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SHORT COMMUNICATION

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African bees to control African elephants

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Abstract Numbers of elephants have declined in Africa and Asia over the past 30 years while numbers of humans have increased, both substantially. Friction between these two keystone species is reaching levels which are worryingly high from an ecological as well as a political viewpoint. Ways and means must be found to keep the two apart, at least in areas sensitive to each species' survival. The aggressive African bee might be one such method. Here we demonstrate that African bees deter elephants from damaging the vegetation and trees which house their hives. We argue that bees can be employed profitably to protect not only selected trees, but also selected areas, from elephant damage.

Introduction

Locally, with adequate protection, populations of elephants can increase steadily at 3–5% per year. Often the restriction of elephants to local "safe havens" causes an even more rapid build up (Dublin et al. 1997; Douglas-Hamilton 1987; Whitehouse and Hall-Martin 2000). While healthy protected elephant populations are desirable, increases can put greater strains on the interactions of elephants with vegetation and human beings (Douglas-Hamilton 1987; Hoare and du Toit 1999; Whyte et al. 1999). The average adult elephant consumes around 110 t of forage annually, with a small (but increasing and politically highly significant) amount raided from the fields of farmers. Clearly, although elephants are ecologically important as landscape 'gardeners' and pillars of the tourist industry (Western and van Praet 1973), they also conflict with people, especially with smallholders. This conflict needs to be diminished if elephants are to retain adequate range and political support for their existence. Thus selective non-lethal methods are needed to steer elephants away from fields, smallholdings and natural vegetation of ecological and aesthetic value. Shooting 'problem' animals, as often done, is deeply disturbing to other animals, generally has a delayed response, and is also frequently dangerous by fostering antagonism to humans in the survivors. Ideally, ways should be found which are efficient as well as effective, i.e. which are immediate, cheap in capital outlay, self-supporting once set-up, and strongly reinforcing in the raiders (actual and would-be) – sending the message of a considerable local danger without actually being life threatening.

It appears that the African bee (*Apis mellifera africana*) might be an answer to the problem. Although thick-skinned, African elephants (*Loxodonta africana*) have their weak spots (Fig. 1). For example, their skin is surprisingly thin on the belly where it is easily penetrated by small ecto-parasites such as ticks (Sikes 1969) or behind the ears and under the trunk where the blood flows close to the surface (Benedict et al. 1921) and where the elephant-lice feed (Braack 1984). In addition, inner trunk membranes (Jacobson et al. 1986) and eyes (see below) are extremely sensitive areas where even a few bee stings can have a serious effect. For example, a mature, tame bull on the Ol'Jogi ranch in Kenya was quickly and totally blinded during an encounter with an aroused swarm of bees; the swelling subsided and his eyes opened only after 24 h and substantial injections of anti-histamine (Dan Subaitis, personal communication).

Clearly, honey-bees can and will sting elephants with considerable effect. Moreover, the African honey-bee is also notoriously aggressive especially near its hive where it is easily aroused to swarm in large numbers, drawing in more recruits as attackers release their pheromones (Wilson 1971). Eyewitness accounts of such one-sided interactions were given to F.V. during ten separate and

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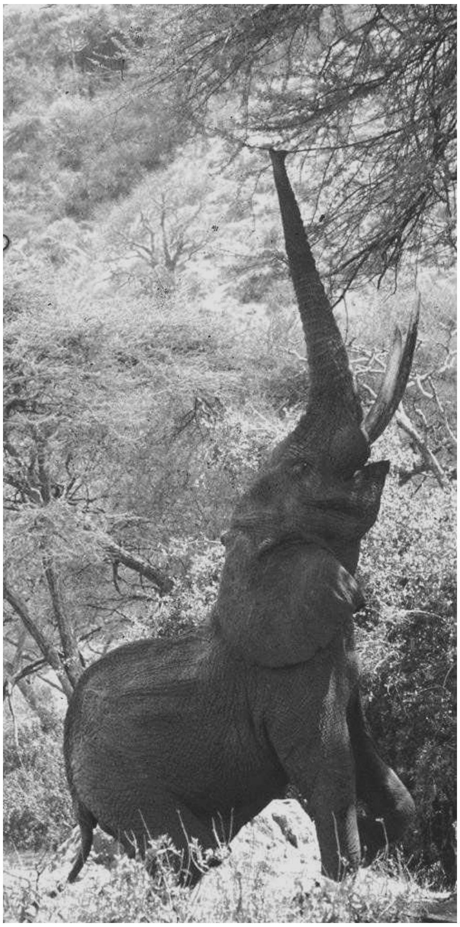

Fig. 1 African elephant reaching up to pull down a branch of an *Acacia tortilis* tree

controlled interviews of Lewaso Maasai bee-keepers and honey-hunters, which reported elephants being chased by bees over long distances (3–5 km) after an encounter with a hive or a swarm. So far, we have no record of bees actually killing an elephant, although this has been observed (Foran 1958) for a Cape buffalo (*Syncerus caffer*). However, it appears from the interviews that bees are effective in putting a whole elephant herd to flight. Consequently we asked whether bees could be used to guard a specific area or location against elephant 'depredation' and here we set out to test this idea in a first experiment.

Methods

To test the hypothesis that bees can deter elephants from selected vegetation we used native log beehives to 'mine' an area of fever tree (*Acacia xanthophloea*) regrowth on Mpala Ranch in the Laikipia Plateau, Kenya. Our two 1-acre plots along a permanent river were favourite elephant foraging spots where all trees without exception were regularly 'attacked'. At the height of the dry season (mid-February 2002) we hung 30 unoccupied (but seasoned, i.e. smoked and honey primed) hives and six occupied hives at 1.5–2 m height in trees in the 3–5 m size range. In our locality the 2-metre plus range is the favourite height for 'eye level' elephant browsing, as indicated by the extent of damage.

The hives we used in this experiment were of the traditional Masaai (N'dorobo) log-type, consisting of a metre-long hollow *Euphorbia* spp. stem of approximately 20–30 cm diameter coated with a centimetre-thick cow-dung *cum* earth layer for insulation and cover. These hives are surprisingly light as well as strong although the coating will split or peel off when the hive is agitated sufficiently. The hives are hung in the shade from a strong branch by two wires and swing lightly in the breeze. They are occupied by wild swarms and in the right season they fill up rapidly with brood and honey (Mann 1991). A hive swarm with a large brood is particularly aggressive and will attack at the slightest provocation (such as moving or shaking). The local Masaai are expert bee-keepers who make a living from honey, and they regularly tend to their hives without specialist equipment or accidents.

The transition of dry to wet season in mid-March is a time of maximum browsing by elephants taking advantage of the flowing sap, and the trees we chose were (judging from old damage) in the preferred size range. The 36 experimental trees were spaced on average 19 (±5.4) m apart from their paired control trees, and pairs were always of a similar stature. During the 40-day experiment, all trees were checked three times weekly; and any fresh damage to trees with or without hives (occupied or not) was noted. Damage done by elephants is readily distinguishable as such. We classified damage from absent to strong in a 6-scale ranking with '1' showing a very slight nibble at the tip of one or two branches (as if in passing) to '6' having major branches within reach broken and stripped of all bark (indicating concentrated feeding) and typically such trees having lost over 50% of their live biomass.

Results

Less than 10% of the control trees without hives were left undamaged by elephants. In contrast, of the experimental trees with hives only one-third were left undamaged. Thus the 36 trees without hives experienced elephant damage ranging from serious (two trees) through strong (seven trees) to moderate (24 trees), with only three trees (8%) being left undamaged. At the same time among the 36 trees with hives, 12 trees (33%) were left undamaged while the remaining trees experienced some damage (Table 1). This difference between the two treatments is significant (Fisher's exact probability, two-tailed, $P<0.02$; Table 2) indicating that hives – even empty ones – provide some protection.

Note that of these 36 hives, six contained bees while 30 had none (Table 2). While empty hives without bees provided limited protection to their tree (24 of 30 trees attracted some damage), a hive full of bees always provided full protection to its tree. Thus occupied hives gave significantly higher protection than empty hives

Table 1 Effect of presence or absence of hives on degree of damage to tree

Tree damage	None	Some	Substantial	Serious	Total
Hives absent	3	24	7	2	36
Hives present	12	23	1	0	36

Table 2 Effect of hive occupancy on damage to tree

Damage to tree	No	Yes	Total
Tree without hives	3	33	36
Tree with hives	12	24	36
Hives empty	6	24	30
Hives full	6	0	6

(Fisher's exact probability, two-tailed, $P<0.001$; Table 2), indeed, not one of the six trees which carried an occupied hive was in any way touched nor was the surrounding vegetation eaten.

However, judging from the relatively low level of damage when compared with the control trees without hives (Table 1), even an empty hive provided some protection to its immediate surroundings. Only one of the 24 trees with an empty hive sustained serious damage. However, in this case a branch next to the hive had apparently whip-lashed when being pulled away and swinging back broke the empty hive in half; anyone with relevant experience can imagine the ensuing scene had the hive been occupied.

However, none of the other unoccupied hives were harmed in any discernible way, which strongly suggests that the elephants generally sensed and avoided the hives themselves and their immediate neighbourhood although they may have nibbled distant branches on the same tree.

Discussion

Smell is crucial for elephant social and foraging decisions (Marschner 1970; McComb et al. 2000) and we assume that smell deters elephants from harming a hive (live or not) and from feeding in its immediate surroundings. However, elephants also have excellent hearing (Payne 1998) and sound might very well be another factor in hive avoidance, as occupied hives emit a busy hum.

Since elephants react well to sound experiments (Poole 1999), we decided on a simple pilot 'play-back' experiment (so far unpublished but of some relevance to this discussion). Playing 'angry-bee-humming' sounds to unknown elephants in the wild gave ambiguous results, with the animals either running away, backing away, showing displacement activity or ignoring the sound, with distance to the speaker apparently being a crucial variable. However the Ol'Jogi bull was visibly startled when confronted with the bee play-back coming from a tree he was approaching with a view to a meal. He backed away immediately and with obvious alarm although nearly 4 years had passed since he had been stung. Our control sound (a Bach violin concerto) played earlier had had no visible effect on his behaviour. Our interviews with the bee-keepers suggested that occasionally a whole elephant herd is stampeded by bees; this should reinforce in all herd members (even unstung ones) a negative 'bee-sound-experience'. As elephants have long memories and are highly social (McComb et al. 2001; Langbauer et al. 1991) such negative group experiences could result in strong and lasting conditioning by social facilitation (Hinde 1966).

Whatever the mechanism, it seems that African bees can confer on both small and mature trees some direct and efficient protection against foraging elephants. It might even be possible (remember the Ol'Jogi bull) to condition individual elephants or even herds to associate a deterrent (bee sound or smell) with attacks. Finding a means to prevent elephants from destroying individual trees (such as landmark thousand-year-old baobabs) or the shading riverine forests (popular with tourists as well as being ecologically important) is a problem that is far from trivial.

However, here we want to go one step further and propose that bees could also be used to profitably protect farming smallholdings – for example by strategically placed hives that are easily disturbed. As elephant numbers increase, ways have to be found to control their impact on human lives and livelihoods. Using bees as a selective deterrent would more than pay for itself through sales of honey. It would also be using a means that is already an integral part of the natural environment. Wild bees are always present at some level and are thus a constant natural reinforcer. Throughout Africa, bees are already kept for honey, often in surprising numbers (for example over 2,000 hives on a 25 km stretch along the Ewaso River at Mpala; unpublished data). Using bees in strategic defence against elephants would constantly reinforce the negative association in the minds of the pachyderms between being stung and panicked and specific localities and/or crops. Where feasible, controlling elephants with bees is preferable to fencing or shooting; and it is certainly less costly or destructive although the customary care must of course be taken by the bee-handlers or bystanders. It seems unlikely that elephants would as easily habituate to bees with their stings and attendant pain as to firebrands or firecrackers, which have no direct physical feedback (pain). However this may be, larger scale experiments must now be conducted to show how the African bee compares in effectiveness with other temporal control measures such as spraying chili powder (Osborn and Rasmussen 1995) or pheromones (Rasmussen et al. 2002).

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