Pick Me, I Have Great Genes!

BE&W

Impressive antlers and victorious duels with rivals signal that a stag is healthy and strong. That, in turn, indicates that his offspring will inherit such traits

AGNIESZKA KLOCH
Faculty of Biology, University of Warsaw
Academia, Magazine of the Polish Academy of Sciences
akloch@biol.uw.edu.pl

Dr. Agnieszka Kloch studies the mechanisms of evolution. Having previously focused on the effects of genetic variability in the major histocompatibility complex (MHC) on parasitic infections and mate selection in wild rodents, she is currently working on the evolution of other immunity-related genes.

Females of most species cannot rely on their mates to help raise their young, so they strive to at least get the best possible genes for their offspring. But how do males communicate that they are good father material?

The reasons behind sexual dimorphism – significant differences in the appearance of males and females – were discussed by Darwin in his seminal *On the Origin of*

Species. He was fascinated by the origins of such impractical characteristics as huge antlers that make it difficult for stags to negotiate their way through thickets, or the dazzling tails of peacocks that surely attract predators. He concluded that since individuals with those traits have not died out but, on the contrary, actually thrive and are popular with the opposite sex, they must be subject to a specific type of selection, which he named sexual selection. In contrast to natural selection, which determines the individual's likelihood of survival, sexual selection affects their chances of finding a mate and producing offspring.

Size and color mean quality

The main reason for the imbalance between the sexes is the discrepancy in the effort involved in reproduction. Males' input is generally limited to fertilization - simply providing genetic material. The main burden of procreation is borne by females: it is their bodies that develop nutrient-rich eggs or carry live young during pregnancy; they feed the offspring after they are born, care for them, protect them and prepare them for adulthood. If they cannot rely on support from the males, they expect them to at least transmit the best possible genes to the young. As such, they carefully select potential fathers and choose those that seem to be the healthiest and strongest. This means that the offspring will likely inherit these traits, and the mother's efforts put into producing and rearing the young are not wasted.

Of course there are exceptions to all rules in nature, so we should note here that it is not always females that choose their mates. In certain species, the roles are reversed: in wadepipers (three species of shorebirds from the *Phalaropus* genus), females' only contribution is to lay the eggs, and the entire burden of incubating the clutch and feeding the chicks is borne by males. The females are larger and more colorful, and they pursue and fight over males. Similar principles are observed in Amazonian poison dart frogs (*Dendrobatidae*) and seahorses.

So how do females assess the quality of males? During the course of evolution, males have acquired a number of traits that clearly communicate their attributes. They frequently present as ornaments - various types of structures whose only function is to attract females. According to Amotz Zahavi's handicap principle, a trait that honestly communicates the male's status must also be costly to him. A good example is provided by antlers, which stags grow anew each year. Forming an external bone structure weighing several kilos is a massive energy expenditure for the body, but its visual appearance reflects any diseases or dysfunctions, such as an imbalance of sex hormones. This means that for the female, antlers are a clear signal of their owner's status. In birds, sexual dimorphism is frequently reflected in differences in coloring. Although growing bright plumage does not require a great deal of energy, the dazzling colors can be attractive to predators. This is the kind of information the female is looking for: if the colorful male is able to successfully avoid predation, he must be strong and fast. Furthermore, William D. Hamilton and Marlene Zuk note that attractive, bright feathers are only present in healthy individuals, as parasitic infections (common in birds) render them dull. As such, plumage is a direct signal of the male's health.

Attractive males transmit these traits to their offspring, which means that their sons are very likely also to be attractive to females. In turn, daughters inherit from their mothers a preference for sexual ornaments present in their fathers. And so sexual selection strengthens sexual dimorphism, driving evolution towards increasingly splendid ornamentation. Powerful sexual selection may, at times, lead to an absurd development of sexual characteristics; one example is the now extinct *Megaloceros* genus of deer, whose antlers spanned up to four meters and weighed up to 40 kg.

Almost all biological phenomena sooner or later find an alternative explanation, and this is also the case for sexual ornaments. The Australian-Georgian evolutionary biologist Joseph Jordania believes that such traits have nothing to do with reproduction, and rather they serve as a warning by signaling the individual's strength and status, preventing aggressive behavior and fights. However, confrontations within a species are frequently indirectly linked with reproduction - for example, males defend their territory to maintain access to females inhabiting that area. Jordania's concept has not been widely accepted by evolutionary biologists, and the formation of ornaments remains ascribed to sexual selection.

Scent of a relative

There is a further element helping females select the best mate: scent. It is an extremely rich medium carrying a wealth of information about individuals, such as any existing and former infections and even emotional state. It may also provide information about kinship between individuals. This is of great importance, since reproduction between close relatives carries many significant risks; one well-known example in humans is the hemophilia that plagued the Habsburg family. The ability to distinguish relatives from strangers is of particular importance during sexual selection.

Species raised in family groups generally regard any individuals whose scent they have been familiar with since infancy as relatives. This has been shown by "cross-fostering" studies in mice, where litters were switched immediately after birth. However, it also turned out that the animals were able to detect components in

BE&W

Rodents generally regard individuals they have been raised with in the same nest as relatives. However, they are also able to detect genetically-distinct impostors using scent

the scent of non-related individuals that carried information about the genetic composition of certain regions of DNA. In particular, the regions code for proteins of the major histocompatibility complex (MHC), an element of the immune system. The MHC gene sequence is an excellent marker of relationships between individuals: the closer the kinship, the more similar the MHC sequences. Although we do not know exactly how information about the MHC sequence translates into scent, the process is likely controlled mainly by the vomeronasal organ (also known as Jacobson's organ), involved in the detection of pheromones. In mice, it has been found to contain receptors responsive to proteins with structures very closely related to MHC proteins.

How do women seek mates?

Studies into mate preferences in animals usually provoke questions regarding similar mechanisms in humans. Is our search for the perfect "other half" driven by biological instinct, or is it shaped by cultural norms and the standards of beauty they impose? During the 1990s, researchers at the University of Bern conducted an experiment in which female students were asked to rate the attractiveness of their male counterparts purely by smelling their T-shirts. It turned out that they showed a preference for scents of students whose MHC gene composition differed from their own. Curiously, this was not observed in women taking oral contraceptives, which skew their hormonal profiles, making them similar to pregnancy. Other studies show that pregnant females tend to seek out the company of relatives as potential care-givers.

However, despite the apparently spectacular results of this experiment, it is unlikely that scent plays an important role in people's search for mates. The results have not been confirmed by researchers working with other ethnic and national groups, for example Japanese or Native Americans. It seems more likely, then, that while scent may carry some information about potential mates, its significance in humans is secondary. This could be due to the fact that our species relies chiefly on sight. It is also important to remember that human babies are generally cared for by both sexes. Although the immediate burden of childrearing often falls to the mother, she can count on the help from her partner, who in most traditional societies provides her and their offspring with financial and general support. Where equal partnership of the parents is encouraged, the father shares all responsibilities, apart from those beyond his biological means, such as pregnancy and lactation. This means that a man's attractiveness depends less on biological signals he sends and more on the female partner's expectations as to his potential abilities as a father. Also important are cultural beauty standards, and the potential partner's social standing.

However, it is also worth remembering that – in contrast to other species – men's external physical attributes do not translate directly into reproductive ability. As it is, the evolutionary race is won by those individuals who leave behind the highest number of offspring, even if their attractiveness or input in the care of their own children leaves a lot to be desired. ■

Further reading:

Zahavi A. (1975). Mate selection – a selection for a handicap. *Journal of Theoretical Biology 53 (1)*, 205–214.

Hamilton W.D., and Zuk M. (1982). Heritable true fitness and bright birds: a role for parasites? *Science 218*, 384-387.

Wedekind C., Seebeck T., Bettens F., Paepke A.J. (1995) MHC-dependent mate preferences in humans. *Proc Biol Sci. 260*, 245-249.