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长山列岛附近海域野生鱼类体内微塑料的分布特征研究*

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摘要　随着海洋微塑料污染的日益加剧，长山列岛附近海域生物体内微塑料的分布现状亟待研究。本文研究了长山列岛附近海域 7 种常见海洋野生鱼类的胃肠道和肌肉中微塑料的污染情况。结果显示，在鱼类肌肉中并未检测到微塑料的存在，微塑料普遍存在于鱼类胃肠道中，其丰度范围为 0.19~3.79 个/个体；微塑料的尺寸以<300 μm 为主，占微塑料总丰度的 85.91%；微塑料的形状以纤维为主，其次为碎片和颗粒；微塑料的颜色大多为透明色；在鱼类胃肠道中检测到的聚合物类型为赛璐玢(Cellophane)、纤维素(Cellulose)和聚乙烯(Polyethylene)，其中，以赛璐玢为主要类型。研究结果为探明微塑料对海洋生态环境中鱼类生物效应提供了基础数据和科学依据。

关键词　长山列岛；微塑料；野生鱼类；胃肠道；污染特征

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塑料制品被广泛用于人类日常生活中，但由于塑料垃圾的回收和处理措施不足，导致其在环境中累积量逐渐增加。目前，塑料污染已成为全球关注的重要环境问题。预计到 2025 年，海洋中的塑料垃圾量将增长到 2.5 亿 t，其与鱼类的质量比约为 1∶3 (赵娟, 2020; 贾峰, 2019; Jovanovic, 2017)。自 20 世纪 80 年代以来，研究者就开始关注塑料对海洋生态系统的潜在影响(Stefatos *et al*, 1999)。近年来，王维等(2019)研究发现，海洋塑料能在光、热、化学等环境因素作用下降解成更小尺寸的微塑料(<5 mm)。Chen 等(2020)研究表明，微塑料广泛分布于海洋环境中，从近岸海域到开阔大洋中均有微塑料检出。根据 Eriksen 等(2014)的预测，目前，海洋大约存在超过 5 万亿个微塑料，在太平洋表面，微塑料平均丰度约为 1.0×10^4 个/km^2 (Pan *et al*, 2018、2021)，在中国渤海、黄海、东海海水中的微塑料密度为 0.011~2.198 个/m^3；韩国沿海潮间带的微塑料丰度为 56~285 673 个/m^2 (Kim *et al*, 2015)，这些微塑料的存在严重地威胁了海洋生态系统的安全性和稳定性。

微塑料因其尺寸小，可以被海洋生物摄入，进而

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在生物体内转运和积累(Andres *et al*, 2017; Browne *et al*, 2008)。有研究表明，微塑料可能诱发生物体的生理生化反应，包括窒息、遗传毒性、氧化应激、行为改变、生殖损伤、死亡率升高、种群增长率下降和衰老效应等(Chiara *et al*, 2017; Lucia *et al*, 2018; Yin *et al*, 2018; Qiao *et al*, 2019)。鱼类是海洋生态系统的重要组成部分，对维护生态系统稳定性具有重要意义，同时，海洋鱼类还是人类优质蛋白的提供者，为世界上 2/3 的人口提供了 40%的蛋白质(赵培强等, 2022)。野外调查表明，海洋生物门类中，摄食微塑料最多的生物物种是鱼类(Silvia *et al*, 2018)；室内模拟研究表明，鱼类摄食微塑料会导致肠道阻塞、肠道组织病理学变化、运动失衡、氧化应激和鱼肝脏代谢谱的改变等(Lusher *et al*, 2013; Lu *et al*, 2016)。因此，分析鱼类体内微塑料的含量对评估微塑料对渔业生物的潜在危害十分重要，同时，为政府部门制定保障渔业绿色高质量发展的相关政策提供科学参考(曾永平等, 2020)。

长山列岛是我国八大群岛之一，位于黄海与渤海两大海洋生态系统交汇处，地理位置独特。岛间鱼类群落多样性高、物种丰富，鱼类种类组成和优势种季节更替明显，鱼类群落表现出明显的时空异质性(邹建宇等, 2022)。长山列岛镶嵌式格局加速了该海域频繁的物质流动，不同水团流系影响着该海域的环境条件，促使其成为黄渤海鱼类重要的繁育场所和洄游通道。近年来，随着旅游业的发展，长山列岛及其周边海域人类活动频繁。孙雪梅等(2022)研究表明，长山列岛附近海域沉积环境中的微塑料含量已达到 133.14~499.82 个/kg，海洋环境中的微塑料与食物来源掺杂，从而使微塑料直接或间接在鱼类体内积累，可能对鱼类的生长发育和食物产出等造成负面影响。本研究通过对长山列岛野生鱼类的采集，对其胃肠道和肌肉组织中的微塑料进行分离，并分析微塑料的丰度和类型，进而阐明长山列岛邻近海域鱼类体内微塑料的污染现状，为研究微塑料对长山列岛生态系统生态环境安全的影响提供基础数据。

1　材料与方法

1.1　取样和样品制备

样品采集于 2021 年 10 月 28 日在长山列岛渔业资源与环境调查航次，主要采集于大黑山岛与小黑山岛之间，使用每节长、宽、高分别为 30、20 和 25 cm 的地笼网采集到 7 种鱼，包括褐牙鲆(*Paralichthys olivaceus*)、许氏平鲉(*Sebastes schlegelii*)、大泷六线鱼(*Hexagrammos otakii*)、刀鲚(*Coilia nasus*)、绿鳍马面鲀(*Thamnaconus modestus*)、尖嘴扁颌针鱼(*Ablennes anastomella*)和孔鳐(*Raja porosa*)，采集鱼类的基本信息见表 1。使用包装袋妥善封存后置于泡沫箱中冷藏并运送至实验室，置于–20 ℃冰箱中保存，用于微塑料的提取、计数测量、镜检和化学成分分析。

表 1　长山列岛 7 种海洋鱼类样本基本体征信息
Tab.1　Basic physical information of 7 marine fish samples in Changshan Islands

物种 Species	样本数 Sample /items	长度 Length/cm	体重 Weight/g
大泷六线鱼 *H. otakii*	10	11.58±1.51	19.21±6.72
孔鳐 *R. porosa*	3	29.57±1.35	201.71±10.71
褐牙鲆 *P. olivaceus*	10	14.13±1.28	32.12±5.58
刀鲚 *C. nasus*	10	46.79±2.19	53.53±8.26
绿鳍马面鲀 *T. modestus*	10	16.80±1.78	62.67±10.26
尖嘴扁颌针鱼 *A. anastomella*	10	13.63±3.11	24.54±4.59
许氏平鲉 *S. schlegelii*	10	8.22±0.78	9.07±2.29

1.2　微塑料的分离

在实验室解剖前，将生物样品置于通风橱中解冻，并使用超纯水冲洗泥沙等杂质，记录鱼类个体的体长和体重，对每个鱼类个体解剖，分离其胃肠道和肌肉并进行称重。鱼类消解和微塑料分离方法：将组织放入 250 mL 锥形瓶，加入 KOH 溶液(10%)于恒温水浴振荡器中 60 ℃恒温下消解至少 48 h，直至组织完全消解。通过真空过滤将溶液过滤至 0.45 μm 玻璃纤维滤膜上，在过滤过程中，使用超纯水多次冲洗以去除残留的 KOH (Keenan *et al*, 2018; 蔡慧文等, 2021)。滤膜干燥后进行进一步分析。

1.3　微塑料的观察和鉴定

使用配备有高清摄像头的 Nikon 立体显微镜(NE900,日本)对滤膜进行观察，对滤膜上的疑似“微塑料”逐一进行尺寸、颜色和形状分类，并将典型微塑料进行拍照记录。微塑料的尺寸分为<0.3、0.3~0.5、0.5~1.0、1.0~2.0、2.0~3.0、3.0~4.0 和 4.0~5.0 mm；形状分为颗粒、碎片和纤维；颜色分为黑色、透明色和彩色。

使用傅里叶变换红外光谱仪(美国)对镜检挑出的疑似微塑料个体进行化学成分分析。在 650~4 000 cm^{-1} 范围内对疑似微塑料个体扫描 32 次，分析每个微塑料的 FTIR 光谱并记录光谱。将所有光谱与数据库

(Hummel Polymers and Additives, Putuzu, Thermo-Fisher)进行对比，以验证塑料的成分，仅将与标准数据库匹配>70%的光谱鉴定为微塑料。

1.4 质量控制与数据处理

为了减少现场和实验室外部微量微塑料污染，在现场采样、分析程序和所有溶液制备过程中，实验人员穿棉质衣服，佩戴手套和口罩。在每次实验之前，所有的超纯水和化学试剂均通过 0.45 μm 玻璃纤维滤膜过滤，所有的容器和设备均为不锈钢、铝或玻璃制品，使用过滤的超纯水洗涤 3 次。将每个样品暴露在空气中的时间控制在 10 min 以内，整个微塑料提取过程均在层流柜中进行。相同的实验步骤进行了 3 个程序空白(超纯水)以进行背景校正。

微塑料组成根据形状、大小和聚合物类型分类。使用 Microsoft Excel 2019 和 Origin 2020 软件进行图表绘制，SPSS 17 软件进行数据分析。关于微塑料丰度的所有结果表示为每个生物个体中微塑料颗粒的数量(个/个体)，采用平均数±标准差(Mean±SD)表示。

2 结果与讨论

2.1 鱼类体内微塑料的丰度

在全部待测鱼类体内发现，鱼类胃肠道中均检测到微塑料，而肌肉组织中并未检测出微塑料。每种鱼类个体胃肠道中微塑料的丰度见图 1。从图 1 可以看出，鱼类胃肠道中微塑料丰度范围为 0.19~3.79 个/个体，其中，许氏平鲉的丰度最低，刀鲚的丰度最高。Su 等(2018)研究发现，在中国沿海的鱼类肠道中检测到大量塑料，但在肌肉中未检出。其原因可能是微塑料的

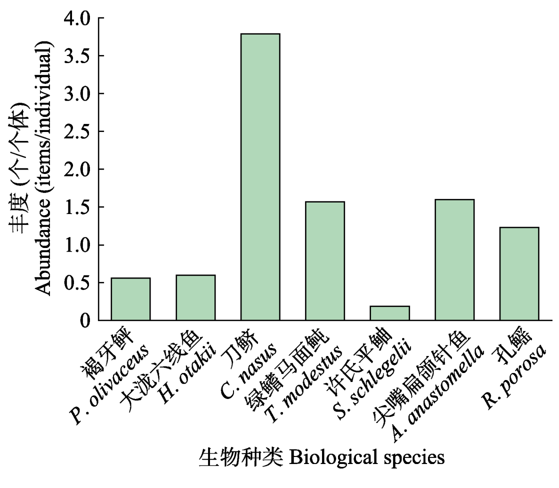

图 1 不同海洋鱼类胃肠道内微塑料丰度
Fig.1 Abundance of microplastics in gastrointestinal tract of different marine fish

尺寸过大，不能被肠道上皮细胞吞噬，进而无法参与鱼类的生物体内循环(Ilium *et al*, 1982; Lu *et al*, 2016)。

本研究表明，长山列岛的野生鱼类普遍受到微塑料的污染，野生鱼类体内胃肠道的微塑料平均丰度为(1.23±1.18)个/个体。Li 等(2021)研究表明，在远海太平洋采集的野生鱼类肠道中，微塑料的平均丰度为 9.3 个/个体；在近岸开放海域如天津近岸沿海海域采集的野生鱼类胃肠道中，平均微塑料丰度为 8.8 个/个体(韩龙等，2022)；在近岸半封闭海湾北部湾(张帅朋，2021)中，多鳞鱚(*Sillago sihama*)肠道中微塑料丰度范围为 5.32~6.21 个/个体。相比较而言，长山列岛的鱼类胃肠道中微塑料丰度与全球范围内其他沿海地区相比，如远海(太平洋、大西洋)、近岸开放海域(渤海、澳大利亚南部海域)、近岸半封闭海域(地中海近岸海域、中国马鞍列岛)等处于较低水平(Luis *et al*, 2020; Wang *et al*, 2021; Wootton *et al*, 2021; Sayed *et al*, 2021; Zhang *et al*, 2020)。刀鲚的微塑料丰度在所有鱼类中处于最高水平，这可能与刀鲚的生活环境和捕食习性有关。刀鲚多生活在近海的海域底层，沉积物中的微塑料会在水体流动下发生悬浮、沉降、再悬浮这样一个循环往复的过程，因此，大大增加了底层生物对微塑料的暴露和摄入风险(Wang *et al*, 2018)。另外，刀鲚主要以大型甲壳类动物和其他鱼类为食，处于相对较高的营养等级水平，微塑料也可能通过食物链传递的形式在刀鲚等较高营养级生物中累积(陈璇等，2021)。

2.2 鱼类胃肠道微塑料的类型

鱼类体内微塑料的形状以纤维为主(图 2 和图 3)，占比为 71.32%，其次为碎片(25.44%)和颗粒(3.26%)。环境中的大型塑料会在光氧化、波浪作用、物理磨损和交替冻融等作用下而破碎，本研究检测到的不同形状微塑料可能源自这些分解的大型塑料。在全球范围内，纤维是目前采集到的野生生物中的主要微塑料形状(表 2)，如澳大利亚采集的野生鱼类(Wootton *et al*, 2021)，印度东南沿海采集的贻贝(*Mytilus edulis*) (Naidu *et al*, 2019)，中国辽河河口采集的软体动物、甲壳类动物以及鱼类中微塑料的主要形状也均为纤维(Wang *et al*, 2021)。纤维微塑料在生物体内出现率最高，一方面可能是由于海洋环境中纤维微塑料丰度最高；另一方面，可能是由于纤维微塑料可以弯曲或与食物交织，导致其排出较慢，从而增加其生物体内的残留时间(Elizalde *et al*, 2020)。

表 2　全球范围内海洋鱼类胃肠道中微塑料污染现状

Tab.2　The status of microplastic pollution in marine fish gastrointestinal tract worldwide

地区 Region	鱼类种类 Fish species	平均丰度 Average abundance /(items/individual)	尺寸 Diameter /μm	主要形状 Major shape	主要成分 Main component	参考文献 Reference
太平洋 Pacific Ocean	野生鱼类 Wild fish	9.30	<2500	纤维 Fiber	PES	Li 等(2021)
大西洋东北部 Northeast Atlantic Ocean	野生鱼类 Wild fish	1.20±2.00	501~1 500	纤维 Fiber	PE	Luís 等(2021)
天津近岸海域 Tianjin coastal waters	虾虎鱼 Gobiidae	8.80	430~8 240	纤维 Fiber	PET	韩龙等(2022)
渤海 Bohai Sea	野生鱼类 Wild fish	2.14±1.81	18~4 995	纤维 Fiber	CP	Wang 等(2021)
澳大利亚 Australia	野生鱼类 Wild fish	1.58±0.23	>38	纤维 Fiber	PO	Wootton 等(2021)
黄海 Yellow Sea	野生幼鱼 Wild juvenile fish	1.10	16~4 740	纤维 Fiber	PE	Sun 等(2019)
东海 East China Sea	野生鱼类 Wild fish	0.06~4.00	26~4 808	碎片 Fragment	PET, PP	Zhang 等(2021)
南海 South China Sea	深海野生鱼类 Abyssal wild fish	1.77±0.73	<1 000	薄膜 Film	ST	Zhu 等(2019)
湛江红树林湿地 Zhanjiang mangrove wetland	野生鱼类 Wild fish	2.83±1.84	200~5 000	纤维 Fiber	PE	Huang 等(2020)
马来西亚 Malaysia	经济鱼类 Commercial fish	1.40±3.70	20~3 490	碎片 Fragment	PE	Samaneh 等(2019)
北部湾 North Bay	前棱龟鲅 *Eastern keelback mullet*	3.21~4.36	100~500	纤维 Fiber	PET	张帅朋(2021)
	鳞鳍叫姑鱼 *Johnius distinctus*	1.22~2.31				
	多鳞鱚 *S. sihama*	5.32~6.21				
	犬牙缰虾虎鱼 *Amoya caninus*	3.26~5.36				
埃及地中海 Egypt Mediterranean	野生鱼类 Wild fish	1.56±0.50	1~5 000	纤维 Fiber	PP, PE	Sayed 等(2021)
舟山群岛 Zhoushan Islands	野生鱼类 Wild fish	2.30±1.50~7.30±3.50	500~1 000	纤维 Fiber	PE	Zhang 等(2020)
莱州湾 Laizhou Bay	矛尾鰕虎鱼 *Chaeturichthys stigmatias*	3.20±1.20	396±321	纤维 Fiber	PES	滕佳(2021)
象牙湾 Ivory Bay	斑尾刺虾虎鱼 *Acanthogobius ommaturus*	0.50±0.80	1 246±1 119	纤维 Fiber	RY	于翔等(2021)
	短棘银鲈 *Lucid mojarra*	0.20±0.40				
南海南薰礁 Nanxun Reef, South China Sea	野生鱼类 Wild fish	3.10	<500	纤维 Fiber	PVC	Nie 等(2019)
波斯湾北部沿海 North coast of the Persian Gulf	中上层野生鱼类 Pelagic wild fishes	5.79±5.98	23~75	纤维 Fiber	—	Hosseinpour 等(2021)
	底层野生鱼类 Ground wild fishes	3.89±3.53				
孟加拉湾 Bay of Bengal	云鲥 *Macrura ilisha*	19.13±10.77	300~1 500	纤维 Fiber	—	Siddique 等(2022)
沙特阿拉伯红海沿岸 Saudi Arabia´s Red Sea coast	野生鱼类 Wild fish	14.40±0.30	1 000~3 000	纤维 Fiber	PP	Fadiyah 等(2018)

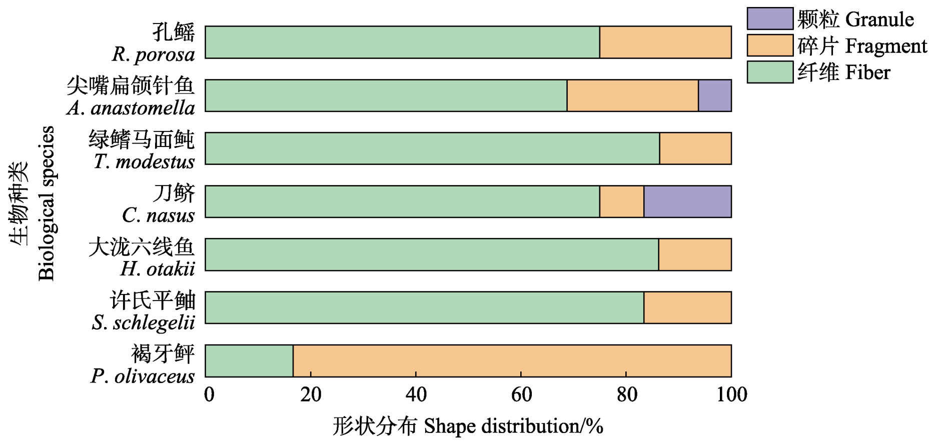

图 2 海洋鱼类胃肠道中微塑料的不同形状比例

Fig.2 Different shapes proportions of microplastics in marine fish gastrointestinal tract

图 3 海洋鱼类中典型微塑料

Fig.3 Typical microplastics photos in marine fishes

A：纤维；B：碎片；C：颗粒

A: Fiber; B: Fragment; C: Granule

鱼类体内微塑料的颜色分布见图 4。从图 4 可以看出，鱼类体内微塑料的颜色大多为透明色(70.25%)，丰度最低的颜色为黑色(10.72%)。鱼类胃肠道中微塑料的尺寸分布见图 5。从图 5 可以看出，小尺寸的微塑料(<300 μm)在生物中普遍存在(85.91%)，此外，300~500 和 500~1 000 μm 的微塑料占所观察到微塑料分别为 7.04%和 4.55%，而较大的微塑料(1 000~5 000 μm)很少被检测到(2.50%)，其原因可能是本次调查采集的鱼类个体尺寸较小，较大尺寸的微塑料不能通过摄食进入鱼类的胃肠道中。

海洋环境中的微塑料大多粒径较小，尺寸以微米为主(孙承君等，2022)，其颜色、大小和形状与浮游生物相似，可能被鱼类当作猎物而误食(Lusher *et al*, 2017)。研究表明，海水中的大多数微塑料是透明色和白色，如南黄海(Jiang *et al*, 2020)和长江口表层(Zhao *et al*, 2014)水中检测到微塑料大多数为透明色。

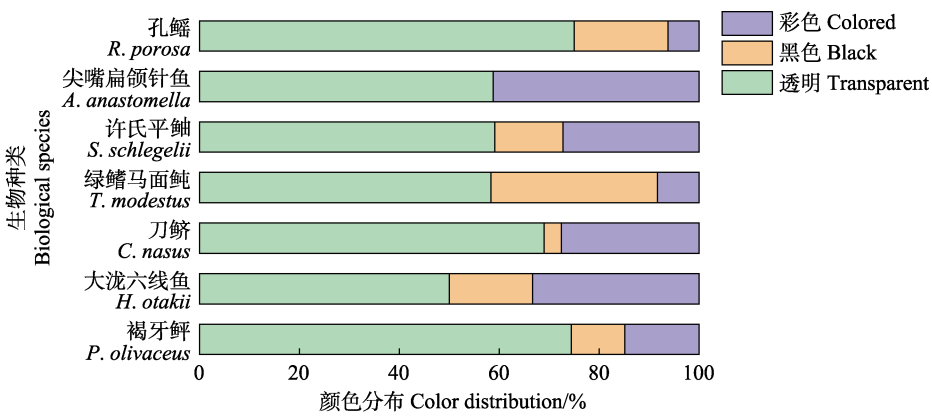

图 4 海洋鱼类胃肠道中微塑料的不同颜色比例

Fig.4 Different color proportions of microplastics in marine fish gastrointestinal tract

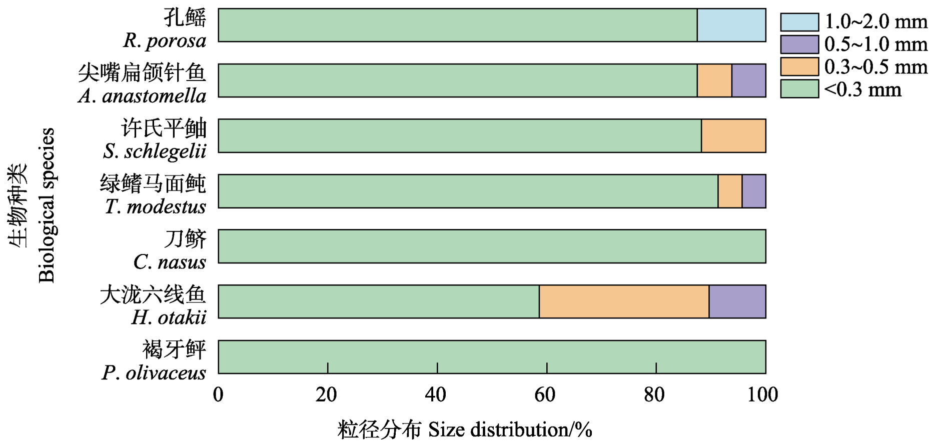

图 5　海洋鱼类胃肠道中微塑料的不同粒径比例

Fig.5　Different particle size ratios of microplastics in marine fish gastrointestinal tract

通过室内模拟实验发现，鱼类优先捕获黑色微塑料，而对于其他颜色(蓝色、半透明和黄色)的微塑料很少被单独捕食(Xiong *et al*, 2014)。鱼类能从食物中分辨出不可食用的颗粒，在没有食物的情况下，捕获微塑料颗粒会被吐出，只有当微塑料颗粒与食物混合时，才会最终被鱼类吞食(Ory *et al*, 2018)。然而，现实海洋环境中，由于受海流、自然风化等各种因素的影响，鱼类摄食不同颜色微塑料的规律性相较于实验室环境弱，导致鱼类摄食的微塑料类型与水体中丰度最高的微塑料颜色相似。

2.3　鱼类胃肠道微塑料的聚合物成分

从图 6 可以看出，鱼类胃肠道中检测到的聚合物类型为赛璐玢(Cellophane)、纤维素(Cellulose)和聚乙烯(Polyethylene)，其中，赛璐玢是最常见的一种聚合物，它也是长山列岛沉积物中最丰富的聚合物成分(图 7)(孙雪梅等, 2022)。赛璐玢是一种有机纤维素基聚合物，常用于食品包装和卷烟包装。它也被用作玻璃纤维和橡胶制品制造中的脱模剂，经常被用作与合成聚合物结合的涂层(Yang *et al*, 2015)。在本次采集样品中也检测到大量的纤维素，其来源可能包括来自大气沉降的纤维、从污水处理厂的废水中释放的纤维以及污泥在地面应用产生的纤维。此外，在鱼类胃肠道中检测到一定数量的纤维素，它虽然不是一种典型的油基聚合物(如再生纤维素纤维材料：黏胶、莫代尔或莱赛尔)，但许多研究发现，这种纤维含量高，不易降解，也视为一种微塑料(Kolbe *et al*, 2019)。Brate 等(2018)研究了来自挪威贻贝中的微塑料，发现纤维素在贻贝中占主导地位。

聚合物危害指数(polymer hazard index, PHI)是目前不同类型微塑料风险评估的重要标准，它主要借助特定聚合物的百分含量和聚合物的危险分数进行生态和健康风险评估(Lithner *et al*, 2011)。通过聚合物危害指数可以估算出微塑料对人类的潜在风险，聚合物危害指数越高说明该海域生态风险越高。Lithner 等(2011)将聚合物毒性系数分为了 5 个等级，每个危险等级(I~V)增加 10 倍，即 1~10 000，其中，聚乙烯的毒性系数为 10，毒性等级为Ⅱ级，危害指数低，属

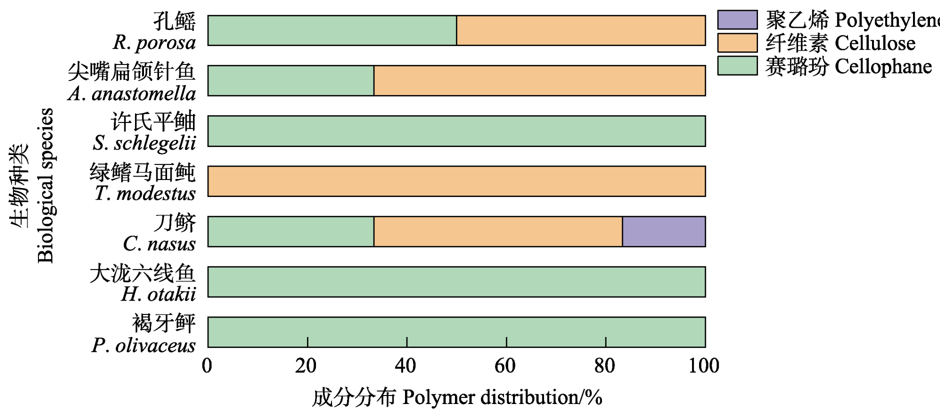

图 6　海洋鱼类胃肠道中微塑料的不同成分比例

Fig.6　Different proportion of microplastics in marine fish gastrointestinal tract

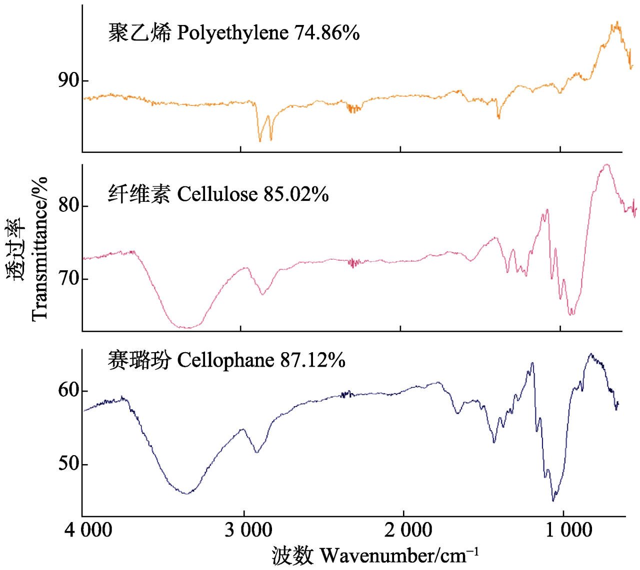

图 7 海洋鱼类胃肠道中 3 种主要微塑料的红外光谱

Fig.7 The μ~FTIR spectra of three main microplastics identified in marine fish gastrointestinal tract

图中的百分比数字为获取的光谱与有机聚合物谱库比对后的匹配度。

The percentage indicates the matching degree of a spectrum obtained with the organic polymer library.

于低等风险聚合物。本研究鱼类体内的微塑料分布主要集中于胃肠道中，肌肉组织中并无微塑料，聚乙烯微塑料仅在刀鲚胃肠道中少量检出，且人们通常会在食用之前丢弃鱼类的胃肠道。因此，长山列岛附近海域的鱼类海产品安全系数较高。

3 结论

本研究表明，长山列岛近海域 7 种海洋野生鱼类胃肠道普遍受到微塑料的污染，体内胃肠道微塑料的丰度范围为 0.19~3.79 个/个体，鱼类肌肉中并未检测到微塑料。检测到的聚合物类型为赛璐玢、纤维素和聚乙烯，其中，纤维素和赛璐玢对生物体无明显毒性作用，聚乙烯聚合物的危害指数较低。因此，长山列岛水域微塑料的存在暂时不会对其鱼类的食品质量安全构成威胁。通过与其他类型近海区域相比，长山列岛近海鱼类胃肠道内的微塑料丰度处于较低水平，未来还应加强研究其他野生生物体如贝类等经济生物可食用部分的微塑料分布情况，从而为长山列岛海域微塑料的污染水平分析和防控策略制定提供科学依据。

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Distribution Characteristics of Microplastics in Wild Fish near Changshan Islands

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Abstract Plastic products are widely used in human daily life, while facilitating human life, plastics have also produced many negative effects due to the lack of effective recovery measures, plastic pollution has become an important environmental issue of global concern. Marine plastics can be degraded into smaller microplastics (MPs) through various ways under the influence of environmental factors. They can be ingested by marine organisms mixed with food sources, and then accumulated in the body, causing serious negative effects on marine lifes and marine ecology. Recently, it has been proved that the Changshan Islands sediments contain a certain amount of MPs, the content reached 133.14 to 499.82 n/kg. Changshan Islands is one of the eight major islands in China. It is located at the confluence of the Yellow Sea and the Bohai Sea, and has a unique geographical location. The fish community between the islands is rich in species, especially in many migratory species, and high in species diversity. The seasonal change of fish species composition and dominant species is obvious. It has been proved MPs can cause a certain degree of harm to marine organisms. Therefore, the distribution of MPs in organisms in the Changshan Islands sea area deserves to be studied. In this study, the MPs in the gastrointestinal tracts and muscles of wild fish were digested and separated after collecting them from the marine culture zone of Changshan Islands. The results showed that MPs were detected existing in the gastrointestinal tracts of all fish, but not in muscle tissues. The reason may be that MPs are too large to be endocytosed by intestinal epithelial cells, and thus can not participate in the blood circulation of fish. The abundance of MPs in the gastrointestinal tracts of seven species of marine wild fish ranged from 0.19 to 3.79 items/individual. The abundance of MPs in *Coilia nasus* is the highest among all fish, this phenomenon may be related to the living environment and predation habits of *C. nasus*, which living in the bottom of the sea. The MPs in sediments will undergo a cyclic process of suspension, sedimentation and resuspension under the flow of seawater, thus greatly increasing the exposure and intake risk of MPs by bottom organisms, such as *C. nasus*. The shape of MPs was dominated by the fiber, and the color was mostly transparent, which size is mainly less than 300 μm. The reason may be that the individual size of fish collected in this survey is small, and larger-sized MPs cannot enter into the gastrointestinal tract of fish through feeding. Large plastics in the environment are broken under the photooxidation, wave action, physical wear and alternating freeze-thaw. The different shapes of MPs detected in this study may be derived from the decomposition of these large plastics. Fibers are the predominant form of MPs encountered in global wildlife studies. It could also be because fibrous MPs are the most abundant in the marine environment. Additionally, MPs Fibers can be bended or intertwined with food, possibly due to long-term accumulation for the slower fibers excretion, increasing the chance of being ingested by organisms. The types of

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polymers detected were cellophane, cellulose and polyethylene, among which cellophane had the highest content. Cellophane is an organic cellulose-based polymer that has been used in food packaging and cigarette packaging. It is also used as a release agent in the manufacture of glass fiber and rubber products, or as a coating in combination with synthetic polymers. There was no obvious toxic effect on cellulose and cellulite. The polymer hazard index (PHI) is an important criterion for risk assessment of MPs, and is based primarily on the percentage content of a given polymer and the polymer's hazard fraction for ecological and health risk assessment. The potential risk of MPs to humans can be estimated by the polymer hazard index. The higher the polymer hazard index, the higher the ecological risk in the sea area. The toxicity coefficient of polyethylene is 10, the toxicity grade is grade II, the hazard index is low, and it belongs to the low risk polymer. Moreover, people usually discard the gastrointestinal tract of fish before eating, thus the MPs in the fishes of Changshan Islands, and the safety factor of fish products in Changshan Islands is higher. In this study, through the collection of wild fish in Changshan Islands, the MPs in gastrointestinal tract and muscle tissue were extracted, and the abundance and type of MPs were analyzed. The pollution status of MPs in fish in the adjacent waters of Changshan Islands was clarified, which provided basic data for exploring the impact of MPs on the ecological environment safety of Changshan Islands ecosystem. Further research on the distribution of MPs in other wild organisms, such as shellfish, and in other economically viable locations should be considered, which can provide a scientific basis for the analysis of MP pollution levels and the formulation of prevention and control strategies in the marine environment.

Key words Changshan Islands; Microplastics; Wild fish; Gastrointestinal tract; Pollution characteristics