

## 西南大西洋阿根廷滑柔鱼夏季产卵 种群繁殖生物学的初步研究

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**摘要:** 根据我国鱿钓船于2012年12月—2013年3月渔汛期间,在西南大西洋公海海域作业时随机采集的阿根廷滑柔鱼夏季产卵种群样本(雌性148尾,雄性99尾),初步研究了其种群繁殖生物学。结果表明,渔汛期间阿根廷滑柔鱼夏季产卵种群雌性胴长172~252 mm,雄性胴长164~248 mm。随着月份推移,雌性占比逐月递减,从12月份的84.21%递减至次年3月份的27.03%;雄性个体占比则逐月递增,从12月份的15.79%递增至次年3月份的72.97%。雌性样本超过30%的个体性腺发育成熟并且部分处于繁殖期,雄性个体超过60%的个体性腺发育成熟并且部分处于繁殖期。雌雄个体的胴长和体质量均在性腺功能发育成熟时达到最大值,但是雌性胴长大于雄性,体质量却小于雄性。性腺指数、缠卵腺指数和精英复合体指数随着个体生长逐渐增长。雌性个体性腺指数为0.001 2~0.31,平均值0.074;缠卵腺指数为0.003 1~0.55,平均值0.29;两者随着个体生长逐渐增长,在性腺功能成熟时达到最大值。雄性个体性腺指数为0.007 5~0.084,平均值0.038;精英复合体指数为0.000 79~0.035,平均值0.012;两指数在繁殖期时达到最大值。

**关键词:** 阿根廷滑柔鱼;夏季产卵种群;繁殖生物学;西南大西洋

**中图分类号:** S 917.4

**文献标志码:** A

阿根廷滑柔鱼(*Illex argentinus*)为大洋性浅海柔鱼科属种,广泛分布在22~54°S的西南大西洋大陆架和大陆坡海域,尤以35~52°S海域资源最为丰富<sup>[1-2]</sup>,是西南大西洋重要的头足类资源<sup>[3]</sup>,也是西南大西洋生态系统重要的营养指标之一<sup>[4]</sup>。该种类具有生命周期短,生长速度快,季节性洄游等特点<sup>[2,5-8]</sup>,并且种群结构复杂,种群之间在成鱼大小、产卵场所、产卵季节、繁殖持续时间等方面存在显著性差异<sup>[9-14]</sup>。目前,国内外对西南大西洋阿根廷滑柔鱼的繁殖生物学进行了很多研究,但是研究相对集中于秋冬季或冬春季产卵的种群<sup>[5,9,15-17]</sup>,以及阿根廷沿海或巴西

外海的常驻型种群<sup>[14,18]</sup>。阿根廷滑柔鱼夏季产卵种群,成鱼个体小,亲鱼和前期稚鱼均见于42~48°S的西南大西洋巴塔哥尼亚大陆架外侧海域或过渡海域<sup>[1,10,19]</sup>。该种群为我国鱿钓船在西南大西洋的重要钓捕对象<sup>[20]</sup>,全面掌握该种群的繁殖生物学,是合理开发和利用该资源的重要前提。为此,本研究将根据2012年12月—2013年3月我国鱿钓船于45°S附近作业海域采集的阿根廷滑柔鱼夏季产卵种群样本,进行雌雄组成、性腺发育及其个体生长,以及性腺生长指数等繁殖特性的初步研究,为更好地掌握阿根廷滑柔鱼繁殖生物学提供基础。

收稿日期:2013-10-08 修回日期:2014-03-14

资助项目:国家自然科学基金(NSFC41276156);国家“八六三”高技术研究发展计划(2012AA092303);上海市科技创新行动计划(12231203900)

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## 1 材料与方法

### 1.1 样本采集海域和时间

阿根廷滑柔鱼样本来自阿根廷公海海域作业的“沪渔 908”鱿钓船。时间为 2012 年 12 月下旬和 2013 年 1—2 月及 3 月上旬,采集海域为 45°08'S ~ 45°46'S、60°03'W ~ 60°37'W。由于鱿钓船海上作业具有地点流动,及其作业持续时间仅

为 1 d 的特点,在每个作业地点进行随机采样,11 个作业地点采样 11 次,平均为每周采样 1 次,每次平均随机采集 22 尾(17 ~ 33 尾)。其中,2012 年 12 月 1 个作业地点进行 1 次采样,2013 年 1 月、2 月分别在 4 个作业地点进行 4 次采样,3 月在 2 个作业地点进行 2 次采样。样本经冷冻保藏运回实验室进行解剖学分析。共解剖分析了 247 尾,其中雌性 148 尾,雄性 99 尾(图 1)。

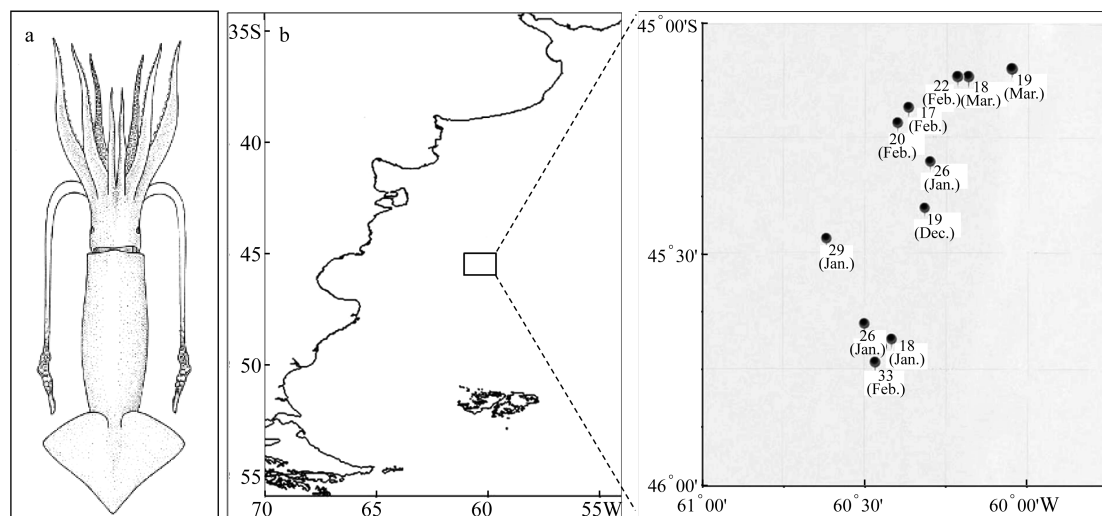


图 1 阿根廷滑柔鱼外部形态及其采样站点图

(a) 阿根廷滑柔鱼,引自 Rober 等<sup>[21]</sup>; (b) “17, …, 33”为样本数量;“Dec., Jan., Feb., Mar.”为采样月份

Fig. 1 The external morphology of *Illex argentinus* and the sampling area and positions

(a) *Illex argentinus*, cited from Rober *et al.* <sup>[21]</sup>; (b) the numbers such as 17, …, 33 stand for samples number; the months such as Dec., Jan., Feb., Mar. etc refer to sampling month

### 1.2 生物学测定

样本在实验室解冻后进行生物学测定,测定项目包括胴长(mantle length, ML)、体质量(body weight, TW)、性腺成熟度(maturity stage)、卵巢重(ovary weight, OW)、精巢重(testis weight, TeW)、缠卵腺长(nidamental gland length, NGL)、缠卵腺重(nidamental gland weight, NGW)、精英复合体重(含精英器、输精管、精英囊和阴茎)(spermatophoric complex weight, SCW)、输卵管系统重(含输卵管和卵管腺)(oviducal system weight, OSW)。胴长测定精确到 1 mm,缠卵腺长测定精确到 0.01 mm。体质量、净重测定精确到 1 g,卵巢重、精巢重、缠卵腺重、精英复合体重和输卵管系统重等测定精确到 0.01 g。

阿根廷滑柔鱼样本生殖系统发育划分,以 Arkhipkin<sup>[22]</sup>和 ICES<sup>[23]</sup>性腺成熟度划分标准为基准,结合实验的观察结果进行描述,共划分 I、

II、III、IV、V、VI、VII 和 VIII 8 个时期(表 1)。其中, I 期未发育, II 期开始发育, III 期生理性发育; IV ~ V 期生理性发育成熟, VI 期功能性发育成熟, VII 期排卵或排精, VIII 期排卵或排精结束。 I ~ III 期属于性腺发育未成熟期, IV ~ VI 期为性腺发育成熟期, VII 期为繁殖期, VIII 期为繁殖后期。

### 1.3 数据分析

根据阿根廷滑柔鱼夏季产卵种群样本的采集月份及其性腺成熟度,分析该种群雌雄组成和性腺发育随月份推移的变化规律。同时,以性腺成熟度为基础,进行该种群个体生长、性腺指数(gonadosomatic index, GSI)<sup>[24-25]</sup>、缠卵腺指数(nidamental gland index, NGI)<sup>[17]</sup>、精英复合体指数(spermatophoric complex index, SCI)<sup>[25]</sup>的比较分析,探讨该种群的繁殖生物学特性。

性腺指数:

$$GSI_F = (OW + NGW + OSW) / TW_F$$

$$GSI_M = (TeW + SCW) / TW_M$$

缠卵腺指数:

$$NGI = NGL / ML_F$$

精荚复合体指数:

$$SCI = SCW / TW_M$$

式中,  $GSI_F$  为雌性的性腺指数;  $GSI_M$  为雄性的性腺指数;  $TW_F$  为雌性体质量(g);  $TW_M$  为雄性体质量(g);

量(g);  $NGI$  为雌性的缠卵腺指数;  $SCI$  为雄性的精荚复合体指数;  $OW$  为卵巢重(g);  $NGW$  为缠卵腺重(g);  $OSW$  为输卵管系统重(g);  $TeW$  为精巢重(g);  $SCW$  为精荚复合体重(g);  $NGL$  为缠卵腺长度(mm);  $ML_F$  为雌性胴长(mm)。

数据分析及其处理采用 Excel 2007 和 SPSS 20.0 软件进行处理。

表 1 阿根廷滑柔鱼性腺成熟度划分标准  
Tab. 1 Macroscopic maturity scale for *I. argentinus*

性腺成熟度 maturity stage	雌性(♀) female	雄性(♂) male
I	卵巢小,白色,半透明,没有颗粒结构,肉眼不见卵母细胞。缠卵腺和卵管腺小。输卵管平直,透明	精巢小,白色,半透明。精荚复合体细薄,半透明状,肉眼不见输精管,精荚囊没有精荚
II	卵巢变大变厚,白色,可见颗粒结构,肉眼可见很小的卵母细胞。缠卵腺变大变厚,覆盖部分内脏器官。输卵管迂回弯曲,可见白色褶皱结构	精巢变大变厚,白色。精荚复合体白色,可见细小的白色输精管。阴茎突出精荚复合体。精荚囊没有精荚
III	卵巢显著增大,草青色,内含大量拥挤的卵母细胞。缠卵腺覆盖整个内脏。输卵管变宽,管壁变厚,可见空泡结构,但不见卵子	精巢灰白色,占据整个胴体腔后半部。精荚复合体结构清晰。输精管白色,迂回曲折,变大。精荚囊可见白色颗粒物和(或者)少量发育成熟的精荚
IV	卵巢完全发育成熟,青黄色,占据整个胴体腔后部,可见大量大小均一的卵母细胞。缠卵腺和卵管腺膨大,白色。输卵管内可见成熟卵子,但不膨大,卵子数量占输卵管总体积 < 10%	精巢完全发育成熟,淡黄色。输精管白色,管径大。阴茎延长,凸出于内脏膜。精荚囊可见成熟精荚,精荚数量占精荚囊体积 < 20%
V	卵巢形态如IV期。缠卵腺进一步增大,前端几乎达到胴体腔边缘。输卵管开始膨大,并覆盖部分卵巢。成熟卵子数量占输卵管总体积的 10% ~ 60%	精巢、输精管的形态如IV期。精荚囊显著增大,前、中、后3段区分明显,并可见成熟的精荚整齐排列,精荚数量占其体积的 20% ~ 50%
VI	卵巢、缠卵腺的形态如上。成熟卵子大量聚集输卵管腔。输卵管显著膨胀,覆盖整个卵巢,两者已无法分辨彼此	精巢、输精管、精荚囊的形态如上。精荚囊进一步增大,50% ~ 100%的体积充满精荚。阴茎延长,凸出于左鳃基部,但未见有精荚
VII	两鳃基部有大量精荚。卵巢大小与IV期时相当。输卵管饱满度则如同VI期时。缠卵腺开始变灰、松软	精巢和精荚复合体松软,灰白色。精荚囊前段、中段充满精荚,后段精荚数量明显变少。阴茎延长,可见正在外排的精荚
VIII	卵巢萎缩状、松软,少量卵母细胞附着于中央组织。缠卵腺和卵管腺松软	精巢萎缩,精荚复合体松软。精荚囊没有精荚或少量精荚

## 2 结果

### 2.1 雌雄个体组成

采集的样本中,雌性样本的胴长和体质量范围分别为 172 ~ 252 mm 和 72 ~ 314 g,雄性样本的胴长和体质量范围分别为 164 ~ 248 mm 和 56 ~ 302 g,雌雄比例约为 1.5:1。然而,随着采样月份的推移,雌性个体占比逐月递减,从 12 月份的 84.21% 递减至次年 3 月份的 27.03%;雄性个体占比则逐月递增,从 12 月份的 15.79% 递增至次年 3 月份的 72.97% (表 2)。

表 2 不同月份阿根廷滑柔鱼的性别组成百分比  
Tab. 2 Monthly sex percentages of *I. argentinus*

月份 month	尾数/尾 number	百分比/% percentage	
		雌性(♀) female	雄性(♂) male
12月 December	19	84.21	15.79
1月 January	99	70.71	29.29
2月 February	92	56.52	43.48
3月 March	37	27.03	72.97
合计 total	247	59.92	40.08

### 2.2 各月份性腺发育情况

解剖学分析,样本的性腺成熟度在繁殖后期(VIII期)的个体中没有发现。雌性样本中,性腺成

熟度 I ~ III 期的未成熟个体占 69.6%, 性腺成熟度 IV ~ VI 期的成熟个体占 23.6%, 性腺成熟度 VII 期的繁殖个体占 6.8%。随着月份推移, 未成熟个体比例逐渐递增, 在 2 月份时达到最大值, 为雌性样本数的 33.1%, 3 月份则明显减少, 仅占 5.4%; 成熟个体在 12 月至次年 3 月均有发现, 在 1 月份时比例达到最大值, 为雌性样本数的 19.1%; 繁殖个体仅在 12 月至次年 1 月占有一定比例, 2—3 月均没有发现(图 2-a)。

雄性样本中, 性腺成熟度 I ~ III 期的未成熟个体占 39.4%, 性腺成熟度 IV ~ VI 期的成熟个体占 39.4%, 性腺成熟 VII 期的繁殖个体占 21.2%。与雌性样本相同, 随着月份推移, 雄性未成熟个体数量在 2 月份达到最大值, 占雄性样本数的 30.3%, 12 月份没有出现未成熟个体。成熟个体

分布于 12 月一次年 3 月, 并且在 1—3 月的占比稳定, 分别为雄性样本数的 14.1%、9.1% 和 13.1%。繁殖个体在 12 月没有出现, 2 月数量较少, 1 月和 3 月均有较高的比例, 且均为雄性样本数的 10.1% (图 2-b)。

### 2.3 性腺个体生长

分析发现, 基于性腺发育成熟度的雌雄个体生长呈单峰型, 在性腺成熟度 VI 期时, 雌雄个体大小生长达到最大值, 即个体生长在性腺功能发育成熟时的胴长和体质量达到最大值; 在性腺成熟度 VII 期时, 个体大小略显下降趋势(图 3-a、3-b)。然而, 性腺功能性成熟时, 雌雄个体的胴长和体质量区间跨度范围大于性腺发育未成熟期和繁殖期。研究还发现, 在性腺发育过程中, 雌性个体胴长大于雄性, 体质量却小于雄性(图 3-a、3-b)。

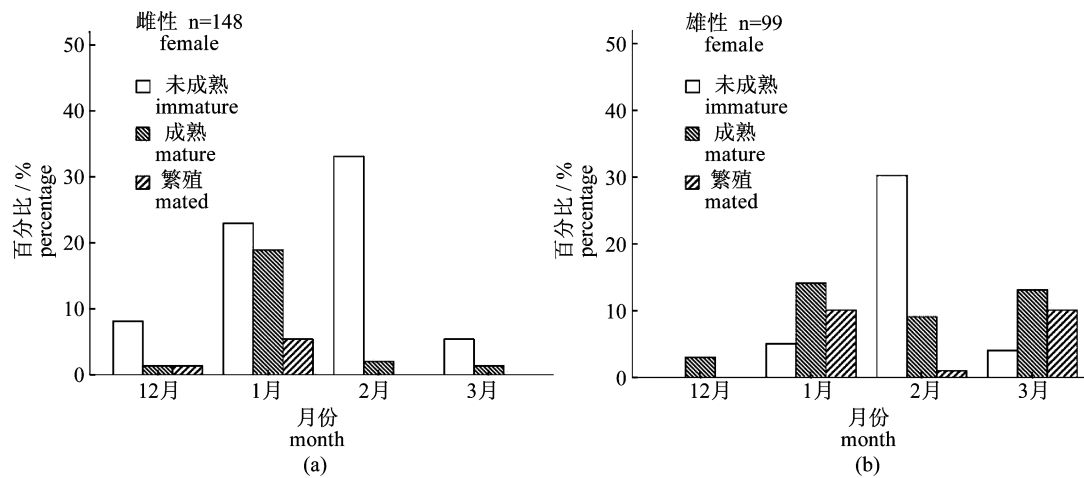


图 2 不同月份不同性腺成熟度组别阿根廷滑柔鱼的组成百分比

Fig. 2 Monthly percentages of *I. argentinus* at different maturity stage groups

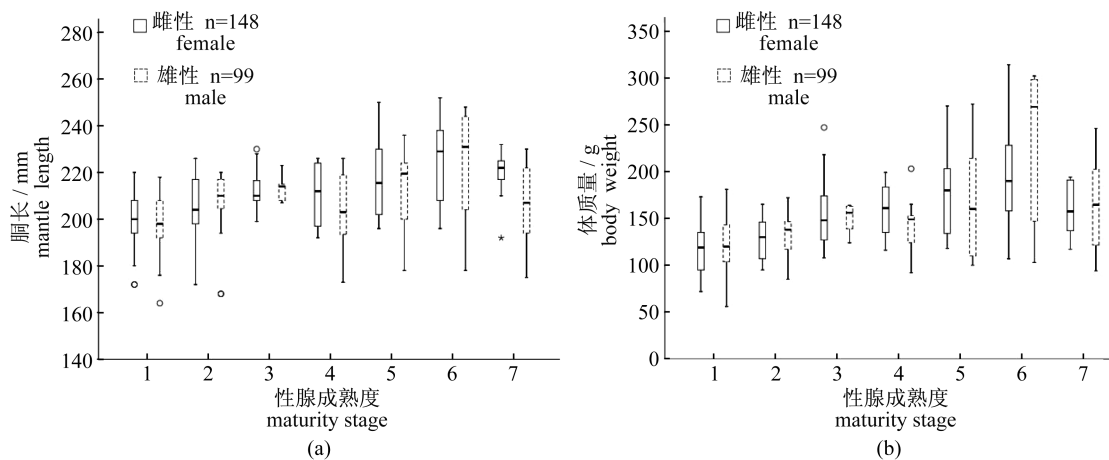


图 3 不同性腺成熟度阿根廷滑柔鱼胴长和体质量分布

1~7 代表性腺成熟度 I~VII 期, 下同

Fig. 3 Mantle length and body weight of *I. argentinus* at different maturity stages

1-7 represent stages I-VII at different maturity, respectively, the same as the following

## 2.4 性腺指数

分析显示,雌性个体性腺指数为 0.001 2 ~ 0.31,平均值为 0.074;性腺发育成熟时(IV ~ VI 期)的性腺指数为 0.039 ~ 0.31,平均值为 0.18。雄性个体性腺指数为 0.007 5 ~ 0.084,平均值为 0.038;性腺发育成熟时(IV ~ VI 期)的性腺指数为 0.029 ~ 0.082,平均值为 0.050。

随着个体生长发育,雌性个体的性腺指数逐渐增长,性腺逐渐发育成熟,在性腺发育功能成熟(VI 期)时,性腺指数达到最大值,随后呈平缓趋势(图 4-a)。与雌性一样,随着性腺逐渐发育成熟,雄性个体的性腺指数也逐渐增大,然而雄性个体性腺指数最大值见于性腺成熟度 VII 期的繁殖期(图 4-b)。

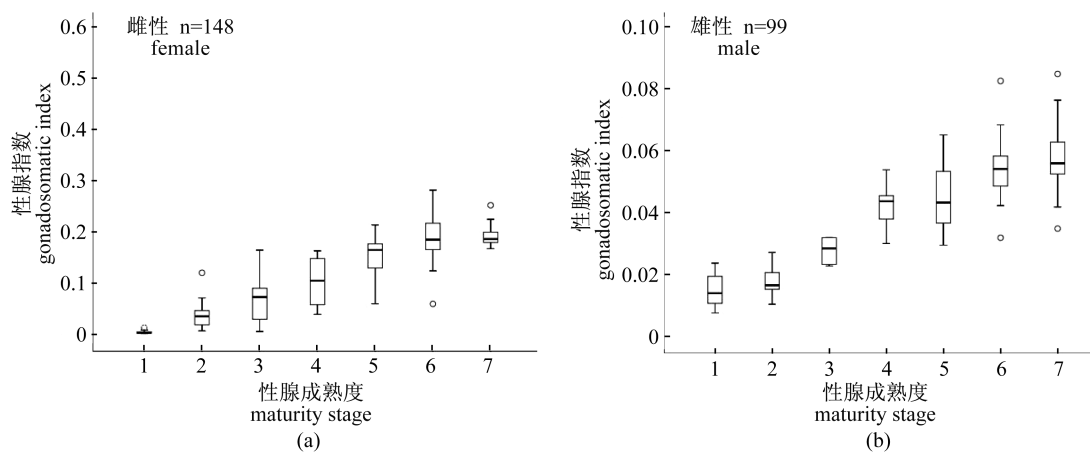


图 4 不同性腺成熟度阿根廷滑柔鱼性腺指数分布

Fig. 4 Gonadosomatic index of *I. argentinus* at different maturity stages

## 2.5 缠卵腺指数和精英复合体指数

雌性个体缠卵腺指数为 0.003 1 ~ 0.55,平均值为 0.29;性腺发育成熟时(IV ~ VI 期)的缠卵腺指数为 0.13 ~ 0.55,平均值为 0.40。与雌性性腺指数分布一致,随着性腺发育成熟,缠卵腺指数逐渐增大,在性腺成熟度 VI 期时达到最大值,在性腺成熟度 VII 期时则略变小(图 5-a)。

0.035,平均值为 0.012;性腺发育成熟时(IV ~ VI 期)的缠卵腺指数为 0.004 1 ~ 0.029,平均值为 0.015。与雄性性腺发育变化有所不同,雄性精英复合体指数在性腺发育未成熟时(I ~ III 期)变化不大,在 0.005 5 ~ 0.007 9 之间;在性腺生理性发育后,该指数迅速增大,在性腺功能成熟时(VII 期)达到最大值(图 5-b)。

雄性个体精英复合体指数为 0.000 79 ~

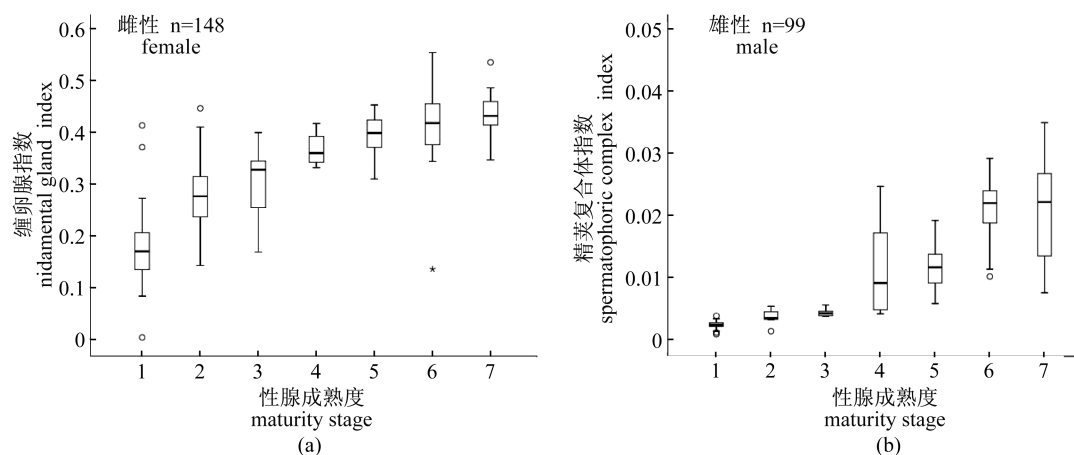


图 5 不同性腺成熟度阿根廷滑柔鱼的缠卵腺指数和精英复合体指数分布

Fig. 5 Nidamental gland index and spermatophoric complex index of *I. argentinus* at different maturity stages

### 3 讨论与分析

以往研究认为,柔鱼科属种的雌雄个体组成表现为雌性占优<sup>[17,26-29]</sup>。本研究中采样的阿根廷滑柔鱼夏季产卵种群的雌雄组成,也表现为雌性数量多于雄性,并与其他季节产卵的种群雌性占优的情况一致<sup>[17,26]</sup>。但是,本研究中种群的雌雄性比组成随着采样月份推移,雌性样本的占比逐月下降,而雄性样本的占比则逐月递增。同时,本研究样本中,尽管雌性超过 20%、雄性近 40% 的个体性腺已经发育成熟,并且 6.8% 雌性个体和 21.2% 雄性个体已经开始繁殖交配(雌性左鳃或两鳃底部可见精荚束,雄性阴茎延长并外露精荚),但是,2—3 月份均未发现雌性繁殖个体。Hatanaka 等<sup>[7]</sup>认为阿根廷滑柔鱼在其 1 年的生命周期最后阶段进行索饵育肥场—产卵场的“短距离洄游”,夏季产卵种群将洄游至阿根廷沿岸海域进行产卵。Crespi-Abril 等<sup>[30]</sup>也认为阿根廷滑柔鱼的产卵活动不仅仅局限于西南大西洋陆架坡和大陆架中部及其外部海域,同时存在着准持久性(quasi-permanent)的向岸洄游产卵。因此,本研究的雌雄比例随月份推移变化,以及雌性繁殖

个体未见于 2—3 月份,可能是阿根廷滑柔鱼夏季产卵种群的繁殖交配场及其产卵场存在空间差异,雌性个体交配后洄游至沿岸海域产卵、雄性个体则停留在繁殖交配场继续进行交配活动。

阿根廷滑柔鱼夏季产卵种群资源量较少,分布海域范围相对集中,性腺成熟个体的胴长小于其他种群<sup>[1,7,10]</sup>。本研究结果也显示,性腺发育成熟的阿根廷滑柔鱼夏季产卵种群个体的胴长较其他种群的短,其中雌性个体短 90 ~ 160 mm,雄性个体短 50 ~ 90 mm(表 3)。Arkhipkin 等<sup>[9]</sup>研究发现,日龄 150 ~ 180 d 是阿根廷滑柔鱼个体生长的关键时期,该时期的生长情况将很大程度上决定其个体的最终大小。夏季产卵种群在夏季产卵<sup>[10,31]</sup>,受精卵孵化 150 d 刚好处于低生产力的冬季;南巴塔哥尼亚种群和布宜诺斯艾利斯—北巴塔哥尼亚种群在秋末—春初产卵<sup>[16,32-33]</sup>,受精卵孵化 150 d 后则处于高生产力的春夏季,从而造成秋冬季产卵的种群在日龄 150 ~ 180 d 的生长率高于夏季产卵种群的同日龄期生长率,最终表现在个体大小生长上均较夏季产卵种群的大。因为特定的海洋环境(如初级生产力、水温、水深等)与其生命周期密切相关<sup>[3,34-36]</sup>。

表 3 阿根廷滑柔鱼 4 个主要种群的一些繁殖生物学特征

Tab. 3 Some reproductive characteristics of the four main spawning stocks of *I. argentinus*

指标 parameters	夏季产卵种群 summer spawning, SSS	南巴塔哥尼亚种群 south Patagonic, SPS	布宜诺斯艾利斯—巴塔哥尼亚种群 Bonaerensis-north patagonic, BNS	南巴西种群 southern Brazil, SBS
成熟时的胴长范围/mm range of ML at maturity	♂ :140 ~ 220 <sup>[37]</sup> 164 ~ 248 * ♀ :150 ~ 250 <sup>[37]</sup> 192 ~ 252 *	♂ :190 ~ 320 <sup>[16,37]</sup> 185 ~ 298 <sup>[26]</sup> ♀ :250 ~ 410 <sup>[16,37]</sup> 192 ~ 346 <sup>[26]</sup>	♂ :180 ~ 320 <sup>[31]</sup> ♀ :230 ~ 370 <sup>[34]</sup>	♂ :188 ~ 296 <sup>[17]</sup> 131 ~ 330 <sup>[36]</sup> ♀ :240 ~ 356 <sup>[17]</sup> 166 ~ 341 <sup>[33]</sup>
成熟时的性腺指数均值 mean GSI at maturity	♂ :0.050 * ♀ :0.18 *	♀ :0.20 <sup>[16]</sup>	—	♂ :0.060 <sup>[17]</sup> ♀ :0.22 <sup>[17]</sup>
成熟时的缠卵腺指数均值 mean NGI at maturity	0.40 *	0.40 ~ 0.55 <sup>[16]</sup>	0.44 <sup>[38]</sup>	0.47 <sup>[17]</sup>

注:\*,本研究结果

Notes: the asterisk \* stands for this study

同时,本研究结果发现 12 月—次年 3 月采集的阿根廷滑柔鱼夏季产卵种群雌性个体的胴长大于雄性个体,然而相对应的雌性体质量却小于雄性。一般地,头足类雌雄个体性腺发育模式表现为雄性先行发育<sup>[9,22,39-42]</sup>。雄性个体性腺先行发育,其头部和足腕异速生长率显著大于雌性,导致其体质量增长率大于雌性<sup>[9]</sup>。然而,个体性腺开始发育后,摄食获取的能量部分用于生殖系统的

发育生长,并引起个体生长率降低<sup>[43]</sup>,从而导致性腺先行发育的雄性个体胴长小于雌性。Santos 等<sup>[17]</sup>也发现阿根廷滑柔鱼南巴西种群的雄性体质量大于雌性,并认为这是雄性个体头部及其足腕的快速生长所造成的结果。因此,本研究的阿根廷滑柔鱼夏季产卵种群雄性个体胴长小于雌性个体,体质量却大于雌性个体,是雄性个体性腺先行发育、头部和足腕异速生长率变大、胴长生长率

变小等综合因素的结果。

此外,本研究结果显示,阿根廷滑柔鱼夏季产卵种群雌雄个体的性腺指数均随着个体性腺发育逐渐增长,雌性个体性腺指数在性腺成熟度Ⅵ期时达到最大值,雄性个体在性腺成熟度Ⅶ期达到最大值;雌性的缠卵腺指数、雄性的精荚复合体指数均表现出同样的增长趋势。该变化趋势与南巴西种群的个体生长及其性腺发育变化一致<sup>[17]</sup>。比较研究还发现,性腺发育成熟时,夏季产卵种群的性腺指数、缠卵腺指数与其他种群相类似,不存在显著性差异( $P > 0.05$ ) (表3)。但是,由于本研究样本来源于鱿钓船,难免对样本个体大小的随机性有一定影响。性腺成熟度鉴别基于解剖学目测方法,对其性腺发育的判别可能会带来一点偏差。这些均需在以后的研究中加以补充和完善。

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## Preliminary study on reproductive biology of summer spawning stock of *Illex argentinus* in the southwestern Atlantic Ocean

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**Abstract:** *Illex argentinus* is a neritic-oceanic squid species, not only supporting the most important world cephalopod fishery in the terms of landing volumes, but also playing an important role in the southwestern Atlantic Ocean ecosystem owing to its high abundance. However, like other annual lifespan Ommastrephid species, it has been found that the recruitment abundance was closely related to the reproductive success the year before. So, in this study, 148 females and 99 males of summer spawning stock of *I. argentinus* were randomly sampled from the catch of Chinese jigger fleet during the fishing season from December 2012 to March 2013, in the high sea of southwestern Atlantic Ocean, and their reproductive biology was studied, in order to fully understand the important reproductive aspects of this species biology. Results showed that the mantle length of this stock during the fishing season was in the range of 172 – 252 mm for females and 164 – 248 mm for males. According to the sampled months, the proportion of females decreased monthly, from 84.21% in December to 27.03% in March, but inversely for males, which had the smallest proportion of 15.79% in December, and then increased to the largest proportion of 72.97% in March. Among the females, more than 30% of individuals were mature and some of them were spawning. However, the mature males were in the proportion of more than 60%, nearly twice of that of females, and some of them had mated. With the gonads development, both of females and males grew gradually and attained their largest mantle length and body weight at the functionally maturity stage. The mantle length of females was longer than that of males according to the maturity stages, whereas the body weight of females was lighter than that of males, and the possible reasons were discussed. Moreover, the gonadosomatic index (GSI) for both sexes, nidamental gland index (NGI) for females and spermatophoric complex index (SCI) for males gradually increased with growth, even though the males' SCI was at a same low level during the immature phase. The females' GSI and NGI were in the range of 0.001 2 – 0.31, with a mean value of 0.074 and 0.003 1 – 0.55, with a mean value of 0.29, respectively, and both indices attained their greatest value at the functionally maturity stage. The males' GSI ranged from 0.007 5 to 0.084 with a mean value of 0.038, and SCI ranged from 0.000 79 to 0.035 with a mean value of 0.012. These two indices attained their greatest value when the individuals were being mated.

**Key words:** *Illex argentinus*; summer spawning stock; reproductive biology; southwestern Atlantic Ocean

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