Can bees deter elephants from raiding crops? An experiment in the communal lands of Zimbabwe

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Abstract

Mitigating human–elephant conflict has arguably taken centre stage in elephant conservation concerns across the range states of Africa and Asia. Farmers in settlements that abut elephant range need sustainable ways of keeping elephants and other crop pests out of their fields. Here we examine the use of the African honeybee (*Apis mellifera scutellata*) as a possible means to deter the African elephant (*Loxodonta africana*) from raiding crops. We tested whether mounting beehives strategically around crop fields would deter elephants from crop raiding. No deterrent effect was detected, but the tests were small in scale, and further tests are needed to better assess the hypothesis that bees can be used to discourage elephants from raiding crops. Although not tested here, beehives might prove a useful livelihood addition if honey can be successfully harvested and marketed. We suggest that bees alone will not stop elephants from raiding crops, but if combined with a suite of 'low tech' methods and practically linked with the economic potential of honey production, bees can be another tool for rural farmers to use to improve their livelihoods and aid in conserving elephants.

Additional key words: human–elephant conflict, problem animal control, African honeybee

Résumé

On pourrait dire que la mitigation des conflits hommes-éléphants est au centre des préoccupations de la conservation dans tous les Etats de l'aire de répartition, tant en Afrique qu'en Asie. Les fermiers voisins de l'aire de répartition des éléphants ont besoin de moyens soutenables pour maintenir les éléphants et les autres animaux nuisibles pour les récoltes en dehors de leurs champs. Ici, nous examinons l'utilisation de l'abeille africaine (*Apis mellifera scutellata*) comme moyen éventuel de dissuasion contre les éléphants africains (*Loxodonta africana*). Nous avons testé le fait de placer des ruches à des endroits stratégiques autour des champs pour voir si cela dissuaderait les éléphants. Nous n'avons décelé aucun effet dissuasif, mais les tests se faisaient à petite échelle et il faudrait en faire d'autres pour mieux tester l'hypothèse selon laquelle on pourrait se servir d'abeilles pour décourager les éléphants de s'attaquer aux récoltes. Bien qu'on ne l'ait pas testé dans ce cas, les ruches pourraient s'avérer un moyen de subsistance très utile si le miel peut être récolté et vendu. Nous suggérons que les abeilles seules ne vont pas empêcher les éléphants de détruire les récoltes, mais que si on les combine à d'autres méthodes « *low tech* », et qu'on tient compte du potentiel économique de la production de miel, les abeilles peuvent être un autre moyen pour les fermiers d'améliorer leur quotidien et d'aider à la conservation des éléphants.

Mots clés supplémentaires : conflit homme–éléphant, control des animaux nuisibles, l'abeille africaine

Introduction

If human–elephant coexistence is to be a realistic long-term goal, then conflict must be addressed. Community-based crop protection programmes are becoming more widespread and recent research has suggested that the bee might be an answer to the persistent human–elephant conflicts as wildlife personnel seek non-lethal methods to mitigate this problem. In Kenya, Vollrath and Douglas-Hamilton (2002) observed that elephants did not feed on trees with hives, and trees prone to elephant damage experienced no further damage when beehives were placed in them. They suggested that hives situated around fields might help keep elephants from raiding crops and that beekeeping could also be a source of income for people living in elephant range. We set out over the past two years to explore this hypothesis in the Zambezi Valley of Zimbabwe.

People and bees have a long and mutually beneficial history. In almost every community and country, bees are kept for the honey and wax that they produce, and for the crops that they pollinate. Human use of honeybees in fighting perceived or actual foes has a long history. Bérubé (2002) stated: 'It would probably be easier to enumerate the cultures which do not chronicle some kind of use of bees as weapons since this motif is so pervasive and most of these accounts are historical rather than mythical.' Some of the earliest battles were fought with honeybees being the chief agents of victory. In the 11th century, Irnmo, general of Emperor Henry I of England, threw beehives from cliffs onto the attacking troops of Geiselbert, Duke of Lorraine. The citizens of Gussing, Hungary, used the same technique in 1289 against the troops of Albert, Duke of Austria (Bromenshenk 2004). In several instances bees have been used in the more obvious way, as 'meat-seeking missiles'. The Romans, for instance, simply sent beehives catapulting into the ranks or fortifications of their enemies. Aouade (1979) described how the Tiv people of Nigeria kept bees in special horns that contained powdered poisons. Thus dusted to increase the efficacy of their own venom, the bees would be released in the heat of battle to attack Tiv enemies. This concept is also believed to have been used by the Sunde and the Varenje people of Lower Guruve in northern Zimbabwe in ancient times.

Beekeeping has had a more dubious history during the past few decades as a tool for rural people to develop economically. The honey business is competitive and the product is difficult to produce in quality and quantity high enough to be marketed sustainably. Much money, training and hives have been invested by well-intentioned donors, and the people in our study area had been part of two previously failed beekeeping projects.

Study area

Lower Guruve District encompasses an area of 2700 km^2 in the mid Zambezi Valley, northern Zimbabwe (Cumming and Lynam 1997) (fig. 1). The Zambezi Valley lies about 350–500 m above sea level and experiences low annual rainfall (650–850 mm per year), falling mainly between December and mid-March (Cumming and Lynam 1997). There are three seasons: a hot, dry season from August to October (mean daytime temperature > 35°C); a rainy season from November to March; and a cool, dry season from April to July (mean daytime temperature 24–28°C). The dominant vegetation consists of *Colophospermum mopane* and *Terminalia* woodland and mopane–combretum woodland, with dense riverine thickets of mixed species along the major rivers. Agriculture is practised mainly in bands of colluvial soil along the Zambezi escarpment and in alluvial soils bordering the major rivers (Cunliffe 1992). Most farming is

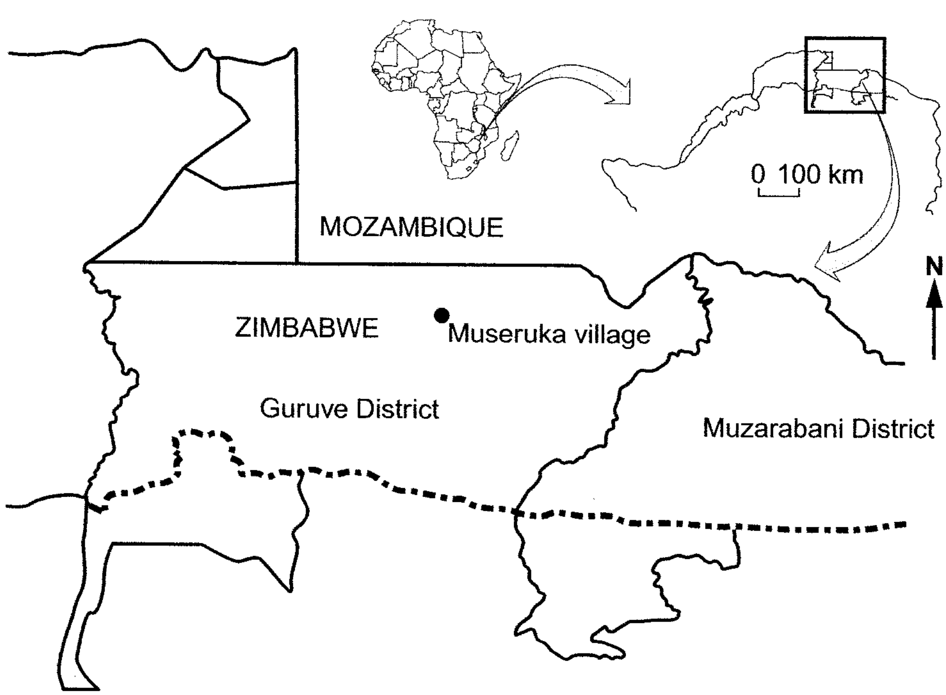

Figure 1. The study area, its location in northern Zimbabwe, and the approximate position of Museruka village in Guruve District.

small-scale dryland cultivation, and the main wet-season crops are maize (*Zea mays*), sorghum (*Sorghum vulgare*), and cotton (*Gossypium hirsutum*), all of which elephants and other wildlife predate (Cunliffe 1992).

Materials and methods

Measuring the effect of a potential deterrent on a wild elephant is difficult, and measuring the subtle deterrent properties of bees on elephants is not an exact science. Away from fields and also on paths that elephants were known to use, we set up control plots with different crops. We also situated hives at the edges of fields and in gardens at water points. This shotgun approach gave us coverage of different situations where people would tolerate the bees but the bees could deter the elephants.

We tested the effectiveness of beehives in deterring elephants from selected areas in three different ways, by mounting beehives, both empty and fully colonized by honeybees, 1) around test crop fields of cotton, sorghum and maize; 2) along selected paths in well-known elephant refuges, and 3) in trees surrounding entrances to natural water points that elephants were known to frequent in trials carried out in 2004 and 2005.

In the first test, trial plots were established at the onset of the wet season to coincide with the growing cycle of field crops. In virgin bushland away from human influence, we planted eight plots with maize, sorghum and cotton, the latter two being the most common crops in the area, to test whether placing beehives would deter elephants from visiting and raiding such crop types. Each plot was 10 m x 10 m and contained 35 seedlings of each crop. Four of the plots were left without beehives as controls. Both the test plots and their controls were sited at least 200 m from the edge of the community fields near Museruka village, Lower Guruve District. This distance was considered far enough for humans to have no observable influence over whether elephants would visit these fields.

Plots were arranged alternately in a randomized block design so that each plot had an equal probability of elephants visiting it. We mounted 12 hives (6

EPDT file photo

Fully colonized log-type beehive placed near a waterhole.

full and 6 empty) on poles 3 m long and 20 m equidistant from each other at an average height of 2 m—'a favourite elephant feeding height' (Vollrath and Douglas-Hamilton 2002)—around the test plots along elephant routes into the area identified as those most frequented. The hives used in this experiment were either the traditional log type, hollow *Colophospermum mopane* logs a half metre long and with a diameter of approximately 30–40 cm, or the manufactured Kenyan topbar hive, about a metre long. The hives were hung on the poles by two wires, baling twine or tree bark and were left swinging lightly in the breeze.

The plots were visited five times a week for six months, and crop raids by elephants were monitored over the same period. On every visit the number of intact plants was counted. If the count was different from the previous day, the dead plants were found and the reason for death determined from footprints and plant remains. If the death was not related to elephants, it was entered as 'other cause'. If the reason for death could not be ascertained, it was entered as 'unknown'.

Each enumerator was equipped with binoculars and a stopwatch to note movements and reactions of elephants (if any) upon encountering the hives. An 'incident' was defined as an occasion when elephants caused damage to the test crops, but we made a distinction between a 'raid' and a 'visit' by elephants to a field. A raid was an incident in which elephants destroyed crops by either consuming or trampling them. A visit was an incident in which elephants attempted to enter fields but moved away before causing damage. We collected crop damage reports in the control plots and compared it with the damage experienced in the test plots.

The severity of an incident was measured using two indicators: the area percentage of the field that was damaged, which was measured by pacing, and the type of damage to the crops, which was assessed visually. Crop damage was assessed in three general categories: low, medium and high. The seriousness of each damage incident was assessed by scoring the age and quality of the crop and the amount of damage reported on each incident. For example, damage to 10 seedlings would score medium where damage to 10 mature plants would be classed as high.

Occasionally it was necessary to provide supplementary watering and fertilizer to the plots, and each was weeded twice per month to remove any competing grasses and weeds. At the end of May the plots were discarded as this date coincided with the end of the wet-season peak of crop raiding and with the harvesting of most of the rain-fed crops.

We placed a further 12 hives around well-known elephant refuge areas, along selected paths crop-raiding elephants were known to use. Another 12 beehives were placed in trees of different species around three entrance points leading to waterholes that were identified as those the elephants of this area favoured. These hives were spaced at an average distance of 5 m (± 2) apart and at a height of 2 m. In both tests we primed half of the hives with honey molasses, beeswax and propolis, leaving the remaining half unprimed, to test whether the mere presence of a beehive would deter elephants. By the end of the trial, honeybees had fully colonized all the primed hives but had left the unprimed ones unoccupied.

Results

We tested the effectiveness of bees in deterring elephants by comparing the mean severity of elephant crop damage in the test plots where we placed beehives with the control plots without beehives. At the end of the crop-raiding season, 58 incidents of crop damage had been recorded in both test and control plots. Of these incidents, 79% were identified to have been caused by individual bulls or in groups, with approximately 14% attributed to cows and 7% to mixed herds (fig. 2). Approximately 59% of the damage occurred when the crops were at their intermediate stage of growth and the remaining 41% when they had matured. No damage was recorded at the seedling stage. The maize crop proved to be highly susceptible to elephant damage as reflected by the number of damage incidents experienced by the crop: 19 in test plots and 23 in unprotected plots; next was sorghum with 18 incidents in test plots and 20 in unprotected; and finally cotton, which had damage incidents of 13 in test and 12 in unprotected (fig. 3).

In the test plots most of the damage (62%) was of medium severity, 10% low, and 28% high. Similarly, damage incidents in the control plots occurred more often in the medium severity category (59%), no incidents denoting low damage severity were noted, and 41% of the damage was classified as high (fig. 4).

This difference in damage between the two treatments was tested for significance using Student's two-tailed t-test and was found to be insignificant (t = 0.391; p = 0.05; df = 56), indicating that the presence

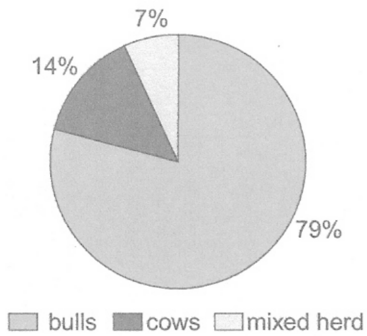

Figure 2. Sex of elephants visiting plots.

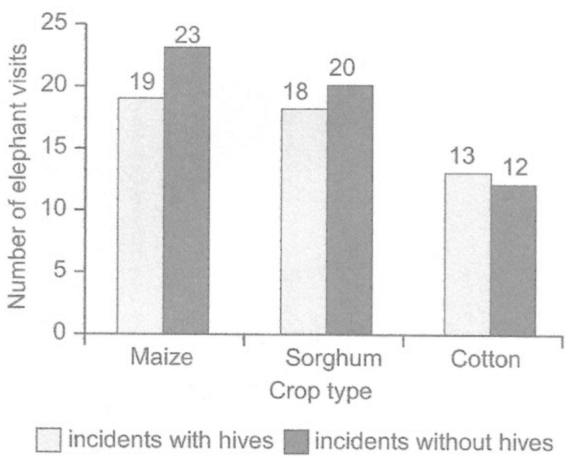

Figure 3. Frequency of elephant visits to test and control plots.

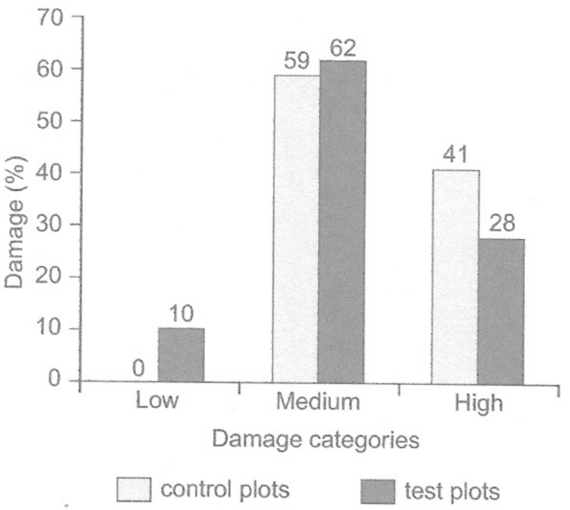

Figure 4. Level of crop damage in both test and control plots.

of beehives, with or without honeybees, did not provide the treatment plots with significant protection.

Elephants destroyed 2 uncolonized hives of the 12 hives mounted around the entire test plots; thus approximately 83% of the hives survived elephant harm. Elephants generally avoided entrance points into the plots with 'live' hives. This was clearly depicted by elephants not only continuously using the control points but also opening up three new points away from the hives that led into the hive-protected plots. They opened no new points of entry in the control plots and the regular routes showed signs of continuous and consistent use.

Interestingly, the same trends were noted in the other two tests, which involved placing hives on paths along elephant refuge areas and on paths around natural water points that elephants regularly visited and used. In the former, two days after mounting the hives the elephants started moving away from their refuge into deep and thick forests. By the time six of the hives had been fully occupied, the elephants had abandoned the area. They had not tampered with the trees with fully occupied hives, although a bull elephant had felled a tree that had a hive without bees. Beehives were then moved into the areas newly settled by the elephants with similar occurrences of the elephants retreating.

In the waterhole test, we noted that at the peak of the rainy season elephants preferred using the control watering hole. When the waters of the control waterhole began to recede rapidly, the elephants increased their use of the test water source. When honeybees fully occupied the primed hives, the elephants opened up two new entrance points around that water point, clearly showing that the elephants avoided the live hives. It is important to note, however, that we never actually observed an elephant avoiding beehives.

Discussion

In Lower Guruve District, rapidly expanding agricultural activities and an increasing and mobile population of elephants are the perfect conditions for human–elephant conflict to occur. From the crop damage data it appears bulls were responsible for nearly all of the recorded damage and that beehives, either colonized or uncolonized, did not provide much protection to the crops.

Villagers in the study village gave an account of how a common waterbuck cow (*Kobus ellipsiprymnus*) and her calf were stung to death by a rare combination of enraged swarms of wasps and bees from the test hives around one watering hole, and they hoped that if their crop fields were filled with colonized beehives elephants with crop-raiding proclivities could meet the same fate, as 'honeybees can and will sting elephants with considerable effect' (Vollrath and Douglas-Hamilton 2002).

Using honeybees to deter elephants from raiding crops is fraught with many challenges. It is appreciated that guarding one's crop fields from marauding elephants at night is no mean task. But it is important to note that from either a technical or a practical perspective, being able to use bees on a large scale is questionable. It is not clear how many beehives would be required to protect lengthy crop boundaries spanning hundreds of hectares, and moving fully occupied beehives from one spot to another to follow elephants' movements is not only hard, tedious work but also dangerous, as one risks getting severely stung.

Crop raiding was nocturnal, the time when bee activity is at its lowest but wild elephants with crop-raiding proclivities are at their most alert state. Moreover, bees do not fly during heavy rain or wind, or when temperatures drop to near or below freezing (Bromenshenk 2004). Also the practicability of the idea from a social point of view in a human settlement, as compared with a protected area where few people are found, is also a major consideration because of the risk that the particularly aggressive African honeybee poses.

While every effort was made to position the test plots far from the villages, where human influence or disturbance was minimal, working in the fields proved difficult, particularly when the bees were disturbed. In one incident two goats were stung to death after knocking down a colonized hive, and people could not work in nearby fields as the enraged bees sought any exposed body on which to vent their anger. The issue of compensation on the affected families in such cases would also be raised, with questions as to who should be responsible for compensating the affected party in the event of an attack on humans, particularly if life were to be lost.

However, we noted that none of the trees in which hives were mounted and fully occupied experienced any form of damage or disturbance. We further noted that elephants frequenting the plots had opened up new entrance points, apparently to avoid the paths with hives. Here we believe that smell or sight might have been a contributing factor causing them to change their movement pattern, as 'smell is crucial for elephant social and foraging decisions'. (Marschner 1970 cited in Vollrath and Douglas-Hamilton 2002).

Elephants are known to follow well-defined paths consistently, and we believe the presence of the hives and bees likely contributed to the elephants changing their points of entry in the test plots. This assumption is supported by the fact that in the control plots no new entrance points were created. If we can assume that smell had an effect in causing the elephants to change their movement pattern, it is important to note that in this study we dealt with wild elephants with a history of being harassed by humans who defend their crops and who engage in isolated poaching activities. Thus, such elephants are wary of humans, and with their acute sense of smell they might have detected and associated the human scent on the hive test trees with the crop protection and poaching incidents they may have experienced in the past.

Unfortunately, at the time of publication we had yet to harvest the first crop of honey so we were unable to assess the practicalities of honey production and sales. This would be extremely important if beekeeping were to be integrated into the livelihood strategies of people living in elephant range.

We support the continued examination of the use of honeybees proposed by Vollrath and Douglas-Hamilton (2002) as a potential tool, if combined with other locally available mitigation methods, to improve the livelihood of farmers losing crops to elephants.

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References

Aouade JAA. 1979. Traditional beekeeping in Nigeria. Editorial summary from *Beekeeping among the Tiv.* Beekeeping in rural development: unexploited beekeeping potential in the tropics with particular reference to the Commonwealth. Commonwealth Secretariat and the International Bee Research Association, London. 23 p.

Bérubé C. 2002. *War and bees, military applications of apiculture.* Island Crop Management website: www.beekeeping.com; www3.telus.net/conrad. Accessed 6 May 2003.

Bromenshenk J. 2004. *Can honeybees assist in landmine detection?* Division of Biological Sciences, University of Montana, Missoula, MT 59812, USA.

Cunliffe RN. 1992. An ecological resource survey of the communal lands of Centenary District. WWF Maps Project Paper No. 26. World Wide Fund for Nature Programme Office, Harare, Zimbabwe.

Cumming DHM, Lynam T. 1997, Land use changes and utilization and the sustainability of agro-ecosystems in the Zambezi Valley. WWF Maps Project Paper. World Wide Fund for Nature Programme Office, Harare, Zimbabwe.

Marschner C. 1970. Qualitative und quantitative Untersuchungen am Bulbus olfactorius des Elefanten im Vergleihch mit dem des Menschen und des schweines. *Acta Anatomica* 75:578–595.

Vollrath F, Douglas-Hamilton I. 2002, African bees to control African elephants. Naturwissenschaften online publication. Website: www.savetheelephants.org/publications. Accessed 10 March 2003.