Evolutionary ecology

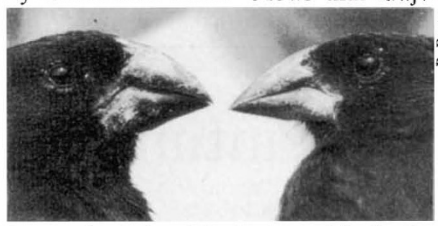
El Niño and Darwin's finches

Jon Seger

LIKE astronomers, evolutionary biologists can seldom make direct experimental tests of their central theories, so they rely instead on natural perturbations that can later be interpreted as if they had been planned. Astronomy now has a supernova, and evolution has the aftermath of the recent El Niño – Southern Oscillation event, which briefly but dramatically altered weather patterns in many parts of the western hemisphere. The Galápagos islands experienced eight months of record-breaking rainfall between November 1982 and July 1983. Many plant species responded with equally record-breaking levels of seed production. Several species of Darwin's finches bred continuously throughout this extraordinary eight-month wet season, and some of the offspring born early in the season had matured and bred successfully before it was over[1,2]. On page 511 of this issue[3], Gibbs and Grant show that during the next two years (1984–85) there was strong natural selection for reduced body size in one population of the seed-eating ground finch *Geospiza fortis*.

Rainfall on the Galápagos is always highly variable and, as a consequence, so is seed production. During the dry years of 1976–77 and 1981–82, Grant and coworkers[2,4,5] found that there was selection for increased body size (and in particular, for increased bill depth) within this same population of *G. fortis* (see figure), and they traced the ecological cause to a changing distribution of seed sizes. Small, relatively soft seeds are eaten by both small and large birds. Thus, as the seed supply shrinks during a period of low rainfall, it becomes dominated by large, relatively hard seeds that are more easily cracked and eaten by large birds than by small ones. The two years following El Niño were very dry, but small seeds were more abundant than they had been during previous dry years, owing to the huge crop produced in 1983 (see cover picture of this issue). This appears to be the reason why Gibbs and Grant found a pattern of selection essentially opposite to what would otherwise be expected during a drought. One implication is that small birds tend to use small seeds more effectively than do large ones[1], which in turn implies that selection on bill and body sizes often includes a frequency-dependent component. It should be emphasized that these studies concern only differential survival, not differential reproduction among the survivors, which also occurs in this population[6,7]. Nonetheless, evolutionary responses of the expected signs and magnitudes have been observed[2].

Many previous studies have demonstrated selection in nature, but as Endler[8] emphasizes in a recent review, there are few cases in which the ecological causes of differential survival or reproduction have been clearly identified. Endler's list of notable exceptions includes studies on two genera of Lepidoptera, one fish, three plants and *Geospiza*. In only one of these cases has selection been shown to have acted in opposite directions within the same population at different times, and in that case (industrial melanism in the moth *Biston betularia*) the ecological cause was of human origin. The new work by Gibbs and Grant[3] shows that major natural episodes of selection in opposite directions can follow each other at short intervals.



P. Boag

Two individuals of G. fortis *on Isla Daphne Major, showing variation in bill shape.*

The six morphological characters studied by Gibbs and Grant[3] seem to have served mainly as proxies for overall body size; none stands out as a distinct target of selection. But during earlier droughts, when selection generally favoured large size, differences in the intensity and even in the direction of selection on these six genetically correlated characters had been detected. If such strong and constantly changing patterns of selection should turn out to be the rule for many species (as they seem to have been for *G. fortis* on Isla Daphne Major during the past decade), then we are probably far from understanding the processes that maintain heritable quantitative variation in natural populations[9,10]. □

1. Gibbs, H.L. *et al. Auk* **101,** 872-874 (1984).
2. Grant, P.R. *Ecology and Evolution of Darwin's Finches* (Princeton University Press, 1986).
3. Gibbs, H.L.& Grant, P.R. *Nature* **327,** 511-513 (1987).
4. Boag, P.T. & Grant, P.R. *Science* **214,** 82-85 (1981).
5. Price, T.D. *et al. Nature* **309,** 787-789 (1984).
6. Price, T.D. *Evolution* **38,** 327-341 (1984).
7. Price, T.D. *Am. Nat.* **123,** 500-518 (1984).
8. Endler, J.A. *Natural Selection in the Wild* (Princeton University Press, 1986).
9. Turelli, M. *Genetics* **111,** 165-195 (1985).
10. Turelli, M. in *Evolutionary Processes and Theory* (eds Karlin, S. & Nevo, E) 607-628 (Academic, Orlando, 1986).

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Cellular immunology

Interleukin-2 receptor proteins

Ian Trowbridge

THE proliferative response of mature T lymphocytes to stimulation by antigens is regulated by the lymphokine interleukin-2 (IL-2). The production of IL-2 by a subset of helper T cells and the induction of specific IL-2 receptors on T cells occur as a consequence of activation by the antigen. Activated T cells express two classes of IL-2 receptor that differ in their affinity for IL-2. About 10 per cent of the receptors are high affinity (dissociation constant (K_d) ~ 10 pM) and appear to mediate the physiological response of T cells to IL-2; the remaining receptors bind IL-2 with much lower affinity (K_d ~ 10 nM). The structural basis for these two classes of receptors has remained unclear. A cell-surface glycoprotein, p55, of relative molecular mass 55,000 (55K), first identified on activated human T cells by the monoclonal antibody anti-Tac, binds IL-2 and has been implicated as a component of both classes of receptor. Recent results from several laboratories[1-4], including the report by Dukovich *et al.* on page 518 of this issue[5], provide strong evidence that there is a second IL-2 binding protein that could interact with p55 to form the high-affinity IL-2 receptor.

The search for other structural components of the IL-2 receptor was prompted by several observations that challenged the view that p55 was the only molecule involved in binding IL-2 and triggering a physiological response. Whereas transfection of nonlymphoid mouse cells with complementary DNAs encoding human p55 generated only low-affinity receptors[6], similar transfectants of two mouse T-cell lines displayed both high- and low-affinity human IL-2 receptors[7,8]. These results suggested that T cells express a cell-specific component that modulates the binding affinity of p55. Further, the deduced structure of p55 predicts that only 13 amino acids form the cytoplasmic domain, raising questions as to the mechanism of signal transduction[9-11]. Finally, some lymphoid cells, including natural killer cells and precursors of lymphokine-activated killer cells, apparently do not express p55 but nevertheless bind and respond to IL-2.

The approach taken by Dukovich *et al.* in this issue[5] and by the other groups[1-4] to characterize the molecules involved in