BEEKEEPING AND HONEY PRODUCTION IN NIGERIA

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Beekeeping is one of the oldest branches of agriculture and a form of animal husbandry. It includes the collection and care of bee swarms, pollination of field crops by bees, the study of bee products and the breeding of bees for large-scale honey production. Beekeeping is thought to have originated in ancient Valencia from where it spread to other parts of Europe and thence to the New World (Ioyrish,1974). Rock paintings depicting activities of Stone Age honey hunters have recently been discovered in South Africa (Pager,1973). Today, beekeeping for honey production is a profitable agricultural enterprise in many countries and an important foreign exchange earner for those that export honey and beeswax. Unfortunately, beekeeping as a commercial venture is still largely unexplored in Nigeria, and the country meets domestic demand for honey mostly by importation from producer countries. This paper discusses the techniques of beekeeping and honey production developed and practised at the Agricultural Research and Training Station (ARTS), Umuahia, Nigeria, using the tropical African bee, *Apis mellifera adansonii*.

PRODUCTION AND PROCESSING OF BEE PRODUCTS

Raising bees in hives: There are three castes of bees in a complete colony, one queen, several hundred drones (males) and 30,000 to 75,000 workers (sterile females). The queen lays all the eggs for new bees and plays a key role in the colony. The drones mate with the queen, and the workers carry out such other duties as nectar collection, feeding the queen, ventilating and cleaning the hive, building combs, making honey, etc.

Beekeeping generally starts with the construction of a suitable hive, the home of the bees. Several types are available, such as the frame hive developed and used at ARTS, the pot hive, calabash hive, the log or bark hive used in the bush, the African Dadant, the gable hive, Langstroth hive and William Broughton Carr hive. While pot hives are simple, economical and suited to small-scale honey production, the frame hive (Fig.1) is preferred for large-scale production. This hive is equipped with movable frames and the colony of bees builds its comb within the confines of the frame. The frame hive allows periodic inspections to be made without unnecessarily disturbing the bees. Most modern apiaries use the multiple-chambered frame hive called the Lang-

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stroth hive, which allows more room for bee activities and hence more honey yield (Anon., 1971).

One way to develop an apiary is to collect and domesticate swarms of wild bees. Generally, when bees are looking for a new home, they swarm out from the old one with their queen and settle on some convenient place such as the trunk of a tree, or the eaves of a house, where they quickly form a cluster. When the cluster has settled, the beekeeper should examine it to see if it is a true swarm complete with a vigorous queen. If so, a pot hive may be placed near the bees and they are induced to enter by means of a smoker (Fig.2). The smoker consists of a metal canister into which some pieces of old sack are placed and set alight. By pressing a pair of bellows attached to the canister, a puff of smoke is emitted. Although bees do not like smoke, it does not harm them. They are tranquillized and induced to enter the collection hive. The mouth of the pot is then quickly inverted over a wooden board and the colony carried away to the apiary where the bees are transferred to a frame hive.

Decoy hives can be useful in collecting wild swarms. These are put in suitable places in the hope that a passing swarm may investigate. If the new hive is suitable, the bees on the outside of the cluster open their scent glands and fan their wings to guide the rest of the swarm into the hive. Hives should be kept in an area that is well-drained, close to a source of water, protected from prevailing winds, and far from footpaths and areas where ants are nesting. At ARTS, the apiary is protected by palm leaves, and the hives are placed on wooden stands heavily coated with motor oil to protect them from ants. Seasonal temperature changes may necessitate re-locating the hives. The maximum temperature for bee activity is about 95°F; at higher temperatures the bees tend to collect water to cool their hives, instead of going for nectar. Initially the bees are fed on sugar syrup, (about 50% sugar in warm water).

Manufacture of honey by bees: As soon as the bee population in a hive attains about 35,000 and feeding of syrup has ceased, the bees start extensive foraging to gather nectar from a variety of flowering plants, both wild and cultivated. Table 1 shows the major sources of nectar for bees in south-eastern Nigeria.

Table 1

Plant	Time of flowering
Kola	July - September
Cassava	September - November
Citrus	April - September
Melon	March - June
Cashew	February
Oil palm	September - November
Pitanga cherry	Mid-September
Copaiba balsam	December
Bush marigold	June
Portulaca	All the year

Nectar is a watery solution of fructose, glucose and sucrose, with traces of proteins, salts, acids, vitamins and essential oils. The sugar content of nectar varies from 4% to 80% depending on the type of flower, soil and air conditions, especially moisture (Ioyrish, 1974). Bees generally prefer nectar with at least 15% sugar. Nectar has been classified according to the proportions of glucose, fructose and sucrose it contains (Crane,1975).

Honey is produced from nectar by the bees. The forager or field bee, on return to the hive, discharges the nectar into empty wax-comb. The house worker bee picks it up and stores it in her honey stomach where it undergoes complex processing which has already begun in the field bee's honey stomach. This involves alternate swallowing and regurgitation of the nectar repeatedly 120 to 240 times, by which the sucrose is hydrolyzed to glucose and fructose by the enzyme invertase produced by special salivary glands. The nectar, now transformed into honey, is deposited in the wax-comb where it is further concentrated to about 80-85% sugar by evaporation. The cells of the honeycomb, now filled with ripened honey, are securely sealed with wax secreted by the bees. This honey can be stored for years.

Honey is monofloral or multifloral depending on whether the nectar is gathered from one main floral source or from several sources. Because of the extensive cassava (*Manihot esculenta*) and citrus plantations available at ARTS, cassava and citrus honeys have been produced and evaluated for several years. Apart from nectar, other sugar-containing extra-floral exudates and saps can be used in honey production (Crane,1975).

Harvesting and processing of honey: One of the advantages of using a frame hive is that it facilitates periodic inspection of the hive, and the beekeeper can know when the honey is ready for harvest. Unripe honey appears somewhat greenish. Harvesting disturbs the bees, and the beekeeper must try to avoid being stung by letting several puffs of smoke from a smoker into the hive. The bees, on sensing the smoke, anticipate danger and go back into the hive to eat lots of honey in preparation for escape. Swollen with honey, they are neither capable of escaping nor effectively stinging an intruder. The ripened combs laden with honey are carefully removed from the hive, placed in a honey press (Fig.3), squeezed by applying pressure, and the liquid honey with chunks of broken comb allowed to settle for seven days. Periodically the broken comb floating on top of the honey is filtered through two layers of cheese-cloth and the resulting filtrate allowed to settle again to eliminate air bubbles that enter the honey during filtration. The honey is finally scummed, placed in labelled glass or plastic bottles and stored in a cool dry place.

Recovery of beeswax and propolis: The broken combs are further processed to recover beeswax and propolis (gums from buds), both of which are of some commercial interest. In Nigeria, beeswax is rendered by heating crude combs either over a wood fire or with a

solar wax extractor.

The method using a wood fire is shown in Fig.4. The squeezed or crushed combs are soaked in water overnight to remove the propolis. The crude comb is then removed and put in a fabric bag, which is lowered into a wide-mouthed earthen pot equipped with a false bottom and secured by a rope tied to an overhead wooden rod. Water is poured into this pot and heated until the wax melts and floats, leaving rubbish behind in the bag. The floating wax is skimmed into a mould containing warm water, and at the same time the baft bag is poked to stimulate flow of wax into the mould until the flow stops. The wax is covered, allowed to harden by cooling when it takes on the shape of the mould.

The solar wax extractor is a simple device for rendering wax using the heat of the sun. It consists of a rectangular wooden box with an overlapping cover whose top is a sheet of glass (Figs.5 & 6). This box houses a deep metal tray in which the propolis-free combs are put. At a temperature of 130-140°F, the wax starts to melt and flows through the perforations on the narrow side of the tray into the deep wooden box leaving rubbish behind. The molten wax is allowed to cool and cake before it is removed (Fig.7).

Rendering of the crushed comb without prior removal of the propolis is possible with the solar wax extractor, allowing simultaneous extraction of the beeswax and the propolis. The propolis usually settles at the bottom of the metal tray and can be scraped off after the beeswax has been collected. The propolis thus recovered does not require further processing.

Extraction of bee venom: Bee venom possesses useful medicinal properties, and is collected by placing a clean polythene sheet on the bees' entrance to the hive. This infuriates the bees which react by stinging the polythene sheet at random, depositing their venom on it. On drying, the deposited venom solidifies into a white crystal-like substance which can be carefully recovered.

CHEMICAL COMPOSITION OF SOME NIGERIAN HONEYS

Studies carried out at ARTS on forest trees and agricultural fruit crops indicate that the plants listed in Table 1 provide the best nectar for honey bees. Cassava and citrus honeys are produced in large quantities at ARTS.

Honey samples were obtained from the Institute's apiary and stored in the cold room at 4°C until analyzed. The three imported honeys came from Chellaram Stores, Zaria.

Colour was determined with the USDA honey colour classifier. Moisture content was computed by determining the refractive index of honey at 23°C with an Abbe refractometer and using the Chataway table. Carbohydrates were separated by liquid chromatography on a column of activated charcoal (White *et al.*,1962). Glucose, fructose, sucrose, other disaccharides, higher carbohydrates, free acidity, lactone acidity, total acidity, pH and diastase activity were determined

after the method of White *et al.* (1962). Nitrogen content was obtained by the micro-kjeldahl procedure (Howitz,1975). Protein was estimated by multiplying the nitrogen figure by 6.25.

Table 2 gives the results of analyses carried out on three indigenous and three imported honeys. The most important components of honey are the simple sugars which are largely responsible for its characteristic sweetness. Glucose, fructose and sucrose were present at comparable levels in the samples studied, except for the wild Nigerian honey. However, the latter's relatively low figures were not reflected in decreased sweetness during tasting and smelling tests. Diastase activity is crudely related to the extent of processing and storage time of the honey. Monthly losses in diastase activity of 0.70, 0.83 and 1.30 were observed in the Nigerian wild, citrus and cassava honeys respectively when stored at 4°C. The levels of free, lactone and total acidity compare with values reported by White *et al.* (1962) for over fifty American honeys. The percentage nigrogen is an index of the presence of nitrogenous substances such as proteins. The three Nigerian honeys adequately meet the specifications laid down by the U.S. Food and Drug Administration (White *et al.*, 1962).

There are large cassava plantations throughout Nigeria, and we believe that honey production from cassava can be a viable enterprise which will help to reduce Nigeria's consumption of imported honey and conserve foreign exchange.

Table 2 Chemical composition of some Nigerian and imported honeys

Geographic source	Designation or name	Colour	Moisture %	Ash %	Glucose %	Fructose %	Sucrose %	Maltose %	Higher sugar %	Diastase activity (arbitrary units)	Nitrogen %	Free acidity (meq/kg)	Lactone acidity (meq/kg)	Total acidity (meq/kg)	pH
Nigeria	Cassava	Light amber	23.1	0.00	29.7	33.3	0.90	9.4	2.7	7.3	0.035	7.37	2.72	10.09	4.2
Nigeria	Citrus	Extra-light amber	21.6	0.09	30.6	36.8	1.20	4.3	2.2	15.8	0.037	6.85	1.90	8.75	4.0
Nigeria	Wild	Dark amber	21.0	0.21	26.5	30.0	0.60	1.7	1.3	16.2	0.065	6.05	1.75	7.80	4.3
Greece	Hymettus	Light amber	16.2	0.60	32.4	40.2	1.00	4.1	2.3	8.3	0.065	4.85	0.05	4.90	4.2
Cyprus	Honbee	Dark amber	23.5	0.24	30.4	36.4	1.90	6.9	0.9	4.1	0.358	6.10	1.15	7.25	4.3
U.K.	Pure	Light	23.5	0.20	31.4	35.1	1.90	7.0	1.1	13.0	0.107	5.20	0.65	5.65	4.3

USES OF HONEY, BEESWAX AND VENOM

Of the estimated annual world consumption of honey, 90% is eaten directly as honey while the remaining 10% is used in various commercial and domestic products.

Honey is used in breadmaking as a substitute for refined sugar. In some countries, notably the United States and Canada, there is hardly a place where bread baked with honey cannot be purchased. There are some confectionary products that can only be made with honey, e.g. *halvar* (Turkey), *pasteli* (Greece), *torrone* (Italy), *turron* (Spain), *nougat* (France) and 'honey drop' (Italy). Confectioners in the United States use honey in various candies. In the world today, some 1500 - 2000 tons of honey are used annually in commercial confectionery. Other uses of honey include the manufacture of breakfast cereals, honey spreads, honey butter, baby foods, packaged meat, honey preserves, dry cake mixes and a honey-milk product.

Honey is extensively used in tobacco products, especially cigarettes. The hygroscopic nature of honey helps to keep tobacco moist.

Honey has been regarded as a cure from very early times. Recent medical practice recommends honey as effective and inexpensive for healing infected surgical wounds and bedsores. The honey renders the wound bacteriologically sterile within 3-6 days and finally effects total healing. Soviet scientists have claimed good results from using an ointment of honey and fat on infected necrotic wounds (Ioyrish, 1974). Honey has been used for gastrointestinal ailments, such as gastric ulcers, in which there is hyperacidity; the honey is thought to act by first healing the surface of the gastric mucosa, and secondly by promoting the general building of the body and particularly the nervous system. Honey is a basic ingredient of several medicines, including cough syrups. The high fructose content of honey speeds up alcohol metabolism in sobering drunken patients. American scientists have shown that honey's antibacterial effect derives from hydrogen peroxide, a toxic chemical produced by the natural glucose oxidase system in honey (Crane,1975). The ancient Greeks, Romans and Egyptians used honey to preserve meat as well as to embalm the dead.

Cosmetic uses of honey date from early times. Nero's wife, Poppea, who employed 100 slaves to look after her beauty, used honey and asses' milk as a face lotion. Today, honey is found in many lotions, handcreams, facial masks, shampoos, soaps and hair conditioners.

Bee venom, a by-product of beekeeping, has long been used in the treatment of rheumatism and certain eye and skin diseases. Beeswax is important in modelling, and the manufacture of cosmetics, adhesives, polishes and candles.

Honey is fermented with yeast to produce alcoholic beverages, the most popular of which is mead. The world consumption of honey for commercial alcoholic beverages stands at 100 tons for liqueurs and another 100 tons for wines. To this must be added 40,000 tons for African honey beers.

PROBLEMS AND FUTURE OF BEEKEEPING IN NIGERIA

The Appendix presents some useful tips for year-round bee handling and management. The most serious problem of beekeeping in Nigeria is the bee itself. *Apis mellifera adansonii*, the dominant bee in West Africa, is very aggressive, difficult to manage and has an unusual propensity to abscond. The fear of being stung deters people from beekeeping. This fear is due to ignorance about the behaviour and sociology of bees. A bee uses its sting only in self-defence, and in so doing, brings about its death. When the sting pierces the victim's skin, the last segment of the abdomen ruptures and the bee cannot survive more than two days. In removing a sting from the skin, care should be taken to avoid squeezing the white bulb which adheres to it. It is best to pry out the sting with a finger nail, thus preventing the poison from entering the blood stream.

Bees have a remarkable ability to smell sweat from an intruder, and this appears to stimulate stinging. If one tries to ward them off by beating them, they are likely to respond by stinging. If any bees are crushed, the scent will infuriate others, which pursue and sting any moving animal. Stings can be avoided if the bees are handled calmly, methodically and gently, and by wearing protective clothing. A bee veil consisting of fine-meshed net draped over a wide-brimmed hat will protect the face and neck. Shirt cuffs should be securely fastened to protect the arms and body, and gloves with long gauntlets protect the hands.

There is very little sustained research on beekeeping in Nigeria. Even the literature is difficult to come by. In the 1966 edition of World Bee Research Directory, only one worker was listed for Nigeria (Crane,1966). It is desirable to set up centres to undertake full-scale breeding of a bee that will be easier to handle, and also possess good honey-gathering qualities. This will meet the demand for bees, as modern bee farming replaces traditional beekeeping. Other areas for research are the identification of more plants that produce nectars with good honey potential, techniques for protection of bee colonies against predators, use of bees in the pollination of economic crops and honey quality control.

Another problem is the lack of trained beekeepers. There are so few of them in Nigeria (Table 3) that it will be very difficult to interest more people in beekeeping as a means of livelihood and not just a hobby.

Adverse weather conditions can create problems ranging from the inability of flowers to secrete enough nectar to that of the efficiency of bees to transform nectar into honey. Bees are cold-blooded and if the temperature is too low (below 46°F) they not only suffer from a cold cramp but are unable to fly to collect nectar and may die. Plants cannot yield nectar unless the temperature is 75-95°F. Rain or high relative humidity tends to dilute the nectar, thus needing extra work by the bees to carry the nectar home and concent-

rate it by evaporation. In addition, few bees will fly in a wind of more than 25 k.p.h. (Crane,1975). The weather is the single most important factor causing year-to-year variations in nectar production from the same plant.

Table 3 Statistics of honey production in Nigeria (data extracted from Crane, 1975, p.137)

Approximate number of beekeepers	100,000
Estimated number of bee colonies	700,000
Annual honey production (tons)	2,800
Production/colony (kg)	4
Colonies/beekeeper	7
Colony density or colonies/unit area	0.8
Average honey consumption/capita (g)	30

With the domestic consumption of honey growing, the future for beekeeping is bright. Because the cost of starting a bee farm is low compared with other kinds of farming, it is an industry that can help develop rural areas. A trained beekeeper with three support staff should be able to run 1000 colonies of bees, and produce about 4000 kg of honey per season (Anon,1981). Given the current price of honey as ₦5 per kg in Nigeria, this represents a gross income of about ₦20,000 per season.

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APPENDIX Calendar of Bee Activity and Management in Nigeria

January: Each colony of bees has honey in store. It is time to crop the honey. Few young bees remain in the brood chamber; all comb with brood is at the centre of the single-chambered hive. The double-chambered frame hive will have honey in the brood chamber. Crop the super and reserve the honey in brood chamber for the bees to feed on during the rains when nectar is scarce.

February: Honey is still available in hives. Certain plants, cashew for example, are in flower.

March: Honey in hive; bees feeding normally. Pollen arrives in the hive. Queen starts laying eggs. Some wild plants are in flower, e.g. *Acioa*, pitanga cherry and citrus.

April: Brood chamber is filled with young bees and brood; occasional queen cells are found. The bees are preparing for swarming; take swarm control measures; plan for new hives. Citrus and oil bean trees are now in flower.

May: Put out decoy hives; bees are swarming. Collect swarms. Inspect your stock. Continue with precautionary swarm control methods. Garden vegetables are in flower, e.g. melon.

June: Peak period of swarming. Do not let new swarms escape. Get them into proper hives.

July: There are few swarms issuing; collect and feed them with sugar syrup. Plants such as kola, cucumber, *Phaseolus* and other Papilionaceae (garden legumes) are in flower.

August: Colonies may run out of stores; feed them with sugar. If subsistence plants like *Portulaca* are grown near the apiary, they will provide nectar for food.

September: The swarms collected in June and July are established and building up in strength. The queen in lay produces more young bees. Field crops such as cassava, citrus and oil palm are in flower.

October: End of rainy season. Bush or forest trees are flowering. Put queen excluder or a brood chamber and honey super on top. This prevents the queen from going into the honey super to lay eggs in the cells of the comb. The bees will ascend into the super and start building honey combs. Cassava is still in flower.

November: Bees are building honey comb as nectar arrives in the hives. Bees are making joyous hum. Cassava is still in flower.

December: Bees are ripening the honey. They notice any movement around the hive and will defend their store. Manage them calmly. Let them work.

Explanation of Figures:
Fig.1. Bees in a frame-hive.
Fig.2. Smoker.
Fig.3. Honey press.
Fig.4. Rendering of beeswax over wood fire.
Fig.5. Solar wax extractor (closed).
Fig.6. Solar wax extractor (opened).
Fig.7. Beeswax.

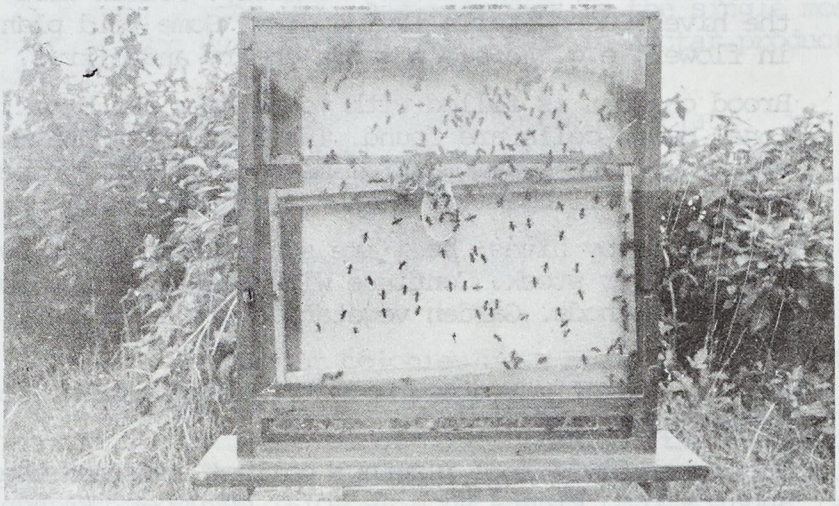


Fig. 1

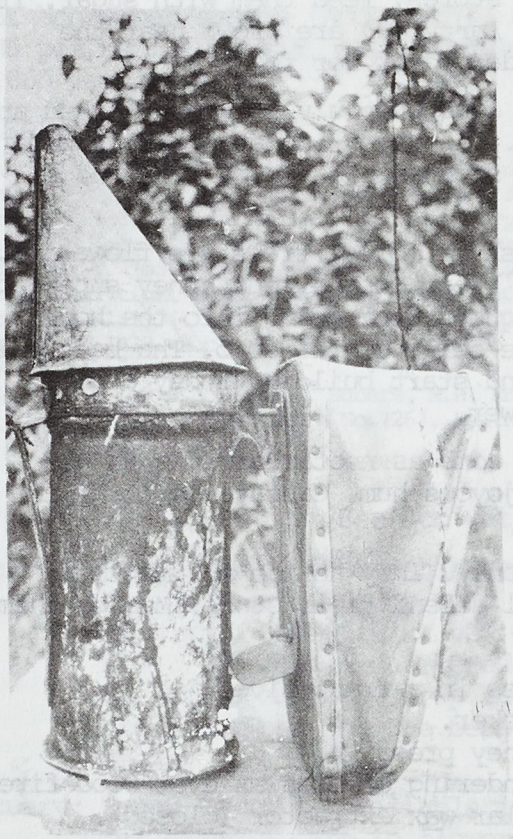


Fig. 2

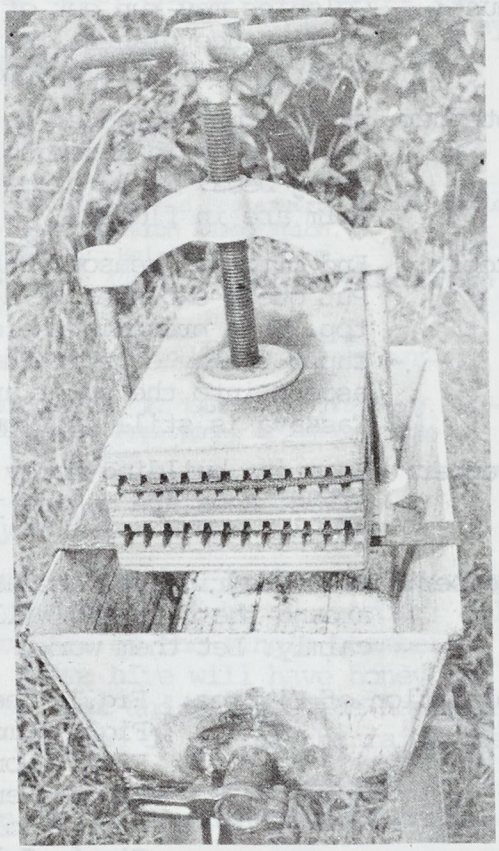
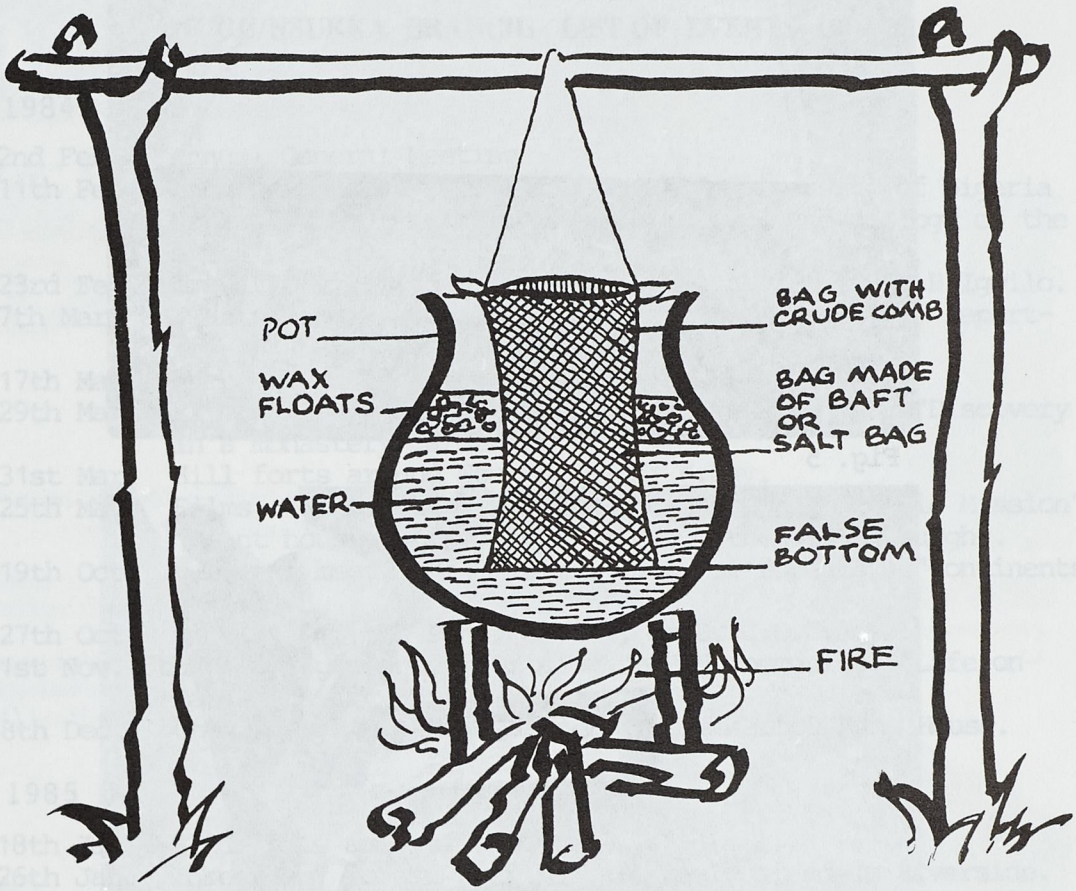
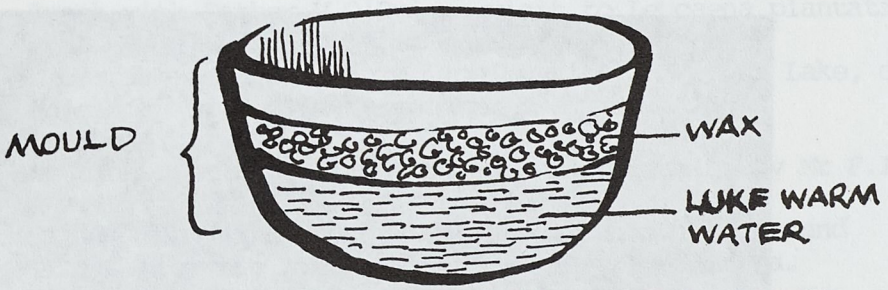


Fig. 3



BOILING BEE-WAX OVER WOOD FIRE



WAX IN MOULD SOLIDIFIES WHEN COLD

Fig. 4

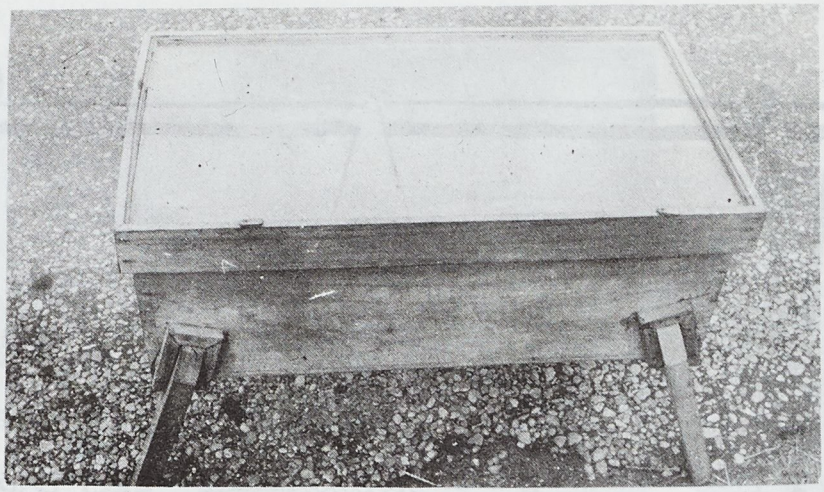


Fig. 5

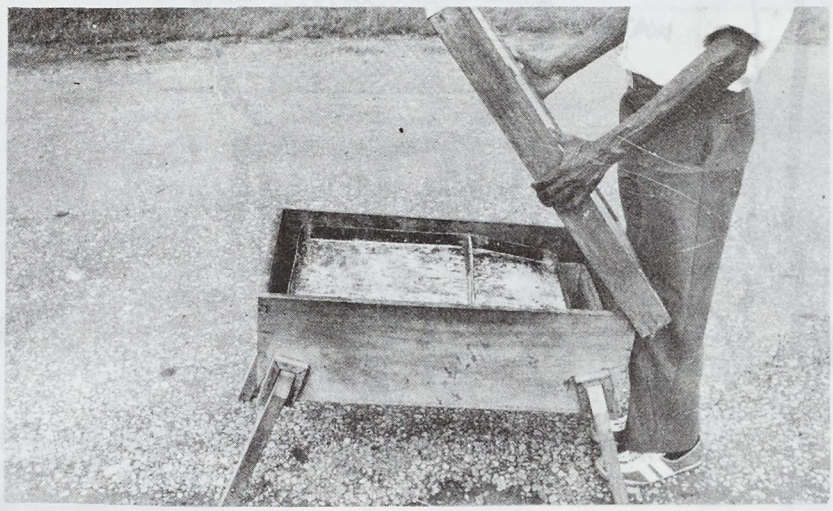


Fig. 6

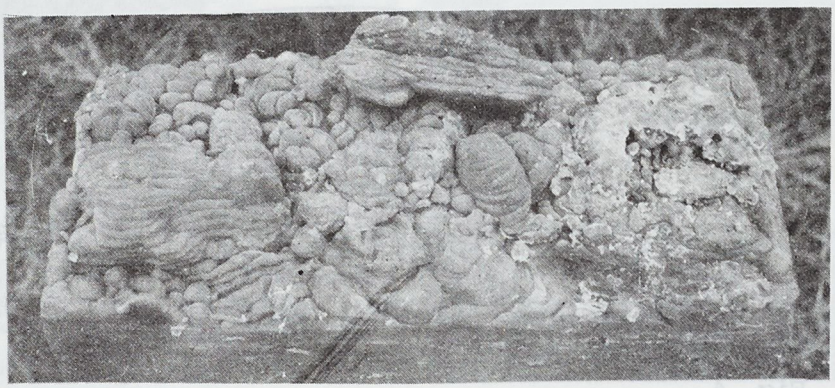


Fig. 7