IS ORGANISMIC FITNESS AT THE BASIS OF EVOLUTIONARY THEORY?

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FITNESS: BASICS

Fitness *of what?*

individual/organismic fitness

vs.

trait fitness

Sober (2013):

"[E]volutionary biology has little use for [individual] fitness."

Sober, Elliott. 2013. "Trait Fitness Is Not a Propensity, but Fitness Variation Is." *Studies in History and Philosophy of Biological and Biomedical Sciences*

Sober (2013):

"[E]volutionary biology takes no interest in the fitnesses of token organisms. For example, biologists don't bother with the fitness of Charlie the Tuna, though they may want to discuss the fitness of tuna dorsal fins."

Sober, Elliott. 2013. "Trait Fitness Is Not a Propensity, but Fitness Variation Is." *Studies in History and Philosophy of Biological and Biomedical Sciences*

What is individual fitness?

Pence, C.H. and Ramsey, G. 2013. "A New Foundation for the Propensity Interpretation of Fitness." *British Journal for the Philosophy of Science.*

What is individual fitness?

- Individual fitness is a disposition to survive and reproduce
- It looks something like expected number of offspring

THREE QUESTIONS

1. What *is* trait fitness?
2. How is it related to individual fitness?
3. How is it related to what biologists actually do?

First clarification: two roles for trait fitness

- conceptual role – What is the correct way to understand fitness as it appears in the conceptual foundations of evolutionary theory?
- metrological role – What is it that biologists measure when studying selection in the wild?

Sober's claim: Trait fitness is fundamental in the conceptual role, and is the only useful concept of fitness in the metrological role.

WHAT IS TRAIT FITNESS?

TF1 The fitness of a trait t is equal to the average individual fitness values of the individuals bearing t

"the fitness value of a trait is the average of the fitness values of the individuals that have the trait"
(Sober 2001)

TF2 The fitness value of a trait t is a quantity that is, given some model of population dynamics, predictive of the future dynamics of that trait in a population

e.g., Hartl and Clark (1997): $\frac{p_t}{q_t} = w^t \cdot \frac{p_0}{q_0}$

TF3 **Trait fitness is the reproductive advantage to the individual conferred by possessing the trait**

This definition echoes the original usage of ‘fitness’ in evolutionary theory – organisms bearing some traits are “better fitted” to their environment than those with other traits (Darwin 1859)

ARE THEY DISTINCT?

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THE CONCEPTUAL ROLE

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THE CONCEPTUAL ROLE

TF1 The fitness of a trait t is equal to the average individual fitness values of the individuals bearing t

If TF is just average IF, can clearly derive TF from IF, but not vice versa.

THE CONCEPTUAL ROLE

TF2 The fitness value of a trait t is a quantity that is, given some model of population dynamics, predictive of the future dynamics of that trait in a population

Here, TF is IF *plus* heritability, segregation distortion, response to selection, etc.

THE CONCEPTUAL ROLE

TF3 Trait fitness is the reproductive advantage to the individual conferred by possessing the trait

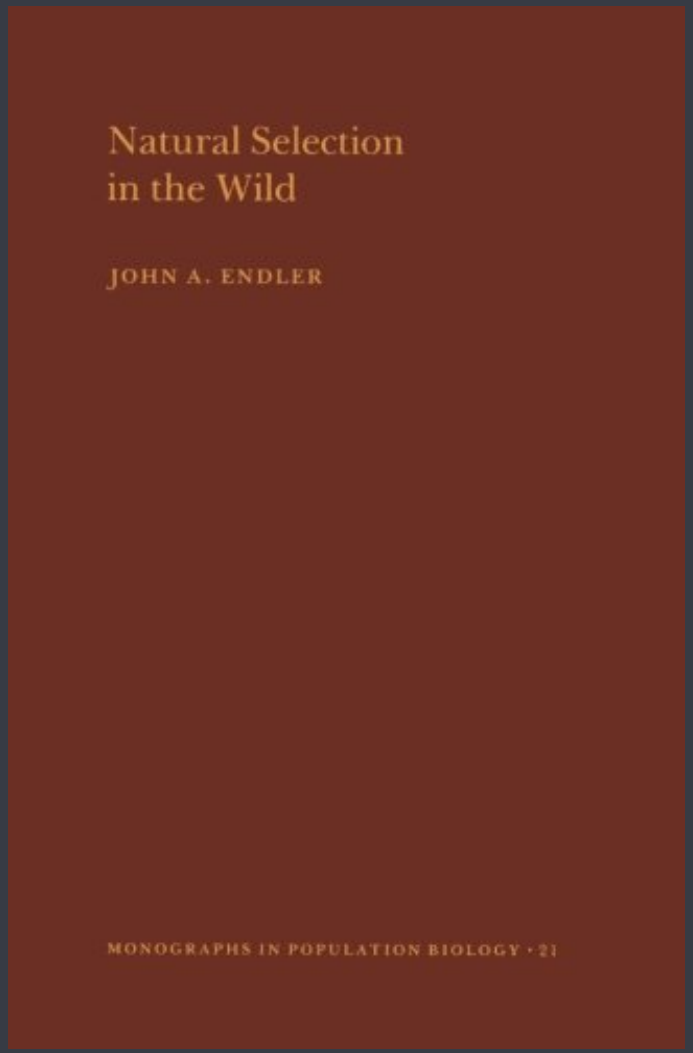
TF = IF with the trait – IF without the trait (or with another trait)

THE CONCEPTUAL ROLE

IF is conceptually prior to TF

IF is the correct way to understand fitness in its conceptual role.

THE METROLOGICAL ROLE



THE METROLOGICAL ROLE

Ten methods of measuring selection: is individual or trait fitness measured?

THE METROLOGICAL ROLE

Method VII (Cohort Analysis): "By gathering detailed data on individuals, data can be obtained on survivorship, fertility, fecundity, mating ability, and so on. Data on parents and offspring can also provide information on genetics.... Data are best gathered from individually marked individuals, though some information can be gained by giving all members of the same cohort the same mark" (Endler 1986)

TABLE 5.1 Direct demonstrations of natural selection

Species	Traits Examined	Method of Demonstration	Selective Agent	References
ANIMALS.				
COLENTERATA				
Acropora sp	morphology[a] m,v	VII, VI (introduction)	unknown, physical factors	Potts 1978, 1984
MOLLUSKA				
Bivalvia.				
*Agerostrea mesenterica**	3 morphological traits m,v	VIII (fossil)	unknown	Sambol & Finks 1977
*Cardium edulae**	ribs per shell m,v	VIII (live/dead) single samples	wave action?	Palenzona et al 1971
*Modiolus demissus**	allozymes *lap, to*	VIII 2 loc , 1 gen	unknown	Schopf et al. 1975, Koehn et al 1973
Mytilus californicus	*lap* allozyme	VIII. many loc., 4 gen.	unknown	Levinton & Koehn 1976
*M edulis**	*lap* allozyme	VIII. cline, 3 gen	salinity. temperature, and physiology	Koehn et al 1980, Koehn & Immerman 1981, Koehn & Siebenaller 1981, Hilbish & Koehn 1985

(continued)

(Endler 1986)

What percentage of the species listed in Endler's study were studied by Method VII?

If Sober is right:

Method VII $\approx 0\%$

What percentage of the species listed in Endler's study were studied by Method VII?

Method VII $= 57\%$

What percentage of the species listed in Endler's study were studied by Method VII?

Methods VII + VIII = 85%

Organismic fitness is:

Conceptually foundational

Metrologically important

QUESTIONS?

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