XIV WORLD FORESTRY CONGRESS, Durban, South Africa, 7-11 September 2015

Understanding forest beekeeping in Africa as an efficient forest-resource harvesting system and not a rudimentary system in need of modernisation

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Abstract

African honey and beeswax exports come from forests. In Mwinilunga, Zambia, 40,000 people depend on honey. In south-west Ethiopia honey is the main source of cash for many; likewise in parts of Angola, Cameroon, DRC, Mozambique and Tanzania. The simple hives used by forest beekeepers are often dismissed as backward and 'modernisation' is promoted. This is misguided. We present a conceptual situation and evidence to support the proposition that forest beekeeping is efficient and cost-effective. Honey yield is directly related to nectar availability and the greatest nectar yields are available in less-degraded forests far from people. Beekeepers must find a way to harvest nectar which is dispersed, at distance and fluctuates in time and place. The solution is to disperse many hives which they visit infrequently. So-called 'modern' hives need regular care and this is only achievable if they are placed near the home. By taking this approach beekeepers, in effect, forgo the opportunity to harvest large nectar resources further afield. It is not proven that more intensive management of tropical *Apis mellifera* makes up for this loss of forage opportunity. Forest beekeeping comprises a suite of strategies which work well considering the natural resource base, the mobility of tropical bees and socio-economic context of beekeepers. Its persistence tells of its sustainability, and its co-evolution in different forests tells of its applicability. However, the paucity of scientific study of the topic in Africa is to be deplored given its importance for livelihoods. Notable gaps exist in our understanding of forest honey production capacity, economics, honey bee population dynamics, harvesting methods and user rights of bee trees. Forest beekeeping is threatened by deforestation. It is also under threat from neglect and misunderstanding by the scientific bee and forest community. The science of forest beekeeping must be included in studies and research programmes across Africa.

Keywords: Beekeeping, extensive, resource system, honey, beeswax, Apis mellifera, livelihoods.

Introduction, scope and main objectives

Honey and beeswax exported from Africa come from forests, and for communities engaged in this activity, income from selling this produce is incredibly important. In Mwinilunga, Zambia, beekeepers earn twice as much household income as non-beekeepers, and 40,000 people depend on the honey and beeswax trade in this area (Dan Ball pers. comm. Oct 2014). For many households in Sheka and Bench Maji, south-west Ethiopia, honey is the primary source of cash (Endalamaw 2005). The number of hives is used as a wealth indicator, and someone with over 100 hives is considered rich in their local context. Livestock owning is a wealth indicator also, but while the poorest have no oxen - they may still have some hives (van Beijnen et al 2004:17). This shows the crucial importance of honey for the local economy. In Cameroon honey contributes an average of 52% of household income for tens of thousands of beekeepers in the Adamaoua savannah (Ingram and Njikeu 2011). Forest beekeeping is also widespread in many other countries, including Angola, Democratic Republic of Congo, Mozambique and Tanzania.

Honey production methods tend to be described according to the type of hive only. This appears to be a result of the lack of alternative intellectual thinking. This gap becomes most apparent when considering African forest beekeeping. In this paper we challenge this limitation and present an alternative. We show that African forest beekeeping must be understood as an efficient system within which beekeepers employ a cost-effective strategy for maximum nectar harvest. This is important because many hundreds of thousands of poor and marginalised forest people rely on this type of beekeeping for their livelihoods. There is a significant investment in many African countries dedicated to replacing so-called 'traditional' hives, with so-called 'modern' hives. With this paper we attempt to explain why much of this investment is misplaced and is based on an unacceptable level of ignorance about the beekeeping systems being replaced.

Methodology

In this paper we present a novel intellectual model to interpret African forest beekeeping. We do this by reviewing how honey production methods are generally described. We then pose a theoretical alternative, backed up by empirical examples. We draw on the literature and the combined 40 years of work experience of both authors in beekeeping in Africa. We offer definitions of beekeeping systems and extensive forest beekeeping.

Honey production approaches

Beekeeping methods are often described according to whether 'traditional' or 'modern' hives are used. The authors reject both these terms, because they are usually used badly, in prejudicial and inaccurate ways. It is more useful to describe hive types technically.

Forest beekeepers use simple, fixed comb hives. These are usually cylinders made of local materials with no moveable parts. They provide a protected home for a colony of bees[1] and most are designed with a *honey door* to permit access to the honey stores. They are cheap and easy to aquire. Some development actors dismiss these hive types as backward, and aim instead to introduce so-called 'modern hives'. Forest beekeepers locate hives in trees, spread out in different and distant locations. Projects sometimes state a deliberate intention to bring hives 'down from the trees' and 'out of the forest'.

Introduced hives tend to be of two types (a) the top-bar hive, where the comb of the honey bee nest is built (by the bees) suspended from bars at the top of provided containers and (b) frame hives, where the comb is built within a wooden frame which affords strength and moveability to the combs. Both these hive types employ moveable comb technology. This means, (1) the combs can be manipulated, giving the beekeeper the opportunity to manage the colony, (2) honey in frames can be extracted using a centrifual honey extractor. This allows the replacement of empty, intact honey comb into the colony to be re-filled with honey, so permiting a shunting of resources from comb building to honey storage.

Moveable comb hives need to be relatively near the home so they can be attended to. Forest beekeepers choose to locate their hives where there is maximum nectar availability and place them in trees to keep them safe from predators and fire. They do not intensively manage invdividual colonies, although through the informed design and placement of the hive they are providing nesting sites to the bee population (thousands of colonies) as a whole.

Theoretical model

The hive is a management tool used by all beekeepers. And yet confining analysis to hive-type is a mistake. Beekeeping must be defined by a wider system of interdependent variables and processes. In forest beekeeping there are two components to the system - the resource system and the resource unit. The resource system is the forest and the nectar produced by trees. The resource unit is the individual hive, housing a colony of bees.

[1] In this paper we refer only to the honey bee *Apis mellifera*

Nectar is the primary resource which beekeepers seek to harvest. Bees are agents which collect and process this primary resource, making it accessible to, and useful for, beekeepers. Bees will fly as far as 10km when forage is scarce, but more typically the majority of nectar is collected within 2-4 km of the nest (Beekman and Ratnieks 2000; Seeley 1996). The model described here refers to landscapes where large areas of natural forest provide significant nectar resources.

For beekeepers to access nectar they must place their hives throughout the total forest area otherwise more distant nectar resources will not be harvested. If beekeepers confine their hives to locations near to their villages, their bees will feed at the forest edge only - and vast quantities of nectar will remain untapped. It will of course be collected by un-owned bees, but will not be available to beekeepers. This distance is one of the factors which determines the management approach. A beekeeper must compare the cost (including time) of collecting the honey, with the potential income that they can earn. One way to achieve a favourable cost-benefit ratio is to minimise the number of trips to the hive locations. Most forest beekeepers visit distant hive locations for placing hives, and for harvesting only. Making more frequent trips to intensively manage the bees would be prohibitively time costly. A beekeeper who seeks to harvest distant nectar sources must place his hives so far away as to make regular management costly - in this situation simple and cheap hives are most appropriate. Cheap hives also keep costs down and increase profits.

Honey yield is directly related to nectar availability, and forests tend to be more degraded near where people live. This is another reason why bringing the hives ‘out of the forest‘ is unlikely to lead to increased yields. Where there are no roads or poor roads, and where beekeepers typically have no means to use vehicular transport (and it would be too expensive if they did), intensively managing bees at distant sites is impossible. Beekeepers must therefore adopt extensive beekeeping systems, which do not depend on colony manipulation and do not benefit from moveable comb hives (top-bar or frame hives).

This scenario is represented in Figure 1. The circles show an area of nectar which can be harvested by one colony, or a small group of colonies, at the centre of the circle. The radius of the circle is the average foraging distance of the bees. In Forest A beekeepers are using moveable comb hives. They must keep them near their homes so they can manage the colonies and attend to the bees. In Forest B many beekeepers are placing hives far from their homes to increase the area of nectar resource which they can tap. They cannot cost-effectively manage these colonies intensively because of the distance. Their simple cheap hives are eminently suitable because they are not manipulating the colony, and the cheapness means they can afford many, to exploit the whole forest. The use of moveable frame hives in Forest A does not compensate for reduced access to nectar. A greater total yield of honey is harvested in Forest B.

Another part of the model concerns the complexity and uncertainty of the resource system. Rains, flowering times, bush fires and pest outbreaks are unpredictable and occur in different places at different times. Tropical *Apis mellifera* migrate and abscond readily as part of their own survival strategy in these uncertain and complex environments. Beekeepers cope with this situation by placing many hives in many places. If a yield cannot be harvested from location Y, then location Z. This strategy is only workable if hives are cheap and easy to acquire.

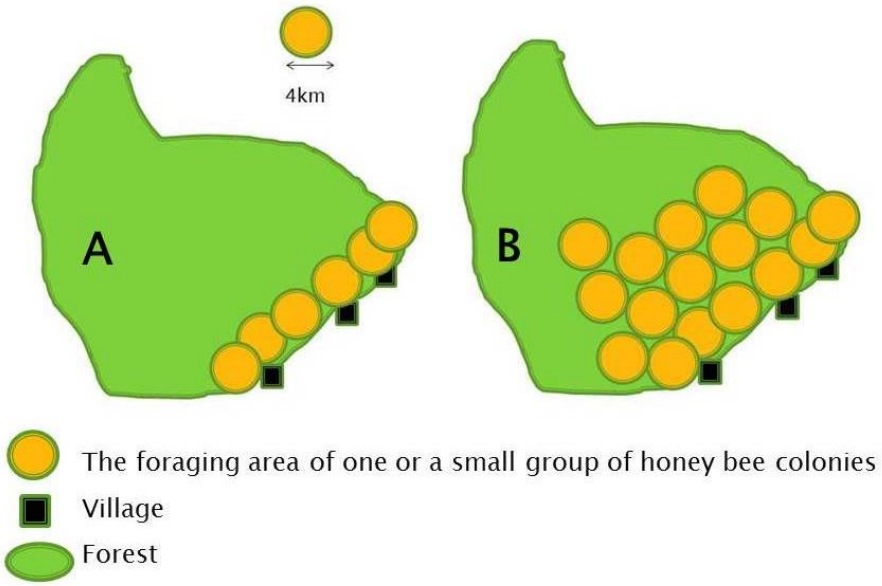

Figure 1. Theoretical visual of model of intensive beekeeping (Forest A) versus extensive beekeeping (Forest B) showing that keeping hives near the village only, limits access to untapped nectar resources further afield.

Harvesting nectar from different places according to seasons is a feature common to beekeeping worldwide. In industrialised countries, migratory beekeeping involves loading hives on to trucks and driving them long distances (Benjamin 2009). In sub-saharan Africa, beekeepers have no opportunity to practice this type of migratory beekeeping: situating a large number of low-cost hives throughout distant locations is the strategy they have designed. Within this system the use of expensive moveable comb technology is incompatible and unnecessary.

Results

There is much empirical evidence from natural settings which support the theoretical model.

In south-west Ethiopia beekeepers report to placing hives,

> "*more than a day's walk away … because there is more forage, beehives are colonised quickly and there are fewer ants*" (Lowore 2014).

Endalamaw, also reporting from south-west Ethiopia records:

> "*Hives are observed in high density in the remaining forest areas. There is a positive correlation between hive concentration and the presence of intact forest*" (Endalamaw 2005:35).

Supporting the contention that transitioning to moveable comb technology would not be profitable, Endalamaw records beekeepers' reasons for not adopting moveable comb hives,

> "*They are economically less feasible"* and *"They are tiresome, requiring more follow up*" (Endalamaw 2005:30).

A study in Kenya supports the association between forests and nectar:

> "*In the present study, honey yield (and thus income from beekeeping) decreased dramatically with distance from the forest. This could be due to decreased overall floral density - and a decrease in bee flora further from the forest*". (Sande *et al* 2005).

In Zambia, Clauss recorded that the average distances beekeepers travelled to their hives sited in six locations, ranged between 8 and 30km. The reasons beekeepers gave for spreading their hives over large areas were to compensate for local fluctuations and to tap various other forest (nectar) resources (Clauss 1992). This deliberate intention to capitalise on nectar resources in different locations is also reported from Ugalla Game Reserve in Tanzania,

" *…in order to hang beehives you can't just have one place…*", "*… bees may miss food in one place so they move, and if you have hives in another place they move there and then you won't lose.*.", (Fisher 1997:274).

A beekeeper in south-west Ethiopia who had converted to frame-hive beekeeping had been taught to visit his apiary once every nine days during the swarming season for management purposes (Yohanes Bekele pers. comm. Feb 2014). This level of management can be achieved only for hives placed relatively close to the home. By confining his operations in this way, this beekeeper has, in effect, forgone the opportunity to harvest the considerable nectar resources further afield.

An economic analysis of forest beekeeping was undertaken by David Wainwright in Zambia in 1988. He calculated daily-wage outcomes for different combinations of hive yields and cropping ratios and compared these to prevailing wage rates. His results showed that even at relatively low yields per hive, and relatively low cropping ratios, forest beekeeping was more rewarding than average agricultural wage rates, (Lowore and Bradbear 2013b, Wainwright 1989).

Discussion

Instead of categorising beekeeping approaches according to hive-type, it is correct to describe systems based on broader distinguishing features. So for example, intensive bee farms are characterised as high-input, high-output systems, while back-yard beekeeping systems are typically small-scale and integrated within a mixed agricultural landscape. Forest beekeeping is defined primarily by the resource base i.e. nectar produced by large natural forests or savannah woodlands.

Another prevailing misconception is the assumption that a change from simple, local-style hives to frame hives is progressive and inevitable, with top-bar hives regarded as a transition between the two. We challenge these misconceptions and propose that:
(1) Beekeeping must be understood and defined according to its system and not just hive-type
(2) The optimal beekeeping system for any context depends on many factors, and change from one system to another does not always represent progress.

Any approach to keeping bees consists of a number of elements. A hive is a container for bees to nest inside and a tool for management, and thus hive-type and management approach cannot be considered independently. Other elements of every beekeeping system are the bees, the nectar source and the environment in which they (and the beekeepers) live. A beekeeping system is thus defined;

Definition of beekeeping system
A beekeeping system includes the bees, the management approach and technology, and the wider environment with which beekeepers interact as they utilise bees to secure yields of their products and services
Lowore and Bradbear 2013a

Frame hives are useful for beekeepers who extract honey and re-use drawn comb, and is less useful for beekeepers who harvest whole combs so they can sell beeswax and honey. A beekeeper who changes their beekeeping system from a tree-based system to a ground-level system for ease of management, must also, by necessity, introduce new approaches (and costs) to predator control - which had hitherto been provided by the hive being located at height in the tree. Elements of each beekeeping system cannot be understood in isolation, and need to be taken as a whole.

To permit an enhanced understanding of extensive forest beekeeping we offer a definition. Forest beekeeping is not unique to Africa and neither is the definition.

Definition of extensive forest beekeeping
Forest beekeeping is a close-to-nature system for forest resource harvesting, which has proven to be a sustainable and cost-effective way to harvest nectar from large, remote, natural forests.

The system has been designed by forest beekeepers to harvest honey made by indigenous wild bees inhabiting a very large area, and they do this by placing simple, locally-made hives throughout the forest. The use of hives sets forest beekeeping apart from honey hunting as the hives afford ownership over the wild bees and the honey they store in their nests. Hive and colony ownership mean that forest beekeeping is not an open-access resource harvesting system.

One defining characteristic of extensive forest beekeeping is that beekeepers utilise simple, inexpensive hives in large numbers. Having a large number (a) enables many hives to be sited over a large area; (b) means that beekeepers can be confident of having a proportion of hives occupied, considering/despite the highly mobile character of tropical honey bees; (c) ensures that bees have adequate numbers of nesting sites available; (d) ensures that nectar yields, which vary over time and place, can be harvested by the bees and made available to the beekeepers in a cost-effective way and (e) spreads and lowers risk.

The simple hives are usually cylinders (made from bark, hollowed out logs, clay, basket, woven sticks, grass or stems) inside which the honey bees build their natural nest, consisting of a series of beeswax combs attached to the inside ceiling of the cylinder. The indigenous honey bees live and reproduce according to their natural behaviour towards maintaining the maximum bee population that the forest can support.

Conclusion

By seeking to offer an intellectual model to demonstrate the validity of extensive forest beekeeping we are not proposing this is the only way. The diversity of beekeeping systems is broad; different situations demand different solutions. Other beekeeping systems that utilise different strategies and technologies include small-scale farm-based beekeeping, urban beekeeping, migratory beekeeping and large-scale industrial beekeeping. The purpose of this paper is to show that in forested environments in Africa (and other countries) - where the environment is complex and uncertain - extensive forest beekeeping is often the optimal system for the prevailing conditions. Development projects which introduce moveable comb hives do not always fail - but some do. The reasons lie in a poor understanding of the variables of the system as a whole.

Forest beekeeping is an extensive system comprising a suite of strategies and decisions which work well considering the natural resource base, the infrastructure and socio-economic context of the beekeepers. Its persistence tells of its sustainability, and its co-evolution in different forests tells of its wide applicability. Yet it remains poorly studied by professionals within the beekeeping community in African countries - where forest beekeeping persists as an economically important wild-resource harvesting system.

The paucity of detailed scientific study of forest beekeeping systems in Africa is to be deplored given the importance of this type of beekeeping for many thousands of families: Notable gaps exist in our scientific understanding of:

- Forest honey production capacity – such as nectar yield per hectare;
- Economics – understanding the return on effort invested;
- Honey bee population dynamics – the balance between honey production colonies and mother colonies;
- Harvesting methods – total cropping of all combs versus partial cropping of combs;
- Ownership and user rights of bee forests and bee trees.

It is clear that forest beekeeping is under threat from changes in land use and receding forests. It is also under threat from neglect and misunderstanding by the professional and scientific bee and forestry community. As a matter of urgency the science of forest beekeeping should be included in beekeeping studies and research programmes across Africa.

Acknowledgements

I would like to acknowledge and thank the support of the University of Huddersfield Wild Coffee and Conservation Project, UK and Ethiopia, Ethio-wetlands Natural Resources Association and CB Dennis Trust, UK

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