Short Communication

Would masking the smell of ripening paddy-fields help mitigate human–elephant conflict in Sri Lanka?

Charles Santiapillai and Bruce Read

Abstract Despite its small size and high human population Sri Lanka is home to c. 4,400 wild Asian elephants *Elephas maximus*. Human–elephant conflict around agriculture is severe, with > 100 elephants and c. 50 people killed annually. Elephants appear to be able to time their raiding of paddy-fields in Sri Lanka with the harvesting of the rice, as if they are responding to an olfactory trigger. It is the elephant's sophisticated chemosensory system that may hold the key to resolving human–elephant conflict. Research is required to determine the odours associated with the various development stages of rice, using gas chromatography, and to find a suitable substance that could be used to mask the specific odour of ripening rice. The use of chemosensory-based methods, if feasible, will not be a universal panacea for the mitigation of human–elephant conflict but, in combination with other methods, could reduce conflict and make it easier for farmers to harvest their crops in safety. Such a combination of methods could be useful across the range of both Asian and African elephants.

Keywords Crop raiding, *Elephas maximus*, human–elephant conflict, mortality, olfactory trigger, paddy-field, seasonality, Sri Lanka

'To see what is in front of one's nose needs a constant struggle', George Orwell (*Tribune*, London, 22 March 1946)

Despite its small size (65,610 km^2) and high human population (> 20 million) Sri Lanka is home to c. 4,400 Asian elephants *Elephas maximus* that represent c. 10% of the global population of this species in the wild (Kemf & Santiapillai, 2000). As the human population increases and agricultural areas expand at the expense of forests, elephant habitat is being continually reduced. As a consequence almost 70% of the elephant's range in Sri Lanka lies outside reserves (Santiapillai et al., 2003), leading to increasing conflict between humans and elephants.

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During 1950–1970 in Sri Lanka a total of 1,163 elephants died in the wild, of which 639 were killed by farmers in defence of their crops, i.e. a loss of c. 32 per year. During 1990–2001 a total of 1,369 elephants died in the wild, i.e. c. 125 per year. In 1951, on average, one elephant was killed per week by farmers in defence of their crops (Nicholas, 1952), whereas in 2001 wild elephants were killed at a rate of three per week (Santiapillai, 2003). In 2007 c. 183 elephants died, of which 80 deaths were from gunshot injuries, 19 were electrocuted, eight fell into unprotected wells, seven were poisoned, four were killed by land mines, six died in accidents, 19 perished from other causes and 40 from unknown causes (data from the Department of Wildlife Conservation). In addition, c. 50 people are killed annually by wild elephants in Sri Lanka (Ranawaka, 2008).

Elephants are not being killed in Sri Lanka for ivory because tuskers are rare (< 7% of the bulls are tuskers), they are not being killed for meat because no one eats elephant meat, and they are not being killed for leather because the hide has no commercial value. Elephants are being killed in Sri Lanka mainly because they interfere with agriculture.

Despite growing concern and numerous studies, general solutions to human–elephant conflict remain elusive (Dublin et al., 1997). Recently, however, a number of innovative methods to deter elephants from agricultural areas have been tested. In Kenya, for example, honeybees have been used to mitigate elephant raids (King et al., 2009). In Sri Lanka, however, wild elephants have been known to attack beehives, and honeybees are diurnal whereas much of the crop depredation by wild elephants is nocturnal. Another potentially cost-effective method involves hanging used CDs along the periphery of agricultural areas. In the Salakpra Wildlife Sanctuary in West Thailand it seems to work best during the full moon when the CDs reflect light and give the appearance of people moving about with torches (Sitati, 2007). Chilli-grease fences have also been tested but, in Sumatra at least, have not proved to be as effective as community-based guarding using conventional tools (Hedges & Gunaryadi, 2009). During colonial times in Sumatra, Dutch farmers used human urine-soaked rags as a deterrent against elephants in oil palm plantations (van Heurn, 1929).

Research on human–elephant conflict has given us a greater understanding of why elephants raid crops. The frequency and intensity of elephant crop-raiding in Sri Lanka appear to be related in part to the geographical arrangement of farming areas, and elephants respond to seasons as well as the types of crop cultivated. Conflict is variable: in a survey of 100 villages in 2008, 35% of the families interviewed experienced elephant incursions into their neighbourhood on an almost daily basis whereas 65% encountered elephants only seasonally (Wijeyamohan et al., 2008).

Rice is the staple food of the people of Sri Lanka and is cultivated as a wetland crop. There are two cultivation seasons, *Maha* and *Yala*. *Maha* falls during the north-east monsoon of September–March and *Yala* during the south-west monsoon of May–August. During the *Maha* season paddy is cultivated at a time when water supply is plentiful, whereas in the *Yala* season paddy cultivation relies on water stored in irrigation reservoirs. There appear to be two peaks of elephant movement into agricultural areas during these seasons: (1) Near the end of both *Maha* and *Yala* just before the rice is ready to be harvested, at which times much of the elephant depredation occurs (Wijeyamohan et al., 2008). (2) During the early stages of rice growth, coincident with the onset of rain, when elephants move into irrigated paddy-fields to feed on the young rice plants, which are highly palatable and nutritious.

Research and recommendations on human–elephant conflict in Asia and Africa focus mainly on minimizing the conflict rather than understanding why elephants choose certain times to raid crops. The conflicts can be mitigated either passively or actively (Osborn & Welford, undated). Passive systems involve the use of a variety of physical and psychological barriers to elephant movement, whereas active systems include traditional methods such as chasing elephants. Elephants, however, quickly habituate to such threats and habitual crop raiders cannot be kept away by such simple bluffs (Sukumar, 1989).

Elephants are able to time their arrival at paddy-fields in Sri Lanka with the harvesting of the rice, as if they are responding to an environmental trigger. A study of the elephant's sophisticated chemosensory system could thus hold the key to resolving human–elephant conflict. The fact that elephants travel long distances, sometimes up to 5 km, to reach cultivated areas indicates that the trigger could be olfactory. But, as elephant herds have been known to send a few individuals ahead to see if maize, for example, is ready, before signalling to others (WWF-UK, undated), the cue could be a combination of visual and olfactory stimuli. Elephants have an excellent sense of smell. When observing wild elephants for any length of time it can be seen that they wave their trunks to collect air samples, which are analysed by their extensive sensory system of scrolls of spongy turbinal bones in the upper nasal cavity. The elephant has a sensitive olfactory apparatus for gaseous compounds and a vomeronasal organ for detecting liquid compounds (Rasmussen, 1998; Sukumar, 2003). African elephants *Loxodonta africana* in Amboseli National Park, Kenya, for example, can tell the difference by smell alone between human ethnic groups such as the Masai, whose younger men spear elephants, and the Kamba, agricultural villagers who pose no threat (Bates et al., 2007).

The trigger for the incursion of wild elephants into paddy-fields near harvest time could be the odorant molecules produced by ripening rice. If wild elephants are able to detect smells over several kilometres, giving them an early warning system of approaching danger, they may also be able to detect changes in the phenology of rice plants by the odours associated with the various growth stages, and thus time their raids accordingly.

If this is the case, masking the olfactory signals from ripening paddy-fields could eliminate the trigger alerting elephants to the ripening crop. This could potentially be accomplished by first identifying the substances that are emitted by ripening rice and then determining the timing of the event so that an alternative substance could be sprayed that either nullifies or masks the emitted substance. This could give farmers time to harvest their crops in safety before elephants have the opportunity to eat or destroy them, and thus reduce the numbers of people and elephants killed each year in human–elephant conflict. Research is required to determine the odours associated with the various development stages of rice, using gas chromatography, and to find a suitable substance that could be used to mask the specific odour of ripening rice.

In Sri Lanka human–elephant conflict is not simply a conservation problem to be tackled by the Department of Wildlife Conservation but rather a general agricultural problem. Liaison with the Department of Agriculture is therefore required. Cooperation between the two Departments and the farming community may be the best way to address the problems associated with elephant crop-raiding. We recommend research on the phenology of rice to determine the odorant molecules of ripening rice and then testing on wild elephants to see if the odour is an attractant.

The use of chemosensory-based methods, if feasible, will not be a universal panacea for the mitigation of human–elephant conflict but, in combination with other methods, could reduce conflict and make it easier for farmers to harvest their crops. Such a combination of methods could be useful across the range of both Asian and African elephants.

References

Bates, L.A., Katito, S.N., Norah, N.W., Moss, C.J., Poole, J.H. & Byrne, R.W. (2007) Elephants classify human ethnic groups by odour and garment colour. *Current Biology*, 17, 1938–1942.

Dublin, H.T., McShane, T.O. & Newby, J. (1997) *Conserving Africa's Elephants: Current Issues and Priorities for Action*. WWF International, Gland, Switzerland.

Hedges, S. & Gunaryadi, D. (2009) Chilli-based elephant deterrents. *Oryx*, 44, 139–146.

Kemf, E. & Santiapillai, C. (2000) *Asian Elephants in the Wild, 2000—A WWF Species Status Report*. WWF International, Gland, Switzerland.

King, L.E., Lawrence, A., Douglas-Hamilton, I. & Vollrath, F. (2009) Beehive fence deters crop-raiding elephants. *African Journal of Ecology*, 47, 131–137.

Nicholas, C.W. (1952) The present status of the Ceylon elephant. *Ceylon Today*, 1, 19–21.

Osborn, F.V. & Welford, L.A. (undated) *Living with Elephants. A Manual for Wildlife Managers in the SADC Region*. USAID Publication, Lilongwe, Malawi.

Ranawaka, C. (2008) No reasons to fear that elephant population is diminishing. *Daily Mirror*, 5 March 2008, A9.

Rasmussen, L.E.L. (1998) Chemical communication: an integral part of functional Asian elephant (*Elephas maximus*) society. *Ecoscience*, 5, 410–426.

Santiapillai, C. (2003) Converting dung to dollars to conserve the elephant in Sri Lanka. *Current Science*, 84, 622–623.

Santiapillai, C., Wijeyamohan, S. & Vandercone, R. (2003) *The Asian Elephant*. Http://www.manrecap.com/asian-elephant.html [accessed 23 July 2010].

Sitati, N. (2007) *Guidelines for Protecting Crops from Raiding by Elephants Around Salakpra Wildlife Sanctuary, West Thailand*. A report submitted to Elephant Conservation Network, Kanchanaburi, Thailand.

Sukumar, R. (1989) *The Asian Elephant: Ecology and Management*. Cambridge University Press, Cambridge, UK.

Sukumar, R. (2003) *The Living Elephants: Evolutionary Ecology, Behavior, and Conservation*. Oxford University Press, Oxford, UK.

Van Heurn, F.C. (1929) *De Olifanten van Sumatra*. Unpublished monograph.

Wijeyamohan, S., Bandara, G., Athurupana, R., Dissanayake, N., Read, B. & Santiapillai, C. (2008) *An Assessment of the Human-Elephant Conflict in Sri Lanka*. A paper presented at the Elephant Managers Association Conference, Orlando, USA.

WWF-UK (undated) *A Hot Idea for Elephant Conservation*. Http://gowild.wwf.org.uk/tenalpreports/elephantconservation.asp [accessed 22 July 2010].

Biographical sketches

Charles Santiapillai carries out research on the management and conservation of large mammals in Asia. He worked with WWF International's Asia Programme from 1984 to 1992 and co-authored *The Action Plan for the Conservation of the Asian Elephant*. He has worked extensively in Asia and was the Deputy Chairman of the IUCN/Species Survival Commission Asian Elephant Specialist Group from 1998 to 2005 and edited its journal *Gajah*. Bruce Read is Vice President of Animal Stewardship at Ringling Bros and Barnum & Bailey, where he supervises the Asian elephant care programmes of The Greatest Show On Earth. He was formerly deputy general curator at the St Louis Zoological Park, USA. Throughout his tenure there he taught conservation education and animal management across South-east Asia, established the Conservation Academy for the American Zoo and Aquarium Association, and became active with the IUCN Species Survival Commission.

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