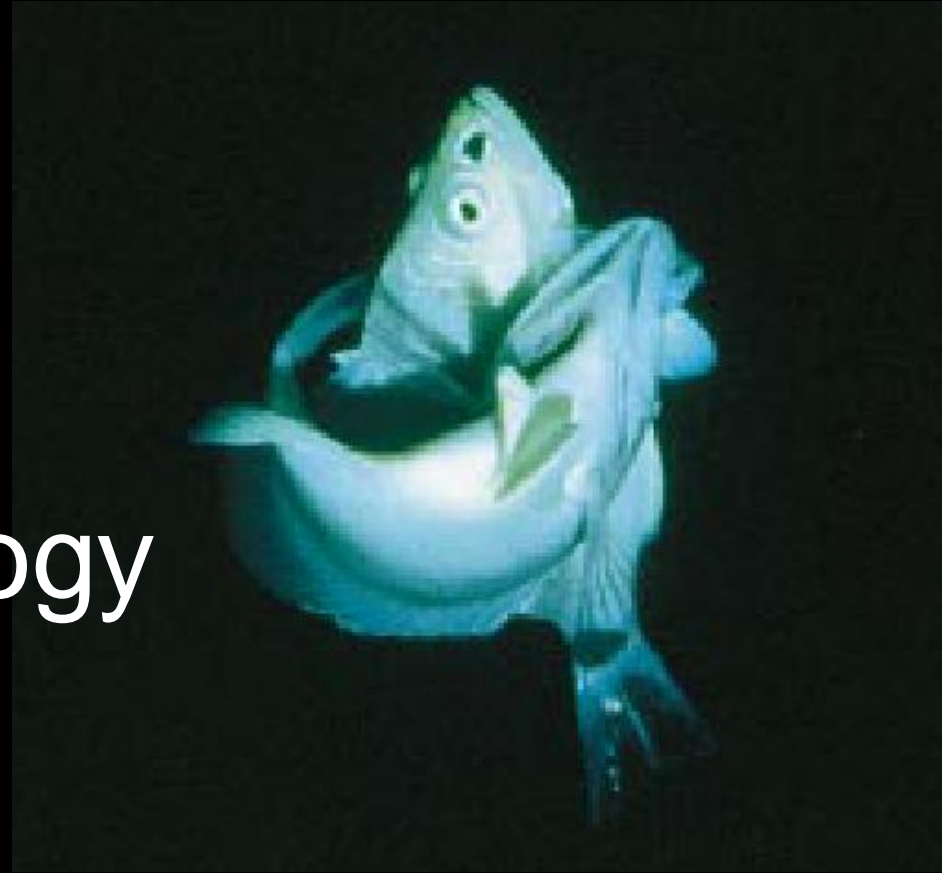


Lecture 3

Guidelines for Reproductive Biology







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Photos by Margaret Marchaterre (1998)



(courtesy Gordon Haas, lecture notes, Alaska)







(courtesy Gordon Haas, lecture notes, Alaska)

Reproduction studies

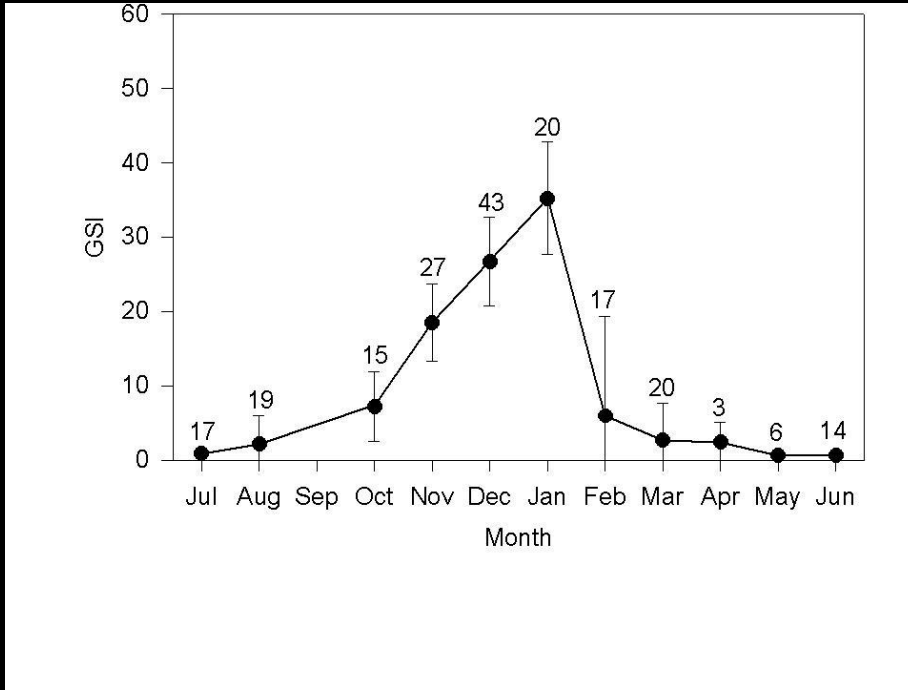
- Different fish species have different reproductive strategies.
- Understanding reproductive processes is important for:
 - Understanding life-history and evolutionary success.
 - Managing fisheries.
 - Successful aquaculture.
- How, when, where & how many?

Typical Key Questions

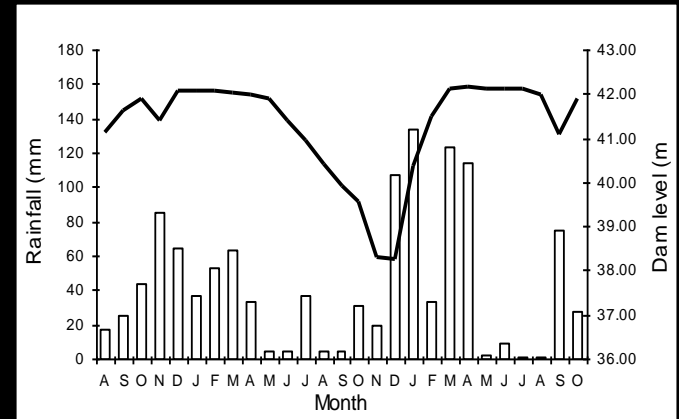
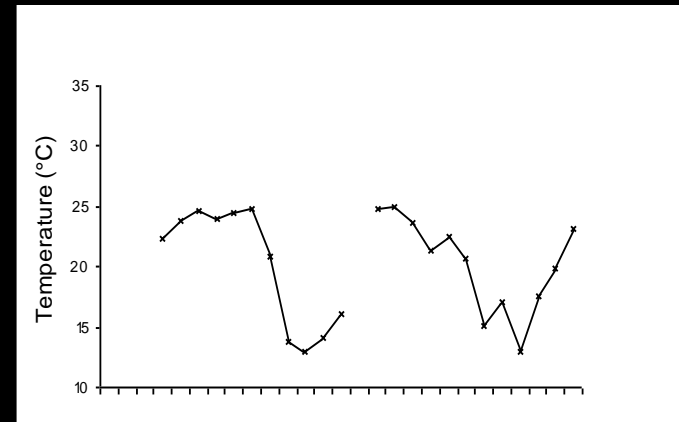
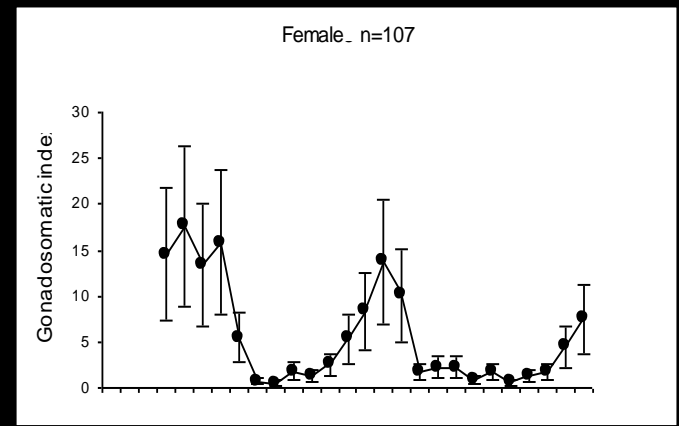
- When is the spawning season?
- Where do the fish spawn?
- What is the size/age at maturity?
- What environmental factors influence the spawning period?

WHEN - season?

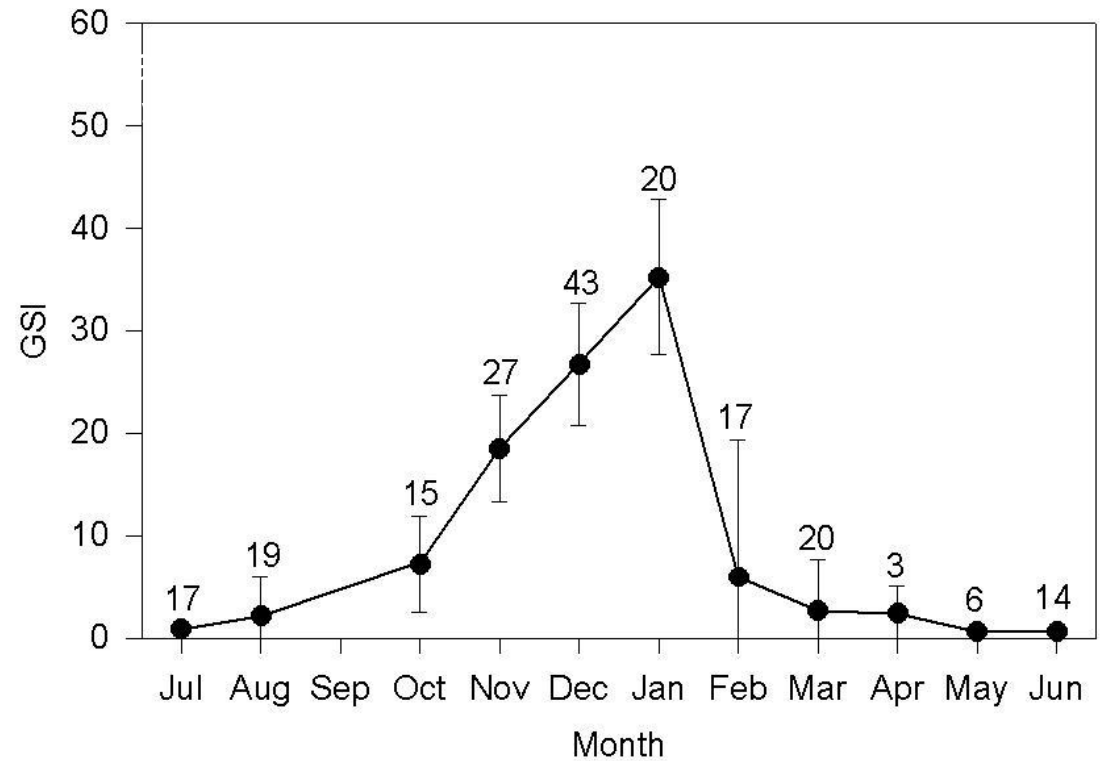
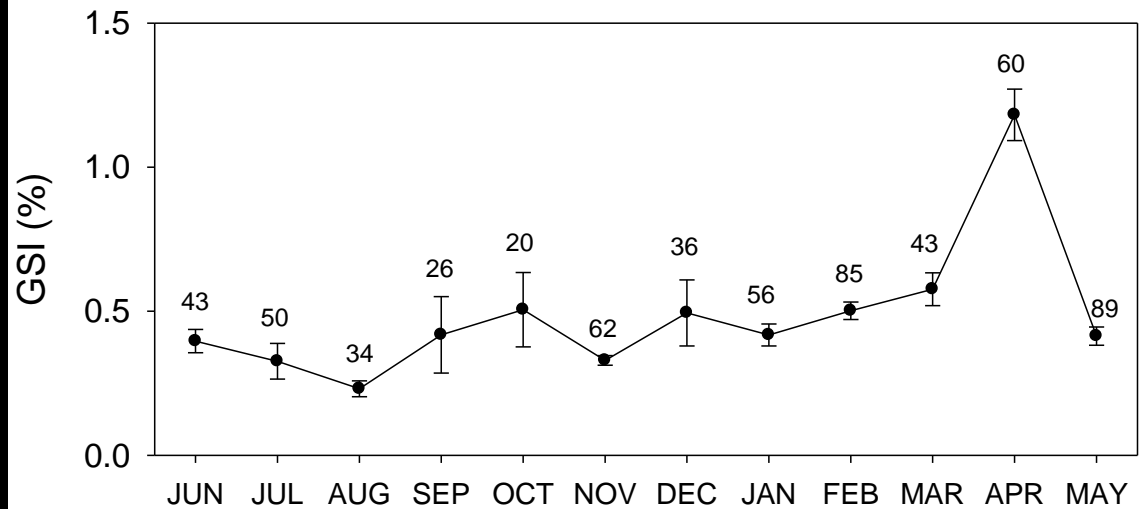
Gonadosomatic Index

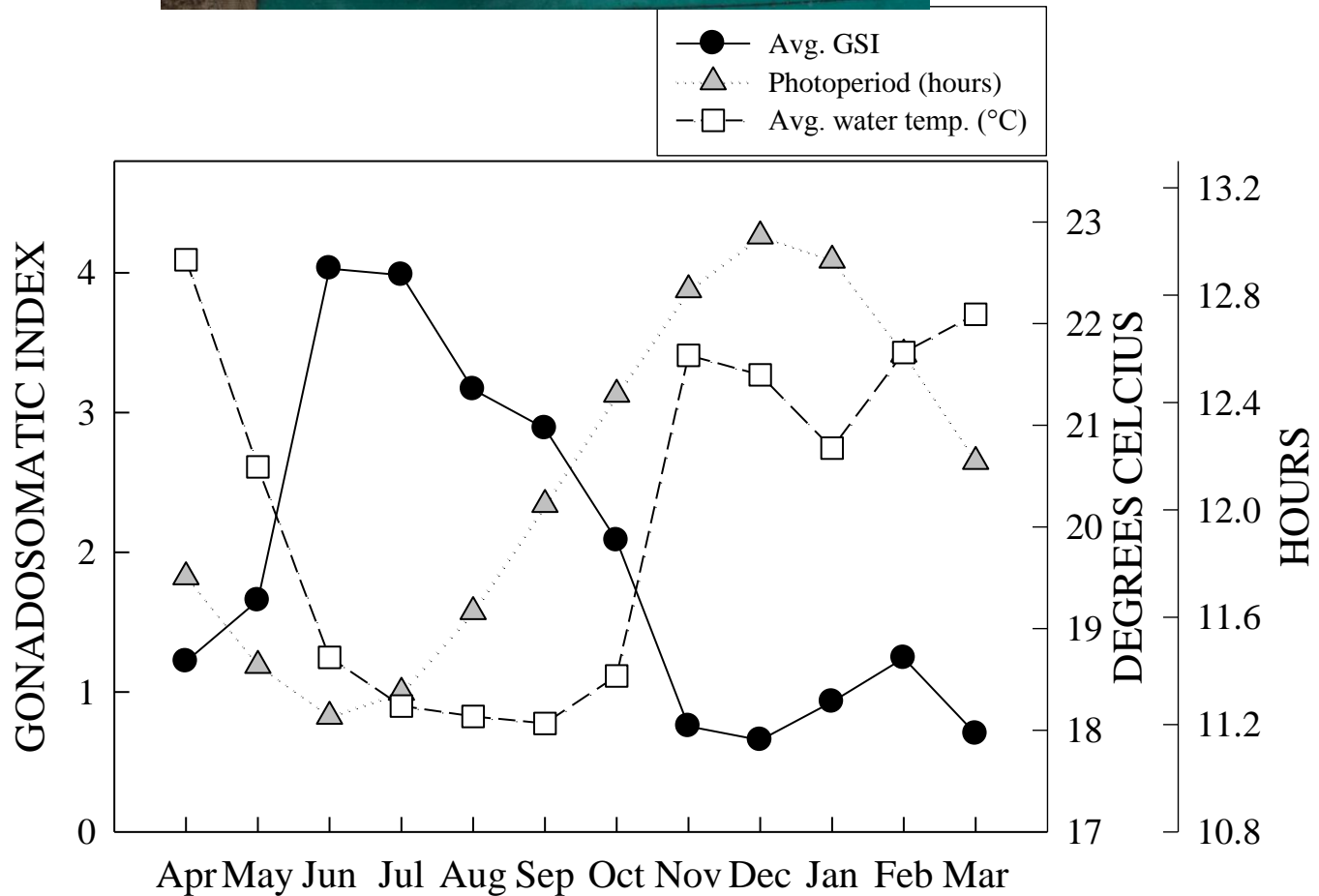


Labeo cylindricus (Weyl & Booth 2000)



Relative change in GSI





Two spawning peaks

J of Marine Science 9

1990

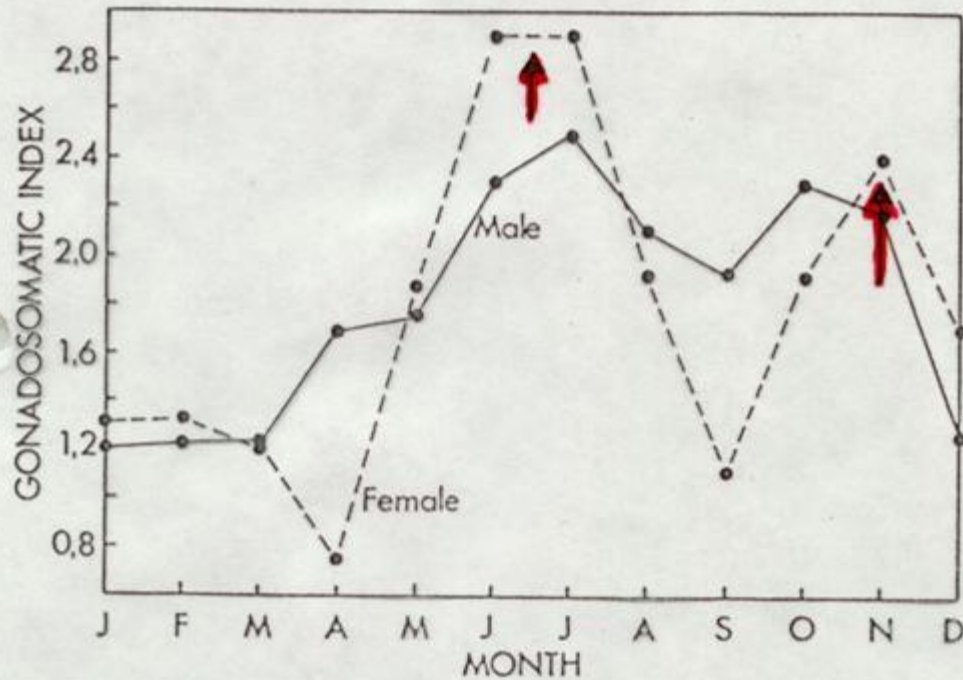


Fig. 7: Monthly gonadosomatic index for female and male horse mackerel on the South-East Coast. Arrows indicate spawning peaks

Macroscopic Staging

Stage 1: Immature

Very small sexual organs close under the vertebral column, usually transparent. Young individuals which have not yet engaged in reproduction.

Stage 2: Quiescent or Inactive/Recovering

Sexual organs still small and translucent. Gonads appear as a gelatinous mass. Eggs usually cannot be seen by naked eye.

Stage 3: Developing or Active

Testes and ovaries opaque, reddish-white in colour with blood capillaries. Eggs visible to the naked eye.

Stage 4: Active / Ripe

Ovaries occupy about two thirds of abdominal cavity. No sperm or eggs are extruded on applying pressure to abdomen. Eggs clearly visible, testes occupy about one third of abdominal cavity.

Stage 5: Ripe

Ovaries usually occupy whole of abdominal cavity. Eggs begin to be translucent. Testes have usually become enlarged and are creamy white in colour. The gonads during this stage have usually attained maximum size at this stage. Eggs and sperm can be extruded by pressure exerted on abdomen.

Stage 6: Spawning

Eggs and spawning are extruded by applying pressure to abdomen.

Stage 7: Spent

The gonads are deflated and bloodshot.

•size

•position

•colour

•extrude?

♂ 2
Resting



Stage 2: Quiescent or Inactive/Recovering

Sexual organs still small and translucent. Gonads appear as a gelatinous mass. Eggs usually cannot be seen by naked eye.

♂ 3
Active



Stage 3: Developing or Active

Testes and ovaries opaque, reddish-white in colour with blood capillaries. Eggs visible to the naked eye.

♂ 4
DEVELOPING



Stage 4: Active / Ripe

Ovaries occupy about two thirds of abdominal cavity. No sperm or eggs are extruded on applying pressure to abdomen. Eggs clearly visible. testes occupy about one third of abdominal cavity.

♂ 6
RIPE RUNNING



Stage 6: Spawning

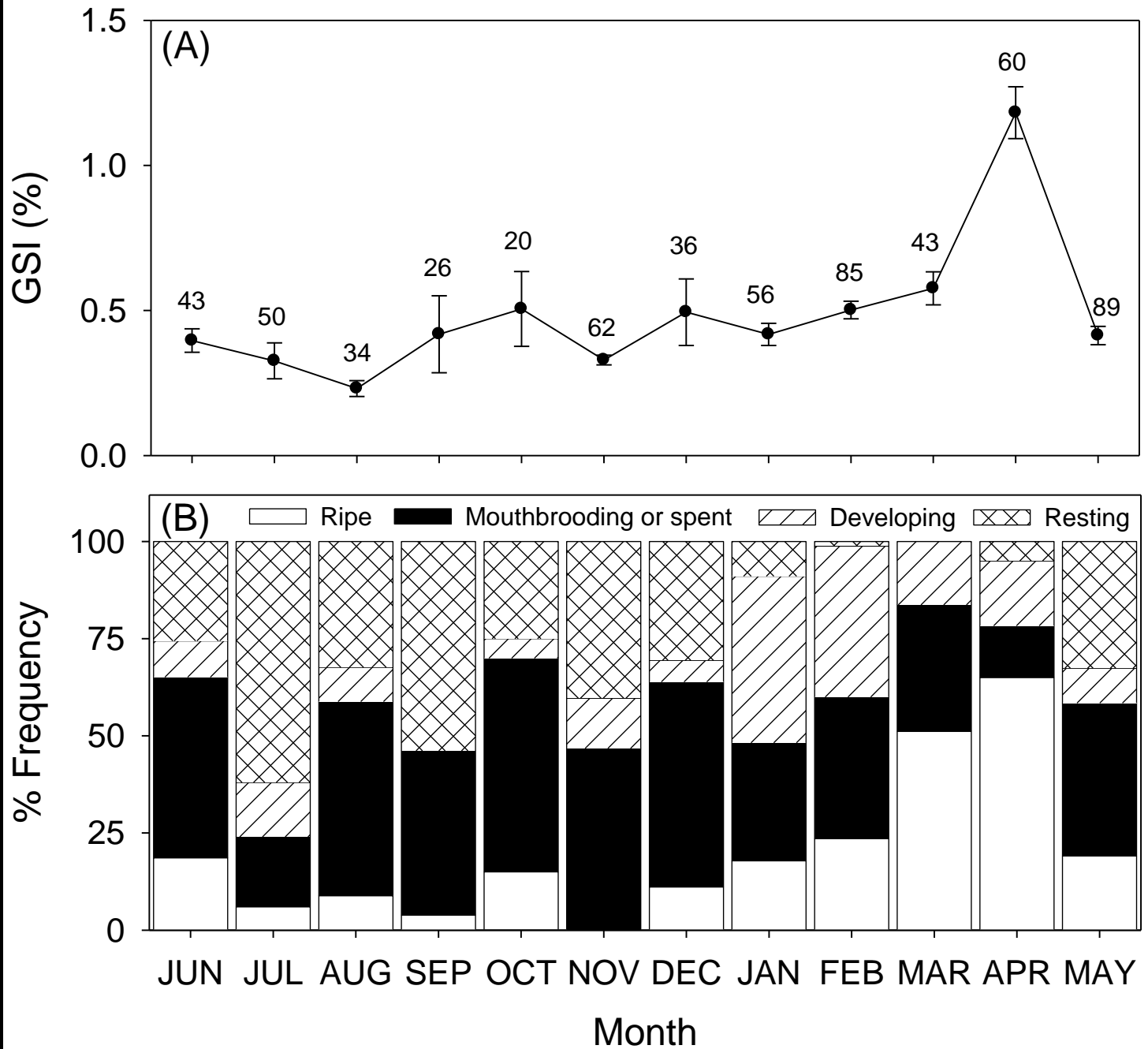
Eggs and spawning are extruded by applying pressure to abdomen.

Stage 7: Spent

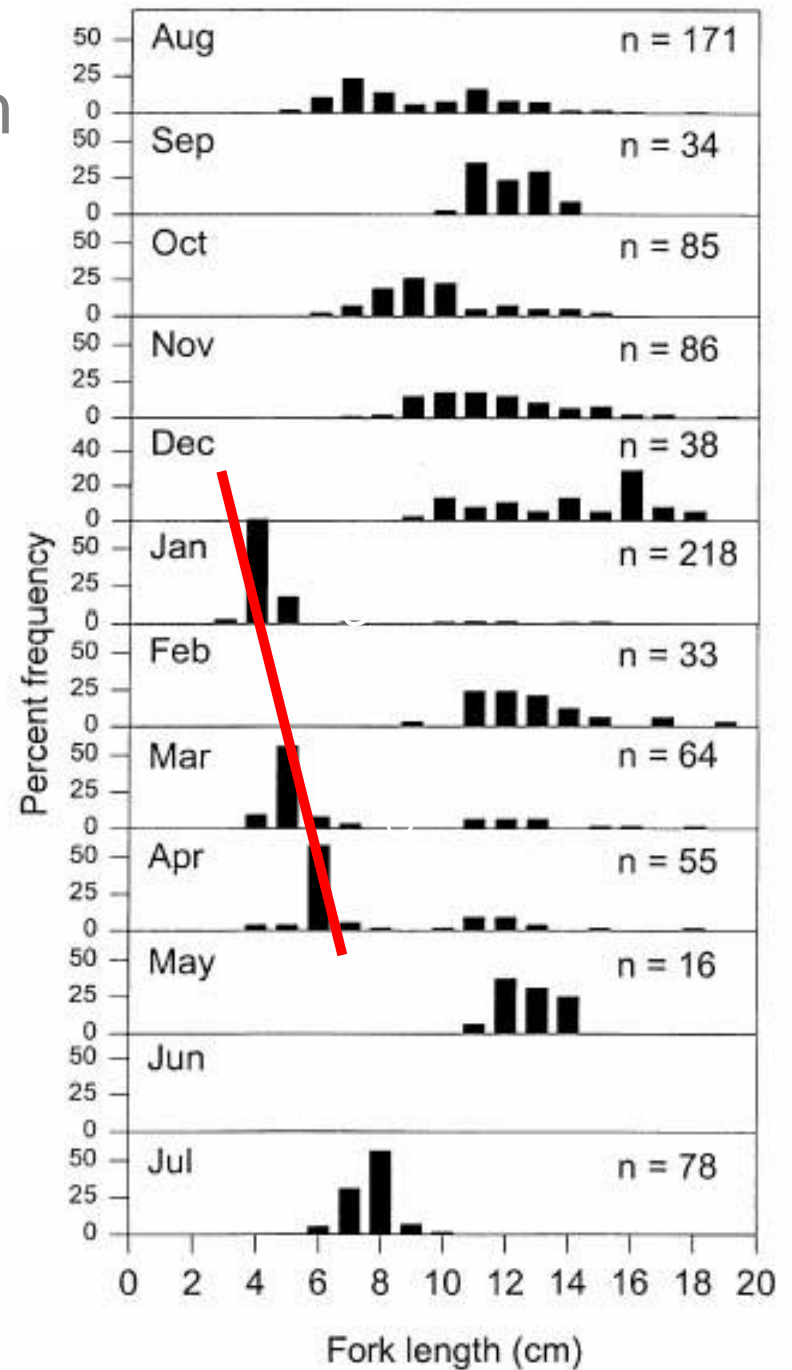
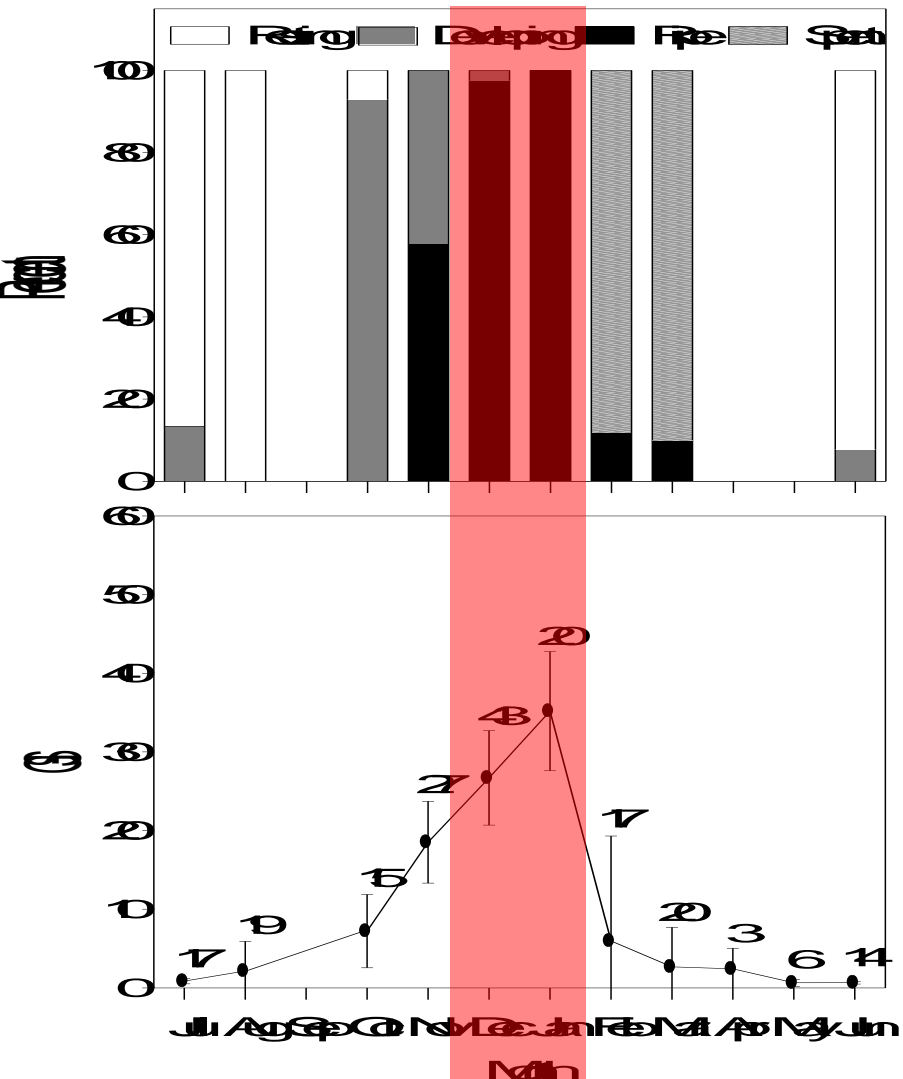
The gonads are deflated and bloodshot



Stage	<i>Labeo victoreanus</i> (Rutaisire & Booth in press)	<i>Labeo umbratus</i> (Potts <i>et al</i> 2006)	<i>Pterogymnus laniarius</i> (Booth 1997)
I	Juvenile: Ovary thick, straight, translucent, strap-like structure.	Juvenile: Not possible to visibly distinguish sex. Gonad appears as a translucent gelatinous strip	Virgin & Resting: Ovotestis long and thin, pink in colour with no visible eggs in ovarian element.
II	Regressed: Ovary straight, flaccid, yellowish structure.	Resting: Ovaries white or slightly yellowish. Oocytes are distinguishable.	
III	Maturing: Ovary straight. Ova visible through the capsule. Ovary increases in size and started forming lobes.	Developing: Ovary enlarged, oocytes readily visible and yellow.	Developing: Ovotestis increases in size, filling half or more of the visceral cavity becoming darker orange with grainy appearance due to visible eggs in ovarian element.
IV	Ripe: Ovary fully distended and fills the abdominal cavity. Oocyte olive green and easily shed on application of slight pressure on the ovary.	Ripe: Oocytes of maximum size, readily extruded from female under abdominal pressure.	Active: Ovary swollen with orange-yellow and translucent eggs visible in the tissue and lumen.
V	Spent: Ovary flaccid and often haemorrhagic if spawning was successful. Few oocytes visible giving the ovary a speckled appearance.	Spent: Ovaries flaccid and sac-like with few vitellogenic oocytes visible.	Post-spawning: Ovary slightly flaccid with few translucent eggs visible. Brown spots noticeable over most of the gonad.



Macroscopic staging and GSI can be accompanied by a length frequency analysis



Frequency within a spawning season

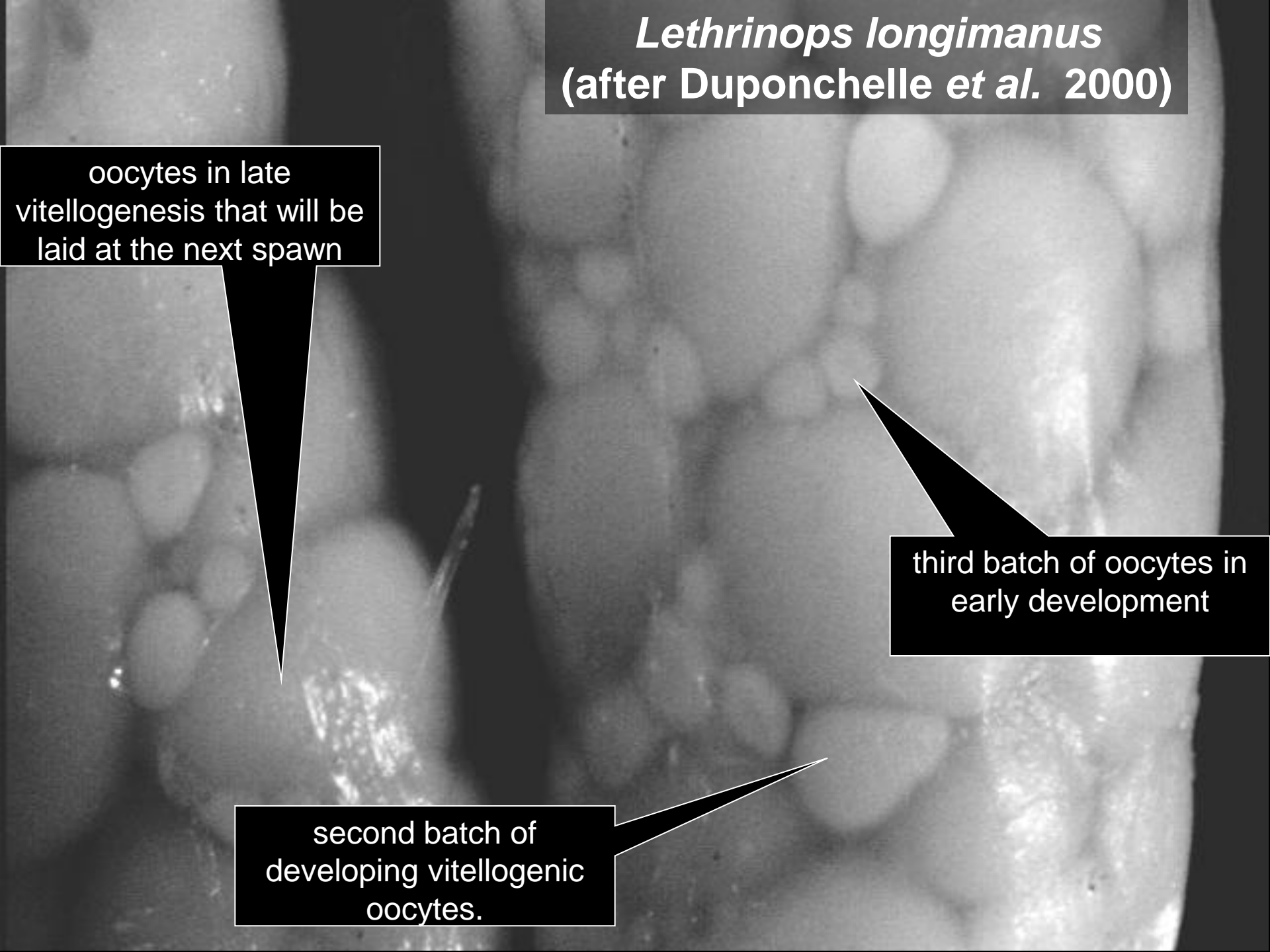
- Synchronous (semelparous) – all oocytes develop synchronously and ovulate at the same time (e.g. Labeos, Clarias, Pacific salmon)
- Group synchronous (iteroparous) – vitellogenic oocytes are divided into groups which ovulate over the course of one breeding season (e.g. rainbow trout, panga).
- Asynchronous – oocytes of all developmental stages are present in the ovary (tropical cichlids).

Lethrinops longimanus
(after Duponchelle *et al.* 2000)

oocytes in late
vitellogenesis that will be
laid at the next spawn

third batch of oocytes in
early development

second batch of
developing vitellogenic
oocytes.

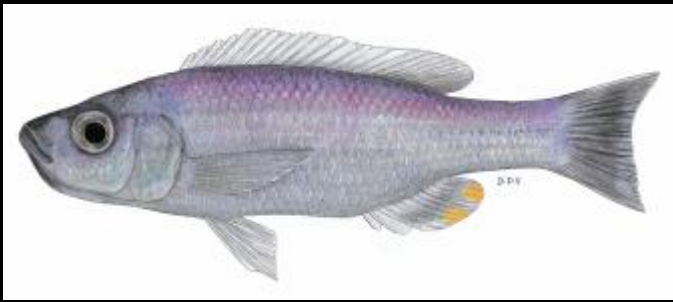


When do they mature?

- First maturity
 - Size/age at which 1st fish in a population become sexually mature
- 50% maturity
 - Size/age at which $\frac{1}{2}$ fish in the population are sexually mature.
- 100% maturity
 - size/age at which all fish in a population are sexually mature.

Stage	<i>Labeo victoreanus</i> (Rutaisire & Booth in press)	<i>Labeo umbratus</i> (Potts <i>et al</i> 2006)	<i>Pterogymnus laniarius</i> (Booth 1997)
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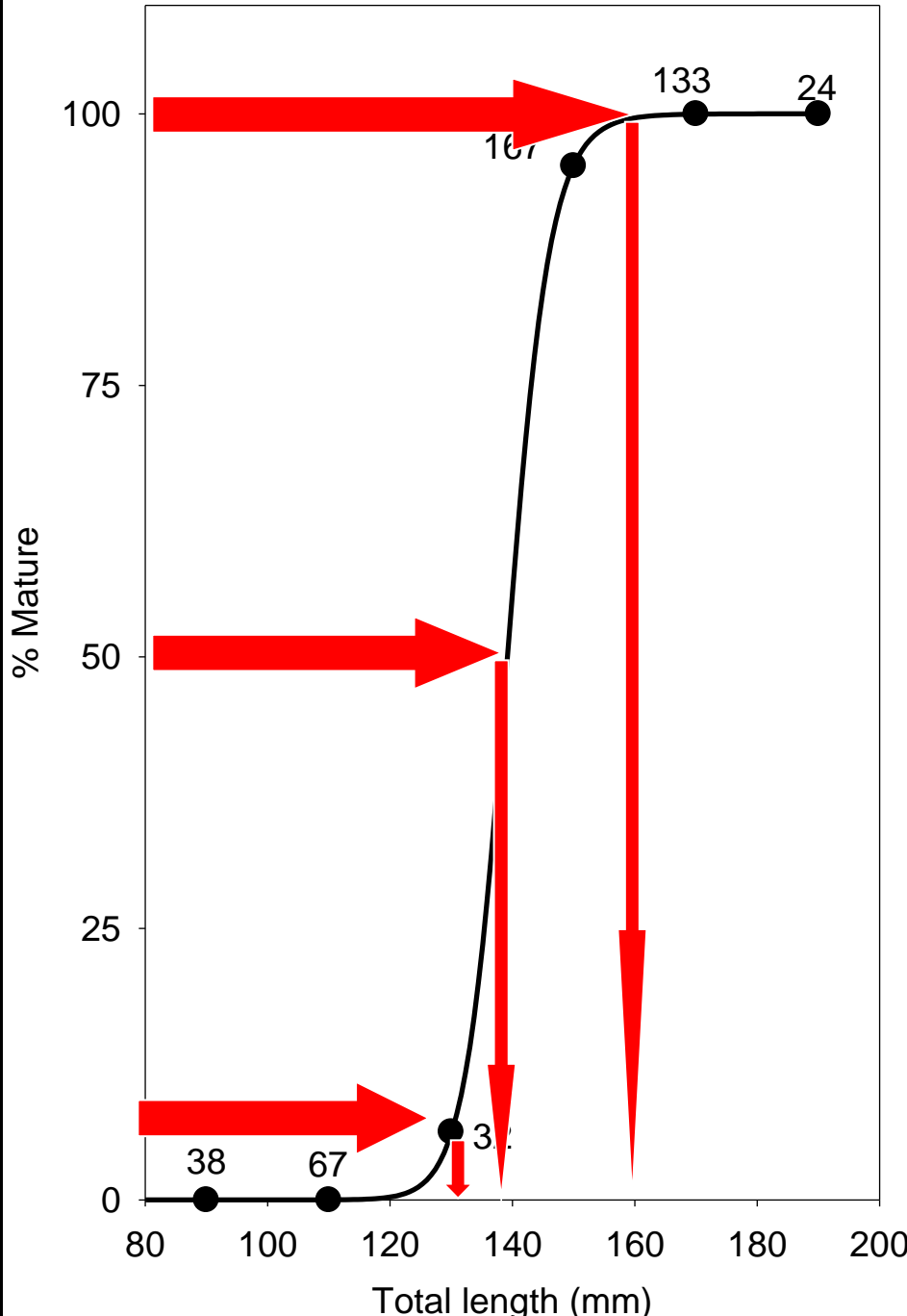
MATURE	MATURE		
	Maturing: Ovary straight. Ova visible through the capsule. Ovary increases in size and started forming lobes.	Developing: Ovary enlarged, oocytes readily visible and yellow.	Developing: Ovotestis increases in size, filling half or more of the visceral cavity becoming darker orange with grainy appearance due to visible eggs in ovarian element.
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- Fit a 2-parameter logistic ogive (see King 1995 for worked example)

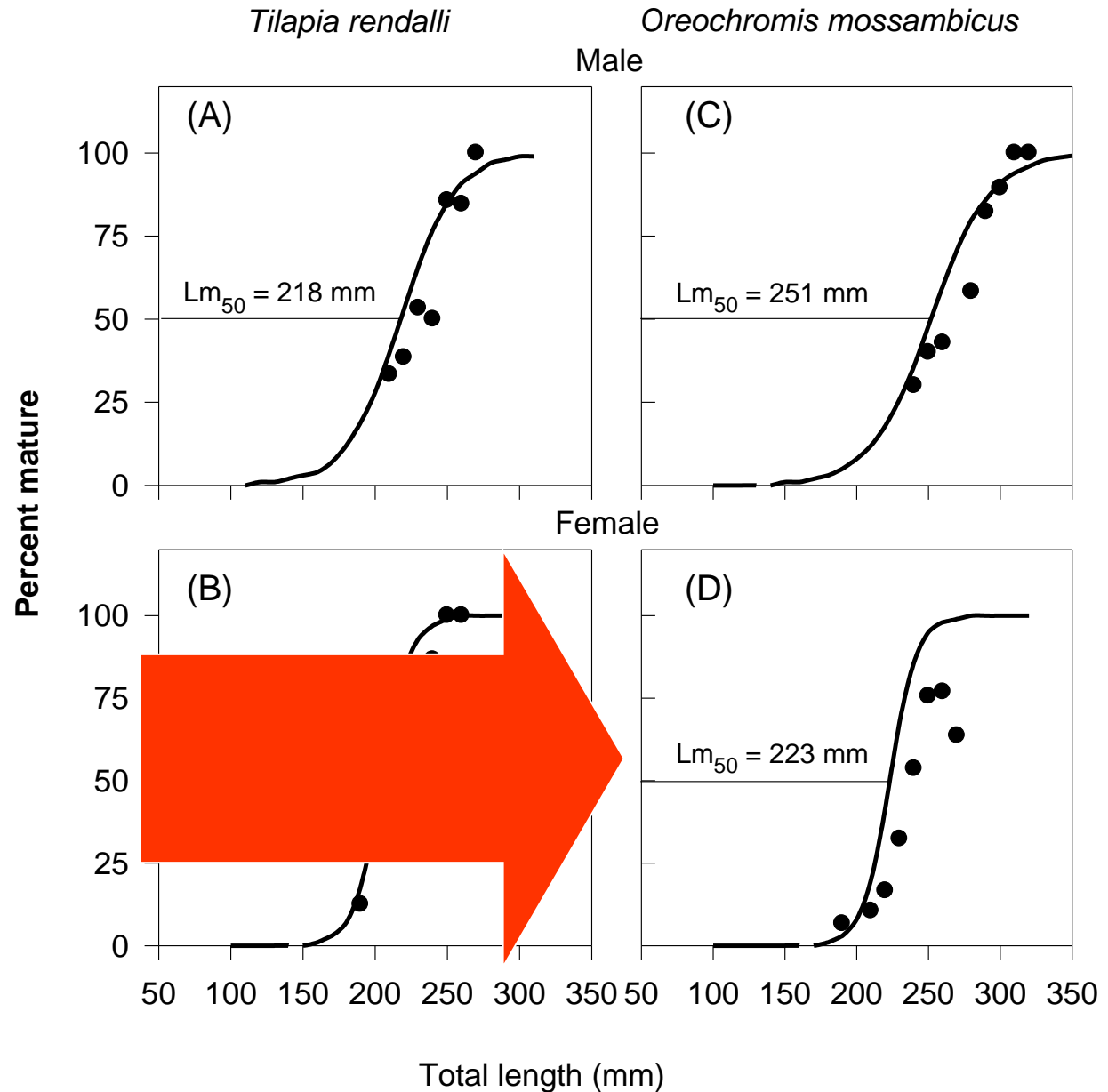
$$P(L) = \frac{1}{1 + e^{-(L-L_{50})/\delta}}$$

P(L) = % of mature fish at length L
L₅₀ = Length at 50% sexual maturity
δ = Width or steepness of ogive



What if not all fish in the population are mature at the same time?

- Seriously overestimate size at maturity.
- Samples corrected using a raising factor (see King 1995).



Sampling

- With all of the spawning season methods, at least monthly sampling for an entire year is required.
- A minimum number of mature males and females (± 30 each) are required for rigorous results.

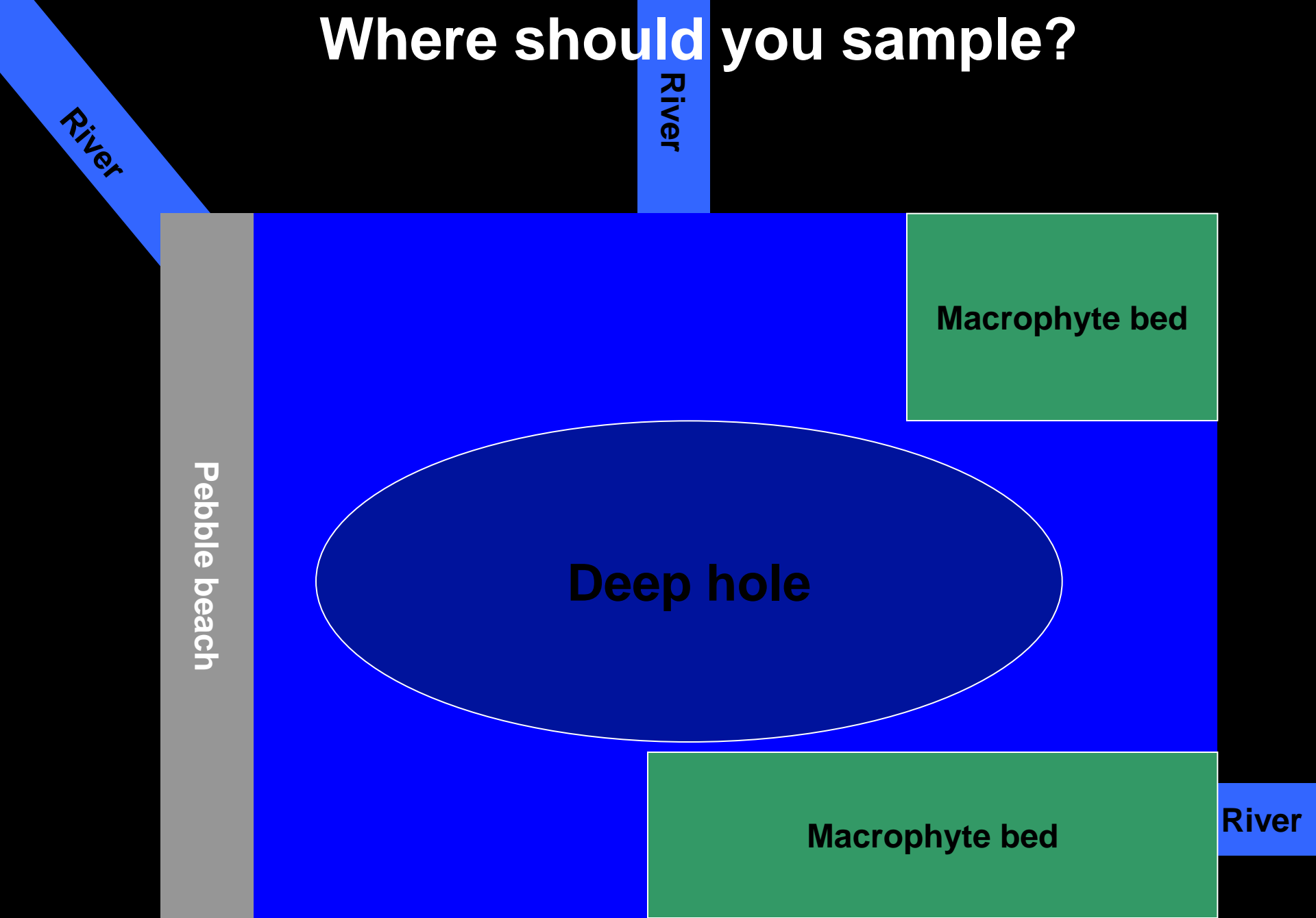
GEAR TYPES

Gear type will not influence the results directly, but you must try to get a sample with a length frequency representative of the population under study. This often means sampling in more than one habitat with multiple gears.

However, if you are sampling during the spawning season to estimate size at maturity, gears should be suited to the spawning habitat. Eg. If they spawn in rocky fast flowing, riverine habitats, gillnets could be the best sampling method.

Rod and line and longlines are seldom good for spawning fish as often fish do not feed actively during these times.

Where should you sample?



River

River

Macrophyte bed

Pebble beach

Deep hole

Macrophyte bed

River

end