Identification of African naked mole-rat *Heterocephalus glaber* for ABS Agreement

***Picture adopted from* Mengistu Wale *et al.* (2013)**

Naked mole-rat (*Heterocephalus glaber*)

Reviewed by Abiyselassie Mulatu

Genetic Resources Access and Benefit Sharing Directorate

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1. Introduction

Ethiopia has a legal framework for the implementation of the Access and Benefit Sharing (ABS). The laws regarding the National Access and Benefit Sharing legal framework are the Proclamation on Access to Genetic Resources and Community Knowledge and Community Right Proclamation No. 482/2006 and Regulation No.169/2009. The Ethiopian Biodiversity Institute (EBI) is the National Competent Authority which has established a directorate, Genetic Resources Access and Benefit Sharing (ABS Directorate) since 2012. This directorate plays vital role in the implementation of the Nagoya Protocol on the Access to Genetic Resources (and Associated Traditional Knowledge) and the Fair and Equitable Sharing of Benefits arising from their Utilization to the Convention on Biological diversity (CBD). Using the above-mentioned laws, Ethiopia has implemented the CBD 3rd objective of Access and Fair and equitable benefit Sharing of the Genetic Resources and Associated Traditional Knowledge.

Plants and animals are undoubtedly the basis of many bioprospecting opportunities around the world. Although the bioprospecting potential of animals has been little explored, compared to plants, available studies show that animal genetic resources are highly promising in the search for new drugs of medical or pharmaceutical interest. Ethiopia is rich in animal biodiversity from which it can be benefited by providing to bioprospecting companies.

In this line Access and Benefit Sharing Directorate of EBI has taken the initiative to introduce the potential genetic resources for bioprospecting. Therefore, the aim of this review is to introduce the really bizarre looking animal and economically important rodent pest from the Horn of Africa which is known as East African naked mole-rat, *Heterocephalus glaber*. Science News (2013) named the naked mole-rat "Vertebrate of the Year" for 2013.

The East African naked mole-rats, *Heterocephalus glaber*, belong to the mammalian Order Rodentia. The naked mole-rat (*Heterocephalus glaber*) also known as the sand puppy or desert mole rat, is a burrowing rodent native to parts of East Africa and is the only species currently classified in the genus *Heterocephalus* (Woods and Kilpatrick, 2005).

2. Description of the animal

There are approximately 30 different kinds of mole rats. The best known is the naked mole rat. Naked mole-rats have little/no body hair (hence the common name, naked mole rat). The only

hairs that can be found are touch-sensitive hairs which they use for feeling their way through their tunnels. Naked mole-rats have cylindrical bodies with short limbs and very loose skin. It has a purplish brown back and tail. The skin is wrinkled and loose, which helps them to turn in compact spaces or squeeze through the tiniest of tunnels. And, it can easily walk on top of and around its friends (Wikipedia, 2015).

The naked mole rat's tube-shaped body is 8 to 10 cm long. Its skinny tail adds 3 to 5 cm of length. It weighs 30 to 35 grams but the queens are larger and may weigh well over 50 grams, the largest reaching 80 grams. The naked mole rat has small eyes and small holes for ears. Its large incisors stick out beyond its mouth (Wikipedia, 2015).

As they are well-adapted to their underground existence, their eyes are quite small, and their visual acuity is poor. They have small holes for ears. Their legs are thin and short; however, they are highly adept at moving underground and can move backward as fast as they can move forward. Their large, protruding teeth are used to dig and their lips are sealed just behind the teeth, preventing soil from filling their mouths while digging (Wikipedia, 2015).

3. Diet / Food habits

Naked mole rats are exclusively fossorial rodents and spend all of its life underground. They spend much time digging for food with their constantly growing long incisors. They also dig, randomly, in order to find food - roots and tubers from above ground plants. They eat the underground parts, particularly the succulent tubers of the arid growing plant species. They have adapted to survive in the desert by extracting their liquid needs solely from plants. In the wild, they survive on long roots and fat tubers from the grassland plants above and vegetation (DSI, 2014). Naked mole-rats have high densities of gut fauna that aid in digestion of their indigestible higher cellulose diet. They also regularly practice coprophagy, the reingestion of feces, which allows them to maximize their uptake of nutrients from their food (Wikipedia, 2015).

4. Geographic range

The species African naked mole-rat (*Heterocephalus glaber*) has a wider range of distribution. It is found throughout most of Somalia, central Ethiopia, and much of northern and eastern Kenya (Jarvis and Sherman, 2002). The species has also been recorded from Djibouti of an altitudinal range of 400 to 1,500 m a.s.l. (Pearch *et al*., 2001 cited in Maree and Faulkes, 2008).

The naked mole-rat is native to the drier parts of the tropical grasslands of East Africa, predominantly southern Ethiopia, Kenya, and Somalia (Sherman *et al.*, 1991). Clusters averaging 75 to 80 individuals live together in complex systems of burrows in arid African deserts. In Ethiopia, it is found in Oromia Region of Mizan Teferi, Babille and Fadis of Eastern Hararghe, and Somali Region of Ethiopia (Mengistu Wale *et al.*, 2016).

Heterocephalus glaber was identified as a widely distributed pest rodent in the study sites of Dire Dawa Administration, Eastern Ethiopia (Mohammed Kasso, 2013). Mengistu Wale *et al.* (2016) found out that 92% of the Eastern Ethiopian communities in the Eastern Harerghe Zone and Dire Dawa City Administration considered the naked mole-rat as a pest. Naked mole-rat is fairly common in many of the above-mentioned sites despite variation in abundance of their molehill.

5. Habitat and Ecology

The Naked mole rats species is subterranean i.e. they live underground in arid regions. They occupy dry grasslands and savannas in Ethiopia, Kenya, Djibouti, and Somalia. In these East African countries, they make their underground homes. Naked mole-rats live in arid habitats, characterized by high temperatures and low and irregular rainfall, which generally average 200-400 mm/year. They are found most frequently in hard, consolidated, lateritic loams, although they can live in fine sand, pure gypsum, and laterite (Jarvis and Sherman, 2002).

Naked mole rats live in mazes of tunnels. The tunnel systems built by naked mole-rats can stretch up to 3 to 5 kilometres in cumulative length. Each tunnel system has rooms with specific purposes. These include kitchen, toilet, and nesting chambers. Naked mole rats store food in kitchen chambers. All colony members use the toilet chamber for waste (Dawkins, 2006).

6. Behavior

Naked mole-rats are the first and only mammals known to have a colony structure similar to that of social insects such as ants, termites, bees and wasps. This is known as eusociality or eusocial behavior. They are eusocial and live in groups (colonies) that are comprised of one breeding female (Queen), one to three breeding males, and hormonally-suppressed, non-reproducing workers. Each colony acts similar to a hive of bees. They are extremely dependent on one another for survival. They work together to help their colony flourish (Jarvis, 1981; DSI, 2014).

These eusocial species are living in colonies averaging between 75 and 80 animals per colony and yet some have up to 300. The colonies are extended family groups, with overlapping generations. The queen rules the land of the large colony. Responsibilities of workers are assigned based on the hierarchical ranking of the animal. Workers care for the queen and her young; find food for the entire colony; and expand the tunnel system (by one worker digging at the front using its strong teeth and other workers lining up nose to tail). Large, strong soldiers protect the colony and threaten invaders and predators. The social structure is fragile and the loss of one animal can change the duties of many (Jarvis and Bennett, 1993; Bennett and Faulkes, 2000; DSI, 2014).

7. Reproduction and Life span

Reproduction is restricted to a single reproductive female i.e. the queen, and at most three breeding males (usually one or two). Non-breeders (which are sociologically suppressed by aggressive behaviours of the dominant female) help care for and defend the reproductive animals and young. The non-breeding animals maintain and defense of the colony burrow system (Jarvis and Sherman, 2002). The species has a gestation length of 66 to 74 days, after which between one and 28 young are born. Females can bear litters every 76 to 84 days, and wild females regularly bear more than 50 pups per year in 4 or 5 litters (Jarvis and Sherman, 2002).

African naked mole-rat (*Heterocephalus glaber*) is a relatively long-lived species in captivity; females living up to 23 years, and males to up to 28 years (Sherman and Jarvis, 2002).

8. Scientific researches on *Heterocephalus glaber*

8.1. Pain sensitivity

The skin of naked mole-rats lacks a key neurotransmitter called substance P that is responsible in mammals for sending pain signals to the central nervous system. The naked mole-rats feel no pain when they are exposed to acid or capsaicin. When they are injected with substance P, however, the pain signaling works as it does in other mammals, but only with capsaicin and not with acids. This is proposed to be an adaptation to the animal living in high levels of carbon dioxide due to poorly ventilated living spaces, which would cause acid to build up in their body tissues (Park, 2008). Petherick (2008) reported that nasty stimuli including acid and capsaicin,

the ingredient in chilli peppers that causes a burning sensation in many animals did not bother the naked mole rats. These mole-rats are also odd in that their skin, when inflamed, does not become hypersensitive when exposed to unpleasantly hot objects, even though they react to excessive heat in the same way that other mammals do.

The African naked mole rat is being targeted for its resistance to pain inflicted by acid. German researchers have discovered why it is immune to feeling pain on its skin and they now bears vast implications for analgesic drug research-bringing new hope to chronic pain sufferers. Its protein can also be used as a local anesthetic in dentistry (Bishton, 2012). Naked mole-rats' substance P deficiency has also been tied to their lack of the histamine-induced itching and scratching behavior typical of rodents (John *et al.*, 2010).

8.2. Resistance to cancer

Cancer has not so far been detected or observed in the naked mole-rat. Recent studies have suggested that its cells possess anti-tumour capabilities that are not present in other rodents or in humans. Naked mole-rats are highly resistant to cancer or tumours (Buffenstein, 2008). A potential mechanism that averts cancer is an "over-crowding" gene, p16, which prevents cell division once individual cells come into contact (known as "contact inhibition"). The cells of most mammals, including naked mole-rats, undergo contact inhibition via the gene p27 which prevents cellular reproduction at a much higher cell density than p16 does. The combination of p16 and p27 in naked mole-rat cells is a double barrier to uncontrolled cell proliferation, one of the hallmarks of cancer (Seluanov *et al*., 2009). Blind mole-rats *Spalax golani* and *Spalax judaei* also appear to be immune to cancer but by a different mechanism (Cormier, 2012).

7.3. Longevity and Anti-ageing

Naked mole rats (*Heterocephalus glaber*) are the longest-living rodents known, with a maximum lifespan of 30/31 years - 5 times longer than expected on the basis of body size, i.e. an extraordinarily long-lived for a rodent of its size (Edrey *et al.*, 2011; HAGR, 2014) and holds the record for the longest living rodent (Buffenstein and Jarvis, 2002; Buffenstein, 2005) and maintain healthy vascular function longer in their lifespan than shorter-living rats (Csiszar, 2007). The reason for their longevity is debated, but is thought to be related to their ability to substantially reduce their metabolism during hard times, and so prevent aging-induced damage

from oxidative stress. This has been referred to as "living their life in pulses" (Science Daily, 2007). Their longevity has also been attributed to “protein stability” (Pérez *et al.*, 2009). For at least 80% of their lives they maintain normal activity, body composition, and reproductive and physiological functions with no obvious age-related increases in morbidity or mortality rate. Their long lifespan is attributed to sustained good health and pronounced cancer resistance. Clearly physiological and biochemical processes in this species have evolved to dramatically extend both their good health and lifespan (Edrey *et al.*, 2011).

For the first time, scientists, in partnership with The Genome Analysis Centre (TGAC), Norwich, have sequenced the genome of the naked mole rat to understand its longevity and resistance to diseases of ageing. Researchers will use the genomic information to study the mechanisms thought to protect against the causes of ageing, such as DNA repair and genes associated with these processes. Because of their extraordinary longevity, an international effort was put into place to sequence the genome of the naked mole-rat. Further transcriptome sequencing revealed genes related to mitochondria and oxidation reduction processes to have high expression levels in the naked mole-rat when compared to mice, which may contribute to their longevity (Yu *et al.*, 2011). Surprisingly, they have high levels of oxidative stress and relatively short telomeres, yet they are extremely and inexplicably resilient when subjected to cellular stressors and appear capable of sustaining both their genomic and protein integrity under hostile conditions. Elucidating these mechanisms will provide useful information for enhancing human life and healthspan, making the naked mole rat a true “supermodel” for aging research and resistance to chronic age-associated diseases (Edrey *et al.*, 2011). Telemetry is used by scientists as an ideal method to unravel the mystery of naked mole-rats (DSI, 2014).

8. Conservation status and threat

Naked mole-rats are not threatened. They are widespread and numerous in the drier regions of East Africa (IUCN, 2001; Maree and Faulkes, 2008). It is regarded as pest as it does eat crops such as cassava and sweet potatoes, which are both important agricultural products. Farmers usually kill the entire colony of naked mole-rats by pouring hot water onto their tunnels so as to protect crop damage. Mengistu Wale *et al.* (2016) identified factors such as agricultural

expansion, human killing and lack of awareness about this important genetic resource as the main threats of naked mole-rat.

9. Conclusion and Recommendation

The exploitation of animal genetic resources requires a careful strategy that allows the sustainability of the species exploited, since the exploitation of fauna in medicinal bioprospecting can result in overharvesting of target organisms. Although naked mole-rats are not threatened at present, they might in the future be experiencing the threat through use and utilization by consumers and bioprospectors. In view of this reality, economic development associated with animal bioprospecting should be preceded by a broad discussion of the conservation of biodiversity and the sustainable management of these genetic resources.

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