Ants as a Diet for the Life Cycle of the Terrestrial Firefly *Luciola cereta*

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BLACK WINGED FIREFLY

- Endemic species and widely distributed.
- They are probably the most important and well-known species observed for their flashing behavior by the general public in the field.
- The flashes of interactions were recorded and analyzed. Male flashes interval was 0.6~0.8s, flashes lasting about 0.24s, female flashes being blinking light and its flash communication system was classifying as HP system (Ohba and Yang, 2003).
- Males with a pentagonal segment have a faster flashing rate than those with a semi-oval segment and are considered more attractive to females in groups with male-biased sex ratios (Wu et al., 2010).
Distribution

- Horizontal distribution except south-eastern Taiwan.
- Habitats included betel palm orchard, bamboo, grass land, citrus orchard, and low altitude mountains.
Firefly Festivals

- Firefly festivals were held from 1987 in Ali Mt. annually.
- Better income of home stay was increased due to firefly watching activities in spring.
- Local community people joint the firefly protections and habitat management.
- To create sustainable relationship between ecology, sociality, and economics in harmony.
Larval habitats and observation
Firefly larvae are carnivorous

- Some aquatic species feed on water snails in Asia (Ohba, 1973; 1977; Ho, 2010; Fu, 2006).

- Terrestrial species feed on snails and slugs to complete their life cycle include *Pyrocoelia praetexta*, *P. analis*, and *P. pectoralis* in Asia (Ho, 1998; Ho & Huang, 2003; Ho *et al*., 2003; Wang *et al*., 2007); *Lampyris noctiluca* in Britain (Tyler, 1997; 2002); and *Pyractomena lucifera* and *Photuris* spp. in America (Buschman, 1984; 1987).

- Obligate earthworm predators such as *Phosphaenus hemipterus* had been described (Majka and MacIvor, 2009).

- Fu and Ballantyne (2008) had described how *Pygoluciola qingyu* larvae attacked and ate ants in the field, but whether ants are necessary for completion of this life cycle is unknown.
Larval illumination of L. cerata
Materials and Methods

- Tests of larval foraging preference
- External morphology
- Life cycle
  - Egg collection
  - Larval breeding
Tests of larval foraging preference was conducted and results show nine preys are acceptable.

Larvae are carnivous and polytrophic.
Adult morphology

Male

Female

3 mm
Larval Morphology

Mandible
Antenna
Head
Fore leg
Pronotum
Dorsal ridge
Mid leg
Mesonotum
Postnotum
Hind leg
Abdomen

Spiracle
Later spine
Dorsal spine
Larval breeding and Ants as a diet

- *Crematogaster* spp.
- Completed whole generation successfully

Figure Two stage breeding of larvae *L. cerata*. A: First stage for the young larvae; B: Second stage for mature larvae. Shape of mud cocoon with lid and open without soil. The open container will later be sealed with soil and a small hole will be provided for ventilation.

8/20/2014
Reared conditions and results

- All were kept at room temperature 18-30°C, RH = 80±5%, and photoperiod L:D = 10:14.

- 97 replications were conducted and reared by “terrestrial Luciola larval breeding method” individually.

- After the experiment, emergence rate of 59.79% (n = 58) was calculated. All paired females in container collected and let them ovipositor.

- Regeneration breeding will be possibly in our work.
## Developmental durations

<table>
<thead>
<tr>
<th>Sex</th>
<th>(n)</th>
<th>Developmental duration (mean ± SD) (day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Egg</td>
</tr>
<tr>
<td>Female</td>
<td>32</td>
<td>16.0±0.0</td>
</tr>
<tr>
<td>Male</td>
<td>26</td>
<td>16.0±0.0</td>
</tr>
<tr>
<td>Both</td>
<td>58</td>
<td>16.0±0.0</td>
</tr>
</tbody>
</table>
The ratio of each life stage

- Egg: 74.82%
- Larvae: 3.15%
- Making cocoon: 0.78%
- Prepupae: 4.42%
- Pupa: 7.88%
- Adult: 8.95%
Instar variations sexually

- 3rd instar: Male and female
- 4th instar: Male > Female
- 5th instar: Female > Male

Number of males and females across instars.
Life cycle of *Luciola cerata*

- **Eggs** (Mar to May)
- **Larva** (Mar to Nov)
- **Mature larva of overwinter** (Dec to Mar)
- **Mud cocoon** (Mar to May)
- **Mating adults** (Mar to May)
- **Male**
- **Female**
Parasites

Flour mite (Acaridae)

Entomopathogenic fungi (Metarhizium anisopliae)
Discussion

- Self-designed rearing apparatus for the terrestrial firefly, *L. cerata* using the frozen lift tail ants (*Crematogaster* spp.) could complete whole life cycle and an univoltine.

- Ants are abundant and take important roles as primary consumers and decomposers in ecosystem.

- *L. cerata* larvae select survival strategies and consider the nutritional preys, and high population and density. Better strategies are more able to ensure its survival advantage in ecosystem.
Ants provided better nutrition for L. cerata larva development. They have been estimated that 10% of the animal biomass of the earth is comprised. Not only are they abundant, but they are also quite diverse. Ants have far more abundant of protein than chicken, fish, beef, and 100 g dry weight of ants product 650 calories which contain rich amino acids, minerals, selenium, and zinc (Rastogi, 2011; Redford and Dorea, 1984).
Formosa pangolin
Assassin bugs (Reduviidae)
Specialized myrmecophages

- *Pygoluciola qingyu*
- *Luciola praestuta*
- *Luciola cerata*
- *Luciola terminalis*
- *Luciola anceyi*
Thank you for listening
We are grateful to Mr. Kuo-Yun Fang, the director of ESRI for encouragement. We also thank the assistance of Mrs. Shu-Lin Chang (ESRI) and Mrs. Na-Hua Tsai (ESRI) in field collection, laboratory breeding work and diet collection.
Applications of Individual Breeding

- Basic model for science study
- Create the chance for mass production
- Habitat restoration
- Environmental education

(Tsai, 2012)
黑翅螢 - 嘉義若蘭山莊
黑翅螢 - 嘉義圓潭生態園區
黑翅螢 & 紅胸黑翅螢 - 嘉義山美村
黑翅螢 – 嘉義里佳藍色部落
黑翅螢 - 阿里山公興村
黑翅螢 & 脈翅螢 - 南投圳頭湖
The flashes of interactions were recorded and analyzed. Male flashes interval was 0.6~0.8s, flashes lasting about 0.24s, female flashes being blinking light and its flash communication system was classifying as HP system (Ohba and Yang, 2003).

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# Nature enemy

<table>
<thead>
<tr>
<th>Opiliones</th>
<th>Spider</th>
</tr>
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<tbody>
<tr>
<td>盲蛛</td>
<td>蜘蛛</td>
</tr>
<tr>
<td>Bipalium</td>
<td>Stink bug</td>
</tr>
<tr>
<td>渦蟲</td>
<td>椿象</td>
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