Traditional beekeeping with the Indian honey bee (*Apis cerana* F.) in District Chamoli, Uttarakhand, India

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Abstract
The present study aimed to recognize and document the traditional knowledge and methods of beekeeping in district Chamoli. A structured questionnaire on different aspects of traditional beekeeping was administered to 460 traditional beekeepers to collect data from 110 villages of the district during 2011. Beekeeping with *Apis cerana* is a common practice in district Chamoli and has been mostly carried out through traditional methods. The bees are mainly kept in wall hives besides the log and miscellaneous hives, which are made from locally available materials. The people have indigenous knowledge of beekeeping which is passed from one generation to another. In the hill area traditional hives are more suitable than modern hives but for the drawback in colony management. Modern beekeeping is in its infancy in the area, so people need to be encouraged to use modern bee hives for better management of colonies and to minimize loss in the form of the re-use of honey combs for rapid multiplication of *A. cerana* colonies.

Introduction
Beekeeping is an environment friendly (Verma 1989; Verma & Pratap 1993) and agro-forestry based occupation (Singh 1955 and Mishra 1995). It provides enormous potential for income generation, poverty alleviation and sustainable use of forest resources (FAO 1990). Traditional beekeeping with *Apis cerana* is widely practised by rural people in district Chamoli who inherited the tradition from their forefathers and maintain it to this day. It is not a full time pursuit, however, but a supplementary one. Honey is the only product of beekeeping to the villagers.

The state of Uttarakhand is extremely rich in bee forage plants, but proper use of this resource is not being made (Gaur & Nawani 1989; Gaur & Tiwari 2000, 2001). The area is rich in plant species like *Aesculus indica*, *Alnus nepalensis*, *Bassia latifolia*, *Berberis* spp., *Bombax ceiba*, *Citrus* spp., *Cotoneaster microphyllus*, *Cornus capitata*, *Juglans regia*, *Lagerstroemia* spp., *Myrica esculenta*, *Ougeinia oojeinensis*, *Phyllanthus emblica*, *Prunus cerasoides*, *Prinsepia utilis*, *Pyrus* spp., *Rosa* spp., *Rubus* spp., *Rhododendron arboreum*, *Terminalia* spp., *Toona hexandra*, *Zanthoxylum armatum* and numerous Asteracean, Crassulacean, Lamiacean members along with oil, vegetable, fruit and cereal crops which are good sources of nectar and pollen for bees. Authentic documentation of traditional beekeeping in this region is lacking; the present study is an attempt to record the knowledge and methods of traditional beekeeping as practised in district Chamoli.

Study area
The present study was conducted in district Chamoli of Uttarakhand which is well known for its rich biodiversity and cultural mosaic. Geographically it lies between 29º 55' N to 31º 54' N and 78º 54' E to 80º 02' E with an altitude range from 600-7817 m. It is the second largest district of the state, occupying a total area of 7,519 km^2. The district is divided into nine administrative blocks. It has diverse climatic conditions that vary with changes in altitude. Temperatures reach up to 42^0C in summer and in winter plunge as low as 0^0 C. The average annual rainfall is 1203 mm. The total population of the district is 391,114, which constituted 3.87% of the total population of the state. The population density is 49 persons/ km^2 with a sex ratio of 1000:1021. The overall literacy rate is 83.48 % (State census 2011).

Data collection
Data was collected by conducting field surveys during 2011 from nine developmental blocks *viz*., Dasholi, Dewal, Gairsain, Ghat, Joshimath, Karnaprayag, Narayanbagar, Pokhari and Tharali of district Chamoli. 465 villagers possessed traditional bee hives with active colonies which they had in the past also. At least 50 villagers from each block were randomly selected for interview. A structured questionnaire was used to collect information during door to door interviews of

respondents. The information was collected on the socio-economy of beekeepers, hive technology, traditional methods of catching swarms, honey extraction, classification of honey, sting protection, colony management, protection from pest and diseases, knowledge of bee forage and methods for using honey. Both primary and secondary data sources were used; primary data was collected from the respondents. The documentation was done on the basis of interviews and field observations.

Results and discussion

A small proportion (14%) of total families in the district was engaged in traditional beekeeping as a subsidiary with agriculture. Most of the respondents (85%) learnt beekeeping from their parents, elders or from the neighbourhood, 10% developed their own skills through experience, while 5% gained it from training organized by different agencies. Education levels ranged from primary to senior secondary. Most (72%) had primary schooling, and 20% had secondary or senior secondary. Only 2% had higher education while 6% had not had any schooling. Most of the respondents were more than 50 years old. There were 5 or more members in each family in the area. The total land holding size was up to 2 hectares or less per family. Agriculture is the main occupation.

Hives used for traditional beekeeping

Three types of traditional hives are used in the district; their shape and size vary from one location to another.

Wall hives

Wall hives locally known as '*Khadra*', '*Jaala'* or '*Jalota'* are rectangular structures made in the walls of houses and '*Chhaan*' or '*Sunni*' (cattle sheds) at the time of construction. Each hive has a small round or rectangular opening on the outer side as an entrance for bees. The size of '*Jalotas*' varies in different locations; usually they are 45-60 cm in length, 25-30 cm in width and 20-30 cm in height (Figure 1 & 2). Generally one hive is made in each wall, but numbers may vary from 2-4. The interiors of hives are smoothed with cow dung and clay. In winters due to lack of floral resources and extreme cold in the hills, the population of *Apis cerana* colonies decreases to a great extent. Thick wall hives provide considerable insulation in such conditions (Crane 1998).

Log hives

Two types of log hives are found:

Type I: These are made up of cylindrical hollowed pieces of tree trunk 60-100cm long and 20-40 cm in diameter; however size depends upon the circumference of available trunks (Figure 3 & 4). This type of log hives is usually made from the trunk of *Quercus leucotrichophora, Q. floribunda*, *Rhododendron arboreum* and *Pinus roxburbhii*. The entrance is made at the mid front side. Both sides are plastered with a mixture of cow dung and clay.

Type II: Old cooperages locally known as '*Pariya*' or '*Dokha*' when rendered useless for milk products, are used as hives. These are about 70-90 cm long with the diameter at top from 25-35 cm and thickness of log 3-5cm (Figure 5 & 6). An entrance is made towards the outside and the hive is placed horizontally on a raised platform of stones or the wall of a courtyard. It is mainly made up of the wood of *Ougeinia oogeinesis*, *Rhododendron arboreum*, *Toona* spp. A stripe of old comb is fixed to the upper part, inside the hive, and is plugged with a wooden or metal cover, then sealed with a mixture of clay and cow dung. The wooden lid is fixed at the top with an entrance on it.

Miscellaneous Types

These are rectangular box hives made up of separate wooden boards with movable top cover (Figure 7). Their size varies in different localities. Usually these are 80-110 cm long, 25-30 cm wide and 40-50 cm high. During extraction, the top cover is removed along with attached combs and bees, and taken away from the hive, then each comb is smoked and shaken gently. Bees return to the hive and beekeepers cut combs easily. Other types of hives were made up of materials like bamboo, grass and abandoned boxes (Figure 8). However these were rare.

All hives are made from locally available materials, thus are economically cheaper and environmentally friendly. These hives have thicker walls as compared to modern hives thus provide protection to bees from extremely low and high temperatures. In higher hills traditional hives are more suitable than modern hives but for the drawback in colony management. 90% beekeepers used only wall hives, while 7% used log hives, miscellaneous hives and modern hives along with the wall hives. Wall hives were 94% of total hives and sustained 88% of total colonies in the district

(Table 1). The average annual honey production is 3.8 kg from wall hives, 4.1 kg from log and 4.3 kg from miscellaneous hives. Wall hives accounted for 75.5%, log hives 1.5%, and miscellaneous hives 13.6% (Tiwari *et al* 2012). Mattu (1989) has reported 3 to 5 kg honey per *Apis cerana* F. colony from Himachal Pradesh, while Verma (1990) has reported the average honey yield as 4.3 kg for India. As compared to this, the average yield per hive in this area is low.

Methods of attracting and catching swarms

Swarming is a natural process for propagation of honey bees[7]. Swarms are the lone source of bees in traditional beekeeping while only a few empty hives are inhabited by absconded or feral colonies. People clean their empty hives and smear them. 37% used clay, 19% cow dung and 11% used a mixture of both. They put some honey or jaggery in the hive as bait. Some people stick flowering shoots of *Brassica campestris,* or *Raphanus sativus* just above the hive entrance, hoping that scout bees will find their home in the empty hive. The structure of traditional hives makes it impossible to control swarms by inspecting the hive internally. When beekeepers get swarms in their vicinity, they sprinkle water and throw soil or ash to settle them. Some beekeepers follow the swarm and let it settle on its own. Most of the beekeepers (45%) used '*Tofri*' or '*Garori*' (special baskets) made up of '*Ringal*' (bamboos); while the rest uses a '*Jhola'* (bag) to catch and carry swarms. They used burning '*Ghoosa'* or '*Maogu*s' (dry cow dung) in long handled pans (Figure 13). '*Kutrine*' (burning cotton cloth) is used as a traditional smoker and '*Talikh*' (a cloth) to save their faces while catching the swarm. To catch a swarm they apply a layer of jaggery or honey at the inner base of the basket and hang it inverted near the settled cluster. The cluster is gently displaced from the other side with smoke to direct the bees towards the basket. As the swarm makes a cluster on the basket, it is transferred to the hive. When the bees are settled the basket is removed. Finally the hive is closed with its wooden cover and besmeared with a mixture of cow dung and clay.

Honey extraction

The main honey seasons are '*Chait*' (April), '*Baisakh*' (May) and '*Ashaad*' (July-August). In some localities, an additional extraction during '*Kartik*' (October) is also done. Colonies yield most honey in '*Chait*'-'*Baisakh*' and the least in '*Kartik*'. Traditional tools used are '*Dathule*' (sickle) to open the cover or wooden plug and '*Buwan*' (traditional brush) made up of '*Babul*' (*Eriophorum comosum*) to brush off bees (Figure 14). Besides these traditional smokers, large pans for keeping combs, a pot with water and '*Parunla*' or knife for cutting '*Faur*' or '*Fwar*' (bee combs) are required at the time of extraction. Honey is mostly extracted at night but a few beekeepers do it in day time also. They cut down combs, leaving the innermost comb for feeding and to attract swarms the next year. Most beekeepers (85%) squeeze honey combs after removing the brood area from the cut combs, but some squeeze them with the brood intact. The extracted honey has many impurities like insect body parts, wax cells, etc. Usually, squeezed combs are thrown away after extraction, but some beekeepers feed these to their cattle especially bulls. Honey is stored in plastic or metal containers and in bottles. Some households did not extract honey from their beehives for several years on account of lack of knowledge and fear of bee stings.

Classification of honey

Honey is locally known as '*Mou'*, *'Saut'* and '*Sattu*'. Generally honey is classified into three classes on the basis of period of extraction, taste and colour. '*Chait*' honey extracted in April-May has a golden colour and is sweetest '*Ashad*' honey extracted in July is less sweet while '*Kartik*' honey of October in some localities is reported as slightly sour by inhabitants. Based on the floral sources, the honey are classified as '*Payain saut*' (*Prunus cerasoides*), '*Aanyair saut*' (*Lyonia ovalifolia*) and '*Ghariya saut'* (*Brassica campestris*.). People recognise old and new honeys on the basis of colour and crystallization. Deep blackish honey with much crystal accumulation is termed '*Puron saut'* (old honey) while light coloured with less crystals is called '*Nayu saut*' (new honey).

Sting protection

People handle the bee colonies gently to reduce the chances of bees being irritated. They protect themselves by smoke and sprinkling water on the bees while some rub leaves of '*Almor*' (*Rumex hastatus*) on their hands when working with bees. To relieve pain they rub soil or ash, leaves of '*Bhilmor*' (*Oxalis corniculata*) or '*Bhang'* (*Cannabis sativa*) and immerse the stung part in cold water. Sometimes a thin layer of honey is applied over the stung portion or '*Dathule*' (sickle) is

ground on stone with water drops and the paste applied to the affected portion.

Colony management

In the hills, colony management is nearly zero. People open their hives only during honey extraction and then close them till the next extraction. But some beekeepers are aware of their bees noticing that severe winter, heavy rain and foggy environmental conditions stop bees' activity. 17% respondents reported that they feed their colonies once in winter, 12% that they leave a comb to feed bees during dearth periods, while the remaining felt that there is no need to feed bees as they are able to get their food in every season. Only 4% kept pieces of half baked bread made up of '*Mandua'* or '*Koda*' (finger millet), 5% placed piece of '*Gur*' (jaggery) and 2% put honey inside the hives as dearth period food. None of the beekeepers feed their colonies with sugar. Leaving the entrance open, log hives are plastered all around with a mixture of cow dung and clay and covered by 'sacks', '*Puaal*' or '*Paraal*' (straw of rice), dry grasses, etc., to protect them from cold. Some people reported that if the wood of '*Akhor*' (*Juglans regia*) and '*Khinna*' (*Sapium insigne*) was used as fuel, the bees absconded.

Protection from pests and diseases

As the area is rich in biodiversity, a lot of harmful organisms are also in abundance. Bees' enemies are ants, cockroaches, wasps, birds, lizards, pine martine, bears, spiders, phorid fly, wax moth, varroa mite, etc. Of these, the wasps create serious problems. People protect bees by watching for pine martine, birds, lizards and spiders. They use brooms to kill wasps. Some beekeepers reduce the size of hive openings by using metallic plates, iron or wooden mesh (Figures 9-12) to check the entry of wasps into hives. The traditional method to check the entry of ants is spreading ash or turmeric powder in their way. However, people do not have any remedy for wax moths, phorid flies and cockroaches. The beekeepers never use chemicals to control diseases or pests though 7% sprinkled '*Gaont*' (cow urine) in and over the hive.

Traditional knowledge about bees

The local people recognise '*Muwar*'or '*Muwara*' or '*Maara*' (honey bee) by its shape, size, colour and stripes on the body. Most people think that all members (worker, drone and queen) of colonies have stings and '*Koov*'or '*Koo*' (queen) is considered king of the colony. 48% beekeepers identified the queen cells whereas only 31% differentiated between the drone and worker cells. People believe that bees are the gift of '*Lakshmi'* (goddess of wealth) while some consider them gifts from their forefathers. Thus some villagers do not favour the sale of their honey and even disagree to transfer wall colonies into modern hives. Women are not allowed to touch the active colonies during the menstruation period for two reasons. First the colony will abscond and second they will be punished by the goddess for disobeying this belief. A few respondents (4%) believe that a bee becomes handicapped once it stings someone and then can supply only water to the colonies instead of pollen and nectar. Honey bees never accept a wall hive with '*Treekon'* (triangular) cornera; they will abscond, if it is so.

Knowledge about bee forage

People have a good knowledge of bee forage plants in their surroundings. The common bee forage plants are cereals such as '*Mungari*' (*Zea mays*); vegetable as '*Barsati bel*' (*Cucurbita* spp.), '*Gudri*' (*Luffa cylindrica, L. acutangula*), '*M*ooli' (*Raphanus sativus*), fruits as, '*Aaru*' *(Prunus persica),* '*Melu*' *(Pyrus pashia),* '*Panyaa*' (*Prunus cerasoides*)*,* '*Limba*'*,* '*Malta*'*,* 'K*aggi*'*,* '*Chakotra (Citrus* spp.); oil yielding plants as '*Gharia or Deina*' (*Brassica campestris*) and wild plants as 'Aanyair' (*Lyonia ovalifolia)*, '*Burans*' *(Rhododendron arboreum)*, '*Tun*' (*Toona sp.*) '*Ghingaru*' *(Pyracantha crenulata)*, '*Hisar*' (*Rubus* spp.), '*Kilmor*' *(Berberis* spp.), '*Kunja*' *(Rosa* spp.), '*Paingar*'*(Aesculus indica)*, '*Ust* or *Utees*' *(Alnus nepalensis),* etc*.*

Uses of honey in the study area

Honey is consumed as a spread over '*Roti*' (bread) after mixing with '*Ghee*' (clarified butter) in equal proportion (1:1). It is also consumed alone or mixed with other foods. It is not the part of daily food of the inhabitants of this region. Some people use honey as a sweetening agent in lieu of sugar in some traditional dishes. Honey is used in different rituals, religious and cultural ceremonies. Honey is an important ingredient of traditional medicines; '*Kartik*' honey is considered the best medicinal value (Figure 15). Honey is used to heal cuts, wounds and burns, and to cure cough and cold, eye infections and respiratory problems. Most inhabitants give honey as a special gift to their relatives.

Conclusion

The study revealed that traditional beekeeping is a live heritage in the area. Besides using traditional bee keeping, there is a need to adopt modern beekeeping practices. Sectors like bee management, better extraction and storage practices with the potential of raising the quality and quantity of honey need to be strengthened which Reuse of honey combs after extraction by minimizing the loss of bees labour, will help in rapid multiplication of *A. carana* colonies.

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Table 1. Status of bee hives and bee colonies in District Chamoli (Year 2010-11)

Block	Village Surveyed	Number of bee hives			Number of bee colonies		
		Wall hives	Log hives	Miscl. hives	Wall hives	Log hives	Miscl. hives
Dasholi	50	12370	138	211	950	32	41
Dewal	58	19414	105	203	712	9	55
Gairsain	52	17998	50	96	932	6	14
Ghat	44	15430	63	89	936	16	21
Joshimath	46	16528	42	62	587	4	8
Karanpraya g	46	9800	79	95	606	13	27
Narayanbag ar	50	13850	140	222	900	14	64
Pokhari	42	11464	38	29	856	5	3
Tharali	50	9682	64	172	854	8	48
Total	**438**	**126536**	**719**	**1179**	**7333**	**107**	**281**

Fig. 1-2 Wall hives (inner view); Fig. 3 Log hive inner view; Fig. 4-6 Log hives side view; Fig. 7-8 Miscellaneous hives; Fig. 9-12. Hive entrance; Fig. 13 Traditional smoker; Fig. 14 Bee brush; Fig. 15. Granulated honey.

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