Chapter 4

Extraterrestrial 'Anthropology,' Xenobiology, Morphology, and Theological Systems

This chapter will examine the subject of possible extraterrestrials themselves, important for the theological discussion. Although speculative, it represents the beginning of the consideration of possible xenobiological structures, extraterrestrial environments, culture, and psychological and social compositions. This data will be considered on the basis of types of planetary or stellar habitats, evolutionary theory, competition models, and behavioral analogs. The putative psychological and sociological compositions of extraterrestrials will necessarily reflect their biological and environmental conditions. This 'anthropology' of potential extraterrestrial beings will be extrapolated from the resources available through human anthropology, and the scientific disciplines encompassed by astrobiology. As past theological scholarship has considered the extraterrestrial in a wholly generic manner and with little regard for possible environments, social structures, forms, states, capacities, and abilities, the paucity of consideration of the these fundamental aspects has resulted in little insight into the Christological possibilities and hence the repetitious and limited nature of theological work thus far. As discussed in chapter 1, this information will later be utilized to extrapolate potential theological anthropologies of extraterrestrials in Section B below.

Section A: Extraterrestrial Exoanthropology

Xenobiological Structures

Historian Steven Dick outlined these scientific premises regarding the development of intelligent extraterrestrials: Results from the WMAP[1] date

1. Wilkinson Microwave Anisotropy Probe, a NASA explorer probe launched in

the universe at ≈13.8 billion years. The first stars were formed about 200 million years after Big Bang, and the oldest Sun-like stars (population I) are between zero and ten billion years old. Heavy element generation and interstellar breeding through supernovae resulted in the first rocky and gaseous planets with solid cores to form; it may have taken another four to five billion years before life evolved on favorable planets. The maximum age of extraterrestrial natural or artificialized intelligence could be in the range of billions of years given the age of the universe and planets hosted by second-generation stars that contain high metallicity; allowing for the development of rocky planets containing heavier elements capable of producing sufficient gravity to sustain an atmosphere, liquid water, and lifeforms. Given this framework, the lifetime of a technological civilization is >100 years and likely much longer; and in the long term on a planet bearing intelligent life, cultural evolution (termed by Dick) can supersede biological evolution, eventually producing an artificial intelligence surpassing biological intelligence.[2] As the oldest Sun-like stars formed within a billion years of the Big Bang, and interstellar breeding produced the necessary heavy elements necessary for life to develop on rocky host planets, intelligent life could have developed up to 7.5 billion years ago using Earth history as an example.[3] In our terrestrial case, cultural evolution (meaning technological and social) has proceeded at an expeditious pace compared to biological evolution.[4] The main efforts leading the emerging field of cultural evolution in relation to our concerns here (and several Darwinian models have been explored),[5] are biotechnology, genetic engineering, nanotechnology, artificial intelligence, and space exploration. Dick proposes what he terms the *Intelligence Principle* to define the central idea of cultural evolution: that the maintenance, improvement, and perpetuation of knowledge and intelligence is the central driving force of a civilization, and that to the extent intelligence can be improved, it will be improved.[6]

2001 commissioned to provide fundamental measurements of the architecture of the universe.

2. Dick, "Cosmotheology Revisited," 294.

3. Norris, "How Old is ET," 103–5.

4. Dennett, *Darwin's Dangerous Idea*.

5. See Aunger, *Darwinizing Culture*; Dyson, *Darwin Among the Machines*; Lalande, and Brown, *Sense and Nonsense*; Richerson and Boyd, "Build for Speed," 423–63.

6. Dick, "Cosmotheology Revisited," 295.

Several AI experts[7] have envisioned the eventual dominance of intelligent machines according to the *Strong AI argument*.[8]

In pre-scientific cosmological and theological conjecture, extra-terrestrial beings in ancient and early modern literature were typically conceived as essentially anthropomorphized and animalistic beings with little to no physiological, behavioral, or intellectual deviations. Well before science-fiction and Darwinian theory became the benchmark for what we may infer humanoid life forms to be, Christiaan Huygens's monograph *The Celestial Worlds Dicover'd, Or, Conjectures Concerning the Inhabitants, Planets and Productions of the Worlds in the Planets*, published posthumously in 1698, described possible beings as similar to humans but in other ways quite dissimilar:

> Nor does it follow from hence that they must be of the same shape with us. For there is such an infinite possible variety of Figures to be imagined, that both the Oeconomy of the whole Bodies, and every part of them, may be quite distinct and different from ours.[9]

Many early-modern astronomers like Huygens considered intelligent extraterrestrials a natural consequence resulting from favorable environmental conditions on other planets. Later, Darwinian theory provided a theoretical model of natural selection, variation, and environmental adaptation for our modern consideration of the potential morphologies of extraterrestrials. Scientists and astronomers from the mid-twentieth century onward were hence more skeptical of the probabilities of intelligent extraterrestrial life given their acceptance of the evolutionary synthesis and the increased understanding of the unique conditions needed to produce intelligence.[10] Of the few scientists that have speculated on the nature and morphology of extraterrestrial life, American geneticist and evolutionary biologist Theodosius Dobzhansky affirmed and emphasized mutation and natural selection:

7. See Searle, "Minds, Brains, and Programs," 417–57.; Moravec, *Mind Children*; Kurzwell, *The Age of Spiritual Machines*; Tipler, "Extraterrestrial Intelligent Beings Do Not Exist," 133–50.

8. The most modern form argued by Kurzweil, *The Singularity is Near*, of an intelligent machine that is capable of general intelligent action that rivals or exceeds the thinking capacity of humans. Strong AI refers to a computer capable of consciousness, rather than merely the running of pre-programed instructions.

9. Huygens, *The Celestial Worlds Dicover'd*, 74.

10. Morris, *Life's Solution*, 344; Barrow and Tipler, *The Anthropic Cosmological Principle*.

> Despite all the uncertainties inevitable in dealing with a topic so speculative as extraterrestrial life, two inferences can be made. First, the genetic materials will be subject to mutation. Accurate self-copying is the prime function of any genetic materials, but it is hardly conceivable that no copy errors will ever be made. If such errors do occur, the second inference can be drawn: the variants that arise will set the stage for natural selection. This much must be a common denominator of terrestrial and extraterrestrial life.[11]

More recently, extrapolating from Darwinian models, mathematician Carl DeVito[12] and geneticist Norman Horowitz[13] hypothesize based on biological, psychological, and sociological equivalencies that intelligent extraterrestrials would have an analogous mathematical system, function according to a modern understanding of physics, and would be composed of and interact with similar elements according to our periodic table. Dobzhansky also argued for convergence, noting how various forms of aquatic life with disparate ancestral lines have similar morphologies in their adaptation to an aquatic environment. However, he also argued for divergent evolution for Earth life forms in similar environments.[14] Oceanographer Robert Bieri's article, "Humanoids on Other Planets?" asserted limitations inherent in biological chemical elements, as well as the available forms of energy seen in the limited range of terrestrial morphological variability.[15] Bieri states that due to these restrictions on possible biological adaptations, extraterrestrial intelligent beings will conform to the patterns we are familiar with on Earth. Scientist Zoltán Galántai[16] outlines several possible types of biology which may be present in the universe: Biology 1: Earthly life as it is known; Biology 2: an extension of our understanding of biology 1 in considering and searching for extraterrestrial life forms, known as today's astrobiology;[17] Biology 3: xenolife having an alternate form of biochemistry; and Biology 4: which refers to at present hypothetical other universes having different physical constants or different physical forces. In this chapter I will argue for a Biology 2 model. It can be safely

11. Dobzhansky. "Darwinian Evolution," 170.

12. DeVito, *Science, Seti, and Mathematics*.

13. Horowitz, *To Utopia and Back*.

14. Dobzhansky, "Darwinian Evolution," 168–69.

15. Bieri, "Humanoids on Other Planets?", 425–58; see also Beadle, "The Place of Genetics in Modern Biology."

16. Galántai, *Life, Intelligence, and the Multiverse*.

17. Astrobiology is founded on the uniformity principle, which claims that the physical processes of nature known to Earth are the same throughout the universe.

assumed for the present that extraterrestrials are likely carbon-based lifeforms, due to the unique ability of carbon to form the core of a very diverse range of macromolecules, and be water-based given the unique properties of water in the formation and maintenance of biological life. However other biochemistries may be possible based on silicon (although these to our knowledge do not allow for the same extensive variety of molecular combinations as carbon). It is no longer believed that oxygen is an absolute requirement for life as oxygen was absent from the surface of the Earth in the first few billion years while simple and multicellular life forms existed. Whether the genesis of intelligent life would require an oxygen rich atmosphere similar to Earth remains an open question.

As regards the development of possible alien life, convergence evolutionary theory posits that species with similar capabilities in similar habitats may evolve to look alike, as common functional demands that channel the solution of selection and shared molecular and environmental constraints limit the range of likely solutions. Different species with the capacity for swimming look alike.[18] Alien life on planetary surfaces in gaseous atmospheres and using intelligence to manipulate their environment with tools could have bilateral symmetry, with legs for locomotion, appendages used as hands for manipulating objects, and a pair of eyes to provide stereo vision.[19] However, it is possible there could also be much evolutionary divergence. Physicist W. G. Pollard has provided an example of the likely independent evolution of species on different planets, and how life tends towards divergent forms. He notes that about 180 million years ago Australia broke off from Gondwanaland and can be thought of as Earthlike planet "A," where evolution continued independently from a primarily reptilian stock. Similarly, South America broke off from Africa 130 million years ago and can be viewed as independent planet "S." Independent evolution also continued on planet "E" (meaning the rest of the Earth, especially Africa and the adjoining land). During the last 130 to 180 million years, independent evolution has diverged towards different kinds of animals on these three "planets," rather than converged. Humans appeared only on planet "E," certain primates on "S" and marsupials on "A." Humans on "E" appeared only about 4 million years ago and have existed for only 0.1 percent of Earth's history.[20] Natural selection appears to produce many species capable of occupying any habitable environment, therefore, given favorable environmental conditions, we should not be surprised if life has evolved from more elementary

18. Morris, *Life's Solution*, 147–223.
19. Darling, "Variety of Extraterrestrial Life."
20. Pollard, "The Prevalence of Earth-Like Planets," 653.

forms on another planet. However, given the magnitude of disparate life forms present in the myriads of environments on Earth it is possible that many forms of life on other planets given the proper conditions, including highly intelligent life forms, may appear humanoid or occur in a variety of physical realizations. Biologist Allen Broms once stated, "Life elsewhere is likely to consist of odd combinations of familiar bits."[21]

As lifeforms tends to expand their habitat until meeting a limitation, such as a food source or lack of geography, competition for resources is created as Darwinian evolution assumes any number of offspring will typically exceed replacement level. Charles Cockell and Marco Lee have argued that intelligent extraterrestrial life are likely to evolve at the end of a series of trophic levels, and for energetic reasons predation is likely to be widely represented, and would be influential in determining the morphological and behavioral characteristics of extraterrestrials.[22] Predatory pressures also contribute to the nature of a diversity of behaviors including aggression, speed and maneuverability, vigilance, flight, territoriality, and flocking, all of which can have an important influence on sociobiology and thus the potential characteristics of intelligent societies. Darwinian theory states modern humans resulted from a long struggle for existence, by way of violence, suffering, and death, which impacted our social and psychological makeup. Geophysical conditions of prehistoric Earth were quite different than our current epoch, and was inhabited by terrestrial creatures foreign to moderns. Therefore, it is reasonable to infer that other planets may have their own assortment of creatures adapted to their own environment, evolved from more primitive forms. Other variables, which cannot be measured or necessarily predicted in any meaningful way according to evolutionary theory even on Earth, include predation pressures, foraging patterns, metabolic requirements, genetic mutations, and developmental interconnections of the phenotype.[23] The biological classification of life forms on Earth includes kingdom, phylum, class, order, family, genus, species; and the five kingdoms include animals, plants, fungi, protists, and monera. It may be discovered that life on other planets could extended upwards to include super-kingdoms.

Physicist Gerald Feinberg and biochemist Robert Shapiro,[24] have argued in favor of evolutionary convergence, as has Simon Conway Morris, namely that historical contingencies may make it possible to predict certain

21. Broms, *Our Emerging Universe*
22. Cockell, "Interstellar Predation," 1.
23. Powell, "From Humanoids to Heptapods."
24. Feinberg and Shapiro, *Life Beyond Earth*, 411.

properties of extraterrestrial life forms.[25] However each have rejected the view of space scientists Roger MacGowan and Frederick Ordway's claim that the majority of intelligent extrasolar land animals will be of the two legged and two armed variety.[26] By means of mutual action of natural selection and mutation, great divergences are possible, however they agreed that "we will undoubtedly encounter [convergent evolution] on other worlds."[27] Robert A. Freitas Jr. has stated that xenobiologists have formulated a simple rule known as the Assumption of Mediocrity, whereas the Earth is considered as "typically exotic."[28] With Earth life as an example, as a means of survival, evolution devised solutions where we could expect to find parallels, but not necessarily their duplicates in extraterrestrial species.[29] The most obvious instance of convergent evolution is the "camera eye," developed independently in five major terrestrial animal phyla (chordates, mollusks, annelids, coelenterates, and protists), each having diverse developmental histories. The camera eye is the most ubiquitous because it clearly is the best evolutionary solution to the general problem of vision on this or perhaps any other world,[30] with lens, retina, focusing muscles, and transparent cornea—placed high in the body so to view obstacles and predators at a distance.[31] Other abilities that may vary from those of humans are power of vision, means of locomotion, hearing, and communication, or the ability to see in other bands of the electromagnetic spectrum, such as infrared, visualize heat waves, or display a sensitivity to magnetic waves, electric fields, or radioactivity. Each alien sense would have developed as a means to maximize survival in its particular planetary, geographical, and local environment and in competition for available resources.

As mentioned, evolutionary paleobiologist Simon Conway Morris has emphasized the ubiquity of evolutionary convergence, and argues against those claiming the impossibility of predicting extraterrestrial morphologies:

> [W]hat we know of evolution suggests . . . convergence is ubiquitous and the constraints of life make the emergence of the

25. Morris, *Life's Solution*, 283–84.

26. MacGowan and Ordway, *Intelligence in the Universe*, 240.

27. Fienberg and Shapiro, *Life Beyond Earth*, 411.

28. The idea that Earth is unusual among most planets known to us in possessing an abundance of life forms, whereas Earth is considered special, privileged, exceptional, or even superior.

29. Freitas, "Extraterrestrial Zoology," 53–67.

30. Freitas, "Extraterrestrial Zoology," 58.

31. Ernst Mayr has argued the evidence of convergence of the eye in at least forty unrelated lineages in "The Probability of Extraterrestrial Intelligent Life," 23–30.

> various biological properties very probable, if not inevitable. Arguments that the equivalent of Homo sapiens cannot appear on some distant planet miss the point: what is at issue is not the precise pathway by which we evolved, but the various and successive likelihoods of the evolutionary steps that culminated in our humanness.[32]

Biologist Richard Dawkins in his argument for "Universal Darwinism"[33] along with anthropologists Kathryn Coe, Craig T. Palmer, and Christina Pomianek, asserts that the principle of convergence is the norm; and "evolutionary theory, theoretically, should apply anywhere to anything that is living."[34] Confirmation of convergent evolution is widely evidenced on this planet; therefore, it is not unreasonable to hypothesize a similar convergence on an equivalent planetary environment capable of supporting complex life forms. This is best explained by Robert Bieri,[35] most notably in his argument on bilateral symmetry. The importance of bilateral symmetry in evolution is essential to maximum speed of movement in hunting and escaping and reducing resistance and turbulence in an aquatic environment; whereas those with more stationary habits tend to have radial symmetry and a lower level of organization, without the accompanying complex nervous system. Therefore, having a more complex nervous system is contingent upon a more predation-influenced way of life. Bieri states that an anterior mouth and posterior anus are the most effective method for ingestion and secretion for a predatory being. Additionally, the most important sensing organs and grasping organs and appendages are located in close proximity to the mouth, with the brain located closest to these sensing organs so to protect the brain from attack or damage. This is seen almost universally and independently among Earth creatures regardless of their evolutionary antecedents. Anthropologist Loren Eiseley made similar arguments and supported this view regarding its morphological advantages.[36] Therefore, it is reasonable to suppose that an extraterrestrial predatory species will have bilateral symmetry with a brain and sensing organs at the anterior portion of its body, and that higher complexity of the nervous system and brain achieve further development on land. Bieri believes large-scale brain development

32. Morris, *Life's Solution*, 283–84.

33. Palmer et al., "ET Phone Darwin," 215; Dawkins, "Universal Darwinism," 403–5.

34. Palmer et al., "ET Phone Darwin," 214–25.

35. Bieri, "Humanoids on Other Planets?" 453.

36. Eiseley, "Is Man Alone in Space?" 80–86. Eiseley states regarding cytologist Cyril D. Darlinton's opinion of Homo sapiens: "Darlington . . . dwells enthusiastically on the advantages of two legs, a brain in one's head and the position of surveying the world from the splendid height of six feet."

and conceptualization occur more easily as a result of social existence, speech, and use of tools. Claws would not be advantageous to an intelligent being, nor would feathers or thick scales from a being evolved from a land predator. Convergence is also evident in binaural hearing, which is essential for discerning the source of sounds. Smell sensors are ideally located nearest the mouth, to test the edibility of foods. Tactile sensors are ubiquitous to all organisms and provide additional self-defense. Walter Sullivan[37] states extraterrestrial creatures must be able to move about and build things. That is, they must have something comparable to hands and feet, have senses, such as sight, touch, and hearing, although the senses that evolve on any given planet will be determined by the environment. Vision in the infrared part of the spectrum (may) be more useful than sight in the wavelengths visible to human eyes. The amount of food available would set a limit on overall mass of a being, and the fixed sizes of molecules must limit the extent to which the size of a complex brain can be compressed. Therefore, given these and the aforementioned arguments, it is likely that an intelligent extraterrestrial species would have originated in a predatory environment with a basic symmetrical structure, large brain and sensing organs, exist in social groups, and use tools.[38] Therefore, it seems, given these morphological elements, it is likely that intelligent extraterrestrials will be generally humanoid in appearance, with variations in secondary features due to dissimilarities in physical environments and particular evolutionary tracks.[39]

Diverse extraterrestrial species would have certain morphological differences due to variations resulting from star types, planetary gravity, environmental conditions, food sources and predation, and evolutionary and social histories. As a result, many would likely behave and process information differently, and may have great differences in their subsequent technological achievements. Planetary orientation in space has a particular influence on the development of what we can surmise to be intelligent extraterrestrials. Super-Earths, several which have been discovered in the past few years, would have correspondingly higher gravity, resulting in a heavier endoskeletal (or exoskeletal) structure and more powerful muscles and connective tissues. Beings evolved on such a planet would possess shorter, stockier bodies and denser bones than those evolving in low-g environments

37. Sullivan, *We Are Not Alone*, 300.

38. Other variations from the prototypical humanoid can be considered, such as Larry Niven's "Puppeteers," a fictional race of intelligent beings having two forelegs, a single hindleg with hooved feet, and two snake-like heads rather than a humanoid upper body. This being uses their mouths to manipulate objects which contain finger-like knobs, enabling the use of tools by which they develop a high technological society.

39. Puccetti, *Persons,* 96.

as proper structural support depends on a bone diameter proportional to the square root of gravity.[40] The size and shape of an extraterrestrial will be partially determined by its source of energy, planetary gravity, and ambient density. For example, Pandora, the planet featured in the film *Avatar* (2009) has a lower gravity, a thicker atmosphere, more powerful magnetic fields, and differing day-to-night cycles than Earth, creating a variety of unique ecological conditions. Giantism of vegetation resulted due to lower gravity, and plants which absorbed metals from the soil utilized the planet's magnetic field for movement which the Earth's biologists referred to as "magnetonasty." Plants on Earth are green due to the presence of chlorophyll in their cells which processes the chemical compound necessary for photosynthesis; on other planets there may be other ways to achieve photosynthesis where green plants are not a requirement.[41] If Earth had double its present mass, higher gravity would have resulted in a stronger endoskeleton, which may have precluded bipedalism; an Earth analog with half its mass would have possibility resulted in quite different looking humans. Similarly, if Earth's axial tilt of 23.5° were altered to 60°, seasons and climates would be dramatically altered and with that our evolutionary adaptation to them. Similarly, our circadian rhythms, developed over the long period of our ancestry, allow for the opportunity for cells to replicate at night while avoiding DNA damage from ultraviolet radiation in sunlight. If an Earth day consisted of one hundred hours rather than twenty-four, mutations would have occurred in skin pigmentation, eye development, and metabolism, among others; modern humans would appear substantially different.

Given the above arguments, it is not surprising that a number of highly respected physicists and astronomers and a small minority of biologists hold that we are not entirely unique in our general physical structure, and that extraterrestrials would in many ways appear humanoid. Physicists such as Steven Weinberg and Sheldon Glashow emphasize similarity in terms of mental capacity and ability to perceive the same universal physical laws, while others claim physical similarity.[42] Astronomer Frank Drake writes, "They won't be too much different from us . . . [A] large fraction will have such an anatomy that if you saw them from a distance of a hundred yards in the twilight you might think they were human."[43] Biologist Robert Bieri agrees that "they will look an awful lot like us."[44] Astrophysicist Joel

40. Freitas, "Extraterrestrial Zoology," 57.
41. Baxter, *The Science of Avatar*.
42. Basalla, *Civilized Life in the Universes*, 198.
43. Basalla, *Civilized Life in the Universes*, 184.
44. Basalla, *Civilized Life in the Universes*, 18

Primack reports that intelligent aliens will approximate the general size of humans; optimal for complexity and fast thinking, and that they may possibly share our fractal circulatory system, rates of energy use, and even lifespans.[45] Many biologists, on the other hand argue for uniqueness on the grounds that the many unpredictable historical steps leading to intelligence could never be duplicated. We cannot assume a binary male-female gender that defines Homo sapiens, and should consider the possibility of xenomorphs, hermaphrodites, neutrois, or transgenders. Extraterrestrials could be ovoviviparous[46] or be monosexual, parthenogenetic, or variable-sex. Propagation through cloning and genetic engineering are also likely outcomes in a highly advanced technological civilization, to be discussed in the following section.

Philosopher Roland Puccetti has stated that the development of human intellectual capacities was rooted in early social learning, which allowed for the maturing of symbolic speech[47] for transmitting collective knowledge of the environment. An extraterrestrial species evolved from land predators, similar to humans, could exist in isolated culture-groups during its immediate pre-scientific, early historical period; and would likely compete amongst itself in exploiting environmental resources.[48] Eventually these societies could reach, by means of scientific and technological advancement, a level of possible self-extermination due their inherent behavior in tribal warfare, rooted in pre-conscious predatory instincts. However it cannot be assumed that other races have not found the means to live peaceably prior to the advent scientific achievement, technology, and political institutions. According to the jurisprudence and philosophy of law of H. L. A. Hart, humans are characterized by "limited altruism," being neither totally motivated by self-interest and aggression, nor entirely benevolent and considerate of others.[49]

Humans require food, clothing, and shelter; since the sources of these necessities are limited it is necessary to obtain these by labor; thus some form of property, whether individual or communal, needs to be instituted and acknowledged.[50] Due to the logical advantages of cooperative effort and division of labor, rules and contracts become necessary, and given humans

45. Primack and Abrams, *The View from the Center of the Universe*, 224–28.

46. Producing young by means of eggs that are hatched within the body of the parent, as in some snakes.

47. Terrence Deacon describes the emergence of symbolic thought and language as a concurrent, co-evolutionary process. See Deacon, *The Symbolic Species*.

48. Puccetti, *Persons*, 105.

49. Hart, *The Concept of Law,* 219.

50. There are exceptions to this, as aboriginal Australians were discovered to have no concept of private property. See West and Murphy, *A Brief History of Australia*, 20.

have a limited understanding of their long-term interest in forbearance and compromise, and a limited strength of will to resist manipulation or abuse of others for personal gain, these contingent realities require systems of coercion and legal sanction for those who will not voluntarily submit to a system of mutual forbearances. Therefore, according to Hart, voluntary cooperation within a coercive system is what reason requires of beings constituted similarly to Homo sapiens within an equivalent environment.[51] Since convergent evolution provides a plausible hypothesis for some uniformity between Homo sapiens and intelligent extraterrestrials, we can consider that they will be descended from a predatory environment; a "limited altruism" can be suggested based on a similar sociobiological ancestry, and their social existence based on their achieved conceptualizing intelligence. Extraterrestrial biological entities will require physical nourishment, shelter, and perhaps clothing gained through labor and thus should be characterized by the same "natural necessities."[52] Advantageous to Homo sapiens in dominating Earth life forms were a long gestational period and extensive life-span, a highly developed brain, the evolution of arms and dactyls through arboreal ascent allowing for the manipulation of tools and weapons; and an extended parental dependence resulting in a longer period for maturation of the brain for complex cognition.[53] As outlined by Hart, "In the first instance is assured some selfish aggressiveness, in the second social egalitarianism and benevolence, reinforced by a long period of parental dependence."[54] We can, then, cautiously hypothesize according to the argument laid out for intelligent extraterrestrials a similar bipedal locomotion, manual dexterity, control of differentiated muscles of facial expression, vocalization, intense social and parenting behavior, stereoscopic vision, and forms of sexual behavior.

The genetic engineering of species, if chosen, could be beneficial for a host of reasons to an extraterrestrial race: to extend life well beyond its natural limit, enhance native intelligence, and repress certain negative innate characteristics, such as violent tendencies and extreme competitiveness, or increase one's passivity and willingness to obedience. In practical use engineering of the genome could be utilized to alter the body's ability to withstand radiation and other conditions necessary for interstellar travel or long-term habitats in biologically hostile environments. There might be sexually reproducing engineered species, while others might decide on cloning or purely genetically engineered biological life or synthetic life forms. Those having engaged in

51. Puccetti, *Persons*, 108–9.
52. Hart, *The Concept of Law*, 222.
53. "A Long Childhood Is of Advantage," Max-Planck-Gesellschaft.
54. Given the example in Homo sapiens.

non-sexual means of reproduction for very long periods, perhaps thousands or tens of thousand of years, might judge sexual reproduction a baser and less-advanced method of perpetuating a species, and consider engineering-produced life, with artificially introduced beneficial genetic variants less prone to hereditary errors and undesirable characteristics. Those societies where sexual means of reproduction have been engineered out for extremely long periods might have no concept of gender and exist as a homogenous, gender-less or androgynous species.

Extraterrestrial Psychology

Steven Dick maintains that Darwinian models for determining alien evolutionary psychology are problematic; lacking a robust theory, we are reduced to the extrapolation of current trends supplemented by the most general evolutionary concepts. Accordingly, the most relevant fields for understanding what may be extraterrestrial psychology can be best extrapolated from genetic engineering, biotechnology, nanotechnology, and space travel. While the evolutionary development and ultimate morphology of intelligent extraterrestrials will fundamentally depend on the general and specific physical environment of their given planet, moon, or artificially constructed habitat, as well as specific chemistry and biology, these same conditions determine thought processes and behavior. Basic biological heritage and early social and environmental conditioning will determine many of the later, developed intellectual functioning and cultural characteristics. Fear responses, aggressiveness, competition, hierarchical behavior, mating rituals, and innate curiosity are preconditions of pre-intelligent predatory and social behavior. Intelligent extraterrestrials, having developed along a dissimilar evolutionary trajectory may not possess identical human behaviors, thought processes, motivations, and goals. If it is possible for a species to survive the red giant phase of their parent star, civilizations may have lifetimes that greatly exceed our own, providing them with a far different psychology and world view towards other species and civilizations.[55] In fact, some intelligences may have consciousnesses that are structured and perceive reality wholly different than humans, or exist as a single integrated intelligence rather than a civilization of self-determinate individuals. Physicist Guillermo Lemarchand and science journalist Jon Lomberg refer to this as the *incommensurability problem*:[56] that

55. Billingham, "Summary of Results."

56. A conceptualization taken from epistemology of science to mean paradigm or worldview, a process through which an intelligent mind creates conceptions of its environment and utilizes them for regular functioning. Hoyningen-Huene, "Kuhn's Development," 185–96.