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Bacteria and the stock exchange

Nature evolves market dodging strategy when needed, says S.Ananthanaryanan.

The complex structure of living things is maintained across generations by the genetic code, but is moulded when challenged, through the interplay of random genetic changes and natural selection. When changes in the environment are frequent, it may be more effective to sacrifice some of the benefit of genetic stability and generate deliberate variations, to be ready in advance and faster to adapt.

Dr Hubertus Beaumont and others at the Leiden University, Nederlands report that they have discovered such anticipatory variations, which are inheritable and may be selected, in bacteria when they are exposed to rapidly changing environment, where failure to adapt may lead to extinction.

Hedging and the market

Dealing with uncertainty is familiar to those in business. One way of doing business is to price the product strictly according to the cost of inputs and thereby under-price all competition. This method would be successful so long as the cost of inputs does not vary. But if the cost goes up, one will run into losses and one cannot count on prices going down, even if they do not stay put.

The other way would be to price the product a little higher, so that good profits so long as prices do not rise would neutralize the losses that come when they do. But the trouble with this method is that there has to be an estimate of how much to over-price, because a competitor may over-price a little less and take over the market!

The method that business-persons actually use is that when they enter a venture where the cost may go up, they make an investment which would also rise and compensate the loss. In this way, the person can quote prices based on real costs and still be insulated from instability. This kind of compensating investment is called hedging and in real conditions, it involves investment in a complex of related commodities, shares, commitments, contracts etc.

Hedging in nature

The practice of hedging is not without cost. Markets are complex and it is not possible to find a basket of investments that would exactly reflect the variations in prices of other commodities. Hence the approximation has to be on the ‘safe side’, and this translates into accepting slightly smaller net profits, in exchange for the security of not being wiped out by market fluctuations.

A similar behavior would be that of a punter placing a large bet on the season favourite. Racehorses are notorious for defying the form book and coming in last when thousands

have bet their shirt on the opposite result. The bright race-goer (if there be one) then places a second, safety bet on the 'next to favourite', a cost, if the favourite wins, but a blessing if she does not.

Behaviour like this is also seen in nature in organisms that face rapidly changing demands for survival. With every challenge, the biological qualities of individuals in a population would need to change and be selected when they favour survival. A species that continuously generates random variations in fitness-related traits among individuals is then likely to be ready with a sub-group that is equipped to survive a sudden new environment. Of course, such variety in fitness-related features would come in the way of specializing and optimizing the benefit of the existing environment and this would be a cost. The benefit of variability is then related to the extent of variation in the environment, how readily the species can react to changes, etc.

While all species have 'under-specialised' to different degrees, as a security net in case of changing environment, an instance of rapidly changing, hostile environment is the action of the immune system against invading pathogens. The way the immune system works is by rapidly creating antibodies, which attach to the antigens, or surface features of invading organisms. While one defense, on the part of the invader, is to adapt rapidly and evolve new strains on the fly, this would keep happening, as immune system is quick to react. Many invading micro-organisms have thus evolved bet-hedging strategies of random antigen switching, to be ready with alternative forms of surface features. This would impede the organism's effectiveness, no doubt, but it would help evade the immune reaction for some time!

Bacteria and evasion

Dr Beaumont and company worked with twelve strains derived from a stock of ***Pseudomonas fluorescens,*** a common, gram-negative bacterium found in soil and water. Each of the twelve samples was subjected to sixteen cycles of specialization and selection – that is, they were propagated to many generations, till the cells showed inheritable features that were different from their ancestors. When such a new strain developed, this was transferred to a new and hostile environment. And this was repeated sixteen times.

Alongside these strains developed in rapidly varying conditions, was a series of samples that moved at each cycle to an environment that selected for the ancestral colony. Over the sixteen cycles, it was found that the hostile selection regime did drive the arising of new colony shapes, size, pigmentation, and other features. But a remarkable feature was that two out of the twelve samples showed the ability to rapidly switch colony features – an ability to have a seed population that would adapt directly in a new environment. And further, this feature, once developed, continued for the next seven generations that the experiment covered.

A series of control tests showed that it was indeed colony switching that enabled one of the existing genetic types to survive a change of environment, which was the 'bottleneck' – it allowed only one type to make the grade. In the absence of such the pressure of

selection, the rapidly changing strains even if they arose, were swamped by the faster growing, non-fast-changing strains.

The importance of the finding is that adaptive evolution of bet-hedging strategy has been induced and recorded in a simple organism. This suggests that risk-spreading strategies may have been one of the earliest evolutionary solutions for survival in environments that fluctuated rapidly.