Stressed-out African naked mole-rats may provide clues about human infertility

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Lyon, France: A tiny, blind, hairless subterranean rodent that lives in social colonies in the harsh, semi-arid conditions of Africa could shed light on stress-related infertility in humans, the 23rd annual meeting of the European Society of Human Reproduction and Embryology will hear.

Dr Chris Faulkes, a senior lecturer at the School of Biological & Chemical Sciences, Queen Mary, University of London, will tell the conference that the African naked mole-rat is at the extreme end of a continuum of socially-induced reproductive suppression among mammals, with other examples including primates such as marmosets and tamarins, mongooses and members of the dog family (such as wolves and jackals).

The naked mole-rat lives in colonies of between 100-300 animals, but only the “queen” reproduces, suppressing fertility in both the females and the males around her by bullying them.

Dr Faulkes said: “The queen exerts her dominance over the colony by, literally, pushing the other members of the colony around. She ‘shoves’ them to show who’s boss. We believe that the stress induced in the lower-ranking animals by this behaviour affects their fertility. There appears to be a total block to puberty in almost all the non-breeding mole-rats so that their hormones are kept down and their reproductive tracts are under-developed.

“Currently, we think that the behavioural interactions between the queen and the non-breeders are translated into the suppression of certain fertility hormones (luteinizing and follicle stimulating hormones). In the non-breeding females this has the effect of suppressing the ovulatory cycle, while in the non-breeding males it causes lower testosterone concentrations, and lower numbers of sperm. In most non-breeding males, sperm that are present are non-motile.

“The queen also seems to exert control over the breeding males, so that concentrations of their testosterone are suppressed except when she is ready to mate.”

However, this stress-related block to fertility is reversible. When the queen dies, the other non-breeding, highest ranking females battle it out for dominance, with the winner rapidly becoming reproductively active.

“Studies of dominance within colonies have revealed that breeding animals have the highest social rank. Furthermore, concentrations of urinary testosterone, a hormone associated with aggression, in the queen and non-breeders of both sexes correlated significantly with rank position. In experiments where the queen is removed from her colony, reproductive activation in the female taking over as queen was accompanied by the development and expression of aggressive behaviour in the form of ‘shoving’. These succeeding females were also previously high ranking and had relatively high concentrations of urinary testosterone. This supports the hypothesis that the attainment and maintenance of reproductive status in the queen, and control of the social order of the colony, is related to dominance behaviour,” said Dr Faulkes.

Natural cues such as changes in day length and social stress act through areas of the brain that control reproduction and, as it is likely that such neuroendocrine pathways are similar across species, understanding how

they work in naked mole-rats could lead to a better understanding of the mechanisms involved in some stress-related infertility in humans. Dr Faulkes said: “Social suppression of reproduction in marmoset monkeys is very similar to that in naked mole-rats, and as these are primates the applications to understanding human stress-related infertility aren't so far fetched.

“The neurobiological process underlying the way mammals respond to social and environmental cues are still largely unknown,” he continued. “In a wider comparative study of African mole-rat species, we are also researching into genes that may give rise to the quite different forms of social bonding and affiliative behaviours observed in mole-rats. Studies on voles by researchers in the US have shown that complex behaviours like monogamy and promiscuity can be influenced by single genes that differ among species in their patterns of expression in the brain.

“Humans also vary widely in the way in which they form social bonds with their partners, offspring and kin. By making careful comparisons with model species like mole-rats, we may be able to tease apart the relative contribution of genes, environment, up-bringing and culture to complex social behaviour in our own species.”

For the African naked mole-rat, the advantages of their social organisation mean that almost all the members of the colony are co-operating and directing their energies towards foraging for food in order for the whole community to survive, rather than indulging in physically exhausting mating and reproductive behaviour. The “workers” dig a network of tunnels, often several kilometres long, which they use to find their food of roots and tubers, while the “soldiers” defend the colony against foreign mole-rats and predators such as snakes.

“By living in large social groups with a co-operative non-breeding workforce, naked mole-rats are able to exploit an ecological niche where

solitary animals or small groups would be unlikely to survive," said Dr Faulkes.

Source: European Society for Human Reproduction and Embryology