HIGH MOTIVATION ENABLES SMALLER CONTESTANTS TO WIN THE CONTESTS AGAINST LARGER OPPONENTS IN FIDDLER CRABS

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Introduction

Why do animals fight?

- The winner gets the territory ownership
- The winner gets the mates
- The winner gets the dominance right
Introduction

Who has more chance to win the fights in a pair?

Larger contestants have more chances to win because:

- They are physically stronger
- They inflict more energetic cost on the smaller contestants

So, body size is the main factor to predict the fighting outcome
Introduction

Do smaller contestants have any chance to win the fights?

Many previous studies observed that in crickets, lizards, and fishes, smaller contestants won more than 30% of the contests against larger opponents (Neat et al., 1998; Hofmann & Schildberger, 2001; Sacchi et al., 2009).

In this case, body size does not predict the fighting outcome
What factors enables smaller contestants to win the fight?

High motivation and resident ownership are the important factors to predict their fighting outcome.
Objective:

To investigate the fighting outcomes of smaller contestants against larger opponents during male-male contests in *Uca annulipes*, *Uca bengali* and *Uca rosea*.
Introduction

Hypotheses:

(1) Smaller contestants should win at least 30% of the contests

(2) In lesser-size asymmetry contests, smaller contestants should win more, but in greater-size asymmetry contests, they will lose the contests

(3) If the smaller contestants are highly motivated, they should fight for longer time to win the contests than larger winners

(4) Most of the smaller winners should be residents (burrow owners).
Observations:

**Uca bengali:**
70 contests in Kantang, Trang in April, 2014

**Uca annulipes:**
46 contests in Pakmeng Seabeach, Trang in November 2015

**Uca rosea:**
67 contests in Mangrove Extension, Learning and Development Centre 5, Satun from January to March, 2016
Material and methods

We recorded:

1. Fighting durations of the contests (determined as fighting motivation)

2. Residency status (resident or intruder) of each contestant

3. Winning status (winner or loser) of each contestant

4. Body size (major claw lengths) of each contestant
Material and methods

Body size asymmetry of fighting pairs:

- Lesser-body size asymmetry: asymmetry less than 10%
- Greater-size asymmetry: asymmetry of greater than 15%

There were 21, 33, and 31 contests with lesser-size asymmetry, and 25, 37, and 36 contests with greater-size asymmetry in *Uca annulipes*, *Uca bengali*, and *Uca rosea*, respectively.
Material and methods

Statistical analysis:

1. Chi-square tests
2. Independent sample $t$-tests
3. Data were reported as mean ± SE
4. All tests were considered statistically significant at $P<0.05$. 
## Results

### Winning status of the smaller contestants:

<table>
<thead>
<tr>
<th>Species</th>
<th>Winning status of small contestants</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Uca annulipes</em></td>
<td>30% (14 out of 46 contests)</td>
</tr>
<tr>
<td><em>Uca bengali</em></td>
<td>31% (22 out of 70 contests)</td>
</tr>
<tr>
<td><em>Uca rosea</em></td>
<td>37% (25 out of 67 contests)</td>
</tr>
</tbody>
</table>
Results
Asymmetry and winning status of the contestants:

<table>
<thead>
<tr>
<th>Uca species</th>
<th>Smaller winners</th>
<th>Larger winners</th>
<th>Statistical tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uca annulipes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesser asymmetry</td>
<td>11</td>
<td>10</td>
<td>$\chi^2_1 = 0.05$, ns</td>
</tr>
<tr>
<td>Greater asymmetry</td>
<td>3</td>
<td>22</td>
<td>$\chi^2_1 = 14.40$, $P&lt;0.001$</td>
</tr>
<tr>
<td>Statistical tests</td>
<td>$\chi^2_1 = 4.57$, $P&lt;0.05$</td>
<td>$\chi^2_1 = 4.50$, $P&lt;0.05$</td>
<td></td>
</tr>
<tr>
<td><strong>Uca bengali</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesser asymmetry</td>
<td>17</td>
<td>16</td>
<td>$\chi^2_1 = 0.03$, ns</td>
</tr>
<tr>
<td>Greater asymmetry</td>
<td>5</td>
<td>32</td>
<td>$\chi^2_1 = 19.70$, $P&lt;0.001$</td>
</tr>
<tr>
<td>Statistical tests</td>
<td>$\chi^2_1 = 6.54$, $P&lt;0.05$</td>
<td>$\chi^2_1 = 5.33$, $P&lt;0.05$</td>
<td></td>
</tr>
<tr>
<td><strong>Uca rosea</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesser asymmetry</td>
<td>18</td>
<td>13</td>
<td>$\chi^2_1 = 0.81$, ns</td>
</tr>
<tr>
<td>Greater asymmetry</td>
<td>7</td>
<td>29</td>
<td>$\chi^2_1 = 13.44$, $P&lt;0.001$</td>
</tr>
<tr>
<td>Statistical tests</td>
<td>$\chi^2_1 = 4.84$, $P&lt;0.05$</td>
<td>$\chi^2_1 = 6.09$, $P&lt;0.05$</td>
<td></td>
</tr>
</tbody>
</table>
## Results

### Contest durations:

<table>
<thead>
<tr>
<th>Species</th>
<th>Durations to win contests</th>
<th>Statistical tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smaller winners</td>
<td>Larger winners</td>
</tr>
<tr>
<td><em>Uca annulipes</em></td>
<td>21.50 ± 2.86s</td>
<td>12.81 ± 1.67s</td>
</tr>
<tr>
<td><em>Uca bengali</em></td>
<td>31.73 ± 2.96s</td>
<td>14.96 ± 1.68s</td>
</tr>
<tr>
<td><em>Uca rosea</em></td>
<td>25.18 ± 2.07s</td>
<td>16.36 ± 2.10s</td>
</tr>
</tbody>
</table>
## Results

**Residency status of the winners:**

<table>
<thead>
<tr>
<th>Species</th>
<th>Smaller winners</th>
<th>Statistical tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Uca annulipes</em></td>
<td>Residents: 20, Intruders: 2</td>
<td>$\chi^2_1 = 14.73$, $P&lt;0.001$</td>
</tr>
<tr>
<td><em>Uca bengali</em></td>
<td>Residents: 22, Intruders: 3</td>
<td>$\chi^2_1 = 14.44$, $P&lt;0.001$</td>
</tr>
<tr>
<td><em>Uca rosea</em></td>
<td>Residents: 10, Intruders: 4</td>
<td>$\chi^2_1 = 2.57$, ns</td>
</tr>
</tbody>
</table>

**Larger winners**

<table>
<thead>
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<th>Smaller winners</th>
<th>Statistical tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Uca annulipes</em></td>
<td>Residents: 20, Intruders: 12</td>
<td>$\chi^2_1 = 2.00$, ns</td>
</tr>
<tr>
<td><em>Uca bengali</em></td>
<td>Residents: 24, Intruders: 24</td>
<td>$\chi^2_1 = 0.00$, ns</td>
</tr>
<tr>
<td><em>Uca rosea</em></td>
<td>Residents: 19, Intruders: 23</td>
<td>$\chi^2_1 = 0.38$, ns</td>
</tr>
</tbody>
</table>
Discussion

Winning status of the smaller contestants:

Based on our and previous findings, we can say that ≥30% of the contests should win by smaller contestants despite of their body size disadvantages.

In this case, body size does not predict the fighting outcomes.
Factors enabled the fiddler crabs smaller contestants to win:

1. Longer fighting duration or high motivation
2. Burrow ownership

Highly motivated smaller contestants increase the possibility of extended attrition through increasing fighting duration, and that might inflict additional costs on their larger opponents, and their opponents may decide to give up.

Similar result was observed in cricket fighting (Hofmann & Schildberger, 2001)
Residency status:

- Motivates the smaller contestants to fight longer and win despite their body size disadvantages.

- Whereas in the case of larger contestants, residency status does not effect. Only when they are very larger compared to their opponents, they may win based on body size advantages.
Outcomes of this research

  
  High motivation enables smaller contestants to win the contests in fiddler crabs (Brachyura, Ocypodidae). Accepted (in press).


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