Socio-ecology Part 3: Philopatry and Delayed Dispersal

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Biol 417: Evolutionary Ecology

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Review

Review

Mate guarding, predator avoidance and information sharing brings individuals together, but often fall short when providing a mechanism for the maintenance of stable spatial groups.

The RDH provides a mechanism for the passive formation of spatial groups without the need for any benefits and many of the mechanisms have empirical support... but the RDH hasn't been explicitly linked to the evolution of group living.

From the pieces we have so far, no single hypothesis is likely to explain the propensity for group living in any species.

We will continue with mechanisms that can drive the evolution of group living.

Ecological Constraints Hypothesis

Fitness and Survival

The relationship between fitness and survival can be represented as the summation of the probability of survival to age x, l_x, and age-specific reproduction, m_x (Pianka, 2000):

$$R_0 = \Sigma l_x m_x$$

Mechanistically fitness can accrue via direct investment in reproduction (maximising m_x), or indirectly through investment in survival (maximising l_x).

Fitness and Survival cont.

$$R_0 = \Sigma l_x m_x$$

For iteroparous species, fitness can increase with age provided individuals:

i) Survive until the next reproductive season ($l_x > 0$).

ii) Remain reproductively active and are in sufficiently good condition to reproduce ($m_x > 0$).

iii) Are at the front of the breeding 'queue' ($m_x > 0$).

Offspring fitness

We saw how individuals need to balance decisions to reproduce against spatio-temporal differences in reproductive rates.

		Time: Now	Time: Later
Space	Here	$R_0 \pm \sigma^2$	$R_0 \pm \sigma^2$
	Elsewhere	$R_0 \pm \sigma^2$	$R_0 \pm \sigma^2$

Southwood (1977)

... the same decision matrix applies to their offspring.

C. lupus

Source: End. Wolf Center

D. virginiana

Source: Getty Images

S. suricatta

Offspring fitness

Where the balance falls will determine patterns of philopatry (here) versus dispersal (elsewhere)

		Time	
		Now	Later
Space	Here	$R_0 \pm \sigma^2$	$R_0 \pm \sigma^2$
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Southwood (1977)

C. lupus

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Offspring fitness

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Southwood (1977)

... in turn influencing the propensity towards group living.

C. lupus

Source: istock.com

D. virginiana

Source: Wikipedia

S. suricatta

Ecological Constraints Hypothesis

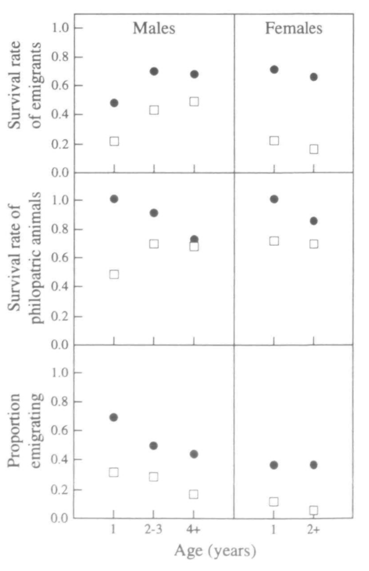
Related to these concepts, Emlen (1982) proposed the Ecological Constraints Hypothesis (ECH) as a mechanism for group formation.

Mechanism: Costs of dispersal, such as the greater mortality risk for dispersers ($\downarrow l_x$), competition for breeding opportunities ($\downarrow m_x$), and local habitat saturation ($\downarrow m_x$ & $\downarrow l_x$) will delay dispersal and promote group living.

ECH in Dwarf Mongoose

Source: San Diego Zoo

Lucas *et al.* (1994) quantified the survival rates of emigrant and philopatric offspring in a pop. of dwarf mongoose (*Helogale parvula*) in the Serengeti.



Lucas *et al.* (1994)

ECH in Carrion Crows

Source: Wikipedia

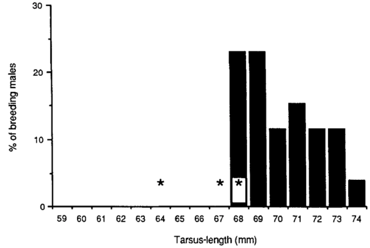


Figure 1. Tarsus-lengths of male Carrion Crow territory holders (■, $n = 28$) and the three male helpers*.

Richner (1990)

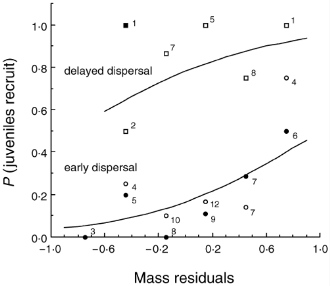
Richner (1990) looked at the relationship between body size, territory establishment, and philopatry in carrion crows (*Corvus corone*) in Switzerland.

Small males can not establish territories and stay in their birth territory and act as ‘helpers’ instead of dispersing.

ECH in Brown Thornbills

Source: eBird

Green & Cockburn (2001) looked at the relationship philopatry and recruitment in Brown Thornbills(*Acanthiza pusilla*) in Australia.



Green & Cockburn (2001)

Juveniles that delayed dispersal were four times more likely to recruit into the local breeding population than juveniles that dispersed early.

The ECH model of philopatry is based primarily on cost-driven criteria and evidence supports the mechanisms

... but the costs associated with dispersing have to be overcome by some advantage of staying at home if delayed dispersal is to be explained

... and philopatry is not without costs:

- Competition for resources.
- Breeding competition and reproductive suppression.
- Increased disease transmission.
- Inbreeding.
- ... and so on.

Safe Havens and Natal Philopatry

Safe Havens and Natal Philopatry

Kokko & Ekman (2002) proposed the idea of the natal territory acting as a 'safe haven' for waiting for breeding opportunities.

They built a general model of different routes to breeding to show under which conditions philopatry is favored:

Benefit of dispersal, $D = \frac{\beta T_F}{\mu_F}$

$\beta =$ competitive ability of floater
$T_F = \#$ of terr. floater can obs.
$\mu_F =$ Mortality of floater

Benefit of philopatry, $P = \frac{\alpha T_S}{\mu_S}$

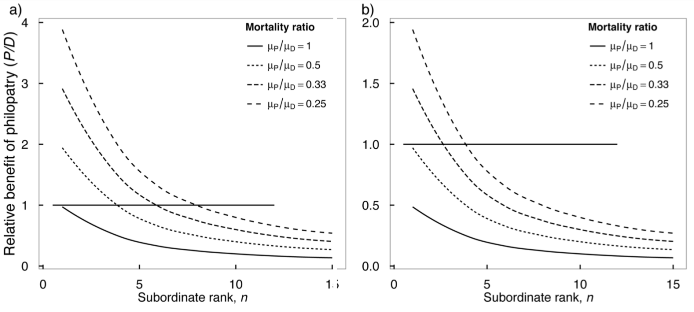
$\alpha =$ competitive ability of sub.
$T_S = \#$ of terr. sub. can obs.
$\mu_S =$ Mortality of subordinate

when D>P, or $\frac{D}{P} > 1$, dispersal is favoured

Safe Havens cont.

The safe haven model provides a framework for comparing information on **both** the costs and benefits of philopatry to predict patterns in group-living.

Example: Toy models without (a) and with (b) reproductive suppression.



(Noonan, 2015)

Safe haven in striped skunk

Communal denning in the striped skunk (*Mephitis mephitis*) leads to 16.2% more body fat conservation over the winter period when compared to individuals that den alone (Hwang *et al.*, 2007).

Source: Wikipedia

Safe haven in African ice rats

African ice rats (*Myotomys sloggetti*) compete with each other for food above ground, but huddle in groups below ground in communal dens during cold periods (Hinze *et al.*, 2013).

Source: Wikipedia

Safe haven in wolverines

Years of high prey abundance allow for delayed dispersal and offspring retention at sub-nivean natal dens in wolverines (Gulo gulo), whereas in years of low prey availability juveniles are forced to disperse as they mature (Vangen *et al.*, 2001).

Source: Wikipedia

Philopatry and Dispersal Take Homes

The safe haven model extends the Ecological Constraints Hypothesis to account for both the relative costs and benefits of dispersal and philopatry.

There is evidence from multiple taxa that this balance dictates patterns in dispersal, and that this balance can tip from one generation to the next depending on local ecological conditions.

The model's mechanisms have support, but it is difficult to parametrise $(\alpha, \beta, \mu_F, \mu_S, T_F, T_S)$ making it a challenge to apply to real systems.

Next lecture we will explore group-living in European badgers (*meles meles*) as a case study.

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