Why Mammal Body Hair Is an Evolutionary Enigma

Jerry Bergman*

Abstract

Mammal body hair is a complex structure that involves several basic parts, including a shaft, a root, and a follicle. The most common theory currently in vogue is that hair evolved from reptile scales. Although both scales and hair preserve well in the fossil record, especially in amber, no evidence of hair evolution has been found after more than a century of searching. Another problem is that all primates have thick, coarse hair called fur, and explanations as to how this fur was lost in human evolution are deficient and contradictory.

Introduction

Hair is a defining characteristic of mammals. It is found on all mammals and on no other animal (Denton, 1986). Even the "hairless" mammals, including pigs, elephants, hippopotamuses, rhinoceroses, whales, dolphins, and other cetaceans (all of which are mammals) are partly covered with very fine short hair, especially in the young. The many functions of hair include the retention of heat, sexual dimorphism, attraction of mates, protection of skin, reflection (or absorption) of sunlight and, in the case of pets, the elicitation of a protective response from humans.

The Structure of Hair

Hair is a complex structure that is epidermal in origin. Animal hair is constructed out of proteins "composed of thousands of amino acids linked together in a highly organized arrangement and sequence" (Saferstein, 2002, p. 205). Hair is held in place below the epidermis by a root situated in a shaft surrounded by a hair follicle. The hair follicle consists of an epidermal and a dermal root sheath. One or more sebaceous glands also exist in the hair follicle and serve to secrete oil into the space between the shaft and the surrounding tissues. This oil lubricates the area and traps moisture, a function that benefits both the hair and the skin.

A small, smooth muscle called the *Arrector pili* runs from the epidermis to the base of the hair shaft. Cold temperature causes this muscle to "stand the hair on its end" to help insulate the body. Also, muscle activity is a means the body can use to produce heat. The muscle contraction produces the familiar "goose bumps" that result from cold temperatures, embarrassment, or fear (and is an important means of communication both to one's self and to others).

Located in the hair root, the external root sheath contains all the epidermal strata existing in normal skin. If the epidermis and superficial part of the dermis are damaged, the undamaged part of the hair follicle (which is protected because it lies deep with in the dermis) is a source of new epithelium to repair surface skin damage (Seeley *et al*., 2003).

Each hair shaft has an inner layer of cells called the *medulla* or pith, containing soft keratin and shrunken cells of dried epithelial structures. The next layer is called the *cortex*, which is a semi-transparent, thick layer that contains "hard type keratin" filled cells (Seeley *et al*., 2003). It occupies the bulk of the hair. The cortex contains scattered pigment cells that produce melanin, giving hair its color. Color is an important tool used to differentiate hair for both biological research studies and forensic work (Saferstein, 2002).

The outer layer of the hair shaft, the **cuticle**, consists of a single layer of colorless keratinized cells that cover the hair somewhat like skin. These hardened, flat cells overlap like house shingles and are arranged "in an imbricate fashion and often beautifully sculptured" (Hamilton, 1939, p. 69). The ends of the flat cells always point toward the *tip* of the hair, not the hair root (Saferstein, 2002).

Types of Hair

Hair comes in many types, from very fine, short hair called "vellus hair" to the stiff quills of the porcupine, but the

*Jerry Bergman, Ph.D., Northwest State College 22-600 State Rt 34, Archbold, OH 43543

Received April 4, 2003; Revised October 13, 2003

most common type is the soft, woolly hair commonly covering most mammals—from dogs to bears (Cooper, 1971). The thick coat of body hair found on mammals is commonly called **fur**. The length and color of fur is a genetically determined, species-specific trait. Nonetheless, the "basic design of mammalian hair is invariant" (Denton, 1986, p. 106). Almost the entire human body is covered with very fine **vellus hair**; only the lips, parts of the genital organs, the nipples, soles of the feet, and palms of the hands are totally free of hair.

Another variance in mammal hair is that it can be straight, curly, or kinky. Straight hair has a round circular shaft, curly hair a flatter, more elliptical shaft, and kinky hair, an even flatter shaft. The flatter the shaft, the more kinky the hair.

Theories of Why Hair Evolved

It commonly is believed that hair evolved to help retain body heat, because hair is an excellent heat insulator (Wong and Simmons, 2001). This conclusion, however, is pure speculation. As one researcher admits, researchers do not even agree on the question whether hair or warm-bloodedness (endothermy) evolved first. Wong and Simmons (2001, p. 1) also admit that the theory that hair evolved as a means of insulation is only:

> one of the ideas about why we have hair. Of course, there is no way for us to tell whether hair evolved first and then endothermy evolved, or whether endothermy evolved and then somehow hair evolved. We really don't know anything about these things.

Most Darwinists believe that humans evolved in Africa along with other primates, all of which were almost totally covered with thick fur. As such, a common view is that now the "body hair of men and women is purely vestigial," a useless evolutionary leftover from when we were ape-like animals (Wells *et. al.*, 1931, p. 415).

The Evidence for the Evolution of Hair

Hair is widely believed by Darwinists to have evolved from scales, yet "no structures are known which can be considered in any sense transitional between hair and any other vertebrate dermal structure" (Denton, 1986, p. 106). Some mammals, such as the Order Pholidota, have both horny scales and fully developed hair (which grows between their scales), but no animal has less than fully developed hair; none has structures that are morphologically in-between hair and scales or even hair that is not fully developed. Scientists have not been able to determine when hair evolved. We only know that it existed very early in the fossil record as fully developed, completely modern hair. Studies of mammal hair have found no evidence of hair evolution; ancient hair is found to be identical to modern hair in all respects.

Hair is one of the better-preserved parts of the body and, in some situations, is even better preserved than bones. Its resistance to chemical composition is due partly to the keratinized cuticle covering the hair, and is one reason why hair is of such importance in forensics (Saferstein, 2001). The structural features of hair can remain intact for thousands of years, and for this reason, hair is a critically important tool in the study of early humans and human evolution. Mammalian hair has even been found perfectly preserved in amber, with some of the best examples coming from Baltic and Dominican amber (Lewis and Grimaldi, 1997; Poinar and Columbus, 1992; Poinar, 1988). The preservation is so good that the order, family, or even genus can be identified (Poinar and Poinar, 1999). Often, only a few strands are found in amber, but complete tufts or clusters have been preserved. Hair is also well preserved in tar pits and ice, as well as fossil impressions.

Also, the hair of different mammals is often distinctly different, and no evidence exists that the hair from "more advanced" mammals is more evolved than that of "less advanced" mammals (such as rodents). They are just simply different. Furthermore, insects also have hair-like structures that are very different from mammal hair, yet are also somewhat similar. Since no one claims that humans evolved from insects, the only current neo-Darwinian explanation is convergent evolution—hair evolved separately several times in history.

One problem with this explanation is that even more evidence is required to demonstrate the evolution of these different types of hair-like structures. In contrast to many structures (such as the eye, which Darwinists teach evolved independently as many as 34 times), scientists believe that mammal hair evolved only *once* and never reversed, i.e. is not the product of devolution from feathers or another structure. Researchers do not even have evidence for the phylogenetic origin of hair. Kardong (2002, p. 221) concluded that:

> The phylogenetic origin of hair remains speculative. One view holds that hair arose initially as surface insulation, retaining body heat in primitive mammalian endotherms. An alternative view is that hair evolved first as tiny projecting rods in the hinges between scales and served as tactile devices. The "protohairs" could help monitor surface sensory data when an animal was hiding from an enemy or re-

> treating from the weather. If such a role increased in importance, it would have favored longer shafts and perhaps the evolution of structures resembling vibrissae. This sensory protohair might then have evolved secondarily into an insulative pelage as mammals become endothermic. Although insulative in modern mammals, hair still retains a sensory function.

Kardong (2002) adds that the fossil record does not even give a hint of hair evolution. The evidence claimed by some, such as the tiny pits on the ancestors of mammals, does not provide support for hair evolution:

> Some therapsids, ancestors to mammals, have tiny pits in the facial region of their skulls. These pits resemble pits on skulls associated with sensory vibrissae in modern mammals. Some have interpreted these pits as indirect evidence of hair in therapsids. ...But the skulls of some modern lizards with scales have similar pits and, of course, lizards have no hair. Thus, such pits are not conclusive evidence of the presence of hair. Further, one especially well-preserved skin impression of *Estemmenosuchus*, a therapsid from the Upper Permian, shows no evidence of hair. The epidermis was smooth, without scales, and undifferentiated, although it was supplied with glands ... Thus, we still do not know when hair first arose in primitive mammals or in their therapsid ancestors (Kardong, 2002, p. 221).

Loss of Hair in Human Evolution

Darwinists claim that mammals evolved hair primarily as a result of sexual selection and also for protection and heat insolation (Darwin, 1871). Of the approximately 3,000 living mammals, only a few lack fur, such as pigs, whales, elephants, humans, mole rats and walruses. With the exception of humans, the absence of fur is consistent with the animal's natural environment—walruses and whales are aquatic, wild pigs are fairly hairy, and mole rats are ground burrowers. Darwin was very emphatic about the importance of sexual selection in primate evolution, and tried to explain human nakedness by selection (Darwin, 1871). Others have attempted to continue this line of reasoning, suggesting that as prehumans continued to evolve into humans, the species lost most of their hair due to sexual selection (Schwartz and Rosenblum, 1981).

Cooper (1971) notes the somewhat contradictory argument where Darwin taught that at one time sexual selection selected *for hair* in prehumans, and later, sexual selection selected *for hairlessness*. It would seem more logical that selection would select for human brains that found hairiness sexually attractive—after all, allegedly, *all* prehumans were once hairy. Those prehumans that saw hair in potential mates as erotic would be more likely to mate, and as a result, they would be more likely to have offspring to pass this trait on. Consequently, humans would continue to maintain a positive affinity for hairiness in mates.

Actually, prehumans must have had a positive affinity for *hairiness* in mates. Otherwise, how did they successfully mate for thousands of generations as primates? Remember, all primates except humans are almost totally covered with thick, furry hair, and those with less hair would be regarded as freaks. They would also be less socially connected due to the importance of mutual grooming (removing ticks and other insects). Wong and Simmons (2001) admit the reason why humans today have lost most of their fur-type body hair is not known. They add:

> There's a lot of variation in how much of the body is covered with fur in various primate groups. Some are incredibly hairy, and some have considerably less fur on the face and the chest and so on. Primates tend to rely on facial expressions for social communication, and of course the better you can see the face, perhaps the better that social communication works. That doesn't mean you have to get rid of the hair to see the face. That just happens to be what happened in apes. But that could be one of the reasons why we don't have hair on our faces (Wong and Simmons, 2001. p. 1).

Morris (1986) considers reasons for human hair loss in evolution at length, but was unable to produce a plausible explanation. The latest theory is that humans lost their hair to reduce their vulnerability to fur-loving parasites (Bhattacharya, 2003). Actually, hair protects against many types of insects, such as mosquitoes and biting flies. It also protects against sunburn and skin cancer. In addition, humans have enough hair on their heads and pubic areas that lice and ticks can still pose a problem.

Darwinists also admit they have no idea why humans did not lose *all* their body hair, including that on the head, pubic, and auxiliary hair (Cooper, 1971). If humans selected for hairlessness, why do humans today still have considerable body hair? Why would males or females select certain traits in a male when they had been successfully mating with hair-covered mates for eons, and no non-human primate preferred these "human" traits. If sexual selection caused the development of the male beard (and its lack in females), why do women often prefer clean shaven males? Obviously, cultural norms are critical in determining what is considered sexually attractive, and these stan-

dards change, precluding the long term sexual selection required to biologically evolve them. Desmond Morris addressed this question in his best selling book, *The Naked Ape* (Morris, 1986). Morris points out that all primates (including all 192 species of monkeys) are covered with hair, the only exception being humans. Actually, humans have more hair than a chimpanzee; the difference is that most human hair consists of the almost invisible, fine hair.

The fact that the animal morphology most like that of humans, the great apes, are all covered with thick hair and most aquatic mammals are hairless is important evidence for the aquatic ape theory supported by Sir Alister Hardy, Daniel Dennett, and Elaine Morgan, among others (Ingram, 2000: Morgan 1997; 1982). This theory argues that so many aspects of human anatomy resemble, not the great apes, but aquatic mammals, thus the idea that we once lived in the water, like dolphins, is considered a reasonable interpretation (Morgan, 1982; 1997). Needless to say, this theory does not fit much of the data and has never been widely accepted among paleontologists. Also, this theory illustrates the difficulty evolutionists face in explaining the loss of fur if the human evolutionary ancestor resembled the great apes.

For most people, especially young adults, their head hair is one of their most important physical features—so much so that both males and females in all cultures carefully style it, trim it, dye it, and spend billions of dollars and numerous hours caring for it. Its importance is so great that hair color alone is synonymous with attractiveness, as evident in the expression "gentlemen prefer blonds." Humans have, on average, 100,000 scalp hairs, the loss of which can cause significant social and psychological problems. Hair can also lose its volume as one ages; it can, for example, thin from 100 micrometers to 50 or fewer micrometers. Treatment of hair loss, a common problem in males, or loss of hair pigment (which results in gray and eventually white hair) are multi-billion-dollar industries.

Conclusions

Hair appears in the fossil record as a complex, fully functional structure, without antecedent evolutionary stages. The reason for the putative problem of human hair loss in evolution is unknown, and the reasons proposed are contradictory. Studies of 23 anthropoid primate taxa have found that the larger (and usually more human-like) the primates, the fewer hairs per equal unit of body surface (Schwartz and Rosenblum, 1981).

Acknowledgments

I wish to thank John Woodmorappe, M.A., Clifford Lillo, Debra Bryan, and Bert Thompson Ph.D. for their helpful comments on an earlier draft of this manuscript.

References

Bhattacharya, Shaoni. 2003. Early humans lost hair to beat bugs. *New Scientist*, June 3. Online www.newscientist.com/news/print.jsp?idns99993807.

Cooper, Wendy. 1971. *Hair*. Stein and Day, New York.

Darwin, Charles. 1871. *The decent of man, and selection in relation to sex*. John Murray, London.

Denton, Michael. 1986. *Evolution: A theory in crisis*. Adler & Adler, New York.

Hamilton, W.J. 1939. *American mammals: Their lives, habits, and economic relations*. McGraw-Hill, New York.

Ingram, Jay. 2000. *Homo Aquaticus*. In Ingram, J. (editor), *The Barmaid's brain*, pp. 102–117. W. H. Freeman, New York.

Kardong, Kenneth V. 2002. *Vertebrates: Comparative anatomy, function, evolution*. 3rd Edition. McGraw-Hill, New York.

Lewis, Robert E. and David Grimaldi. 1997. A pulicid flea in Miocene amber from the Dominican Republic (Insecta: Siphonaptera: Pulicidae). *American Museum Novitates*, 3205:1–9.

Morgan, Elaine. 1982. *The aquatic ape*. Stein and Day, New York.

———. 1997. *The aquatic ape hypothesis*. Souvenir Press, London.

Morris, Desmond. 1967. *The naked ape*. McGraw-Hill, New York.

Poinar, George. 1988. Hair in Dominican amber evidence for Tertiary land mammals in Antilles West Indies. *Experientia* 44(1):88–89.

——— and J.T. Columbus. 1992. Adhesive grass spikelet with mammalian hair in Dominican amber: first fossil evidence of epizoochory. *Experientia* 48(9):906–909.

Poinar, George and Roberta Poinar. 1999. *The amber forest: A reconstruction of a vanished world*. Princeton University Press, Princeton, NJ.

Saferstein, Richard. 2002. *Criminalistics: An introduction to forensic science*. Prentice-Hall, Upper Saddle River, NJ.

Schwartz, G.G. and L.A. Rosenblum. 1981. Allometry of primate hair density and the evolution of human hairlessness. *American Journal of Physical Anthropology* 55(1):9–12.

Seeley, Rod, Trent Stephens and Philip Tate. 2003. *Anatomy and physiology*. McGraw-Hill, New York.

Wells, H.G, Julian S. Huxley, and G.P. Wells. 1931. *The science of life*. Doubleday, Garden City, NY.

Wong, Kate and Nancy Simmons. 2001. What is the difference between hair and fur? *Scientific American* Feb. 20. Online www.sciam.com/askexpert/biology/biology45.