Reproduction in fishes

Reproduction

sexual strategies:

females must be ‘careful’ in mate selection due to cost

- energy investment in eggs
- migration, brooding

male investments in reproduction :

- advertisement, colors, tubercules, displays
- mate competition
- nest building, territorial defense, migration
- parental care, brood guarding

Reproduction

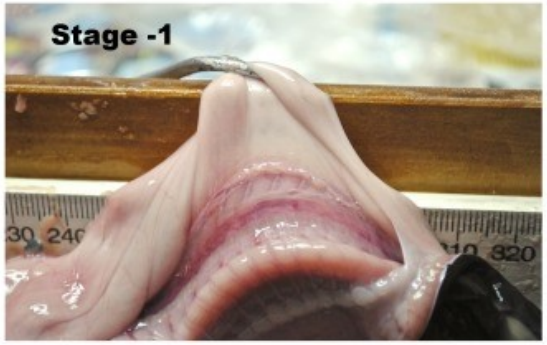
bioenergetics: $C = E + M + G + S + R$

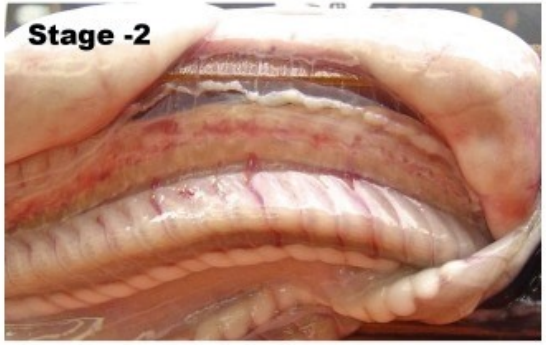
C – consumption
E – excretion
M – metabolism
G – growth
S – storage
R – reproduction

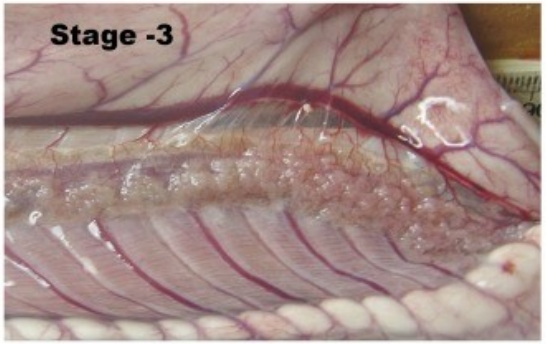
Anatomy

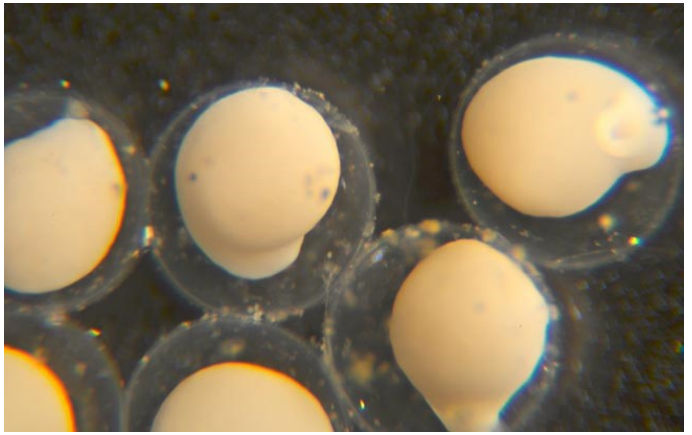
hagfish, lamprey: single gonads

no ducts; release gametes into body cavity









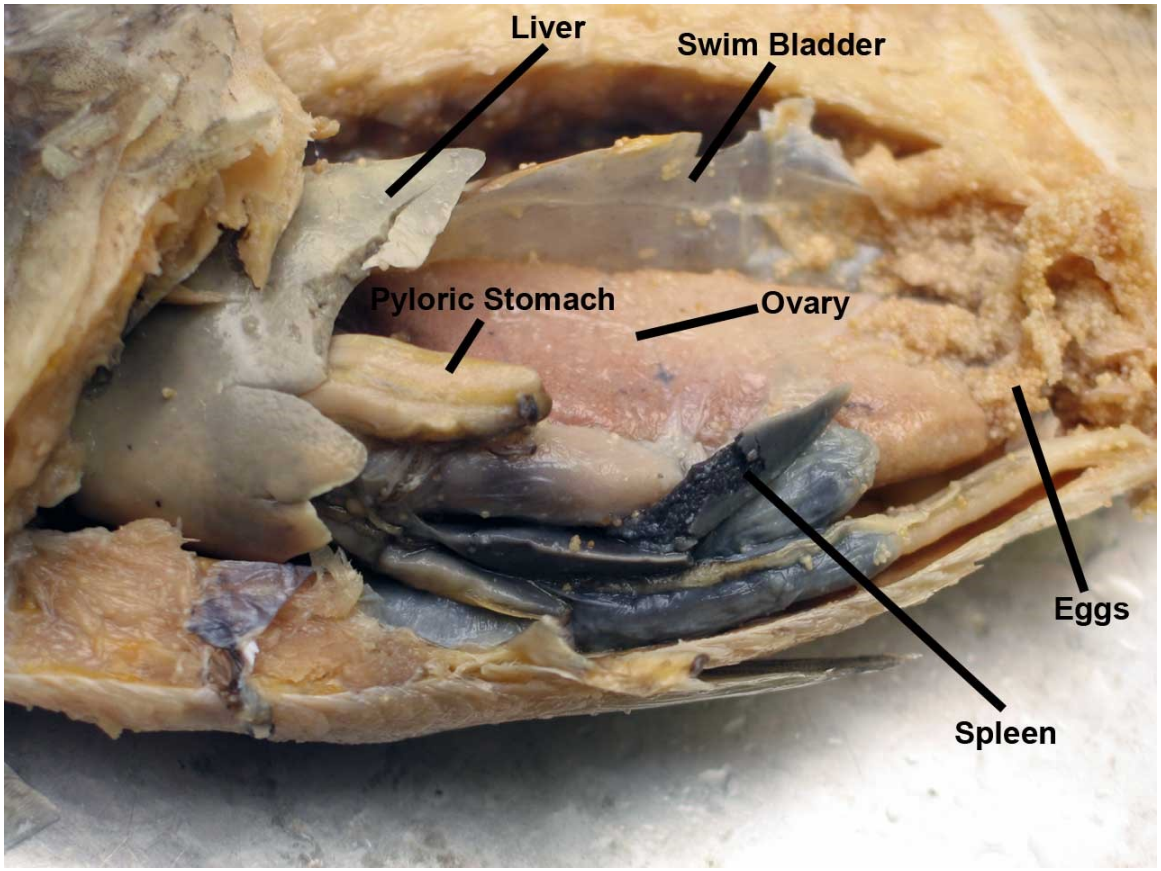
Anatomy

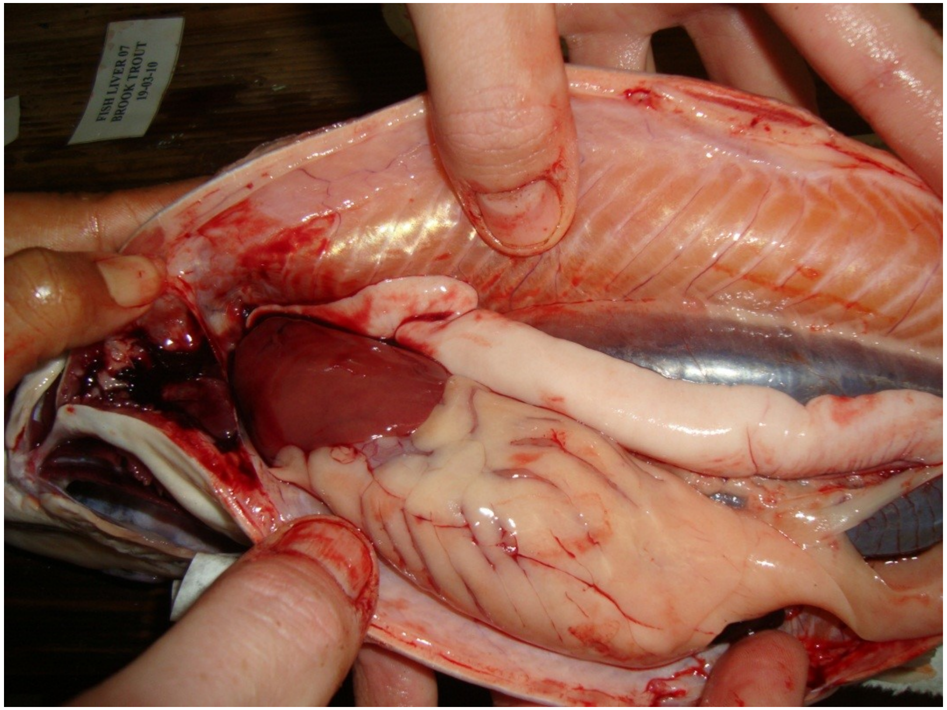
Teleosts: paired gonads

- external fertilization
- sperm released through separate opening of sperm duct
- ova maintained in continuous sac from ovary to oviduct
- exceptions: Salmonidae, Anguillidae, Galaxida

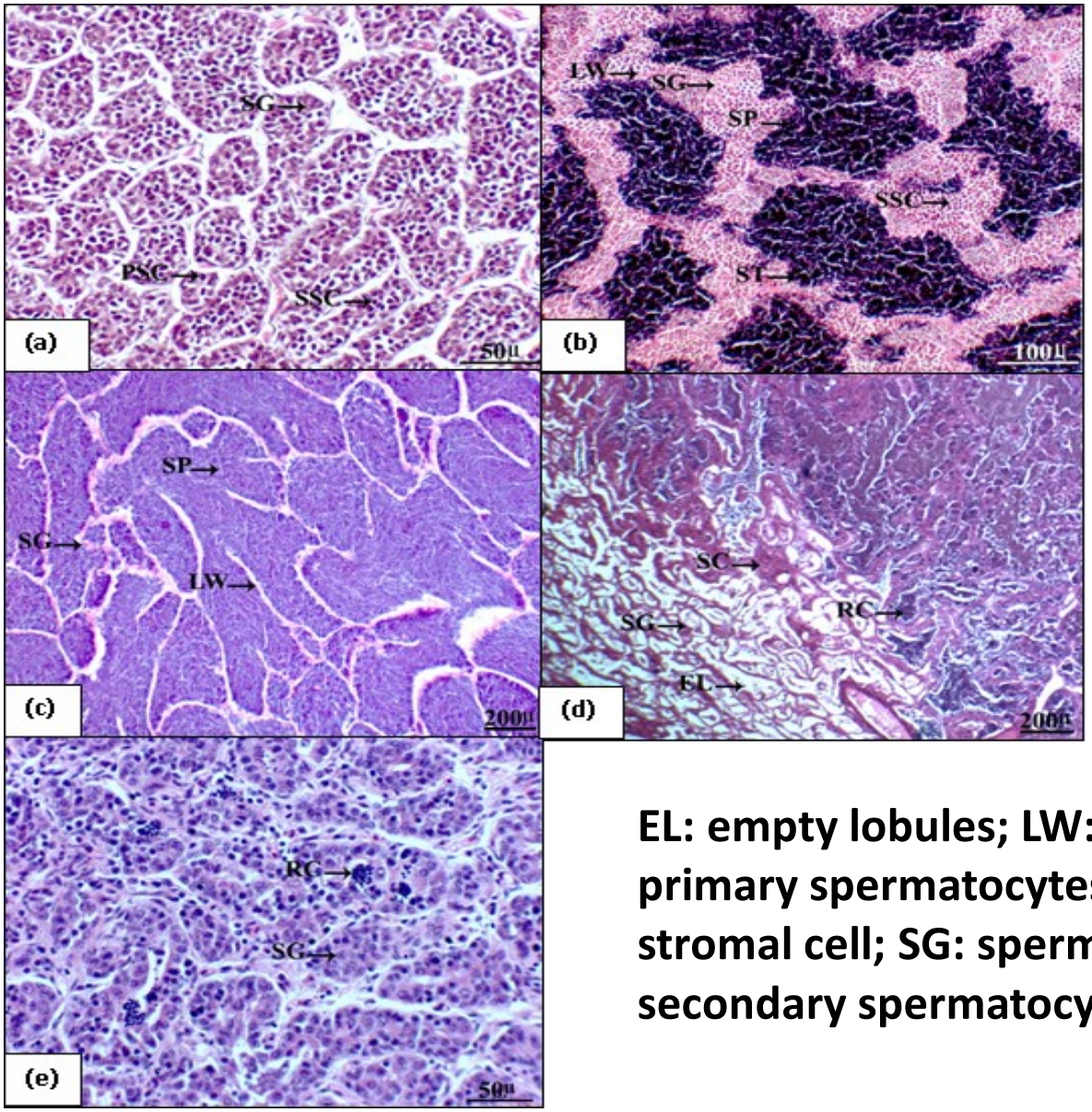
- these release eggs into body cavity when ripe

Anatomy



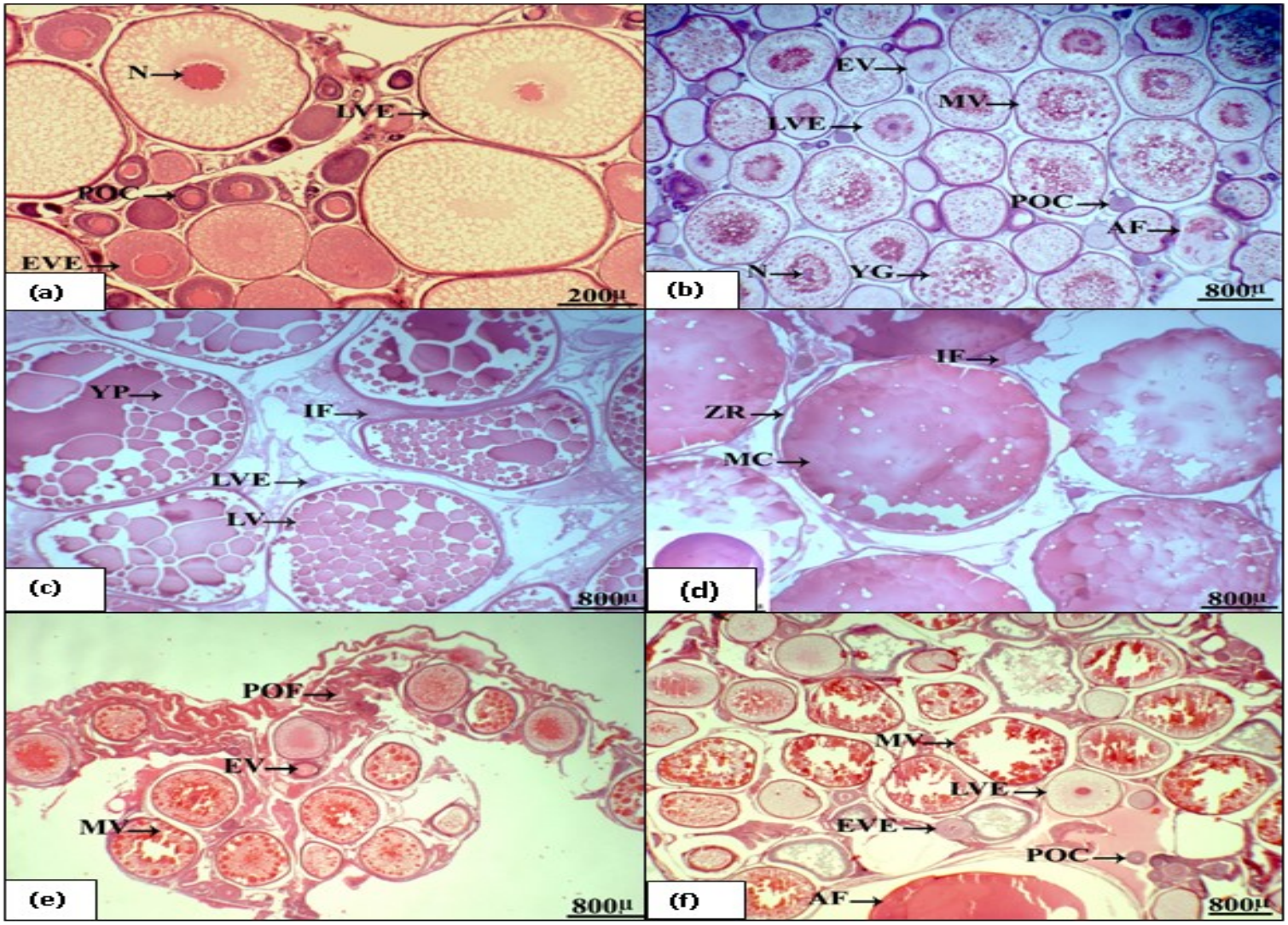

FISH LIVER 07
BROOK TROUT
19-03-10

Testicular development



EL: empty lobules; LW: lobular wall; PSC: primary spermatocytes; RC: residual cyst; SC: stromal cell; SG: spermatogonia; SP: sperm; SSC: secondary spermatocyte; ST: spermatid.

Ovarian development

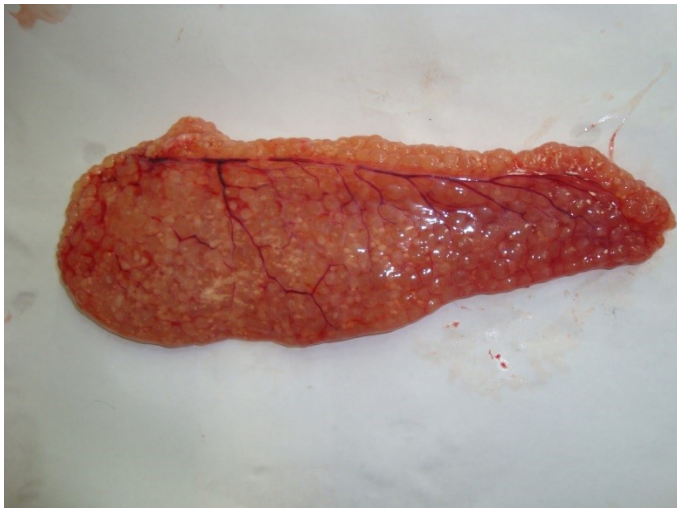


AF: atretic follicle; EV: early vitellogenic oocyte; EVE: early vesicular oocyte; GC: granulosa cells; IF: interstitial fluid; LV: late vitellogenic oocyte; LVE: late vesicular oocyte; MC: mature cell; MV: mid vitellogenic oocyte; N: nucleus; POC: primary oocyte; POF: post ovulatory follicle; TC: thecal cells; YG: yolk globule; YP: yolk plate; ZR: zona radiata.

Anatomy

in general:

gametes produced only during spawning season
gonads reduced during non-reproductive season



Timing and location of spawning

strategy:

avoid competition for spawning habitat
maximize access to food for offspring
minimize access to offspring by predators

Timing and location of spawning

example: Lake Champlain

anadromous – salmon (SW to FW)
catadromous – eels (FW to SW)
fall spawners – lake trout, whitefish
spring spawners – smelt
littoral spawners – (near shore) sculpins, sunfishes, basses
stream spawners – suckers, darters, minnows, sturgeon
pelagic eggs – (attached to a floating object in water column)

e.g. burbot

Single spawner:

Batch spawner

Reproduction

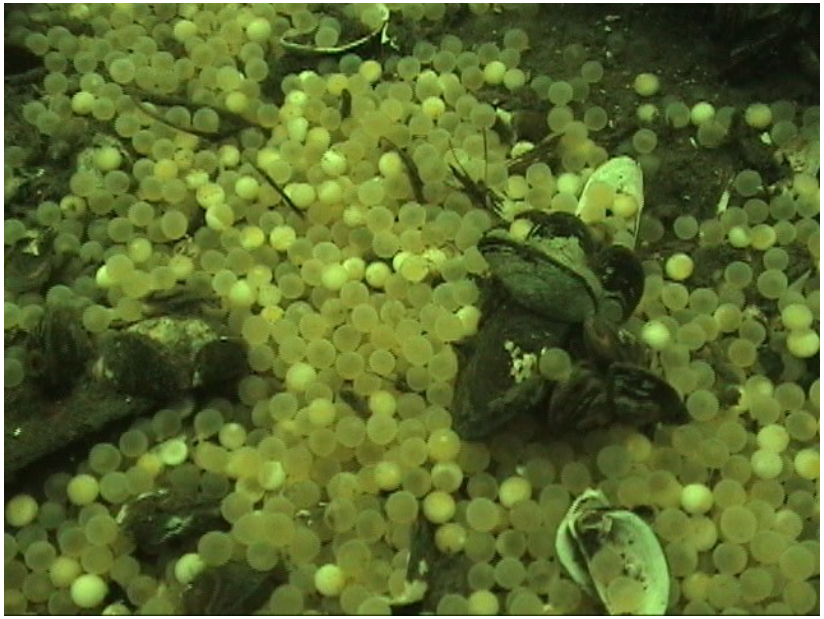
fecundity

egg size and number inversely related

egg number directly related to female size (within species)

related to food supply, competition

population-regulating mechanism



Reproduction

fecundity

fractional spawners – produce eggs continuously,
spawn frequently

batch spawners – single reproductive season
release all eggs in a short period

Reproduction

frequency of reproduction

semelparity - spawn and then die

- huge investment in egg production

e.g. Pacific salmon

iteroparity - repeated reproduction

allows compensation for a “bad” year

more common in more unstable environments

may not spawn every year (sturgeon)

Reproductive strategies

fertilization

external except livebearers (elasmobranches, Poecilidae, etc)

mass spawning events (Clupeiformes, smelt, etc.)

several males to each female (Salmoniformes, lampreys)

several females to each male (Gobiidae)

single-pair matings (guppies)

Reproductive strategies

non-guarders

- pelagic (broadcast) spawners

semi-buoyant eggs

high fecundity

egg and larval ‘migrations’

Reproductive strategies

non-guarders

- pelagic (broadcast) spawners
- benthic spawners
  - on coarse substrates (lake trout)
  - on vegetation (carp, perch)
  - on fine substrates (smelt)

Reproductive strategies

non-guarders

- pelagic (broadcast) spawners
- benthic spawners
- brood hiders

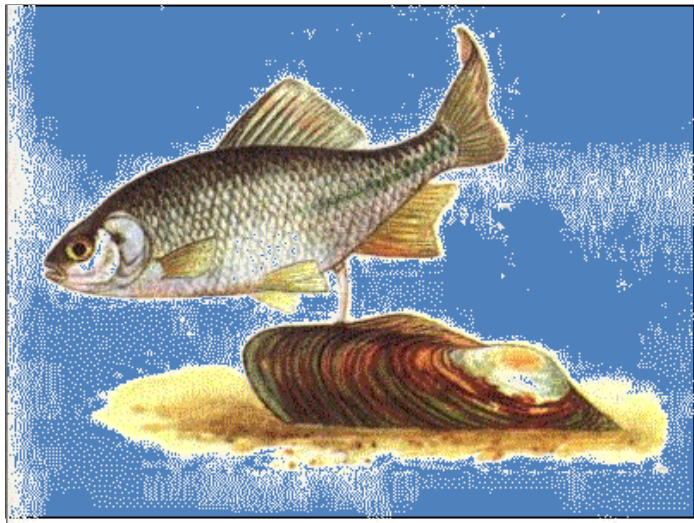
build redd on coarse substrates (salmon, lamprey)

credit: Thomas B. Dunklin

Reproductive strategies

non-guarders

- pelagic (broadcast) spawners
- benthic spawners
- brood hiders
    - build redd on coarse substrates (salmon, lamprey)
    - beach spawners (grunion)
    - use another species (bitterling)



Reproductive strategies

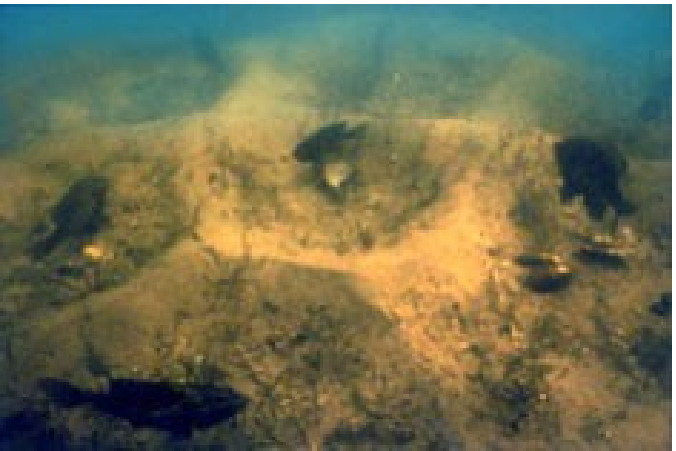
guarders

- nest builders (largemouth bass)

Reproductive strategies

guarders

- nest builders (largemouth bass)
  - rock and gravel (like a lentic redd - sunfishes)
  - plant material (sticklebacks)
  - holes, crevices, cavities (gobies, sculpin, blennies)
  - froth (bettas)
  - anemones (clown fish)



Reproductive strategies

Bearers - carry eggs and/or fry with them

Reproductive strategies

Bearers

- external bearers

transfer: Gasterosteidae, Sygnathidae (pipefishes, seahorses)

grade from attachment to skin, to open pouch, to closed pouch

gill chambers, forehead

obstetrical catfish carry eggs on ventral surface

Reproductive strategies

Bearers

- external bearers

mouth: males or females

some cichlids and bonytongues

Alternative reproductive strategies

Hermaphroditism

synchronous (or simultaneous) hermaphrodites

Myctophiformes: (laternfishes) - several families
Atheriniformes: Aplocheilidae, Poeciliidae
Perciformes: Serranidae (sea basses, hamlets),
Labridae (wrasses), and others

"Egg-trading" in black hamlets *Hypoplectrus nigricans* (serranid)

Alternative reproductive strategies

Hermaphroditism

consecutive (sequential) hermaphrodites

first male (protandrous) – less common

first female (protogynous)

Synbranchiformes (swamp eels – only freshwater example)

Perciformes: Serranidae, Maenidae, Labridae

from 100% female -> 100% male

from 100% female -> 50% male / 50% female

some do not pass thru a female stage ("primary males")

Alternative reproductive strategies

parthenogenesis:
females produce diploid eggs, no sperm used
premeiotic endomitosis - mitotic division without cytokinesis

gynogenesis:
females produce diploid eggs, use sperm to stimulate development
male genome not used
congeneric species arne used for sperm

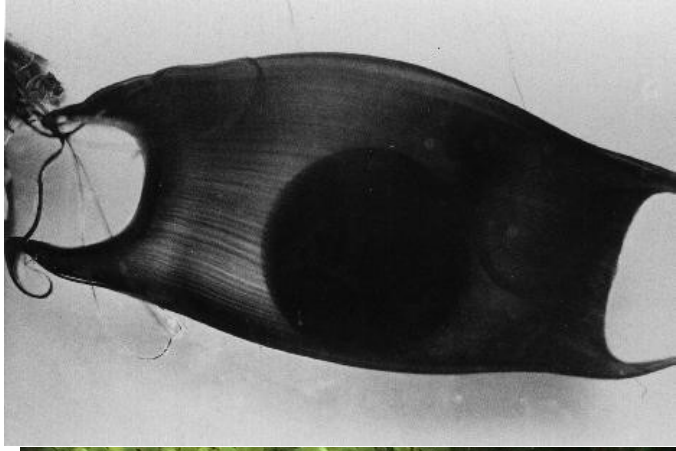
hybridogenesis: one genome from female in egg,
male genome discarded - then uses sperm to restore ploidy
- no crossing over
example: *Poeciliopsis monacha-lucida*

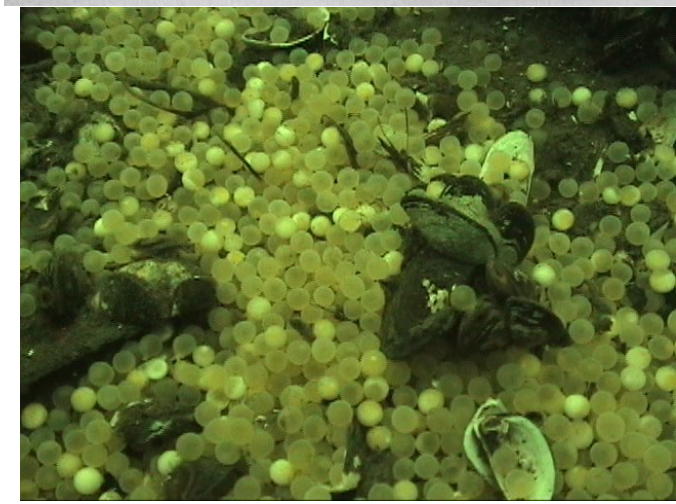
DEVELOPMENT

Developmental stages

egg <0.5 mm - 10 cm
variable shape, attachments
variable buoyancy
water hardening

skate
(5 cm)





lake trout
(5 mm)

yellow perch egg mass

round goby
(0.5 mm)

Developmental stages

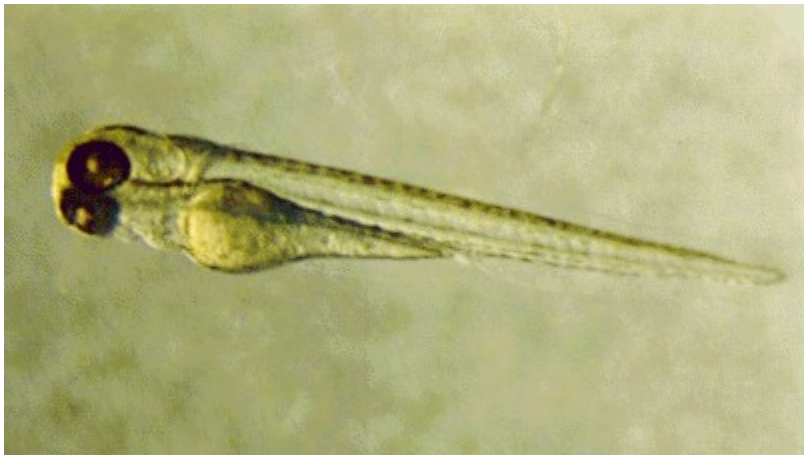
embryo - dependent on mother or yolk sac for food (free embryo)

Susan Middleton & David Liittschwager

Credit: Fly Anglers online

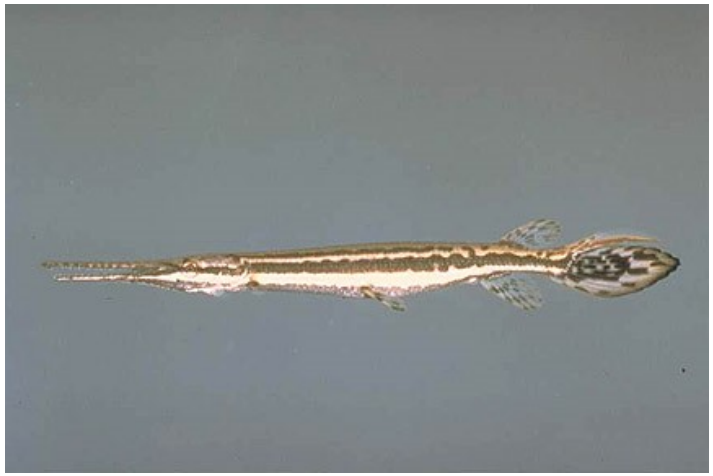
Developmental stages

embryo - dependent on mother or yolk sac for food (free embryo)
larvae - not fully functional, may look totally unlike adult
ends when axial skeleton is formed



Developmental stages

juvenile - small functional individual, immature
adult - reproductively mature



Control of reproduction

- Advancement or retardation of spawning
- No maturation to conserve energy and increase immunity
- Availability of fish at appropriate time/size
- Continuous production and marketing

Control of Reproduction

- Manipulation of the reproductive cycle
- Induction of spawning

HYPOTHALAMO-PITUITARY-TESTIS AXIS

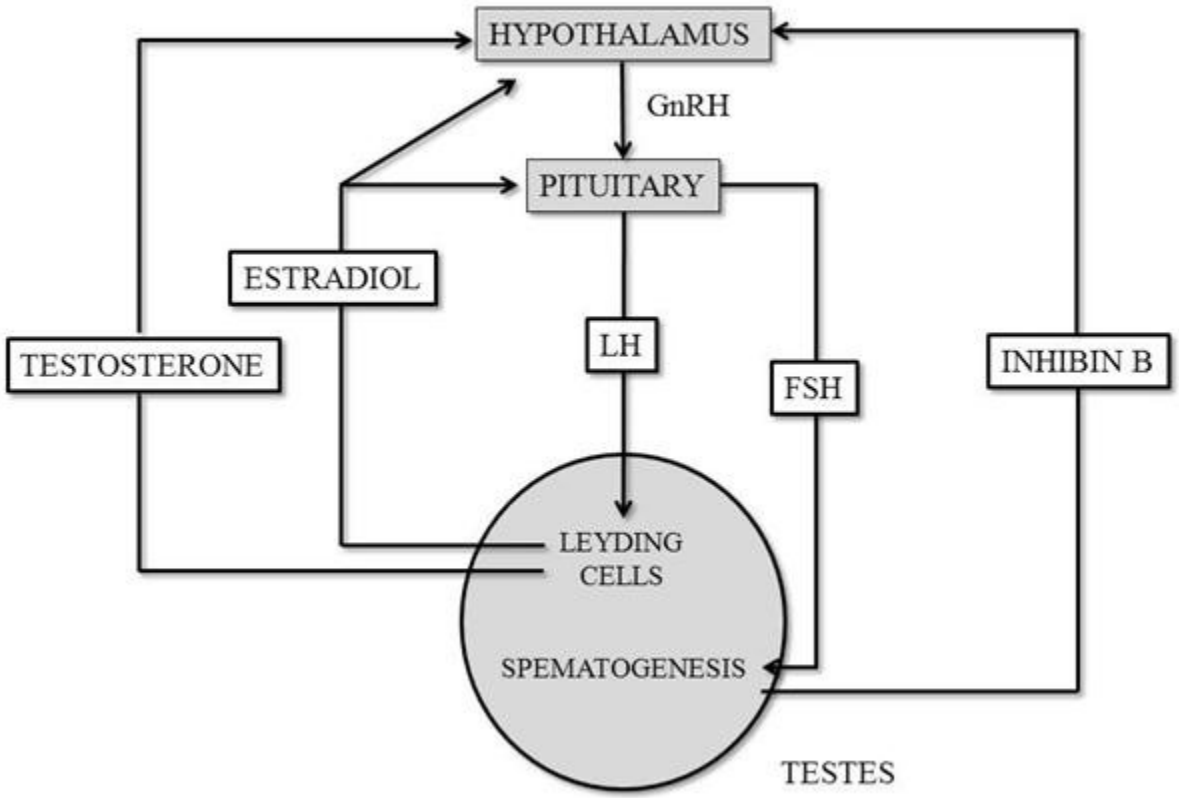
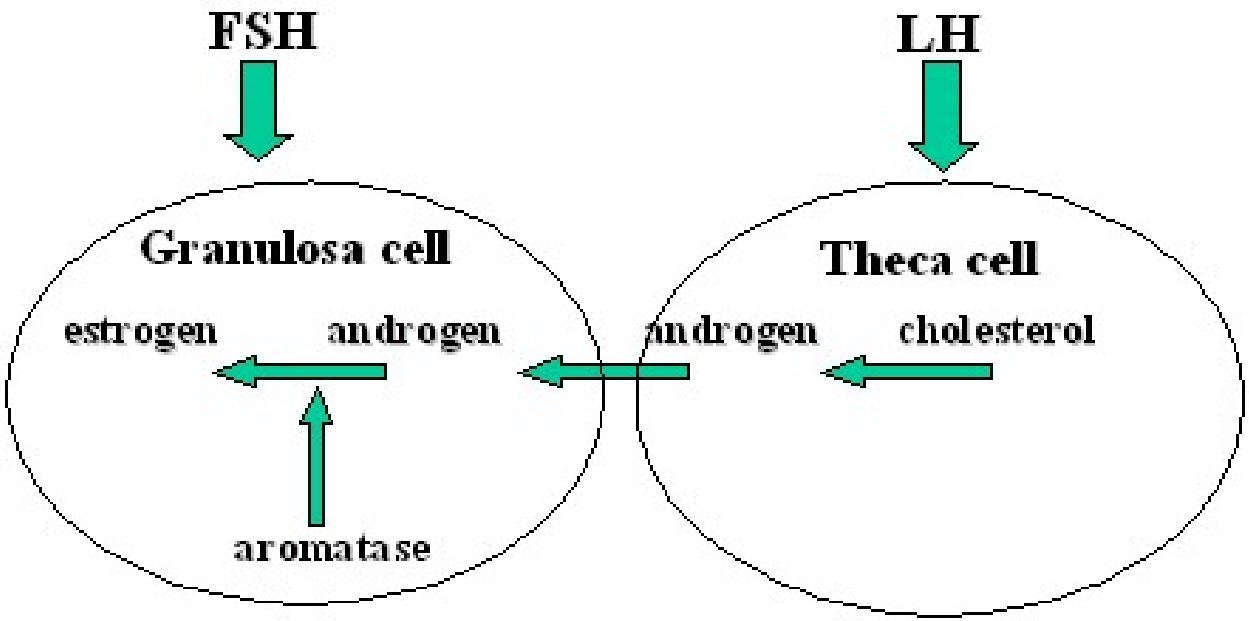
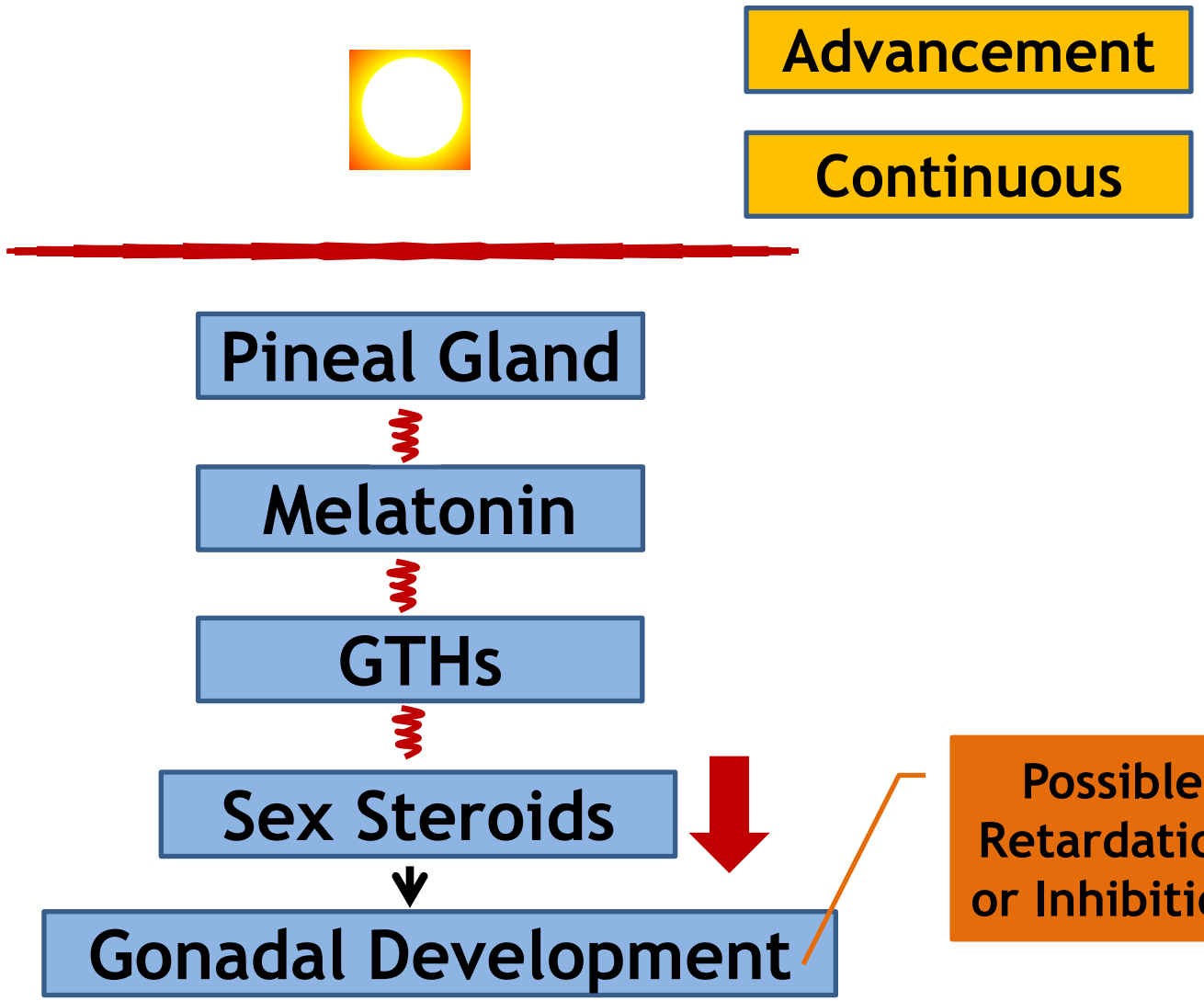


Figure 3


FSH
LH
Granulosa cell
Theca cell
estrogen
androgen
androgen
cholesterol
aromatase


Advancement
Continuous
Pineal Gland
Melatonin
GTHs
Sex Steroids
Gonadal Development
Possible Retardation or Inhibition

Induced reproduction

- Mammalian LH
- Mammalian HCG
- Pituitary extract
- Given in form of injections or LH pallets implants
- Species specific dosage and timing


ACE

Artificial fertilization
Gathering eggs and artificial fertilization

- Gathering eggs is made from perfect sexually matured females. At the time harvesting eggs, the fish is hold by rolling up with a towel around the head and tail, is hold by head with left hand in position with tail down so that by gently palpation of abdomen, eggs to fall in jar prepared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