1 Introduction

The propensity and capacity to exchange one thing for another between two traders – however unrelated to each other – is a profound distinguishing feature of human subsistence. Human beings are endowed with remarkable skills of trade which they deploy spontaneously when confronted with favorable opportunities; skills that lie dormant in the absence of such opportunities. As is true of other innate human abilities – such as the mastery of spoken language – basic skills of trade are taken for granted precisely because they are either inborn or acquired at a young age without conscious effort. Such skills are not as trivial as they may seem to a casual observer or, for that matter, to their very practitioners. Exchange requires certain levels of dexterity in communication, quantification, abstraction, and orientation in time and space – all of which depend (i.e., put selection pressure) on the lingual, mathematical, and even artistic faculties of the human mind. Moreover, exchange relies on mutual trust: predictable codes of conduct agreeable to the human sense of morality. Exchange, therefore, is a pervasive human predisposition with obvious evolutionary implications. The root cause of this predisposition and its evolutionary consequences in history, and prehistory, are the central concerns of this book.

Was exchange an early agent of human evolution, or is it a mere *de novo* artifact of modern civilization? The evolutionary literature treats the question with great caution. Many authors, starting with Charles Darwin and Alfred Russel Wallace, preferred to avoid the issue altogether. When the issue comes to the fore, the importance of exchange in recent industrialized societies is readily acknowledged. However, its importance in any but the most recent stages of human history is typically dismissed. In its present status, human exchange is in the same state of scholarly inquiry as human language was just a century ago (when conventional wisdom recognized sophisticated linguistic forms only in modern civilizations). Conventional wisdom today seems to suggest that human exchange is essentially an incidental by-product of previously evolved mental and social (or even cultural) structures, rather

than a distinct agent of evolution. The discussion throughout this book calls into question the merits of this article of conventional wisdom in view of, among other things, *Darwin's principle of utility* and *Wallace's independent proof*, two sources of difficulty in the study of human evolution from its very dawn in classical Darwinism.

Both Darwin and Wallace were keenly aware of certain structures and refinements of human intelligence which are (seemingly) unaccounted for by natural selection. Each in his own way made equally unsuccessful attempts to identify the missing agent. Wallace's attempt though, was bolder and in the end more embarrassing. The main difficulty was presented by what seems to be a premature and excessive advance in cognitive skills relative to prehistoric needs for human survival. What useful function could the higher faculties of the human mind (like mathematics and music) serve at the stages in human evolution in which they evolved? No good explanation compatible with the demands of natural selection was available either to Darwin or to Wallace, and none has yet been offered. Yet, all the while a plausible explanation was brewing within reach. The full account sounds much like a story of a missed opportunity (to be told in Chapter 3).

From its very inception, the theory of evolution by natural selection has been tormented by frustrating puzzles, not the least, the one just outlined. Many of these are clearly ascribable not so much to lack of evidence as to the availability of evidence that defies interpretation. With the great benefit of hindsight, it is now also clear that the failure in interpretation itself was on many occasions (but not always) due to lack of progress in adjacent fields of science. The age of the earth and the geographic distribution of species were two fiercely challenging puzzles that baffled Darwin to his last days. Both have since been fully resolved in his favor, albeit decades later – the former with the discovery of radioactivity and the latter with the discovery of plate-tectonics. Darwin's triumph (in bequest) was thus accorded, in these two particular instances, not so much by new evidence from within the field of evolution as by belated progress from without – in the fields of physics and geology, respectively. At issue in this volume are outstanding questions in human evolutionary history and the attempt to resolve them with the aid of insights from yet another field, perhaps not closely adjacent to evolution, but at least tangential to it: economics.

Some of the outstanding issues, and puzzles, in the field of human evolution possess a deep economic dimension that is not always fully recognized as such. Examples range from the most general issue associated with the evolution of the human intellect mentioned above to more narrowly focused issues that are equally puzzling, and equally unresolved. Consider some unexplained remarkable facts:

- An allegation of premature development is held not only against the higher faculties of the human mind, but also against the human faculties of making fire. Even by the most conservative estimates going back only 300,000 to 400,000 years (others put it at 1.5 million years and more) the deliberate use of fire by humans represents a considerable technological advance over stone tool manufacturing or, arguably, even over the invention of the wheel (dated, by comparison, only 5,000 years ago). In other words, domestication of fire seems to enter the record unexpectedly ahead of its time.
- Caches of finished stone tools as well as raw material from distant sources of flakeable rocks (10 kilometers or more away) were found in several early hominid East African sites dated between 1.5 and 2 million years ago. Could a hominid with a brain half the size of a modern human have the resources (and foresight) to maintain an inventory of raw materials? If so, what could possibly be the principle of economic organization under which such a practice was motivated, and such redundancy afforded?
- The human gut is markedly small relative to body size and in proportion to similar metabolically expensive organs in the human body: the heart, liver, kidneys, and lungs – not to mention the brain. In fact, it has been estimated (Aiello and Wheeler, 1995) that the total mass of the human gastrointestinal tract is only about 60% of that expected for a similar sized primate. By these standards, human gut dimensions are those of a meat-eater (Chivers, 1992). Yet, world wide, meat usually constitutes only a small proportion of the total human intake of food. This raises a serious question: the compatibility of an organ with its primary function.
- The Upper Paleolithic people (roughly, 40,000–10,000 years ago) greatly extended the geographic distribution of humankind to include easternmost Europe, northern Asia (Siberia), Japan, Australia, and the Americas. But the major thrust was largely inland rather than overseas with eastbound migration flowing from central Europe toward Asia and

northbound migration moving on both continents toward the arctics. Were these people heading in the wrong direction in the midst of an ice age?

- The *Iliad*, the first known masterpiece of western art (literary or otherwise), is a war story. Warfare in all its glory and horrors has been repeatedly depicted (and indicted) in future generations as well: *Henry V*, *Wellington's Victory*, *War and Peace*, *Battleship Potemkin*, *Guernica* – are but a few reminders that this theme is part and parcel of civilized artistic expression as much as warfare and interpersonal violence are part and parcel of civilization itself. Against all preconceptions, the theme is almost invariably absent from all expressions of prehistoric art. Cave paintings and contemporaneous portable art rarely show men or, for that matter, women in combat. Nor does the corresponding fossil record show much in the way of numerous broken human bones or any other compelling skeletal evidence for deliberate injury (these start to appear with any regularity only with agriculture). Is it safe to assume that these early hunter-gatherers "could not afford the kind of risk-for-limited-return involved in hunting their neighbors" (Klein, 1989)?

- No species has ever been observed to abruptly desert the niche it occupied in the environment in favor of another. Yet this is precisely what transpired in the great human transition to agriculture that took place almost simultaneously in widely separated parts of the world, for no apparent reason. Of these, the dual origin of agriculture (in the Old and New World) is the most puzzling of all.

- Husbandry is a labor-intensive undertaking. It takes in general more time and human effort to raise and slaughter a domesticated animal than to hunt and kill its wild counterpart. One lucky strike with an arrow can earn an expert hunter the same amount of meat and nearly all the byproducts (skin and fiber, though not milk) that a herder will obtain only by long hours of toil over months if not years in waiting. It is thus difficult to understand how pastoralism could have so completely displaced hunting to begin with. Why did humans for the first time, and of all times, choose to rely on domesticated stock precisely when (due to a climatic optimum) wild stock in many parts of the world was more abundant than ever?

To be sure, outstanding issues like these come with their own peculiarities and, as such, are treated in the pages of this volume on a case by case

basis: with evidence (when available), with logical inference (when applicable), and – only as a last resort – with conjecture. But they also share a common core that calls for a unified treatment and, perhaps, a unified explanation.

The difficulty in reaching a unified explanation can be traced in part to the relative neglect of economic reasoning in the way we tend, all too often, to approach the affairs of our own ancestors – however remote. Economic principles are not designed for the sole use of modern people. In the application of economic principles or, for that matter, evolutionary principles to the affairs of early humans it is useful to recognize two sweeping trends in their (and our own) evolution: the expansion of the brain and the expansion of the niche. The persistent expansion in brain size is by far the most impressive evolving anatomical trend that, by the very nature of the organ, far exceeds anatomy itself. The ever-expanding niche that humans occupy is the most impressive evolving trend from the viewpoint of economics, for economics is fundamentally the study of niche expansion. The remaining challenge is to make the necessary connection.

Part 1
Bioeconomics

2 Exchange in human and nonhuman societies

Upton Sinclair's novel, *The Jungle* (1906), is a brutally graphic account of the ruthless competition in the stockyards and slaughterhouses of Chicago at the turn of the nineteenth century. Literary observers like Sinclair, and social observers in general, have often appealed to an imaginary animal-like struggle for survival in search of analogies that describe human conduct in the marketplace. The analogy is unfair to humans as much as to animals. In reality, the essential pattern of market activities, perhaps more than any other pattern of human behavior, is marked by the *lack* of analogy with animals.

Exchange, or apparent exchange, among living organisms other than humans is largely confined to the realms of *symbiosis* and *nepotism* (i.e., transfers among members of separate species and transfers among *related* conspecifics, respectively). For human beings these two patterns of exchange are only part of a wider repertoire that includes a remarkable addition in the form of *mercantile exchange* (transfers among conspecifics at large). A preliminary survey of these three patterns of exchange will be given in this chapter.

Adam Smith's zoological digression

Adam Smith was a younger contemporary and, it is told, a great admirer of Linnaeus (Schabas, 1994:332). The Linnaean version of the "economy of nature" had already acquired some enthusiastic following among English-speaking readers like Erasmus Darwin, another contemporary of Linnaeus (and grandfather of Charles), who cast the Linnaean system into verse under the title *The Botanic Garden* (1789). Smith's main concern, however, was the man-made "political economy." It was natural for him to point out a fundamental distinction (one of many) between the two systems:

> Nobody ever saw a dog make a fair and deliberate exchange of one bone for another with another dog. Nobody ever saw one animal

> by its gestures and cries signify to another, this is mine, that yours; I am willing to give this for that. (1976:17)

This remark was meant to emphasize – by *lack* of analogy – the unique *manner* in which exchange operates in human affairs. It denies neither the existence nor the prevalence of exchange elsewhere in nature. "When an animal wants to obtain something either of a man or of another animal it has no other means of persuasion but to gain the favour of those whose service it requires," he states and adds the pivotal insight: "Man sometimes uses the same arts with his brethren" (1976:18). In other words, Adam Smith suggests two distinct mechanisms of exchange. First, a fairly formal mechanism exclusive to humans that operates "by treaty, by barter, and by purchase" (1976:19). The second is a universal mechanism common to humans and animals, relying – as Adam Smith saw things – on benevolence induced by begging, essentially, on emotional currency.

Adam Smith deserves some credit for noticing a pattern of begging in animal exchange. Manifestations of infantile and submissive modes of behavior (typical of mammals and birds) are prevalent between the young and their parents, between mating partners, and among members of packs, flocks, and other group formations in which members react to one another on the basis of individual recognition. The most obvious examples among mammals include some free-living relatives of the domesticated dog (wolves, foxes, bush dogs, and above all, African wild dogs) and to a lesser extent man's own relatives (the great apes and other primates). It does not take long to recognize the interplay of these preadaptations of begging and submissive behavior in the relationship between dogs and man, a relationship Adam Smith used as an illustration.

The main difficulty with Adam Smith's account of animal exchange, however, is that it relies on sentiments. Counter examples are easy to come by. Modern observers of animal behavior may call attention to instances in which exchange operates flawlessly by rigid stimulus-response mechanisms, or by outright reflex, rather than by cognition and sympathy. Little or no begging or benevolence is evident in the exchange between a bumblebee and the plant it pollinates or, for that matter, in exchanges among workers in a colony of social insects. Nestmates in a colony of ants, for instance, typically exchange liquid

food through regurgitation induced by a recipient touching her forelegs to the donor's head. A casual observer may view the event as an encounter between sisters that have the capacity to express and compassionately attend to each other's needs. However, as Hölldobler and Wilson report, the processes can be simulated mechanically by touching the same spot on the donor's head with a fine human hair. The ant will respond by regurgitating in front of its human handler (Hölldobler and Wilson, 1994:51). Evidently, a regurgitating ant scarcely exceeds the level of compassion expected of a vending machine. Exchange is effected, in this instance, by some sort of a vomit reflex rather than by emotional currency.

Adam Smith's skills as an observer of animal affairs apparently fell short of his skills as an observer of human affairs, but his mistakes should not be taken as an excuse to ignore his larger issue. In the end, his main assertions (starting with the one quoted above) echo fundamental evolutionary dilemmas that should challenge observers of humans and observers of animals alike. At issue are the peculiarities and origins of human exchange and, by implication, of division of labor and human diversity. To understand these peculiarities and fully appreciate his evolutionary dilemmas, one needs to refine and sharpen the borderline Smith himself sought to draw between animal exchange and human exchange.

Symbiotic exchange

Symbiosis is the phenomenon of reciprocal and mutually beneficial transfer – or "exchange" – of resources and services across species.[1] Some economists view it as the closest thing to formal trade that involves nonhuman players (e.g., Tullock, 1994:83). Agriculture and, in general, the relationship between humans and domesticated plants and animals is a primary example of *symbiosis*. Obviously, it is hardly an exclusive example.

The most commonly observed examples of symbiosis among nonhuman parties are animal–plant relationships (e.g., between the fig and the

[1] The term *symbiosis* is used here in a restrictive sense. It includes only interspecific relationships that benefit both sides. *Parasitism* and other forms of cohabitation that benefit only one partner are excluded.

fig wasp). Animals and plants best meet the two salient prerequisites of symbiosis: the parties do not compete for the same resources and they tend to make up for each other's shortcomings. Plants typically provide food and shelter in return for pollination, dispersal, fertilization, pest control, and so on. Symbiosis on a grander order of ecological organization takes place, of course, between all animals *as a group* and all (green) plants *as a group* through the exchange of oxygen for carbon dioxide in the atmosphere at large.

Symbiotic relationships between animals are less abundant. A conspicuous example in this category is cleaning symbiosis. Most prevalent among fish and other forms of marine life, cleaning is occasionally observed among land animals as well (e.g., between birds and ungulate animals).[2] Relationships between macro- and microorganisms (e.g., between termites and cellulose-digesting microbial symbionts that live in their guts) are probably more abundant, though obviously less conspicuous. But the most consequential of all the symbiotic relationships is reserved to exchange among microorganisms themselves. It may occur when one cell is engulfed by another, but instead of being digested by its host, the two initially establish a stable relationship of intracellular symbiosis and eventually become fused. In the end, this process of evolution (by infection) results in a new more complex cell. By establishing this process of symbiogenesis, Lynn Margulis (1981) managed almost singlehandedly to resolve one of the greatest mysteries in the history of organic evolution: the breakthrough emergence of cells equipped with organelles. On the whole, the list of ecological phenomena under the heading of symbiotic exchange is open ended, assuming one is willing to use the term *exchange* in a figurative sense.

Nobody can hold Adam Smith liable for all the figurative deflections of the word "exchange." Economists are reluctant to use the term in any but the strict sense (that is, when the transaction is made voluntarily and deliberately by the parties), and symbiotic relationships hardly apply. From an economic point of view symbiosis is little more than a procedure for acquiring resources from the environment, like grazing or, for that matter, mining. It is true that close proximity between "host"

[2] Not counting oxpeckers. Recent work suggests that oxpeckers get a large part of their daily food intake from blood, keeping old wounds in their hosts' skin open, or indeed inflicting new wounds (Weeks, 1999).