

# Male mating strategies –how might they impact hermaphrodite management?

- Group spawning –Sperm competitors
- Territoriality –Mate competitors
  - Leks
  - Harems


# Group spawning and sperm competition

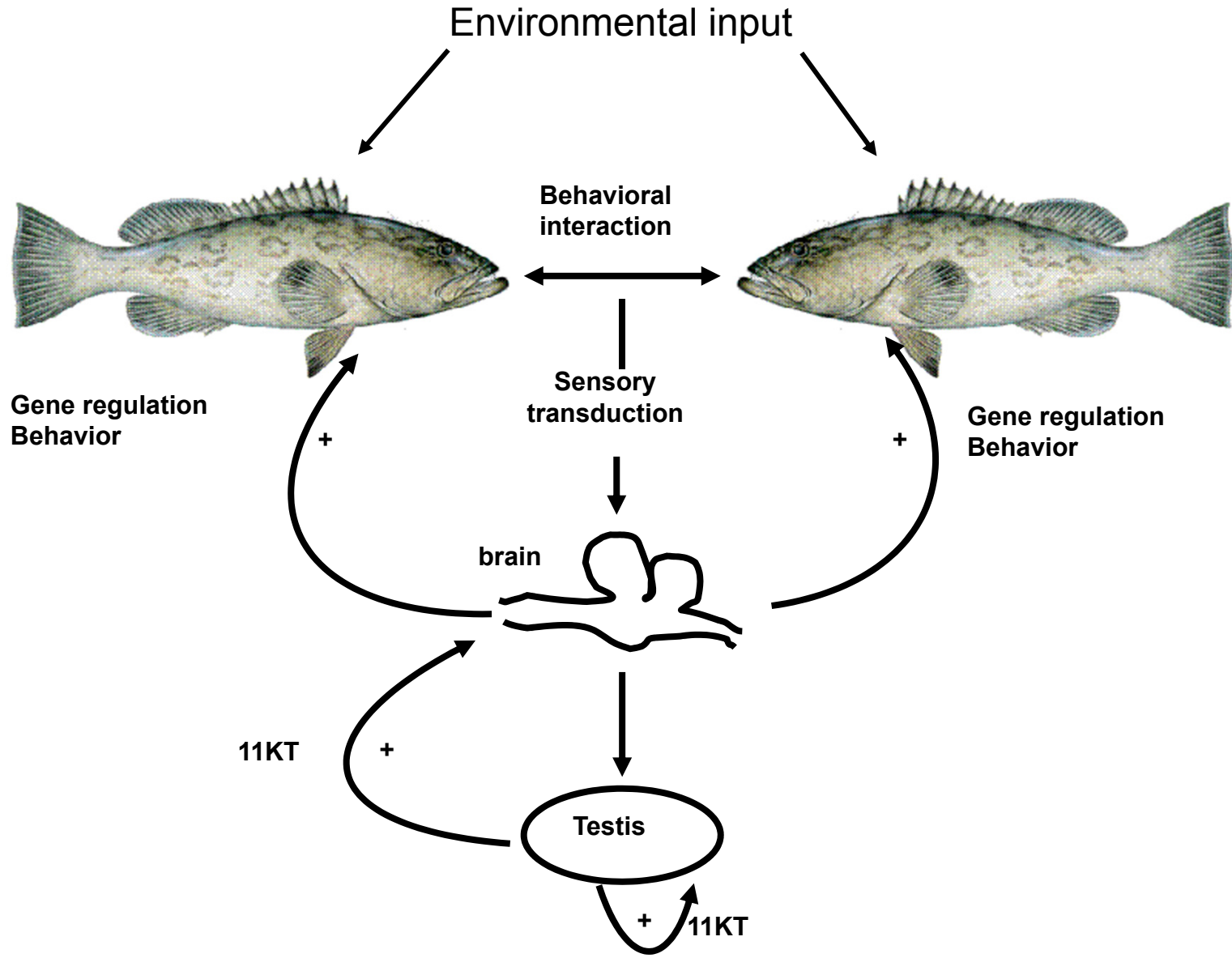
# Territoriality and mate competition



# Territorial behavior in tiger grouper

# Male reproductive tactics, disruption of mating strategies, and “*The Challenge Hypothesis*”

- Multiple strategies for reproductive success
  - Primary/territorial males
    - Aggressive
    - High androgen levels
    - Small testes
  - Secondary males (Sneakers, streakers, and satellite males)
    - Non-aggressive
    - Low androgen levels
    - Large testes
    - Also the tactic of group spawners
- The challenge hypothesis (Wingfield 1984)
  - Territoriality
  - Aggression
  - Mate competition  **Hormone positive feedback loops**



# Spawning strategy

Species	Spawning strategy	Agg. size
<i>E. striatus</i>	Non-territorial, group	1,000-10,000's
<i>E. guttatus</i>	Territorial, pair	100-1000's
<i>E. morio</i>	Territorial, pair	10's+
<i>M. microlepis</i>	Territorial, pair	100-1000's

# Gonadosomatic index in four species of grouper

Species	GSI	SEM	Measurement	Source
<i>E. striatus</i>	9.4	0.9	average	Tucker et al. 1993
	10		maximum	Sadovy and Colin 1995
<i>E. guttatus</i>	0.66		average	Sadovy et al. 1994
<i>E. morio</i>	0.38	0.05	average	Collins et al. 1998
	0.3	0.04	average	Johnson 1995
<i>M. microlepis</i>	0.56		average	Hood and Schlieder 1992
	1.83		maximum	Collins et al. 1998



# Role of androgens in male reproduction

## Testosterone

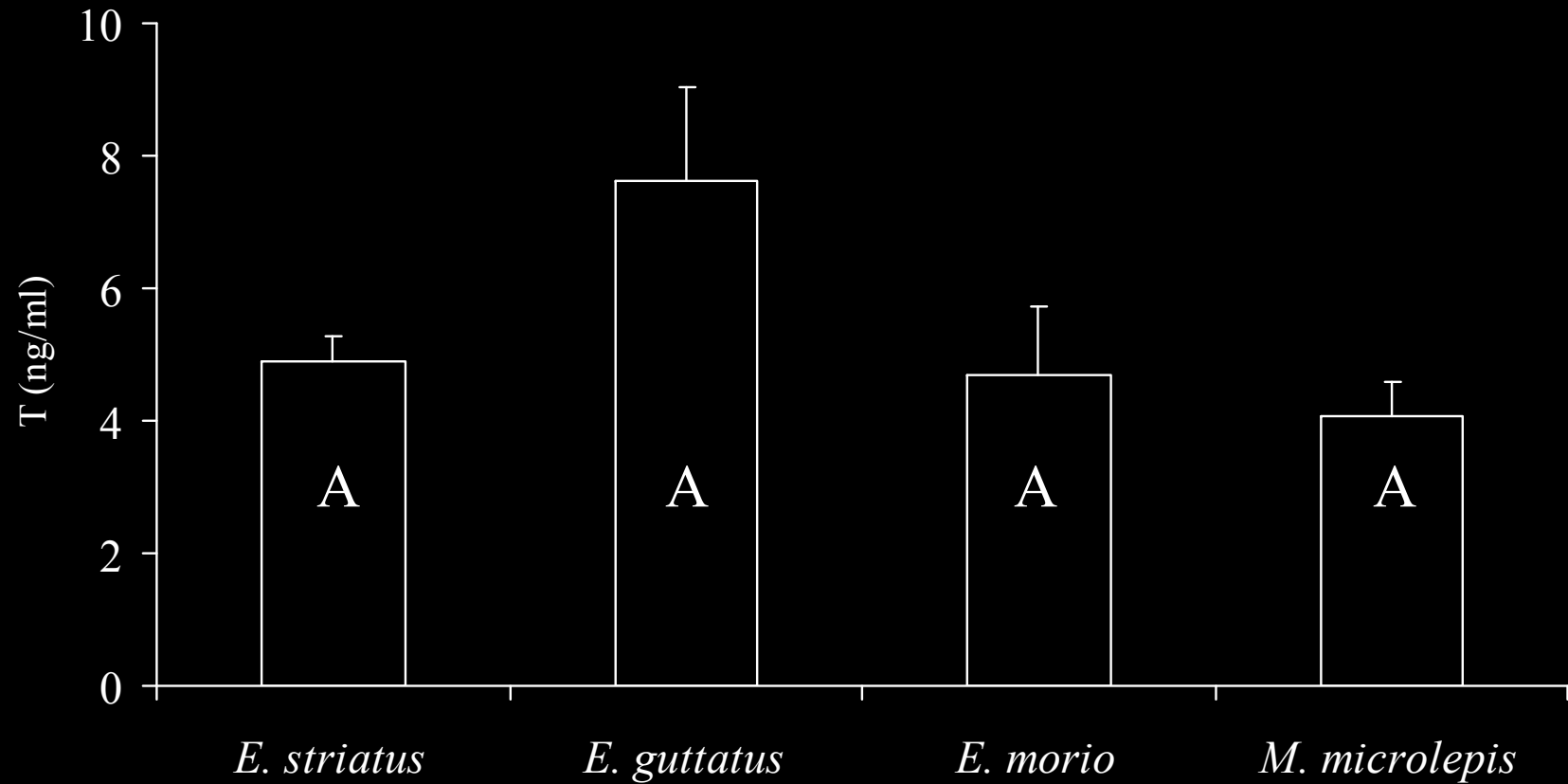
- Sex differentiation and development
- Stimulates the pituitary to induce spermatogenesis
- Precursor to  $E_2$  and KT

## 11-ketotestosterone

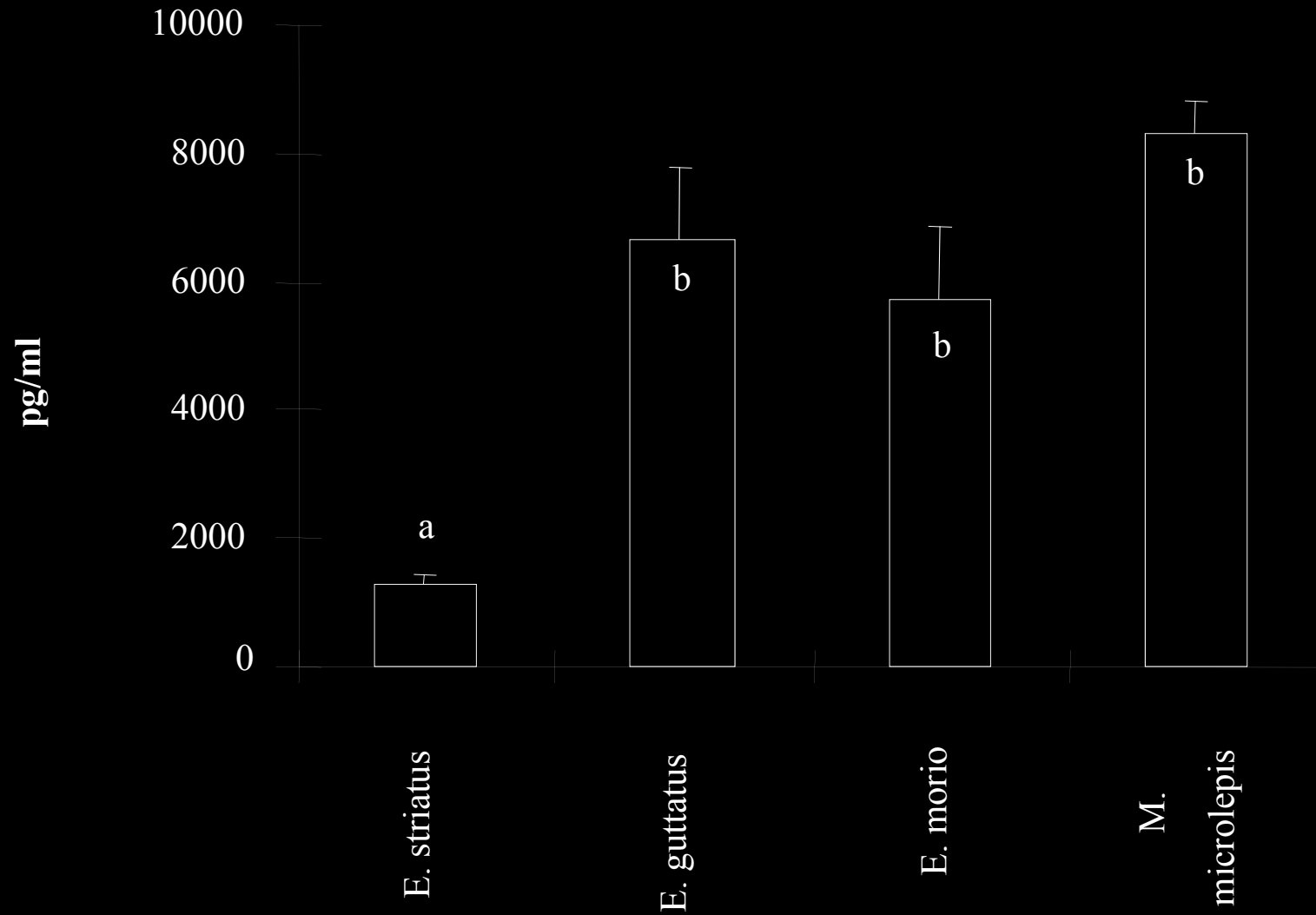
- Territoriality
- Nest building
- Aggression
- Secondary sex characteristics
- Spermatogenesis and sperm maturation
- Tactic switching

# Testosterone

ANOVA  $p = 0.23$



# 11-ketotestosterone



Species	Morph	11KT (ng/ml)	11KT ratio	Reference
<b>Bluegill</b>				
<i>(L. macrochirus)</i>	Parental	13.8	15.3	Kindler et al. 1989
	Sneaker	1.2	1.3	
	Satellite	0.9	1.0	
<b>Garibaldi</b>				Sikkel 1993
<i>(H. rubicundus)</i>	Pre-mate	22.0	2.8	
	Brooding	8.0	1.0	
<b>Stoplight parrotfish</b>				Cardwell & Liley 1991
<i>(S. viride)</i>	Territorial	1.2	3.0	
	Bachelor	0.4	1.0	
<b>Saddleback wrasse</b>				Hourigan et al. 1991
<i>(T. duperrey)</i>				
	Late summer Terminal phase	3.4	2.7	
	Initial phase	1.3	1.0	
	Winter Terminal phase	3.5	3.2	
	Initial phase	1.1	1.0	
<b>Plainfin midshipman</b>				Brantley et al. 1993
<i>(P. notatus)*</i>	Type I	7.1	11.1	
	Type II	0.6	1.0	
<b>Baltic salmon</b>				Mayer et al 1990
<i>(S. salar)</i>	Anadromous	36.0	7.4	
	Mature parr	4.9	1.0	
<b>Brown trout</b>				
<i>(S. trutta)</i>	Dominant	44.3	2.6	Cardwell et al. 1996
	Subordinate	17.2	1.0	
<b>Grouper</b>				
<i>(E. striatus)</i>		1.3	1.0	Heppell, <i>in review</i>
<i>(E. guttatus)</i>		6.7	5.2	
<i>(E. morio)</i>		5.7	4.4	
<i>(M. microlepis)</i>		8.3	6.5	

# Sex ratio estimates for various groupers

Species	Sex ratio (M:F)	Location	Source
<i>Epinephelus striatus</i>	~2:1 to 1-1.4	Various Caribbean	Sadovy and Colin 1995
<i>Epinephelus guttatus</i>	1:4 to 1:115	Puerto Rico	Sadovy et al. 1994
	1:4 to 1:8	Puerto Rico	Shapiro et al. 1993a
<i>Epinephelus morio</i>	1:2 to 1:6	NE Gulf of Mexico	Coleman et al. 1996
<i>Mycteroperca microlepis</i>	1:5 to 1:76	NE Gulf of Mexico	Coleman et al. 1996
	1:49	Gulf of Mexico	Collins et al. 1998

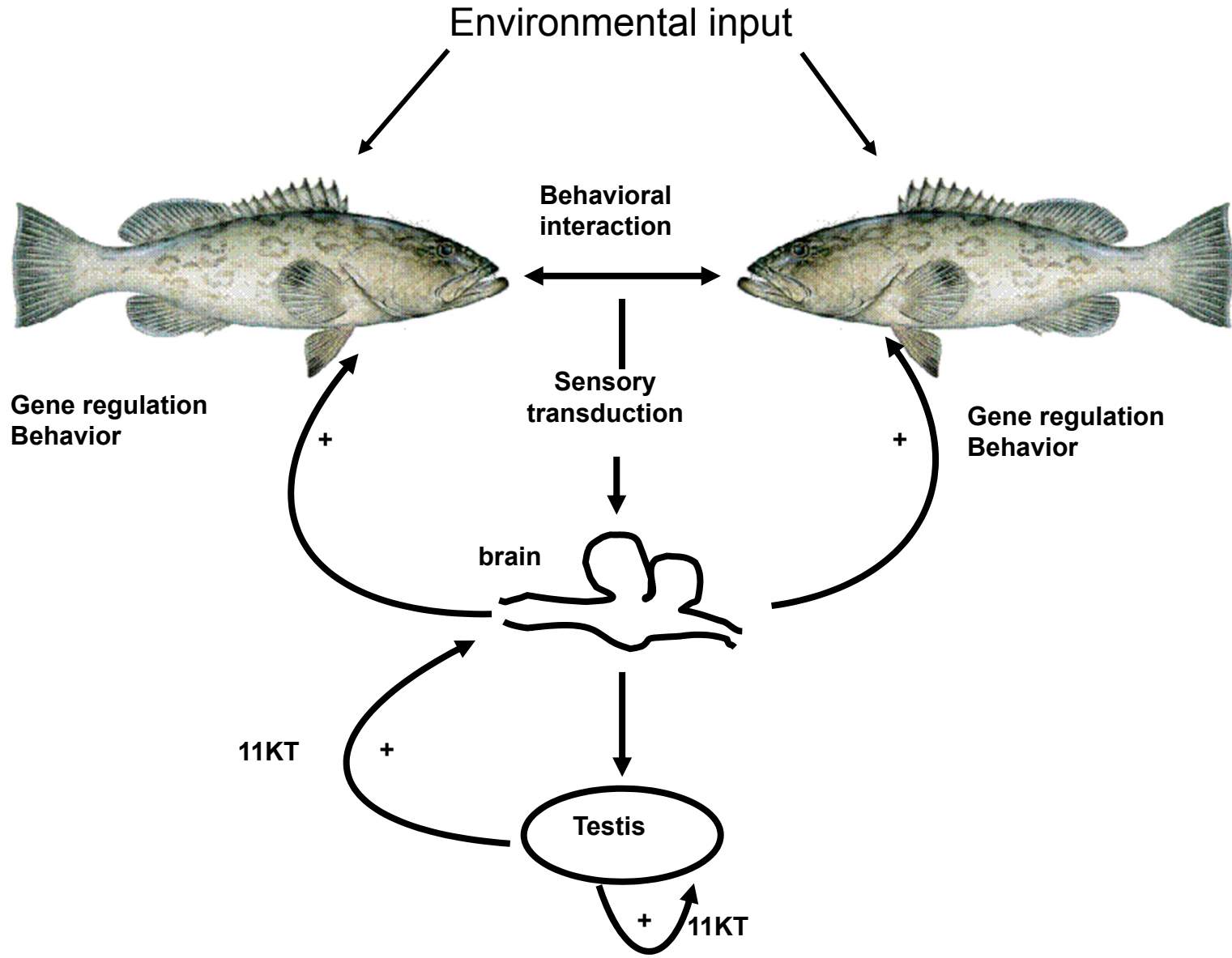
# Social control of sex change

## Warner and Swearer (1991)

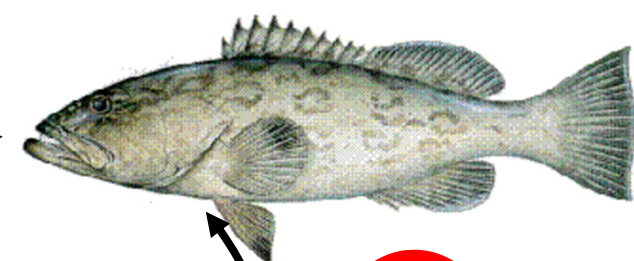
- Behaviors exhibited within minutes
- Color changes within a day
- Mature sperm within 8 days

- Semsar, Godwin, Grober, Bass

- Linked to Arginine Vasotosin production in the brain
- Not necessarily linked to gonad production of steroids



Environmental input



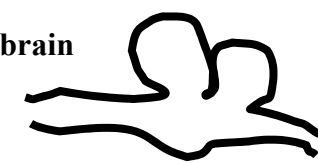
~~Behavioral Interaction~~



~~Sensory transduction~~

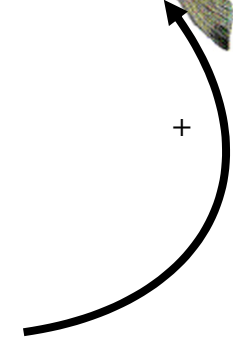


brain



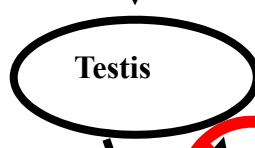
~~Gene regulation Behavior~~

+



↓ Down-regulated

Testis



~~↑ IKT~~

+

Decreased Individual Reproductive Success



Population level (Allee) effects?