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# Two Strategies for Landmine Detection by Giant Pouched Rats

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# Two Strategies for Landmine Detection by Giant Pouched Rats

This article compares the performance of Giant African Pouched Rats under two different management systems, both appropriate for mine-detection operational use. Employing International Mine Action Standards for accreditation, the researchers outline the process of conditioning and testing these mine-detection animals for field use.

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In many countries around the world, landmines do great harm by denying people access to their homes and land, as well as by causing bodily harm, death and psychological duress. Several techniques for detecting mines have been developed, using both automated devices (such as flails and metal detectors) and animals (usually specially trained dogs). Recently, *Anti-Persoonsmijnen Ontmijnende Product Ontwikkeling* (APOPO) has developed operational procedures for landmine detection using Giant African Pouched Rats (*Cricetomys gambianus*). In the first nine months of 2009, these procedures were used to demine 199,318 sq m in Mozambique. The rats found a total of 75 landmines and 62 explosive remnants of war.

The rats are initially trained in a series of steps to sniff the ground in front of them and to pause and scratch when they smell TNT or, with appropriate training, another compound associated with a particular kind of mine or ERW. In Mozambique, a rat wears a harness that is attached by a lead to a rope stretched between two handlers who walk parallel paths down manually demined lanes. The rat moves back and forth along the rope, guided by lines attached to its lead, as the handlers move slowly forward. The photo to the right shows a rat working on a rope. This technique allows the animal to sniff all of the ground between the handlers. Two rats sniff the area and an indication of a mine by either rat is followed by manual demining with a metal detector. In Mozambique, the area to be searched is mechanically cleared of vegetation before the rats are used.

This procedure works well but cannot be used when rocks, large trees or other obstacles block the path of the rope. APOPO has developed another system for using rats in such cases, and when the goal of demining is to clear a relatively narrow linear area—for example, a path and the areas immediately alongside it. In this case, the rat's harness is attached by a lead to the end of a long (2.5-m) lightweight pole, which is moved by the handler to direct the animal slowly across the area to be demined. The photo on the opposite page shows a rat working on a pole. The handler moves along a well-marked, manually demined path. By slowly moving the pole—hence the rat—from side to side as she or he proceeds down the safe path, the handler demines a lane that is roughly twice as wide as the pole is long.

The pole arrangement can also be used as an alternative to the rope system for demining large open areas. In one such application, parallel safe lanes are cleared slightly less than two pole lengths apart, and handlers move down the lanes demining to each side, so there is some overlap in the areas covered by rats demining from adjacent lanes. In the second arrangement, which minimizes the need for manual demining, a safe lane is cleared and the trainer moves down it, directing the rat only to one side. With both systems, a second rat then searches the same area in the same way. If either rat indicates the presence of a mine, that area is manually demined. If neither rat indicates the presence of a mine, the area they have covered is deemed safe. With the second arrangement, a rope is stretched 0.5 m inside the outside boundary of the cleared area to indicate a safe path to be followed by the trainer in their next demining pass. This process is continued until all of the area of concern has been examined.

APOPO's experience indicates that a given rat can be readily trained to perform under both the rope and pole systems, which increases the versatility of the individual animal. The remainder of this article describes an experiment comparing the performance of eight rats in detecting defused mines in test fields using both the rope and the pole systems. The purpose of the experiment, which simulates the International Mine Action Standards' testing procedures for accrediting mine-detection animals, is to demonstrate the viability of the pole system, to compare it to the rope system and to make both available to potential users.

A pouched rat works under the rope system.
ALL PHOTOS COURTESY OF APOPO

### Initial Training

Using procedures described elsewhere,[1,2] eight *Cricetomys* were initially trained in a laboratory setting to emit indicator responses when they detected 2,4,6-TNT. Correct indicator responses were reinforced (rewarded) by a sound from a handheld clicker followed immediately by a mouthful of banana. They were trained to emit indicator responses when they encountered mines containing TNT (PMN, PMR1, PMR2, No. 4, PMD-6, T-59, TM-57, M16, M14 and MK-5 types). Members of the Tanzanian military buried the mines just below the surface of the simulated minefield in 2001. Mines were not disturbed after being buried to avoid contaminating surrounding areas, and the amount of material covering each mine at the time of the present experiment varied, although very few mines were visually evident.

Rats were trained in the minefield using the rope system until, in a blind test, they successfully located each mine in a 100 sq m box with no more than two incorrect identifications (false alarms). The rats were approximately 7 to 9 months old when they attained this status. At that time, they were trained with the pole system for a number of weeks until they met the same performance criteria.

Once the rats had met the criteria for both the rope and pole systems, training alternated between the two on a daily basis. Occasional blind tests and tests in boxes with no mines were arranged to ensure that rats would continue responding for a substantial period without reinforcement. In operational situations, as in blind tests, the handler does not know the locations of mines and therefore cannot determine whether an indicator response is a hit or a false alarm, hence whether the response should be reinforced. Intermittent reinforcement—that is, rewarding some but not all correct responses—is effective in generating persistent responding without diminishing discriminative stimulus control. In APOPO's operational work, *Cricetomys* are exposed to simulated minefields, where it is possible to identify and reinforce hits, as well as to actual minefields, where reinforcement is not provided. They also are given the opportunity to identify a defused mine at the beginning of each day's work, and if they do so, their behavior is reinforced (and they are used operationally that day). This procedure works well and APOPO has not encountered difficulties with the rats failing to work or becoming inaccurate in the operational setting.

### Testing of Rats

Testing of rats occurred at APOPO's 28-ha simulated minefield, which is located in Morogoro, Tanzania. Tests were conducted from 7 to 9 a.m. on Tuesdays and Thursdays during October 2009. The weather was warm and dry throughout testing. Trainers worked with their regularly assigned rats during the tests. Tests were conducted in 64 100-sq-m boxes that had not been used for testing or training for at least two months prior to the current tests. The boundaries of individual boxes were defined by numbered metal stakes, which allowed for accurate identification of the

The pole system in operation during the experiment.

| | Pole | | | | Rope | | | |
|---|---|---|---|---|---|---|---|---|
| Rat | Hits | Misses | False Alarms | Time (Min) | Hits | Misses | False Alarms | Time (Min) |
| 1 | 4 | 0 | 0 | 76 | 4 | 0 | 0 | 47 |
| 2 | 4 | 0 | 0 | 59 | 5 | 0 | 0 | 41 |
| 3 | 4 | 0 | 0 | 62 | 4 | 0 | 0 | 50 |
| 4 | 4 | 0 | 0 | 73 | 4 | 0 | 0 | 52 |
| 5 | 4 | 0 | 0 | 52 | 4 | 1 | 1 | 48 |
| 6 | 4 | 0 | 0 | 65 | 4 | 0 | 0 | 57 |
| 7 | 5 | 0 | 0 | 55 | 4 | 0 | 0 | 43 |
| 8 | 4 | 1 | 1 | 88 | 4 | 0 | 0 | 54 |
| Mean: | 4.13 | 0.13 | 0.13 | 66.25 | 4.13 | 0.13 | 0.13 | 49 |

Table 1: Performance of rats.

rat's location at any point in time. Each box contained between zero and three mines. Vegetation was regularly hand-cleared from the boxes with machetes to a height of approximately 2.5–5 cm.

Each rat was tested in four boxes using the pole system and in four other boxes using the rope system. According to International Mine Action Standard 09.42,[3] which describes operational testing for mine-detection dogs and handlers and also is applied to rats, the animal and its handlers—who are blind to mine locations—must detect every mine in a test area of at least 400 sq m with two or fewer false alarms (defined as recognition responses located farther than 1 m from the nearest mine). IMAS requires there be five to seven test items in that size area. To approximate the density of test items required by IMAS 09.42, the four 100-sq-m boxes used with each rat contained a total of four or five mines and no individual box contained more than two mines. Boxes were selected at random with the provisions that the number and type of mines used for the two types of testing were approximately equal, and only boxes measuring 20 x 5 m were used for pole tests. Not enough boxes were available to allow only 20 x 5 m ones to be used for all tests and a mix of 10 x 10 m and 20 x 5 m boxes were used with the rope system. Each box was used only once in these tests.

Four randomly selected rats were initially tested with the pole system. During this testing, a rat's usual trainer carried the animal to its first selected test box, attached its harness and fastened the harness to a nylon cord affixed by a swivel to the end of a 2.5-m telescoping fiberglass pole. The trainer then took the animal to the right rear of the box and used the pole to direct it across the field. A stopwatch was activated as soon as this activity began. By slowly sweeping the pole from side to side and gradually extending it, then moving forward and repeating the process, the handler led the rat across the right half of the box. When the rat reached end of the box, the trainer crossed to the other side and slowly returned to the left front corner, again directing the rat to cover the entire left half of the box. When the rat had done so, the stopwatch was deactivated and the total elapsed search time was recorded on a data sheet.

Throughout the test session, an observer constantly watched the rat and trainer and recorded on a gridded data sheet any location where, as noted by the trainer, the rat emitted an indicator response (paused and scratched the ground for five consecutive seconds, indicating the presence of a mine). Indicating the presence of a mine had no consequences for the rat, and trainers and observers were not aware of where mines were located. After testing was completed at one box, the trainer removed his rat from the pole and took it to a second box, where testing was conducted as just described. At the end of the second test, the rat was fed and watered in a carrying container, then returned by truck to its home cage in the colony area.

On days immediately prior to pole tests, rats were exposed to training sessions that were identical to the test sessions, save that trainers knew the location of mines and sounded a clicker followed immediately by the presentation of a bit of banana whenever the rat correctly identified a mine. Such training was arranged in two separate boxes for each rat. Training days for the rope system followed the majority of pole training procedures.

The other four rats were initially tested with the rope system. Here, two trainers worked with each rat. They brought the animal to the designated field, attached its harness and connected the harness to a nylon cord joined to a swivel through which a nylon rope passed. This arrangement allowed the swivel (and thus the cord and rat) to move along the length of the rope, which had loops at each end and was slightly longer than the width of the box (approximately 5.5 or 10.5 m). A trainer located at the right front of the box placed one foot through one of the loops at calf level and the other trainer, who stood at the left front of the box, did the same with the other loop. They stepped apart sufficiently to tighten the rope with the rat placed at the right front corner of the box. The trainers held thin cords attached to the harness rope by hand. By gently pulling on one cord and feeding out the other, the trainer could, if necessary, direct the rat to move along the rope. Pulling was rarely necessary, however, because trained animals independently move from side to side along the rope. Once the rat traversed the length of the rope, both trainers took a sideways step (approximately 0.5 m) and the process was repeated. Such activity continued until the rat reached the left rear corner of the box, at which time it had covered the entire area. As with pole tests, the trainers recorded the time required to complete testing and the location of any indicated mine, did not know the location of mines, and ensured that indicating the presence of a mine had no consequences for the rat. Two rope tests were conducted on each of two days for every animal.

After a rat finished four boxes under its initial testing condition, it was given a training session with the other procedure (rope training for rats initially tested with the pole and *vice versa*), and then was tested with the other procedure. Conditions of these tests were as just described.

### Results and Discussion

The performance of individual rats is shown in Table 1 (above). Six of the eight located all the landmines in each box under both testing conditions with no false alarms. Each of the other two rats located seven of eight mines. Rat 5 missed a mine when the rope system was used and Rat 8 missed a mine with the pole system in place. Each of these rats also had a false alarm under these conditions.

The performance of six of the rats under both conditions met IMAS standards for accreditation as described earlier. The performance of the other two rats met IMAS standards under one condition but not the other. Overall, the rats located 31 of 33 mines (94%) under each condition with a single false alarm, which is a very good detection rate.

It is important to emphasize, however, that this assessment occurred under experimental—not operational—conditions, and the data set is not large. APOPO is moving toward having rats handled with the pole system approved as mine-action animals in Mozambique and expects to seek approval later in 2010. Once this occurs, the operational settings in which the pole system is especially useful, and the rats' performance in such settings, will be determined.

As confirmed by APOPO's practical experience in Mozambique, the rats have some significant general advantages relative to dogs for demining applications. They are easy and inexpensive to procure and they are small (1–1.5 kg), which allows them to be housed humanely in small cages and makes it highly unlikely that they will activate a mine or ERW (which has never occurred during the rats' demining in Mozambique). Their food requirements are modest and can, if necessary, be obtained locally at little expense. Their health is robust and they are not bothered by the parasites and fungal infections that beset dogs. Unlike many dogs, *Cricetomys* do not bond with individual handlers and will perform equally well for anyone who knows how to use them. This trait is especially important, because human deminers do challenging work, often in hot and otherwise difficult conditions; hence, staff turnover can be high. Finally, the rats mature quickly, and training can begin when they are young and be completed relatively early in their life, which can span up to eight years in captivity.

Being able to use both the pole and rope systems increases the rats' versatility, not unlike the option of using short- and long-lead systems increases the versatility of mine-detection dogs. The controlled test described here, like APOPO's operational observations in Mozambique, confirms that both systems work well. Not surprisingly, the time required to search 400 sq m in this test was greater with the pole system. On average, 66 minutes was required to search this area with the pole system, whereas the mean search time with the rope system was 49 minutes. Because the rope system requires two trainers and the pole system only one, on average 48% less personnel time was required to demine 400 sq m with the pole system. Whether the pole system actually saves time in an operational setting remains to be determined, but be that as it may, the availability of that system increases the utility of *Cricetomys* as mine-detection animals.

*See Endnotes, Page 83*

**Alan Poling** has a Ph.D. in psychology and is a Professor at Western Michigan University. He is an experienced researcher with articles in 40 different journals and more than 250 publications. Poling has particular expertise in within-subject research designs and behavior analysis. He recently joined APOPO to further its scientific activities.

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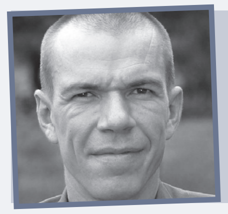

**Bart Weetjens** is a Product Development Engineer. He initiated the idea to train rats as an appropriate technology to detect landmines and to screen for tuberculosis. Weetjens founded APOPO with support from Professor Mic Billet and his colleagues at Antwerp University and has since been elected both an Ashoka Fellow and a Schwab Fellow. He is a practicing Zen Buddhist monk.

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