

Correspondences

African elephants run from the sound of disturbed bees

Lucy E. King^{1,2}, Iain Douglas-Hamilton² and Fritz Vollrath^{1,2}

Encroaching human development into former wildlife areas [1] is compressing African elephants into ever smaller home ranges, causing increased levels of human–elephant conflict [2]. African honeybees have been proposed as a possible deterrent to elephants [3]. We have performed a sound playback experiment to study this hypothesis. We found that a significant majority of elephants, in a sample of 18 well-known families and subgroups of varying sizes, reacted negatively — immediately walking or running away — when they heard the buzz of disturbed bees, while they ignored the control sound of natural white-noise. Whether the observed response was the result of individual conditioning or of learning by social facilitation remains to be established. Our study strongly supports the hypothesis that bees — and perhaps even their buzz alone — may be deployed to keep elephants at bay.

Two of us [3] have reported previously that the elephant damage to acacia trees was significantly less than usual when the trees hosted either occupied or empty beehives. In Zimbabwe, elephants were observed forging new trails into experimental fields of crops to avoid beehives [4]. These observations suggest that African elephants are wary around bees and hives and will avoid them, presumably to prevent being stung on sensitive areas like the eyes, behind the ears and inside the trunk [3].

In our behavioural study, we used a playback method to understand how elephants might react to a disturbed live beehive. We presented playbacks of recordings of bee buzzing sounds in order to test the hypothesis that elephants

‘know about’ the danger of bees and respond to their sound by increased alertness and possibly even running away.

The sounds of disturbed wild African bees (*Apis mellifera scutellata*) were recorded uncompressed onto a Sony MZ-RH1 Hi-Mini Disc with a Steinheisser directional microphone. Using phonetic PRAAT software [5] we extracted and multiplied 30 seconds of sound to create a 4 minute constant bee recording (dB 66.1). Natural white noise extracted from a waterfall recording served as a control (dB 65.4). Both sounds were played back to elephant families resting under trees (11am–2.30pm) through an AQ 863 MHz wireless speaker that was camouflaged inside a fake ‘tree trunk’ constructed from dry reeds and a plastic rack. This was placed within 10 metres (± 2 m) of the closest elephant. Both sounds were played back loudly at twice the recorded volume (+3 dB) to compensate for speaker distance. The elephants’ response was filmed from a distance and at an angle of 45° to the speaker before, during and following playback of the 4 minute sounds.

The study site was the Samburu/ Buffalo Springs National Reserves in Kenya. During February to April 2007, 18 well-known family groups of approximately 8 elephants per group ($x = 8.8 \pm s.d.4.2$; $n = 284$ individuals) were identified before either sound was played. After a

minimum of 7 days [6] we relocated 9 families to which both sounds were played controlling for order effect, environmental variations and family composition.

Of the 17 families, 16 (94%) left the tree under which they had been resting within 80 seconds of bee sound onset (see Table 1 in the Supplemental Data available on-line with this issue). Of these 16 families, 8 responded after only 10 seconds of sound onset. This latency of response differs from the 15 families hearing the control sound where no elephants had moved after 10 seconds and only 4 (27%) had moved after 80 seconds of sound onset (Figure 1). By the end of the 4-minute sound playback of bee buzz only one elephant family (5.9%) had failed to move compared to 8 families (53.3%) hearing the control (significant χ^2 df 3, $P = 0.041$).

Of the 9 elephant families to which both sounds were played, the elephants’ latency of response was significantly faster to bee sounds than to control sounds (Wilcoxon Matched-pairs test, $n = 9$, $P = 0.004$; using 360 seconds as data for ‘no movers’). Within these 9 families there was no significant difference between the latency of response to sounds played first or second for either bee buzz or control, suggesting the experimental design was not affected by an order effect (Mann-Whitney U test: bee sounds $n = 5(1^{st}), 4(2^{nd})$; $P = 0.127$; Control sounds: $n = 4(1^{st}), 5(2^{nd})$; $P = 0.571$).

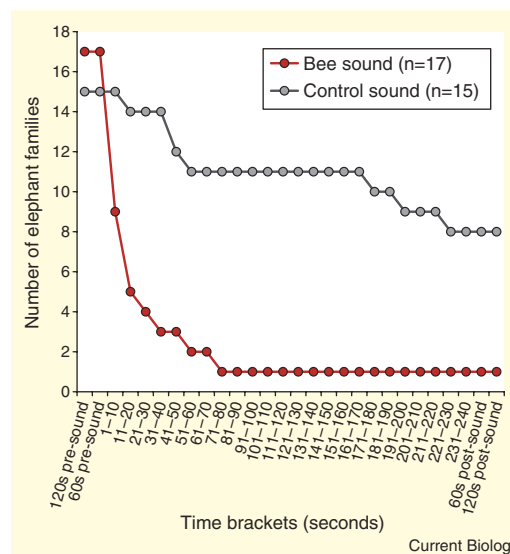


Figure 1. Number of elephant families remaining stationary in response to sound within time groupings of 10 seconds. Within 20 seconds, 70% of the herds listening to bee sounds had moved away compared to 7% in the control herds. Within 80 seconds, 94% of families had moved away from resting positions in response to bees compared to 27% of families in response to the control sound.



Figure 2. The Spice Girls family's reaction at the onset of playing bee buzz.

On hearing bee sounds, elephants demonstrated a variety of alarm behaviours [8] that appeared to ripple through the family. This included ceasing of any activity — feeding, sleeping, playing — raising of the head, ears out, slow turning of the head from side to side, headshaking and smelling with trunks both up and down towards the direction of the sound. Bunched retreat behaviour was usually led by one adult with tails in the air and backward glances towards the sound. In a typical flight run young calves were seen running directly next to their mothers with tails up, ears out and flicking their trunk from side to side. In this trial, the family took 18 seconds between onset of the sound and the start of a group retreat lead by the matriarch, Rosemary (collared individual to right of photo).

Figure 2 illustrates the group reaction to the onset of bee sounds (also see the Supplemental movie). For mode of retreat, 41.2% of families responding to bees 'ran' away, 29.4% 'walked fast' away and 23.5% 'walked' away. No 'running' or 'walking fast' behaviour was observed for the control groups, which showed 46.7% of families 'walked' away and 53.3% 'did not move'.

We observed a significant negative correlation between the latency of response and the distance moved (Spearman's rank = -0.668 , $df\ 30$, $P < 0.001$). The mean distance moved was significantly related to the sound that was played, with those families responding to bee sounds moving significantly further than those responding to natural white noise (bee: $64.2\ m \pm s.d.\ 43.3$; control: $19.7\ m \pm s.d.\ 26.1$, Mann-Whitney U, $U = 50$, $P = 0.002$). Variations in air pressure, temperature, time of day, altitude, number of elephants or number of sub-adult elephants in the responding families were not significantly correlated to the latency of response.

Our study demonstrates that elephants respond to the buzz of disturbed and aggressive bees with alarm by moving away from the sound source. The evidence suggests that elephants are aware of bees, they retain a memory about bees and they can identify bees by sound alone. Their response suggests that they remember or associate the sound of bees with a negative historical event, be it individual or collective, to which the correct response was rapid retreat. This flight informs, or alarms, the others. Conditioning to the buzz may have been learnt either directly by being stung, through observation of another elephant being stung or by social learning during a family retreat caused by disturbed bees. If social learning about a perceived threat results in such specific individual and group responses, this highlights the importance of elephant social structure in young family members' learning experiences.

One subgroup of the Virtues family did not respond to the bee sound. It was unusually small and consisted of a young bull (20 yrs),

a young female (14 yrs) and her calf. This lack of any response suggests that these 3 individuals may not have experienced (or did not remember) any direct or indirect negative interaction with bees. However, the absence in this group of an experienced matriarch [7] to provide the relevant cue (alarm) may have contributed to the atypical behaviour not observed in all 16 other groups ($n = 157$ elephants).

How well our observations — that whole family groups of elephants retreat together from the buzz of aggressive bees — can be turned to a profitable deterrent (through the protection of crops as well as the sale of honey) is now the topic of further investigations using both powerful loudspeakers and live beehives.

Supplemental data

Supplemental data including a movie clip are available at <http://www.current-biology.com/cgi/content/full/17/19/R832/DC1>

Acknowledgements

We thank the Office of the President of the Republic of Kenya, Kenya Wildlife Service, Samburu and Isiolo County Councils for permission to conduct this research and Lukas Lepuyipui for field assistance. Funding was by ESRC/NERC, The Wingate Foundation and Save the Elephants.

References

1. Douglas-Hamilton, I., Krink, T., and Vollrath, F. (2005). Movement and corridors of African Elephants in relation to protected areas. *Naturwiss.* 92, 158–163.
2. Hoare, R.E. (2000). African elephants and humans in conflict: the outlook for coexistence. *Oryx* 34, 34–38.
3. Vollrath F., and Douglas-Hamilton I. (2002). African bees to control African elephants. *Naturwiss.* 89, 508–511.
4. Karidozo, M., and Osborn, F.V. (2005). Can bees deter elephants from raiding crops? An experiment in communal lands of Zimbabwe. *Pachyderm* No. 39.
5. PRAAT vr. 4.5.01, (2006). DSP package, P Boersma & D. Weenink, University of Amsterdam, The Netherlands.
6. Kangwana, K. (Ed.) (1996) Studying Elephants. AWF technical handbook No.7. African Wildlife Foundation, Nairobi.
7. McComb, K., Moss, C., Durant, M., Baker, L., and Sayialel, S. (2001). Matriarch as repositories of social knowledge in African elephants. *Science* 292, 491–494.
8. Langbauer, W.R., Jr, (2000). Elephant communication. *Zoo. Biol.* 19, 425–445.

¹Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK. ²Save the Elephants, P.O. Box 54667, Nairobi 00200, Kenya. E-mail: lucy.king@zoo.ox.ac.uk