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OUR BIG BRAINS & HOW THEY GREW

How did the first *big-brained* primates come into being — the ones that way down the pike became *Homo sapiens neanderthalensis* and then the brainiest of all, *Homo sapiens sapiens?* What happened in the environment to single them out from their cousins who remained frozen in time on the evolutionary tree? Did diet have anything to do with it?

Primates first showed up when tropical forests covered the earth fifty million years ago, evolving from tiny insect-eating mammals. Small, mainly insect-eating primates such as the tarsier and loris exist today, but most primates while still enjoying insects and grubs are mainly fruit and foliage eaters. Many species of monkeys and apes, in addition, capture and eat small reptiles, birds, and mammals. However, *Human beings eat more animal food than any ape.* Not just people today, but our Stone Age ancestors 40,000 years ago ate a lot of it as well.

The Greedy Brain

At a symposium, "Diet and Human Evolution,"[1] anthropologist Richard Wrangham posed the question: "Are we specialized as part-carnivore — protein seeker? — small-animal feeder? — seeds, fruits, nuts seeker? In a sense we're specialized for none of those things but actually we're specialized for *all* of them." Compared with other primates, he says we are devoted to finding *rapidly digested, energy-rich foods containing minimal levels of chemical protection.* By "chemical protection", Dr. Wrangham means tannins and other natural chemicals with which plants discourage bacteria, viruses, insects, etc. Green unripe fruit are full of tannins, but most monkeys are able to eat them, plus great amounts of leaves, flowers, stems, nuts, seeds, husks, grasses and bark without needing so much as a Tums. Their digestive apparatus is just different enough from ours to allow it to break down and detoxify large amounts of high-cellulose vegetation containing natural chemicals which might not only prove uncomfortable but actually toxic to us. (Monkeys also can detoxify drugs faster and better than we can, Dr. Wrangham noted.)

We look for foods that are easy to digest, he said, because they go through our digestive system fast and free us to take in still more energy-giving food. Why do we, more than other primates, need *energy-concentrated, rapidly digested, chemically unprotected packets of food?* He says the reason is *the brain is a greedy organ.* Ours kept expanding over the last two million years, eventually becoming three times as large proportionally as the modern ape's. It's the most "expensive" organ in our body: though only one-fortieth of our weight, *it burns up 20 percent of our basal metabolic energy.* Unlike other parts of the body, the brain needs this energy all the time, even when we're asleep . . . even when a person is in a coma!

The Aquatic Ape Theory

How did we get our big brain? Did it have something to do with leaving the placid arboreal Eden for more challenging neighborhoods? In *The Aquatic Ape,*[2] Welsh scholar Elaine Morgan expands on Sir Alister Hardy's theory, which she first elaborated on in *The Descent of Woman.*[3] The primate that evolved into our species, Hardy said, did what many other land-based mammals have done: he went to live in the sea, or at least to its shores and shallows. When these primates emerged a few million years later, they could stand upright, had hairless bodies, were brainier, and had the beginnings of speech!

Islands, by virtue of their isolation, "have always been forcing-housing of evolutionary change and speciation, as Darwin's Galapagos observations made clear," Morgan notes. In northeastern Africa the sea came in and flooded vast forested areas, cutting them off from the rest of Africa and forming islands and sea marshes. "Populations of apes marooned on such islands may have found their usual food resources dwindling and turned to the sea that surrounded them for means of augmenting their diet . . . Their incentive for learning to swim could have been similar to that of the proboscis monkeys in the often water-logged forests of Borneo." According to the theory, the forested Danakil Alps between what is now Ethiopia and the Arab States became such an island, during the millions of years in which the evolution of ape to manlike creatures (hominids) occurred.

Shifting geological conditions eventually created land bridges from the island, so that beginning some four million years ago, hominids from Danakil Island began to migrate in a southwestern direction, following the waterways of the African Rift Valley towards Olduvai Gorge. Here, most of the significant fossil remains of *Australopithecus, Homo habilis,* and *Homo erectus* have been found. Later, others traveled in the opposite direction, across the then existing Suez Isthmus land bridge to Europe and Asia. *Homo erectus,* who spanned the period from 1.5 million to 300,000 years ago, made stone axes, scrapers, and other tools and already had a brain three-quarters the size of ours. Their remains are found in Africa, Europe, and Asia (Java and Peking Man).

Mammals That Went to Sea

The Aquatic Ape story begins five million years ago, when the Pliocene era ushered in a long spell of heat, dryness, and deforestation. On Danakil Island the central highlands might still have been habitable, but at lower elevations the forests would have dried out, forcing some coastal apes to the shallow waters to find food and escape predators. Similar circumstances might have driven other mammals to the sea a long time before. Whales, dolphins and porpoises were the first mammals to leave the land for the water, some 70 million years ago. They are warm-blooded, breathe air, suckle their young, etc., but Morgan notes,

"they have lost all their hair and, in their general shape and mode of life, have grown to resemble fish so closely that Catholics used to be allowed to eat them on Fridays." Manatees and dugongs, rare but now protected, are descended from vegetarian hoofed mammals related to the elephant that went to sea more than 50 million years ago. They are amiable browsers on sea vegetation with bulky, rubbery grey bodies up to 15 feet in length. Some time later, a group of bearlike carnivorous mammals took to the water, becoming present-day sea lions and walruses; while seals are descendants of a doglike carnivore. Other mammals to make the transition wholly or partly include the beaver, otter, and hippopotamus.

We Have Aquatic-Type Fat

Morgan suggests that each of them must have been grossly unsuited at first to aquatic life. The remarkable ways in which they adapted produced similarities in totally unlike species. One example is the streamlining of aquatic mammals, compared with their lumbering land ancestors. In this light, we might view ourselves as a somewhat streamlined ape, with improved hydrodynamic features! Another common adaptation is the unusual fat distribution. The aquatics that shed their fur replaced it with a thick layer of fat under the skin all over their bodies — an ideal way to insulate against heat loss. This layers works so well to protect them in cold waters, make them more buoyant, and provide a rounded, streamlined outline, that even species that kept their fur, such as the seals, have also acquired the subcutaneous fat layer. *We are the only primates with an aquatic-style subcutaneous layer of fat.* Terrestrial animals, including other primates, maintain only enough fat under the skin to keep it supple. Fat is stored internally instead — around the kidneys, in the membranes between visceral organs, etc. Morgan explains that when a zoo-living chimp or orangutan becomes obese, his excess fat makes him potbellied, "but it will never, as with obesity in human beings, give him fat thighs and fat cheeks and fat fingers."

A Fur-less Ape

Another adaptation is the loss of fur. "Virtually all the hairless mammals in the world today are either aquatics, or wallowers, or show clear signs of having descended from aquatics or wallowers," Morgan observes. These include besides the whales, dolphins, walruses, dugongs, etc., such animals as the hippopotamus, rhinoceros (a wallower at every opportunity), and the elephant who shows many signs of being ex-aquatic! *Again, man is the only fur-less primate.* The subcutaneous fat layer was a better way to conserve body heat in the water; water-logged fur would have lost its insulating capacity. Hair remained on our heads and grew long, Sir Alister Hardy suggested, to shield us from the sun's rays during days spent either in water or on hot, treeless shores. Morgan adds that long hair, in addition, would have been something an infant could cling to in the sea if it slipped out of its parents' arms! Since, in fact, mothers did the nursing and most of the cuddling, she says this may be one reason women's scalp hair grows thicker during pregnancy. "What in fact happens is that at the onset of pregnancy thick hairs are produced in abundance, while the production of thin hairs is diminished. By the time the baby is born it has been provided with a stronger anchorage."

Aquatic life would have made it easier to stand up and, later, to walk on two feet. Morgan describes a species of monkey, the crab-eating macaque, that has overcome a fear of water common to most primates and will wade up to its waist hunting for sea food. American scientists studying another species of island-living Japanese macaques would supply them with sweet potatoes; they observed that the monkeys got in the habit of carrying the potatoes down to the water to wash the dirt off, walking on their hind legs while taking the food down to the beach and standing up in the water to wash it. Morgan speculates that when swimming became a natural extension of wading for Danakil Island's hypothesized apes, in time a gradual shifting of the pelvis took place, so that the spine and hind legs became aligned to one straight line, just as they did in seals and sea otters. In effect, this would make it easier to adopt and maintain an erect posture and bipedalism.

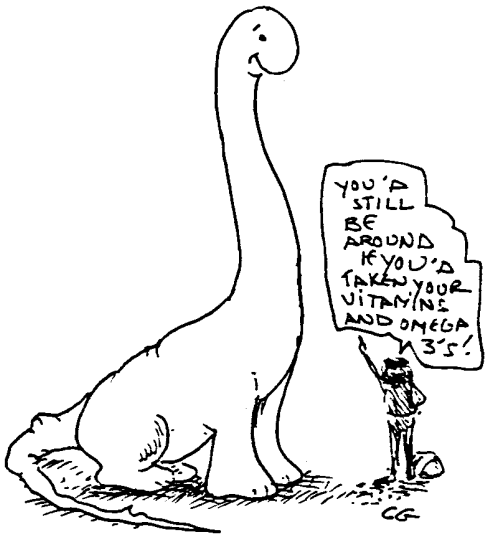
The Sound of Speech

Well, we've now got a fur-less, upright ape-person who may be learning to walk on land. What changed the apelike grunts and shrieks into speech? Elaine Morgan says the semi-aquatic ape, unlike its forbears in the forest, was able to achieve *conscious control over the utterance of sound because swimming and diving gave him conscious control over breathing.* Our closest cousin, the chimpanzee, is able only to make sounds that are stereotyped or involuntary. Viki, a chimp given loving, intensive training in speech, after six years was able to say just four words, not very distinctly: "papa," "mama," "cup," and "up," even though chimps and gorillas show great ability to use sign language ingeniously and even to teach it to younger apes. Morgan suggests that Viki was being asked to acquire control over an essentially *involuntary* process. "It is as though a human being had been requested to demonstrate voluntary control over blushing, or the rate of his heart beat." (Some measure of control *can* be acquired, but only with huge effort and training.) But during the long process of "aquatization" involving swimming and diving, our hominid acquired conscious control both over breathing *and* vocalization.

On land, apes communicate by scent, touch, and vocal and visual signals. In the water, scent and touch are practically useless, while visual signals become blurry and distorted. That leaves vocal signals, mainly, to carry the day. The Cetaceans (whales, dolphins and porpoises) use consciously controlled vocalizations in communicating with their species, and make clicking sounds to locate objects in the water, sonar fashion. Maybe it was the uselessness of other forms of signalling in the water that created the urgency in the apes for clearer vocal signals. At any rate, the hominids leaving the water for the grassy plain, or savannah, were probably by then making people-type noises to get their message across, Morgan speculates.

The Tool Maker

We used to think tool-making, like speech, was a hallmark of humanness, until we learned not long ago that chimps use twigs to fish out edible termites from hiding places; break off branches to wave and pound them in a threatening manner at a foe; and systematically place nuts on flat stones or tree roots, using sticks or rocks to crack them open and extract the meat.[4] Sir Alister Hardy suggested that *hominids learned tool-making on the shore,* using stones lying on the beach to crack open shells of clams and sea urchins and to crush lobster's claws "to get out the delicacies we so much enjoy today." From the use of such natural stones, he writes, it was just a step "to split flints into more efficient tools and then into instruments for the chase . . . Man, now erect and a fast runner, was equipped for the conquests of the . . . vast open spaces with their herds of grazing game."[2] In other words, although millions of years were needed, semi-aquatic life prepared the hominid in exceptional ways for the Savannah stage of evolution.



Special Fats for the Brain

My long-time readers probably have guessed why I have a soft spot in my heart for the still controversial Aquatic Ape theory: *it explains in a thoroughly satisfying way why we as a species have extra needs for foods rich in omega-3 fatty acids!* Plankton and seaweed, and the fish, shellfish, and sea mammals that feed on them, are great repositories of the omega-3 fatty acids, required in very large amounts in neural tissues, *primarily the brain and the retina of the eyes.* Dr. Wrangham emphasized that the human brain is a greedy organ in terms of caloric needs, but the working parts of the brain that are fueled by the calories are mostly *lipid.* Mono-unsaturated and polyunsaturated fats outnumber saturated fats in the brain. Our bodies can easily manufacture mono-unsaturated and saturated fat, *but can't make the precursors of the highly un-*

saturated omega-3 and omega-6 fatty acids comprising much of the brain's substance. They must come from the diet. Once obtained from food, the essential fatty acids — omega-6 linoleic acid, and omega-3 alpha-linolenic acid — can be transformed by our cellular enzymes to become, respectively, omega-6 arachidonic acid, and omega-3 EPA and DHA.* When we eat fish, shellfish, and fresh seaweed, we get EPA and DHA ready-made.

For centuries, popular wisdom had it that fish was "brain food." The highly polyunsaturated fats in sea food give brain tissue the fluidity to zip messages along the neural circuits. Dolphins, whose diet is one long smorgasbord of omega-3's, have a brain proportionately as large as ours and are terribly smart! So are seals, and very likely killer whales. Moby Dick, Melville's fictional white whale, was thought by his pursuer Captain Ahab to be fiendishly intelligent. Its real life counterpart, a colossal sperm whale known by sailors in the 19th century as "Mocha Dick," was responsible for what people said was a deliberate series of shipwrecks costing many lives.

**Eicosapentaenoic acid & Docosahexaenoic acid.*

Our Brain Got Bigger

One outcome of acquiring new skills, particularly locomotor skills, seems to be an evolutionary increase in brain size. Elaine Morgan points out that life in the water demands the acquisition of "an entirely new locomotor repertoire by every land animal that makes the transition. Limb movements, which on land had been automatic and stylized, in water become the subject of trial and error, conscious control and adjustment." Over the period of time that the brain was enlarging in response to the evolving repertoire of locomotor, manual, and verbal skills, our aquatic creature was getting a steady supply of omega-3-rich "brain food" to sustain the process. I suggest they had a lot do to with making the aquatic ape a smarter one!

From Sea to Savannah: Stalking the Omega-3's

We began our story with Dr. Wrangham's description of the energy-dense, rapidly digestible, chemically unprotected nature of the food human beings especially need because our big brain — nutritionally and metabolically — is such a costly organ. If the Aquatic Ape scenario is more than just a theory, the hominid finally leaving the sea for the plains had developed a strong dependance on a marine diet which is unequalled in its abundance of EPA and DHA, the ultrapolyunsaturated omega-3 fatty acids. In his migrations our hominid naturally followed waterways, so he could still get fish and shellfish, while the savannah provided vegetable foods, including fruits, roots, beans, leaves, berries, nuts, seeds, and blossoms.

Of course, the savannah also had herds of horses, deer, and other herbivores. Wild game, even today, contains only 4 percent fat, compared with 25 percent or more fat in domestic animals.[5] The flesh of wild animals also supplies ample omega-3 and omega-6 fatty acids (modern beef has comparatively little) and the organs — liver, kidney, heart, etc. — are especially good sources of arachidonic acid, EPA, and DHA. A brisk debate currently is going on in paleontological circles: Were the hominids who came before *Homo sapiens* the bold stalkers of big game they were first pictured to be, or were they actually timid scavengers, scurrying to haul away the bones of prey left by fierce carnivores! In either event, the evidence shows they hacked away with their stone tools at the leg bones of horses and other hooved herbivores *specifically to get at the fat-rich marrow.*[6] I think they did it because they instinctively craved the essential, vitaminlike polyunsaturated fatty acids. They also broke open the skulls of herbivores to get at the brains. My point, again, is that omega-3 DHA and EPA, as well as omega-6 arachidonic acid, are particularly concentrated in the brains of all animals.

Anthropologists John Tooby and Irven DeVore wrote recently: "The role of meat may go beyond its production of calories; the constituents of the brain require essential fatty acids, which may prove to be the real limiting factor made available by meat."[7]

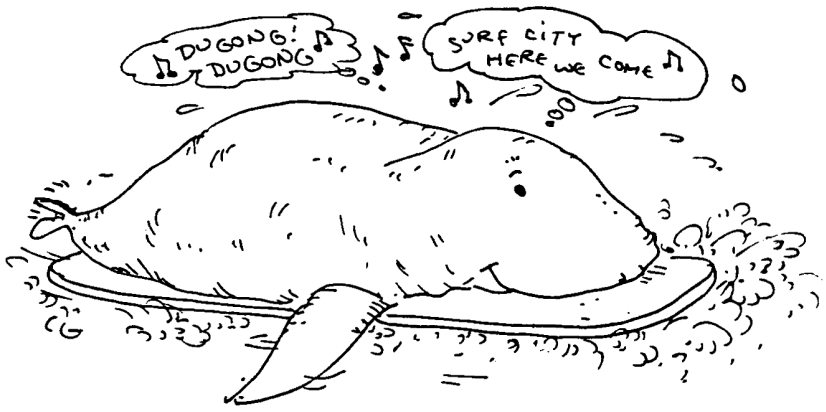
If so, meat today may have outlived much of its usefullness! It's loaded with at least six times more saturated fat than wild game, has hardly any polyunsaturated omega-3's, and is likely, as often as not, to contain residues of antibiotics, hormones and pesticides. Rich nations and people eat more meat than poorer ones and have higher rates of heart disease and cancer; heavy meat-eating may be a factor in these disorders. A better and safer way to get the omega-3 fats would be through fish, shellfish, and sea and land plants. [See *Felix Letters* 33/34 for role of omega-3's in preventing both diseases.]

Benign Sea Greens

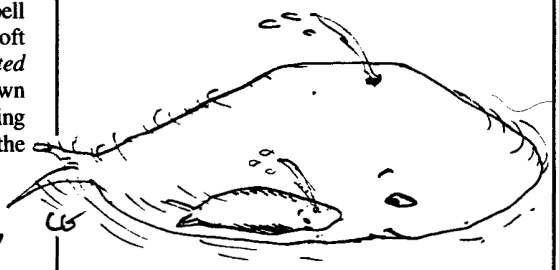
In musing about the dietary factors that made us what we are today, I came up with two possible reasons why we lost the ability to consume large amounts of fibrous, chemically protected plants. First of all, during the aquatic phase of evolution, the greens we ate would have been mostly gentle sea vegetables. Elastic cell walls allow kelp and other algae to sway with the currents; they would be handicapped by the stiff cellulose that keeps plants erect on land. The soft fiber of sea vegetables has a well-known soothing effect on the gut. Japanese scientists S. Arasaki and T. Arasaki note that it "regulates intestinal action without damaging intestine walls," and commonly is used therapeutically in Asian medicine. Their book, *Vegetables From the Sea,*[8] gives the nutritional and medicinal properties of sea vegetables and something of their immense historical importance to seacoast people. The large, placid sea vegetarian called the dugong — thought to be a mermaid by early sailors because the female held its infant in its arms and suckled it from humanlike breasts — lives on certain sea grasses and a red algae, *Digenea simplex.* "The ancient Okinawans, who regarded the dugong as a creature that lives to immense ages, observed its eating habits and consumed a porridge of *Digenea simplex,* which they believed to be the secret of the animal's longevity."

Secondly, the Arasaki's make the telling point that *toxic components are far less prevalent in sea vegetables than in land plants.* Perhaps they are protected from bacteria, viruses, insects, etc. by the sea itself, so they don't have to make as many toxic chemicals as terrestrial plants do. In any event, I offer the notion that the eons our progenitors spent nibbling at soft, chemically unprotected sea vegetables might have something to do with our diminished capacity to handle large quantities of the harsher vegetation on land that other primates consume routinely.

Richard Wrangham says hominid fossils reveal that as brain size got larger, teeth became smaller! The more calorie-dense and easily digested the food became, the less work



(crushing, grinding, etc.) the teeth and jaws had to do. My thought is that here, too, a long spell of consuming tender sea greens and the soft flesh of sea food *could very well have initiated the reduction in tooth size.* Somewhere down the line, the controlled use of fire and the eating of cooked foods would have continued the trend.



EPA & DHA for Vegetarians!

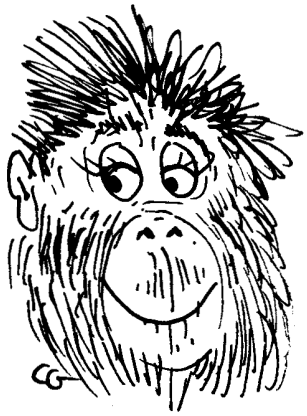
If our habit of gulping down large amounts of meat came about partly because of a special need for ultrapolyunsaturated omega-3's, then modern technology surely can come up with ingenious alternatives, to avoid the price to eco-systems and health from massive beef consumption. For starters, I think it's high time for enterprising researchers to extract EPA and DHA from kelp and other sea vegetables to make them available as food supplements. They would be a boon to "pure" vegetarians (no fish, eggs or dairy), whose diet lacks them altogether, and would be invaluable for infant formulas and foods during the first two years of life, when the baby's brain is still growing. (Human infants quadruple their brain size within the first two years after birth. Other primate infants typically only double theirs.)

The Tofu Revolution

If it's the *protein* in meat we crave, all sorts of interesting substitutes are becoming available. I talked to William Shurtleff, author of the best-selling *The Book of Tofu* and director of the Soy Food Center.[9] It's a research and information institute, founded in 1976 to encourage the use of traditional low-energy-cost methods to make what Shurtleff calls "low-tech" soy foods, such as tofu, tempeh and miso, just as Asian people have done for at least a few thousand years. It sparked the growth of a whole new industry here, supplying tofu cheese, tofu dips, tofu ice creams, tofu hot dogs and burgers . . . Shurtleff says these are only the beginning! Low-tech soy foods are good-quality, easily digested protein; contain both omega-3 and omega-6 fatty acids; and lend themselves to a remarkable variety of cuisines. The cost in land and energy of nutrients gotten from raising beef cattle is astronomical compared with getting the same food values by raising soybeans. Besides, soybeans don't cause destruction of ecological sanctuaries, as do millions of grazing beef cattle who are munching and trampling their way through our national parklands at taxpayers' expense! Shurtleff said the low-tech soy foods have great relevance to Third World countries. Fifteen years ago, India didn't grow soybeans but today it's the fifth largest producer in the world, providing its people with a new source of much-needed affordable protein.

Options

We're getting hints from paleontologists and anthropologists that early man may not have been lord of the savannah and big-game stalker, but a timid creature who snagged small animals when he was lucky, depended mostly on clams, limpets, mussels and vegetable foods such as fruits, seeds, nuts, leaves, roots, etc., and craved the fatty contents of leg bones and skulls of animals some other predator had killed. Much later, the first truly modern human, Cro-Magnon (*Homo sapiens sapiens*) with his big brain appeared. A high level of social organization and skill in weaponry finally brought the world Man the Mighty Hunter. That world, thirty thousand years ago, was covered with animals and had just a handful of Cro-Magnons. In a short span of time, relatively speaking, Big Brain reversed the proportions! Today, we have a lot of re-evaluating to do about our meat-eating priorities. The question is not whether we're supposed to be vegetarians or meat-eaters, since by morphology and history we're omnivores; i.e., within a very broad range of dietary options, we can follow our spiritual, ethical, or even whimsical bent and still feed our big brain. The problem lies in the contradictions in a profit-oriented society which allows the misuse of land and energy resources in order to bombard us with *spurious* food options — the Twinkies, wine coolers, and Big Macs — which may be "killing us softly," while real hunger stalks the world, killing people harshly. We need to use our big brain — after all, we're *Homo sapiens sapiens,* or double-wise! — to find ways to nourish us all and not harm our planet.■



THE OMEGA-3 PHENOMENON: *The Nutrition Breakthrough of the 80s* by Donald O. Rudin, M.D. and Clara Felix, published by Rawson Associates of Scribner/Macmillan, will be out in hardback late August or early September ($16.95). Dr. Rudin is the first scientist to recognize that a dietary deficiency of the little-understood omega-3 fatty acids is almost the rule today; that it disrupts and violates the body's major regulatory system, controlled by the omega-3 and omega-6 prostaglandins; and that this sets the stage for most modern disorders such as heart disease, cancer, arthritis, skin ailments, mental illnesses, obesity, and premature aging.

1. Symposium of Diet & Human Evolution, presented by the L.S.B. Leakey Foundation, U. of Calif, Berkeley, Feb. 9, 1986.

2. *The Aquatic Ape* by Elaine Morgan, Stein & Day, N.Y., 1982.

3. *The Descent of Woman* by Elaine Morgan, Stein & Day, N.Y., 1972.

4. *The Evolution of Human Behavior: Primate Models,* edited by Warren Kinzey, State U. of N.Y., Albany, 1987.

5. S. Boyd Eaton & Melvin Konner, "Paleolithic Nutrition," *New Eng. J. of Medicine,* Vol. 312 No. 5, Jan. 31, 1985.

6. Lewis Binford, "Ancestral Lifeways: The Faunal Record" in *Anthroquest,* The L.S.B. Leakey Foundation News, No. 32, Summer 1985.

7. "The Reconstruction of Hominid Behavioral Evolution," by Tooby and DeVore in *The Evolution of Human Behavior: Primate Models,* 1987.

8. *Vegetables From the Sea* by Seibin & Teruko Arasaki, Japan Publications Inc., Tokyo, 1983.

9. Soy Food Center, P.O. Box 234, Lafayette, CA 94549. Send SASE for information and free catalog.

Illustrations are by Clay Geerdes and other artists as noted.

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