Maturity and Spawning of the Small Yellow Croaker, *Larimichthys polyactis*

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1. Introduction

- Small yellow croaker

**Geographic Distribution**

- Northwest Pacific Ocean: Yellow and East China seas

- Depth: surface - 160 m

- Water temperature: 7 - 25 °C

- Feeds: crustaceans, euphausiids and decapods

- Maximum size: 42 cm
Annual Yield

Commercially important demersal fish in China, Korea.

- Largest catches country: China, Korea

The annual catch of small yellow croaker has been rapidly increased in China since 1990, based on FAO fishery statistics.
Previous study..

- **Age and growth**

- **Estimation of the survival rate**
  - Lee, 1997

- **Fluctuations in Biomass**
  - Zhang et al., 1992b

- **Embryonic development, Larvae and Juveniles reared in aquarium**
  - Myoung., 2004

- **Seasonal, diel and ontogenetic variation in feeding patterns**
  - Xue et al., 2005
Reproductive Biology of this species has been poorly known.

The purpose of this study

- Suggest that spawning period, maturation size and sex ratio of small yellow croaker.
2. Materials and methods

- **Sampling**
  - The small yellow croaker caught by trawls, lift nets and gill nets in the Yellow and East China Seas from January 2005 to December 2008.

- **Measurement**
  - Total Length: 0.1 cm
  - Total weight: 0.1 g
  - Gonad weight: 0.01 g
- A total of 5,939 specimens of small yellow croaker were collected between Jan. 2005 and Dec. 2008.

- May to Aug; very few specimens throughout sampling period.

Table 1. Number of specimen of Small yellow croaker.

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Female</th>
<th>Male</th>
<th>Year</th>
<th>Month</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>Jan</td>
<td>287</td>
<td>76</td>
<td>2007</td>
<td>Sep</td>
<td>71</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Feb</td>
<td>102</td>
<td>17</td>
<td></td>
<td>Oct</td>
<td>70</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Mar</td>
<td>95</td>
<td>25</td>
<td></td>
<td>Nov</td>
<td>98</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Aug</td>
<td>48</td>
<td>12</td>
<td></td>
<td>Dec</td>
<td>144</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Sep</td>
<td>73</td>
<td>17</td>
<td>2008</td>
<td>Jan</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Oct</td>
<td>94</td>
<td>26</td>
<td></td>
<td>Feb</td>
<td>378</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>Nov</td>
<td>95</td>
<td>25</td>
<td></td>
<td>Mar</td>
<td>287</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>Dec</td>
<td>75</td>
<td>44</td>
<td></td>
<td>Apr</td>
<td>290</td>
<td>60</td>
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<tr>
<td>2006</td>
<td>Jan</td>
<td>46</td>
<td>14</td>
<td></td>
<td>May</td>
<td>29</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Feb</td>
<td>72</td>
<td>18</td>
<td></td>
<td>Jun</td>
<td>34</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Mar</td>
<td>66</td>
<td>24</td>
<td></td>
<td>Jul</td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Apr</td>
<td>96</td>
<td>21</td>
<td></td>
<td>Aug</td>
<td>81</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Nov</td>
<td>87</td>
<td>33</td>
<td></td>
<td>Sep</td>
<td>217</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Dec</td>
<td>84</td>
<td>32</td>
<td></td>
<td>Oct</td>
<td>337</td>
<td>140</td>
</tr>
<tr>
<td>2007</td>
<td>Jan</td>
<td>108</td>
<td>12</td>
<td></td>
<td>Nov</td>
<td>404</td>
<td>164</td>
</tr>
<tr>
<td></td>
<td>Feb</td>
<td>32</td>
<td>28</td>
<td></td>
<td>Dec</td>
<td>266</td>
<td>154</td>
</tr>
<tr>
<td></td>
<td>Aug</td>
<td>49</td>
<td>11</td>
<td>Total.</td>
<td></td>
<td>4,339</td>
<td>1,600</td>
</tr>
</tbody>
</table>
Sexual Maturation & Spawning period

- The stages of gonad development:
  - using a maturity scale and gonadosomatic index

- Immature stage
- Maturing stage
- Mature stage
- Ripe & spent Stage

- A four maturity stages were determined by eye through the observation and histological observation of the gonad

Female

Male
2. Materials and methods (cont’d)

- **Spawning season**

  - **Gonadosomatic Index**
    
    \[
    GSI = \left( \frac{GW}{TW} \right) \times 100
    \]
    
    GW = gonad weight
    TW = total weight

- **Maturation Size** (Total length at 50% group maturity)

  \[
  P_i = \frac{1}{1 - e^{-bo-biTL}}
  \]

  \(P_i\) = maturity rate at
  \(i\) class interval of total length
 Monthly change of Egg diameter

- Fixed in Gilson’s sol.
  → Using IMAGE ANALYZER (μm)
Sex ratio

- Significant deviations of the 1:1 proportion were tested using the \( \chi^2 \) test.
The stages of gonad development - Female

- Immature stages of females were shown every month
- Ripe stages of females were High proportions from March to April

Fig. 1. Monthly changes of maturity stages for Small yellow croaker
The stages of gonad development - Male

- Mature stages of males were observed Jan - Apr and Nov, Dec.
- Ripe stages of males were high proportions from March to April.

Fig. 2 Monthly changes of maturity stages for Small yellow croaker
Fig. 3. Monthly changes of gonadosomatic index for Small yellow croaker

Gonadosomatic Index

- began to increase in December and reached to a maximum between March and May, then decrease from June.
Monthly change of Egg diameter

-reached to a maximum April, then decrease from May.

Fig. 4. Monthly changes of egg diameter for small yellow croaker
The estimated mean length at maturity for both male and female was 17.62 cm in total length.
Sex ratio of females to males was 1:2.7

The proportion of females was significantly higher than males.

Fig. 6. Sex ratio of Small yellow croaker
Spawning period

March - June

In present study, we elucidated the spawning season and diel reproductive periodicity of female and male small yellow croaker in East China sea on the basis of Gonadosomatic Index and histological examination of gonad.

The spawning season: from March to June.

- In previous studies, the spawning season of small yellow croaker was shown to last from Apr. to Jun., in the Yellow sea and Japan sea.

<table>
<thead>
<tr>
<th>Spawning season</th>
<th>Area</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr - Jun</td>
<td>Yellow sea</td>
<td>Park, 1981</td>
</tr>
<tr>
<td>May</td>
<td>Yellow sea</td>
<td>Bae, 1960</td>
</tr>
<tr>
<td>Apr - Jun</td>
<td>Japan sea</td>
<td>Yamada, 1940</td>
</tr>
</tbody>
</table>
The total length of small yellow croaker at the first maturity was 12.8 cm.

Matured small yellow croaker are roughly 50% at 17.6 cm.

In previous studies, the Maturation size of small yellow croaker was shown 19.1 cm, 18.3 cm, 20 cm.

<table>
<thead>
<tr>
<th>Maturation size</th>
<th>Area</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.1 cm (T.L)</td>
<td>Yellow sea</td>
<td>Park, 1981</td>
</tr>
<tr>
<td>18.3 cm (B.L)</td>
<td>Yellow sea</td>
<td>Bae, 1960</td>
</tr>
<tr>
<td>20.0 cm (T.L)</td>
<td>Japan sea</td>
<td>Yamada, 1940</td>
</tr>
</tbody>
</table>
Sex ratio

Male : Female = 1 : 2.7

<table>
<thead>
<tr>
<th>Sex ratio</th>
<th>Area</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>M : F = 1 : 2</td>
<td>Yellow sea</td>
<td>Park, 1981</td>
</tr>
<tr>
<td>M : F = 1 : 2.2</td>
<td>Yellow sea</td>
<td>Bae, 1960</td>
</tr>
</tbody>
</table>

The proportion of females was significant higher than males !!
- Spawning period: from March to June
- Maturation size: 17.6 cm
- Sex ratio (Male : Female) = 1 : 2.7
  - Sex ratio was significant ($\chi^2$ - test, $p < 0.05$)
Thanks for your time and attention!