Salamander Courtship, Mating, & Egg Deposition

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Lecture Goals
To familiarize students with salamander courtship, mating, and egg deposition strategies

Reading Assignments:
1) Organ 1958
2) Wells 2007
   Chpt. 9:  404 – 418
   434 – 447
   Chpt. 10: 459 – 461
   487 – 493
   Chpt. 11: 540 – 546

Lecture Structure
1. Migration
2. Fertilization
3. Courtship
   A. Plethodontidae
      - Plethodon
      - Desmognathus
   B. Ambystomatidae
   C. Salamandridae
4. Sperm Competition
5. Egg Deposition
   A. Fecundity
   B. Location
   C. Parental Care
Why Do Salamanders Reproduce?

- Doomed for extinction

What is necessary for reproduction

- Environmental Conditions
- Male & Female must meet
- Transfer of Gametes

Migration to Breeding Areas

- Often Ambystomatids
- Rainy nights
- Typically males migrate first
  \((A.\ opacum & A.\ maculatum)\)
- 164 meters – 95% adults (Semlitsch 1998)
- Plethodontids – \(D.\ organi, H.\ scutatum\)

Conservation Implications

- Cloacal Swelling in males
- August - November
- Large flat rocks
- Male trap females in nest
- Mean fecundity = 450 eggs
- Polypermy
- Male guards nest and often consumes eggs

External Fertilization

- Cryptobranchidae
- Sirenidae
- Hynobiidae

Similar?
External Fertilization

Internal Fertilization
Copulatory organ? Spermatophore
Spermatotheca
50–70+ % Failure

(Arnold et al. 1993)

(Organ and Lowenthal 1963)

(Organ and Lowenthal 1963)

(Arnold et al. 1993)
Courtship
“Courtship” glands named for anatomical location

Functions of Exocrine Secretions:
• Identification
• Orientation
• Persuasion

Glycoproteins

Mental
CEFhalic or “genial”

Courtship - Plethodontidae

Abrading female’s skin

Ron Bonnett’s Lab University of Tulsa
Courtship - Plethodontidae

Male places his snout along the female’s back and side

“foot dance”

• Male moves head toward female’s head
• Male presses his mental gland over female’s nasolabial grooves

(Organ 1958)
Courtship - Plethodontidae

Male passes under females chin and begin to undulate his tail

Organs (1978)

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Courtship - Plethodontidae

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"Tail straddle walk"

Organs (1978)
Courtship - Plethodontidae

Maintain contact even over objects

Female – lateral head movements
Male – sacral movements

(Organ 1958)
Courtship - Plethodontidae

- Spermatophore deposition
- Both stop when female is over spermatophore

Typically only 1 spermatophore per courtship
Courtship - Plethodontidae

Desmognathus ochrophaeus complex

- Male “follows” female
- Male snout makes contact “nudge”
- Front limbs move in circular motion “butterfly”
- Male rubs female head:
  - cheek to cheek
  - top of males head to females throat

Photo by Steve Tilley
Courtship - Plethodontidae

• Males presses his chin against the female’s dorsum and “pulls” back
• Modified pull with quick back movement “snap”
• Tail undulation & Slide

(Mead & Verrell 2002)
Can courtship be used for evolutionary relationships?
**Courtship – Incompatibility**

<table>
<thead>
<tr>
<th>Pair</th>
<th>Within</th>
<th>Between</th>
<th>Coefficient of joint isolation</th>
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<tr>
<td>SI x JK</td>
<td>44</td>
<td>36</td>
<td>0.20 ± 0.15 NS</td>
</tr>
<tr>
<td>SI x RB</td>
<td>39</td>
<td>18</td>
<td>0.67 ± 0.16 *</td>
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<tr>
<td>SI x WA</td>
<td>33</td>
<td>23</td>
<td>0.33 ± 0.17 *</td>
</tr>
<tr>
<td>SI x HP</td>
<td>31</td>
<td>5</td>
<td>0.43 ± 0.15 *</td>
</tr>
<tr>
<td>WA x RB</td>
<td>31</td>
<td>20</td>
<td>0.27 ± 0.17 *</td>
</tr>
<tr>
<td>WA x HP</td>
<td>27</td>
<td>12</td>
<td>0.50 ± 0.16 *</td>
</tr>
<tr>
<td>RB x HP</td>
<td>37</td>
<td>21</td>
<td>0.36 ± 0.14 *</td>
</tr>
<tr>
<td>HP x JK</td>
<td>24</td>
<td>4</td>
<td>0.63 ± 0.14 *</td>
</tr>
</tbody>
</table>

*Abbreviations refer to the following localities in North Carolina (NC), Kentucky (KY), and Alabama (AL): HP: Highlands Plateau, Jackson Co. (NC); WC: Watsil Creek, Macon Co. (NC); BM: Big Black Mountain, Harlan Co. (KY); CW: Coweta, Macon Co. (NC); MU: Mount Cheaha, Choctaw Co. (AL); HI: Standing Indian Mountain, Macon Co. (NC); JK: John’s Knob, Graham Co. (NC); RR: Rough Butt Butte, Jackson Co. (NC).*  

[Mood & Verrell 2002]

**Courtship**

(Mood & Verrell 2002)

**Courtship - Ambystomatidae**

- **Variation in clasping:**
  - Absent
    - *A. annulatum*
    - *A. maculatum*
    - *A. opacum*
    - *A. talpoideum*
  - Present
    - *A. jeffersonianum*
    - *A. laterale*
    - *A. macrodactylum*
Courtship - Ambystomatidae

- Male contacts female’s dorsum
- Male circles & female nudges male

- Circles repeatedly “waltz”

Courtship - Ambystomatidae

- Male moves away with vent contacting the substrate
- Arches body upward and undulates tail

Courtship - Ambystomatidae

- Nudging and circling is repeated
- Females might collect 15-20 spermatophores before ending courtship
Spotted Salamander Breeding

Fall not Spring in TN

Marbled Salamander Breeding

Courtship - Ambystomatidae

Number of spermatophores per night:

- A. maculatum 40.4 (10-81)
- A. tigrinum 20.6 (8-37)
- A. laterale 23.6 (13-34)
- A. jeffersonianum 12.4 (6-21)

Time per spermatophore:
- A. maculatum 1.4 min
- A. opacum 4.5 min
- P. jordani 56 min

Arnold 1977
Courtship - Salamandridae

*Notophthalmus viridescens*

- Cephalic glands applied to female nares
- Clasping and continued gland application (> 45 min.)

Not always!

Courtship - Salamandridae

- Male fans female with tail
- Violent contortions
- Dismounts and deposits spermatophore
- Turns and blocks female
- 3.8 spermatophores per courtship

Courtship - Salamandridae

Red spotted Newt - *Notophthalmus viridescens*
Courtship - Similarities

- Males face away from females
- Females orient toward male’s gland
- Male responds to contact with his cloacae
- Female movement to pick-up spermatophore

Sperm Competition

D. ochrophaeus
D. wrighti
D. fuscus

7% of all clutches products of more than one male

Inseminated up to 15 times during one season

<table>
<thead>
<tr>
<th>Population A</th>
<th>No. contact</th>
<th>Total</th>
<th>No. of</th>
<th>No. of</th>
<th>No. of</th>
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<tbody>
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<td>male</td>
<td>males</td>
<td>males</td>
<td>males</td>
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<td>A-5</td>
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<table>
<thead>
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<th>No. contact</th>
<th>Total</th>
<th>No. of</th>
<th>No. of</th>
<th>No. of</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>male</td>
<td>males</td>
<td>males</td>
<td>males</td>
</tr>
<tr>
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<td>26</td>
<td>10</td>
<td>10</td>
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<tr>
<td>B-2</td>
<td>2</td>
<td>24</td>
<td>22</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* Last male to inseminate this female

Paternity?

(Fecundity)

r/K-selected?

D. organi 6
D. orestes 15
D. quadramaculatus 32
P. welleri 6
P. cinereus 7

<table>
<thead>
<tr>
<th>Species</th>
<th>Male size</th>
<th>Female size</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. opacum</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>A. maculatum</td>
<td>400</td>
<td></td>
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<tr>
<td>A. tigrinum</td>
<td>700</td>
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<tr>
<td>Paedomorphs</td>
<td>&gt;5,000</td>
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</table>

Fecundity

K

30,000 / lbs.
**Egg Development**

- Larger eggs → Slower development
- Warmer temperatures → Faster development
- Larger prey → Larger eggs
- Terrestrial → Larger eggs
- Aquatic → Smaller eggs

**Surface area to volume**

- More advanced (often larger)

**Egg Deposition Locations**

Aquatic vs. Terrestrial

**Parental Care**

- Typically Plethodontids
- Why guard nests?

- Desiccation
- Antimicrobial
- Predation