Giant Honeybee (*Apis dorsata*), its Foraging Plants and Honey Hunting in the Sundarban of Bangladesh

Dr. M. Wahed Baksha
Bangladesh Forest Research Institute, Chittagong 4211.

Abstract

The Sundarban, the largest single tract of mangrove forest in the world, is famous for its economically and ecologically important flora and fauna. The Sundarban of Bangladesh is the main natural home of the giant honeybee, *Apis dorsata* Fabr. (Apidae : Hymenoptera). The bee gives honey and wax contributing to fetch handsome revenue to the national economy and supports the livelihood of a group of resource-poor honey hunters, locally known as '*mowalis* or *mowals*', living in the vicinity of the Sundarban. This paper presents author's observations and reviews on scientific and practical aspects of the bee, its nectar source and age-old honey hunting in the Sundarban. It also analyzes the constraints and prospects with suggestions for better management of the resource based on ecological consequences and socio-economic conditions of the people living in the adjoining areas. The paper, highlighting the value of the bee to environment and society as a whole, is expected to be useful to the scientists, extension workers, policy makers, planners, forest managers and aid agencies.

সারসংক্ষেপ

সুন্দরবন পৃথিবীর মধ্যে একক বৃহত্তম ম্যানগ্রোভ বন। এর উদ্ভিদ ও প্রাণীকূল অর্থনৈতিক ও বাস্তুসংস্থানগত কারণে সুবিদিত। বাংলাদেশের সুন্দরবন বড় মৌমাছির (*Apis dorsata*) প্রধান প্রাকৃতিক আবাসভূমি। এ মৌমাছি হতে প্রাপ্ত মধু ও মোম জাতীয় অর্থনীতিতে প্রচুর রাজস্ব যোগায় এবং বনের আশে-পাশে বসবাসকারী দরিদ্র মধু সংগ্রহকারী "মৌয়াল বা মৌয়ালী"-এর জীবিকা নির্বাহে অবদান রাখে। এ প্রবন্ধে এ মৌমাছির বৈজ্ঞানিক ও কারিগরী দিকগুলো, এর মধুর উৎস এবং চিরায়ত মধু সংগ্রহের বিভিন্ন দিকগুলো পর্যবেক্ষণ ও পর্যালোচনা করা হয়েছে। এতে এগুলোর সমস্যা ও সম্ভাবনার দিকগুলোও বিশ্লেষণ করা হয়েছে। বনের চারপাশে বসবাসকারী জনগণের আর্থ-সামাজিক দিকের ও সুন্দরবনের বাস্তুসংস্থানের উপর ভিত্তি করে মৌমাছির উন্নত ব্যবস্থাপনার উপর সুপারিশ প্রদান করা হয়েছে। পরিবেশ ও সমাজের উপর এ মৌমাছির প্রভাবের উপর লিখিত এ প্রবন্ধটি বিজ্ঞানী, সম্প্রসারণকর্মী, নীতিনির্ধারক, পরিকল্পনাবিদ, বন ব্যবস্থাপক এবং সাহায্যকারী প্রতিষ্ঠানের কাজে লাগবে বলে আশা করা যায়।

Key words : Apiculture, beekeeping, bee pollination, honey hunter, Sundarban mangrove.

Introduction

The Sundarban, literally meaning the 'beautiful forest' or the 'forest containing Sundari (*Heritiera fomes*)', is the single largest tract of natural mangrove forest in the world. About 60% of the Sundarban covering an area of 6,000 km^2 lies within Bangladesh and the remaining 40% in the Indian territory. The forest is located in the delta of the river Ganges and intersected by a complex network of rivers and channels. Biodiversity of the

forest is very high comprising about 70 plant species of which sundari (*Heritiera fomes*) and gewa (*Excoecaria agallocha*) are the dominant. The forest has been given the status of World Heritage Site by the UNESCO in 1997. The height of the forest generally varies from 15 m in the east to 5 m in the west (Siddiqi 2001a). The Sundarban has been managed and protected for about 125 years by the Forest Department and has the status of a reserved forest with controlled and very limited human access. The forest is intended to be managed on a sustained yield basis under a selection-cum-improvement felling system with a 20-year felling cycle (Choudhury 1968). The Sundarban in the Bangladesh territory is divided into 55 Compartments under four administrative Forest Ranges such as Shorankhola, Chandpai, Khulna and Satkhira from east to west. According to the degree of water and soil salinity the forest is broadly divided into three zones, namely slightly saline (Shorankhola Range), moderately saline (Chandpai and Khulna Ranges) and highly saline zone (Satkhira Range).

The Sundarban is a highly dynamic ecosystem, because of the size of the area, the large amount of river water with great sediment load, the abundance of monsoon waters, the advance of tidal surges and damaging winds, and tectonic movements (Vannucci 2001, Siddiqi 2003). Another peculiarity is the large human population living in the vicinity of the forests, in addition to labourers and occasional or periodical visitors, who live directly or indirectly on the forests. Peoples' occupations are fishery, honey hunting, wood collecting and agriculture. Community management of this mangrove ecosystem is therefore vital for the sustainability of the forest. Sundarban is the main natural home of the indigenous giant honeybee, *Apis dorsata* Fabr. (Apidae: Hymenoptera). Its honey and wax fetch a handsome amount of revenue to the government exchequer annually and largely support the livelihood of a group of people living around the forest. This paper highlights the scientific and practical aspects of the bee, its foraging plants, honey hunting and its economic benefit in order to improve the management aspect of the resource for obtaining sustainable yield from the forest.

Materials and methods

General observations on honeybee, its foraging plants and honey hunters were made by periodic visits in the Sundarban during 1991-92 and 1996-98. Field visits were also made with the FAO Entomology Consultant, Dr. H. Roberts and the World Bank Entomology Consultant, Dr. E.B. Lapis as their national Counterpart Specialist. Information on the resources and their beneficiaries were noted during the field visits. Interviews were taken from the honey hunters and the Forest Department's personnel. Previous record, literature and relevant information both published and unpublished were reviewed and assessed.

Observation and discussion

Giant honeybee of the Sundarban

The Sundarban forest is the major natural habitat of the wild indigenous giant honeybee, *Apis dorsata* Fabr. (Apidae: Hymenoptera). Two other indigenous species, the Indian bee (*A. cerana* Fabr.) and the little bee (*A. florea* Fabr.), are also present in the Sundarban but they are of little value as regards to the production and extraction of honey and wax from the Sundarban.

As found in the plain land and hill forests of the country, *A. dorsata* builds a single large comb varying in size from 1.5-2.0 m in length and 0.6-1.2 m in wide depending on the season and stage of comb development. Combs are built in such localities where flowers with abundant nectar supply are available. As soon as the nectar supply in a particular locality depletes, they migrate to other places. Frequently many nests occur together in favourable sites, and the sites of the colony are used year after year (Beeson 1941).

Every year thousands of colonies of *A. dorsata* migrate into the vast tidal forest of the Sundarban usually from December to February. The

bee migrates from the Sundarban and plain land to the sheltered hilly areas in the monsoon and returns back again in the winter.

A. dorsata is not suitable for domestication. Being very aggressive and ferocious, it readily attacks those who disturb its nest or approach a colony, and frequently pursues an intruder for miles. When irritated the abdomen of the worker bee is pointed downwards and the bee then ejects a transparent poisonous liquid from its sting. There are occasional reports of human beings and animals being stung to death by the bee.

Biology of *A. dorsata*

The egg of *A. dorsata* hatches after 2-3 days. The larval stage lasts for 4-5 days in workers and drone bees and 4.5 days in queen bees. The duration of the pupal stage varies from 9.5-12.0 days in workers bees, 13.5-15.5 days in drones and 6.5-7.0 days in the queen bees (Qayyum and Ahmad 1967). The size of queen cells is much longer, and such queen cells are found protruding from the lower edge of the comb. *A. dorsata* are good honey gatherers and they even forage at night on nocturnally blooming plants, and active foraging ranges between 15-23^{0}C (Verma 1990).

Comb building sites

In other parts of the country, *A. dorsata* usually builds combs high on the branches of tall trees such as banyan or bot (*Ficus benghalensis* L.), ashwatha (*F. religiosa* L.), mango (*Mangifera indica*), Indian black berry or kalo jam (*Syzygium cumini*), etc. Sometimes dozens of colonies can be found on one tree. It also builds comb suspended from rock, cliff and ceiling from houses (Baksha 2001).

In the Sundarban hives are formed at a very low height, a trait dissimilar to the behaviour shown by the species elsewhere. The honeybee avoids trees growing in the open or along wide channels and at the margins of the islands. The preferred height is 1.5-2.5 m above the ground, whereas the most trees are of 5-10 m tall. Few hives are constructed 4-5 m above the ground level. *Phoenix-Excaecaria* association forms an ideal habitat, and *Excoecaria agallocha* is the most preferred nesting sites, though it has no large crown or spreading branches. The other tree species selected for comb building by the bee are *Avicennia* spp. *Ceriops* spp. *Rhizophora* spp., *Heritiera fomes*, *Sonneratia* spp., *Bruguiera* spp. and *Xylocarpus* spp. Usually one hive is constructed on a tree, but two hives are found rarely. Generally the hives are constructed on a new site. New hives are constructed on the waxy base of the old hive in only 7.3% of the cases (Chaudhuri and Choudhury 1994).

Quantity of honey harvested

Honey and wax contribute to a substantial amount of revenue to the Government exchequer every year. About 50% of the harvested honey in Bangladesh comes from the Sundarban (Burgett 2000). Table 1 gives the quantity of honey and wax extracted from the Sundarban during 1985-86 to 1996-97 and 2001-02. The average honey yield was reported to be 4-5 kg/comb depending on its size (Siddiqi 2001b). Singh (1962) reported that a single colony could yield as much as 37.3 kg of honey during a year.

Honey and wax are extracted mainly from the western part of the Sundarban i.e. from Satkhira Range adjoining the Indian Sundarban. The forest in this Range is degraded and supports mainly *Aegiceras corniculatum* and *Ceriops decandra*. Both the species are favoured by *A. dorsata*. Honey hunters claimed that in recent years honey and wax harvest has declined, and combs were found less frequently. Table 1 supports this view. It might be due to the migration of bees to the safer abode. It is reported that about 90% of the potential honey crop is lost every year due to the lack of enough bees (Alam *et al.* 1964).

Table 1. Quantity of honey and wax harvested from the Sundarban of Bangladesh (abridged from Helalsiddiqui 1999, Kibria *et al.* 2000, Anon. 2003a).

Year	Honey (in M. ton)	Wax (in M. ton)
1985-86	224.00	56.00
1986-87	229.00	Not known
1987-88	224.00	56.00
1988-89	100.00	24.86
1989-90	146.00	36.51
1990-91	210.00	52.73
1991-92	159.00	44.00
1992-93	182.00	36.00
1993-94	107.00	26.00
1994-95	90.00	1.00
1995-96	109.00	1.00
1996-97	168.48	42.08
2001-02	95.90	24.00
Mean $\pm$SD	157.26$\pm$51.24	33.35$\pm$18.06

Factors for honey and wax production

The amount of honey and wax production in an area depend, among others, on the strain and foraging ability of the bee, population level of the bee, size of the hive, first or second comb formation, comb distance from the ground level, abundance of nectar and pollen yielding plants, and the weather. Hives on slanting branches yield more honey than those on the horizontal branches. Hive made early in the season are bigger in size and yield higher honey. Hives constructed later in the season were found to be smaller in size.

Honey yield increases with the elevation of the hive up to 2.59 m beyond which the yield decreases. In *Excaecaria-Phoenix* association, hive forms at a height as low as 60-240 cm from the ground level. Hives constructed for the second time were found at a higher elevation and were smaller in size. They yield comparatively more honey and wax than the first formation. During the hotter period the hives are formed in higher branches, seemingly to avoid hotness of the ground. Hives dependent on *Excoecaria agallocha* nectar yield comparatively more honey (Chaudhuri and Choudhury 1994).

Nectar and pollen yielding plants and their flowering

The main period of honey hunting is during April to June, coinciding with the flowering of the plants utilized by the honeybee. Nectar and pollen yielding plants of the Sundarban of Bangladesh and their peak periods of flowering are given in Table 2. However, many mangrove plants flower sporadically during any month of the year, and this tends to obscure the existence of a single regular peak of flowering (Karim 1994). *Ceriops tagal, Rhizophora apiculata* and *Xylocarpus molluccensis* are included in the list as they are recently reported to occur in the Sundarban (Das and Alam 2001). Besides, Baksha (2001, 2002) gave lists of good nectar and pollen yielding plants found in hilly areas and elsewhere in Bangladesh.

Table 2. Nectar and pollen yielding plants visited by *Apis dorsata* in the Sundarban.

Scientific name	Local name	Type of plant	Maximum flowering period	Status as nectar and pollen source
Acanthus ilicifolius	Hargoza	Thorny woody herb	March-April	Minor
Aegiceras corniculatum	Khalshi, kholisha	Shrub or small tree	March-April	Major
Amoora cucullata	Amur	Small tree	May-June	Poor
Avicennia alba	Sada baen	Small tree	May-June	Moderate
A. officinalis	Kalo baen	Tree	May-June	Moderate
Bruguiera gymnorrhiza	Kankra	Small tree	April- May	Minor
B. sexangula	Kankra	Small tree	April-May	Minor
Ceriops decandra	Goran	Small tree	March- April	Major
C. tagal	Math goran	Small tree	March-April	Major
Dendrophthoe falcata	Porgachha	Parasite on tree	May-June	Poor
Derris trifolia	Gila lota	Climber	June-July	Minor
Excoecaria agallocha	Gewa	Tree	May-June	Major
Heritiera fomes	Sundari	Tree	May-June	Moderate
Kandelia candel	Gura, gural	Small tree	March-April	Minor
Phoenix paludosa	Hantal	Thorny palm	March-April	Major
Pongamia pinnata	Karanja	Small tree	June-July	Minor
Rhizophora apiculata	Khamo gorjan	Small tree	April-May	Minor
R. mucronata	Gorjan, jhanna	Small tree	April-May	Minor
Sonneratia apetala	Keora	Large tree	March-April	Major
S. caseolaris	Chhaila, choyla	Tree	March-April	Major
Viscum monoicum	Porgacha	Parasite on tree	May-June	Poor
Xylocarpus granatum	Dhundul	Small tree	May-June	Moderate
X. mekongensis	Passur	Tree	April-May	Moderate
X. molluccensis	Passur	Tree	April-May	Moderate

Honey hunters or *mowalis*

Honey collection from wild nests of *A. dorsata* is a very ancient art dating back to 12,000 years as evident from paleolithic cave paintings (Verma 1990) and still a common practice. The usual practice has been to gather honey from the combs of wild bees, bee wax being obtained as by-product. The honey hunters, locally called *mowalis* or *mowals* derived from the Bangla word *'mow'* meaning 'honey', usually inherit the profession from their fore-fathers. Most are illiterate and live below the subsistence level. An estimated 2,000 honey hunters enter the Sundarban each year during a restricted hunting season from April to July.

The *mowalis* must obtain permission from the local forest Range Office before entering the Sundarban. Permits of collection of honey and wax are issued from April 1 to June 15 each year. Before going to the forest, the *mowalis* form groups of 5-8 people, each group having a leader, and usually take a high-interest loan from local moneylenders. Each group gives royalty to the local forest office, and a permit is issued to the leader. Then each group enters the forest with a boat, taking food and drinking water for one or two months at a time. It takes usually two days to reach deep into the forest. They spend their days venturing into the forests to find out nests of the honeybee. The nights are spent on the boats anchored as far as out into the river channels. This is for a security from the tiger though safety is not guaranteed as the tiger can swim over a distance of 10 km (Chaudhuri and Choudhury 1994) at night and carry man away from the boat. In many cases there are rituals to invoke blessings of the folk deity and lord of the forest to obtain immunity from the tiger and other creatures.

Method of honey hunting

Honey hunting season starts on April 1 each year. There is a competition among the groups to reach the forest first in an attempt to get more honey. They follow the foraging bees to locate the nest. They run keeping a space of usually10-15 feet between them. When one finds a nest he shouts to come together the rests. The *mowalis* then drive the bees off the nest with smoke and fire from a large burning torch, locally called *karu* or *moshal,* usually made of dried leaves of nipa (*Nypa fruticans*) or hantal (*Phoenix paludosa*). During the daytime plundering of the nests, the *mowalis* have little if any protective clothing excepting long scarves wrapped around their neck. As a result the *mowalis* experience hundreds of stings as the bees are capable of mounting a very stout defense of their colony. The portions of the comb containing honey are quickly cut out and placed in the basket for transport back to the boat. The *mowalis* attempt to get all the honey from a colony. Once back at the boat, the honey is extracted by traditional squeezing method, and then honey is kept into a large collection barrel.

The use of fire to drive bees off the combs is detrimental to the honeybee and its colony. In this process thousands of adult bees and broods are killed. Besides, larva and pupa are also killed during squeezing of combs for extraction of honey. As a result, the bees become scared and fly away to other safer abode, presumably to the Indian Sundarban. However, the continual, annual harvesting of honey over many hundreds of years suggests that the population of bee is large enough to sustain such a loss.

Smoke caused reduction in the number of guard bees that would otherwise have been produced in great numbers by the effect of the alarm pheromeone, i.e. isopentyl acetate and the number of outgoing foragers were similarly affected (Newton 1969). Roonwal (1956) observed that during partial solar eclipse, the number of bees leaving and returning to the hives increased considerably.

Problems associated with honey hunting

Falling prey to tigers : According to Rashid *et al.* (1994), the Sundarban of Bangladesh contains about 300-450 tigers (*Panthera tigris tigris* Linn.), making it one of the largest biogeographical

concentrations of tigers in the world. In spite of the availability of prey species (mainly *Axix axis, Sus scrofa*, and other animals abundantly available) some tigers have an unusual behaviour of killing human beings on all and every opportunity. In the Sundarban tiger attacks are annual occurrences, and honey hunters are frequent victims. From official records, tigers took a toll of about 19.80 reported human lives annually during 1956-1983 in the Bangladesh Sundarban (Siddiqi and Choudhury 1987). The record of the 28 years (1956-1983) revealed that out of a total of 554 casualties, 31.2% in *Nypa* leave collection, 30% in honey collection, 13.4% in fuel wood collection, 11.86% in fishing, 7.5% in *Ceriops decandra* collection and 2.8% in *Phoenix paludosa* leaves collection (Siddiqi and Choudhury 1987). Satkhira Range was a hard-hit area than the other three Ranges. For the last 5 years only Satkhira Range had a casualty record of 60 persons of which 30 were fishermen, 14 honey hunters, 13 wood collectors and 2 shellfish collectors (Anon. 2003b). The actual rate may be higher since not all cases are reported to the Forest offices. Casualty is high in April-May corresponding to the high influx of honey gatherers who enter the forest at that time and December-January coinciding with wood and nipa leave collection season when large population enters the forest.

Tyranny by dacoits and miscreants: There is also tyranny by the dacoits and miscreants hovering in the Sundarban. The *mowalis* are beaten up and snatched away the honey and wax collected during their venture into the forest. Sometimes they are taken hostages by them in an attempt to receive a ransom. However, the *mowalis* retain their age-old profession disregarding all these risks.

Colour and taste of honey

The colour of honey is affected by climatic condition and the chemical composition of the nectar. Secondly, the pollen grains of many species are coloured which is also reflected in the colour of the honey produced by the bees. The colours of pollen grains of *Acanthus ilicifolius, Bruguiera gymnorrhiza, Ceriops* spp., *Phoenix paludosa, Rhizophora mucronata* and *Xylocarpus* spp. are yellow, vermilion, cream, red, cream and yellow to deep brown respectively (Chaudhuri and Choudhury 1994).

Honey made from *Aegiceras corniculatum* is thick, cream coloured, has a distinctive flavour and considered to be the best as it tastes good. Honey made from *Acanthus ilicifolius* is also thick and creamy in colour. Honey from *Ceriops* spp. is reddish. Honey derived from *Sonneratia apetala* is yellowish and slightly light while honey from *Avicennia* spp. has a reddish tinge and is light. Honey made from *Excoecaria agallocha* has a reddish colour and the taste is slightly acidic (Chaudhuri and Choudhury 1994).

Quality of honey collected

Honey is usually extracted from the comb by squeezing method. Honey so obtained contains the body parts of bees, their faecal matters and other materials. Straining is done to remove the extraneous materials only. This composite of ripe and unripe honey is a major reason for the high moisture content of the final product, usually in the range of 25-40% (Burgett 2000). Because of its high moisture content, the quality of honey collected from the Sundarban is generally poor as such honey ferments readily. Nevertheless, honey from the Sundarban has a special demand in the local market.

Seasonality of honey production

The main period of honey production is during March to June. About 70% are produced during March-April and 25% during May-June. This indicates that the bulk of the honey is produced from *Acanthus ilicifolius, Aegiceras corniculatum, Ceriops decandra, Phoenix paludosa, Xylocarpus mekongensis* and *X. molluccensis*. Honeybees of the Sundarban also utilize many agricultural and horticultural crops cultivated around the forest. Analysis of honey from the

Sundarban confirms the presence of pollen grains of many plants that do not occur in the Sundarban (Chaudhuri and Choudhury 1994).

Marketing of honey

Honey from the Sundarban has a high demand in the market, which is used as a traditional food and medicine and is rapidly consumed by the local people. Honey is not usually processed. At present honey is sold at about Tk. 120-180 (US$ 2-3) per kg and the wax at about Tk. 180 per kg. In some local company the honey is packed in glass jars and advertises the honey as "pure honey collected from the Sundarbans" and fetches a higher price. However many false companies are bluffing the public.

Prospect of beekeeping in the mangroves

In Cuba, during the flowering season of mangroves, some 40,000 beehives of the domesticated honey bee, *Apis mellifera*, are taken to the mangrove forests fringing the southern coast, where they remain for five months every year, so that they can take advantage of the flowering mangrove trees, especially of *Avicennia germinatum* (Padron *et al.* 1993). In India, frame hives for *Apis cerana* are being extensively used in the forest and in the reclaimed areas of the Sundarban (Chaudhuri and Choudhury 1994). The production from this is only 3-4 kg per hive (Chaudhuri and Choudhury 1994). In Tanzania, sometimes beekeeping is practiced in the mangroves (Semesi 1991). Therefore, there is a scope for introducing beekeeping with local domesticated bee, *A. cerana* in and around the Sundarban. It could fetch at least a net profit of Tk. 3,000 (US$ 50) per hive annually (Baksha 2001). However, many NGOs and private beekeepers attempt to introduce the exotic high yielding European bee *A. mellifera* in Bangladesh. This should be discouraged because it could have adverse impact on local biodiversity.

Honeybee in pollination

Although honey and wax are very important products of honeybee, many people tend to overlook the major role of honeybee as pollinator. It has been estimated that the value of honey as pollinator is 10-20 times greater than its value as honey producer (Verma 1990). In developed countries apiaries are kept in the crop field to promote pollination and thereby increasing the productivity of crops. Thousands of colonies are rented annually for pollination services in the United States alone (Todd and Mc Gregor 1960). The indigenous bees constituting an important component of local biodiversity are needed for pollination of many plant species in the Sundarban. At the same time the bees play an important role as pollinators in agricultural and horticultural crops in the adjoining areas ensuring increased productivity.

Pollination in most mangroves occurs through the agency of wind, insects and birds. *Apis dorsata* is an important agent for pollination. A worker bee could visit 20-30 flowers a minute, and an estimated 12,000 pollinations could be done daily by a worker bee (Beeson 1941). Pollination in *Nypa fruticans* probably occurs by many insects, particularly drosophilid flies. *Aegiceras corniculatum, Cynometra ramiflora, Xylocarpus granatum, X. mekongensis, X. molluccensis, Heritiera fomes* and *Avicennia* spp. are predominantly bee-pollinated (Hutchings and Saenger 1987, Saenger 2003).

Suggestions for better management

1. Artificial hives of the local domesticated honeybee, *Apis cerana* should be kept in and around the Sundarban to make use of the nectar of the flowering plants of the Sundarban and the adjoining areas.
2. Use of fire to drive bees off the comb should be prohibited and implemented strictly to prevent killing of adult bees and their broods; only smoke could be used to drive bees off during honey hunting.
3. Hand-operated honey extractor machine should be used to extract honey instead of traditional squeezing method of extraction.

4. Only machine-extracted honey should be processed and marketed as table or medicine honey.

5. There should be different price policy for table and squeezed honey.

6. Strict quality control in terms of physico-chemical properties of honey extracted from the Sundarban should be ensured, which is lacking at present.

7. Honey cooperatives for processing, packaging and sale of honey and other hive products should be formed to meet up the demand of local and potential export markets.

8. Better quality packaging is needed to ensure increased shelf life of honey.

9. Mowalis should be trained on scientific management of bees, and harvesting, transportation, processing and packaging of honey.

10. Initial storage and transportation time should be reduced to a minimum.

11. Tranquility and serenity of the Sundarban should be restored by taking appropriate actions against dacoits and miscreants with the help of law enforcing agency.

Conclusion

The Sundarban being a mangrove forest is relatively an unstable ecosystem as changes in various aspects of biotic and abiotic environments are constantly occurring. Many changes are unpredictable and beyond the control of the foresters. Apart from this, human induced stresses on forest resources in a poor and densely populated country like Bangladesh are unavoidable. Under the prevailing socio-economic conditions of the country, sustainable management of different resources of the Sundarban ecosystem is not an easy task. When scientific management is combined with traditional wisdom reasonable success will result. Review of the resources of the Sundarban, their current utilization, and effects of resource extraction on the sustainability of biodiversity within the forest are in progress. This could eventually result in major changes in the tradition of honey hunting within the Sundarban.

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