

**FR-Project**



**ITTO**

**Investigation of the Steps Needed  
to Rehabilitate the Areas of East Kalimantan  
Seriously Affected by Fire**

**GTZ-PN: 38.3021.3 – 11.000**

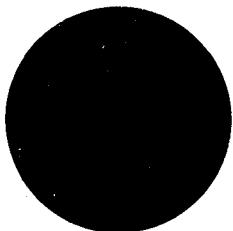
**ITTO: PD 17/87 (F)**

**Effects of the Forest Fire 1982/83  
in East Kalimantan on Wildlife**

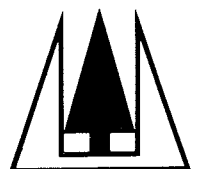
**Chandradewana Boer**

**FR-Report No. 7**

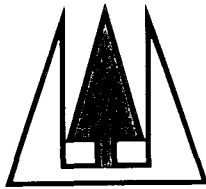
**1989**



**Balai Penelitian  
Kehutanan**



**DFS**



**DFS**

Deutsche Forstservice GmbH

# **Investigation of the Steps Needed to Rehabilitate the Areas of East Kalimantan Seriously Affected by Fire**

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in East Kalimantan towards Wildlife**

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## **Preface**

The present report has been compiled for the project entitled "Investigation of the Steps Needed to Rehabilitate the Areas of East Kalimantan Seriously Affected by Fire". This project was carried out by the Indonesian Ministry of Forestry and Balai Penelitian Kehutanan (Forestry Research Institute) of Samarinda and financed by ITTO (International Tropical Timber Organization) and the Government of Indonesia.

The Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ) GmbH, was charged by the Indonesian Government with the implementation of the technical assistance. On behalf of the GTZ the DFS Deutsche Forstinventur-Service GmbH carried out the study.

The present report was revised and supplemented by W. Schindele, team leader of the above mentioned project.

## 1. Introduction

In 1982/83 a serious drought related with the southern oscillation of El Nino, a current of the pacific ocean, affected the Southeast Asian region. Especially East Kalimantan, one of Indonesia's four provinces of Borneo, suffered very heavily under this drought. In addition, the tropical rain forest, mainly the logged-over and peat swamp forests, caught fire. Initiated by shifting cultivators fires spread through the area and burnt 3.2 million ha of which 2.7 million ha were forest lands.

Depending on the forest conditions, the specific climatic condition and the site prior to the fire, different degrees of damage to the vegetation were caused. From creeping fire in primary forests to complete destruction of the vegetation in parts of the peat swamp forests and logged over areas all degrees of damage appeared.

Now, 7 years after the fire, natural succession has formed various types of secondary forests. From well structured tropical rain forest ecosystems (lightly disturbed forests) to uniform and even level stands of pioneer species all stages of succession are present. The effects of the fire and the present condition of the vegetation are described in detail by Schindele, Thoma and Panzer, 1989 in *The Forest Fire 1982/83 in East Kalimantan Part I: The Fire, the Effects, the Damage and Technical Solutions* (FR Report No. 5).

The present report tries to compile all information available on the effects of the fire on wildlife. Sources of information include personal communication with the local populace, research reports and studies, which were carried out by different research institutes, and by our own observations.

There had only been a small amount of research work on wildlife carried out in East Kalimantan before the fire; these investigations being concentrated on primates and mammals. Therefore, it is impossible to assess the change in the animal population caused by the fire. Also, almost all of the research work was carried out at Kutai National Park and Bukit Soeharto Protection Forest, which is, because of its lower average degree of damage, not necessarily representative for the whole area. For the swamp forest habitat, no information was available.

## **2. General Remarks: Effects of the Fire on Wildlife**

Fire is one of the natural forces with the highest impact on tropical ecosystems. Flora, fauna and soil (site) are closely interrelated and, as a result, they are all directly and indirectly affected in the event of a fire. This makes it very difficult to point out cause and effect relationships between fire and wildlife.

In general, two types of influences, direct and indirect, can be distinguished, as the result of fire and its effects on wildlife. Much wildlife perished as the result of the forest fire (Strait Time, June 5, 1984), especially those animals, which were too slow to escape and those which were enclosed by the fire. Also, many birds died by heat exposure and smoke. Many animal habitats were destroyed (crocodiles) and most of the animals suffered from malnourishment as the result of lack of available foodstuffs during the first weeks of the fire. Indirectly, fire affected animal populations by the change in their habitat. Where the fire-intensity was particularly high, the tropical rain forests were correspondingly heavily damaged. After the fire, natural succession formed uniform stands of pioneer species. "Special" animal species lost their host and feeding sources as a result and died or were forced to emigrate. Others, like most of the primates, were able to adapt to the new environmental conditions thereby changing their feeding behaviour.

### **3. Effects of the Fire on Mammals**

Aside from the highly detailed studies on the effects of the fire on primates, there is almost no research data available on the effects of the fire on mammals. The information found in this report is, therefore, not very detailed, being based mainly on information obtained from local people (hunters) and from our own observations.

#### **3.1 Pigs (*Sup spp.*)**

As the fire raged quickly through dry forest lands, wild boars bolted in panic, fell, were enclosed by fire and consumed by the flames (personal communication with three forest guides of the Bukit Soeharto Protection Forest).

Soon after the fire, wild pigs became a major pest in the gardens and rice fields of local villages and transmigration areas (Mayer 1989). Furthermore, in the research area of Kutai National Park, bearded pigs became commonplace; the most abundant species of all (Doi, 1988).

There is no special study on the effect of the fire on the pig population, but according to local accounts it can be assumed that the very strong and active pigs are easily adapting themselves to the dramatic changes in their habitat. It is expected that their feeding habits are adapting correspondingly.

#### **3.2 Banteng (*Bos javanicus*)**

At the Kutai National Park, which was established by the Government of Indonesia in 1985, Banteng is still very common. Wirawan (1985) recorded the presence of Banteng along the old logging road of Kayu Mas from Teluk Kaba to km 45. This was also reconfirmed by Doi (1988).

Banteng are usually nomadic and move in groups consisting of some males and a large number of females and their calves. Banteng are easily spooked their occurrence can only be determined by counting tracks or by observing them at their drinking holes.

Banteng were also able to change their diet. After the fire they began feeding on the bark of young stems (Wirawan, in Kompas, June 26th, 1984).

### 3.3 Deer (*Cervus unicolor*, *Muntiacus muntjak*, *Tragulus spp.*)

During the fire many sambar deer (*Cervus unicolor*) and barking deer (*Muntiacus muntjak*) perished. After the fire the deer population found nutritional relief through the sprouting of young grass, herbs and tree shoots, on which these herbivores feed (Leighton, 1983). The tendency of the ungulate population to increase may also be due to the low population density of predators. Sambar deer became the major pest in the *Acacia mangium* plantations at Batu Ampar (personal communication).

According to Mayer (1989), the deer population declined during the drought and fire but recovered in numbers one year later.

Chevrots, or mouse deer (*Tragulus javanicus*), a very clever ungulate species, were also killed in some cases by fire. Such was reported by local people at Long Nah.

Ungulates have a very important role in seed dispersion. Their population increase due to better food availability and reduced number of predators will have a favourable effect on natural succession and will help to increase the species diversity of the flora in the secondary forests in the future.

### 3.4 Bear (*Helarctos malayanus*)

At the Kutai National Park one might still find some Malayan sun bears, yet along the former Kayu Mas road, the main research area for wildlife observation, Malayan sun bears have become a rare sight since the fire.

The Malayan sun bear is not very large, having a body length of only 1.4 meters and weighing 50 - 65 kg. They live in dense forests and have a low reproduction rate. The favoured diet of these omnivores consists of fruits, bird eggs, insects and honey.

The damage caused by the fire as well as the present condition of the vegetation has not had a very favourable effect on the bear population. Doi (1988) doubts whether the bears at Kutai National Park will be able to recover. Perhaps the few unburnt primary and lightly burnt forests will be able to serve as a refuge for this species securing their recovery and future survival.



### 3.5 Squirrels (*Ratufa affinis*, *Calloscirus prevostii*, *C. notatus*)

After the fire Leighton (1983) observed only three species of squirrels (*Ratufa affinis*, *Calloscirus prevostii*, *C. notatus*) foraging and travelling actively in Kutai National Park, instead of the former common five species. According to previous counts in undisturbed forests, their number also declined as a result of their changed habitat caused by fire.

### 3.6 Bats (Various Genera)

There are unfortunately no studies available on the bat population. However, Leighton (1983) investigated the mortality of some bat fruit trees due to fire at Kutai National Park; (see table 1).

Mortality of bat fruit trees (Source: Leighton 1983)

Tree species	Family	Mortality rate (%)
<i>Dillenia reticulata</i>	<i>Bombaceae</i>	6 %
other <i>Dillenia</i> sp.	"	11 %
<i>Elaeocarpus stipularis</i>	<i>Elaeocarpaceae</i>	100 %
<i>Syzygium tawahense</i>	<i>Myrtaceae</i>	14 %
Various genera	<i>Sapotaceae</i>	67 %
<i>Irvingia malayana</i>	<i>Simaroubaceae</i>	0 %
Other species	various families	22 %
All bat fruit trees		26 %

Bats are very mobile animals and can fly long distances. Most probably bats were not killed by fire and, when their food sources were reduced, it is assumed that they moved to areas offering more favourable conditions.

### **3.7 Fresh Water Dolphin (*Orcaella brevirostris*)**

Both, drought and fire affected the dolphin population. During the dry spell some of the numerous lakes of the Mahakam River basin dried out completely. Also the water table of the Mahakam and its tributaries was very low. After the fire, when the heavy rains appeared in May/June 1983, ash and other debris were flushed into the rivers and lakes changing their colour into a dark black-brown. Humic acids also changed the water chemistry affecting the fish population and breeding behaviour.

At Jempang Lake (15 000 ha) there was a population of fresh water dolphin (*Orcaella brevirostris*) which had been under wildlife protection since 1982. Jempang Lake, too, almost completely dried-up during the drought. It is not completely clear what happened to the dolphins, but it is assumed that they migrated into the river. (Kompas, June 24th, 1985). After the fire, dolphin sightings had become increasingly rare.

Pesut (the Indonesian name for the fresh water dolphin) is included on the endangered species list. They feed on fish and thus compete with fishermen for the catch. Furthermore, the fish population was significantly reduced after the fire and since then, overfishing has been the result since fish stocks are low both in lakes and rivers (Sarwono, 1989).

### **3.8 Primates**

Perhaps it is due to their high affinity and close relationship to human beings that make orangutans the most intensively studied primates in East Kalimantan. For years, researchers have been observing the daily life of different orangutan populations. The influence of the fire and the response of the orangutan population to it was of supreme interest.

As the information concerning other animals is somewhat limited rare, we would like to discuss the effects of the fire on primates more intensively. We hope this will point out the direct and indirect effects of the forest fire on the forest wildlife more closely.

### 3.8.1 Orangutan (*Pongo pygmaeus*)

During periods of drought and fire, population figures, behaviour, diet and other characteristics are subject of change. One of the most important indirect effects of the fire is the change in food availability for wildlife. Most of the fruit bearing trees were consumed by the fire forcing animals to adapt to a new diet or to migrate into other areas. Mr. Emil Salim, Minister for Population and Environment, expressed it more dramatically, when he said that it will be interesting to see if orangutans and monkeys begin feeding on mosquitos or other edible stuffs, which in East Kalimantan was never before included in their diets. What the Minister said was confirmed after the fire. Orangutans are presently feeding on the bark of young tree stems (Wirawan, in Kompas, June 26th 1984).

Immediately after the fire there was a considerable shortage of food for orangutans. They were forced to expand their diets to include bark from young stems and, when the vegetation became green again after the first rains, new buds and leaves of the secondary growth (Suzuki, 1988). Also, orangutan became a nuisance at the *Acacia mangium* timber estate at Batu Ampar, where they removed the bark from the stem and licked it (personal communication). Perhaps, the bark of the *Acacia mangium*, especially the cambium, contains water and some minerals, which are required by the orangutan. Also the *Trema spp.* and *Anthocephalus cadamba* bark was a favourite food. At Sangata, orangutans were observed nesting in Jabon (*Anthocephalus cadamba*) trees. An event which had never been recorded before.

Investigations two to three years after the fire came to the conclusion that food plants were more plentiful in the burnt forests than in the unburnt ones (Susilo, 1986). The maturing secondary forest vegetation offers more food value to orangutans than the former forest vegetation. Their food consumption, however, decreased in burned forests (Suzuki, 1985). Table 2 reflects the varied diet of the orangutan.

Type of diet	Before fire		After fire	
	Rodman (1978)	Suzuki (1985)	Jusilo (1986) burnt	unburnt
Fruits	75	10	56.8	67.1
Leaves	15	30	7.0	8.1
Bark	-	50	35.9	4.8
Herbs	-	10	-	-
Insects	-	-	0.3	-
Other	10	-	-	-

Table 2: Diet of the orangutan

According to Rodman (1977) and Galdikas (1980) orangutans are frugivora and spent about 60 % of their time feeding on fruit (under normal conditions). The consumption of fruit is considerably lower in burnt forests than in unburnt forests (Suzuki 1985).

Susilo compared the total feeding, travelling and resting times in burnt and unburnt forest areas but did not discover a significant difference. Table 3 shows the time spent by orangutans for different activities according to various research results.

Activities	Before fire		After fire	
	Rodman (1977) ?	Galdikas (1980) Tanjung Puting	Susilo (1986) Mentoko (burnt)	Prifab (unburnt)
Feeding	45.9%	60.1%	48.6%	32.2%
Travelling	11.1%	8.7%	9.5%	11.3%
Resting	39.2%	18.2%	41.9%	56.5%

Table 3: Activity breakdown of orangutans in % of time spent (Rodman: 5.30-18.30, Galdikas:?, Susilo: 6.00-19.00).

As early as 1984, orangutans at the Kutai National Park were observed carrying infants which were born after the fire. Mark Leighton saw a single habituated female orangutan in a large fig tree near Mentoko camp feeding with its three-year old son. Wirawan (in Kompas, June 20th, 1984) points out the ability of orangutans to adapt quickly to changes in the environment.

The density of the orangutan population in Kutai rests at approximately 1.8 per km<sup>2</sup> (Suzuki, 1988). This figure fluctuates in direct proportion to the availability of fruits in this forest area (Leighton, 1983).

### 3.8.2 Macaques and Other Primates (Various Genera)

The *Macaca fascicularis* was able to adapt to the new conditions after the fire very quickly by changing its feeding behaviour and by extending its home range. Macaques responded with extensive ground travelling by severely curtailing daily travel and by switching their diets from primarily fruit, their preferred food type to higher quantities of immature leaves and insects (Berenstain, in Susilo, 1988).

Four months before the fire, Macaques were feeding on 61 different fruit trees and on flowers from 18 different species. Four months after the fire they were only feeding on only 31 different fruits and 8 different flowers (Berenstein, in Susilo, 1988).

Macaques changed their diet after the fire to unusual food plants. In burnt forest near Mentoko (Kutai National Park) it was observed that macaques were feeding on young fruits and shoots from the *Dipterocarpus confertus*, *D. lanceolata*, *D. validus*, other *Dipterocarpus sp.*, *Shorea johorensis*, *S. palembanica* and other *Shorea spp.* According to Susilo (1987) macaques fed on fruits, seeds, flowers and leaves from 32 different plant species. Only *Guensia petandra* and *Dillenia reticulata* are secondary forest species. This means, that macaques do not depend solely on the secondary forest environment as it was once thought. The main food plants of the macaques are trees commonly found in logged-over forests, such as *Cananga spp.*, *Diospyros macrophylla*, and *Palaquium sp.*

During the long drought of 1982/83 a group of macaques fed solely along on the bank of the Sangata river which belongs to the Kutai National Park. After the fire a group of macaques were suddenly observed on the other side of the Sangata River outside of the Park where they were feeding on bamboo shoots and fruits of *Dracontomelon dao* (Susilo, 1988). Although the monkeys were undoubtedly under

some nutritional stress, their mortality rate is not thought to have been influenced by the fire and its effects.

The composition of the vegetation at the Kutai National Park near the Mentoko Research Station is, according to Campbell (1987), heavily represented by successional vegetation, but apparently the forest site still supports a healthy population of primate and other diurnal vertebrate species.

The fluctuation of the pig tailed macaques (*Macaca nemestrina*) is similar to that of the orangutans and directly dependent on the availability of fruit. (Leighton, 1983). Among the many complex ecological changes that have occurred after the fire, wood bearing insects have increased; a fact which particularly macaques and gibbons took advantage of. Leighton (1983) investigated the mortality rate of primate fruit trees caused by drought and fire and found that 44 % of all fruit trees and 97 % of all primate fruit lianas perished in the fire. However, the two most important species for primate food, *Koordersiodendron pinnatum* and *Dracontomelon dao* survived well (see table 4).

Species or genera	Family	Mortality (%)
<i>Alangium</i> (3 spp.)	<i>Alangiaceae</i>	60
<i>Dracontomelon dao</i>	<i>Anarcardiaceae</i>	25
<i>Koordersidendron pinnatum</i>	"	22
Several genera	<i>Annonaceae</i>	44
<i>Fissitigma</i> , <i>Uvaria</i> (lianas)	"	94
<i>Eriocybe</i> sp. (liana)	<i>Convolvulaceae</i>	100
<i>Diospyros</i> sp.	<i>Ebenaceae</i>	20
<i>Drypetes</i> (3 spp.)	<i>Euphorbiaceae</i>	88
<i>Baccaurea</i> (5 spp.)	"	67
<i>Phytocrene racemosa</i>	<i>Icacinaceae</i>	100
<i>Aglaiia</i> , <i>Reinwardtiodendron</i>	<i>Meliaceae</i>	50
<i>Dimocarpus</i> , <i>Nephelium</i>	<i>Sapindaceae</i>	43
<i>Tetrastigma</i> sp.	<i>Vitaceae</i>	90
Other trees		55
Other lianas		100
All primate fruit trees		44
All primate fruit lianas		97

Fig trees (*Ficus spp.*), one of the most important food suppliers for mammals and birds suffered heavily by fire (84 % for strangling figs and 100 % for climbing figs). Also during the first few years after the fire fruit production of the live trees was still curtailed, because crowns were seriously damaged (only about 50 % retained full crowns and roughly one-third had relatively sparse foliage. Others showed crown dieback in which the terminal twigs were dead or more severely damaged. Of these only some major limbs or trunks are leafing out again. Seven years after the fire, natural succession has favoured figs and lianas and other primate fruit trees (Schindele, Thoma and Panzer 1989).

After the fire, Mark Leighton encountered all five gibbon families (*Hyllobates muelleri*) at the Kutai National Park within whose territories he worked, as mapped by D.R. Leighton in 1977-1979. He observed two families yet determined change in neither behaviour nor activity. He did not find any leaf monkeys in the forest and it is unclear, if a reduction in density or restriction in activity had occurred. He only heard a single *Presbytis hosei* leaf monkey male calling. Berenstein had heard the males of 3-4 groups calling on a single morning some weeks before Leighton's study. The silvered leaf monkey (*Presbytis cristatus*) was found after the fire in several types of vegetation. Even six months after the fire *Presbytis sp.* were hardly encountered at Mentoko Station (Suzuki, in Azuma, 1988). The densities of leaf monkeys and macaques is still low at Kutai National Park. Western tarsier (*Taricus bancanus*) and slow loris (*Nycticebus coucany*) were extinct or extremely reduced in number in 1986. The proboscis monkey (*Nasalis larvatus*) still lives in fair density in mangrove forests.

### 3.9 Carnivora Species (Various Genera)

Carnivora species like the Malay civet (*Vicerra tangalunga*), otter (*Lutra sp.*), leopard cat (*Felis bengalensis*), flat headed cat (*Felis planiceps*), and feral dogs (*Canis familiaris*) are species which are very difficult to study due to their nocturnal habits. (Doi, 1988). The carnivora density increased after the fire. Their increased numbers were significantly noticed at km 24 at the Kutai National Park. Compared to dense natural forests the density and diversity of prey animals is more rich in secondary forests. Also civets, which are not only carnivorous but also feed on fruits, are still numerous in the forests.

The potential ability of adaption to new environmental conditions might have helped most of the large mammals to survive and to change their habits according to the new circumstances. However, some arboreal species had lost their habitats to a great extent after the fire. It will take many decades until similar habitats are formed again by natural succession. Maybe they can survive in the few unburnt or lightly burnt forests and reoccupy secondary forests when their condition is improved (Silitonga, in Kompas, July 24th, 1984).

#### **4. Effects of the Fire on Some Reptiles**

Before the forest fire it was quite easy to find crocodiles as well as other animals in the swamp area. Fire and drought have reduced wildlife in the swamp area considerably. But in 1989 most of the animals have since reoccupied their former habitat, even if their numbers are not as great as before the fire. Crocodiles have not since reappeared (personal communication with local people at Kota Bangun).

People at Kecamatan Pasir Belengkong, Kabupaten Pasir, reported, that there are still many snakes in the forests, with the exception of the larger ones such as the *Phyton sp.* The lack of large snakes also promoted the the increase in the pig population, as large snakes are the main predators of the wild pigs.



## 5. Effects of the Fire on the Hornbill and Other Birds

During and immediately after the fire, the bird population was influenced negatively. According to observations by local people, birds became disorientated in the heavy smoke and died seemingly of smoke and heat exposure (Mayer, 1989).

Among the birds there are many "special" species which require a corresponding special habitat or food source. Habitat changes by certain species of birds can be used as bioindicators to identify disturbance and destruction of the environment (Balen, 1987).

The forest fire has changed the environment considerably and thus effected the bird population. Several species of hornbill, including two endangered species were considerably reduced. Pipit, a bird pest in garden and rice fields, has increased in some villages after the fire (Mayer, 1989).

Leighton (1983) tells of seven hornbill species which were once very common in the Mentoko area of the Kutai National Park before the fire. Two of these were nomadic, flocking species which were seasonally uncommon, when some of their preferred fruits were available. Five species occurred as highly territorial pairs, or cooperatively breeding groups, and were calling, several times a day while defending these permanent territories against neighboring conspecific groups. After the fire, Leighton only noticed one distant call from a single black hornbill (*Anthracoceros malayanus*), He concluded that the groups he had studied earlier had abandoned their territories, probably as their nutritional health declined. Since an alternative appropriate habitat was undoubtedly already occupied by other conspecifics it is inconceivable that the pairs or groups could have successfully moved and survived elsewhere (Leighton, 1983).

The change in vegetation also created a new habitat for other bird species, or as Mackinnon (1989) formulated it: Anywhere where plants grow or fish, insects or other invertebrates are found, there are birds making a living, as seed, fruit or nectar eaters, insectivores, fish eaters, birds of prey or scavengers on carrion.

Leighton investigated the mortality rate of bird fruit trees immediately after the fire at Kutai National Park (see table 5). He found out that 52 % of all specialized hornbill fruit trees were killed. The most important hornbill fruit trees of the family of *Meliaceae* and *Lauraceae* suffered high mortality; 62% and 57% respectively. Bird fruits with lipid rich pulp are predominant in the diets of two species of fruit pigeons (*Ducula*, *Ptilinopus*),

six species of barbets, the hill myna (*Gracula religiosa*) and the green broadbill (*Calyptomena viridis*). Only the trees of the species *Myrantes corymbosa* were virtually unaffected by fire. These are important food trees for nomadic *Ryticeros* hornbills.

Species or genus	Family	Mortality (%)
I. Specialized hornbill fruits		52
<i>Durio spp.</i>	<i>Bombaceae</i>	40
<i>Neoscortechinia forbsii</i>	<i>Euphorbiaceae</i>	50
<i>Aglaiia</i> (3 spp.)	<i>Meliaceae</i>	78
<i>Chisocheton granatum</i>	"	67
other <i>Chisocheton</i>	"	3
<i>Dysoxylum</i> (7 spp.)	"	57
<i>Myristica, Horsfieldia, Knema</i>	<i>Myristicaceae</i>	47
II. Other bird fruits with lipid rich pulp		54
<i>Cananga odorata</i>	<i>Annonaceae</i>	60
<i>Friesodelsia spp.</i> (lianas)	"	100
<i>Polyalthia sumatrana</i>	"	53
<i>Xylopia malayana</i>	"	50
<i>Xylopia spp.</i>	"	88
<i>Durio acutifolius</i>	<i>Bombaceae</i>	20
<i>Dacryodes, Santiria</i>	<i>Burseraceae</i>	38
various genera (lianas)	<i>Connaraceae</i>	100
<i>Maranthes corymbosa</i>	<i>Chrysobalanaceae</i>	0
<i>Macaranga spp.</i>	<i>Euphorbiaceae</i>	73
<i>Gnetum cuspidatum</i>	<i>Gnetaceae</i>	100
<i>Litsea</i> (> 15 spp.)	<i>Lauraceae</i>	53
<i>Nothaphoebe spp.</i>	"	73
various genera	"	65
<i>Elmerrillia mollis</i>	<i>Magnoliaceae</i>	25
other trees	-	64
III. Bird fruits with sugar rich pulp		
<i>Baccaurea</i>	<i>Euphorbiaceae</i>	71
various genera	<i>Rubiaceae</i>	20
other trees	-	38
lianas	-	83

Table 5: Mortality of major bird fruit trees (Leighton, 1983)

## 6. Effects of the Fire on Insects and Other Invertebrates

There are very few studies on the impact of the fire on insects and other invertebrates. However, many newspapers reported on the increase of insect pests in the forests, but there was no extraordinary event of salvage larvae attack on trees or other vegetation.

Trees, which perished in the fire, were soon attacked by large larvae (2 - 4 cm length) belonging to the family *Cerambycidae* and *Coleoptera* having white bodies and brown heads. Mainly the tree species of the Meranti group (*Shorea spp.*) were attacked. The larvae, however, attacked only dead trees.

During the middle of June 1983, after the rains had returned, butterflies of an unknown species appeared in large numbers along the old road from Sebulu to km 35 in the Kutai National Park. Afterwards, the mosquito population increased and, after their numbers normalized, fire flies (Kunang-Kunang) appeared in abundance. Towards the end of August 1983, two new species of butterflies appeared again at Mentoko (Suzuki, 1984).

Yajima (1988) studied the change of the invertebrate community after the fire at Kutai National Park. He concluded, that the fauna and biomass of macrosoil animals had a tendency to become more simplified and smaller corresponding the change in vegetation after fire or logging. However, such a tendency did not apply to floor and phytal invertebrate communities. Floor and phytal invertebrates are not abundant in the forest floor but also in the open fields. Termites and termite hills were difficult to find. Only three specimens were collected by Yajima. Ants, such as *Anoplolepis longipes* (Jerdon), *Leptogenys sp.* and *Crematogaster sp.*, were found widely in various vegetation types. Most of the land snails, which cannot migrate easily, were killed by the fire.

Leeches, which were very common in Kutai National Park were no longer present in burnt forests. The spider population increased heavily immediately after the fire. Spider webs hung between the dead saplings (Leighton, 1983). The terrestrial community recovered much more quickly than expected in the tropical rain forests after the fire. The diversity of terrestrial invertebrates recovered within three years, however the variety of fauna has still yet to reach the pre-fire level.

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