Reptile reproduction

ALL Reptiles have internal fertilization




Intromission organs

- ***hemipenes*** in squamates (paired evaginations in the wall of cloaca that are everted to expose a complex surface)
- proper ***penis*** in turtles and crocs





Hemipenes

- Held inverted within the body
- Everted for reproduction
- Often with spines or hooks to anchor within the female
- Often forked hemipenes (each hemipenis with two tips)
- Only one is used at a time



Sperm storage

- Known in all reptile groups
- Especially common among turtles
  - E.g. painted turtles

- Pearse, Devon E. , Janzen, Fredric J. & Avise, John C. (2001) Genetic markers substantiate long-term storage and utilization of sperm by female painted turtles. Heredity 86 (3), 378-384.

Findings

- Microsatellite markers on free-ranging population over four years
- Genotyped 113 clutches: 80.5% remated each year
- But some females used sperm stored for up to ***three years*** to fertilize some or all eggs laid in consecutive nesting seasons.
- 13.2% of all clutches examined showed evidence of multiple paternity
- Suggests 'last in, first out' operation of the females' sperm storage tubules

Reptiles have two reproductive modes

- **Oviparity**: egg laying
  - All turtles, crocodiles (and birds)
  - Some squamates (snakes, lizards and amphisbaenids)
- **Viviparity**: live-bearing
  - Only found in snakes, lizards and amphisbaenids
  - Has evolved independently more than 100 times

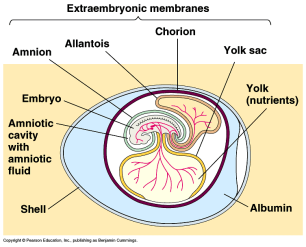
Reptile Eggs

Reptile eggs

- Huge size variation among spcies
- Largest eggs ~ 300 g (pythons) smallest eggs ~ 0.1 g (geckos)
- Two layers:
  - outer mineral layer of calcium carbonate
  - inner layer or shell membrane
- Respiration occurs through the shell

Basic reptile egg structure

- **Embryo**
- **Amnion**= cushion membrane
- **Yolk sac**= nutrition
- **Allantois**= waste sac
- **Chorion**= membrane immediately inside shell
- **Albumin** = egg white
- **Shell:** hard or leathery



Egg teeth

- Assists in hatching by splitting the inner membrane and cracking the outer membrane of the egg.
- It is not a true tooth, and it is resorbed a few weeks after hatching

More egg teeth…

Viviparity

- Retention of embryos within the oviducts until development is complete = live birth.
  - Common in some groups - caecilians and squamates
  - Absent in others - turtles & crocs
- During evolution, viviparity has been accomplished by gradual increases in the amount of time eggs are retained in oviducts.
- Common where environment is too cold or too short to allow normal development
  - Female searches for microenviroments suitable for embryo development
  - Hastens development well beyond that possible in nest chambers.
  - No need for nesting!

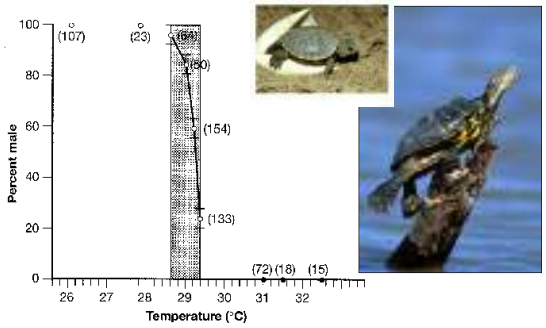
Northern water snake

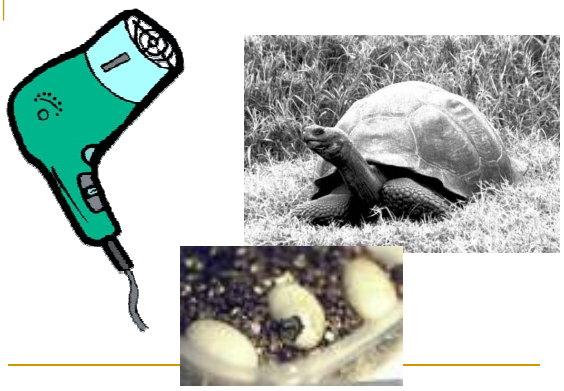
- *Nerodia sipedon* occupies cold waters.
- Females spend much of their time optimizing the thermal environment for their young (that is, basking)
- Produce large litters of young (20-40)
- Males stay small and concentrate primarily on survival

Sex Determination

- ***Genetic in most species***
- But in ***most*** turtles, all crocs, tuatara, and some squamates it is ***temperature dependent ("TSD")***
- Generally a pivotal temperature at which 50% of individuals are of each sex

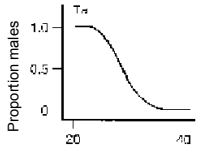
Incubation temperature and sex ratio in the red-eared slider (*Trachemys scripta*)





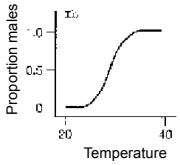
Type Ia TSD

- More females than males are produced at higher temperatures– e.g., many species of turtles (e.g. Loggerhead sea turtle *Caretta caretta*).



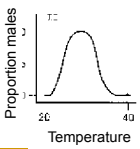
Type Ib TSD

- More males than females are produced at higher temperatures
- Typical of some crocodilians and some lizards



Type II

- Females are produced at low and high incubation temperatures with males at intermediate temperatures -- observed in some lizards (*Eublepharis macularis*), some crocodilians (*Crocodylus johnstoni*), and some turtles (*Chelydra serpentina*).



Mechanisms of TSD?

- Still poorly known
- Likely a link to temperature control of production of sex hormones in embryo
- Possibly related to males and females being more fit if raised at different temperatures
- Permits female to choose the sex of her offspring by nesting in cooler or warmer sites
- Latest news…SD may continue into hatchling stage!

TSD, offspring sex choice, and turtles

- Females can chose sex of offspring by nesting in cool versus warm sites

Why choose?

- Adult females are almost always larger than males of the same species
- Turtles shell size correlates with how many eggs the female can carry; larger turtles means greater reproduction in females
- Male size is unimportant for reproductive fitness – small males quite adept at mating
- So…what do you predict for a nesting site selection in a "bad year" or high density conditions?

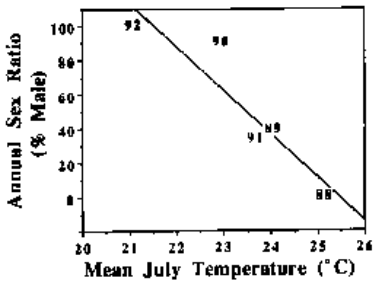
GSD:
(the exception)

?

Conservation Implications of TSD

- Hatchling loggerhead turtles in Florida from 87 to 99.9 percent females
- a 2 degree C warming of the sand would put temperatures solidly in the female- producing range for the entire population
- ***(N. Mrosvovsky and J. Provancha, "Sex ratio of hatchling loggerhead sea turtles: data and estimates from a 5-year study, " Canadian Journal of Zoology, v. 70, p. 530 - 538, 1992).***

Turtles and Global Warming



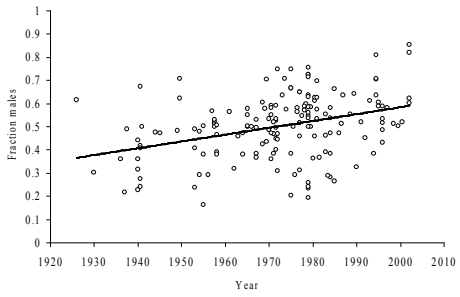
Painted Turtles - From Janzen PNAS (1994)

Can turtles adapt?

- Projected temperature changes ~ 2-3 degrees C
- Slow generation times
- Remote possibility that turtles can evolve quickly enough to track such environmental change and maintain balanced sex ratios in the wild.

Sex Ratios of freshwater turtles

(Dave Steen MS EFB 2003)



Parental Care

- Nearly all crocodilians care for their young
  - Likely necessary to defend against predators
- About 100 species of squamates exhibit some type of parental care
  - E.g. egg brooding in pythons
  - Egg attendance
- Turtles rarely if ever exhibit parental care
  - Likely has costs without major benefits
  - Time energy and increased predation

Parthenogenesis – reproduction without sex

- A few reptiles reproduce asexually
  - ~ 30 squamate species (mostly lizards, only one snake)
- In most cases these species:
  - Result from hybridization of two species
  - Consist only of females
  - Reproduce by clonal inheritance
  - Do not require interactions with other species to reproduce
  - Do not require sperm

The 'flower pot' snake

- *Rhamphotyphlops braminus*
- Successful invasive species
- Fossorial – often introduced via soil of imported plants
- Introduced throughout the tropics and even in greenhouses from Florida to Ohio
- A single female can be the founder of an entire new population because of parthenogenesis

Aspidoscelis uniparnes – desert grassland whiptail lizard

- Parthenogenetic
- One of ~15 unisexual all female lizard species

Aspidoscelis uniparnes – desert grassland whiptail lizard

- Pseudocopulation
- One female plays the role of the male
- Display courtship behavior that increases gonadal activity (as in many unisexual species)

End: Reptile reproduction