Re: Bet Hedging, Risk Aversion, Sex, and the Unit of Selection

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- *From*: William Morse <wdmorse@xxxxxxxxxxxx>
- *Date*: Fri, 27 Jan 2006 00:50:48 −0500 (EST)

"Perplexed in Peoria" <jimmenegay@xxxxxxxxxxxxx> wrote in news:dr1gik$80f
$1@xxxxxxxxxxxxxxxxxxx:

> A man sits down at a roulette wheel with $100. How should he
> distribute his bets?

That's way too easy. He should give it all to me. Now if I were French,
that would make me The Selfish Jean :−)

(snip)

> What does all this have to do with evolutionary biology? Well,
> some theorists have claimed that the units of natural selection
> behave as if they were risk averse maximizers of fitness (i.e.
> reproductive success). For example, Lewontin and Cohen
> On Population Growth in a Randomly Varying Environment
> R. C. Lewontin, D. Cohen
> PNAS Vol 62, No 4, (Apr 15, 1969), 1056−1060
> used the mathematical theory of "Gambler's Ruin' to argue that
> in a randomly varying environment, the unit's goal is not
> the maximization of the expectation of absolute fitness, but
> rather the maximization of the expectation of the logarithm of
> absolute fitness. The expectation is taken over the space
> of environmental variation.
>
> Now, there is some subtlety here. If W is the absolute fitness,
> then ln W = r where r is the Fisher growth−rate metric of fitness.
> There is an important difference between maximizing r = E(ln W) and
> maximizing r' = ln (E(W)). The idea is that an organism can and
> should 'hedge its bets' by having some offspring adapted to one
> environment and other offspring adapted to different environments.
>
> But is this even possible? An organism only HAS a few offspring.

That is only true for a small subset of species. An interesting question
is whether any species could have developed the strategy of only having a
few offspring if they had not already developed the ability to learn, so
that they could hedge their bets by plasticity in responding to changes

in the environment.

> The 'stake' cannot be evenly divided among the bets. However
> risk averse the organism is, its opportunities for bet hedging
> seem severely limited. Furthermore, bet hedging only makes sense
> if the bets are NOT independent. An organism with two offspring
> adapted to two different environments is only hedging if both
> of those offspring encounter the same environment.

> So much for the background − now it is time for some wild conjectures.
> 1. Sex exists because it provides a mechanism for bet hedging.

Interesting conjecture − but if that is the only explanation for sex then
I would think more organisms would have mechanisms for multiple parents
of different offspring. While a number of species (e.g. domestic cats)
have evolved such mechanisms, I don't think they are particularly
numerous.

> 2. But this only makes sense if the unit of selection is seen
> as the gene−clone, as in a gene's eye view justification
> of Hamilton's rule. A gene clone can spread its bets
> evenly among the alternatives − it has a 'stake' that is
> divisible. Organisms, for the most part, do not.

You will need to explain this further for me to understand your argument.
I would have thought that bet hedging only makes sense if the unit of
selection is the organism, or better yet the species. The organism
"tries" different combinations of genes to see which ones will work out.
The species maintains polymorphism so that it can respond to
environmental changes, even though this sacrifices some individual
fitness − The Selfish Gene Pool.

> 3. As suggested in the paper by Bergstrom and Lachmann
> The Fitness Value of Information
> Carl Bergstrom and Michael Lachmann
> http://arxiv.org/PS_cache/q−bio/pdf/0510/0510007.pdf
> the process of natural selection can be given an information
> theoretic interpretation in which there is an identity between
> fitness (Fisher's r) and information acquired about the actual
> distribution of environments.
>
> My rudimentary grasp of probability and statistics doesn't allow
> me to express this stuff in a rigorous model yet. The difficulty
> lies in separating the environmental variation into temporal variation
> (affecting all organisms the same) and spatial variation (affecting
> organisms differently). The interplay between these two kinds of
> variation seems crucial.

The interplay may well be crucial, and I question your trying to make the

distinction, at least without some additional classification. As I understand you, you are trying to differentiate between variations that occur throughout the geographic range of a population based on time (e.g. the Little Ice Age in Europe), and other variations that are severe but occur only in limited portions of the geographic range of a population (e.g. the eruption of Mt. St. Helens). I think the problem you will find is that these effects are not uniform across species.

Thanks for another thought−provoking post.

Yours,

Bill Morse

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- ***Follow−Ups***:
  - ♦ ***Re: Bet Hedging, Risk Aversion, Sex, and the Unit of Selection***
    - ◊ *From:* Perplexed in Peoria
  - ♦ ***Re: Bet Hedging, Risk Aversion, Sex, and the Unit of Selection***
    - ◊ *From:* g

- ***References***:
  - ♦ ***Bet Hedging, Risk Aversion, Sex, and the Unit of Selection***
    - ◊ *From:* Perplexed in Peoria

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