HUMAN-ELEPHANT CONFLICT IN THE SOUTHERN WESTERN GHATS : A CASE STUDY FROM THE PEPPARA WILDLIFE SANCTUARY, KERALA, INDIA

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Introduction

Wildlife of southern Western Ghats in India is unique with several rare, endangered and endemic animals. Many of these are facing extinction due to habitat deterioration and poaching. The State of Kerala is very rich in the diversity of animals and has a long history of protecting wild animals. As per recent information, 75 species of mammals have been reported from this region. Of this number, 47 species are considered as larger mammals with a size larger than mouse deer. Among these, 14 species of mammals are found only in the Western Ghats.

Crop damage by Asian Elephant (*Elephas maximus*), has been studied extensively all over the Asian countries. Studies on crop depredation by elephants are also well documented in India. No extensive studies were carried out in the State of Kerala on the problem of crop damage by Asiatic elephants. Many such works were published from other Indian States and from the Asian and African countries. A recent survey on crop depredation by wild animals in Kerala revealed that crop damage is heavy (Veeramani and Jayson, 1995). A study conducted in 10 villages along the Karnataka, Tamil Nadu border estimated that the total loss to agricultural crops by elephants was about Rs.1.5 lakhs per year (Sukumar, 1989; 1990). Similarly, man-wildlife interaction in Karnataka State has been reported by Appayya (1992). Mishra (1971) and Datye and Bhagwat (1993a) have reported the economic loss due to the crop raiding elephants in the State of Bihar. Balasubramanian *et al.* (1993) and Ramesh Kumar and Sathyanarayana (1993) also carried out identical works in the Nilgiris, India. In Peninsular Malaysia the economic loss to a single agency from destruction of oil palm and rubber plantations by elephants was estimated to be US $ 20 million per year (Blair *et al*., 1979). Similarly, many studies were reported from African countries (Tchamba, 1995; Ngure, 1995).

Human-wildlife interaction in Karnataka State, especially the conflict between elephant and humans has been studied by Sukumar (1989, 1991, 1994) and Appayya (1992). According to Santhiapillai and Jackson (1990) elephants kill about 100 to 200 people each year in India. Human deaths due to elephants have been reported from parts of Central India by Datye and Bhagwat (1993). Injury to human beings from wild animals is

common as shown by Mohan (1994). Conflict between humans and elephants in Northern Kenya was reported by Thouless (1994). In the same way conflict between wildlife and local people living adjacent to protected areas in Tanzania was given by Newmark *et al*. (1994). No similar data were reported from the State of Kerala so far. In this study an attempt is made to investigate the human-elephant conflict in the southern Western Ghats of India and possible measures needed for amelioration of the problem is also discussed.

Study Area

Situated in the southern tip of Western Ghats in the Agasthiamalai ranges Peppara Wildlife Sanctuary comes in Kerala State, India. It is located between 8° 34' to 8° 42' N latitudes and 77° 7' to 77° 14' E longitudes and the extent of the sanctuary is 53 km^2. The altitude varied from 98 to 1,594 m amsl and all the sides of the sanctuary are surrounded by forests. The highest peak is Athirumudi Peak (1,594 m). The sanctuary has a tropical hot and humid climate with a dry summer. Daily temperature varied from 32°C to 20°C in plains whereas it varied from 25°C to 16°C in high altitude. Average rainfall was around 4,810 mm in the catchment area of Peppara Dam. The Peppara Wildlife Sanctuary has all typical vegetation types found in tropical areas like tropical moist deciduous forests (29 km^2), tropical evergreen forests (10 km^2), tropical semi- evergreen forest (14 km^2), shola forests (0.79 km^2), reed brakes (2 km^2), bamboo areas (0.5 km^2) and grasslands (2 km^2). A recent floristic study by Mohanan *et al.* (1997) documented 1084 species of flowering plants from the area.

There are 17 Kani tribal settlements inside the Peppara WLS. These are distributed in the buffer zone as well as in the core area of the sanctuary. Like the other aboriginal hunting and gathering tribes, Kanis also have a history of hunting, gathering and shifting cultivation (Thurston and Rangachari, 1975).

Methods

The study was mainly based on observational methods. Status of larger mammals and elephants were assessed by direct and indirect methods. In addition to this, preferred habitats of elephants were recorded to understand the habitat use.

Direct sightings : To record the presence of larger mammals different trek paths in the sanctuary and adjacent areas were surveyed by walking. Observations were made in the morning and evening and whenever an animal was sighted the species, sex, group size, activity, time and vegetation type were recorded. To document the status of larger mammals six line transects were laid through different vegetation types. The first transect was in a moist deciduous forest (2 km). The second was in an evergreen forest (1.7 km). The third transect covered mixed vegetations such as deciduous, moist deciduous and semi-evergreen forests (2 km). Fourth transect was laid again a moist deciduous and semi-evergreen forest (2 km). The fifth transect was laid between through the moist deciduous and semi-evergreen vegetation (1.6 km). The sixth transect was (1.7 km). This was also through the moist deciduous and semi-evergreen forest. Out of these six transects, three were of two km in length and others were not having 2 km length because of the reservoir and the undulating terrain.

Due to heavy rainfall, growth of grass was rapid and both the direct and indirect sightings became rare in the transects. In the subsequent surveys, it was found that sufficient sighting of large mammals was not available and the data could not be processed, using the program DISTANCE, hence after an year this method was abandoned.

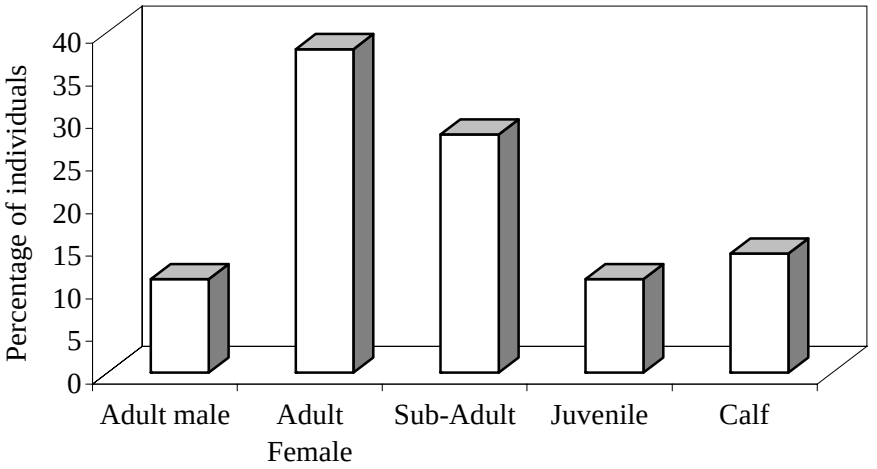
Socio-economic status of tribals : Since the tribal population inside the sanctuary was in 160 families and in 13 settlements, the survey method was followed to study the socio-economic condition. A detailed interview schedule was prepared to gather information on demography, settlement details, educational status, migration patterns, family constellation, cropping pattern, infrastructure and human-animal conflicts. Pre-test: A pre-test was carried out to assess the validity and reliability of the questionnaire. The questionnaire prepared initially for this pre-test was used to collect data from the Chemmankala settlement. This settlement was selected purposely due to the low intensity of outside influence. Based on the preliminary survey, necessary modifications were made in the interview schedule and the final schedule was formulated.

Human-elephant conflict : All the settlements inside the sanctuary were visited for recording the crop damage during the initial period of the study and tribal settlement was selected for regular and systematic observation by purposive sampling. Three households were selected, based on the location of the cultivated fields. One was in the periphery of the settlement, another was in the middle of the settlement and the third was near the reservoir. Members of each house were met once in a week and data was collected on the species of crop damaged, quantity, phenology of crops and the species of animals. Animals were identified from the indirect evidences left during the raid and from the report of members who have sighted or chased the animals. The terrain of the area and the distance from the forest border were also recorded. In addition to this, all the other settlements were visited once in a month and information on crop damage was collected from the settlers. If any severe crop damage was reported from any other settlement, it was visited immediately and detailed information was collected in a format. Data on various indigenous techniques for preventing crop damage by wild animals used by the tribals were also recorded. Detailed studies on wildlife attacks were carried out by visiting the place of incidents and recording details, regarding the animal involved, location, mode of attack and the social and economic background of the victim.

Results

Population of Elephants : Asian Elephant was located 73 times during the period of study. Altogether 217 elephants were seen and the male to female ratio was 1 : 6 (N = 217). Mean herd size was 10 individuals per herd (Fig. 1) and maximum were sighted in the moist deciduous forest followed by eucalypt plantation, swampy areas, semi-evergreen and evergreen forests (Table 1). They were recorded from eleven localities within the sanctuary. Elephants uprooted trees like *Eucalyptus*, *Careya arborea, Dillenia pentagyna, Emblica officinalis, Helicteres isora* and *Terminalia paniculata*. Food species of elephants recorded from Peppara Wildlife Sanctuary is given in Table 2. This was

Fig. 1



Population structure of elephants sighted (n=217)

Table 1

Habitats where elephants were sighted in Peppara Wildlife Sanctuary

Month	EG	SEG	MD	Swamp	EP
January	7	0	35	52	11
February	-	8	21	0	41
March	-	8	17	1	1
April	-	-	28	-	22
May	-	-	8	-	15
June	-	-	11	-	11
July	-	-	23	11	23
August	-	22	12	1	11
September	9	-	27	-	14
October	-	-	44	1	14
November	-	-	8	-	1
December	-	8	22	9	11
Total	16	46	256	75	175

- = No sighting; EG= Evergreen; SEG= Semi-evergreen; MD= Moist deciduous; EP= Eucalyptus plantation.

done to identify the natural food of elephants when they were not involved in crop raiding.

Cultivation : All the tribal families own land and most of them acquired it initially by clearing the forest (91). Some of them

Table 2

Food plants of elephants in the Peppara Wildlife Sanctuary

Plant species	Part of tree used	Remarks
Erythrina variegata	Lower bark	After pushing down
Pandanus sp.	Tender shoots	-
Pennisetum polystachyon	Leaf blades	Extensive feeding
Careya arborea	Tender shoots	
Bamboo	Shoots	
Helicteres isora	Leaf	Tender shoots, bark
Ochlandra ebracteata	Leaf shoots	
Ochlandra travancorica	Shoots	Feed extensively
Artocarpus hirsutus	Fruits Bark and tender shoots	
Ficus glomeratas	Tender shoots	
Shuminianthus virgatus	Leaf and shoots	
Pinanga dicksonii	Shoots	

got it as dowry (24) and others as compensation from the Government when they were evicted from the original settlements. Tapioca, dry land paddy, cereals as Italian millet, common millet, Indian corn and plantain were the main crops. However, at present most of them have abandoned the traditional cultivation and were practicing a mixed cultivation or in a transitional stage (153). Only four families practiced the traditional cultivation and others preferred modern cultivation (149). Due to various reasons, most of them did not utilise the whole area for cultivation (108). Main problems were the destruction of crop by wild animals and the absence of working people. Only few families (10) used pesticides, fertilizers or seeds from the outside.

Cultivation pattern : In yesteryears, Kani tribals practiced shifting cultivation. Nevertheless, due to various reasons, they have abandoned this form of agriculture. At present, they cultivate in lands adjacent to their settlements only. In habitations, which are along the periphery of the sanctuary, modern methods of agriculture were practiced. Perennial crops were more extensively cultivated than the seasonal crops. Paddy was cultivated in the monsoon season. This was mainly done in Podiakala, Chemmankala, Mlavila, Kamalakam and Paranthode. Slash burning was carried out in April-May and sowing in June-July. One peculiarity noticed in the cultivation of Cassava was that, two methods were adopted in its production. If the crop was meant for their own consumption, not all the plants were harvested simultaneously. In this method whenever a culm was removed, the stumps were again planted in the same place. Due to this method, they were able to harvest crop at any day of the year. Intermittent rain obtained in all the months, supported this mode of cultivation.

Crop damage : All the families reported

crop damage problems due to wildlife (Table 3).

Most of the people were aware of crop damage compensation, but rarely applied for it. Only six families so far applied for compensation. Majority of the families have some livestock and poultry was main (116) followed by goat (73), cow (6) and buffalo (1). One hundred and thirty people reported that their livestock were attacked by wild animals. Maximum of the attacks were on fowl followed by goat and dog.

However, when the yield was meant for market, simultaneous harvesting and planting was practiced. In this mode of cultivation, if an attack of wild boar occurs at the time of maturity, the economic loss was heavy. In the past, Kanis cultivated crops for their consumption only, but now they cultivate crops for sale as well.

Animals involved in crop damage : Crop depredation has been recorded in all the 17 tribal settlements. Seven species of animals were damaging 18 crops. Main crops destroyed were tapioca, plantain and coconut (Table 5). Maximum occurrence of crop damage was recorded in the month of June followed by May (Table 6).

Table 4

Crops damaged by wild animals in Peppara Wildlife Sanctuary

Common name		Scientific name
1.	Cassava	*Manihot esculenta*
2.	Paddy	*Oryza sativa*
3.	Plantains	*Musa* sp.
4.	Rubber	*Hevea brasciliensis*
5.	Pineapple	*Ananas comosus*
6.	Coconut	*Cocos nucifera*
7.	Taro	*Colocassia esculenta*
8.	Elephant foot yam	*Anorphophallus companulatus*
9.	Sweet potato	*Ipomea batatus*
10.	Arrow root	*Maranta arundinaceae*
11.	Ginger	*Zingiber officinale*
12.	Cocoa	*Theobroma cacao*
13.	Jack tree	*Artocarpus heterophyllus*
14.	Mango tree	*Mangifera indica*
15.	Lesser yam	*Dioscorea esculenta*
16.	Black pepper	*Piper nigrum*
17.	Areca nut	*Areca catechu*
18.	Medicinal plants	Many species

Table 3

Mode of crop damage by different animals in Peppara Wildlife Sanctuary.

Animal Species	Crops damaged	Mode of damage
Wild boar	Tapioca, tubers, paddy	Digging
Elephant	Coconut, tubers, paddy	Trampling
Porcupine	Tapioca	Browsing
Blacknaped hare	Tubers, paddy	Cutting & feeding
Bonnet macaques	Tapioca	Pulling out
Mouse deer	Tubers, tapioca	Browsing
Barking deer	Tapioca, tubers	Browsing
Palm civet	Pineapple	Feeding
Bandicoot rat	Tubers	Digging

Table 5

Incidence of crop damage during different months.

Months	Tapioca	Plantains	Coconut	Betalnut	Pineapple	Rubber	Paddy	Tuber crops	Others	Total
Jan.	16	1	1	1	2	3	-	5	1	30
Feb.	10	1	-	-	2	-	-	3	-	16
Mar.	13	2	-	-	-	-	-	-	1	16
Apr.	4	1	1	-	-	-	-	-	-	6
May	31	1	1	-	3	-	-	-	-	36
Jun.	19	6	6	1	2	3	2	1	1	41
Jul.	27	-	-	2	-	-	3	3	-	35
Aug.	25	-	1	1	-	-	-	-	-	27
Sep.	8	-	-	-	-	-	-	1	1	10
Oct.	23	-	-	-	1	-	-	1	-	25
Nov.	23	-	-	-	1	-	-	1	-	25
Dec.	6	1	-	-	-	-	-	-	-	7
Total	205	13	10	5	11	6	5	15	4	

- = No raids recorded

Table 6

Number of raids recorded for each animal from the Peppara Wildlife Sanctuary

Months	Animals					
	Wild boar	Elephant	Hare	Deer	Others	Total
January	11	8	4	6	-	29
February	16	-	-	-	-	16
March	15	-	-	-	-	15
April	2	4	-	-	-	6
May	30	4	1	-	1	36
June	14	22	1	-	4	41
July	31	3	-	3	-	37
August	21	3	-	-	-	24
September	8	2	-	-	-	10
October	3	8	3	-	-	14
November	17	3	3	-	-	23
December	4	3	-	-	-	7
Total	172	60	12	9	5	

- = No raids recorded.

Similarly, wild boar attacked crops more, than any other animals. This was followed by elephants and hare (Table 6).

Nine settlements experienced highest crop damage and in other settlements, it was negligible. Moreover, among them, Chemmankala recorded the highest number of attacks by wild animals. Major animals engaged in crop damage were wild boar and elephant. Apart from these, the Indian porcupine, barking deer, sambar, blacknaped hare and bonnet macaque also destroyed crops. The settlements, Erumbiyad, Pothode, Amode, Cherumangal, Mlavila, Pattinipara and Paranthode are in a cluster and the agriculture was not much advanced. Due to these reasons, crop damage was less (Table 7).

The quantum of money claimed by the tribals was higher than the actual loss calculated from the field observations (Table 8).

Mode of damage : The animals involved in crop damage were mainly lone males, in the case of elephants and most of the raids were at night. It was observed that more quantity of crop was damaged than, what was consumed by the animals. In the case of tapioca, a preference was shown for tender shoots and tubers. Coconut was mainly damaged by elephant and was confined to the trees below 20 years. Trees below 10 years were pushed down and the central rachis and shoots were consumed. Plantains were also attacked by elephants and discarding the leaves, the central portion of the stem was consumed. Paddy

Table 7

Incidence of crop raiding recorded from the Peppara Wildlife Sanctuary during the period of study

Settlement	No. of raids	Animals	Time
Chemmankala	87	El, WB, P, BD, BNH	Midnight, morning, evening, day time
Podiakala	47	El, WB, BNH	Night, midnight, evening, morning
Chathankode	27	El, WB	Night, late evening, early morning
Podium	15	El, WB, BD	Night, evening
Ottakudi	19	El, WB	Night
Kochukilikodu	5	El, WB	Night
Cherumangal	4	El, WB	Night
Valiakala	4	El, WB	Night
Kunnatheri	1	El	Night

El - Elephant; WB - Wild boar; BD - Barking deer; P - Porcupine; BNH - Blacknaped hare

was lost due to wild boar, elephant, blossomheaded parakeet and jungle fowl. More waste was due to trampling and rolling by the animals in the field. Elephant also destroyed paddy by trampling.

Pineapple was destroyed by elephant, wild boar, and palm civet and palm squirrels. Elephant and wild boar preferred fruits and central rachis of the pine-apple, where as palm civet and squirrel consumed only the fruits. Elephants trampled and uprooted rubber samplings and they fed on the basal portion of the plants. Cashew trees and betel nut trees were not damaged by any of the animals. No distinct pattern was observed in crop raids. While damage by wild boar was recorded throughout the year, the attack from elephants was related to the species of crops cultivated. Whenever palatable crops like plantain, coconut and areca nut were planted, elephants attacked them.

Preventive measures for crop damage

Indigenous methods : Indigenous and modern methods were employed by the tribals and local people for the protection of crop. Thirteen indigenous preventive measures were identified from the area namely application of bar soap, kerosene, human dummies, cloths, plastic bags and areca nut sheaths. They trap the animals, which come to the vicinity of settlements; for which many death traps are designed by them. Locally available materials like stone, bamboo, reed poles and plant fibers are utilized for making these traps. The skills of hunting and trapping of wild animals are still utilized by them to control the crop raiding animals.

Modern methods : Trenches, cracker lines and live wire fencing are the modern methods applied by the tribals and local people for controlling the crop damage. In addition to this, electric fence with

Table 8

Economic loss claimed by the tribals in the different settlements for crop damage

Settlement	Economic loss claimed (Rs.)	Economic loss assessed (Rs.)
Amode	11000	-
Chathankode	-	9000
Chemmankala	9050	6563
Chemmankala II	6300	-
Cherumangal	23670	1300
Erumbiyad	18865	-
Kamalakam	45540	-
Kochukilikodu	-	1800
Kombodinjal	12850	-
Kunnatheri	22325	700
Kuravampara	38675	9000
Mlavila	25575	-
Ottakudi	-	6000
Paranthode	11410	-
Pattampara	19255	-
Pattinipara	11650	-
Podiakala	44450	8332
Podium	39765	3400
Pothode	16325	-
Thondankal	1640	-
Valiakala	-	1,400

- = No data

energiser were also erected by the Kerala Forest Department to control the crop damage, in some tribal settlements. Tribals of Paranthode settlement employed trenches for protecting the crop. But later they have abandoned it due to the difficulty in maintaining. Maintenance of trenches was laborious due to the loose soil structure and intermittent rainfall in all the months.

Table 9

Preventive measures used against different animals

Preventive measures	Animals
Bamboo fence	Wild boar
Bush fence	Barking deer
Line fence using banana fibre	Wild boar
Reed line	Wild boar
Cracker line	Wild boar
Cables	Wild boar
Sound from bamboo pieces (Kottumula)	Barking deer, Mouse deer
Sound from old metallic parts	Wild boar
Cover	Wild boar
'Dalle' (Deadfall trap)	Palm civet, Porcupine, Mouse deer
Trap	Blacknaped hare, porcupine
Dogs	Wild boar
Fire line	Wild boar
Kerosene	Wild boar
Plastic bags	Wild boar
Cloths	Wild boar
Chasing	Wild boar

Cracker lines are a common method in which a bit of gunpowder is packed in a paper and kept under a stone. When an animal touched the lead line from the cracker assembly, it triggered a mechanism by which the stone placed above the gunpowder falls on it creating a loud sound. This noise functioned as a warning to the watchers and as a threat to the marauding animals. Local people widely applied this method and tribals employed it, when intensive cultivation was going on. One disadvantage of this method was that, as

these lines provide only warning, people have to go to the field to drive away the animals. Deviarkunnu and Pannikuzhi were some of the locations, where this method was prominently used.

Connecting AC current directly to barbed wire fencing or to the iron wires is known as live wire fencing. The connection may be either from domestic wiring or directly from 220 KV lines. In many areas, local people have adopted this method, which is highly lethal to humans and to the wild animals. This method was not employed permanently but whenever threat of wild animals was anticipated, live wire fencing was made active. This was mainly practiced to save the coconut palms against the attacking elephants. No human or animal casualties were detected due to this method, during the period of study.

Electric fence with energizer has been very efficient in controlling the crop damage all over the world including India. A solar electric fence with energiser was constructed at Chemmankala settlement. Electric fence considerably reduced the attack of elephants on crops at Chemmankala. An instance of breakdown of electric fence was observed during March. This was due to an elephant running amok, and entering the settlement destroying the fence. In the case of small animals, the fence was not effective. As the terrain was undulating with small creeks and ditches, wild boar entered the settlement through the fence.

Problems encountered in managing the electric fence : Though the electric fence was effective in controlling the elephants and other large herbivores many problems were encountered in its maintenance. It was observed that, when intensive cultivation was not practiced by a family, they were not interested in maintaining the fence. Due to this, it is not advisable to leave the responsibility of fences to individual families. As the rainfall in this area was heavy and occurs in all the months, the growth of vegetation was heavy. Due to this, one labor was required to remove the vegetation at least on alternate days. With the fast growth of vegetation, lower line of the electric fence used to touch the vegetation, which caused a drop of voltage from the fence. Due to the insufficient sunlight, battery was not fully charged during the months of monsoon. This has caused depletion of voltage in the fence and a fence with low voltage was not a barrier to wild boar.

Human deaths by elephants : Many instances of attacks by wild animals on people were recorded during the period of study. Among them, the prominent was man slaughter by elephants. Four human deaths were recorded in five encounters (Table 10). In the first incident, a lady was killed by a tusker, while she was collecting firewood along with her husband and friends. It happened adjacent to the sanctuary boundary in the Agasthiavanam Biological Park. Vegetation type where this happened was moist deciduous forest with *Helicteres isora* bushes. While the victim was going for collecting firewood, two sub adult tuskers suddenly appeared after a curve. One tusker charged the group and when the women fell down, while running for life, the tusker lashed the women with trunk, killing her instantly. After some time the elephant left the area leaving the body of the victim. Due to the incident, laborers abandoned the area for a month. The cause of attack was identified as close encounter with the tuskers.

Table 10

Human-slaughter by elephants in Peppara Wildlife Sanctuary (March 1993 to March 1996)

Group composition of elephants	Victim's age	Victim's sex	Time	Date	Vegetation type	Location of incident
Two tuskers (Sub-adults)	52	female	10.30	9.8.1993	Reed brakes	Third block of Agasthiavanam Biological Park
Herd	56	Male	16.30	17.7.1994	Eucalyptus plantation	Chembuthangi
Lone tusker	35	Female	11.00	8.12.1994	Moist deciduous forest	Agasthiavanam Biological Park
Lone tusker	53	Male	11.00	Apr. 1995	Swamp and Eucalyptus plantation	Kollotupara

The second human killing by an elephant occurred in a eucalypt plantation. A man was killed by a female elephant from a herd. Initially the group of people comprising the victim threw stones at the elephant herd, to chase them away from the forest path. After some time when they moved through the way thinking that the elephants have left the area, elephants suddenly attacked them and the victim was beaten up with the trunk. No visible injury was seen on the body and he died in the hospital after three days. In the third event, a lady was slayed by a lone tusker. A group of five women was going for fire wood collection. While they were moving through the forest, talking loudly a tusker turned up and chased the women and while running most of them fell down. The victim was attacked with the trunk and died of excessive bleeding. In the fourth case, a male belonging to Aryanad was put to death while he was collecting fibre from *Helicteres isora*.

Discussion and Conclusion

Elephants were mainly sighted in moist deciduous forest and eucalypt plantations. Male to female ratio of 1 : 58 showed the good representation of males in the population. An average of 4.3 people live in each house. The settlement Pattinipara has the maximum illiterates and Pothode and Kuravampara has high literacy rates. The peripheral settlements have more educated people, they were practicing modern agriculture with cash crops, and the incidence of crop damage was more. They become less interested in employing the traditional methods of crop protection such as keeping watch and ward. As cultivation was their main occupation, any incidence of crop damage will seriously affect them. Crop damage incidences can be correlated to their economic condition also. When the families are in debt trap or with low income, they initiate commercial cultivation of cash crops at the instigation

of outsiders. This leads to increased crop damage and more frustration. Another social custom, which promoted the incidence of crop damage, was the custom of marriage with people other than the Kanikkar. Outsiders begin to stay in the settlements when they marry a tribal girl. With their educational background, they initiate cultivation of crops like plantains and coconut. This will lead to more crop damage. Amode, Kunnatheri and Cherumangal are examples. With the adoption of modern way of lifestyle, there is a increased chance for human-elephant conflict.

Since the cash crops are more nutritive, elephants prefer them (Sukumar, 1991). This may be the reason, why the wild boar also attacks the cash crops extensively. One difference noticed in the crop damage between wild boar and elephant was that damage from elephant was seasonal, where as in the case of wild boar it occurred in all months. Seven species of wild animals were involved in crop damage at Peppara. Among them, elephant and wild boar inflict maximum damage. Main produce destroyed was tapioca and plantains. Crop damage by wild boar can be considered as severe where as from elephants it was only moderate. Thirteen indigenous preventive measures were used by the Kanis. Since all the settlements were situated inside the sanctuary, animals attacked the crops regularly. However, where the settlements were in cluster and the agriculture not much advanced the crop damage was low.

Since the Kanis have evolved various 'Chattu pattu' (Magical songs) to prevent the crop damage from time immemorial, it is believed that crop damage was experienced by them from ancient times and they have accepted it as a natural calamity. Careful selection of crops and planting strategy is necessary to reduce the crop damage. Cultivation of crops like medicinal plants and rubber will reduce the problem and increase the income of people where as crops like, plantains and coconut in monoculture will increase the crop damage. When they were practicing shifting cultivation, coconut or plantains were not cultivated. Cassava and cereals were cultivated for sustenance. However, with the change in cultivation pattern they initiated the cash crops, which are highly vulnerable.

It was found that indigenous methods used for crop protection is effective to control the animals up to certain extent. Electric fence with energiser was useful in controlling the elephants. Nevertheless, maintenance of electric fence was a problem. Tribals did not have the organizational initiative or enthusiasm to maintain an electric fence. If day-to-day instruction was not given, they lose interest in maintaining the fence. Solar electric fence was effective with proper maintenance and it completely stopped animals like elephant, sambar and gaur. Electric fence is not a permanent solution, since the sanctuary is having intermittent rainfall in all the months and the growth of vegetation is fast. In order to keep the high voltage in the line, day-to-day removal of tree branches and other vegetation is must. Due to the crop damage, tribals were not able to increase their income from agriculture. Only by increasing the crop area with the monoculture of cash crops, they will be able to increase the income but this is not possible under the present conditions. When Kanis attempt more cultivation of cash crops to increase their income more crop damage is experienced.

There are different hypotheses on the reasons for crop damage. Kushalappa (1990) described that, summer is the critical period for wild elephants, when they attempt to raid nearby agricultural crops. In such period, most of the trees in the forests are without leaves, the grasses are dead and burnt with little or no water in streams and tanks makes the animal to move on to cultivation. The destruction is particularly severe in areas adjoining to the forests with animals such as elephant, tiger, deer, primates and wild pigs. Another hypothesis is the "high risk high gain" strategy of elephants in which males are supposed to make high risk on their life for the reciprocal gain of access to the highly nutritious food which will further increase their chances of having more progenies and thus better transfer of their genes (Sukumar and Gadgil, 1988).

Main conflict of wild animals was with the local people. Regarding man-wildlife conflict, tribals are experiencing only less of it, where as local people are severely affected. Of the four human deaths, in none of the cases a tribal was involved. All the victims were local people, who went to the forest in search of livelihood. Local people rarely cared for the elephants and took least precautionary measures. While considering the preventive measures, Sale and Berk Muller (1988) suggests that most of these conflicts can be alleviated, if wild animals can be confined to areas set aside for them and conversely domestic stock can be prevented from entering National Parks and sanctuaries, where they have no legitimate place. Programmes that are more educational should be introduced for the local people to reduce human casualties.

Providing compensation is not a permanent solution to the problem. Andhra Pradesh, Arunachal Pradesh, Manipur and Rajasthan do not pay any payment. Among the states which pay compensation, it varied from Rs.2,000/- to Rs.10,000/- (Kothari *et al*., 1989). Even in Kerala, adequate compensation was not given for the crop damage. Human - wildlife conflicts can be reduced, if more tribals are engaged in forest works than the non-tribals, who came from far away places.

Recommendations

1. Construct and maintain electric fences in problem areas
2. Local communities should be advised to avoid planting cash crops like plantains, coconut, pineapple and tapioca
3. Maintain the availability of drinking water in the forest areas during summer either by constructing check dams or by providing artificial water holes.
4. Sanction subsidy or bank loans to the farmers for constructing preventive measures against crop raiding animals.
5. Forest fire should be prevented during summer months.

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SUMMARY

Human-elephant conflict in Peppara Wildlife Sanctuary and adjacent areas was studied based on observational methods during the year 1993 to 1996 as a part of project studying the large mammals in the sanctuary. Peppara Wildlife Sanctuary, situated at an altitude ranging from 98 to 1594 m amsl in the southern Western Ghats, India has diverse habitats like tropical moist deciduous and evergreen forests and plantations. Elephants were located 73 times during the period of study and altogether 217 elephants were seen, the male to female ratio was 1 : 6 (N = 217). Mean herd size was 10 individuals per herd and maximum numbers was sighted in the moist deciduous forest followed by eucalypt plantation, swampy areas, semi-evergreen forest and evergreen forest. Plant species used as food by elephants was also recorded, when they were not involved in crop raiding. Major animals engaged in crop damage were wild boar and elephant. The animals involved in crop damage were mainly lone males, in the case of elephants and most of the raids were at night. It was observed that substantial amount of crop was damaged as compared to what was consumed by the animals. Coconut was mainly damaged by elephants and the damage was confined to the trees less than 20 years. Coconut trees less than 10 years were pushed down and the central rachis and shoots were consumed. Plantains were also attacked by elephants, the leaves were discarded and the central portion of the stem consumed. Elephant also destroyed paddy, rubber and pineapple by trampling. While damage by wild boar was recorded throughout the year, the attack from elephants was related to the species of crops cultivated. Besides crop damage instances, four human deaths were also recorded. Crop damage is linked to the cropping pattern and location of settlements and it is one of the problems, which severely affects the economic status of tribals.

Key words **: Human-Elephant Conflict, Peppara Wildlife Sanctuary, Southern Western Ghats, Kerala.**

दक्षिणी पश्चिमी घाट प्रदेश में मानव–हाथी टकराव पेप्पारा वन्य प्राणि अभयारण्य, केरल, भारत में किया गया अध्ययन

ई०ए० जायसन व जी० क्रिस्टोफर

सारांश

पेप्पारा वन्यप्राणि अभयारण्य और उसके साथ लगते क्षेत्रों में हो रहे मानव–हाथी टकराव का अध्ययन इस अभयारण्य में बड़े स्तनियों की अध्ययन परियोजना के अंगस्वरूप प्रेक्षण विधियां अपनाते हुए वर्ष 1993 से 1996 तक किया गया। पेप्पारा वन्यप्राणि अभयारण्य दक्षिणी पश्चिमी घाट प्रदेश, भारत में माध्य समुद्र तल से 98 से 1594 मी० की ऊंचाइयों तक अवस्थित है और यहां उष्ण आर्द्र पर्णपाती, सदाहरित वन और रोपवन जैसे तरह–तरह के प्राकृतावास पाए जाते हैं। अध्ययन करने की अवधि में 73 बार हाथी यहां देखे गए और उनकी कुल संख्या 217 रही जिनका नर : मादा अनुपात 1:6 (संख्या 217) रहा। उनके झुण्ड को माध्य आकार 10 हाथियों का रहा तथा उनकी अधिकतम संख्या आर्द्र पर्णपाती वनों में देखने को मिली जिसके उपरान्त युकेलिप्टस रोपवन, दलदली क्षेत्र, अर्द्ध सदाहरित वन और सदाहरित वन आते हैं। हाथियों द्वारा भोजनस्वरूप खाई जाने वाली पादपजातियों को भी अभिलिखित किया गया जिन्हें वे उस समय खाते हैं जब फसलों को मटियामेट करने में लिप्त नहीं होते। फसलों को हानि पहुंचाने में लगते बड़े पशु जगली सुअर और हाथी ही पाए गए। फसलों को हानि पहुंचाते पशुओं में ज्यादातर अकेले पड़ गए पशु ही हाथियों में देखे गए तथा उनका आक्रमण भी अधिकतर रात को होते पाया गया। देखने में यह भी आया कि पशु द्वारा खाई गई फसल की तुलना में उसके द्वारा बरबाद की गई फसल उससे कहीं ज्यादा रहती है। नारियल को प्रधानतः हाथियों ने ही नुकसान पहुँचाया और यह हानि उन वृक्षों तक सीमित रही जो 20 वर्ष से कम उम्र के थे। 10 वर्ष से कम उम्र वाले नारियल वृक्ष धकेल कर

नीचे गिरा दिए गए और उनका बीच का प्रोक्ष और प्ररोहों का भक्षण कर लिया गया। केलों पर भी हाथियों ने धावा बोला, उनकी पत्तियां चीरफाड़ कर अलग कर दी गई तथा केन्द्रीय भाग को खाया गया। हाथियों ने धान, रबड़ और अन्नानासों को भी पैरों तले रौंद कर विनष्ट कर दिया। जंगली सुअर तो फसलों का विनाश पूरे वर्ष भर करते रहे किन्तु हाथियों का आक्रमण खेती की जा रही फसल जातियों पर ही हुआ। फसलों को हानि पहुँचाने के अलावा, चार मनुष्यों की हत्या भी अभिलिखित हुई है। फसलों को होने वाली हानि फसल उगाने की प्रणाली और मानव बस्तियों की स्थिति से जुड़ी हुई हैं और यह उन समस्याओं में से है जिनसे आदिवासी जातियों की आर्थिक स्थिति पर भारी दुष्प्रभाव पड़ता है।

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