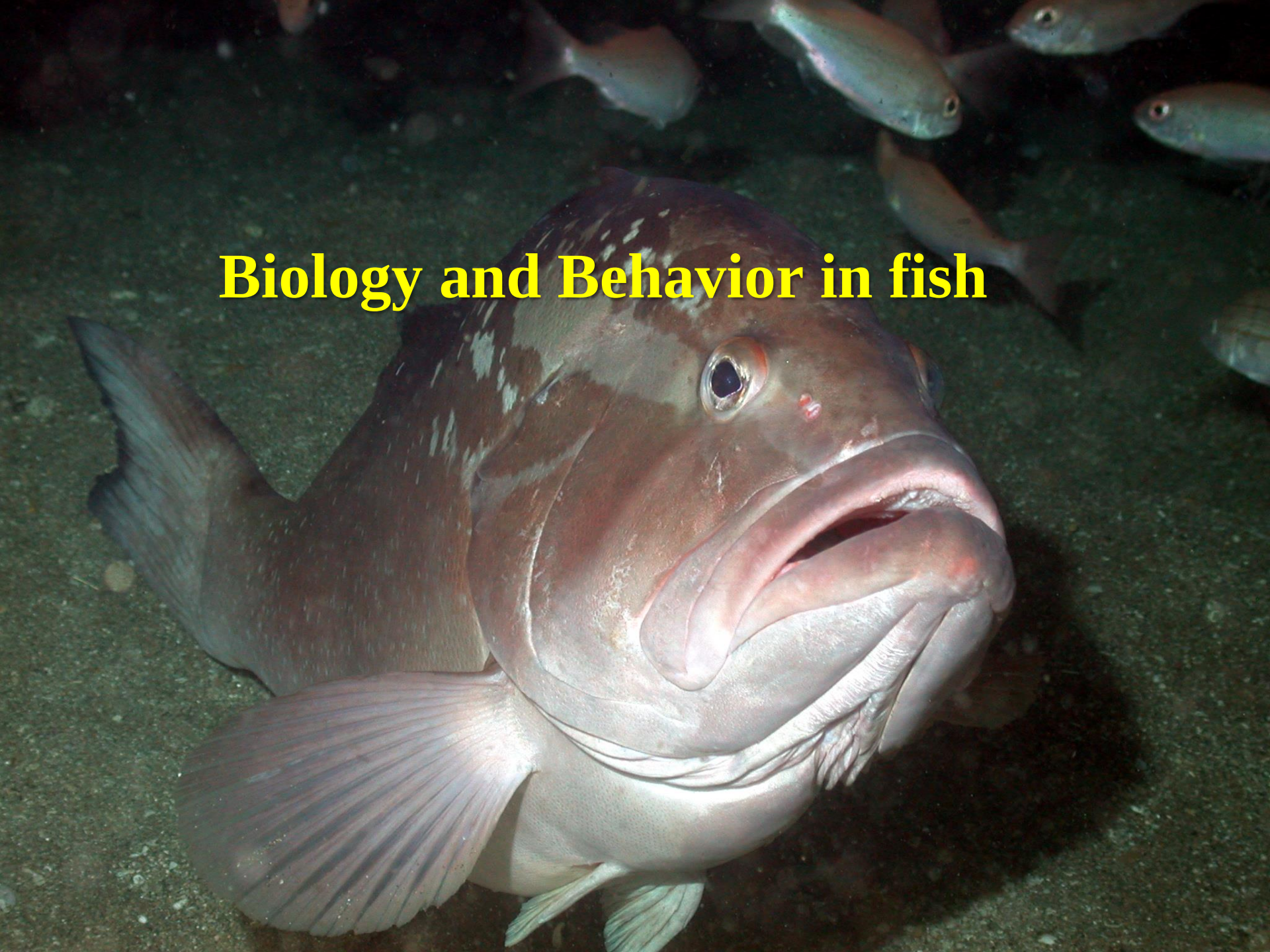
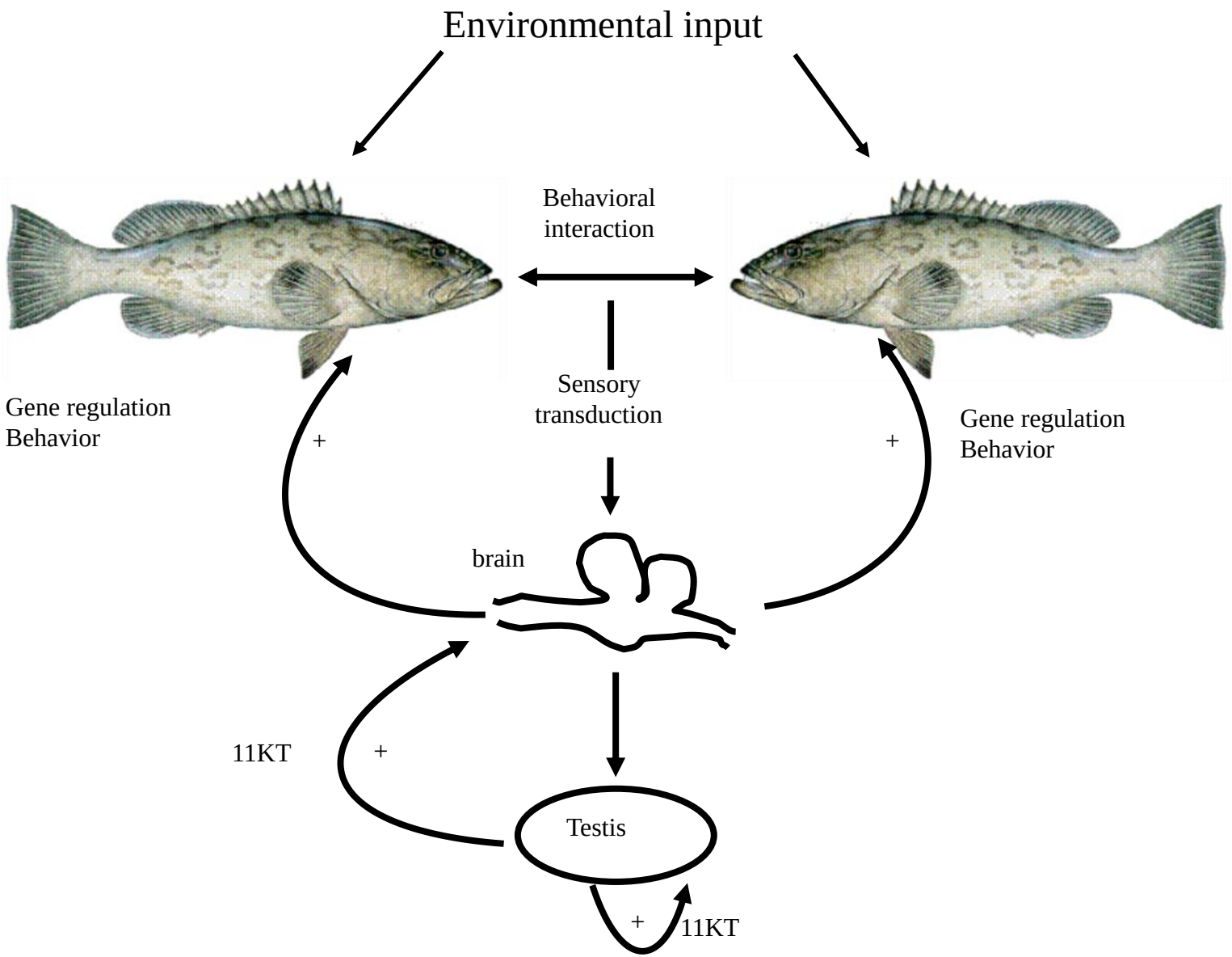

Biology and Behavior in fish

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


Environmental input
Behavioral interaction
Gene regulation
Behavior
Sensory transduction
Gene regulation
Behavior
+
+
brain
11KT
+
Testis
+
11KT

A tale of four groupers

Male grouper reproductive life history analysis

- Collect gonad and plasma samples from males of three different species of grouper (Nassau, red hind, and gag, with an extant dataset for red grouper)
- Confirm stage of maturation w/histology
- Measure androgens (Testosterone, 11-ketotestosterone)
- Evaluate general patterns of androgens, sex ratio, gonadosomatic index, and spawning strategy to determine general life history patterns –identify implications for population level effects

Spawning strategy

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

Gonadosomatic index

Species	GSI	Reference
E. striatus	9.4	Tucker et al. 1993 (from figure)
	10	Sadovy and Colin 1995
E. guttatus	0.66	Sadovy et al. 1994
E. morio	0.38	Alan Collins, unpublished
	0.3	Johnson 1995
M. Microlepis	1.83	Hood and Schleider 1992
	0.56	Collins et al. 1998

Sex ratio

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

Role of androgens in male reproduction

Testosterone

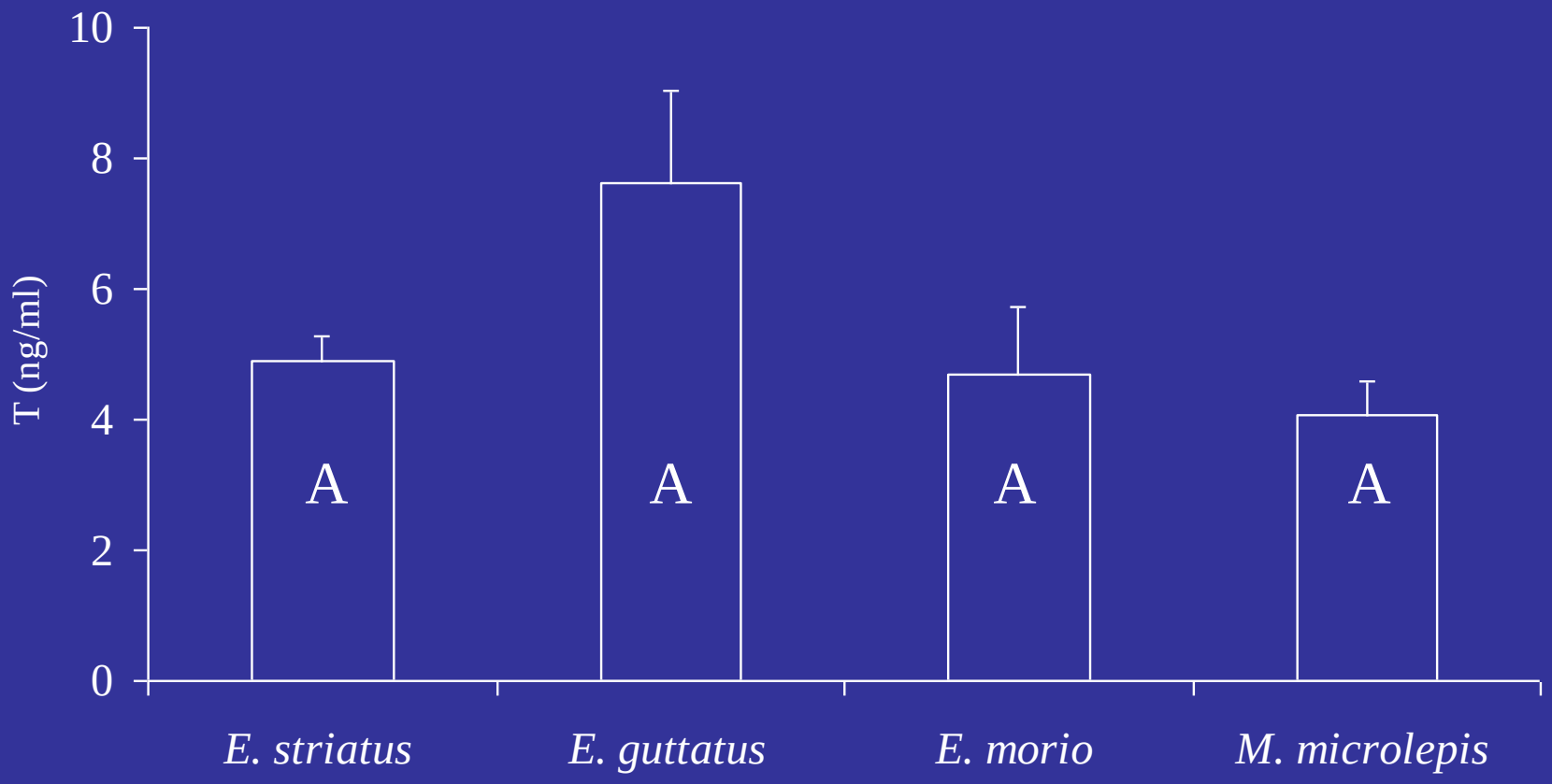
- Sex differentiation and development
- Stimulates the pituitary to induce spermatogenesis
- Precursor to E_2 and KT

11-ketotestosterone

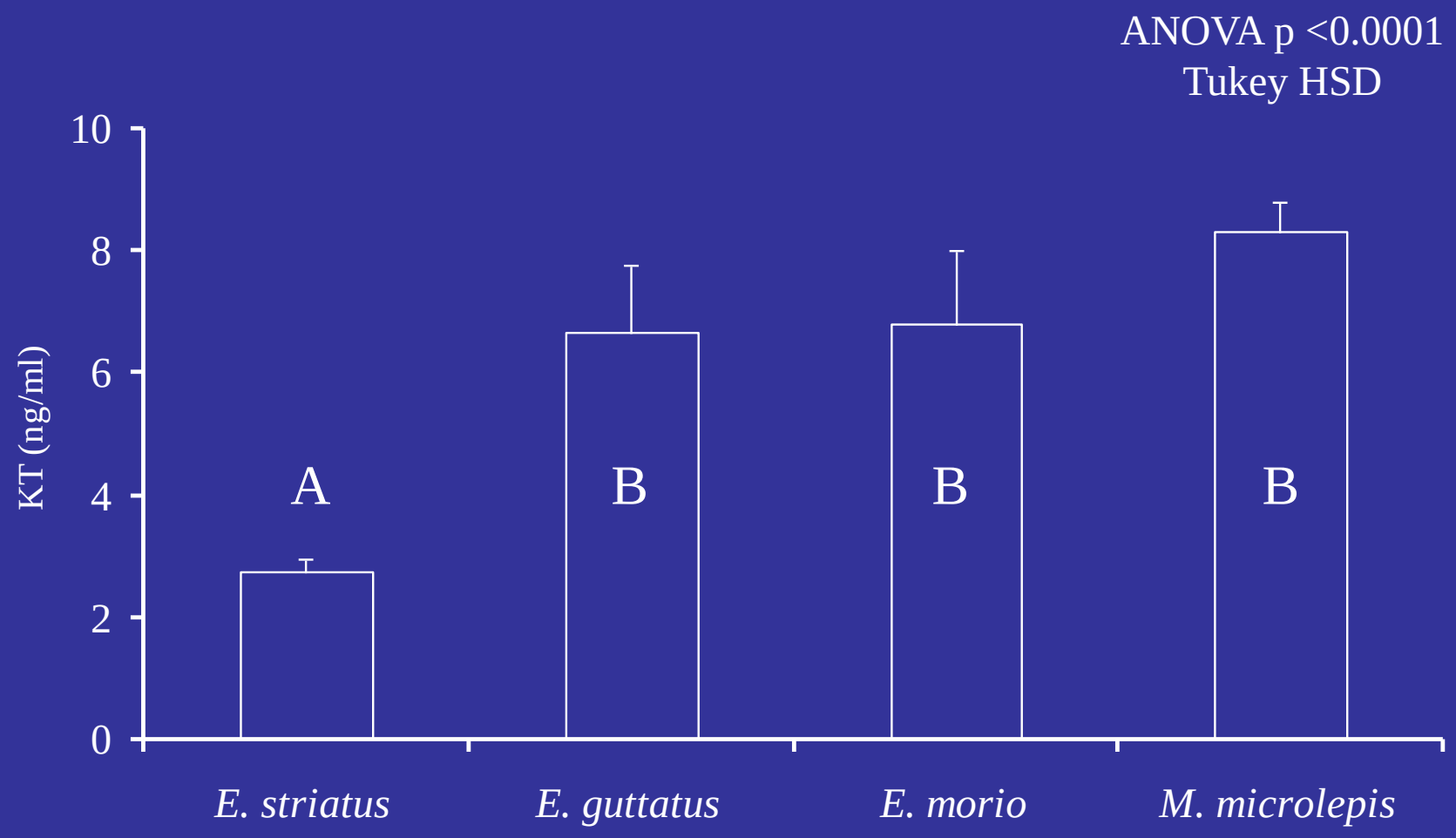
- Territoriality
- Nest building
- Aggression
- Secondary sex characteristics
- Spermatogenesis and sperm maturation
- Tactic switching

Testosterone

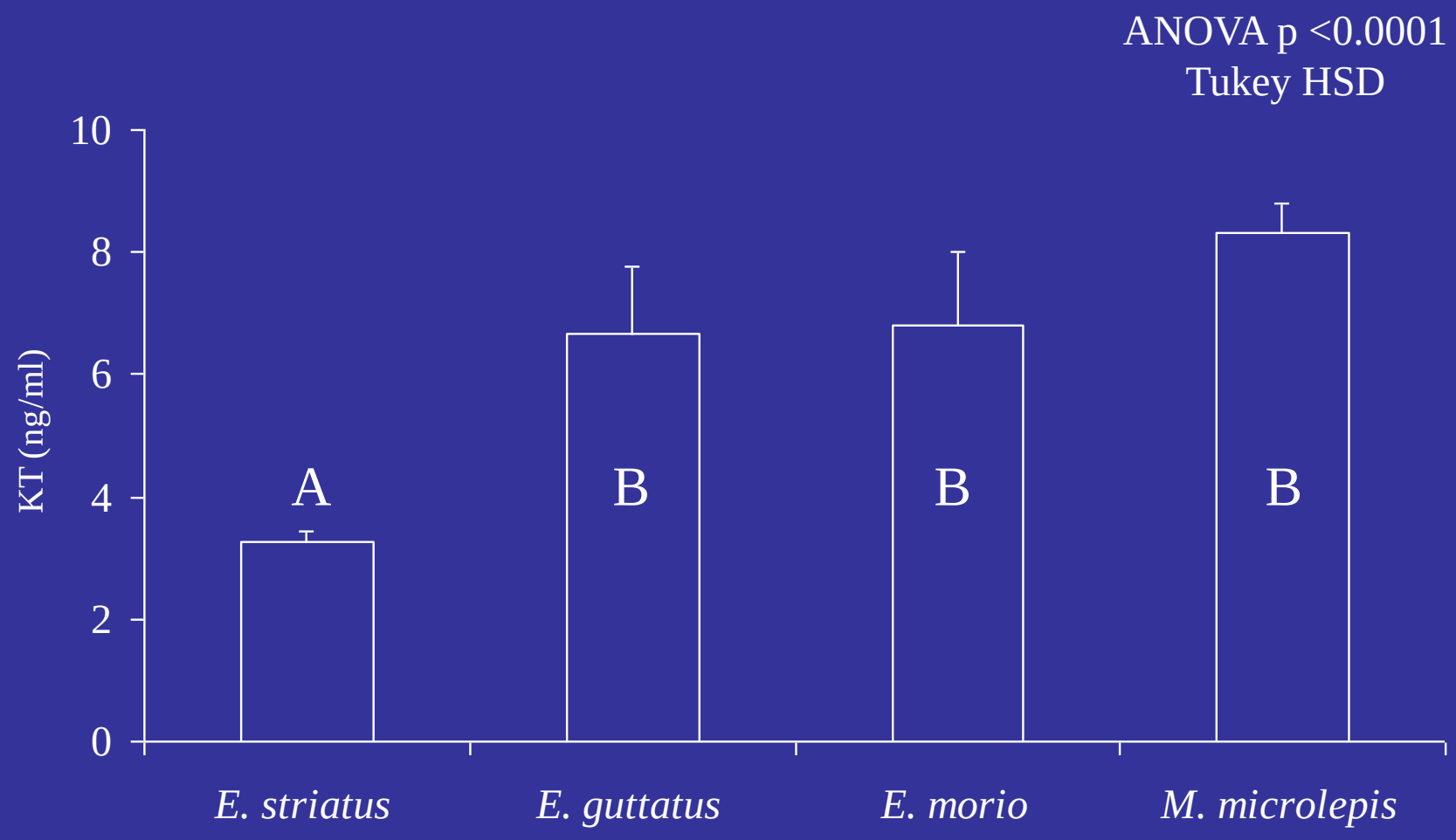
ANOVA p = 0.23



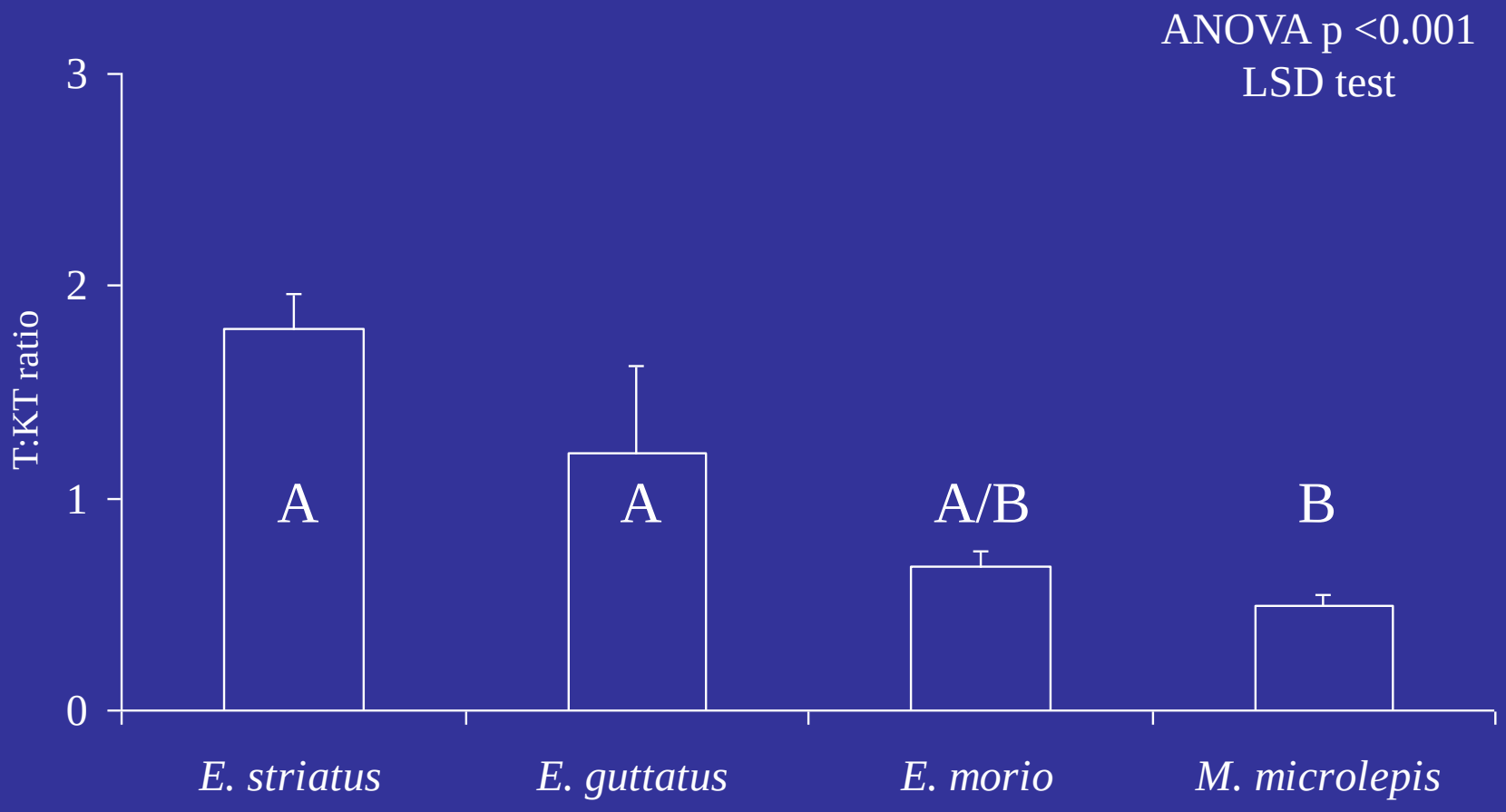
11-ketotestosterone (Belize)

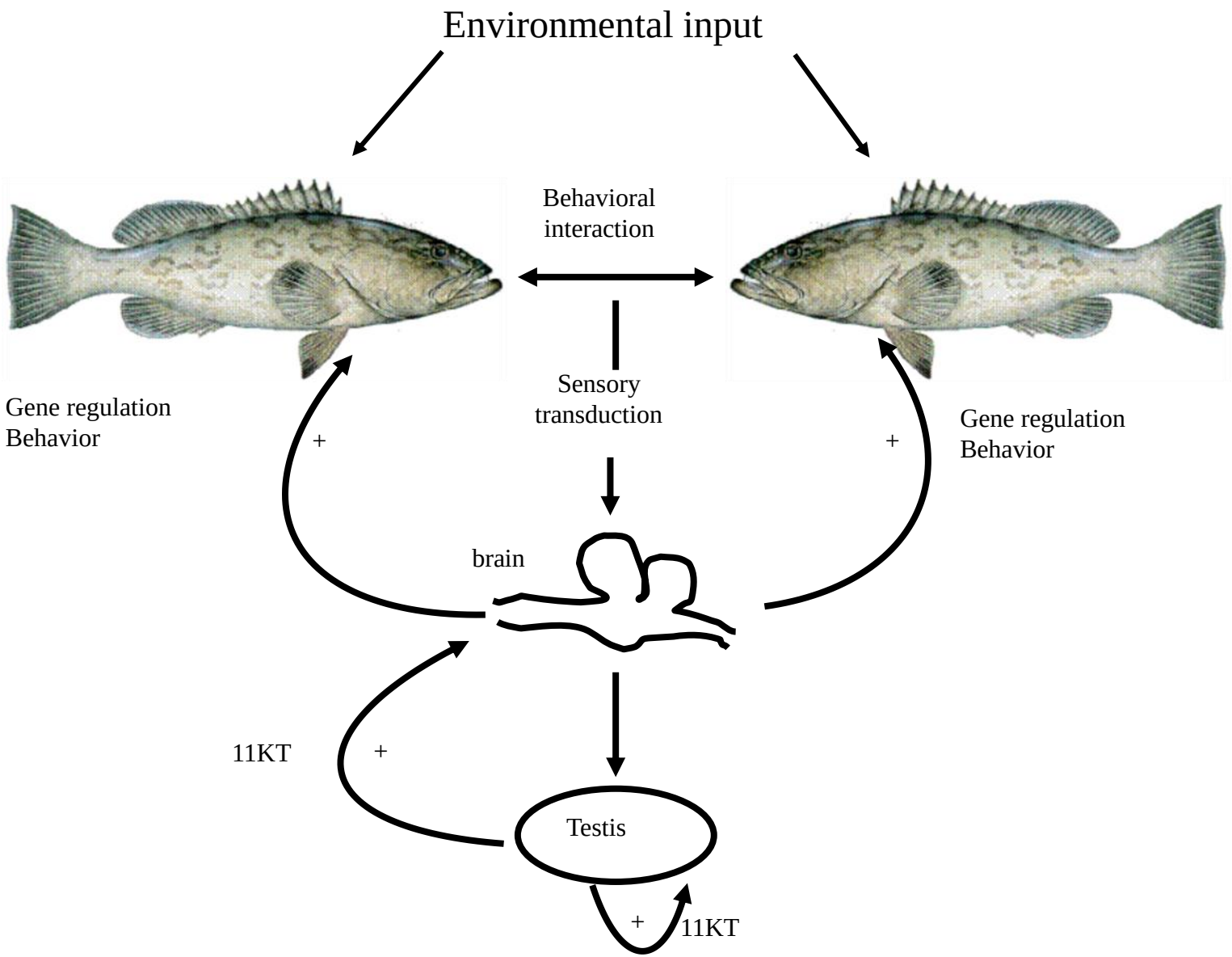


11-ketotestosterone (Cayman)



T:KT ratio (pooled samples)

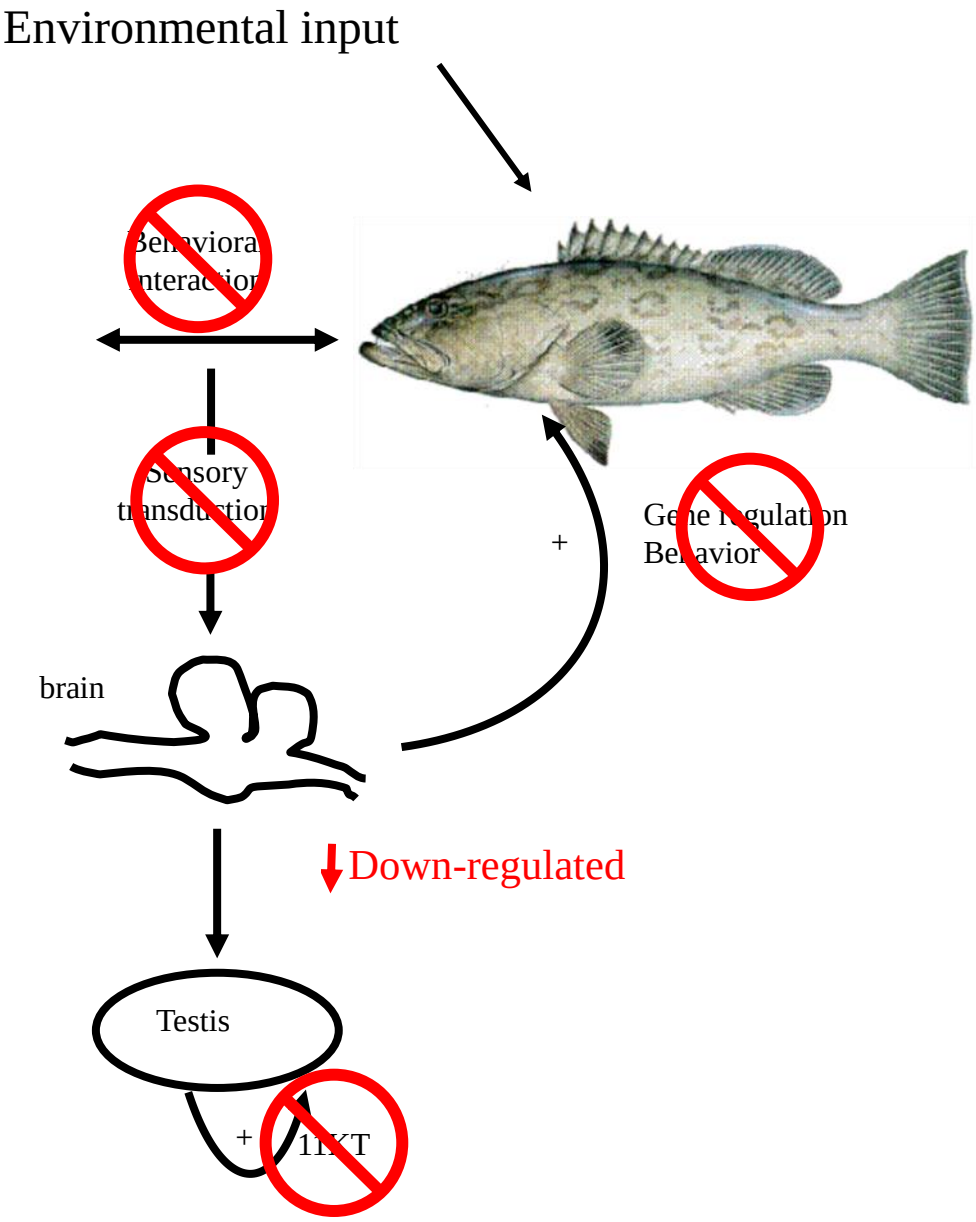



Environmental input
Behavioral interaction
Gene regulation
Behavior
Sensory transduction
Gene regulation
Behavior
+
+
brain
11KT
+
Testis
+
11KT

Decreased Individual Reproductive Success

↓

Population level (Allee) effects?



Conclusions

- Anatomy, behavior, and physiology, correlate with spawning strategy across four species of grouper
- This work presents a possible mechanism for depensation, at least in territorial species
  - A wider variety of species should be investigated to see whether it holds true across the majority of grouper species
- For some species we should manage for sex ratio as well as overall spawning stock biomass
- Critical minimum population sizes may be necessary for patterned behaviors and effective spawning
- Assessing biological/resource issues across multiple scales of biological organization is important