

More Fun Than Fun: The Unlikely Stardom of the Naked Mole Rat

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A naked mole rat. Photo: Smithsonian's National Zoo, CC BY-NC-ND 2.0.

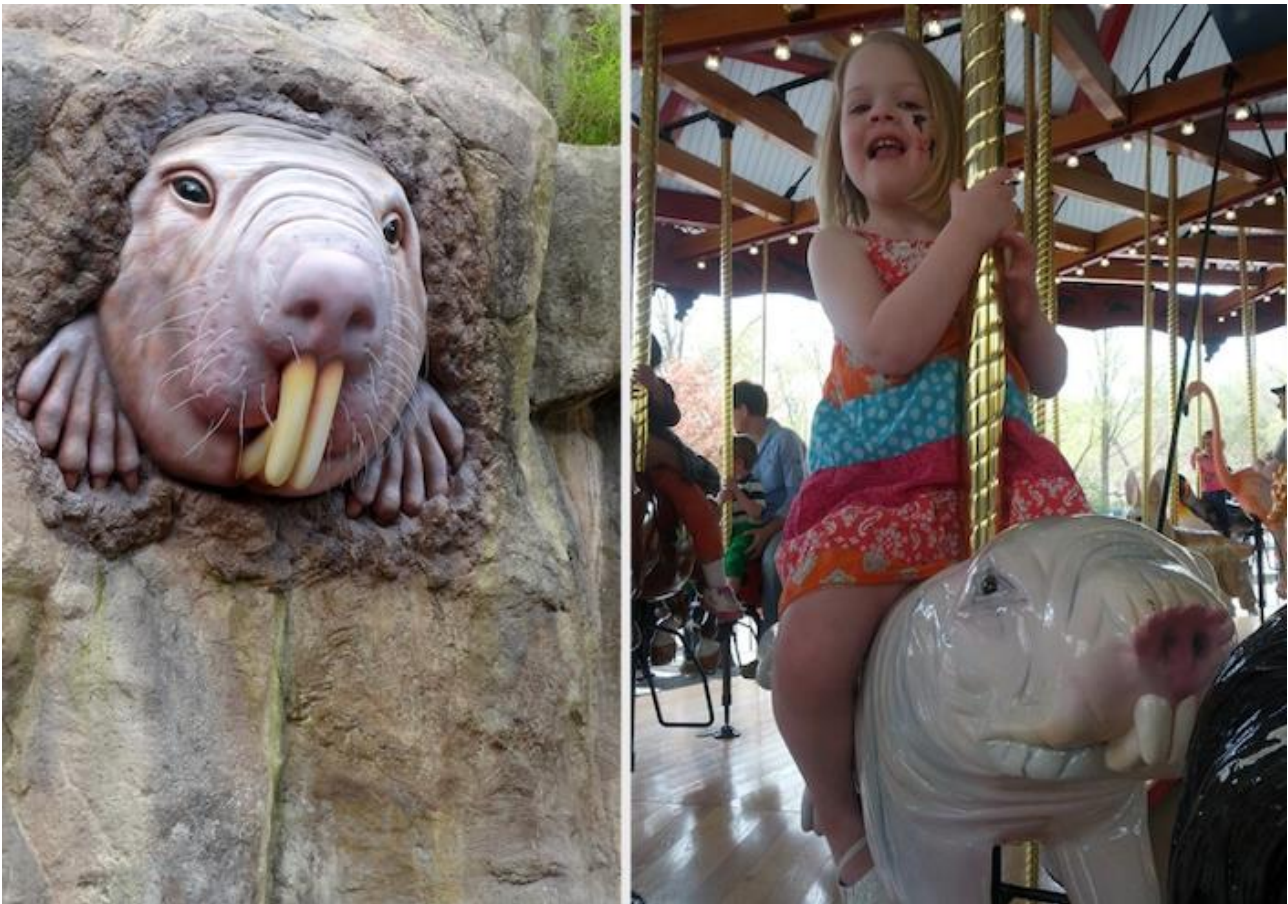


This article is part of the '[More Fun Than Fun](#)' column by Prof Raghavendra Gadagkar. He will explore interesting research papers or books and, while placing them in context, make them accessible to a wide readership.

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I knew about the naked mole rat (*Heterocephalus glaber*) as a little curiosity in my field of research on social insects, the curiosity being that it is the only known eusocial (truly social) mammal, comparable in many ways to eusocial ants, bees and wasps. Imagine my surprise while browsing the internet when I came across a children's book entitled *Naked Mole Rat Gets Dressed* by the American best-selling creator of children's books, Mo Willems. In the story, one naked mole rat 'Wilbur' decides to be different and defy societal norms by wearing clothes, allowing the author to teach children about tolerating other people who may be different from us.

I soon discovered a flood of 'naked mole rat' children's books. In [Naked Mole Rat Saves the World](#), author Karen Rivers weaves a children's fantasy about a 12-year old girl turning into a naked mole rat to save the world. Then there is the series *The Adventures of Herman the Naked Mole Rat* by Mark and Julia Wagman. In *The Naked Mole Rat Letters* by Mary Amato, a girl in seventh grade saves her parents' marriage by sabotaging her father's affair with a zookeeper who cares for naked mole rats. There is also the Burlesque about Men and Women entitled [Naked Mole Rats in the World of Darkness](#) by Mike Folie, not quite for children, I am afraid. Of course, there are also several factual books, such as [*Naked Mole-Rats Unique Animal Adaptations* by Emily Hudd, *Naked Mole Rats (Nocturnal Animals)* by Kristin Petrie, and many more.



Naked mole rats cross over into public imagination. Left: Naked mole rat statue, Singapore Zoo. Photo: Jackerbie, CC BY-NC 2.0. Right: Naked mole rat on the merry go round. Photo: ttrygve, CC BY-SA 2.0

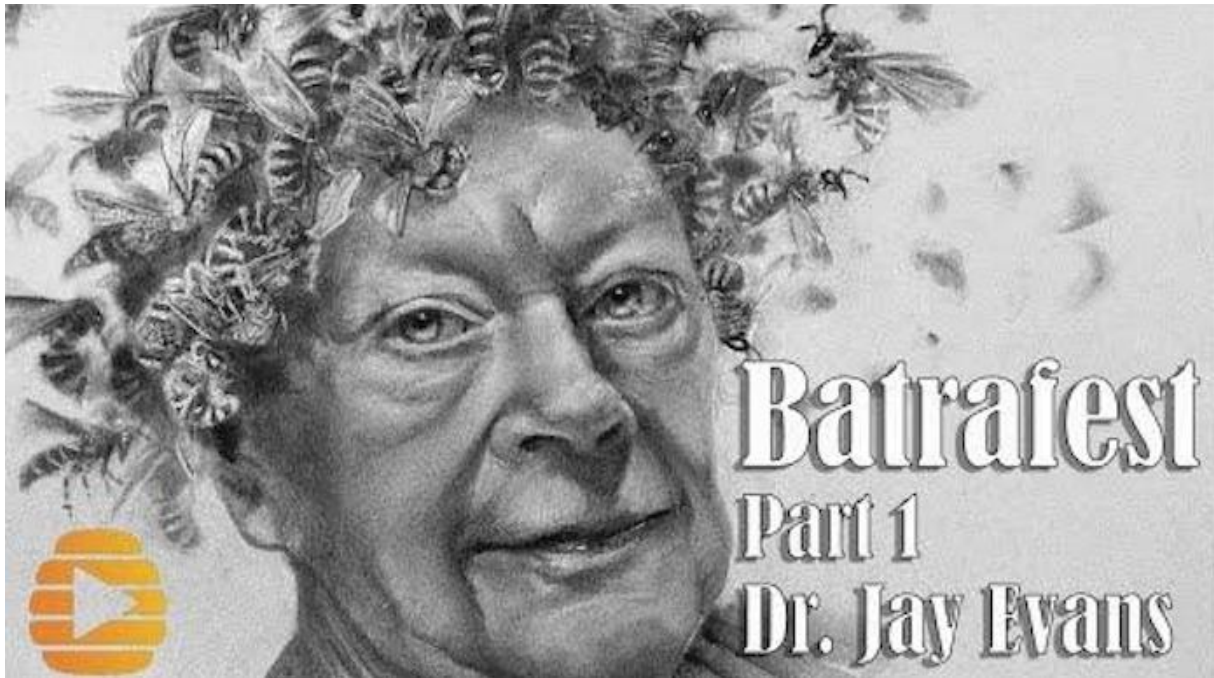
What is the naked mole rat, and how did this obscure African underground rodent, often described as one of the ugliest animals, become such a hero and enter the popular imagination? To trace the naked mole rat's rise to stardom, let us begin at the beginning.

Suzanne Batra

Born in 1937 in New York, Suzanne Wellington Tubby Batra, daughter of Roger W. Tubby, Press Secretary to President Harry Truman, defied family tradition and took to natural history, including fishing, hunting and catching insects. She went on to study the sociobiology of sweat bees for her PhD under Charles Michener's mentorship, the world's foremost authority on bees. She married her botany Professor Lekh R. Batra, originally from India. This brought her to India to study our halictine bees.

Of the many papers she has published during her long and illustrious career, [the article](#) entitled 'Nests and social behaviour of halictine bees of India (Hymenoptera: Halictidae)' published in the *Indian Journal of Entomology* in 1966 is by far her most famous. Not only is this paper a paragon of natural history, but in it, she coined a new term 'eusocial', meaning truly social. Michener [made this term famous](#) in his *The Social Behavior of the Bees: A Comparative Study* (1964), and E.O. Wilson made it immortal as the highest form of sociality in his *The Insect Societies* (1971). As restated by Wilson, a species is said to be eusocial if it displays the following three properties:

1. Members of the group should care for offspring cooperatively, irrespective of whose offspring they are.
2. Members of the group should be differentiated into fertile reproductive castes (Queens or Kings) and sterile non-reproductive castes (workers).
3. There should be an overlap of generations within the group such that offspring assist their parents in caring for offspring and other tasks involved in colony maintenance.



Celebrating Suzanne Batra. Source: [YouTube](#)

The presence of sterile worker castes in eusocial species means that these individuals sacrifice personal reproduction and altruistically work for the colony's welfare. On the face of it, this goes against the grain of Darwin's theory of natural selection. This difficulty was explained by the theory of kin selection, which states that fitness can be gained either by producing one's own offspring or, alternatively, by helping an appropriate number of close genetic relatives. Many researchers chose eusocial social species as promising model systems to understand the paradox of altruism and test kin selection theory. The evolution of eusociality became [one of the best ways](#) to study the evolution of altruism.

Eusociality was known at that time in only ants, bees, wasps and termites. Over the years, eusociality has been discovered in a few species of thrips, aphids, beetles and shrimps. However, eusociality was conspicuously missing among vertebrates. The highest form of sociality was found abundantly in insects but not a single species of fish, frog, reptile, bird or mammal. This was a paradox, and those of us who studied the evolution of eusociality would always be asked to explain this apparent anomaly.

Richard Alexander

A professor of zoology and director of the zoology museum at the University of Michigan in the USA, [Richard Alexander](#) was a prominent evolutionary biologist, a world expert on crickets, and much concerned with [Darwinism and human affairs](#). Richard Alexander was the most prominent member of a small group of people who were not entirely satisfied with kin selection theory, especially on its excessive focus on genetic relatedness and nepotism. In an [influential paper](#) in 1974, Alexander argued that the evolution of altruism and eusociality would be greatly facilitated by the ecological conditions in which the species lives, especially the opportunity for parents to manipulate their offspring into sterile worker roles while they live in close proximity in protected nests.



Richard Alexander, inventor of a hypothetical eusocial mammal, that later surfaced to be naked mole rat, *Hetercephalus glaber*. Photo: Joan Strassmann

Because many mammals live under the conditions imagined by Alexander, the striking absence of any eusocial vertebrate troubled him more than others. To overcome his trouble, Alexander invented a [hypothetical eusocial mammal](#) and described 12 characters that might have made it most likely to evolve eusociality. In brief, Alexander's hypothetical eusocial mammal was "a completely subterranean rodent that feeds on large tubers and lives in burrows inaccessible to most but not all predators, in a xeric tropical region with heavy clay soil".

The naked mole rat

Influenced by Alexander's invention and his many lectures popularising his hypothetical eusocial mammal, Jennifer Jarvis, then a young researcher in the University of Cape Town in South Africa, [presented a real-life example](#) of a eusocial mammal: the naked mole rat (*Hetercephalus glaber*). This led to a period of great excitement. Several leading researchers from Europe and the US, including Richard Alexander, descended on Cape Town to observe and collect the naked mole rat colonies. Several laboratory colonies using a system of plexiglass tunnels were established and [began to be studied](#) extensively.

Naked mole rats were first described by the German biologist Eduard Rüppell in 1842. They are called 'naked' because they have sparse body hair. They are neither moles nor rats but are taxonomically situated in the family *Bathyergidae*, which is endemic to sub-Saharan Africa and whose members are generally known as African mole rats.

I listened to Alexander give a brilliant evening, pre-dinner, special lecture about the naked mole rats during the Congress of the International Union for the Study of Social Insects, in Boulder, Colorado, in 1982. Fascinated, I went to visit him in Michigan soon after, when he proudly showed me his colonies of naked mole rats in the basement of the zoology department. W.D. Hamilton, the proposer of kin selection theory, who worked in the same building, has described his experience of being shown Alexander's naked mole rat colonies more colourfully than I can: "Crossing the threshold into that damp, warm room of the floor below, always on tiptoe so as not to alarm the dim, scrambling shapes in the tubes beyond, was like crossing the river Styx".



Naked mole rats housed in laboratory tunnels stimulating their natural underground tunnels, at the Pacific Centre in Seattle, USA. Photo: Ryan Somma, CC BY 2.0

Imagine a mammal that lives just like a social insect! There was great excitement in the air. A [flurry of research](#) by many scientists, including Richard Alexander and Eileen Lacey in the University of Michigan, Jennifer Jarvis in the University of Cape Town in South Africa, Paul Sherman in Cornell University, Ithaca, New York, Stanton Braude in the University of Missouri, St Louis, Nigel Bennet in the University of Pretoria has greatly advanced our knowledge of naked mole rat sociobiology.

Naked mole rat sociobiology is uncannily similar to social insect sociobiology. Naked mole rats live in colonies consisting of 10s to 100s of individuals of both sexes in underground tunnels and feed on tubers in the hot arid regions of Kenya, Somalia and Ethiopia. They exhibit all three defining features of eusociality: an overlap of generations, cooperative brood care, and reproductive division of labour.

Only one or a small number of males and females breed. The remaining non-breeding males and females divide among themselves, housekeeping chores such as clearing the tunnels of debris, transporting food, building the tunnels and defending the colony against ants and snakes. They also recruit nestmates to food sources, show nest-mate discrimination, nepotism, inbreeding and queen-activation of lazy workers and kin recognition which they seem to use to practice outbreeding. Like in many primitively eusocial insects, most naked mole rat females can become queens, although very few get the chance to do so.

Researchers are excited that within the family of African mole rats, *Bathyergidae*, we can witness a whole range of social organisation from solitary to highly eusocial species, allowing us to understand the forces that mould the evolution of social behaviour in this unique mammalian setting. As is also [becoming apparent](#) with some primitively eusocial insects, ecology [may be as important](#) or even more important than genetic relatedness in shaping the evolution of altruism in mole rats. The naked mole rat continues to enjoy the status of a star in sociobiology.

Crossover into biomedical research

It is turning out that the naked mole rat has several [extremely unusual](#) physiological features that are surprising researchers in the biomedical sciences and sparking their keen interest.

Almost all mammals are homeothermic or warm-blooded, meaning that they can use their metabolism to thermoregulate and maintain a constant body temperature, irrespective of the outside ambient temperature. In contrast, poikilotherms or cold-blooded animals such as reptiles, amphibians, fish and invertebrates cannot do so. The naked mole rat is only partially homeothermic and has to combine its limited homeothermic ability with tricks such as moving to places with more suitable ambient temperature and restricting its activity to certain times of the day or night, as poikilotherms do, to

maintain its body temperature. Naked mole rats have extremely low resting metabolic rates and appear to have a unique thyroid hormone physiology. They are also unique in how their physiology of pain perception is organised, making them [insensitive to pain](#) in many circumstances, such as exposure to noxious substances like acid and capsaicin, which cause pain and irritation in all vertebrates.

Their brain development is spread over a relatively long part of their life span, apparently making them more resistant to neurodegenerative diseases. Their neurons are two to five times more resistant to hypoxia and oxidative stress. Their most striking feature is that they are highly resistant to age-related diseases such as cancer, diabetes, cardiovascular diseases, and even many kinds of infections. They are significantly more resistant to free-radicals, so-called reactive oxygen species, which damage DNA, RNA and proteins and cause death. Moreover, naked mole rats [have more accurate](#) protein translation than the mouse; even their protein synthetic machinery is different in that it has a uniquely cleaved ribosomal structure. Partly because of these unusual features, naked mole rats may live up to 30 years, in contrast to similar-sized mice that live for about three years, making it [an exceptional model](#) for biogerontology.

In January this year, naked mole rats once again grabbed a wider audience's attention when it was discovered that each colony has a colony specific 'song'. Naked mole rats communicate with each other using 17 different vocalisations. The most common of these is the so called 'chirp', which appears to be a form of greeting. Scientists from the Max Delbrück Centre for Molecular Medicine, Berlin, Germany and the University of Pretoria, South Africa, have recorded 36,190 naked mole rat chirps from 166 animals (from seven colonies) over two years. An analysis of the acoustic structure of these chirps, playback, and cross-fostering experiments show that each colony has a [colony-specific dialect](#) that the queen partly controls.

Crossover into the popular imagination

To my mind, the naked mole rat's cross over into the [public imagination](#) is even more remarkable. Not only is the naked mole rat the protagonist of children's adventure books and thrillers, as I mentioned at the beginning of this article, but naked mole rats are among the most popular exhibits in zoos and are the centre-pieces in art and science workshops for children. The naked mole rat has become the ambassador for science and nature outreach programmes. Researchers such as Paul Sharman and Stanton Braude and television series such as [Kim Possible](#) by Walt Disney studios have greatly facilitated this crossover, for which we should be grateful.



A naked mole rat workshop by Translating Nature. Photo: Julie Freeman, CC BY NC 2.0

In the short span of 40 years, since Richard Alexander prophesied its existence and Jennifer Jarvis brought his mythical beast to life, the naked mole rat, which was once described as ugly and repulsive, has become a star among sociobiologists, physiologists, molecular biologists, neurobiologists, gerontologists, oncologists, metabolic disease specialists, creators of children's literature and art, and science communicators. Not bad eh!

The downside of stardom

With such fame and embrace by scientists in different disciplines and artists in various genres, it is not surprising that there are many unproven assertions, misunderstandings, false claims and myths about our hero, the naked mole rat. When I was a graduate student, I had a professor who had declared that he would never speak to journalists because they were sure to misrepresent his work. I used to tell him that it is precisely because he did not speak enough to journalists that they misrepresented his work.

Yes, facts can get lost and twisted in 'translation', but that is no reason to hide our research in the closet. The responsible thing to do is to intervene periodically and clear up misunderstandings and bust myths. A [recent paper](#) entitled 'Surprisingly long survival of premature conclusions about naked mole rat biology' authored by 21 scientists that describes and busts 28 myths about the naked mole rat, is a role-model worthy of emulation.

Finally, we must pause and ponder how many more yet-to-be-born stars there might be among the millions of species out there. Are we doing enough to let them even survive, let alone reach stardom?

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