Salamander Courtship, Mating, & Egg Deposition

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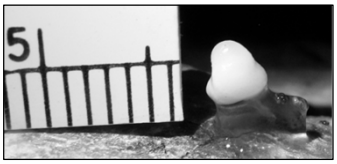
Lecture Goals

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

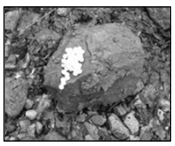
Reading Assignments:

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*

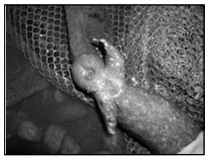
Conservation Implications

External Fertilization

- Cryptobranchidae
- Sirenidae
- Hynobiidae

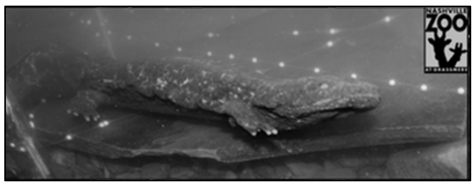
Similar?

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



Photos by Jeff Humphries

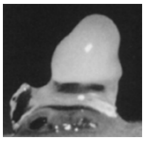
External Fertilization

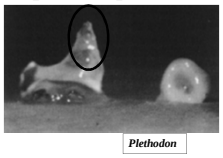


Internal Fertilization

Copulatory organ?

Spermatophore

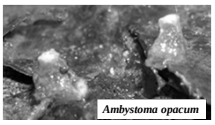




Plethodon

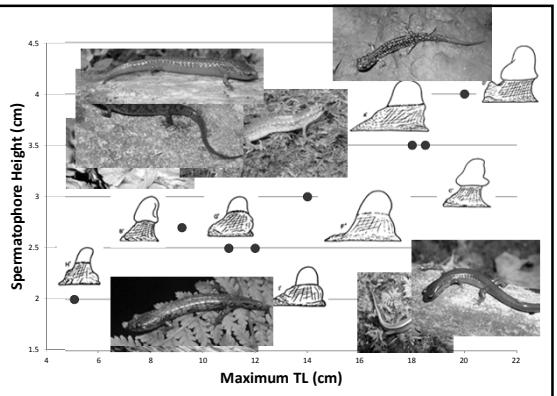
Spermatotheca

50–70% Failure



Ambystoma opacum

(Arnold et al. 1993)



(Organ and Lowenthal 1963)

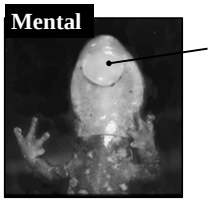
Courtship

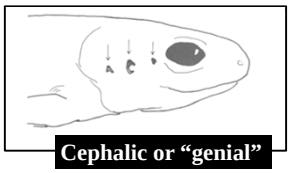
"Courtship" glands named for anatomical location

Functions of Exocrine Secretions:
- **Identification ?**
- **Orientation**
- **Persuasion**

Glycoproteins

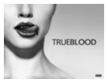
Mental

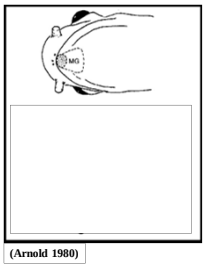




Cephalic or "genial"

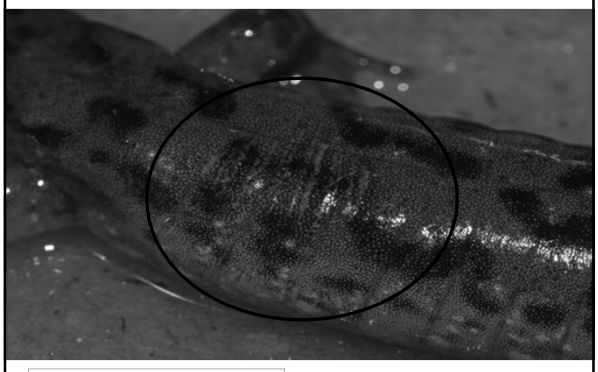
Courtship - Plethodontidae





(Arnold 1980)

Abrading female's skin

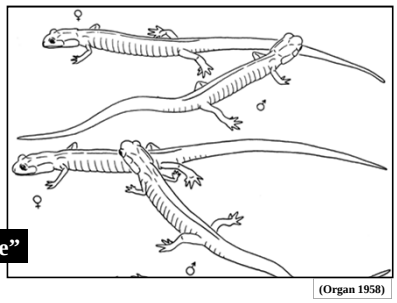


Ron Bonnett's Lab University of Tulsa

Courtship - Plethodontidae

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

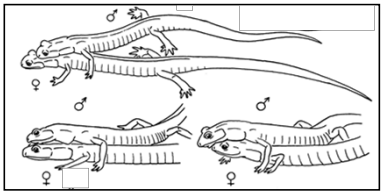
"foot dance"



(Organ 1958)

Courtship - Plethodontidae

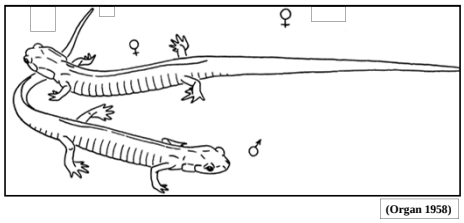
- **Male moves head toward female's head**



(Organ 1958)

- **Male presses his mental gland over female's nasolabial grooves**

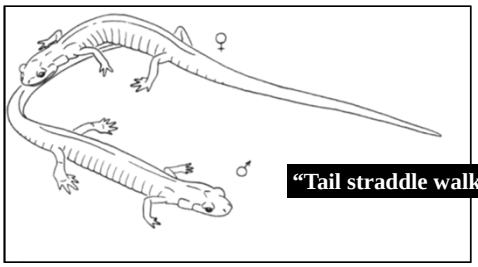
Courtship - Plethodontidae



(Organ 1958)

Male passes under females chin and begin to undulate his tail

Courtship - Plethodontidae



"Tail straddle walk"

(Organ 1958)

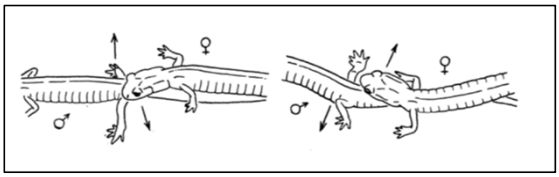
Courtship - Plethodontidae

Plethodon yonahlossee

Courtship - Plethodontidae

Maintain contact even over objects

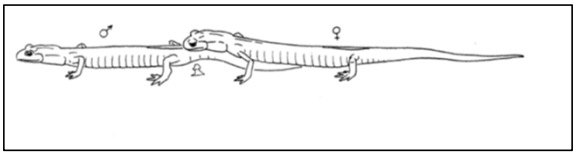
Courtship - Plethodontidae



(Organ 1958)

Female – lateral head movements
Male – sacral movements

Courtship - Plethodontidae



(Organ 1958)

- **Spermatophore deposition**
- **Both stop when female is over spermatophore**

Typically only 1 spermatophore per courtship

Courtship - Plethodontidae

Photo by Steve Tilley

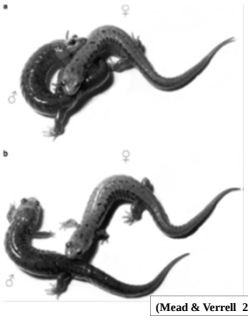
Desmognathus ochrophaeus **complex**

- **Male "follows" female**
- **Male snout makes contact "nudge"**

- **Front limbs move in circular motion "butterfly"**
- **Male rubs female head :**
  - **cheek to cheek**
  - **top males head to females throat**

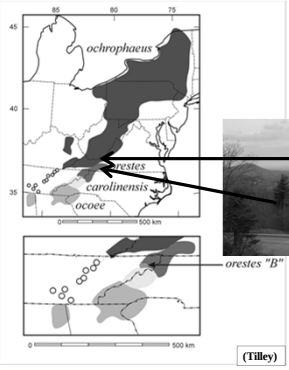
Courtship - Plethodontidae

- **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)

Courtship



Can courtship be used for evolutionary relationships?

(Tilley)

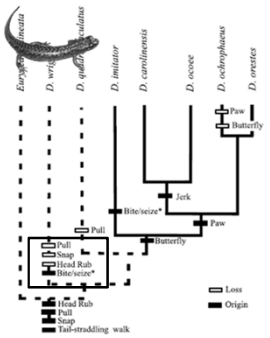
Courtship – Incompatibility

Pair[a]	Frequencies of mating: Within	Frequencies of mating: Between	Coefficient of joint isolation
D. ocoee			
SI × JK	44	38	0.20 ± 0.15 NS
SI × RB	39	19	0.67 ± 0.16 *
SI × WA	33	23	0.33 ± 0.17 *
SI × HP	31	7	0.82 ± 0.15 *
WA × RB	31	20	0.37 ± 0.17 *
WA × HP	27	12	0.50 ± 0.16 *
RB × HP	37	21	0.56 ± 0.14 *
HP × JK	29	4	0.83 ± 0.14 *

[a]Abbreviations refer to the following localities in North Carolina (NC), Kentucky (KY), and Alabama (AL): HP: Highlands Plateau, Jackson Co. (NC); WC: Wayah Creek, Macon Co. (NC); BM: Big Black Mountain, Harlan Co. (KY); CW: Coweeta, Macon Co. (NC); MC: Mount Cheaha, Cleburne Co. (AL); SI: Standing Indian Mountain, Macon Co. (NC); JK: John's Knob, Graham Co. (NC); RB: Rough Butt Bald, Jackson Co. (NC); WA: Wayah Bald, Macon Co. (NC).

(Verrell & Mabry 2002)

Courtship



(Mead & Verrell 2002)

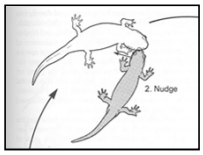
Courtship - Ambystomatidae

Variation in clasping:

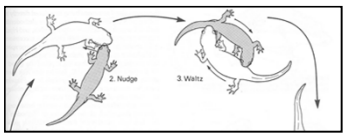
-Absent
- ***-A. annulatum***
- ***-A. maculatum***
- ***-A. opacum***
- ***-A. talpoideum***

-Present
- ***-A. jeffersonianum***
- ***-A. laterale***
- ***-A. macrodactylum***

Courtship - Ambystomatidae

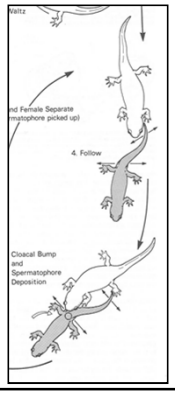


- **Male contacts female's dorsum**
- **Male circles & female nudges male**



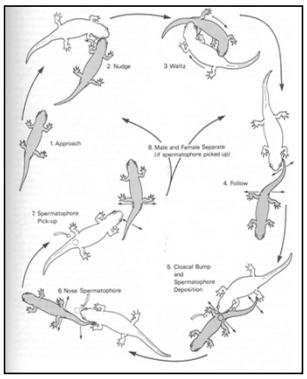
- **Circles repeatedly "waltz"**

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**

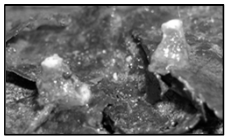
Courtship - Ambystomatidae

Number of spermatophores per night: (Arnold 1977)

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:

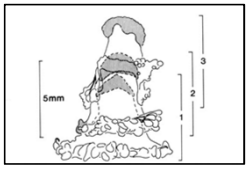
A. maculatum	**1.4 min**
A. opacum	**4.5 min**

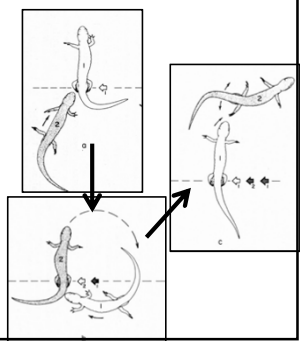


P. jordani **56 min**

Courtship - Ambystomatidae

Competition





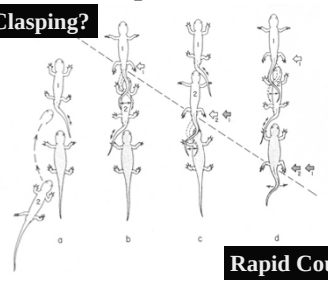
Spermatophore covering

(Arnold 1977)

Courtship - Ambystomatidae

Competition

Benefit of Clasping?

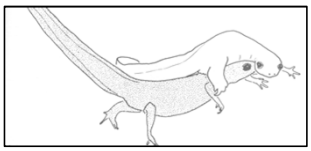


Rapid Courtship?

Courtship - Salamandridae

Notophthalmus viridescens

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



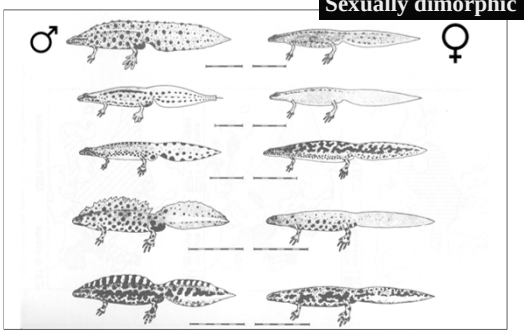
Courtship - Salamandridae

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

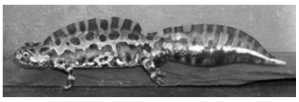
Courtship - Salamandridae

Genus - *Triturus*

Sexually dimorphic

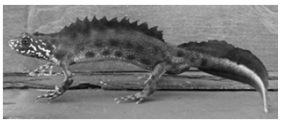


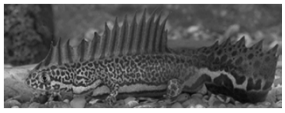
Courtship - Salamandridae



T. marmoratus

T. carnifex





T. vittatus

Courtship - Similarities

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

Sperm Competition

Paternity?

D. ochrophaeus
D. wrighti
D. fuscus

Inseminated up to 15 times during one season

7% of all clutches products of more than one male

(Tilley & Hausman 1976)

Females:	No. of insem. nations in lab. by: Pop. A male	Pop. B male	Initial clutch size	Total no. surviving offspring	No. offspring sired by: Pop. A male	Pop. B male
Population A						
A-1	0	1*	14	13	0	13
A-2	4	1*	7	7	5	2
A-3	11	1*	12	11	9	2
A-4	6	1*	17	17	14	3
A-5	1	1*	15	14	10	4
Population B						
B-1	1*	0	27	26	18	8
B-2	1*	0	24	22	1	21

* Last male to inseminate this female.

(Houck et al. 1985)

Fecundity

r/K-selected ?

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

A. opacum	120
A. maculatum	400
A. tigrinum	700
Paedomorphs	>5,000

?

Egg Development

Larger eggs → **Slower development**
More advanced (often larger)

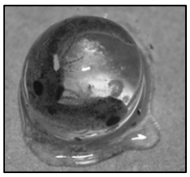
Surface area to volume

Warmer temperatures → **Faster development**

Larger prey → **Larger eggs**

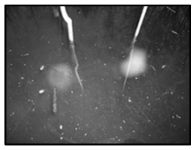
Terrestrial → **Larger eggs**

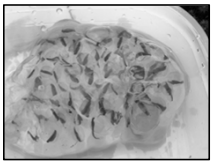
Aquatic → **Smaller eggs**



Egg Deposition Locations

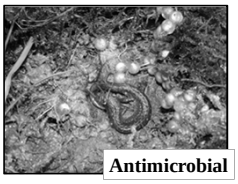
Aquatic vs. Terrestrial





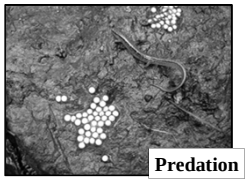
Parental Care

- **Typically Plethodontids**
- **Why guard nests?**



Antimicrobial

Desiccation



Predation

Next