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研究报告

Research Report

埃及红海沿岸，古尔代盖市的两种鹦嘴鱼：白斑鹦嘴鱼(Forsskål，1775)和长吻马鹦嘴鱼(Forsskål, 1775)体内耳石的波动性不对称

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摘 要 测量了成年白斑鹦嘴鱼和长吻马鹦嘴鱼的耳石的长度和宽度的波动不对称性。结果表明，耳石的长度不对称性水平明显高于宽度不对称性。白斑鹦嘴鱼的耳石长度不对称的最低水平是在鱼总长度介于 150~260 mm 处，最高水平是在鱼总长度介于 160~260 mm 处。耳石宽度的不对称性的最高水平是在鱼的长度范围 24-26 mm 处，它在其它长度组的值是 0。长吻马鹦嘴鱼的耳石长度不对称的最低水平是在鱼总长度介于 160~170 mm 处，最高水平是在鱼总长度介于 240~260 mm 处。耳石宽度的不对称性的最高水平是在鱼的长度范围 240~260 mm 处，它在其它长度组的值是 0。引起这些物种的不对称性的可能原因是该地区普遍存在污染物。注意到，随着鱼的长度(年龄)的增加，不对称性会加强。
关键词 耳石；尺寸；双侧不对称性；鹦嘴鱼科；生态指标

Fluctuating Asymmetry in the Otolith of Two Parrotfish Species, *Chlorurus sordidus* (Forsskål, 1775) and *Hipposcarus harid* (Forsskål, 1775) From Hurghada, Red Sea Coast of Egypt

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Abstract Fluctuating asymmetry was calculated for the otolith length and width of the adult fishes *Chlorurus sordidus* and *Hipposcarus harid*. The results showed that the level of asymmetry of the otolith length was the higher than that of the otolith width in both species. For *C. sordidus*, the lowest level of asymmetry in the otolith length was at the fish total length ranging between 150-260 mm, and the highest at the fish total length 160-260 mm. For the otolith width, the highest level of asymmetry is at the fish length ranging between 24-26 mm and it has zero value in the other length groups. For *H. harid*, the lowest level of asymmetry in the otolith length was at the fish length ranging between 160-170 mm, and the highest at the fish length 240-260 mm. For the otolith width, the highest level of asymmetry is at the fish length ranging between 240-260 mm and it has zero value in the other length groups. The possible cause of the asymmetry in these species has been discussed in relation to the general presence of pollutants in the area. An increasing asymmetry with the fish length (age) was noticed.
Keywords Otolith; Dimensions; Bilateral asymmetry; Scaridae; Ecological indicator

介绍

波动性不对称是一个有机体两侧的双边特征的差别发展(Van Vallen, 1962; Leary and Allendroff, 1989)。发展的不稳定性可以通过波动的不对称性来反映，这是一个完善的双边系统的随机偏差。换言之，这是一个有机体在发展过程中无法弥补的干扰(Zakharov, 1992)，这种无能为力受环境或遗传条件的影响。所以高

波动不对称性可以表明鱼的生活环境是最糟糕的。因此，双边的不对称性措施可以对机体的健康产生一个环境影响。

几种成年鱼类被用来研究鱼的状况和波动性不对称之间的关系。在这样的研究中，已经提出了测量的数据，包括鱼鳃的数量、胸鳍条数、鱼的身体比例、眼斑面积以及耳石的尺寸和形状(Escó et al., 1995; Somarakis et al., 1997; Jawad, 2001, 2003, 2004; Gonçalves et al., 2002; Jawad et al., 2012)。

如果有一个不对称的耳石，那么鱼将面临可能会改变它的习惯或行为的后果(Gagliano and McCormick, 2004; Gagliano et al., 2007)。年轻鱼类的生存将受到威胁，因为他们将很难找到一个合适的地方解决这个问题。另一方面，渔业管理人员会对耳石的波动不对称性感兴趣，因为研究老的耳石标本可以为过去的个体和种群适合度提供一个测量方法。这些信息将有助于目前的体系的了解，并对未来的管理策略提出一个理念(Díaz-Gil et al., 2015)。

关于波动不对称性的研究，从来没有在耳石大小问题或不同区域的埃及水域中的同一物种中进行过。目前是第一次对埃及水域中的鱼耳石不对称性的研究。

对长度和宽度的波动性不对称的研究是在两种鹦嘴鱼：白斑鹦嘴鱼和长吻马鹦嘴鱼上进行的，这两种鱼来自埃及红海沿岸的古尔代盖。这两个物种的幼虫提供了有关适合的栖息地的检测信息。

1 材料与方法

1.1 取样区域描述

古尔代盖在红海北部的北纬 27°10’~27°33’之间和东经 33°70’~33°85’之间(图 1)。它位于红海西海岸，距离开罗东南 500 km 处，沿海岸延伸约 36 km，不到周围的沙漠。古尔代盖附近被选为这两个物种：白斑鹦嘴鱼和长吻马鹦嘴鱼的采样点来研究波动性不对称问题，这对显示渔场幼虫的沉降现象有重要影响。

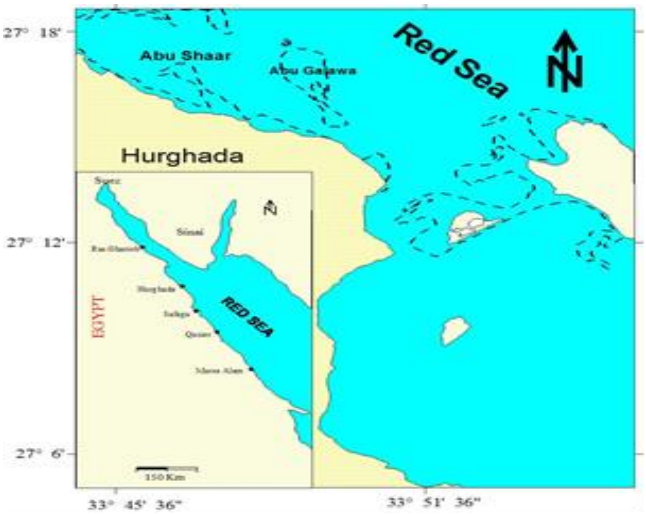

图 1 采样点
Figure 1 Sampling area

1.2 样品收集

鹦嘴鱼样本是从商业平台 2012-2013 年在捕捞季节获得的样品中得到的。鱼是用 60~100 m 长的，带有 2~¼ mm 大的网眼的刺网捕捉到的。标准长度(SL)是使用游标卡尺测量精确到 1 mm。左、右矢耳石通过切除头骨显露，然后清洗和干燥，并保存在玻璃瓶中。分别收集到来自 30 种(标准长度 150~260 mm)白斑鹦嘴鱼和 30 种(标准长度 160~260 mm)长吻马鹦嘴鱼的不同长度组的矢耳石标本。有明显证据的方解石结晶或其它异常的构成标本不能用于本研究。每个矢耳石被系统地安置在面向观察者的听神经裂缝中，长度用普通的光学显微镜测量。最大长度(OL)和最大高度(OW)的测量精确到 0·01 mm，记录从前尖到后边缘(OL)的最大距离和耳石的背侧和腹侧缘(OW)之间的最大距离(Harvey et al., 2000; Battaglia et al., 2010)。

1.3 统计分析

统计分析是基于三个耳石的尺寸系数的平方变化的不对称性(CV^2_a) (Valentine et al., 1973)：

$CV^2_a = (S\ r\text{-}l\ X\ 100/X\ r + l)^2$

S r-l 是符号差异的标准偏差，X r + l 是字符的平均值，通过增加双方的绝对分数，并除以样本大小计算得到。

2 结果

来自埃及红海沿岸古尔代盖的白斑鹦嘴鱼和长吻马鹦嘴鱼的耳石长度和宽度的不对称性数据分析结果(表 1)。结果表明，耳石的长度不对称性水平高于耳石宽度。白斑鹦嘴鱼的耳石变量，最低和最高值在鱼全长 150~170 mm 和 240~260 mm。其它长度组的不对称系数为 0。结果表明，这两个物种的不对称性与鱼的长度有关(表 2)。

表 1 白斑鹦嘴鱼和长吻马鹦嘴鱼的不对称值的平方系数(CV^2_a)和特征值(X_{r+1})

Table 1 Squared coefficient of asymmetry (CV^2_a) value and character means (X_{r+1}) of *Chlorurus sordidus* and *Hipposcarus harid*

特征 Character	不对称值的平方系数 CV^2_a	N	字符平均值 Character mean	个体的不对称性% % of individuals with asymmetry
白斑鹦嘴鱼 *Chlorurus sordidus*				
耳石长度 Otolith length	14.049	30	5.214	6.6
耳石宽度 Otolith width	10.436	30	3.377	6.6
长吻马鹦嘴鱼 *Hipposcarus harid*				
耳石长度 Otolith length	15.190	30	6.109	16.7
耳石宽度 Otolith width	11.962	30	4.048	3.3

表 2 白斑鹦嘴鱼和长吻马鹦嘴鱼的不对称值的平方系数和平均值大小

Table 2 Squared coefficient of asymmetry and character means by size of *Chlorurus sordidus* and *Hipposcarus harid*

特征 Character	不对称值的平方系数 CV^2_a	N	字符平均值 Character mean	个体的不对称性% % of individuals with asymmetry
白斑鹦嘴鱼 *Chlorurus sordidus*				
耳石长度 Otolith length				
150-170	0.032	7	5.60	0
180-200	0	5	5.67	3.33
210-230	0.040	16	6.11	3.33
240-260	0.093	2	6.60	0
耳石宽度 Otolith width				
150-170	0	7	3.78	0
180-200	0	5	3.66	3.33
210-230	0	16	4.00	3.33
240-260	0.058	2	3.94	0
长吻马鹦嘴鱼 *Hipposcarus harid*				
耳石长度 Otolith length				
160-170	0.504	2	5.91	0
180-200	0.913	5	5.82	20
210-230	0	16	6.20	6.25
240-260	0.967	2	6.6	0
耳石宽度 Otolith width				
150-170	0	2	3.76	0
180-200	0	5	3.84	20
210-230	0	16	4.20	6.25
240-260	1.639	2	3.94	0

个体显示的耳石长度的不对称的百分比是在获得这两个物种的两个耳石字符中比例最高的(图 1)。

3 讨论

一些鱼异常的游泳和行为干扰了声音定位，降低了他们整合生活环境的能力(Lychakov and Rebane, 2005)。这样的后果是由耳石双侧质量的不对称性引起的。

白斑鹦嘴鱼和长吻马鹦嘴鱼耳石尺寸的变化可以影响年轻个体在他们的合适的栖息地定位和定居的能力(Gagliano and McCormick, 2004; Gagliano et al., 2007)。根据观察到的不对称，沉降的幼虫可能会受到影响。由于物种的问题是在埃及的商业品种，这样的研究被认为是相关的这些物种的生态，以评估他们在该地区的状况。

不同的环境污染和两个物种的形态之间的关联很难从评价污染梯度的不对称性中得到数据，或者从受控制影响的(不受影响的)站点的鱼，在这个阶段是不可能有确切的迹象表明这种现象的意义的。然而，在这一领域以前研究的基础上，根据这种物种的形态污染和不对称性，可以建立环境应力之间的相关性。这种环境因素是存在于埃及红海沿岸古尔代盖的水域中的(Mansour et al., 2000; Mansour et al, 2005; Madkour et al., 2006; Madkour and Dar, 2007; Madkour et al., 2008, Mansour et al., 2011)。

引起环境的原因可能是自然事件，几个已知的因素产生了营养缺陷，如各种病原体和各种种群现象(Bengtsson and Hindberg, 1985)，这些因素很有可能在阿曼海的水生环境中常见到。

一些作者已经展示出不对称性系数和鱼的长度之间的关系(Al- Hassan et al., 1990; Al- Hassan and Hassan, 1994; Al- Hassan and Shwafi, 1997; Jawad, 2001, 2013)，随着鱼体长度的增加，不对称性有增加的趋势。对耳石的形态特征进行了研究，一些长度组给出的不对称性系数为 0。

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