Distribution, Population and Reproductive Biology of the Fiddler Crab *Uca sindensis* (Crustacea: Ocypodidae)
in a Subtropical Mangrove of Pohl Area

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Abstract

Distribution, population and reproductive biology of *Uca sindensis* were studied in a subtropical mangrove of Pohl port in the northern Persian Gulf. Sex ratio, distribution, population structure, handedness (evenness), diameter burrow, breeding season and fecundity were investigated. Ten 0.5 m² quadrates were randomly sampled during low tide periods from October 2009 to September 2010. A total of 711 crabs, 344 (47.7%) males and 367 (52.3%) females, were sampled. The CW of males ranged from 4 to 16 mm and of females from 5 to 17 mm indicating sexual dimorphism. The overall sex ratio was 1:0.93 and did not differ significantly from the expected 1:1 ($\chi^2$ test, $P>0.05$), however the monthly sex ratio was different from expected 1:1 ($\chi^2$ test, $P<0.05$). Results indicated that the size frequency distributions of this species could also be determined through direct analysis of burrow openings ($r^2=0.99$). Breeding took place during warm season of April 2009 to September 2010. Egg numbers increased with female size ($r^2=0.50$). The regression analysis showed that the number of eggs increased linearly with the increase of carapace width ($r^2=0.766$, $EN=0.1125$ CW-0.1129, $n=31$). It was concluded that two factors of temperature and TOM affected growth and reproduction pattern in *U. sindensis*.

Keywords: Mangrove, Distribution, Population biology, Sex ratio, Handedness, Carapace.

1. Introduction

*Uca* crabs are a famous group of brachyuran crabs in intertidal zone (Rosenberg, 2001). Mangrove crabs and bacteria make a feedback cycle in which enhancement of activity in each organism enchanes the activities of other groups of organisms in the cycle. The activity of most intertidal organisms and *Uca* crabs occur in low as well as high tides because they spend some activity time in semi-terrestrial habitat, then returns to their burrows at high tide (Klassen and Ens, 1993). Males have a major claw for burrowing digs (Crane, 1975). Their adaptive radiation is considered to be related to the habitat and food sources through modifications of their own morphology, behavior, ecology and physiology (Crane, 1975; Christy and Salmon, 1984; Takeda and Murai, 2003). They are deposit-feeders and they construct burrows that have different shapes because the burrows shape associated surface sediments (Olafsson and Ndaro, 1997). Two species of *Uca* have been recorded in the subtropical mangrove of the Persian Gulf in Iran: *Uca sindensis* and *Uca lactealannulipes* (Mokhtari, 2008). These crabs play an important role in the energy transfer in the
ecosystems by creating a connection between bacterial production and microscopic beds and other organisms at higher levels of food chain (Koch and Wolff, 2002).

The study of breeding season in Crustacean can facilitate the understanding of impact of environmental factors on reproduction. Brachyuran Crabs diversified to shape to maximize egg production and offspring survivorship (Harnoll and Could, 1998; Lopez Greco et al., 2000) In the present study, the population biology and reproduction of Uca sindensis is assessed with emphasis on size structure, sex ratio, breeding season, fecundity, distribution, burrow depth and handedness in a subtropical mangrove of the Pohl port mangrove, in the south of Iran.

2. Materials and Methods

2.1. Site Description

The field work took place at the Pohl port mangrove forests Bandar Abbas (27° 01 ´ 50.5" N and 055° 44´ 55.6" E) which is located in Hormuzgan province along the northern Persian Gulf coast line of Iran (Fig. 1).

Fig. 1: Location of Pohl port mangrove in Iran

Hormuzgan has a sub-tropical climate, the average annual mean temperature of the study site is 26.3 °C. Local tides have a semi-diurnal regime with maximum amplitudes of 3 m. The mangrove vegetation of this area is dominated by Avicennia marina.

2.2. Sampling Methods

Ten 0.5 m² quadrates were randomly sampled on monthly basis during low tide periods from October 2009 to September 2010. Quadrates were placed at two substrates, sand and silt. The quadrates were excavated with a corer to a depth of 30 Cm and all fiddler crabs presented in the quadrates were collected, bagged, labeled and preserved in 70% ethanol until further analysis.

2.3. Laboratory Analysis

In the laboratory, sex identification of specimens was performed. The carapace width (CW) was measured using a vernier caliper (± 0.05 mm accuracy). The number of crabs was recorded for each quadrate. The population size structure was analyzed in function of the size frequency distribution of all individuals collected during the study period. The period of time when ovigerous females were found in the population was considered as the breeding season. To estimated fecundity, 31 ovigerous females with eggs at stage I were selected for egg counting according to the methodology proposed by Litulo (2004b). Pleopods were removed from the females, placed in petri dishes filled with seawater, and had their eggs detached by gradually adding a sodium hypochlorite. Bare pleopods were then discarded by being gently stirred in a beaker filled with 50 ml of seawater. Then five subsamples were surveyed. For fecundity analysis, data were analyzed using the power function (Y=aX + b) of egg number were: (EN) vs. CW.

One-way ANOVA was performed to determine right or left major claw during the year. On each sampling date, sediment samples (about 5 Cm deep and 300g) were randomly collected over sampling area in order to analyze the organic matter. Then, samples were incinerated at 540 °C for 3h and weighed again. Finally, organic matter content was calculated as the percent weight loss after combustion. Temperature was recorded from sediment surface by thermometer 2-3 times during the sampling (Koch et al., 2005). T-test was performed to determine whether the organic matter changed during the year.
3. Results

A total of 711 crabs were sampled during low tide period of which 344 were males (48.3%), 336 non – ovigerous females (47.4%), and 31 ovigerous females (4.3%) (Table 1).

Table 1. *Uca sindensis* - total number, handedness and sex ratio of individuals collected monthly at Pohl port mangrove, Iran

<table>
<thead>
<tr>
<th>Month</th>
<th>Males</th>
<th>Non-ovigerous / Ovigerous females</th>
<th>Males and females</th>
<th>Sex ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Total</td>
<td>%</td>
<td>Left</td>
</tr>
<tr>
<td>October</td>
<td>16</td>
<td>4.21</td>
<td>6.4</td>
<td>14</td>
</tr>
<tr>
<td>November</td>
<td>18</td>
<td>4.50</td>
<td>2.6</td>
<td>14</td>
</tr>
<tr>
<td>December</td>
<td>5</td>
<td>1.82</td>
<td>2.1</td>
<td>8</td>
</tr>
<tr>
<td>January</td>
<td>5</td>
<td>1.12</td>
<td>2.8</td>
<td>3</td>
</tr>
<tr>
<td>February</td>
<td>8</td>
<td>3.93</td>
<td>2.2</td>
<td>2</td>
</tr>
<tr>
<td>March</td>
<td>6</td>
<td>1.82</td>
<td>2.2</td>
<td>3</td>
</tr>
<tr>
<td>April</td>
<td>12</td>
<td>6.61</td>
<td>8.7</td>
<td>3</td>
</tr>
<tr>
<td>May</td>
<td>22</td>
<td>6.18</td>
<td>5.2</td>
<td>4</td>
</tr>
<tr>
<td>June</td>
<td>17</td>
<td>3.79</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>July</td>
<td>30</td>
<td>7.03</td>
<td>5.07</td>
<td>8</td>
</tr>
<tr>
<td>August</td>
<td>10</td>
<td>3.37</td>
<td>4.7</td>
<td>6</td>
</tr>
<tr>
<td>September</td>
<td>18</td>
<td>3.93</td>
<td>3.3</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>159</td>
<td>48.38</td>
<td>49.08</td>
<td>31</td>
</tr>
</tbody>
</table>

The overall sex ratio was M: F= 1:0.93 and did not differ significantly from the expected 1:1 ($\chi^2$ test, $p>0.05$), however the monthly sex ratio was different from expected 1:1 ($\chi^2$ test, $p<0.05$). Right to left of major cheliped in males didn’t differ significantly from an expected 1:1 ratio (ANOVA test, $P>0.05$).

3.1. Reproduction

The correlation between carapace width and number of eggs was high (EN) ($r^2= 0.766$, $EN=0.1125 \text{CW}-0.1129$, $n=31$) (Fig. 3).

Reproductive activity of *Uca sindensis* in Pohl port mangrove forests was restricted to warm seasons (spring and summer) (Fig. 4).

Egg- carrying females were higher in July(Fig. 5). Fecundity ranged from 2340 (CW=4.5) to 11300 (CW= 11.5) (Fig.4).

Figures 6 and 7 show the yearly size frequency distributions for males and females in sand and silt substrates. Males were abundant in the size classes between (9-10 mm) and females were abundant in the size classes between (8-9 mm). The monthly number of crabs sampled through the year is shown in Table 1.
Fig. 5: Monthly percent of ovigerous females of *Uca sindensis* collected from Pohl port mangrove area (2009-2010).

Fig. 6: Yearly Size frequency distribution of *Uca sindensis* (A male, B female) in silt area in Pohl port mangrove (2009–2010).

Fig. 7: Yearly Size frequency distribution of *Uca sindensis* (A male, B female) in sand area in Pohl port mangrove (2009–2010).

3.2. Environmental factors

3.2.1. Temperature

Temperature at the soil surface was above 30°C during spring and summer, while descending to 17.3°C in January (Table 2).

Table 2. Seasonal variation (mean ± SD) and range of Soil temperature and percent organic matter content at two levels: Sand area (L1) and Silt area (L2) in Pohl port mangrove (2009-2010).

<table>
<thead>
<tr>
<th>Season</th>
<th>Soil temperature (°C)</th>
<th>Percent organic matter content in Sand, area (L1)</th>
<th>Percent organic matter content in silt, area(L2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold</td>
<td>20.5±1.02 (17.3-23.0)</td>
<td>0.86±0.04 (0.65-0.91)</td>
<td>0.85±0.03 (0.67-0.90)</td>
</tr>
<tr>
<td>Warm</td>
<td>32.1±1.57 (29.0-39.0)</td>
<td>0.60±0.0 (0.58-0.65)</td>
<td>0.63±0.01 (0.61-0.67)</td>
</tr>
</tbody>
</table>
3.2. Environmental Factors

3.2.1. Temperature

Temperature at the soil surface was above 30°C during spring and summer, and 17.3°C in winter (Table 2).

3.2.2. Total Organic Matters

The estimated percent organic matter contents were higher (0.86±0.04) in sand area (L1) in cold season than at the silt area (L2) (Table 2). Pearson correlation coefficient indicated strong positive relationship between the density of crabs and temperature (p<0.01), but there was negative strong correlation between growth rate and total organic matter of sediments (p<0.05).

4. Discussion

4.1. Population Structure

Uca sindensis in Pohl port mangrove showed bigger and smaller size in males and females, respectively. Males grew faster than females. Lower growth and size of females is due to expenditure of greater energy for reproductive and gonad development (Hartnoll and Gould, 1988). The difference between male and female carapaces width was significant with greater abundant of males and females in the smallest size classes. Lopez Greco et al. (2000) suggested that lower size of females in comparison to males was due to the fact that they spent their energy for gonad development so males have a greater chance of success of copulation (Henmi, 2003).

In this study, the overall sex ratio did not differ significantly from the expected 1:1 ratio but significant deviations were observed in some months. Litulio (2005) indicated he did not find significant differences from 1:1 sex ratio Uca annulipes.

In crustaceans, sexuality may be responsible for unbalanced sex ratio (Johnson, 2003). Results of this study indicated that the proportion of males having the right or left major cheliped did not significantly differ from an expected 1:1 ratio. Bezerra et al. (2007) suggested that proportion of right or left major cheliped in U. thayeri in a tropical mangrove from northeast Brazil did not differ significantly from the expected 1:1. In fact, there is no predominance of left or right major cheliped in males U. thayeri population in subtropical area (Negreiros-Fransozo et al., 2002). Aspect of the major cheliped has an important role in the reproductive behavior and defence of territory and mate (Crane 1975, Hartnoll, 1982). The diameters of Uca sindensis burrows (BD) correlated with crab carapace width (CW). Similar results were found by Christy (1982) in Uca puligator and by Skove and Hartnoll (2001) in Uca annulipes from Zanzibar (Tanzania) (Fig. 2). The relationship between burrow diameter and carapace size suggested that the size structure of this species could be estimated from the analysis of burrow diameters and represent defensive behavior due to prevention from being displaced from their burrows by larger crabs and predators.

Reproduction of Uca sindensis in Pohl port mangrove located in subtropical area indicated that ovigerous females were seasonal, primarily between April to September throughout the year. In most subtropical and tropical regions, reproduction occurs during the warmer months when plankton food sources are more abundant (Sastry, 1983; Ashton et al., 2003). Total organic matter and temperature were found to be as two critical factors for U. sindensis.

4.3. Environmental Factors

Total organic matter and temperature are two critical factors affecting growth and reproductive pattern in U. sindensis in intertidal area in Pohl port mangrove. Temperature was also found to have a strong influence on the density of the active crabs in the area; also total organic matters in sediment is effective on growth rate and reproductive period. Organic matter
of sediment in July, when the growth rate was the highest, differed significantly with data of January. It could be suggested that among the various factors, organic matter enhanced feeding crabs, thus reducing the organic matter, as was documented previously in Thailand (Nielsen et al., 2003). The *Uca sindensis* breeds during spring and summer in Pohl port, although in Mozambique (tropical region) breeding was continuous throughout the year (Litulo, 2005). Low temperature has been reported to limit the active season and affect, feeding and reproduction of land crabs (Wolcott, 1988). Temperature was also found to have a strong influence on somatic and gonadic growth in crustaceans (Meusy and Peyen, 1988).

4.4. Reproductive Biology

The reproductive biology of decapods crustaceans exhibits a latitudinal pattern, with smaller crabs inhabiting low geographical areas and larger crabs higher ones (Lardies and Castilla, 2001).

Among the various factors known to influence breeding activity in fiddler crabs, burrow depth is one of the most prominent. In the same study area, Litulo (2005) studied the breeding biology of *Uca inversa* and found that most of them inhabited burrows at depths of 50 Cm, but in the present study, females of *U. sindensis* were mostly found in much deeper burrows (50 Cm). The number of eggs produced by fiddler crabs varies widely with an increase in number of eggs, as the crab grows larger. Moreover, fecundity may vary in relation to latitudinal range and foods disposal and temperatures (Hines, 1982).

The fecundity of *U. sindensis* estimated with CW is found in other brachyurans. The determination coefficients for the relationship between egg number and female size was higher, suggesting that this was a good estimator for fecundity and that egg losses were minimal, since variation was estimated about 0.99%.

This study constitutes the first account on the population ecology and reproductive of *U. sindensis* in this area. Further research on spatial distribution, secondary production, microbial community and larval ecology and reproductive output will be necessary in order to understand *U. sindensis* life cycle.

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References


