2.99 ±0.43 ^B	4.59 ±0.80 ^A
C18 1	28.00 ±1.83 ^b	33.75 ±5.47 ^a	28.19 ±2.31 ^B	35.33 ±3.64 ^A
C18 2	20.22 ±5.68	20.12 ±4.79	15.59 ±3.31	16.36 ±4.13
C20 1	6.03 ±1.45 ^A	2.31 ±1.05 ^B	5.11 ±1.02 ^a	3.85 ±0.87 ^b
C20 4	1.53 ±0.34	1.32 ±0.51	4.85 ±1.00	3.88 ±1.38
C20 5	2.08 ±0.46 ^A	1.07 ±0.48 ^B	4.89 ±0.47 ^A	3.45 ±0.85 ^B
C22 6	1.77 ±0.53	1.76 ±1.10	1.28 ±0.30	1.57 ±0.89
SFA	22.13 ±1.83	23.80 ±2.04	21.20 ±1.20	23.05 ±2.06
MUFA	44.68 ±3.06	42.89 ±5.84	43.29 ±1.93	46.18 ±4.16
PUFA	25.59 ±5.21	24.19 ±4.88	26.60 ±3.86	25.25 ±5.04
HUFA	5.38 ±0.91	4.14 ±1.68	11.01 ±1.56	8.89 ±2.87

2.3 正常、白化症肝胰腺的组织学

正常肝胰腺肝小管的上皮细胞壁由单层细胞构成(图版-1),细胞顶端的微绒毛(Microvilli,Mv)及微绒毛黏膜(Enteric coat,Ec)完整,肝小管管腔(Lumen,Lu)内有内容物(Inclusion,In)(图版-2)。而白化症肝胰腺肝小管上皮细胞壁的细胞排列紊乱,微绒毛及其黏膜消失,肝小管内呈现不规则的空腔,管腔内见有脱落的细胞组织(图版-3、4)。

2.4 正常、白化症肝胰腺的超微结构

正常肝胰腺R细胞(Resorptive cell)的管腔面分布有排列整齐而发达的微绒毛,在脂肪滴(Lipid droplet,L)附近分布有数量较多线粒体(Mitochondria,Mi)(图版-1、2),而白化症肝胰腺的超微结构发生明显的变化,微绒毛大部分已脱落,且排列不规则(图版-3);F细胞(Fibrillar cell)中的内质网绝大部分为层叠状内质网(Packed endoplasmic reticulum,pER)(图版-4);一些细胞中仅有层叠状内质网碎片和零星的脂肪滴、线粒体散落其中,甚至某些细胞的大部分胞质已完全降解,细胞呈现空泡化(图版-5、6)。

3 讨论

肝胰腺是甲壳动物脂类储存和加工的主要器官,是脂类的代谢中心。我们推测正常、白化症肝胰腺总脂含量的差异与颜色有着密切的关系,正常肝胰腺总脂含量为31.54%,并且水分含量低,为44.92%,可能溶有较多的脂溶性维生素和色素,所以呈黄色。而白化症肝胰腺总脂含量远低于正常肝胰腺,仅为19.07%,并且水分含量高达60.46%,

可能影响了这些脂溶性维生素和色素的积累,所以呈白色,而脂溶性维生素的减少与白化症蟹较低的抗应激能力具有一定的关系^[11,12]。

本实验中虽然两种肝胰腺的脂类组成并无显著差异,但计算可知肝胰腺的中性脂含量(肝总脂含量×中性脂含量,表1)在白化症肝胰腺中仅为17.02%,而在正常肝胰腺中约为27.90%,要远高于白化症肝胰腺中的含量。相应甘油三酯、不饱和脂肪酸等各脂类在正常肝胰腺中的含量也明显高于白化症肝胰腺。白化症蟹肝胰腺脂肪含量的显著降低和脂肪酸不饱和度的减少(EPA和HUFA含量减少),意味着和正常蟹相比,其在同期生长过程中的摄食不正常(减少,或营养不均衡引起),影响其肝胰腺脂类的正常积累和功用。研究表明,甲壳动物肝胰腺的脂肪酸组成与其营养状态存在密切的关系,当饵料中必需脂肪酸缺乏时,肝胰腺中C18 1的含量会显著升高,所以有研究建议肝胰腺中C18 1含量可作为甲壳动物饵料中必需脂肪酸是否充足的一个指标^[13]。对中华绒螯蟹的研究也证实^[14],用添加8%猪油饲料投喂中华绒螯蟹幼蟹60d,肝胰腺中C18 1含量为36.58%,而用添加4%鳙鱼油和4%磷脂的饲料投喂同样长时间,肝胰腺中C18 1则为29.99%。据此分析,白化症肝胰腺中C18 1含量显著高于正常肝胰腺,暗示其饲料中缺乏必需脂肪酸。

蟹肝胰腺肝小管的R和F细胞顶端的微绒毛及微绒毛表面的黏膜对物质转运具有重要的作用。当新的营养物质进到肝胰腺之后,旧黏膜脱落,新黏膜形成,所以有时可见肝小管腔内有内容物,为营养物质及条带状的脱落黏膜,提示肝胰腺具有正常的

生理功能。而白化症肝胰腺肝小管的上皮细胞壁结构已被破坏,由于有些细胞解体,周围的细胞会失去正常的位置而进入管腔,使上皮细胞壁呈多层细胞状。管腔内呈现不规则的空腔,且微绒毛及其黏膜消失,这表明白化症肝胰腺已丧失了正常的生理功能。而其 F 细胞中绝大部分的内质网呈层叠状,显示细胞没有处于转运物质的活跃状态,从一个侧面也证实了这一点。并且有研究证实,自然条件下的雌性中华绒螯蟹,当抱的卵孵出以后,其肝胰腺的 R 细胞也呈现细胞器解体、胞质基本上完全降解的现象,此时的肝胰腺已不具备从外界吸收和储存物质的功能,不久后此蟹即会死亡^[15]。据此分析,白化症肝胰腺显微及超微结构的变化会导致其部分或全部生理功能的丧失,而这种生理功能的丧失会进一步影响蟹整体的生理活动,这可能是白化症蟹离水后或气温骤变时很快死亡的主要原因之一。

很多报道指出,甲壳动物肝胰腺细胞超微结构与其营养状态存在有密切的关系^[16—18]。当脂质营养缺乏时,中华绒螯蟹幼体肝胰腺 R 细胞的许多部位出现萎缩,膜向内塌陷^[19];饥饿条件下,锯缘青蟹幼体肝胰腺细胞内部的线粒体会呈现解体的趋势^[20]。由此来看,白化症肝胰腺 R 细胞微绒毛大部分已脱落,细胞内线粒体数量较少,胞质空泡化这些超微结构的变化与其脂质营养缺乏有着密切的关系。宋学宏等^[1,21]的研究也表明白化症肝胰腺符合生理病害的特征,与病原生物关系不大。综上所述,白化症是肝胰腺中脂类积累过少而使脂溶性维生素和色素含量过少所致,而这种现象很可能与投喂的饵料具有密切的关系,但是对于此现象发生的具体原因,是饵料中脂类含量过少,或是脂类营养不均,还有待进一步的研究。

参考文献:

- [1] Song X H, Zhu M X, Wang Y L, *et al* The histopathological changes in tissues of *Eriocheir sinensis* with hepatopancreas albinism [J]. *J Fish China*, 2007, **31** (2): 257—260 [宋学宏,朱茂晓,王永玲,等.中华绒螯蟹肝胰腺白化症组织病理变化.水产学报,2007,31(2): 257—260]
- [2] Song X H, Cheng J X, Zhu M X, *et al* Pathogenic factors of albinism in hepatopancreas of Chinese mitten crab *Eriocheir sinensis* (Decapoda: Grapsidae) [J]. *J Fish Sci China*, 2007, **14** (5): 762—769 [宋学宏,程建新,朱茂晓,等.中华绒螯蟹肝胰腺白化症的病因研究.中国水产科学,2007,14(5): 762—769]
- [3] Sun H. Initial studies on red and white hepatopancreas of *Eriocheir sinensis* [J]. *J Aquacult*, 2004, **25** (1): 25 [孙红.河蟹的“红白膏”现象初析.水产养殖,2004,25(1): 25]
- [4] Castille F L, Lawrence A L. Relationship between maturation and biochemical composition of the gonads and digestive glands of the shrimp *Penaeus aztecus* and *Penaeus setiferus* [J]. *Crusta Bio*, 1989, **9**: 202—211
- [5] Teshima S, Kanazawa A, Koshio S, *et al* Lipid metabolism of the prawn *P. japonicus* during maturation: Variation on lipid profiles of the ovary and hepatopancreas [J]. *Comp Biochem Physiol*, 1989, **92B**: 45—49
- [6] Loizzi R F. Interpretation of crayfish hepatopancreatic function based on fine structural analysis of epithelial cell lines and muscle network [J]. *Zellforsch Mikrosk Anat*, 1971, **113**: 420—440
- [7] Vogt G, Storch V, Quintino E T, *et al* Midgut gland as monitor organ for the nutritional value of diets in *Penaeus monodon* (Decapoda) [J]. *Aquacult*, 1985, **48**: 1—12
- [8] Mikami S, Greenwood J G. Functional morphology and cytology of the phyllosomal digestive system of *Sivacus ciliatus* and *Panulirus japonicus* (Decapoda) [J]. *Crusta*, 1994, **67**: 212—225
- [9] Cheng Y X, Du N S, Lai W. Lipid composition in hepatopancreas of Chinese mitten crab *Eriocheir sinensis* [J]. *Acta Zoologica Sinica*, 1998, **44** (4): 420—429 [成永旭,堵南山,赖伟.不同阶段中华绒螯蟹肝胰腺的脂类及脂肪酸组成.动物学报,1998,44(4): 420—429]
- [10] Li D, Zhang Y H. Application of iatroskan TLC/FD on lipid composition analysis of different season crabs [J]. *J Chinese Instit Food Sci Tech* (suppl), 2003, 227—231 [李锋,张永华.棒状薄层色谱扫描仪在不同季节蟹脂类成分分析中的应用.中国食品学报(增刊),2003,227—231]
- [11] Ai Q H, Mai K S. Advance on nutritional immunity of fish [J]. *Acta Hydrobiologica Sinica*, 2007, **31** (3): 425—430 [艾庆辉,麦康森.鱼类营养免疫研究进展.水生生物学报,2007,31(3): 425—430]
- [12] Wang K Y, Zhou Z, Geng Y. Study on the pathology of vitamin E deficiency in common carp (*Cyprinus carpio*) [J]. *Acta Hydrobiologica Sinica*, 2007, **31** (3): 354—362 [汪开毓,周震,耿毅.鲤维生素 E 缺乏的病理学研究.水生生物学报,2007,31(3): 354—362]
- [13] Chhom L, Harry A, Christopher L, *et al* Growth response and fatty acid composition of juvenile *Penaeus vannamei* fed different sources of dietary lipid [J]. *Aquacult*, 1997, **151**: 143—153
- [14] Chen Z Z. Studies on precocity and its mechanism of Chinese mitten crab *Eriocheir sinensis* [D]. Thesis for Doctor of Science, Shanghai Fisheries University, Shanghai 2002 [陈再忠.中华绒螯蟹早熟及其机理的研究.博士学位论文,上海水产大学,上海.2002]
- [15] Cheng Y X, Du N S, Lai W. Ultrastructure of the hepatopancreatic R and F cells and lipid storage in the Chinese crab (*Eriocheir sinensis*) [J]. *Acta Zoologica Sinica*, 2000, **46** (1): 8—13 [成永旭,堵南山,赖伟.中华绒螯蟹肝胰腺 R 和 F 细胞及其脂类储存的电镜研究.动物学报,2000,46(1): 8—13]
- [16] Anger K, Dawirs R R. Influence of starvation on the larval development of *Hyas araneus* (Decapoda, Majidae) [J]. *Helgol Meeresunters*, 1981, **34**: 287—311

- [17] Storch V. The influence of nutritional stress on the ultrastructure of the hepatopancreas of terrestrial isopods [J]. *Symp Zool Soc London*, 1984, 53: 167—184
- [18] Storch V, Anger K. Influence of nutritional stress on the hepatopancreas of larval *Hyas araneus* (Decapoda: Majidae) [J]. *Helgol Meeresunters*, 1983, 36: 67—75
- [19] Jiang H B, Chen L Q, Zhou Z L, et al. Effects of lipid nutrition on hepatopancreatic ultrastructure of *Eriocheir sinensis* larval (Crustacean: Decapoda) [J]. *Zool Res*, 2001, 22 (1): 64—68 [江洪波, 陈立侨, 周忠良, 等. 脂质营养对中华绒螯蟹幼体肝胰腺超微结构的影响. 动物学研究, 2001, 22 (1): 64—68]
- [20] Cheng Y X, Li S J, Wang G Z. The relationship between the changes of ultrastructure of hepatopancreatic cells and the nutritional status of *Scylla serrata*: studies on zoea [J]. *J Xiamen Univ (Nature science)*, 1998, 37 (4): 576—581 [成永旭, 李少菁, 王桂忠. 锯缘青蟹幼体肝胰细胞结构变化与其营养状况的关系. 厦门大学学报 (自然科学版), 1998, 37 (4): 576—581]

COMPARATIVE STUDIES OF MICRO-ULTRASTRUCTURE AND FATTY ACID COMPOSITION OF NORMAL AND ALBINO HEPATOPANCREAS OF CHINESE MITTEN CRAB *ERIOCHEIR SINENSIS*

CHANG Guo-Liang^{1,2}, CHENG Yong-Xu¹, WU Xu-Gan¹, YANG Xiao-Zhen¹, WANG Zong-Kai¹ and SHEN Hong³

(1. Key Laboratory of Aquatic Genetic Resources and Aquacultural Ecosystem Certified by the Ministry of Agriculture, Shanghai Ocean University, Shanghai 200090; 2. Jiangsu Key Laboratory for Eco-Agricultural Biotechnology around Hongze Lake, Huai'an 223300;

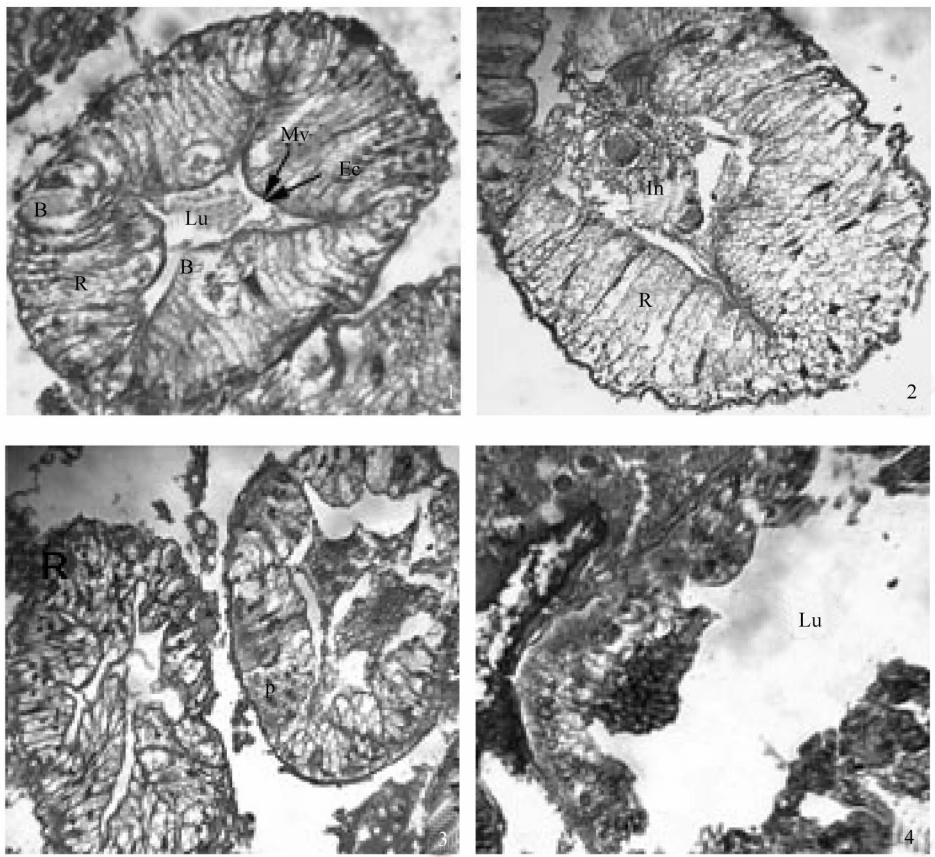
3. Shanghai Muyu Ecological Agriculture Limited Company, Shanghai 202157)

Abstract: In recent years, *Eriocheir sinensis* with white hepatopancreas was frequently observed in the cultivation process, and the white hepatopancreas was called hepatopancreas albinism, but the albino hepatopancreas was mainly observed in male crabs. The study was investigated to determine the factors and causes resulting in that phenomenon during the *Eriocheir sinensis* cultivation process.

The animals used in this experiment were collected from the different cultivation locations in the Yangcheng Lake. They were quickly sacrificed after being taken to the laboratory, and then hepatopancreas were dissected from the experimental crabs. The lipid classes, fatty acid composition and micro-ultrastructure of the crabs with albino hepatopancreas were determined, compared with those crabs with normal hepatopancreas. According to the results, significant difference was found at hepatosomatic index and total content of lipid. The lipid classes of two kinds crabs were almost the same, the contents of neutral lipid were 86.45% in normal hepatopancreas and 89.30% in albino, and the main component was triacylglyceride. The content of C18:1 was 28.00% and 37.75%, respectively, higher than any other kind of fatty acid in neutral lipid. The contents of C15:0, C16:1, C20:1 and EPA of normal crabs were higher than albino crabs, but the contents of C16:0 and C18:1 were opposite. The fatty acid composition of polar lipid in the hepatopancreas of two kinds of crabs was similar to that of the neutral lipid. The content of C18:1 was the highest and the content of albino crabs was significant higher than normal ones ($p < 0.01$). In normal crabs, epithelial cell wall of hepatic tubule was comprised of monolayer cells. B cell and R cell arranged in the order. The microvilli and enteric coat at the top of cells showed complete structure. The lumen of hepatic tubule contained some inclusion. In contrast, the cells of epithelial cell wall of hepatic tubule arranged in disorder in the albino crabs. The microvilli and its mucosal disappeared. Cavity appeared irregularly in hepatic tubule, and cells separating from lumen walls were observed.

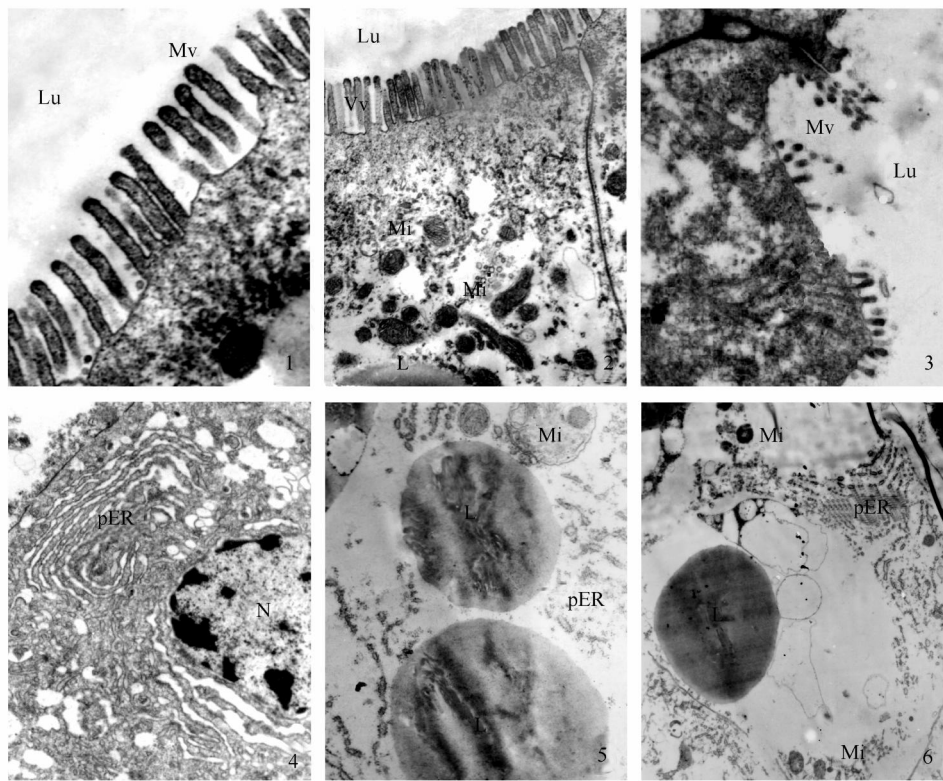
It is estimated that the color of hepatopancreas has tight connection with differences of lipid content. The hepatopancreas of normal crabs have low content of water but high content of lipid, therefore, it contained more lipid-soluble vitamins and coloring matters than albino ones, which leads to yellow color. However, the result of albino ones was opposite. The accumulation of lipid-soluble vitamins and coloring matters were prevented, which leads to white color. According to some surveys, fatty acid composition and micro-ultrastructure of albino hepatopancreas cells has tight relationship to the lack of EFA.

Key words: *Eriocheir sinensis*; Hepatopancreas; Lipid classes; Fatty acids; Structure



图版 Plate

1. 正常肝胰腺, 示肝小管中排列整齐的单层上皮细胞 (×300); 2. 正常肝胰腺, 示肝小管管腔中的内容物 (×300); 3. 白化症肝胰腺, 示管腔中不规则排列甚至从肝小管中脱落的上皮细胞 (×200); 4. 白化症肝胰腺, 紊乱的肝小管上皮细胞壁 (×300)
1. The normal hepatopancreas, showing the single epithelial cells in order in a hepatopancreatic tubule (×300); 2. The normal hepatopancreas, showing the inclusion in an lumen of a hepatopancreatic tubule (×300); 3. The albino hepatopancreas, showing the unordered epithelial cells, even separated from the hepatopancreatic epithelial cell layer in hepatopancreatic tubule (×200); 4. The albino hepatopancreas, showing disorganized epithelial cells or cell debris in hepatopancreatic tubule (×300)



图版 Plate

1. R细胞上整齐的微绒毛 (×12000); 2. R细胞顶端脂滴周围丰富的线粒体 (×10000); 3. 脱落的微绒毛 (×10000); 4. F细胞中的层叠状内质网 (×8000); 5. R细胞中层叠内质网碎片 (×10000); 6. R细胞中零星的脂肪滴和线粒体 (×4800)

1. Microvilli of an R cell in order (×12000); 2. Abundant mitochondria surrounding lipid droplet in an R cell apical (×10000); 3. Separated microvilli (×10000); 4. pERs in an F cell (×8000); 5. Fragmentary pERs in an R cell (×10000); 6. Some scattered mitochondria and lipid droplets (×4800)