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Bioeconomics and the survival model: The economic lessons of evolutionary biology

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1. Introduction

Public choice has made important strides in the last 25 years. The rational choice model, however, has left some important unanswered questions, such as why people vote. Since this paper is about the next 25 years of public choice, I propose an alternative to the old rational choice model. I propose that "rational choice" be replaced with a "survivor model" of biology, which incorporates rational choice as a special case. The survival model includes all behavior, both cognitive and non cognitive, which improves economic fitness. It incorporates, for example, genetics, hormones and environmentally driven behavior.

This paper proposes the development of a field which I would call "bioeconomics," which would investigate the economic and political lessons of evolutionary biology. Sociobiology captures the evolutionary lessons of animal social behavior. Any behavior that is been replicated for hundreds of millions of years has, by definition, survival value. That was Darwin's (1859) insight. Bioeconomics provides a more general theory that is also useful for public choice because it explains both economics and politics within a single framework. Bioeconomics studies both the human traits in animals and the animal traits in humans: animals are rational and humans are instinctual. Human emotions may be our equivalent of animal instinctual behavior. In this regard, psychology provides rich bioeconomic lessons. This paper draws heavily from Magee (1984) and my ongoing work in this area.

Property rights in nature and in politics are generally not well defined. Smith (1992:3) documents the overkilling of megafauna (large animals) such as bison, reindeer and horses by Cro-Magnon man in pit traps. Property right ambiguities erode the efficiency arguments of the rational choice theorists. How do animals solve the problems of politics and property rights? My own view is that species which had territoriality and dominance hierarchies had an advantage over species which did not. Nearly all species which have survived until now display one or both of these social controls. Territoriality economizes on economic resources. But territoriality is not feasible for nomadic and migratory animals. These species displayed dominance hierarchies, or pecking orders. The top chicken in a flock takes the best food, mates and roosts while the weakest chicken takes the hindmost.

Bioeconomic work to date falls into two broad groups. Work by most economists looks to rational choice as paradigm. In contrast, many biologists and sociobiologists utilize a broader notion of survival value, which incorporates rational choice as a subset. Pioneering work on bioeconomics, with a largely rational choice emphasis, includes Alchian (1950), Becker (1976), Hirshleifer (1977,1978), Tullock (1990a,1990b) and Ursprung (1988). Equally interesting work, but with an anthropological slant, includes Rogers (1992) and Smith (1992). Tullock (1990a) presents a nice alternative to the views reported here on group selection theory and both Hirshleifer (1978) and Tullock (1990b) presents important biological alternatives to government solutions to public good problems. Harlow (1988) has a biochemical basis for human risk aversion and Henderson (1989) and Rothschild (1992) suggest biological insights for popular business applications. For the use of biological ideas in the development of economic theories, see Nelson and Winter (1973), Simon (1962) and my own 17-year rational choice effort on endogenous policies and rent seeking in Magee, Brock and Young (1989), which took a predator-prey approach to lobbying and politics. Bioeconomics includes experimental work which economists have done with animals that focuses on animal rationality, i.e., on the human qualities in animals, such as Battalio, Kagel and MacDonald (1985). Bioeconomics also emphasizes the animal qualities in humans.

Important readings from biologists and sociobiologists include the masters Darwin (1859) and Wilson (1975) as well as Dawkins (1976), Gould (1983), Lopreado (1984), MacArthur and Wilson (1967), Trivers (1971), Vehrencamp (1983), and Wittenberger (1981), who emphasize the survival value of animal qualities in humans.

To summarize, we employ a survivor model from sociobiology. Human behavior can be described by a Darwin-type dominance hierarchy, with success based on genes, hormones, the environment as well as rational choices. Bioeconomics utilizes three types of economic selection: directional, stabilizing and group selection. Four implications of bioeconomics are insights from the foraging and fecundity strategies of r versus K species; a law of increasing competition; the impossibility of separating economics and politics; and that animal territoriality is their equivalent of private property.

One type of evidence supporting a bioeconomic approach is the success of non cognitive advertising. Another is evidence of genetic influences on behavior.

2. Genes and behavior

There is both casual and scientific evidence that genes affect behavior. Brain research indicates that over half of human decision making is non cognitive. The Minnesota study of 348 sets of twins, including 44 pairs of identical twins raised separately, found that how people think and act and their very personalities are determined more by the DNA in their cells than by society's influences. Genetics explained 40 to 60 percent of the behavior examined. At the high end, they found that about 60 percent of the behavioral tendencies toward extroversion and conformity were determined by heredity rather than culture.[1]

Genes can retain information, but for how long? If the retention length is short, then a genetic basis for bioeconomics is less compelling. Gould (1983: 182) reports that as the head of the embryos of modern man and other mammals develops, it grows an anterior gill arch which was possessed by ancestral fishes. As the embryo develops, this arch is transformed into a jawbone with teeth. Gould cites an experiment in which chicken embryos were injected with chemicals that caused the chickens to grow teeth.

The striking thing about this result is that birds have not had teeth for over sixty million years. Gould concluded that living creatures have genetic memory. Encoded in our DNA structure is millions of years of genetic history. So apparently, genes can retain information for very long periods.

If genes determine behavior, can they explain individual variations in economic success? Harlow (1988) has determined a link between a neurochemical activity and psychometric variables. He found that individual risk aversion was correlated with catecholamine activity in the brain. Will we some day link genetic endowments and net worth? We know that androgen injections induce aggression in laboratory mice while testosterone injections induce the same effects in rhesus monkeys.[2] Hens injected with testosterone can move from bottom to the top of their hierarchy.[3]

3. Bioeconomics as a general theory

Bioeconomics is a one-factor theory based on hierarchy, which can exlain both economics and politics. In bioeconomics, the strong dominate the weak, economically, politically and socially. Experiments have shown that when, say, 20 chickens are placed together for the first time, they engage in vigorous combat for about an hour until the pecking order is determined, from 1 to 20. Thereafter, when conflicts arise, each chicken typically defers to superior chickens and dominates inferior chickens. The pecking order is much more than a social process.

When resources decline, chicken #20 is the first to die; #19 the second, etc.

The strongest chicken is the last to die. The pecking order is the survival order. An important part of bioeconomics is the dominance hierarchy, or pecking order and it determines both political rank and the distribution of resources – food, territories and mates.

One insight from animal dominance hierarchies is that political rent seeking is just a transaction cost of interactive activity. The animals decide the question of who gets to redistribute wealth from whom when the pecking order is established. Thereafter, little effort is expended on redistributive battles for most species. Species with lower transaction costs for redistributive conflicts experience greater survival, as do nations.

4. Biology and sociobiology

In 1836, Charles Darwin returned to England after his famous five-year voyage on the *Beagle* to South America and the Galapagos Islands. In October of 1838, he read Thomas Malthus' *An Essay on the Principle of Population.* In his autobiography, Darwin wrote that after reading Malthus, he discovered that in the competitive struggle for life, "favorable variations would tend to be preserved and unfavorable ones to be destroyed . . . The result of this would be the formation of new species. Here, then I had at last got a theory," which was the principle of natural selection.[4] Darwin got his theoretical structure from an early economist. It should not be surprising that Darwin's theory of natural selection and subsequent biological research has powerful insights for economic behavior.

Biology and the field of sociobiology pioneered by Wilson (1975), Trivers (1971), Dawkins (1976) and others is a fertile ground for learning both the genetic determinants of human behavior and analogies from animal social behavior for economics. Simple parallels between human and animal behavior include the following. Everything from insects to primates have strikingly human courtship behavior, territoriality and fecundity strategies; Mallard ducks commit rape; chimpanzees practice war and genocide; ants have slaves; dolphins save each other and even humans from drowning; and lizards, dogs and seagulls all practice homosexuality.[5]

In what other ways is animal behavior primitive economics? Animal territoriality is an early form of private property. Dominance hierarchies reveal that animals resort to underlying power in resolving conflicts, a primitive form of politics. Animals have groupings not unlike political lobbies, in which they scavenge, pillage and take kill from other predators. Such cooperative feeding behavior is also done by herbivores. Coloniality by birds and seals and grouping behavior by many grazing animals parallels city life.

The Effects of the Actor's Actions

		On the Recipient +	On the Recipient -
On the Actor	+	Cooperative	Selfish
On the Actor	-	Altruistic	Spiteful

Figure 1. The four forms of behavior by humans and animals.

5. Economics vs bioeconomics

How does interactive human behavior differ from animal behavior? Humans are generally more cooperative while animals are more selfish. In bioeconomics, there are only four ways to behave in interactive relationships. Figure 1 illustrates that we can be cooperative, selfish, altruistic or spiteful. My behavior is *cooperative* if I help myself and help others; it is *selfish* if I help myself but hurt others; it is *altruistic* if I hurt myself but help others; and it is *spiteful* if I hurt both myself and others.

Cooperative behavior is the dominant form analyzed in economics, because of the assumption that voluntary transactions necessarily involve mutual gain. Selfish behavior is the dominant form of animal behavior. Almost all feeding behavior with interspecie interaction is selfish. Predators and parasites increase their welfare at the expense of prey and hosts. Within species, dominants profit from subordinates. The cooperative behavior of pilot fish with sharks and cowbirds with cows are exceptions to the rule.

One can think of economic (cooperative) relationships as horizontal, because both parties gain (win-win). Since both players gain, they are on an equal plane. But political relationships can be thought of as primarily vertical, because they are about rights and redistribution and power, which are relative. Since political relationships are vertical, bioeconomics is particularly instructive for public choice because biological relationships are driven by the dominance hierarchy. The pyramid of nature is also vertical: carnivores consume herbivores, herbivores consume herbs, etc.

Cooperation versus selfishness is the defining difference between humans and animals. In fact, it is also a difference between advanced and developing countries. Advanced countries protect the populace better from predatory and parasitic behavior.

Man's own relationship with animals has evolved. First, it was predatory: man preyed on animals as a primitive hunter-gatherer. Second, man moved to a parasitic relationship, domesticating animals as workers and beasts of burden. Finally, man's relation has evolved to cooperation as animals have become pets. Animals have been replaced today by robotic animals such as cars, airplanes and personal computers.

Both altruistic and spiteful behavior is rare with animals. Most of the examples that come to mind are really a form of cooperation or selfishness. Spiteful behavior is bad for the actor. For example, bee stings hurt both the person stung and the individual bee, because many bees die afterward. However, the behavior is altruistic for the bee vis-a-vis the bee colony because the other bees are protected.

Leadership is typically associated with altruistic acts. But the altruistic acts yield adaptive byproducts which are of benefit to the leader, both human and animal. Arabian babblers are a territorial bird. The leaders of these birds sit in treetops and warn the flock of any impending danger. These sentinels vigorously compete for this right but the cost is that they have higher mortality rates because of greater vulnerability to predators. The benefit is that they gain elevated status and have superior access to females.

6. r vs K strategists

MacArthur and Wilson (1967) note that there are two basic survival strategies in all of biology: r strategies and K strategies. These are parallel to directional selection and stabilizing selection described in a subsequent section. Mnemonically, r species can be thought of as rats and K species as cows. The r strategists include insects, fish, and amphibians while K strategists include birds mammals, and man. The r strategists are characterized as having opportunistic basic life strategies, short lives, many offspring, low levels of parental care for offspring, and small body sizes. K species have sedentary basic life strategies, longer lives, fewer offspring, higher parental care for offspring, and large body sizes. In general, r strategists thrive in variable environments while K strategists do better in stable environments.

Management departments in some business schools teach r and K approaches as business strategy. The basic approach employed by the r strategists is that of generalist, emphasizing adaptability; the K strategists are specialists who emphasize quality. The r strategists tend to be more adaptive while K strategists are more inflexible. Directional selection parallels the ancient mutation: it combines new elements and variation into behavior. Conversely, stabilizing selection generates resistance to change and mutation. Marketing, advertising, and sales departments will be populated by r strategists pushing for creativity and change while more conservative finance and accounting groups resist change, K-style.

The reproduction strategies of insects is an r strategy: they lay hundreds of thousands of eggs and leave the young to fend for themselves. This contrasts with the K strategy of the cow which has a nine month gestation period. There is a weak tendency for males to be r strategists and females to be K strategists. Lopreato reports that the average woman will produce only about 400 eggs in her lifetime whereas the average male can generate hundreds of millions of sperm in the course of a single day.[6]

The r-K strategy distinction is insightful in explaining economic behavior between developing and advanced countries. Developing countries face highly variable economic and political environments. We observe that developing countries display high reproductive rates and lower parental investments in their children than do citizens in high income countries which have fewer offspring per marriage and invest greater amounts of parental investment per child. This is rational in that individuals will shift from K toward r strategies in the face of greater economic shocks.

Popular treatments suggest that r strategists are more aggressive (e.g., type A personalities), more creative, more accident prone, more nonconformist, risk loving, irresponsible, sloppy and spendthrift. In contrast, K strategists are passive, conventional, careful, conformist, risk averse, responsible, precise and frugal. The young prefer r strategies while the old prefer K.

In r environments with low density and low competition, one does not need to waste energy in fighting off rivals. In contrast, in highly competitive situations and in markets with excess supply, then defensive strategies aimed at one's rivals may be necessary for survival. This may explain why there are so many antitrust complaints in highly competitive industries, which are virtually impossible to monopolize. Political investments and antitrust legal activity reflect greater bioeconomic competition. Scramble competition describes the behavior in new product markets. This may also provide insight into the Olson problem: redistributive political coalitions are more prevalent in older societies with greater density and higher levels of economic competition. In general, r strategists tend to have shorter time horizons while K strategists have long ones. See Rogers (1992) for a fascinating analysis of time preference and natural selection.

Higher levels of economic competition in large urban centers push individuals to specialize more, like K strategists. Country dwellers rationally opt for generalist r strategies. The basic economic strategy of r strategists is offensive while that of K strategists is defensive. This means that r strategists have a comparative advantage in making money while K strategists have a comparative advantage in keeping money. Societies like Japan which are moving up the world economic hierarchy are basically employing r strategies while those at the top like the United States and the Europeans adopt various exclusionary devices (e.g., protectionism, etc.) to fend off the interlopers.

The insight from r-K theory is that developing countries will yield larger numbers of offspring per family with lower levels of parental investment; generalists rather than specialists; and greater hierarchical (e.g., political) competition. The pattern is for them to be risk lovers; for them to have short time horizons; for them to employ scramble competition strategies; and for their national citizens to be more adept at hierarchical and social climbing behavior.

7. Welfare bioeconomics

The positive welfare implications of bioeconomics are that individuals with certain traits and more of certain hormones, such as testosterone, will dominate the weak. Bioeconomics stresses that such endowments translate into both political and economic fitness. Are there normative ones? Is it possible to draw normative welfare implications when some consumers in the economy (lions) consume others (gazelles)?

The Kaldor-Hicks criterion suggests that when a lion consumes a gazelle, lion welfare must increase more than the gazelle's decreases. A particularly handsome feature of the Kaldor-Hicks criterion is that compensation need not actually take place. It is ironic that lions usually pursue older, less fit gazelles. Presumably, they are near enough to endgame so the decrement in their welfare is less than the increase for the lions. But this is pulling Kaldor-Hicks out of shape. Biologists argue that while lions harm individual gazelles, they can help gazelles as a specie because the less fit are eliminated.

A bioeconomic lesson for politics is that there are counter strategies for gazelles or anyone being preyed upon in a human economy by, say, political lobbies. Group defenses against predators are available. Baboons, zebras, gazelles and many antelopes forage together so that they can provide warning signals and musk oxen form circles with their horns directed outward.

8. Politics and dominance hierarchies

Politics is about who rules who. Animal politics is based on strength. Animals usually fight only initially to figure out the pecking order and then defer thereafter. Man does not do this because we are further from the starvation margin and can afford the luxury of prolonged dominance contests in politics, law and diplomacy.

A dominance hierarchy is biologically adaptive because it increases resources in the possession of the strongest animal, which increases its reproductive success. For laboratory mice, dominant males fathered over 90 percent of the offspring even though they were only 33 percent of all males in the experiment.[7] For both animals and humans, hierarchy limitations on conflict benefit those at the top and they well may increase group fitness. The Japanese have a feudal and steep social hierarchy, which certainly serves those at the top. But the group cohesion which the hierarchy supports increases the group fitness of Japan relative to their foreign competitors.

Species which resolve conflict efficiently, either via territoriality or dominance hierarchies, have an advantage over those with neither. Wilson (1975:279) indicates that straight chain hierarchies produced greater group efficiencies than more complicated ones. And so it is with nations. Latin American countries which have had 189 governments in 185 years appear to expend excessive resources on dominance competition.

Examples of primarily hierarchical/status rewards include politics: the hierarchical value of being a US senator or the President of the US dwarfs the monetary rewards. The same is true of fame generally: academics face a direct trade-off between fame and remuneration. One study showed that BAs in economics make more than MAs, who make more than Ph.Ds in economics.

Seniority rules are promoted by the top of the hierarchy to prevent entry by newcomers. The seniority rules in Congress preserve the existing hierarchical equilibrium in the face of newcomers to Congress. Seniority rules also promote stabilizing selection: the values of those at the top of the hierarchy become the standard for all who want to move up. Hierarchical competition is also prevalent in most bureaucracies, academic institutions, the military. For a fascinating application of hierarchies in politics, see Vehrencamp (1983). Success in the business hierarchy is measured by ones territory (net worth), witness the ranking of the 400 richest people in the US every year in *Forbes*.

The greater the external threat to a group, the steeper the hierarchy. A steep hierarchy is one with more resources in the hands of dominants. Wars, professional sports and other highly competitive endeavors display rigid and in some cases steep hierarchies. The need of high conformity drives the acceptance of a steep hierarchy: nonconformists can be more quickly eliminated when authority is concentrated in a few hands. Stabilizing selection quickly eliminates poor performers. Older industries are subjected to greater competition, face greater pressures from conforming selection and hence require steeper hierarchical structures within the firms in the industry.

Let us contrast rational choice theory versus bioeconomics in explaining public policy on the question of unemployment. What is unemployment like for animals? In the animal kingdom, the weakest die during periods of scarcity. Consider the red grouse. There is little territorial behavior in the summer months because of an abundance of food. In the fall of each year, males establish territories and begin courting hens. However, not all cocks are successful in obtaining territories. Unsuccessful males and unmated females find themselves in undefended areas where food and covering are both in short supply. Most of the non territorial birds die during the winter because of predation, inadequate cover and insufficient food.

How does man handle unemployment? Because of the diminishing marginal utility of income, one might think that human economies would have individuals with higher incomes absorb more of the costs of business cycle troughs. But this is not what happens in the vast majority of the countries of the world. The bottom of the human food chain is the residual bearer of business cycle risk, just like in the animal kingdom.

Another hierarchy experiment showed that when a mouse was subordinated in its social group, its body produced less testosterone.[8] This is interesting because it indicates that testosterone production is endogenous. The implication is that racism and other forms of dominance can result in the biochemical weakening of subordinates and that steeper dominance hierarchies in developing countries can have perverse effects on the performance of subordinates. It has been observed that dominance hierarchies are more prevalent in caged animals than for animals in the wild.[9]

It would be interesting if the reverse were true. I.e., if subordinates in one group were moved to other groups in which they were dominant, this would increase their testosterone, aggression and confidence. A literature on the meritocracy in the US suggests a parallel idea. If so, we would have an explanation for the success of Western capitalism and democracy, in which there are tens of millions of hierarchies, each stimulating a biochemical surge of creative energy. If every person can be a dominant member of some hierarchy, then we can all experience both the grandeur of success and biochemical reinforcement.

A surprising consideration in animal dominance relationships is the power of tradition. It has been observed that young pigs fight vigorously for teat positions on their mother during their first hour after birth. They scratch and fight and bite each other with their sharp teeth, with piglets on the three anterior teats receiving 84 percent more milk than piglets on the three posterior teats. Interestingly, once the teat order has been established, it tends to stay that way until weaning. Efforts to condition the piglets to a different teat order by getting them to suckle new teats on tranquilized sows was unsuccessful.[10]

There are chemical techniques for hierarchical control. It has been observed that workers in oriental hornet colonies are strongly attracted to the queen because they lick an alcohol extract from the queen. This pheromone is a chemical compound used by the queen to control worker behavior. If the queen is separated and they are not able to obtain this chemical, workers become disinterested in caring for broods, become increasingly combative, and neglect and may even eat larva.

The animal kingdom displays less of the altruism that is common with man.

But much of the third world lives in poverty and the bioeconomic prediction of steep hierarchies with scarcity describes well the unequal distributions of income in these societies. A secondary virtue of economic prosperity is the comfort of a flatter hierarchy and less dominance behavior.

9. A theory of economic selection

Man has existed for about 3 million years, which works out to about 150,000 generations. Our ancestors have successfully reproduced 150,000 times in a row without a single miss. Our origins are traceable to shrew-like creatures that go back 150 million years; mammals originated with aquatic worms that go back 600 million years; and life itself descended from microorganisms that go back 3 billion years.[12]

Theories of natural selection attempt to explain why, for these 3 billion years, some survive while others do not. The three major forms of selection: directional, stabilizing and group selection. Directional selection fosters change and works best when environments are changing rapidly and species must change to survive. Stabilizing selection retards change and is the rule in stable environments. The existing traits are probably optimal, so deviations are discouraged. Group selection explains that actions which reduce individual fitness, such as stings by a bee, can increase specie fitness. The stakes are lower in economics than in biology. In biology, the less fit die; in economics they just lose their assets. Directional selection and stabilizing selection are the biological bases for the r and K strategies discussed above.

Directional selection is the popular form of evolution that most people recognize. It involves a mutation with superior reproductive capability. Research indicates mutant males among ruffs, a promiscuous European shore bird, were larger and had more exaggerated plumage. Females preferred the larger, more colorful males and this increased their ability to attract and mate with females. Directional selection moves a specie in some direction. It changes the mean value of some physical characteristic of an animal, e.g., size or length of wings. The probability of mutant deviations persisting in the gene pools of many small isolated colonies is higher than that in a single larger population. In short, directional selection can lead to greater variety the more separate colonies there are.

The bioeconomic implication is that geographical separation of markets reduces the homogenization that a competitive world market imposes. Product variety increases and economic mutations that work locally can one day spread world wide. The infant industry argument for protection may be correct, because it allows a local industry to develop in isolation. This may foster beneficial variational effects in the long run.

Stabilizing selection is the most important form of selection. But it is much less obvious because it maintains the status quo. Stabilizing selection eliminates mutants and deviants who are less successful reproducers. Through time the variability of individual members of the specie declines. Stabilizing selection is a powerful force during periods when a specie is under (1) severe stress, such as severe weather or overpopulation and (2) cataclysmic mortality, such as long bird migrations.

A study of house sparrows showed greater mortality during severe weather among birds which had either longer or shorter wings than the average. Deviations from conformity also mean death for some prey because predators prefer deviants: sparrow hawks prefer odd colored mice because they are easier to see than normal colored mice. Also, migratory birds whose wing lengths and bone densities deviate from the optimum are incapable of surviving the physical stress of long migrations.

Stabilizing selection is parallel to long-run economic competition. Firms or individuals which are not the most efficient are eliminated. That is, those firms which deviate most from optimal production, costs, or marketing strategies are most likely to be eliminated. Takeover artists and bankruptcy are the vehicles by which economic competition performs stabilizing selection. In stable environments and older institutions, boring K strategists, such as journal referees and cost accountants become kings, à la Mancur Olson (1982).

Another interesting implication of stabilizing selection is the solution it provides to the economic free-rider problem. The more effective are the mechanisms of stabilizing selection, the less prevalent will be the free-rider problem. If these mechanisms break down, then other mechanisms take over, such as group selection theory.

Group selection theory has discovered the following paradox: the proportion of selfish individuals can increase within every subgroup and yet the proportion of selfish individuals in the total population can decrease. Why? Because subgroups with fewer selfish individuals in them grow more rapidly than those with more selfish individuals.[13] This could explain how redistributive activity could be increasing in every country of the world and yet income from redistributive activity could be declining as a share of world income. This happens because countries with high levels of redistributive activity will grow more slowly than countries with lower levels (e.g., US versus Japan).

In general, group selection is a key to bioeconomic selection. While group selection has fallen out of favor in biological selection, it has wonderful insights for politics and economics. The quality of constitutions, political systems, legal systems and all relevant public choice variables are judged by their contribution to country fitness. Countries with expanding wealth and welfare are like animals with superior traits. Public choice in this framework boils down to finding those country traits which generate the most economic and political success.

How does group selection solve the free-rider problem? Animals who free ride excessively in nature find that they are not members of any group. Since loners are more vulnerable to predation, the proportion of loners declines until an equilibrium is reached. There are always loners and free riders, but their numbers are limited by predation. The second natural solution is trait group selection theory. Groups with larger proportions of free riders (selfish individuals) are less successful in competing with other groups. Hence, free riders suffer indirectly at the group level.

10. The law of increasing competition

In the very long-run, species proliferate until every food niche is filled. The species of Australia evolved independently from those in North America. But Australia has many of the same animals. Australia has a Tasmanian wolf, a native cat, a flying phalanger (like our flying squirrel), wombats (like our groundhogs), and marsupial-anteaters, marsupial moles and marsupial mice. None of these can reproduce with their North American counterparts because they are totally different species. But they look like the North American animals and they fill the same food niches.[14]

In the very long run, every animal is an enemy and every animal has an enemy. Even the mighty lion, the king of beasts can be a prey. After kills, solitary lions are frequently driven from the carcass by packs of hyenas and wild dogs. Lions must hunt cooperatively to protect even their own kill.

Total fitness in bioeconomics means competing for resources on all dimensions: economic, political, social and legal. Lobbying and political intervention are not distortions, just different ways of competing. Economic efficiency cannot be expected in a world of pure power because property rights are not defined. For a fascinating example of increasing competition at the protozoa level, see Henderson (1989).

There are two consequences of the law of increasing competition. First, dominance hierarchies get steeper through time. The period of the 1980s have certainly demonstrated this, although the 1980s are a flyspeck in biological time. Lopreato notes that in both human and animal ecologies, increases in competition (population densities) lead to increased aggressive behavior, more fighting wars, and greater dominance conflict.[15] The distribution of income in developing countries is much less egalitarian than in advanced countries, perhaps partly explained by this effect. The density effect explains the Olson phenomenon of greater redistributive conflict in older nations. Older nations have greater densities than the same nation at an earlier time; hence, we should expect lobbying, tax avoidance, lawsuit abuse and other measures of redistributive behavior to increase with density.[16]

Second, hierarchies multiply. Biologists report medium-run advantages for specialists relative to generalists, meaning they leave more descendants. The bioeconomic parallel is the principle of comparative advantage. But a cost is greater vulnerability to redistributive predation from other groups.

11. Concluding comments

This paper was written to provoke some creative thinking in a new area. I hope that readers will be encouraged to explore this field rather than discouraged by the trials of academic selection. K strategists will find the errors in this paper while r strategists will extend it.

At the outset, we suggested that it is hard to explain why people vote. Bioeconomically, people act in concert because it increases their economic fitness. Behavioral and genetic endowments which favor group activity will increase both group and individual fitness. Group selection theory suggests the obvious point that groups will expand which contain larger fractions of altruists. An insight for future research is the study of genetic and hormonal determinants of successful group activity.

For readers who are dubious about the validity of a bioeconomic approach, consider the following. When you meet a stranger for the first time, what percentage of the time do you consider whether that person is better or worse than you on any dimensions? When you meet a person of the opposite sex, what percentage of the time does sex enter your mind? Pecking orders and reproduction are focal points in biology and they are also helpful in explaining economic behavior.

Dawkins (1976) suggests that the gene is the level at which natural selection operates. It is incredible that Darwin would have anticipated the recent revolutions in DNA and RNA research. At the end of his chapter on variation in his *Origin of the Species*, Darwin writes

> ... the germ becomes a far more marvelous object, for besides the visible changes which it undergoes, we must believe that it is crowded with invisible characters ... separated by hundreds or even thousands of generations from the present time: and these characters, like those written on paper with invisible ink, lie ready to be evolved whenever the organization is disturbed by certain known or unknown conditions.
>
> Darwin, quoted in Gould (1983: 186)

Notes

Size limitations did not permit me to include all of the references. In some cases, these notes refer to texts which have the original sources. While they are not responsible for remaining errors, Jack Hirshleifer, Charles Hornung, Chris Magee, Fran Magee, Gordon Tullock and seminar participants at the University of Texas provided helpful comments on earlier drafts.

1. Wellborn (1987:58).
2. Wittenberger (1981:144,151).
3. Wittenberger (1981:151).
4. *Encyclopaedia Brittanica*, (1991a: 978).
5. Wellborn (1987:59).
6. Lopreato (1984:323).
7. Wittenberger (1981:588).
8. Wittenberger (1981:152).
9. Wittenberger (1981:593).
10. Wittenberger (1981:176)
11. Wittenberger (1981:454).
12. *Encyclopaedia Brittanica* (1991b:855).
13. Wittenberger (1981:69).
14. Baken and Allen (1982:Fig 24.7).
15. Lopreato (1984:61).
16. Magee (1992) and Magee and Magee (1994).

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