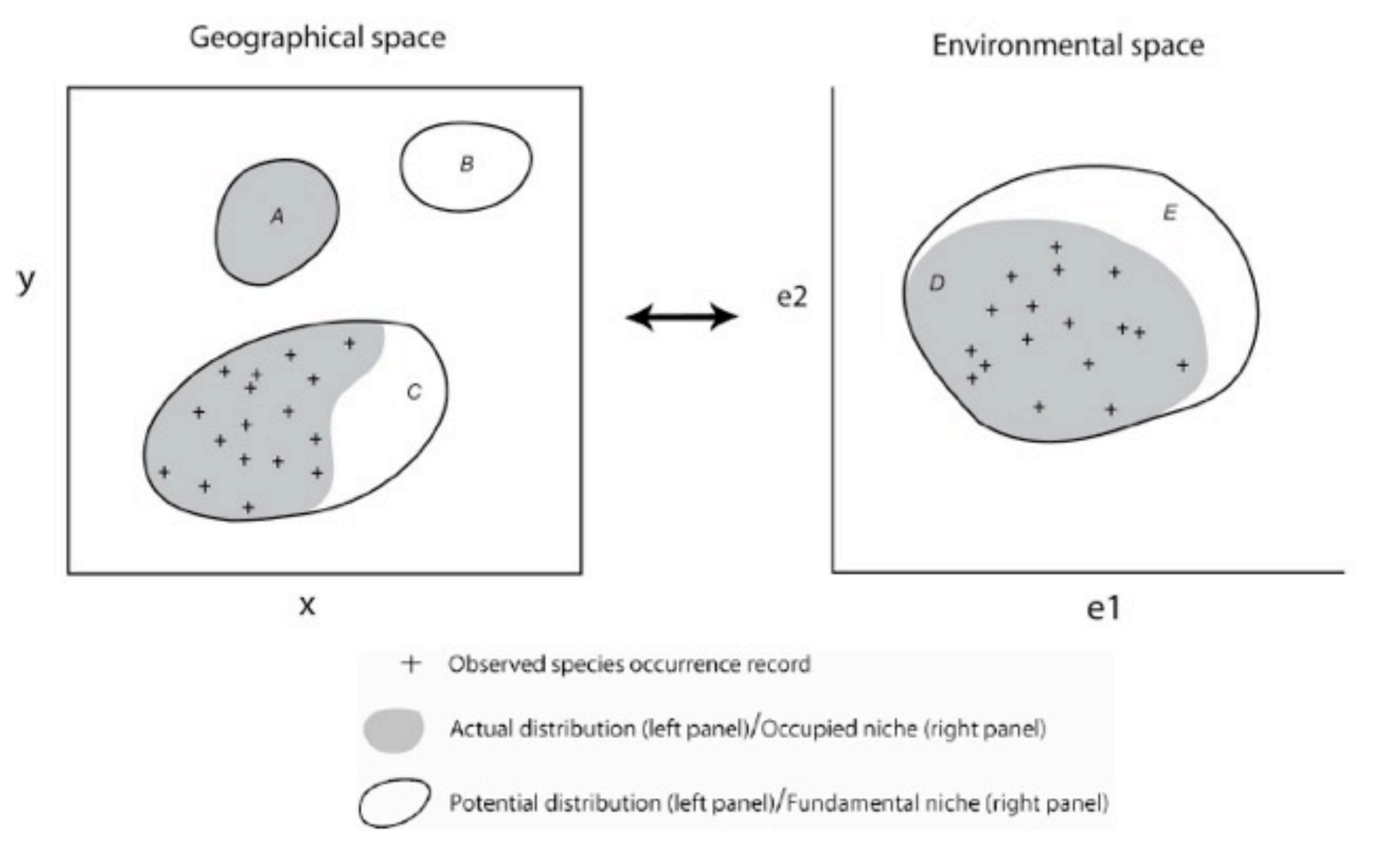
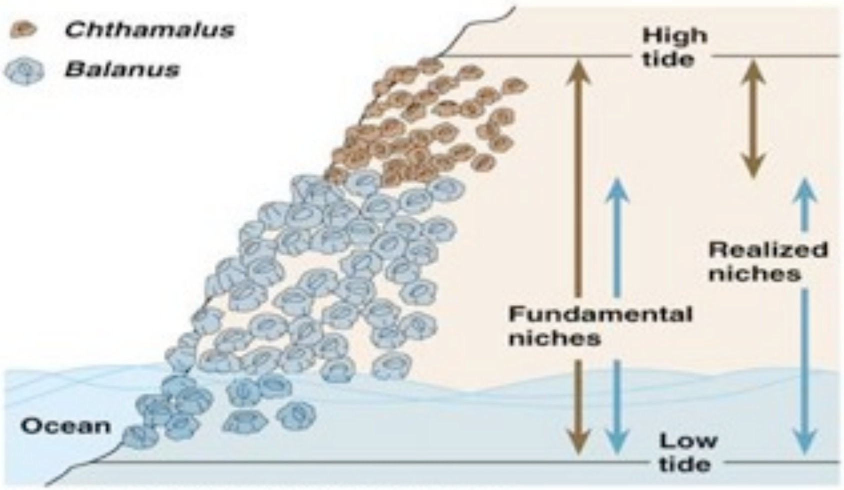
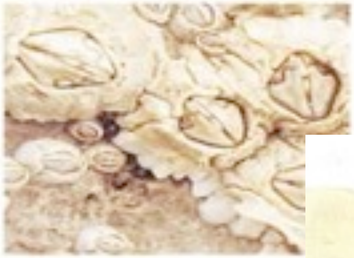
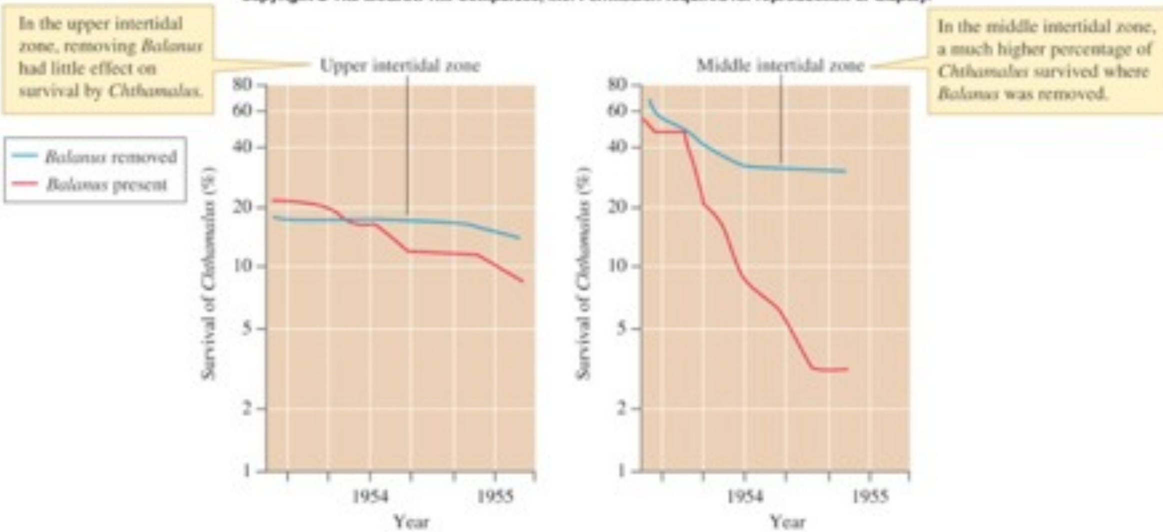
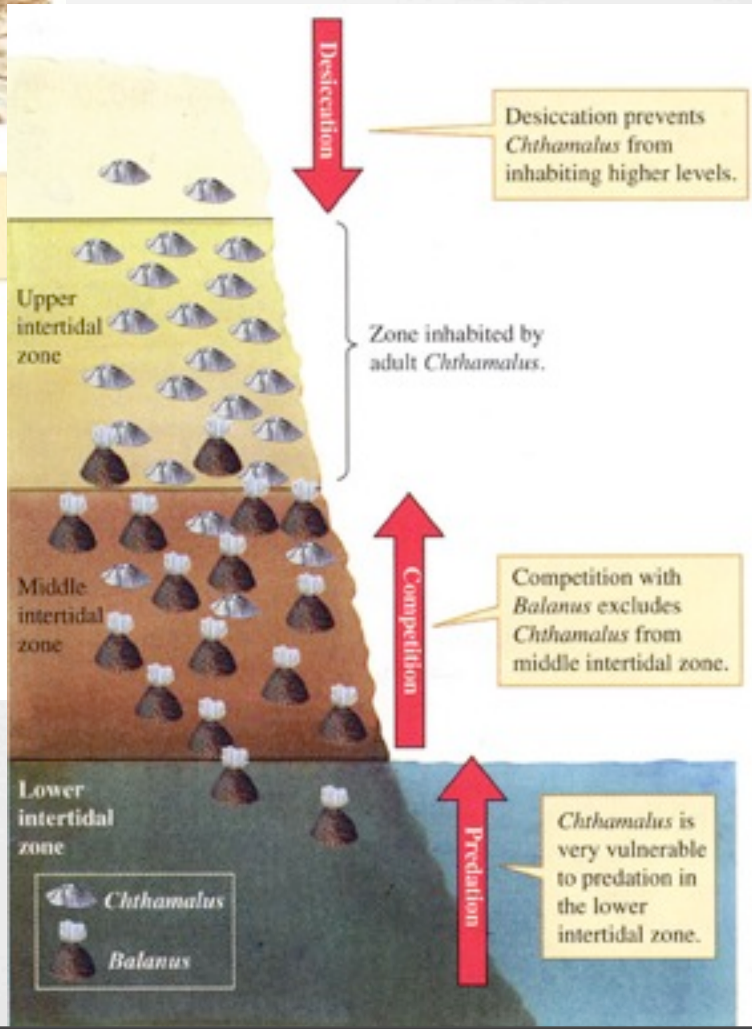


http://biodiversityinformatics.amnh.org/index.php?section_id=104&content_id=296

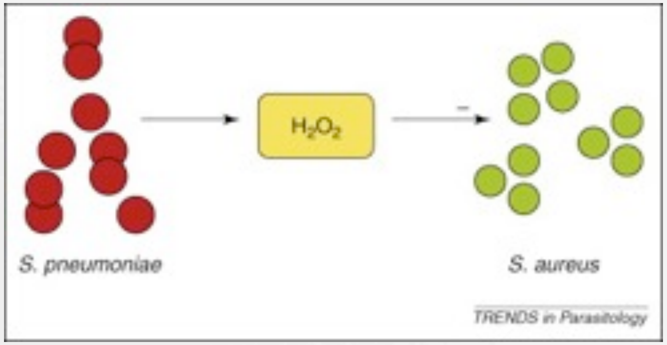

Chthamalus
Balanus
High tide
Realized niches
Fundamental niches
Ocean
Low tide

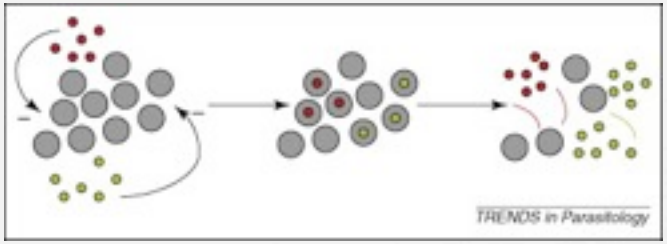



In the upper intertidal zone, removing Balanus had little effect on survival by Chthamalus.
Upper intertidal zone
Balanus removed
Balanus present
Survival of Chthamalus (%)
80
60
40
20
10
5
2
1
1954
1955
Year
Middle intertidal zone
In the middle intertidal zone, a much higher percentage of Chthamalus survived where Balanus was removed.


Desiccation
Desiccation prevents Chthamalus from inhabiting higher levels.
Upper intertidal zone
Zone inhabited by adult Chthamalus.
Competition
Middle intertidal zone
Competition with Balanus excludes Chthamalus from middle intertidal zone.
Lower intertidal zone
Predation
Chthamalus is very vulnerable to predation in the lower intertidal zone.
Chthamalus
Balanus

Mideo, N. 2009. Parasite adaptations to within-host competition. Trends in Parasitology 25(6) 261-268





Interference / direct competition

Harm your competitors

Exploitation / resource/ indirect competition

Use up resources (e.g., host cells) before your competitors can

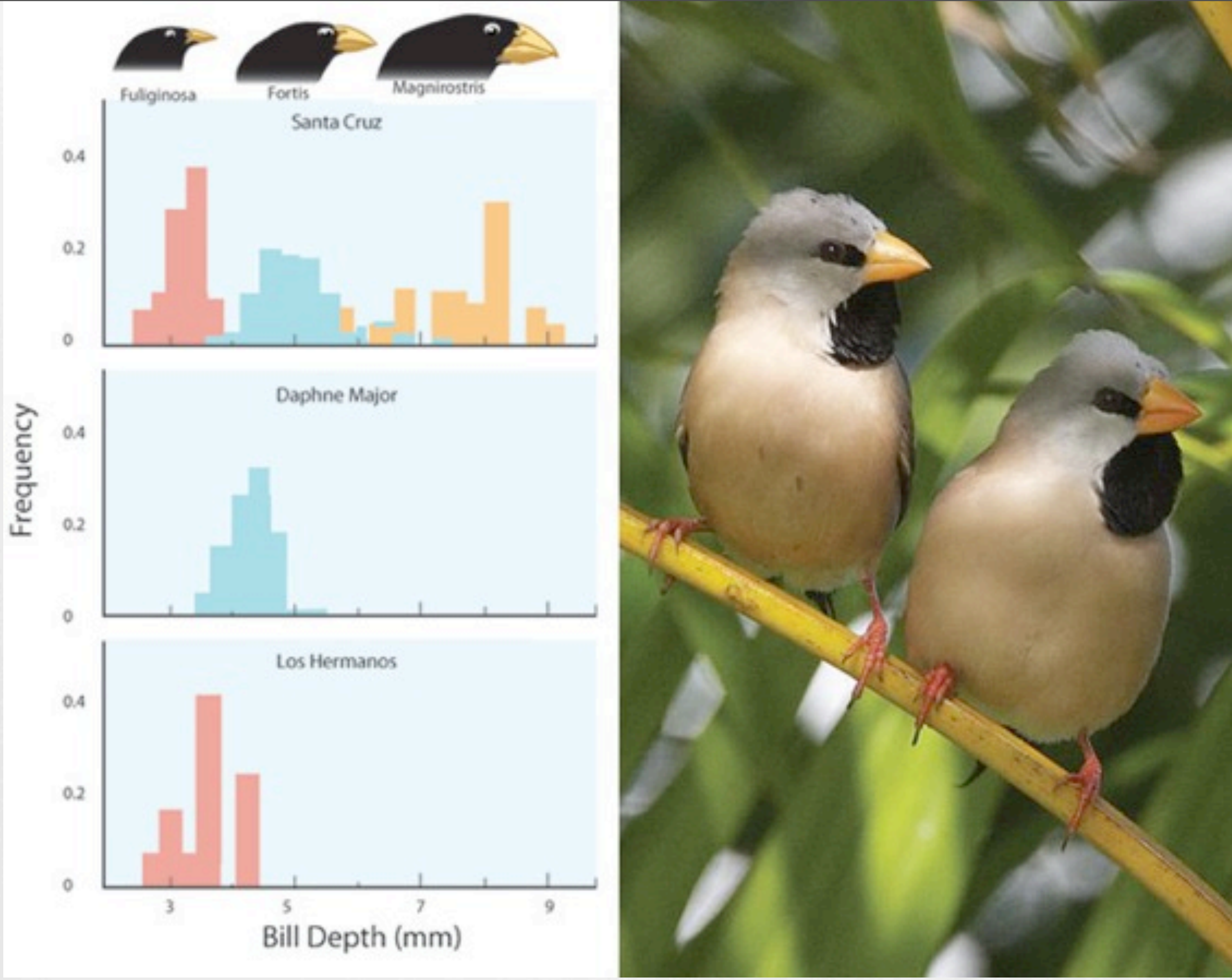


Figure 3: A classic example of character displacement
When multiple species of Darwin's finches co-occur on an island, they show differences in bill depth (and eat different sized seeds) compared to when they are alone on an island.

http://www.nature.com/scitable/knowledge/library/resource-partitioning-and-why-it-matters-17362658

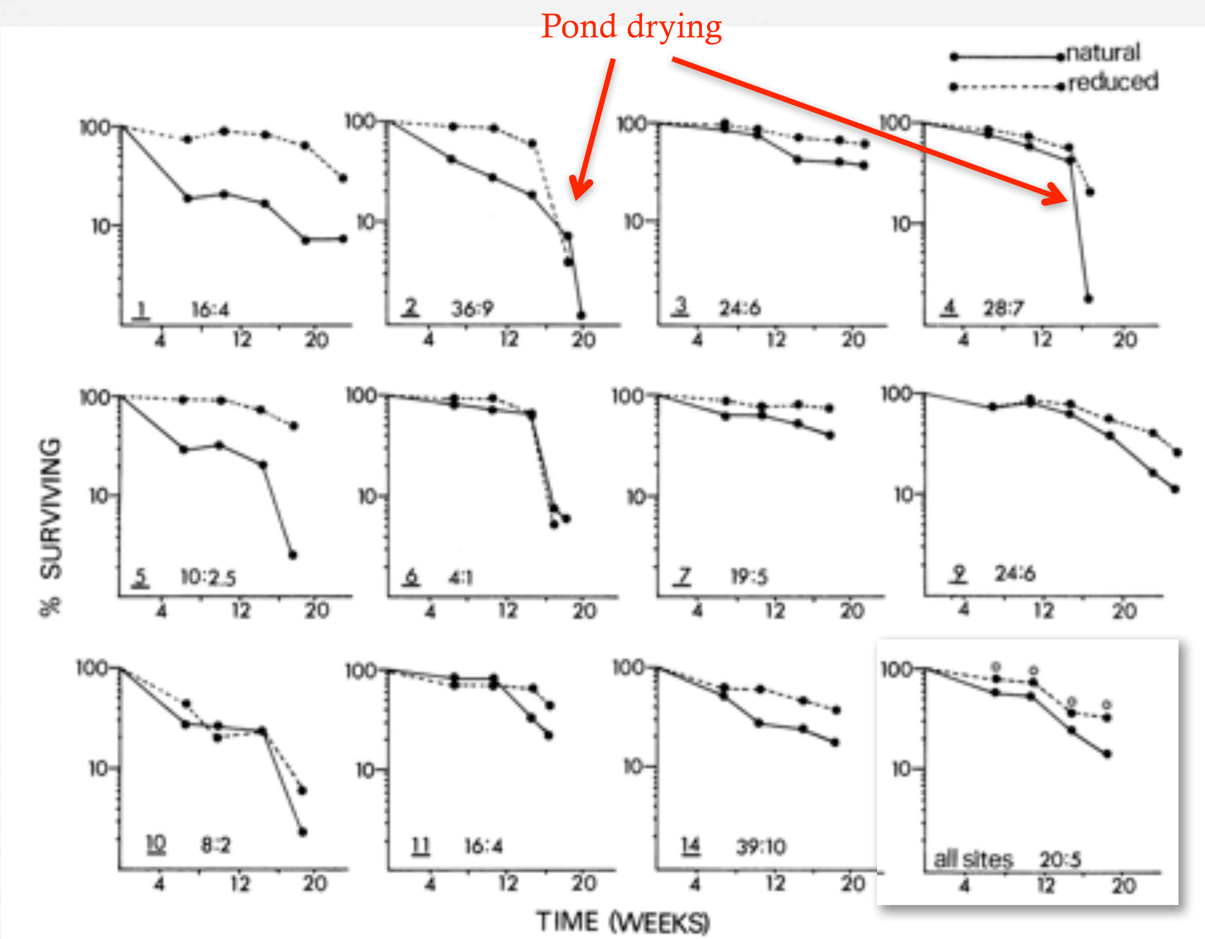


FIG. 5. Survival of larvae established at natural and reduced (¼-natural) densities. The number in the bottom left corner of each graph is the pond site. The ratio in the bottom center of each graph indicates the initial hatchling densities established in the natural- and reduced-density treatments at each site. The average for all sites is presented in the bottom right graph where open symbols indicate means that are significantly different based on paired *t* tests.

Took natural ponds, split them in half, and reduced the density on one side to ¼ of the density on the other side

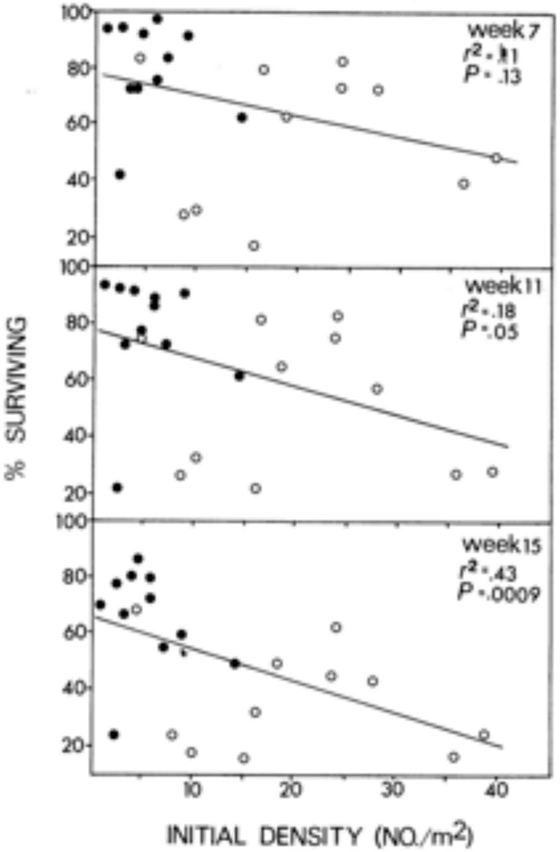


FIG. 6. Relationship between the initial density of hatchlings in 22 experimental populations and their survival to weeks 7, 11, and 15. Density is expressed as number of larvae per square metre of pond bottom. Symbols as in Fig. 3.

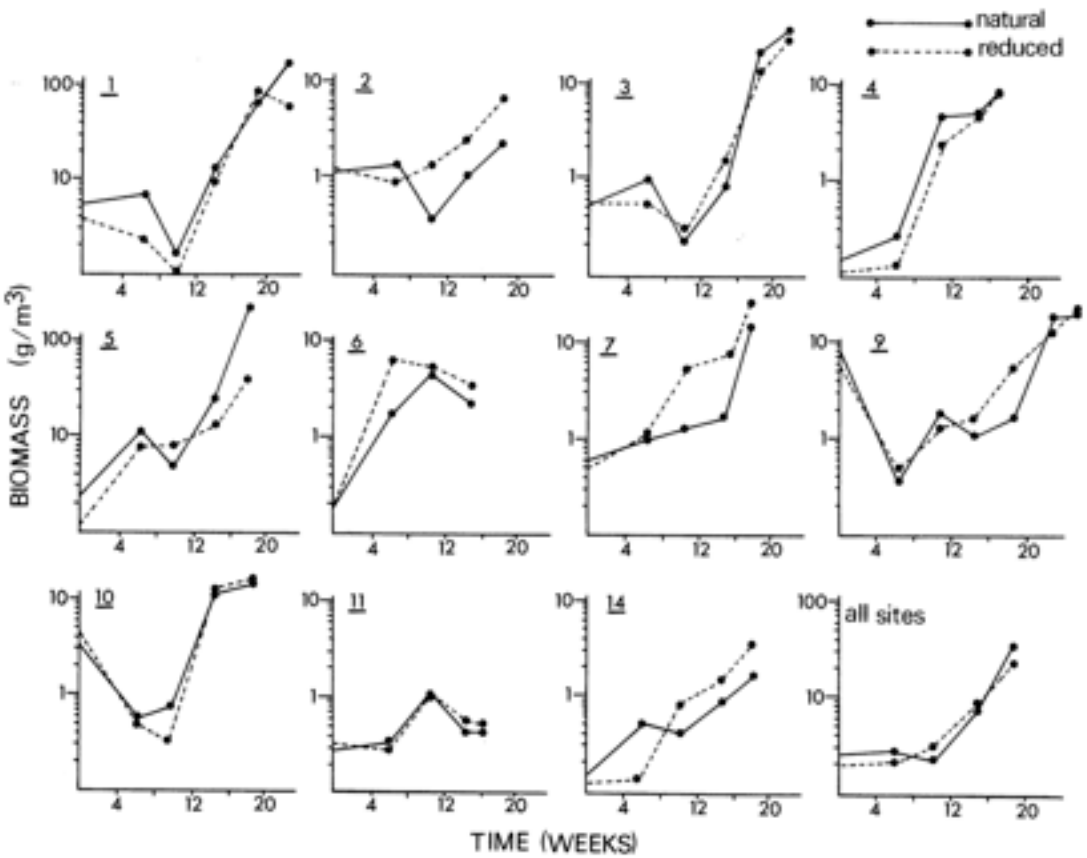


FIG. 9. Seasonal changes in zooplankton biomass in pond halves with natural and reduced densities of marbled salamander larvae. Format as in Fig. 8.

Is it exploitation competition?

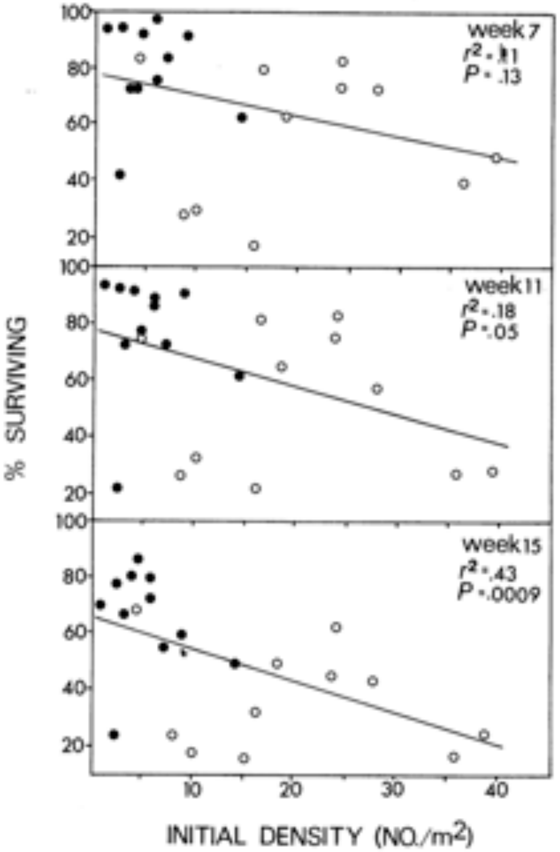


Fig. 6. Relationship between the initial density of hatchlings in 22 experimental populations and their survival to weeks 7, 11, and 15. Density is expressed as number of larvae per square metre of pond bottom. Symbols as in Fig. 3.

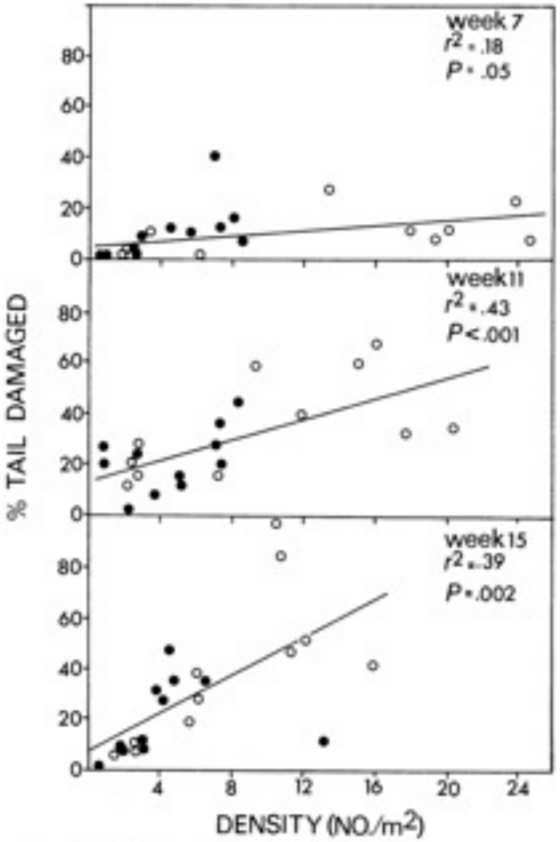


Fig. 7. Relationship between number of larvae per square metre of pond bottom and the percent showing evidence of recent tail damage at weeks 7, 11, and 15. Symbols as in

Or interference competition?

Journal of Animal Ecology (1988), **57**, 119–136

EFFECTS OF POPULATION DENSITY AND SUPPLEMENTAL FOOD ON REPRODUCTION IN SONG SPARROWS

BY PETER ARCESE* AND JAMES N. M. SMITH†

The Ecology Group, Department of Zoology, University of British Columbia, British Columbia, Canada V6T 1W5

Ecology, 73(3), 1992, pp. 805–822

STABILITY, REGULATION, AND THE DETERMINATION OF ABUNDANCE IN AN INSULAR SONG SPARROW POPULATION[1]

PETER ARCESE,[2] JAMES N. M. SMITH, WESLEY M. HOCHACHKA, CHRISTOPHER M. ROGERS, AND DONALD LUDWIG

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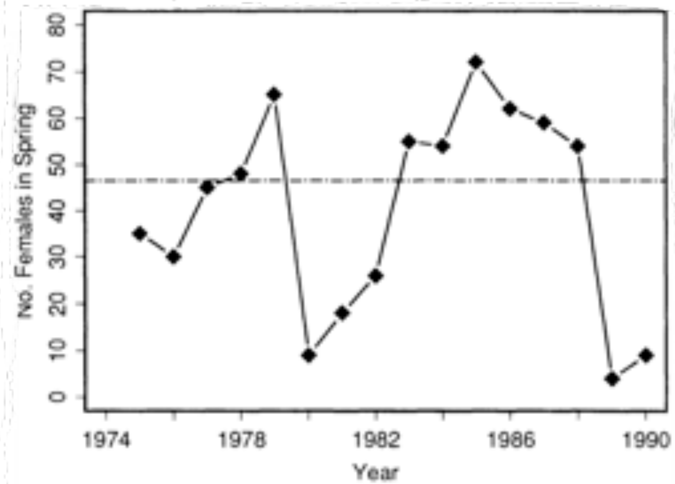

FIG. 10. The number of breeding female Song Sparrows on Mandarte Island in spring from 1975 through 1990. The dotted horizontal line indicates the median breeding density (46.5 females).

What regulates population size? Is it competition?

Is adult survival density-dependent?

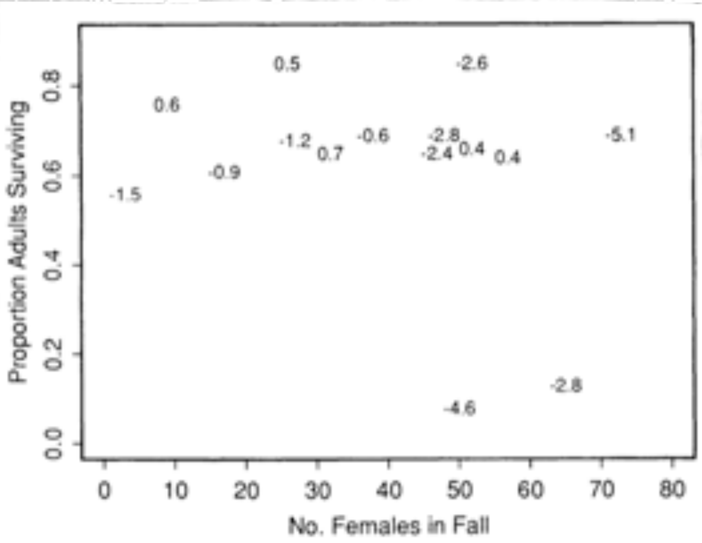

FIG. 9. The proportion of adults surviving over winter vs. fall density. The largest negative deviation from each mean

What about breeding success?

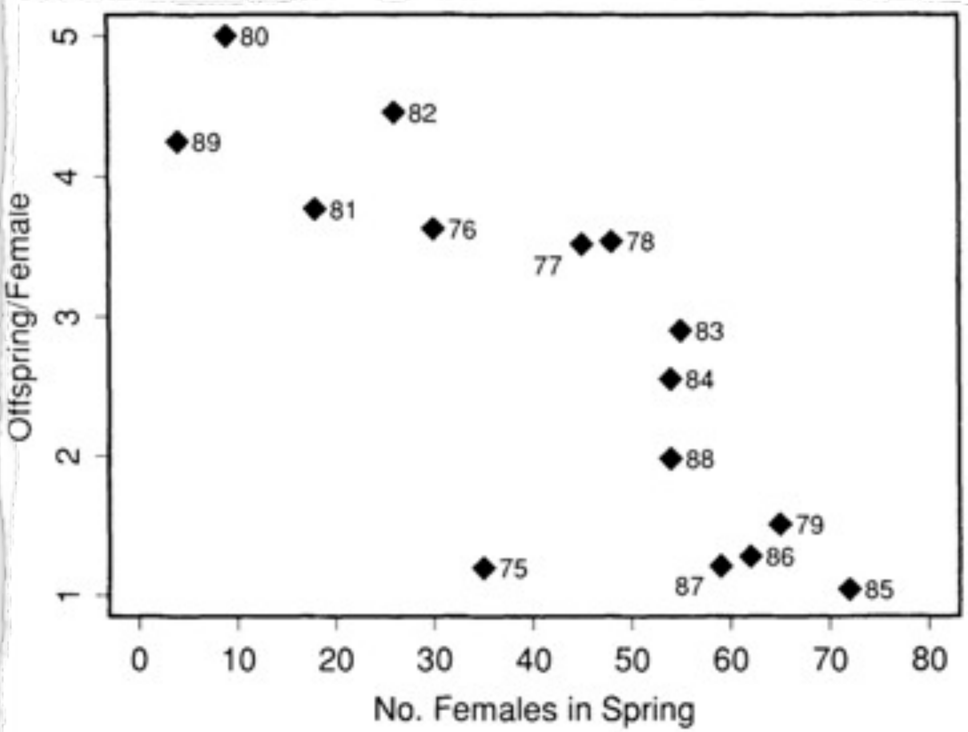

FIG. 1. The mean number of independent offspring produced per female Song Sparrow in each year in relation to population density in spring. Years are indicated beside each point by their last two digits.

So what about breeding success changes with adult density?

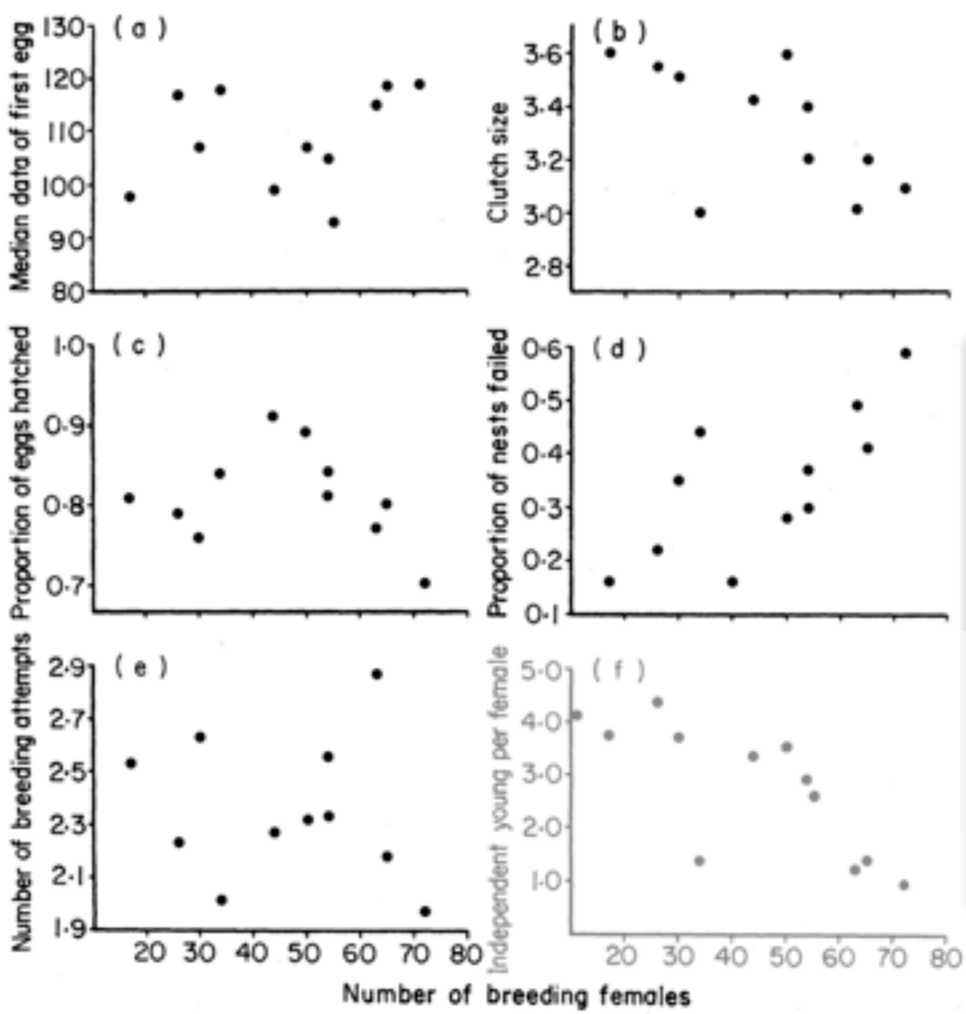

FIG. 2. Six reproductive parameters in relation to population density: (a) Median date of first egg (1 Jan. equals day 1); (b) mean clutch size; (c) proportion of eggs hatched in unparasitized nests; (d) proportion of nests failing by day 6 of nestling period; (e) mean number of nesting attempts and (f) mean number of independent young per female.

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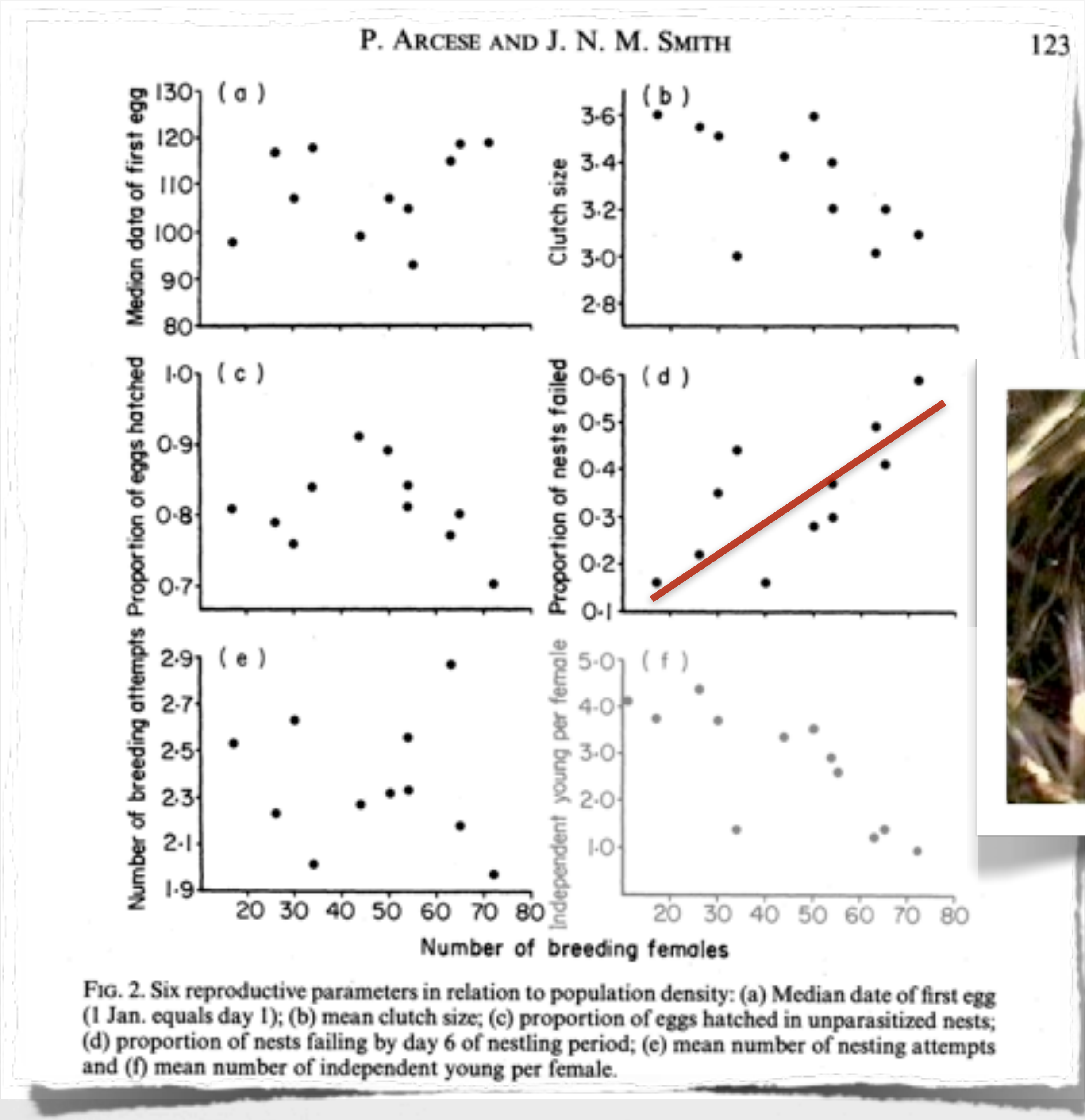
P. ARCESE AND J. N. M. SMITH 123

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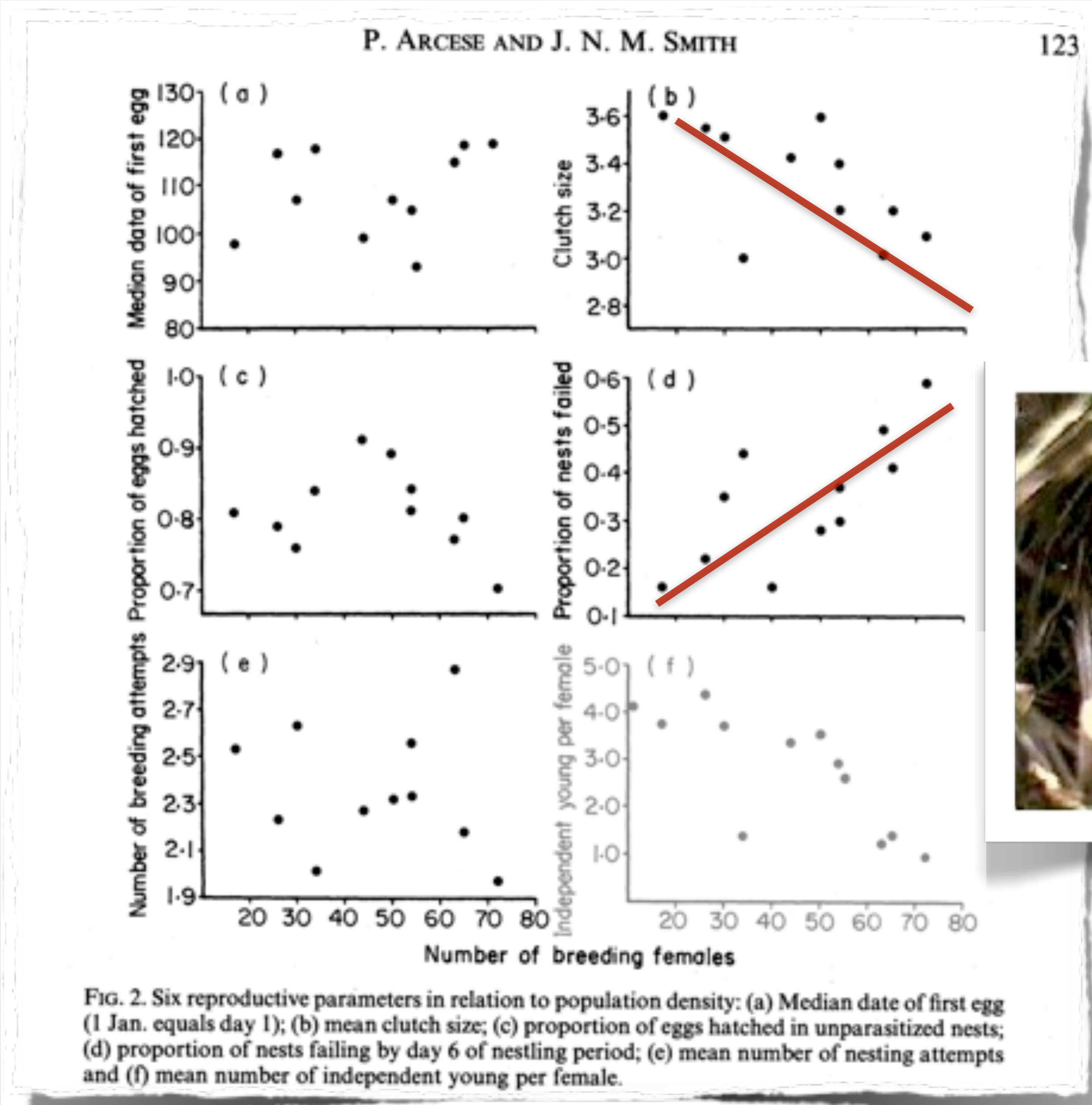

P. ARCESE AND J. N. M. SMITH 123

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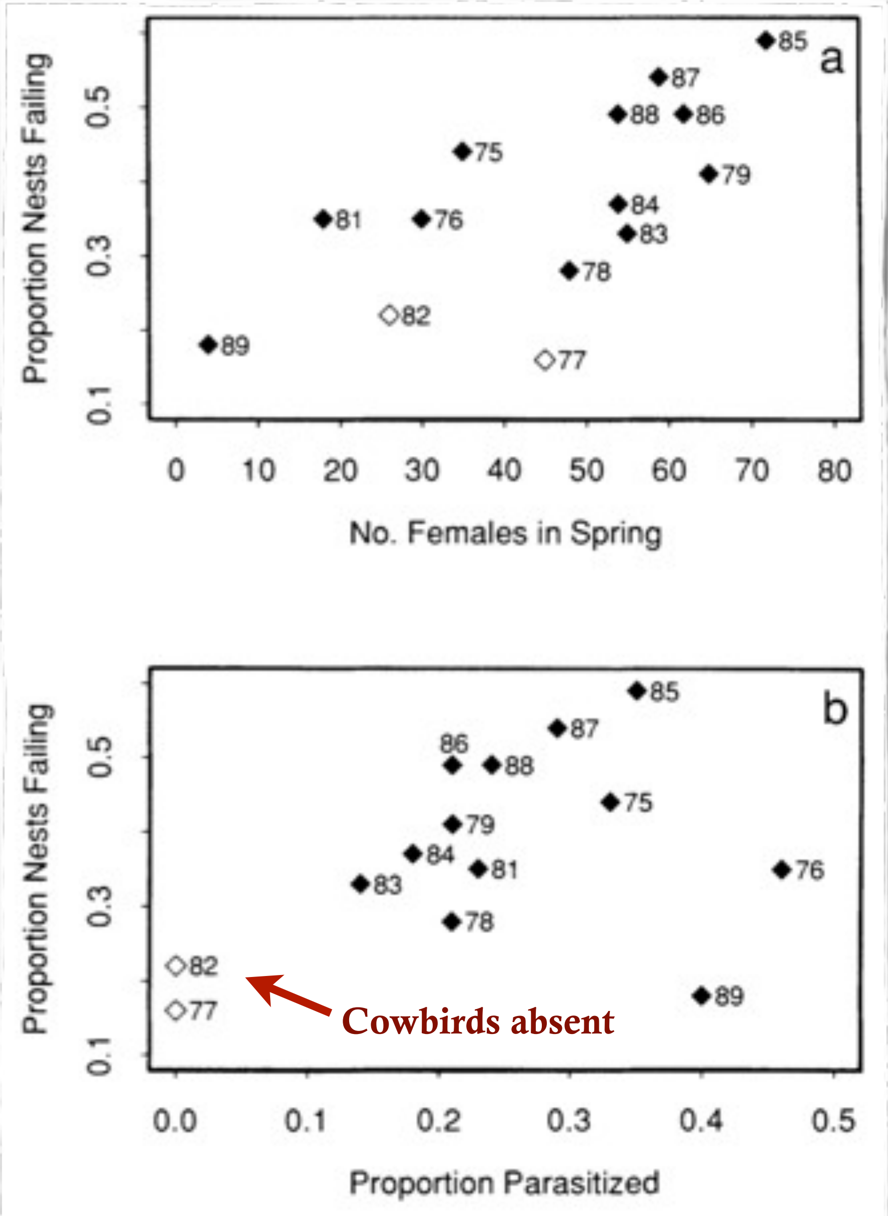


FIG. 4. The proportion of Song Sparrow nests that failed to produce fledglings in relation to (a) population density in spring, and (b) the proportion of nests parasitized by Brown-headed Cowbirds. Open diamonds (◇) indicate 2 yr when no cowbirds were present on Mandarte Island (see *Methods*).

Then why do nests fail?
Is it parasitism?

Then why do nests fail?
Is it resource competition?

Provided high-quality food in feeders in some territories

TABLE 1. The number of nest failures before fledging attributed to different sources in relation to treatment. Percentages are given in parentheses

			Source of nest failure		
Treatment	*N*	Successful	Predation	Starvation	Deserted
Fed	50	30 (60)	18 (36)	1 (2)	1 (2)
Control	100	45 (45)	45 (45)	5 (5)	5 (5)

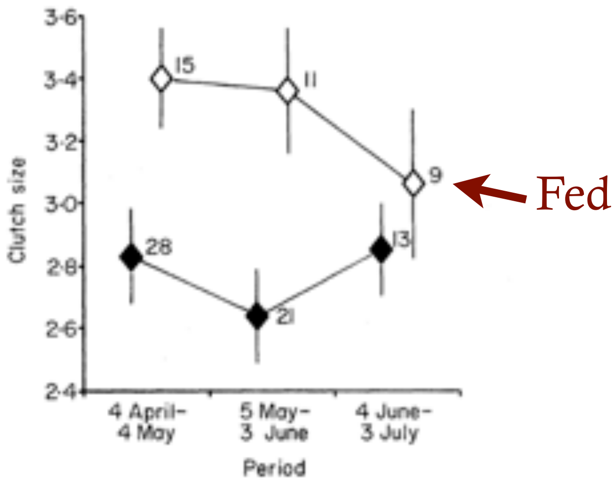
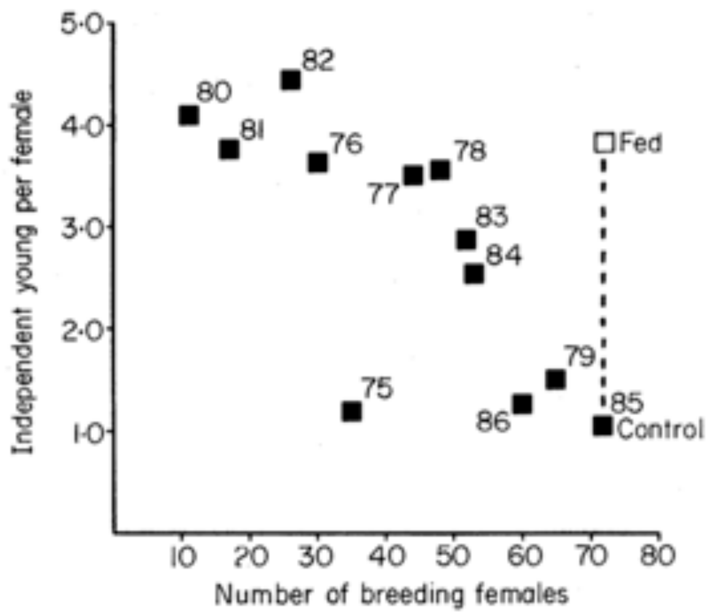


FIG. 4. Mean (S.E.) clutch size of fed and control females in early, middle and late portions of the breeding period. *N* denotes the number of females.



But also… recruitment of young to breeding population depends on adult density

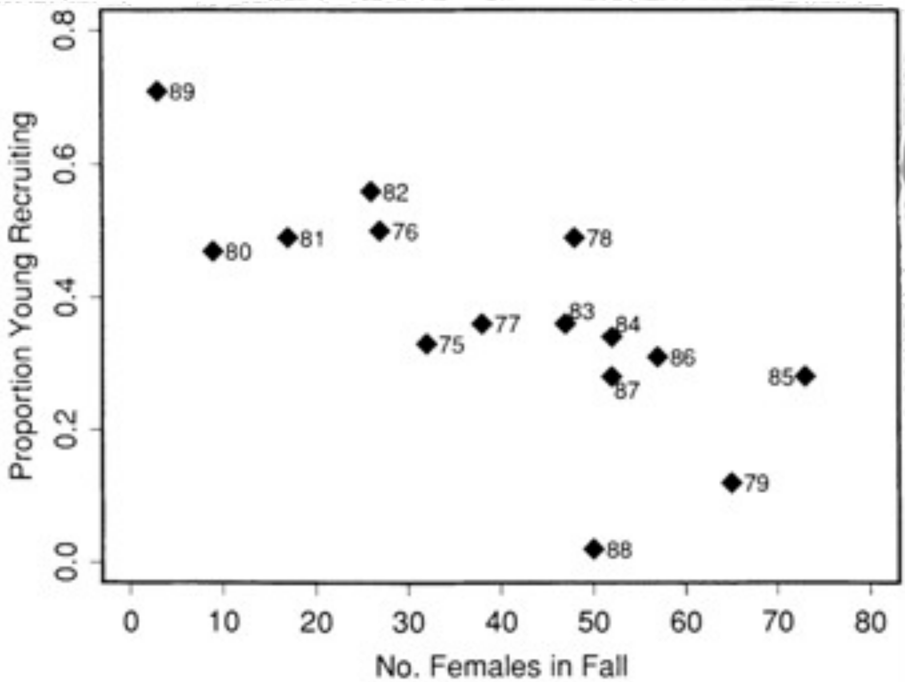


FIG. 5. The proportion of all independent Song Sparrow young that were recruited to the breeding population each year in relation to adult population density in fall. Years indicated by their last two digits, as in Fig. 1.

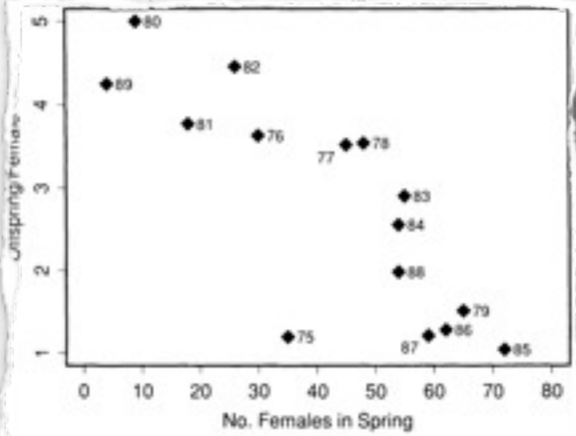


FIG. 1. The mean number of independent offspring produced per female Song Sparrow in each year in relation to population density in spring. Years are indicated beside each point by their last two digits.

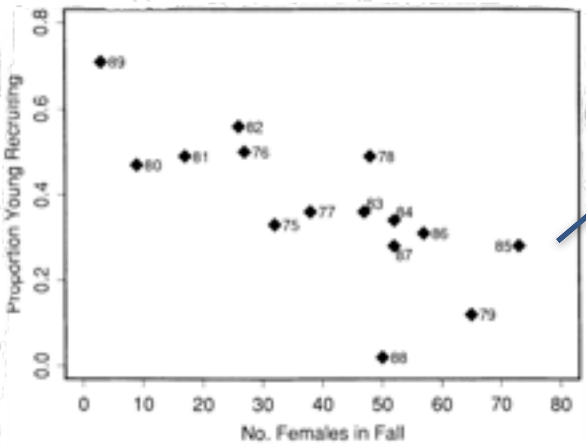


FIG. 5. The proportion of all independent Song Sparrow young that were recruited to the breeding population each year in relation to adult population density in fall. Years indicated by their last two digits, as in Fig. 1.

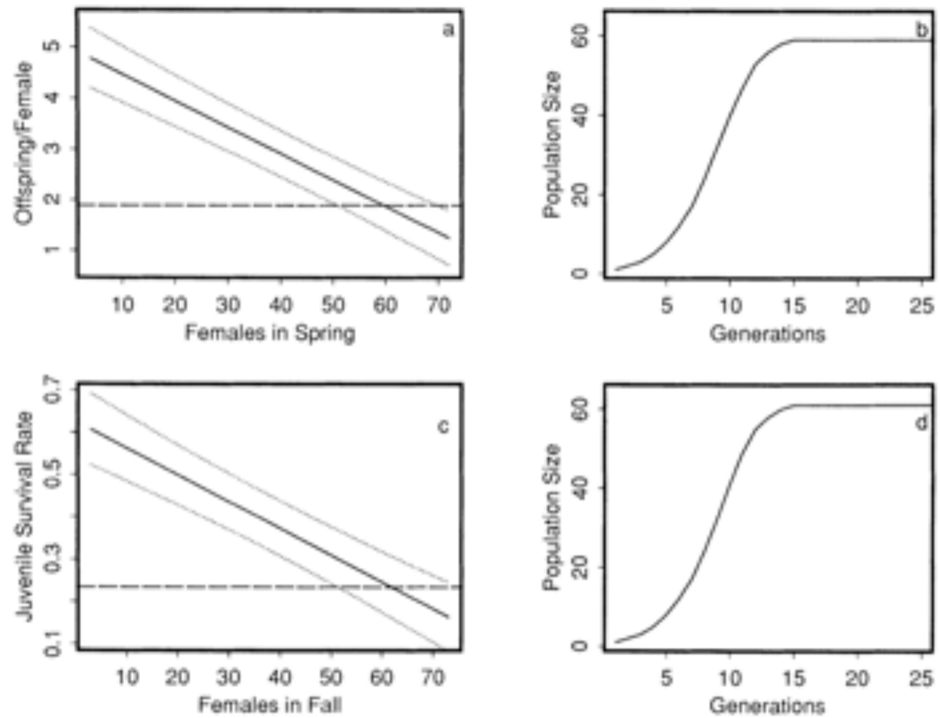


FIG. 13. Models of density-dependent variation in reproductive success and juvenile survival of Song Sparrows on Mandarte Island. (a) plots annual reproductive success against population density in the spring. —— is the fitted regression line and ····· are the 95% confidence belts. — — — indicates the reproductive rate needed to maintain a stable population given the observed annual median survival rates of adults (66%) and juveniles (36%). (b) models the expected change in size of a population starting with one female sparrow, using the above median survival rates, and with the relationship between population density and reproductive success as illustrated in (a). The model population stabilizes at 59 breeding females in under 20 generations. (c) plots the relationship between the recruitment rate of juveniles and population density of adults in fall. The conventions are as in (a), but in this case — — — indicates the juvenile recruitment rate needed to maintain a constant population size given the median survival rate of adults and median reproductive success (2.84 independent offspring per female). (d) models the expected change in population size for a population starting with one breeding female and: a constant adult survival over winter (0.66), a constant reproductive success (2.84 young per female), and the relationship between population density and juvenile survival plotted in (c). The model population stabilizes at 61 females within 20 generations.

Either density-dependent reproductive success *or* density-dependent juvenile recruitment are sufficient to regulate the population