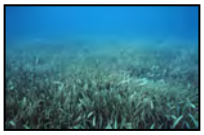




The ties that bind: social environment effects in marine benthic populations

Stephanie Kamel

Introduction

- Fine-scale genetic structure on ecologically relevant scales appears to characterize many marine populations, *e.g.*
  - Fishes (Selkoe et al. 2006; Bernardi et al. 2013)
  - Urchins (Ledoux et al. 2012)
  - Seagrasses (Kamel et al. 2012)
  - Limpets (Hoffman et al.2012)

Introduction

- The density and genetic composition of groups of interacting conspecifics – ***the social environment*** – can influence performance, *e.g.*
  - Barnacles: settlement success (Gamfeldt et al. 2005)
  - Bryozoans: colonization success (Aguirre et al. 2012)
  - Seagrass: resistance to disturbance (Hughes & Stachowicz 2004)


The social environment

- Sessile or sedentary benthic communities
  - Intense competition for food and space
  - Potential impacts on the mating system, *e.g.*
    - Inbreeding depression


The social environment

- Hummocking in the acorn barnacle, *Semibalanus balanoides* (Bertness et al. 1998)


Costs:
- High mortality

Benefits:
- Buffer from thermal stress
- Increased reproductive output
- Increased feeding efficiency

Hamilton's Rule

Cooperative behaviors can evolve when:

$$rB > C$$

r = coefficient of relatedness

B = benefit of cooperation

C = cost of cooperation

Hamilton's Rule

Cooperative behaviors can evolve when:

$$rB > C$$

r = proportion of genes in two individuals that are shared due to common ancestry

- $r = 0$ unrelated
- $r = 0.25$ share ¼ of their gene, e.g. half-sibs
- $r = 0.5$ share ½ of their genes, e.g. parent-offspring, full-sibs
- $r = 1$ if two individuals share all their genes

Hamilton's Rule

Cooperative behaviors can evolve when:

$$rB > C$$

r = coefficient of relatedness

B = benefit of cooperation

C = cost of cooperation

Relatedness is a dominant facet of the social environment

Genetic structure in the sea

Paradigm: marine populations are open

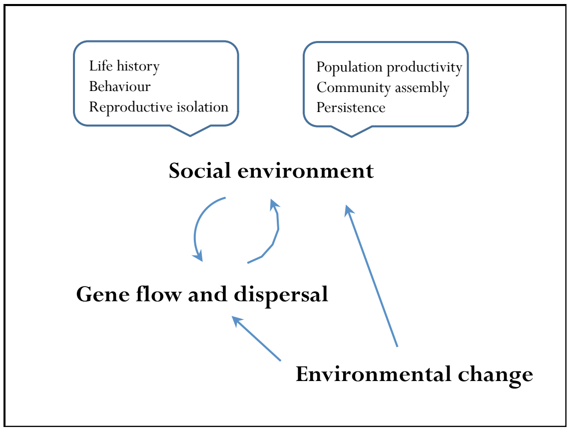
Larval dispersal connects local populations over large distances

↓ allozymes

Fine-scale genetic structure in species with limited dispersal

↓ microsatellites, SNPs biophysical models

Self-recruitment and kin structure in species with extensive dispersal potential



Research Questions

- **Families**: the genetic battleground
  - The evolution of parental care
  - Explaining offspring size variation
- **Neighbors**: relatedness and ecology
  - Relatedness as a predictor of population productivity

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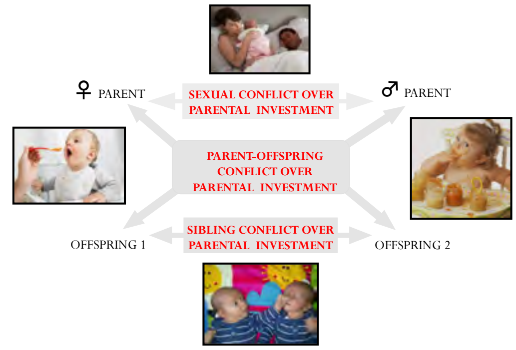
The family unit

Cooperation…

and conflict

Sources of conflict



Magnitude of conflict

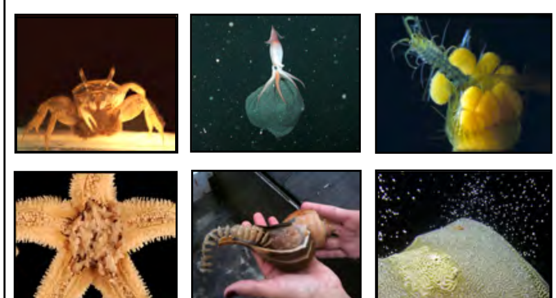
The magnitude of conflict depends upon:

(1) The opportunities for family members to interact

(2) The mating system

– Specifically the degree of multiple mating (polyandry)

Arenas of conflict



Kamel *et al.* 2010TREE

Mating system

Multiple mating decreases relatedness among interacting individuals

Appears to be prevalent in marine organisms across a range of taxa

Paternity and parental care

Exclusive male parental care is rare

•In these cases, males care for their own genetic offspring

•≥ 70% paternity

Paternity and parental care

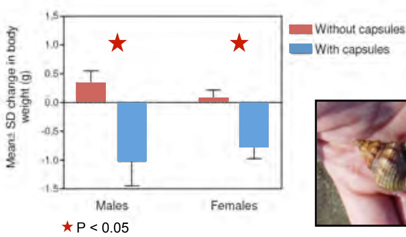
- Males of most mollusc species provide no post-zygotic investment in offspring
- *Solenosteira macrospira* exhibits exclusive male parental care

Kamel & Grosberg 2012 Ecol. Letts.

Paternity and parental care

- Genetically characterize the mating system:
  - Distribution of paternity among caring males
- Quantify the costs of care
  - Experimental manipulations of egg capsule load

Paternity and parental care



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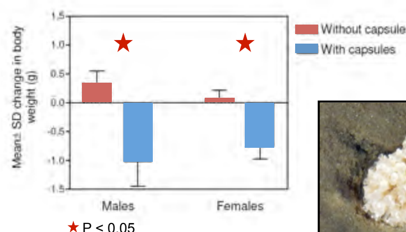
Paternity and parental care



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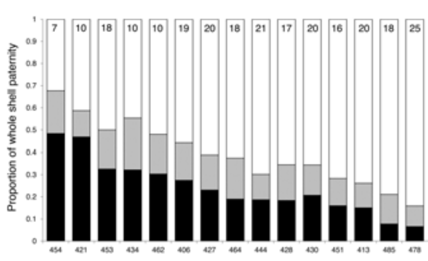
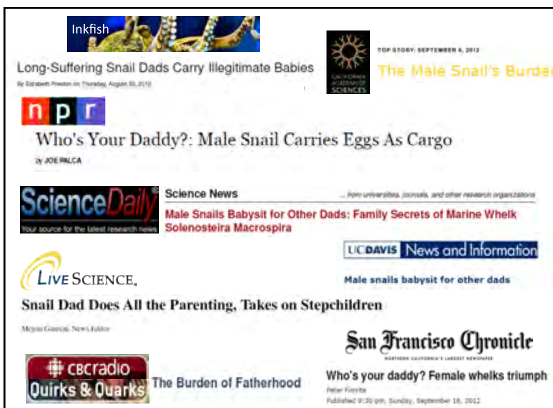
Paternity and parental care



- On average, males sired only 24% of the offspring they were carrying
- Females mated with an average of 13 males within a season



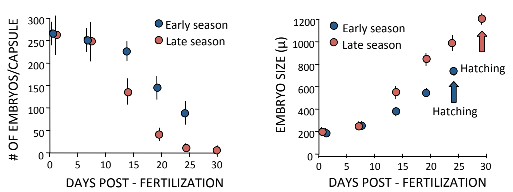
Paternity and parental care

- Males in this species have no choice but to care
  - The price to pay
  - Best of a bad situation
- *S. macrospira* presents an extreme example of the co-existence of high levels of female promiscuity, low paternity, and costly male care
  - Challenges classical theoretical predictions of the expected relationships between mating system, parental care, and relatedness

Sibling conflict

- Females package ≈ 200 eggs/capsule
- Hatchlings emerge after one month
- Severe brood reduction
  - Up to 98% of embryos can be consumed by siblings

Sibling conflict



- The number of fathers within a capsule increases over the reproductive season
- Cannibalism and offspring size appear to vary as a function of polyandry

Kamel *et al.* 2010 ICB

Offspring size variation

- Mating system variation alone can induce significant variation in offspring traits
- Offspring size has important life-history consequences
  - Affects survival, performance, and dispersal

Conclusions

Fine-scale genetic and kin structure

- Appears to characterizes many marine species

Ecological effects of genetic diversity

- Can exert strong effects on performance

The social environment

How and how often are social environment effects expressed in the sea and how are anthropogenic influences affecting them?

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