Rats to the Rescue:

Results of the First Tests on a Real Minefield

The study in this article showed that using rats to evaluate mine risk is a very promising mine-detection method. When three rats were used to evaluate a contaminated area, the success rate was 95 percent, showing that rats can be a speedy and cost-effective means of mine detection.

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After an acclimatisation and training period, *Cricetomys* rats started to evaluate five demarcated boxes in Limpopo, Mozambique. The boxes, 5 metres by 20 metres (5 by 22 yards), were constructed by Menschen gegen Minen (MgM—German for "People Against Landmines") in a strategic minefield along the Limpopo Railway. Vegetation in the area can be characterised as low, relatively dense bush with scattered trees of 5 to 12 metres (6 to 13 yards) high.

MgM staff separated the five boxes with safe lanes that were prepared with a bush-cutter; those safe lanes were manually demined. High vegetation within the boxes was removed as much as possible but was still dense in some parts.

Methods

Weather during the test period was variable with rain on the first day (13 Nov. 2003) and sun during the other days (14–18 Nov. 2003).

Each box was evaluated by three rats according to the method as described in "Preliminary Results on the Use of *Cricetomys* Rats as Indicators of Buried Explosives in Field Conditions."[1] Testing was done early in the morning (between 5 and 8 a.m.). After that, temperatures became too high for the rats to operate. Within each box, rats walked parallel lanes 0.5 metre (2 feet) wide and all relevant behaviour was recorded on a test sheet.

The five boxes had a total area of 427.5 square metres (511 square yards) and were divided in subunits of 0.5 square metre (5 square feet). We used letters to distinguish between strong marking behaviour ("S" for scratching the soil or "B" for biting the soil for a long time) and weak indications ("s" for a short scratch or "b" for a short bite) of the rats. Using these recorded indications, a risk value was calculated for each subunit ranging from 0 (i.e., no indications in that and surrounding subunits by the three different rats) up to 6 (i.e., all rats indicated that particular subunit). "S" and "B" indications were scored as 2 while "s" and "b" indications were given a score of 1. An example of how values were calculated for each subunit is given in Figure 1. The risk value of the central subunit is equal to the score of the central subunit divided by two plus the scores of the surrounding subunits divided by 16.

Using this method, each subunit had a risk score and they were divided into the five classes shown in Table 1.

Figure 1: Example of how the risk value for the central subunit is calculated.

SsS		
	Bb	S

5	0	0
0	3	2
0	0	0

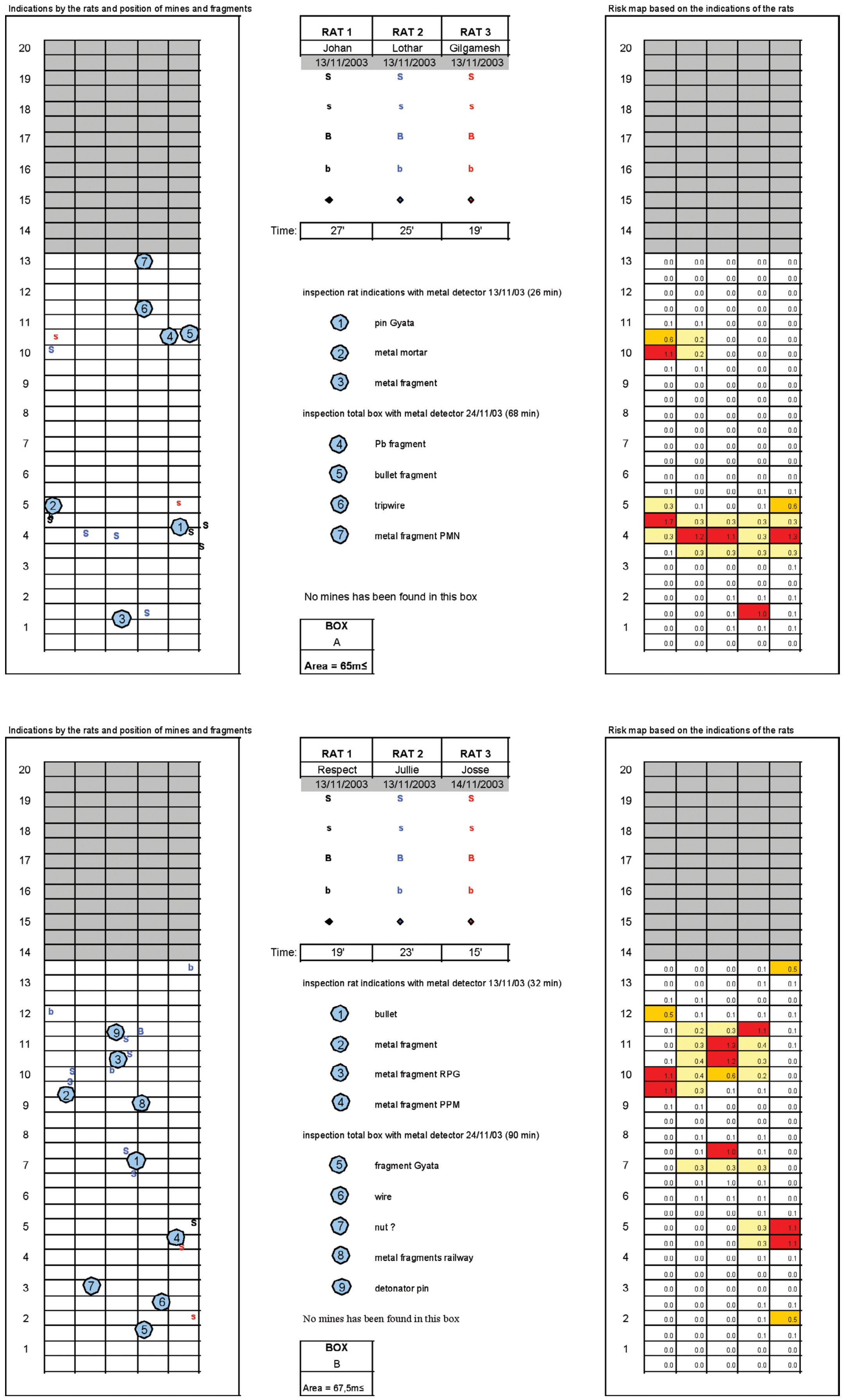
	1.9	

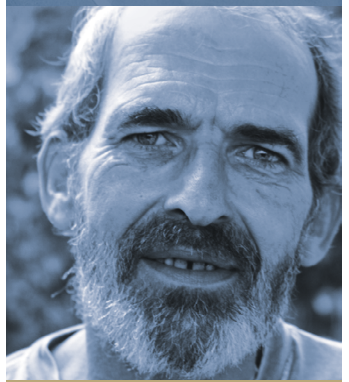
Table 1: Five classes of risk scores.

1 - Score Subunit = 0	no risk
2 - Score Subunit = < 0.1	no risk, indications (s or b) close to this subunit
3 - Score Subunit = 0.1–0.5	indications within this subunit or close by (s or b)
4 - Score Subunit = 0.5–1.0	indications within this subunit or close by (S or B)
5 - Score Subunit = >1.0	strong indications by one or more rats within subunit

Trainer treats his rat with a banana, following an indication of a buried mine.

Figure 2: Box A, Box B, Box C, Box D, Box E.. Grids showing rat indications for each test box and risk maps based on these indications.





Prof. Ron Verhagen, APOPO's deputy director and chief scientist, analyses and interprets the animals' performance in relation to environmental and other influences. Ron is a biologist and leading expert in rodent biology. He is a professor at the department of biology of the University of Antwerp (Belgium).

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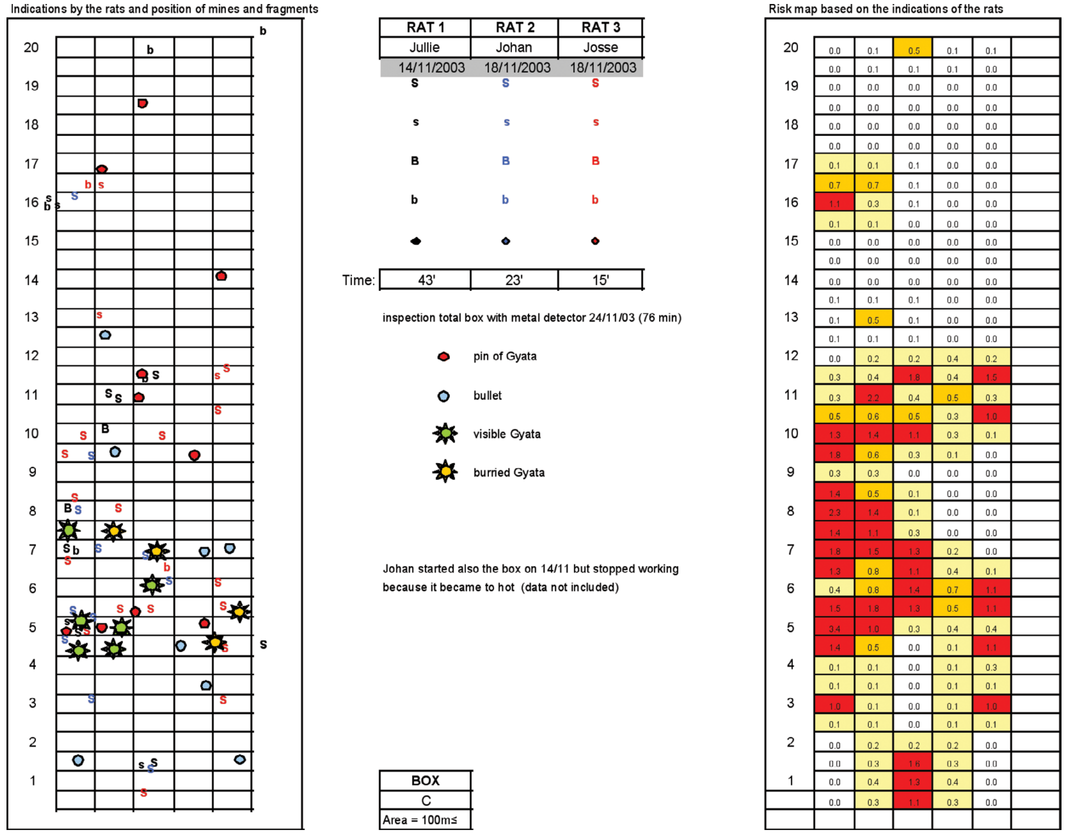

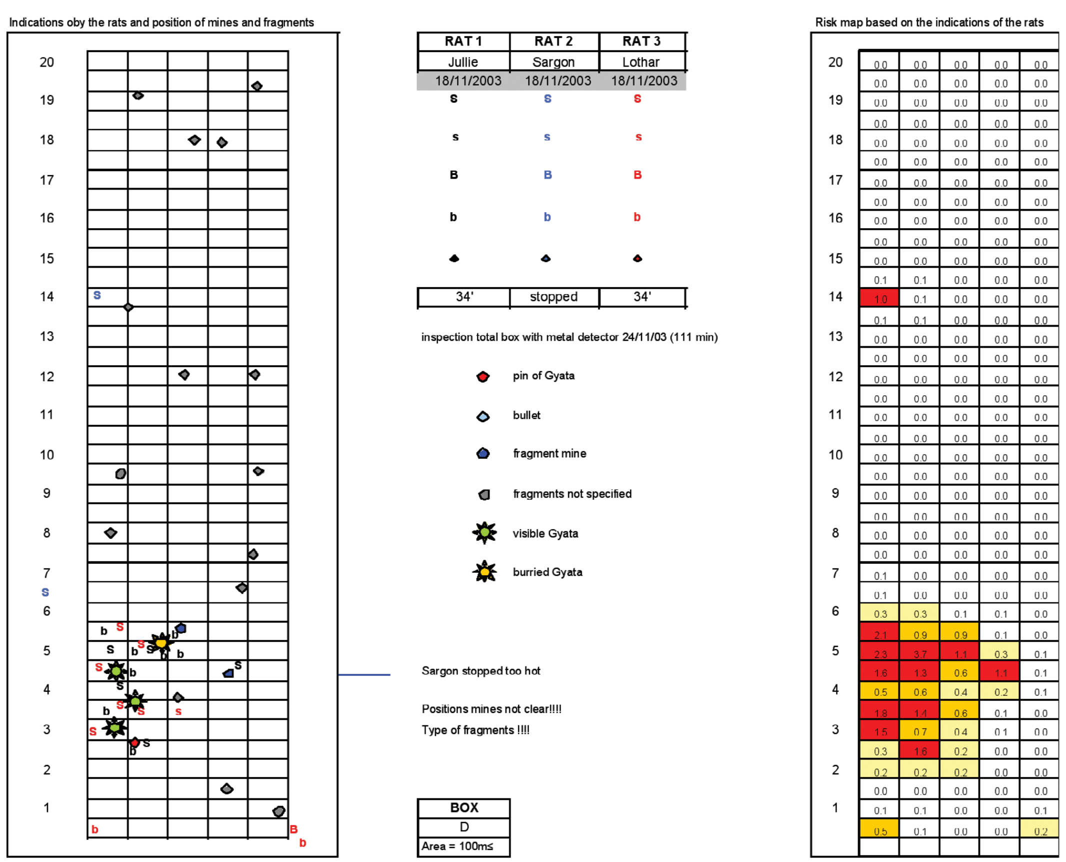

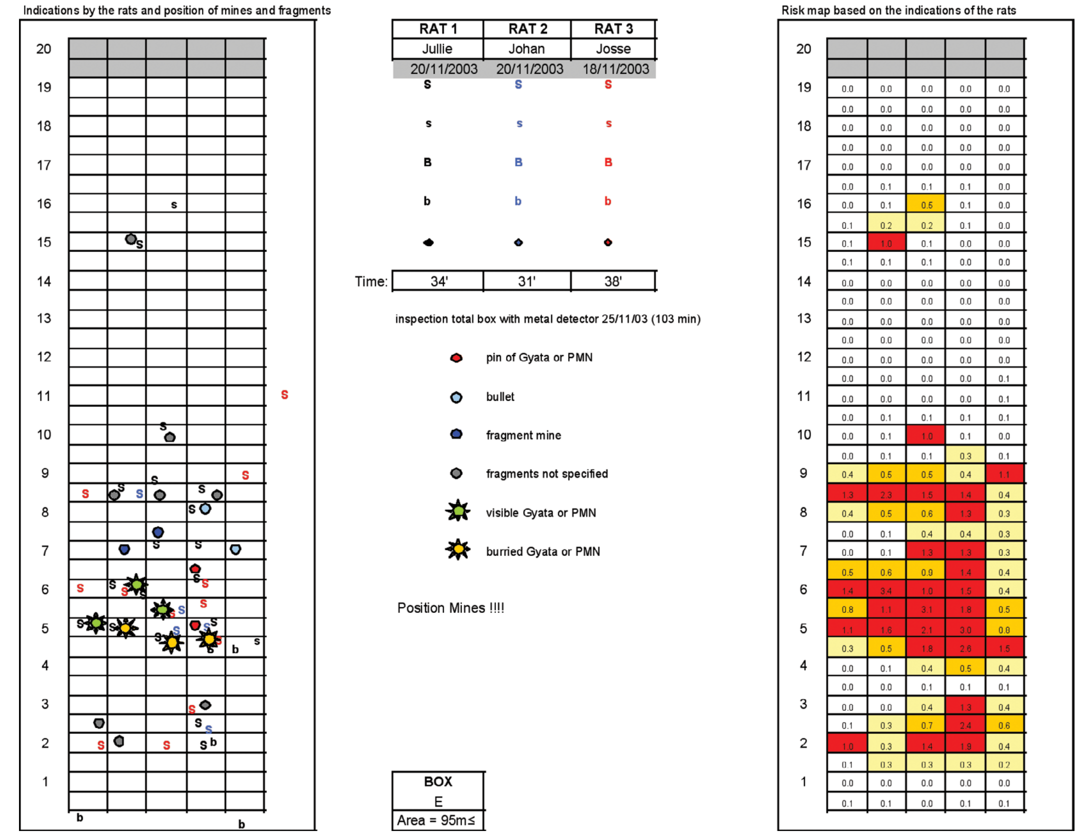

According to this ranking, subunits were given different colours and maps were constructed for each box (results of each box are given in Figure 2). After the rats tested the boxes, each box was inspected and cleared by an MgM deminer using a metal detector and manual prodding. All objects found by the deminer (mines, bullets, fragments, etc.) were mapped in the same way as shown in Figure 2.

Results

Table 2 summarizes the results of the evaluation by the rats done on the five boxes in comparison with what was found by the manual deminer. All mines present in the boxes were indicated by the rats and were located in the subunits that were categorized as risk class 4 (one mine) and 5 (19 mines). Of the 20 mines present, 12 were visible due to erosion of the soil. Although clearly visible, the rats did not indicate the mines directly, but rather detected them all within a distance of 1 metre (3 feet). When the rats found a covered mine, they marked the exact spot by scratching directly over the mine.

In total, seven rats were used to evaluate the five boxes. Three were experienced rats (Johan, Jullie and Josse), and the others were young trained rats (Gilgamesh, Lothar, Respect and Sargon). At least two experienced rats tested each box. Table 3 gives the success scores and number of false positive indications of the individual rats. Indications within 1.25 metres (4 feet) of bullets, mine fragments or detonator pins were not considered as false positives as it is not clear for the moment if these particles were really indicated because of explosive residue on them (they will be tested to determine this). As can be seen from Table 2, there is an obvious marking behaviour by the rats for those items. Of the 70 metal objects found by the deminer, 39 were indicated by the rats (56 percent). Nearly all detonator pins

Table 2: Summary of the test results of *Cricetomys* rats evaluating five boxes on a real minefield in Limpopo, Mozambique.

	Box A	Box B	Box C	Box D	Box E	Total	%	Mines	% subunits with mines	Objects	% subunits with objects
Mines	0	0	10	4	6	20					
Fragments	7	9	19	18	13	66					
Risk class	Number of subunits in each risk class										
1	90	74	80	148	84	476	55.7	0	0	22	4.6
2	19	35	17	20	35	126	14.7	0	0	8	6.3
3	14	14	54	12	26	120	14.0	0	0	13	10.8
4	**2**	**4**	**16**	**8**	**15**	**45**	**5.3**	**1**	**2.2**	**6**	**13.3**
5	**5**	**8**	**33**	**12**	**30**	**88**	**10.3**	**19**	**21.5**	**21**	**23.9**
Total	130	135	200	200	190	855	100.0	20			

From the Belgian office, APOPO's chairman, Professor Mic Billet, handles logistic, financial, administrative and legal matters. Mic is sociologist and communication expert, and has been a driving force of the project since its earliest stage.

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Table 3: Success scores and number of false positive indications of the rats in the five test boxes.

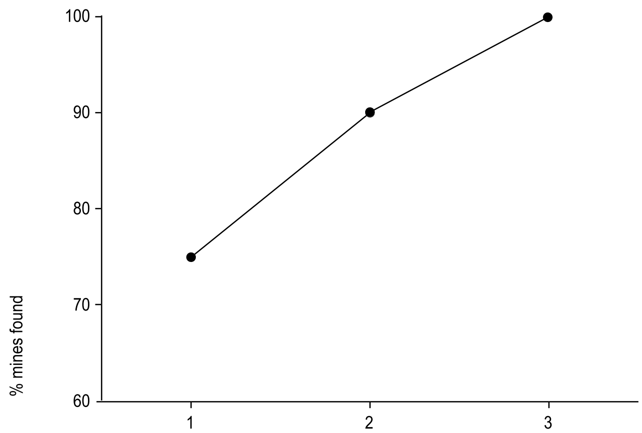
	Boxes tested (area)	Success score	False positives S+B/100m²	False positives S+B+s+b/ 100m²
Johan	A – C – E (265sq m)	9/16 = 56.3%	0.75%	0.75%
Jullie	B – C – D – E (362.5sq m)	15/20 = 75.0%	0.28%	3.00%
Josse	B – C – E (262.5sq m)	10/16 = 62.5%	1.14%	1.53%
Gilgamesh	A (65sq m)	No mines	0.00%	1.54%
Lothar	A – D (165sq m)	4/4 = 100%	2.42%	3.64%
Respect	B (67.5sq m)	No mines	0.00%	0.00%
Sargon	D (100sq m)	0/4 = 0.0%	1.00%	1.00%

were indicated by the rats (87 percent), while other items scored less frequently (fragments = 53 percent, bullets = 33 percent).

With the exception of Sargon, all rats scored relatively well (mean = 63.3 percent) with very few false positive indications (mean < 0.8 indications per 100 square metres [120 square yards] for the major markings S+B and 1.6 for all markings S+B+s+b). It should be noted that many of the false positive indications given by different rats were clustered, which might indicate an explosives-contaminated spot.

Although the individual success score might seem low, the overall score on the C, D and E boxes (those containing mines) was 100 percent after three rats evaluated a box (see Figure 5).

Figure 5: Mean success score of the sequence of three rats that tested the five boxes.



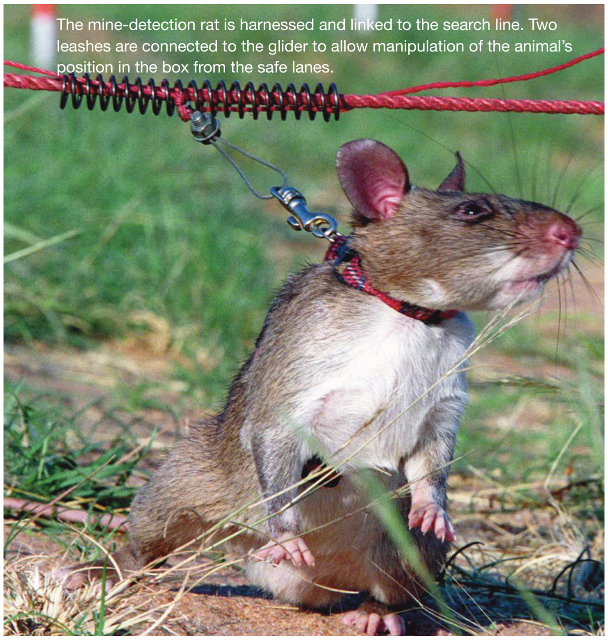
The mean time for a rat to inspect a box was 32 minutes/100 square metres (120 square yards), so when a box was inspected by three rats, this was done in 96 minutes. When we include handling and exchanging animals, the total average time to evaluate one 100-square-metre box (120 square yards) was about 116 minutes.

Conclusions

The test area was a very dense minefield with 20 mines within an area of less than 30 square metres (36 square yards). Besides the mines, the area was highly contaminated with all kinds of war materials (bullets, detonator pins, mine fragments, etc.), which were also often indicated by the animals, especially the detonator pins. After three rats evaluated a box, all mines present in that box were scored.

The construction of risk maps based on the indications of the animals seems to be a very useful tool as 95 percent of the mines were found in the highest calculated risk area and the other mine in the second highest risk area. Using this method, more than 80 percent of the total area evaluated by the rats could be declared free of mines.

See "References and Endnotes," page 108



The mine-detection rat is harnessed and linked to the search line. Two leashes are connected to the glider to allow manipulation of the animal's position in the box from the safe lanes.

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[from page 100]

Endnotes

1. Verhagen R, Cox C., Machang'u R., Weetjens B. & M. Billet. 2003. "Preliminary Results on the Use of *Cricetomys* Rats as Indicators of Buried Explosives in Field Conditions." In: *Mine Detection Dogs: Training Operations and Odour Detection*. Geneva International Centre for Humanitarian Demining. Geneva (ISBN 2-88487-005-5). pp. 175–193.
2. The Tuberculosis Project is a study hoping to change the way Tuberculosis is diagnosed using the exceptional sniffing abilities of rats. For more information, please see http://news.bbc.co.uk/1/hi/health/3486559.stm. Accessed 11 Nov. 2005.