# CHAPTER 6

## ASPECTS OF THE BIOLOGY OF THE BATHYERGIDAE

It should be stressed that very little information about the biology of the Bathyergidae is available at present. This may be partially due to the fossorial nature of the animals and the fact that relatively little fieldwork has been undertaken in the past. In this respect one thinks immediately of modern techniques which can be applied to fossorial or semi-fossorial animals e.g. the use of radio-active isotopes which can be applied to determine activity patterns etc., as well as other interesting aspects of behaviour. An excellent example of this approach is the work by Godfrey and Crowcroft (1960). In this case the European mole *Talpa* was subjected to investigations with the aid of radio-active cobalt and a Geiger counter. It is evident that the possibilities for interesting research as far as the behavioural aspects of the mole-rats are concerned has hardly been begun to be exploited.

The data presented below (scanty as it may be), is based on the existing literature and partially on my own field observations. Much of the evidence given in this chapter may seem to be irrelevant but it may serve a useful purpose in pointing to future research possibilities on the biology of this interesting group of rodents.

On analysing the information available at present,/...

present, it was found that many facets of the biology of the three genera were identical and this information (for the purposes of this chapter) has been compounded for Bathyergus, Georychus and Cryptomys. It will become evident that very little biological information is available on Georychus, while a greater amount of detail concerning behavioural and other biological aspects of Bathyergus and Cryptomys is to be found in the literature, mainly in the papers by Eloff (1951, 1952, 1958).

General behaviour

As far as the bathyergids are concerned, the overall impression gained is that the animals are rather short tempered. This is especially noticeable when they are captured in the field, or when housed in cages in laboratories. There is no information available about their behaviour when they occur normally within their tunnels. According to Eloff (1951, 142) this aggressiveness has been noted by other observers as a marked characteristic of all blind moles.

When on the surface of the soil, there is random movement but no real fleeing (Eloff, 1951, 142). They are extremely sensitive to air currents (this also applies when they are within their tunnels) and a violent reaction is evoked when one blows into the face of a captured specimen. It reacts with snapping movements with its enormous incisors, accompanied by a snorting type of grunt while the whole animal retreats backwards rapidly for a distance of four-to-six inches keeping its head and snout directed at the source of irritation.

When these animals are captured alive they are usually unsettled and agitated but after a while they soon calm down under captive conditions. This has been described very aptly by Moseley (1879) in the case of Bathyergus, when after capture, the animal assumed a "sulking attitude". Furthermore, these animals are apparently not socially inclined and appear to be willing to fight instantly whenever the opportunity arizes, especially if two (captured) individuals (even if they are of different sexes) do not come from the same tunnel system.

Habitat

In view of the fact that these animals are predominantly fossorial it stands to reason that burrowing is an important activity. Not much is known about this aspect although Eloff (1951, 1952) has managed to keep a number of individuals alive under laboratory conditions so that some idea concerning their burrowing activities could be gained. Bathyergus is well adapted to burrowing, not by means of its large incisors but using the well developed claws of the front foot. The amount of time spent burrowing during the day is unknown. Personally, I timed a captured specimen which was released on soft riverine soil after soaking rains. The animal could submerge its head and front limbs in approximately 90 seconds, the major portion of the digging being executed by the claws. Sporadically it bit the ground frantically and savagely with its incisors but this activity may have been induced by the relatively unnatural conditions which prevailed

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(e.g. capture, etc.). It is quite possible however that the incisors are used to a certain extent during normal burrowing operations.

In contrast to Bathyergus however, both Georychus and Cryptomys employ their incisors to a much greater extent during digging while the fore-feet are used mainly to clear the passages from loosened soil.

The tunnels or burrows are permanent constructions i.e.they are used over and over again. The main incentive for the extention of these burrows appears to be the acquisition of new feeding grounds where new and untapped food resources are available. The direction of tunneling is therefore possibly determined by the geographical distribution of the food supply, as well as by the prevailing conditions of the soil (texture, humidity, etc.)

On the average, the diameter of the tunnels of Bathyergus vary between 5-8" and are at least 7-8" below the surface of the soil. They are usually constructed in loose, soft soils. In the south-western Cape there are many areas consisting of loose, unconsolidated, sandy soil types (often in the shape of coastal sand dunes) and in these soils there is usually a high degree of drainage, especially in the higher lying parts. During the rainy season in the Western Province parts of the tunnel systems are often flooded and submerged and especially on the Cape Flats it is evident that the tunnels are constructed in higher lying land, less easily subjected to flooding. In many cases, these burrows appear on the sides of the relatively stationary dunes.

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As would be expected, the diameter of the tunnel in Cryptomys is far smaller, averaging 2-3". One also finds the tendency in this genus for construction of tunnel systems in higher lying ground. Compared to Bathyergus, the genus Cryptomys occurs in a much wider spectrum of soil-types - varying from loose sandy soils (e.g. vicinity of Pretoriuskop, Kruger National Park) to hard, stony soils (e.g. near Fountains, immediately south of Pretoria). No information is at present available concerning the diameter of the tunnels in the case of Georychus. It is expected to be more or less intermediate in size between those of Bathyergus on the one hand and Cryptomys on the other.

In a Bathyergus tunnel system there are not as many side tunnels (which may be called cul-de-sac's) as one finds in the tunnel system of Cryptomys. The scarcity of these side tunnels is a striking feature in the tunnel system of a dune mole-rat.

The excavated earth from the tunnels are heaped up on the surface (i.e. mole-hills) and they lie more or less parallel with the direction of the tunnel. However, it is not always easy to follow the direction of the tunnels in this way due to the fact that they often turn sharply to the left or to the right and the mole-hills then often tend to present a confusing picture. However, it is obvious that these mole-hills present a more or less straight line which may have certain curvatures. On closer inspection, it can be seen that these heaps are pushed up more or less in two parallel rows with the actual main tunnel lying approximately between them. The distances between these hills are not

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constant and are thus irregularly spaced, either to the left or to the right of the main tunnel (see Fig. 6.1).

The main tunnel has side branches leading to the surface of the soil (through which the excavated soil is pushed out) and which make an angle of approximately 45° with the surface of the soil. The excavated soil within the side tunnel immediately below the mole-hill is usually tightly packed, making the tunnel system air tight at that point. (This may not always be the case however). The mole-hills are large (depending on the size of the tunneler), and in Bathyergus are approximately 23" in diameter and about 12-15" high. The hills are far smaller in Cryptomys measuring approximately 12" in diameter and usually they are not higher than 8" in the case of Cryptomys hottentotus. In wet or damp soil, the soil is pushed out from the side tunnel in the shape of bundles, reminding one somewhat of toothpaste being squeezed out of a tube. The (more or less) solid bundles are clearly visible on top of the mole-hill where they usually dry out in the sun and in their shape they correspond to the size of the tunneler and consequently to the diameter of the tunnel. According to Eloff (1952, 211) the main incentive for tunneling (and consequently throwing up the mole-hills) - constituting the removal of excess soil from the tunnels - is to obtain food.

The way these side tunnels are constructed is excellently described by Eloff (1951, 142), and the following information has been paraphrased from that account.

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The first contact the animal makes with the air on the surface of the ground is with its snout when boring the side tunnel until it ruptures the surface. After this, its hindquarters come into contact with the air on the surface of the soil frequently especially when the mole-hill is still in its initial stage, as the excavated soil is pushed outwards.

It is not known whether the juveniles are as efficient at tunneling or digging as the adult specimens. Occasionally (usually on higher lying territory) there are smaller mole-hills interspersed with the larger ones and which may represent the excavatory activities of the young.

Although it may be assumed that digging or tunneling is an instinctive adaptation in the bathyergids it is of interest to note that this activity does not commence before the animals attain a certain minimum age. Eloff (1952, 210) has found that juvenile specimens (which were taken from a nest) only developed an inclination for boring into the surface of the soil after approximately six weeks. This activity pattern was not observed before the animals attained this age. This implies that even in the absence of parents who could thus not condition their offspring as far as digging is concerned, they did so instinctively at a certain age.

The rate of burrowing is not known. This will obviously also be determined by soil conditions. However, based on my own experience, one locality was encountered (a Bathyergus tunnel system near Malmesbury) where three new heaps were thrown up during the night, extending the range of

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the tunnel by approximately seven feet. The volume of sand displaced by means of this activity was approximately 2 cubic feet (see Fig. 6.2).

The length of the tunnel system is determined by the geographical position of the nest, the distance between the nest and feeding grounds and probably also by the physical nature of the soil. A tunnel system of Cryptomys, which was opened by me (the H.B. length of the animal being approximately 120 mm.) attained a length of 60 feet, not taking into consideration the various side tunnels or parallel tunnels. The length of tunnels constructed by Bathyergus are very often much longer: I have followed and opened up such a tunnel system in the Citrusdal district for more than 250 feet without reaching any terminus.

The orientation of these animals below the surface of the soil has been investigated by Eloff (1951, 1952), and it appears that the main orientation mechanism occurs by means of echo localization. (See under orientation and sense organs, below).

Occasionally one finds a hole which leads directly to (into) the main tunnel: this aperture may be used by the animal when leaving the tunnel system to come out on top of the soil and which is not sealed off during its visit to the outside world. Why the animal leaves the tunnel system, is not known: an individual may be pushed out by others, or it may seek new foraging grounds. The latter alternative could evidently be done just as efficiently without leaving the tunnel.

The mole-rat's action when the tunnel system has been disturbed has also been described very aptly

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by Eloff (1952, 214). Assuming that the soil of the mole-hill is removed and that the side tunnel has been opened up, it will be seen that within a relatively short time the mole-rat (Cryptomys) will stick out its head so as to spy on its environment. It then goes back (reversing down the side tunnel) to fetch fresh soil in order to plug up the hole. In one specific instance Eloff and his co-workers opened up 12 side tunnels, which were all plugged between 9 a.m. and 2 p.m.

Eloff also investigated the manner in which the mole-rat detects damage to its tunnel system. These experiments were conducted in glass cages, filled with soil. On opening a portion of the tunnel system, e.g. a side tunnel, it will be seen that the mole-rat comes along in the intact portion of the tunnel in the direction of the opening. Occasionally a pumping action is executed by the entire body: the abdomen is flattened, as if the animal inspires: then the spinal column is curved, bent ventrally, and this action is repeated a half-a-dozen times or so. The animal then comes nearer to the opening and repeats these movements. Eventually, on coming below the opening the head is inserted into the opening of the side tunnel from the main tunnel and the animal moves up into the side tunnel. If a sudden disturbance is detected, the animal slips back down the side tunnel. This process is then repeated. Precise observations have shown that the animal reacts to a change in the pressure of the air within the tunnel system. The pumping actions apparently displaces a volume of air in the tunnel which goes up via the side tunnel. The inflow

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and outflow of air via the leakage is then followed up and the opening or leakage is thus detected. After having localized the damage, the animal then proceeds to fetch soil in order to plug the opening. The soil is then pushed out by means of the hindfeet, a few strong convulsions of the body is excecuted, and the soil fastened in position with the vibrations of the hindfeet which last approximately 1 second and which are excecuted at the rate of approximately 25 vibrations per second with a declining amplitude. In this way, the damaged portion of the tunnel system is repaired. Occasionally, the mole-rat also uses its head to stamp the plug into its final position. Sometimes, more than one mole-rat helps with the reparation of the leakage. In the field one finds that the repaired portion is plugged up to the extent of approximately 4 ft. This, according to Eloff (1952, 215) is evidently a defensive behaviour, for it complicates matters for the predator in localizing the tunnel.

While carting the soil to and fro (i.e. extending its run, or repairing a leakage in the tunnel system), it has been noted by Eloff (1952, 213) that Cryptomys cleans its fur between these trips by means of vibrations of the skin with a vibration rate of 20 tot 25 vibrations per second. In this way, soilparticles etc. are removed from the skin and pelage.

It has not yet been observed whether two individuals can pass each other within the tunnel. Mechanically, this should however be possible with mutual co-operation.

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The soil in which the tunnels are constructed is often very damp and consequently it may be assumed to be damp in the tunnel as well. However, there is no information available about the relative humidity within the burrows. This would obviously vary with the local rainfall and other climatic conditions. Similarly, no data is available about the temperatures occurring within the tunnels. In view of the fact that the tunnel system is an isolated structure, it is not unreasonable to assume that a relatively constant humidity and temperature is maintained within the system.

No definite information is available as to whether the tunnel systems are communal runs i.e. whether both males and females occurring within one system, use the same tunnels. It does seem likely that this occurs.

Whether there is a difference in digging behaviour between the two sexes, and which sex is responsible for the actual construction of the tunnels, is also unknown.

A fact which is often overlooked, is that the farthest point of any tunnel system is usually approximately 12" or more beyond the last mole-hill i.e. the tunnel does not terminate immediately below the last hill.

The depth of the tunnels below the surface of the soil also depends to a certain extent on the physical condition of the soil and the availability of food. In one system of Bathyergus which I followed for a considerable length, the depth below the surface varied between 6" tot approximately 3'5". The actual mechanism of the digging movements of

Cryptomys has been observed by Eloff (1952, 211), under laboratory conditions. These mole-rats were kept in glass cages filled with damp soil and in view of the fact that they often tunneled close to the inner surface of the glass their mode of digging could be observed.

It was observed that the animal bores with its lower incisors, which have a certain degree of mobility because the two hemi-jaws are not ankylosed at the symphysis. The frontfeet are used to push away the loosened soil, using the frontfeet alternatively, up to 25 movements per second, until a small heap of soil is formed below the animal. The hindfeet continue this action until the soil is behind the animal. Assuming that the mole-rat has completed the construction of a side-tunnel leading to the surface, the mole-rat maintains its forwardly directed digging as explained above. After the soil has been concentrated behind the animal, the animal reverses, pushing the soil out via the side tunnel with its hindquarters emerging a short distance on top of the surface of the soil. While walking backwards, the lower incisors are pushed into the soil of the bottom of the tunnel, especially when pushing the soil up the incline of the side tunnel. After a number of similar trips it is then seen that a number of shorter movements are executed by the hindquarters, followed by a vibratory movement of the hindfeet against the lower surface of the excavated soil. These vibratory movements last approximately one second with a speed of 25 to 30 vibrations per second. These vibratory movements have a specific physical meaning, i.e. securing each particle of soil

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which has been excavated and which closes up the side tunnel. The mole-hill covering the aperture of the side tunnel is thereby prevented from caving back into the side tunnel (especially when the soil is dried out by the sun) and similarly, it makes the tunnel system airtight at that point.

Nests

Very often, nests occur more or less at the one end of a tunnel system and all other tunnels leading from such a nest usually converge at the feeding grounds. In one case however, (in the vicinity of Citrusdal) I opened up a tunnel system of Bathyergus and it appeared that the nest was situated more or less in the middle of the home range, with feeding grounds to the left and right of the tunnels (Fig. 6.3). Consequently, these nests are not always terminally situated in a specific system. No firm generalizations can be made therefore concerning the geographical position of the nest. According to Roberts (1951) the nests often occur in higher lying ground but this is not always the case. A Bathyergus nest recovered from the banks of the Olifants River in the Citrusdal area, was actually located within a trough and would easily be flooded, if the drainage of the surrounding soil was not sufficient. The nest of Bathyergus, constructed from roots, leaves, etc. (i.e. vegetable matter from the immediate surroundings) is built in a nest chamber, approximately 15" in diameter, and usually at least 24" below the surface of the soil. There are various tunnels leading to and from the nest and in one specific case, the nest was not very much deeper than the tunnels leading to the nest.

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Two nests of Bathyergus, which I have managed to acquire, were not appreciably deeper down than the tunnels. Nor did the tunnels approach the nest with an irregular spiral, as is the case in Cryptomys (de Graaff, 1962, 158) where the nests are situated at a deeper level than the tunnels of the tunnel system.

The nests are constructed entirely from vegetable matter as indicated above and all these roots, leaves, bracts, etc. are intertwined so that a round structure is obtained, which fits more or less snugly in the surrounding nest chamber.

It is not certain how Bathyergus uses this nest within the nest chamber. We do not know whether it (or they) get on top of this structure or whether it gets into this mass of vegetation and whether the circular shape of the nest is retained by the size of the surrounding nest chamber. A nest removed from a tunnel system was put into a plastic bag: a captured Bathyergus eventually bit its way through the plastic bag and went to lie inside this mass of vegetation. It is however not known whether they do so under normal circumstances.

It may further be emphasised, that these nests are not easy to obtain, due to the great amount of physical work involved in excavating this structure.

Activity

It has been observed that Bathyergus is far more active during the rainy season in the Cape (i.e. winter rainfall area) compared to the dryer, less humid periods of the summer months and a general impression is gained that these animals, i.e. the bathyergids, are more active after rainfall. This

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seems obvious, for after downpours the soil is softer and easier to dig through. In addition (at least in the western Cape), these tunnels are often damaged by flooding or by sagging in of the roofs of the tunnels etc., which may induce the animals to greater activity. Good soaking rains will often damage the tunnels leading to the feeding grounds while the nests (often, not always) lying on or in ground with a higher level, are not damaged. In the drier periods (i.e. the summer months) this is generally not the case, and therefore less activity may be expected.

As has been indicated above, the daily activity rhythmn is not known and consequently it cannot be stated how much time is spent burrowing, sleeping, etc. Instances are known where the animal walks around on the surface of the soil in broad daylight. I have obtained one such a specimen of Bathyergus in the Citrusdal district at 13.00 hours on a clear sunny day. The reason why the animal leaves its tunnel system is not known: whether they are ejected by other individuals after fights, or whether foraging for new food reserves, or collecting nesting materials. However, certain indications point to a greater amount of activity (i.e. burrowing etc.) occurring at dawn or at sunset. This may imply that they are lying still during the warmer periods of the day. It should be borne in mind though, that the differences in temperature, humidity, etc., occurring within the tunnel system is of a low order.

Locomotion

The individual movements executed by each limb during locomotion have not yet been analysed.

On the surface of the soil, the animals create a so-called 'club foot' impression i.e. the front feet (hands) are turned inwards to a certain extent, with the major portion of the weight resting on the outer edge of the hand or pulse. When walking on the surface, they walk stuntily, with a 'wobbly' motion. Based on my own experience, it appears that they do not walk long distances uninterrupted: i.e. they stop often (after perhaps two or three feet) to investigate their surroundings. This frequent stopping may also be correlated with the fact that for orientation (in any case within the tunnels and probably when on the surface of the soil as well) the animals use echo-localization, (ref. Eloff, 1951, 1952) in view of the fact that their sense of sight and possibly of smell seem to be rather poorly developed. Sclater (1901, 73) states that on the surface of the ground the powers of locomotion in <u>Bathyergus</u> are somewhat limited.

On the other hand, these animals are apparently exceedingly agile when fossorial conditions are prevalent (i.e. when occurring within the tunnel). The whole tunnel system reminds one somewhat (in a modern sense) of an underground railway system. The actual speed which can be attained below the surface of the soil is not known. However, on opening up a portion of the tunnel system, and awaiting the animal's reaction, it becomes clear that they can turn around with lightning speed to retrace their steps.

At present, there is no information available whether these animals are good swimmers or not. However, it seems fairly safe to assume that they would be able to cope with emergencies, for all animals have an innate capacity for swimming whenever the need arises. The ability to swim would undoubtedly be an asset especially during certain months of the year when the tunnels tend to be flooded to a certain extent in the western Cape Province. On the other hand, the possibility exists that they may sense the danger signs instinctively, and without prior warning will move to higher lying ground.

The orientation of the mole-rat below the surface of the soil is intimately bound up with its habitat and surroundings. Therefore, the next aspect to which attention is briefly directed is the question of orientation.

Orientation

More information is available concerning this ethological aspect of the bathyergids, than of other facets of their behaviour. This is largely due to the very interesting work done by Eloff (1951, 1952) on the behavioural aspects of *Bathyergus* and *Cryptomys*. Although it appears that Eloff concentrated more on *Cryptomys* as far as ethology is concerned, the same general and overall results seems to be applicable to *Bathyergus* as well, with certain minor deviations. Damage to the tunnel system may be caused by several factors "..... the most important of which are large and small Ungulates, rain, dogs and man". "In this manner, tunnel damage may be a daily occurence where cattle and horses are grazing. A tunnel may be damaged to such an extent that, for fairly long distances, it cannot be used.

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However, where such damage occurs in connection with mole systems, a proper connection between even widely separate undisturbed tunnel systems is effected in a remarkably short time and correct manner, while at the same time, the mole displays highly developed powers of orientation. No matter how severely damaged these tunnel systems may be, either cutting off the moles in the veldt from the nest or vice versa, these animals reach their goal unfailingly without trial or error." (Eloff, 1951 a, 1001).
Eloff (loc.cit.) may be quoted as far as the actual description of the experiments are concerned: "Briefly, the experiments were conducted as follows: (a) In one set of experiments a tunnel was opened up for a certain distance, for example, fifty feet from its terminal portion in the veldt; (b) in another set of experiments the tunnel was opened up between nest and veldt terminus; (c) in still another set of experiments the tunnels radiating from the nest were opened up all around the nest for some distance veldtwards."

Although these circumstances described above, are applicable mainly to Cryptomys, Eloff states that this orientation capability also applies to Bathyergus suillus e.g. in experiment (b) above, the mole-rat, after "plugging one opening, bored another tunnel parallel to the portion opened up, connecting up correctly with the remaining intact portion, the opening of which was then also plugged" (p. 1001). "This process of boring parallel to destroyed tunnels has been observed to be repeated as many as twelve times."

The ability of these animals to orientate

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themselves without the sense of sight is therefore remarkable. Eloff (1951) has shown that these animals can overcome obstacles such as extensive damage to their tunnel systems in a characteristic manner "... and will do so even after some months of hard labour and continual hindrance" (p. 136). It is interesting that it was found that individual mole-rats react differently to these hindrances: e.g. some individuals (when recent tunnels have been opened up) will keep as close as possible to the original route, "... resorting more and more to burrowing under tunnels previously opened up. Others do not bore quite so near to the recent tunnel and therefor do not need to burrow under existing tunnels. Also some plug the tunnel-ends nearest to the nest more often than others do and for longer distances. Some deviate to the right only, some to the left only and others to either side." (p. 136-137).

Based on this type of experiment mentioned above, "... no matter whether the tunnel was disturbed at the far end, at the nest end, or in between veldt and nest, the mole always showed a remarkable urge and ability to orientate itself. If disturbed in the veldt the mole ran back, but then there was such a strong urge to tunnel in the original forward direction that disturbing its work a dozen times during two months and involving roughly 200 ft. of repeated tunneling would not prevent it persuing that direction. Eventually, after two months it reached its original veldt-locality! Several other investigations of this type corroborated this observation.

It is clear that the mole's urge to reach its nest for protection should be strong. Especially when it is disturbed it seeks protection nestward or in its nest. Similarly the drive veldtwards in search of food is strong. The problem of orientation is, however forced on one's attention. An explanation must be found on existing sense organs and on instinctive adapatation to the environment." (Eloff, 1951, 140).

Such an explanation seems to indicate the animals's sensitivity to air currents and its sense of hearing. As the present author has noticed, and as is well known from the existing literature, there is no external stimulus to which the mole-rat is so sensitive as to a current of air. Other types of stimuli hardly ever evoke a more violent reaction, and it is quite feasible that this reaction plays an important part in the life and habitat of the animal. The animals usually plug openings in their tunnel systems very rapidly. I have seen this time and again in the field, both in the case of _Cryptomys_ and _Bathyergus_. For instance, when a tunnel was opened in a system of _Bathyergus_ in the Citrusdal district, the animal came to investigate after only two minutes had elapsed.

As Eloff (1951, 142) states quite correctly, the wind directions at any given time of the year at a certain locality are fairly constant. On the other hand, certain minor local differences may arize e.g. where a certain type of shrub grows year after year, where there are trees, and other factors, e.g. stones and rocks of varying size, causing changes in airpressure and movement. Keeping in mind the animals sensitivity to air currents it is possible that the animal uses the side tunnels leading to the surface of the soil, or the mole-hills as gauges of the surface air condition "... and especially of the permanent conditions. These may provide his cues for orientation from moment to moment....". In addition, the mole-rat may use all his other available senses (p. 143), especially "... the kinaesthetic, smell and hearing". Furthermore, its orientation in space is probably enhanced by repetition, for these tunnel systems are permanent structures, being used over and over again, and therefore it becomes familiar with its run "... with almost mechanical precision". It is also known that these animals live in a certain locality for many generations so that it is possible that fixed sources of sound or noise may provide cues. Eloff then concludes (and which is an acceptable conclusion) that an explanation of the orientation behaviour must be looked for in a combination of senses and factors such as sensitivity to air currents and the use of its auditory apparatus.

Sense organs

From the facts given on the preceeding pages, relating to the orientation of the mole-rats below the surface of the soil, it is evident that these animals must have a well developed sense of hearing. The other sense organs need to be discussed briefly as well.

The opinion is generally held that the mole-rats are able to see for short distances and that they are able to distinguish between light and darkness (Shortridge, 1934, 322). This opinion is also held by Sclater (1901, 73) who states that Bathyergus can make use of its eyes to a certain extent.

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Shortridge (1934, 323) states that the eyes in Cryptomys, although minute, are ".... wide open, prominent, and apparently not altogether functionless; if one moves a finger or a stick gently in front of a captured specimen, it follows the movement with its head, although it may merely sense some slight air disturbance: on the other hand it twists its head as if to peer around in a short-sighted manner, the presumption being that it can see indistinctly for a few inches". (Shortridge, 1934, 323). In addition, many farmers also believe that the animal is not quite blind, for if a stick be pointed near its snout region, it reacts (Eloff, 1958, 293).

It is doubtful whether the sense of sight is of any importance, in view of the fact that the animals live in pitch dark tunnels. Eloff (1952, 218) could not demonstrate any sensitivity to light in the eyes of the mole-rats which were kept under laboratory conditions. Furthermore, specimens of Cryptomys do not shun the sides of the glass cages with light passing freely into their tunnel systems (Eloff, 1958, 295). He also subjected Cryptomys and Bathyergus to bright flashes of light thrown on their eyes when these animals were kept in darkness, yet this evoked no reaction at all. Blinking of the eyes is evoked by brief and slight currents of air blown on to the surface of the eye. Eloff also mentions the interesting fact that occasionally Cryptomys specimens with healthy but fused eye-lids are obtained in the veld. These mole-rats are apparently normal in all respects, e.g. weight, health and behaviour, which shows that the absence of sensitivity to light had no adverse affect on them.

Furthermore, experiments trying to condition the animals to light, failed after several hundred combined presentations of conditioned and unconditioned stimuli (light and a jet of air respectively) whereas"... in control experiments they became conditioned to heat even after 25 combined presentations of heat and a jet of air" (Eloff, 1958, 295).

On the surface of the soil both Cryptomys and Bathyergus may walk about with closed eyes and only tend to open them when they become excited. Eloff found that young mole-rats used for maturation studies also showed no sensitivity to light, while their general behaviour gave no indication of even the feeblest type of light sensitivity.

It is clear that the high sensitivity of the snout region and the cornea of the eye to air currents, sufficiently explains ".... how this blind animal so correctly detects perforations of its burrows or nests" (Eloff, 1958, 294).

Based on the laboratory investigations by Eloff, it is possible to state that the sense of smell in the mole-rats is poorly developed. The animal can not locate food, or members of its colony with the aid of smell (Eloff, 1952, 218). It is stated (Eloff 1951, 140) that its sense of smell is apparently not much higher developed than its sense of sight. While working out loosened soil in the veldt it does not react to the presence of a person coming very close to its body. "Also behaviour during courtship shows that smell is of minor importance ."

On the other hand, it is now known that the mole-rat's sense of hearing is well developed al-

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though there seems to be a total disregard of distant noises, no matter how intense. However, it reacts to nearby auditory stimuli "... which signifies probably a sensitivity only to stimuli of direct biological meaning to the mole" (Eloff, 1951, 141). These noises include teeth-grinding noises, squeaky noises and vibrations (e.g. those caused by walking). The importance of the sense of hearing in the mole-rats has already been commented upon above.

The sense of touch is apparently delicately adapted to its mode of eating, and it is possible that the sense of touch, together with the kinaesthetic sense play an important part in connection with the animals easy movements within the tunnel system. As an example, it may be quoted that the "... bend from the main to the side-tunnel is followed backward with great precision, sometimes with no visible touching of the walls" (Eloff, 1951, 141).

Facilitating the sense of touch, mention must be made here about the well developed vibrissae which all the genera possess, together with the stiffened, bristle-like hairs which are to be found on the outer lateral surfaces of the front- and hind-feet. Added to this, one also finds longer hairs in the dorsal pelage in all three genera and which may also serve a tactile function, so that it seems as if the tactile sense is well developed. The vibrissae, in conjunction with the incisors (which bite into the bulbs) are employed during the localization of bulbs for feeding (Eloff, 1952, 213). Similarly, it is stated that its mate is also recognised by the sense of touch (p. 219). Tactile stimuli which are

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applied to the body of the mole-rat in a careful and calm way, evokes no reaction (p. 223).

Voice

When these animals are captured, they usually give ".... vent to a series of grunts" (Sclater, 1901, II, 73) accompanied by a savage and threatening attitude. This applies to Bathyergus, Georychus and Cryptomys. On being irritated by a current of air ejected on to its body, it "very often utters a low grunt" (Eloff, 1951, 142). This has been found in the case of Cryptomys. Grunts, however, are not the only sounds these animals can make: I have kept a number of Cryptomys specimens in captivity and during their sojourn in captivity they often 'communicated' with each other by means of a series of high-pitched squeaks.

In the case of Bathyergus, Moseley (1879) also described the angry, half-snarling and half-grunting noises these animals emit on being captured.

Food and Feeding

There are possibly two main factors determining the geographical distribution of the mole-rats: firstly, the physical condition of the soil and secondly, the availability of the food supplies. Both these factors may prove to be interdependent.

Food is evidently located by searching within the soil by means of tunneling (and thereby extending their ranges), or by foraging on the surface of the soil, especially at night. The former alternative may however be the more correct interpretation. The localization of food by means of extentions of the tunnel systems is probably facilitated by the sense of touch. Eloff (1952, 213)

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maintains that the food is detected by tooth pressure, in addition to its tactile sense, which is apparently well developed in the snout and submental vibrissae region (Eloff, 1958, 295). In one experiment, dummy bulbs were made of plaster of Paris and surrounded by dry husks of Homeria bulbs which were readily taken and pealed, but not nibbled. "A fresh bulb may be in full view, but if it is not touched with the snout or the submental vibrissae it is not taken" (p.295). I have found exactly the same type of behaviour in a Cryptomys specimen which was fed with carrots. The animal would stumble along on the surface of the soil in its cage, and in view of the fact that the ventral border of the mandibles are usually kept close to the surface of the soil, would react only if the food were touched by its submental vibrissae. It would jerk back its head and body and then reinvestigate the object, before commencing to eat.

In the field, the tunnels leading from the nests all apparently radiate in the direction of the food reserves.

As would be expected, these mole-rats are entirely vegetarian in their feeding habits.

As far as I am aware, these animals have not yet been observed in the wild during the process of eating and the information which is available has been unravelled by Eloff (1952, 213). The depth of the tunnels usually correspond to the depth of the bulbs in the soil (at least at the feeding grounds). Under laboratory conditions, Eloff has made the following observations on the feeding method of Cryptomys:

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