ECOLOGICAL OBSERVATIONS ON DIURNAL BIRDS IN INDONESIAN OIL PALM PLANTATIONS

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ABSTRACT

The nocturnal barn owl, Tyto alba, *has been studied and used as a biological agent for the control of rats in oil palm plantations, but diurnal birds have never been investigated for their impact on oil palm pests. Only birds which damage the fruits have been recorded. However, many species are present from soon after planting up to mature oil palms.*

At the Indonesian Oil Palm Research Institute, Sumatra, we have carried out an inventory of these birds in two plantations and on blocks of different age. Their population and composition vary according to the time since planting and availability of food supplies. Whilst some are granivores feeding on seeds of grasses, or fruit-eaters feeding on weed berries and oil palm fruits, most of them are insectivores with their population fluctuating with caterpillar outbreaks.

Their biology has been studied, especially the feeding and nesting behaviour. Their gut contents have been analysed and the amount of insects found in some species is astonishing and may have an important impact on oil palm pests, especially caterpillars.

Among the 29 species observed, their dominance varies according to plantations: Pycnonotus goiavier *between 24.4% to 28.7% of all individual birds,* Prinia *spp. between 27.59% to 34.4%,* Parus major *9.54% to 10.56%,* Copsychus saularis *4.47% to 8.62%, and* Halcyon smyrnensis *5.07% to 6.90%.* Parus *is found on higher palms,* Copsychus *and* Prinia *more common on younger planting,* Pycnonotus *on both older and younger palms, as well as others such as* Centropus bengalensis *only at the level of the lower strata among the cover crops.*

These dominant insectivorous species feed on caterpillars, small beetles, grasshoppers and ants. For example, a pair of Parus major *providing food for their young (2 or 3) collects up to 139 insects, mostly nettle caterpillars, per day from 6.55 am to 18.15 pm, with the male and female bird catching 60 to 79 of these limacodid larvae respectively.*

The Centropus *feeding at the level of the soil breaks the nettle caterpillar cocoons and up to 12 pre-pupae and pupae of* Setothosea asigna *can be found in the gut of a single bird.* Pycnonotus *and* Cosyphus *are less specific, catching a wider range of insects including small beetles, caterpillars and ants.* Halcyon *catches bigger insects in flight such as grasshoppers and beetles.*

The Orthotomus, *one of the species which is increasing in population, has modified its feeding behaviour by preying only on* Elaeidobius kamerunicus. *This may result in a reduction of the population of this pollinator, with the consequence of decreasing the oil palm fruit-setting during the first years of production.*

Keywords: oil palm, diurnal birds, ecology, inventory, feeding behaviour.

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Nesting occurs generally on oil palm stems in the older petiolar bases for Parus*;* Copsychus *nests in the stem and also on the crown in the palm fronds;* Pycnonotus *in the lower strata in weeds and often ferns such as* Prinia *as well as* Orthotomus, Halcyon *on dead oil palm trunks standing upright or already fallen into holes from damage by* Oryctes *or rats.*

Increase of the bird population is possible with artificial nesting boxes. In our experiment, Parus major *was occupying wooden nesting boxes of 12 cm x 12 cm x 20 cm x 22 cm with an entrance of 3.4 cm diameter, placed on poles inside the plantations. Other birds such as* Acridotheres *nesting in tree holes,* Halcyon *in burrows or tree holes and other diurnal birds might also be able to use nesting boxes adapted for each species.*

Several insectivorous birds found are in insignificant number such as Acridotheres tristis *and* A. javanicus *with less than 1%. These birds and many others which were previously much more numerous in plantations are now being poached and sold as birds to keep in cages.* Copsychus *and* Parus *are also being poached. Consequently, the population of these useful birds is greatly reduced through poaching as well as from the excessive use of pesticides in the plantations.*

Therefore, the diurnal birds which are mostly insectivorous and often quite specific in their feeding habits on several pests, are a very useful component in the general ecosystem of the oil palm plantations. It is necessary to maintain, and increase via nesting boxes, their population and use them in integrated pest management programmes.

INTRODUCTION

Many books have been published in recent years for the identification of birds of Southeast Asia (King *et al*., 1975; Mackinnon *et al*., 1991; Jepson *et al*., 1997; Strange, 2001). It is therefore surprising that no research has been undertaken on the inventory and ecological observations of diurnal birds regarding their feeding behaviour and impact on the pests in oil palm plantations.

Damage to fruits by birds have been recorded with several species of parrots being blamed for eating the mesocarp of ripe fruit bunches and flocks of hundreds have established in oil palms (Ward *et al*., 1967; Wood, 1968; 1969). Even the crow, introduced to Malaysia, has become a scavenger on oil palm wastes and was considered as a potential pest (Chua *et al*., 1980; Siew *et al*., 1979).

Large birds of prey such as eagles and kites have been included in a global environmental project in Indonesia, Bird Life. The species living near oil palm plantations are protected with recommendation of keeping some old trees in new oil palm extension for the birds to perch. The nocturnal barn owl, *Tyto alba*, has been extensively studied, and by increasing its population with the use of nesting boxes, used as a biological agent for the control of rats in oil palm plantations (Smal, 1989a).

However many other diurnal birds are present in plantations, from soon after planting till maturity of the oil palms. At the Indonesian Oil Palm Research Institute (IOPRI), we have therefore carried out investigations on the inventory of these birds in two plantations and on blocks of different age. The bird population and composition according to the time since planting have been monitored on three blocks per year.

The biology of the species found regarding their feeding and nesting behaviour have been studied, particularly taking into account the possible impact of the insectivorous birds on oil palm pests.

The results of these investigations are presented in this paper in order to see how this useful and unknown biological component in the general ecosystem of oil palm plantations can be integrated in a pest management programme.

INVENTORY OF DIURNAL BIRDS IN OIL PALM PLANTATIONS

Methods of Observation

The inventory of the birds was carried out on two oil palm plantations with different ecological conditions. On each estate three planting years were observed: in Bah Jambi, 2000, 1995, 1975 and in Bukit Maradja, 2001, 1998, 1985.

A total of 174 ha was checked in Bah Jambi and 192 ha in Bukit Meradja. From each planting year, three blocks were taken into account. The selected blocks were situated in the middle of the estates so that the birds were out of the range of poachers and to exclude recording bird species that are living outside of the plantation.

From each planting year, three blocks of about 20 ha each were checked two times at two monthly intervals. On each block all the palms on both sides of six interrows (12 lines) were observed which means that 10% of the palms or the area planted were investigated. On the two lines of each interrow chosen, all the birds found were recorded for numbers and species.

The determination of the birds was made with binoculars, magnification 8 x 30. Then, the gut content of several species was analysed and the prey found inside the gut was identified.

Bah Jambi is an estate in the blocks observed where its cover-crop was not yet well established even in the younger blocks of planting year 2000. In the older (1975) planting was found some growth of bushy weeds such as *Melastoma malabathricum*, and on the oil palm stems, some parasitic *Ficus*. On the lower strata, very few legume cover-crop remained in the blocks of planting years 1995 and 1975, but there were Amaranthaceae, Asteraceae, Euphorbiaceae, Malvaceae, Rubiaceae and ferns, among them dominantly *Nephrolepis biserrata*, *Diplazium asperum* and *D. esculentum*. On the borders of the blocks, some grasses were growing in spaces with missing palms that were destroyed by *Ganoderma*.

Bukit Maradja had a denser legume cover-crop with *Pueraria phaseoloides* and *Calopogonium caeruleum* in the 2001 planting and the 1998 planting. In older planting (1985), the ferns *Nephrolepis* and *Diplazium* were dominant in the windrows.

Therefore, the young planting in Bukit Maradja has a more homogeneous legume cover-crop with less plant biodiversity compared to Bah Jambi. But on planting 1998 and 1995 in both estates, there was more biodiversity of plants at the lower strata. In Bah Jambi, the planting year 1975 had higher biodiversity and more possibilities for nesting.

Inventory of the Species Recorded in Two Oil Palm Plantations

In the two plantations, a total 29 species were observed belonging to 18 families. One species *Caprimulgus macrurus,* not diurnal but active at dusk, is mentioned because it is strictly insectivorous. The number of species per family is small with a maximum of three species each for the Cuculidae, Motacillidae, Sylviidae, and two species each for Accipitridae. Alcedinidae, Columbidae, Laniidae, Sturnidae.

The other families are represented by only one species each. This is limited compared with the number of bird species recorded in Sumatra reaching 596 species, but quite numerous considering the oil palm monoculture (5%) (*Table 1*).

In Bah Jambi (BJ), 26 species were recorded with a total of 828 birds counted, and in Bukit Meradja (BM), 25 species with only 464 birds. The number of species is rather similar but the difference in the number of birds observed can be due to the age of the blocks and the diversity of plants present, affecting the availability of food supply and nesting possibilities.

The small family Sylviidae with only 14 species in Sumatra is the dominant one in number of birds counted in the inventories in BJ and BM. This family with three species found in plantations, *Prinia flaviventris*, *P. atrogularis* and *Orthotomus ruficeps*, consists of small birds which are all insectivorous, and are very active in the lower strata of all blocks. Due to their tiny size and therefore the difficulty of identification, we are counting these three species together, considering that one of them, *P. atrogularis*, is dominant at 305 specimens or 93.44% in BJ and 133 specimens or 52.63 % in BM. As a percentage of the total bird population recorded, this means 36.84% in BJ and 28.7 % in BM (34.42% and 15.1% for the dominant species) (*Tables 2* and *3*).

The next dominant family is the Pycnonotidae with only one species *Pycnonotus goiavier* numbering 238 birds in BJ and 113 in BM, reaching 28.74% of total bird population in BJ and 24.35% in BM. This family with great diversity in Indonesia, includes 16 species in Sumatra for the same genus. This species is mostly insectivorous but occasionally feeds on berries and juicy fruits.

The Paridae family is the third dominant group with one species also, *Parus major*, totalling 79 specimens in BJ and 49 in BM, equivalent to 9.54% and 10.56% of the total population respectively. This species with large repartition and many sub-species is well-known from Europe to Southeast Asia. *P. major* is insectivorous and feeds mostly on caterpillars.

The other families are less numerous, the Turdidae with *Copsychus saularis* totalled 37 birds in BJ and 40 in BM or 4.47% and 8.62% of total bird population in each location.

The kingfishers, Alcedinidae, are well represented also with two species, one of them *Halcyon smyrnensis* numbering 40 in BJ and 32 in BM, or 4.83% and 6.90% respectively of total population.

Another family Cuculidae, the Coucals, also insectivores at the level of the ground are numerous with two species, one *Centropus bengalensis* with 10 specimens in BJ and 16 in BM, respectively 1.21% and 3.44%.

The doves Columbidae, although not insectivorous are frequent on the roads along the blocks, *Geopelia striata* 2.29% in BJ, 2.37% in BM and *Streptopelia chinensis*, 1.81% in BJ, 3.45 in BM.

The Laniidae, *Lanius schach* mainly, are present on almost all the blocks in small numbers at 1.81% in BJ and 2.59% in BM of total bird population.

TABLE 1. LIST OF THE DIURNAL BIRDS IN OIL PALM PLANTATIONS OBSERVED (North Sumatra: Bah Jambi and Bukit Meradja Estates, 2003)

Family	No. species	Name of species (English and Indonesian names)
Accipitridae	2	*Elanus caeruleus* (Black-shouldered Kite, Elang Tikus) *Spilornis cheela* (Crested Serpent-Eagle, Elang Ular)
Alcedinidae	2	*Halcyon chloris* (Collared Kingfisher, Cekakak) *Halcyon smyrnensis* (White-throated Kingfisher, Cekakak Dada Putih)
Ardeidae	1	*Ardea cinerea* (Grey Heron, Cangak Abu)
Campephagidae	1	*Tephrodornis virgatus* (Large Wood-Shrike, Petulak)
Columbidae	2	*Geopelia striata* (Peaceful Dove, Perkutut) *Streptopelia chinensis* (Spotted Dove, Tekukur)
Cuculidae	3	*Clamator coromandus* (Chestnut-Winged Cuckoo, Bubut Jambul) *Centropus bengalensis* (Lesser Coucal, Bubut Alang-alang) *Centropus sinensis* (Great Coucal, Bubut Besar)
Dicruridae	1	*Dicrurus aeneus* (Bronzed Drongo, Srigunting)
Laniidae	2	*Lanius schach* (Long-Tailed Shrike, Bentet) *Lanius tigrinus* (Tiger Shrike, Bentet Loreng)
Meropidae	1	*Merops philippinus* (Blue-Tailed Bee-Eater, Kirik-kirik Laut)
Motacillidae	3	*Anthus novaeseelandiae* (Richard's Pipit, Apung) *Dendronanthus indicus* (Forest Wusagtail, Entut Leuncang Hutan) *Motacilla cinerea* (Grey Wagtail, Entut Leuncang)
Paridae	1	*Parus major* (Great Tit, Gelatik Batu)
Ploceidae	1	*Lonchura maja* (White-Headed Munia, Bondol Haji)
Pycnonotidae	1	*Pycnonotus goiavier* (Yellow-Vented Bulbul, Cerukcuk)
Rallidae	1	*Amaurornis phoenicurus* (White-Breasted Waterhen, Kareo)
Sturnidae	2	*Acridotheres javanicus* (White-Vented Myna, Jalak Ungu) *Acridotheres tristis* (Common Myna, Jalak)
Sylviidae	3	*Orthotomus ruficeps* (Ashy Tailor-Bird, Cinenen kelabu) *Prinia atrogularis* (Hill Prinia, Perenjak) *Prinia flaviventris* (Yellow-Bellied Prinia, Perenjak Perut Kuning)
Turnicidae	1	*Turnix suscitator* (Barred Button Quail, Burung Puyuh)
Turdidae	1	*Copsychus saularis* (Magpie Robin, Kucica)
Total: 18	29	

TABLE 2. INVENTORY OF BIRDS OBSERVED IN BAH JAMBI OIL PALM PLANTATIONS

Blocks/ planting year	Birds species																									Total
	Aj	An	Ap	At	Cc	Cs'	Cs	Cb	Da	Ec	Gs	Hc	Hs	Lm	Ls	Mc	Mp	Or	Pa	Pg	Pm	Pfl	Sc	Sc'	Tg	Ts	
1975/F	2	-	-	-	-	-	6	-	-	-	-	-	5	2	-	-	-	6	66	38	21	-	2	-	1	-	149
1975/E	1	-	-	1	-	-	8	-	-	-	-	-	5	6	-	2	-	-	79	44	30	-	-	1	2	-	179
1975/K	-	-	-	-	-	-	10	-	1	-	-	-	3	-	1	-	-	-	73	12	10	4	-	-	3	-	117
1995/V	-	-	-	-	-	-	4	2	-	-	-	-	6	-	-	-	-	10	32	14	4	-	-	-	3	-	75
1995/X	-	-	-	-	-	-	-	-	-	-	2	-	3	-	-	-	-	-	21	11	4	-	-	-	-	-	41
1995/W	-	-	-	-	-	-	-	3	-	1	-	-	5	-	-	-	-	-	6	6	2	-	4	-	-	-	27
2000/F	-	3	1	-	-	-	1	4	-	3	3	2	8	-	2	-	8	-	2	27	-	-	1	-	1	-	66
2000/B	2	-	-	5	1	-	6	-	-	-	7	-	3	-	5	-	-	-	2	31	6	-	4	-	2	-	71
2000/A	-	3	2	-	-	1	2	1	-	1	7	-	4	4	7	-	-	-	4	55	2	-	4	-	5	1	103
Total	5	6	3	6	1	1	37	10	1	5	19	2	42	12	15	2	8	16	285	238	79	4	15	1	17	1	828

Notes:

1. AJ : *Acridotheres javanicus*
2. An : *Anthus novaeseelandiae*
3. AP : *Amaurornis phoenicurus*
4. At : *Acridotheres tristis*
5. Cc : *Clamator coromandus*
6. Cb : *Centropus bengalensis*
7. Cs' : *Centropus sinensis*
8. Cs : *Copsychus saularis*
9. Da : *Dicrurus aeneus*
10. Ec : *Elanus caeruleus*
11. Gs : *Geopelia striata*
12. Hc : *Halcyon chloris*
13. Hs : *Halcyon smyrnensis*
14. Lm : *Lonchura maja*
15. Ls : *Lanius schach*
16. Mc : *Motacilla cinerea*
17. Mp : *Merops philippinus*
18. Or : *Orthotomus ruficeps*
19. Pa : *Prinia atrogularis*
20. Pfl : *Prinia flaviventris*
21. Pg : *Pycnonotus goiavier*
22. Pm: *Parus major*
23. Sc : *Streptopelia chinensis*
24. Sc' : *Spilornis cheela*
25. Tg : *Tephrodornis gularis*
26. Ts : *Turnix suscitator*

TABLE 3. INVENTORY OF BIRDS OBSERVED IN BUKIT MARADJA OIL PLANTATIONS

Blocks/ planting year	Birds species																									Total
	Ac	An	At	Cc	Cs'	Cs	Cb	Da	Di	Ec	Gs	Hc	Hs	Lm	Ls	Lt	Mp	Or	Pa	Pf	Pg	Pm	Sc	Tg	Ts	
2001/11D	1	-	-	-	4	-	4	-	-	-	-	-	-	-	-	-	-	2	12	-	40	-	-	-	-	63
2001/13D	-	-	-	-	1	-	2	-	-	-	-	-	2	-	4	1	-	-	6	-	10	-	2	3	-	31
2001/13E	-	-	-	-	2	1	5	-	-	1	2	-	-	2	7	-	-	4	-	-	14	-	4	-	-	42
1998/27A	2	-	2	-	3	2	1	-	-	-	-	-	5	4	-	-	-	4	-	-	16	3	2	1	1	46
1998/29A	1	-	-	-	-	-	3	-	-	-	2	-	5	-	1	-	-	3	8	-	11	5	-	-	1	40
1998/31A	-	-	-	-	1	7	1	-	-	-	7	-	9	-	-	-	-	5	8	-	17	4	7	1	1	68
1985/10	-	-	-	-	-	8	-	-	1	-	-	-	3	2	-	-	-	19	12	4	1	9	1	-	-	60
1985/17	-	-	-	-	-	14	-	-	-	-	-	-	7	3	-	-	-	14	15	1	-	15	-	-	-	69
1985/16	-	-	-	-	-	8	-	-	-	1	-	-	1	2	-	-	-	7	9	-	4	13	-	-	-	45
Total	4		2		11	40	16		1	2	11		32	13	12	1		58	70	5	113	49	16	5	3	464

Notes:

1. Ac : *Ardea purpurea*
2. An : *Anthus novaeseelandiae*
3. At : *Acridotheres tristis*
4. Cc : *Clamator coromandus*
5. Cb : *Centropus bengalensis*
6. Cs : *Copsychus saularis*
7. Cs' : *Centropus sinensis*
8. Da : *Dicrurus aeneus*
9. Di : *Dendronanthus indicus*
10. Ec : *Elanus caeruleus*
11. Gs : *Geopelia striata*
12. Hc : *Halcyon chloris*
13. Hs : *Halcyon smyrnensis*
14. Lm : *Lonchura maja*
15. Ls : *Lanius schach*
16. Lt : *Lanius tigrinus*
17. Mp : *Merops philippinus*
18. Or : *Orthotomus ruficeps*
19. Pa : *Prinia flaviventris*
21. Pg : *Pycnonotus goiavier*
22. Pm: *Parus major*
23. Sc : *Streptopelia chinensis*
24. Tg : *Tephrodornis gularis*
25. Ts : *Turnix suscitator*

ECOLOGICAL OBSERVATIONS

Distribution of the Birds According to the Age of the Palms

Three years of planting have been checked in BJ (2000, 1995, 1975) and in BM (2001, 1998, 1985). Considering the total number of birds recorded on each plantation, there is an increase in their numbers at each of the two observations where the palms are taller and older.

After planting at 20 months or 30 months, the percentage of birds in BM or BJ is not too much different at 27.20% and 31.54%. But thereafter, the population increases: 30.80% for 1998, then 42.00% for 1985 in BM, and 49.73% in BJ for the year 1975. This proves that the ecological conditions in older palms are more favourable for the birds.

Also between two observations at a two months interval, the number of birds increases from January-February-March compared to March-April-May: from 36.03% to 63.97% in BJ and from 42.20% to 57.80% in BM. This is due to the beginning of the breeding season for the insectivorous species in North Sumatra, with the oil palm plantation offering suitable conditions at this period in terms of shelter, food and nesting possibilities. In fact, this period corresponds also to an increase of the insect pest populations of nettle caterpillars and secondary pests such as Amathusiidae, Drepanidae, Geometridae, Notodontidae, Pyralidae (*Table 4*) (Desmier de Chenon, 1982; Desmier de Chenon *et al*., 1990).

The bagworm population which increases more in September-October in North Sumatra is more preyed upon by the diurnal birds during this period.

Density of the Bird Population

In terms of average density per hectare of diurnal birds, the total population in BJ reaches 24.19 ha, higher than in BM with 13.24 ha. But there is a great variation in density according to year of planting and between the two estates according to our observations at two monthly intervals.

In BJ planting year 2000, the number of birds per hectare increased from 16.97 at the first observation to 28.80 at the second observation, an average of 22.88, whilst on the 1975 planting, the population increased from 26.53 to 46.60, an average 36.07. Therefore on the more populated block 1975, at the second observation, there was nearly one bird for every three palms. In comparison, at BM there is not such a big difference between the younger blocks 2001 and the older blocks 1985: respectively from 9.22 to 12.39, an average 10.80 and from 14.49 to 18.88, an average 16.68. The blocks of 1998 had an average of 12.23 (*Table 5*).

For three important insectivorous birds found in the plantations, *Parus major*, the group *Prinia*/*Orthotomus*, *Pyctonotus goiavier*, the number of birds for each species per hectare is recorded.

These results in BJ show that *P. major*, a very effective predator of caterpillar pests on oil palm, is increasing in per hectare average from 0.76 for planting year 2000 to 1.26 for 1995, and to 4.85 for 1975; and *P. goiavier* from 10.78 in 2000 to 14.94 for 1975. But the more numerous is *Prinia*/*Orthotomus*, increasing according to the age of the palms, 0.76 in 2000, then 6.58 in 1995 to reach the highest level of 18.11 in the 1975 planting. By comparison, in BM the species with the highest number of birds per hectare is *Prinia*/*Orthotomus* reaching an average 1.91 in the 2001 planting, 2.22 in 1998 and 7.34 for 1985; *P. goiavier* decreases from 5.08 to 3.50 and 0.48 for the same year plantings respectively; *P. parus* increases regularly from nil in young planting to 0.95 in 1998 planting and reaching 3.53 for the planting year 1985 (*Table 6*).

The density of birds per hectare is quite low but outside of the breeding season and when not building their nests, the adults should be foraging in groups to locate food, moving in oil palm plantations from one locality to another if insects are available. Large flocks of up to a few hundreds at times can be observed for the Bulbuls *P. goiavier*, for the Great Tits, *P. major*, smaller flocks for the Shrikes, *Lanius shach*, or mixed flocks occurring for the Tits and Drongos, *P. major* and *Dicrurus aeneus*, and other birds.

TABLE 4. NUMBER OF BIRDS OBSERVED IN TWO OIL PALM ESTATES IN NORTH SUMATRA (Bukit Maradja – Bah Jambi, January to April 2003)

Planting year (ha)/ observations (mth)	Bukit Maradja			Total
	2000 (63)	1995 (78)	1975 (56)	
I 02 – 03/2003	58	62	91	211
II 04 – 05/2003	78	92	119	289
Total	136	154	210	500
Planting year (ha)/ observations (mth)	**Bah Jambi**			**Total**
	2000 (53)	1995 (49)	1975 (72)	
I 01 – 02/2003	107	55	167	329
II 3 – 4/2003	181	116	287	584
Total	288	171	454	913

Notes: Each planting year, three blocks observed with six rows per block.
- Bukit Maradja, 192 ha (± 21 ha/Bl.).
- Bah Jambi, 174 ha (± 19 ha/Bl.).

TABLE 5. DENSITY OF DIURNAL BIRDS IN OIL PALM PLANTATIONS AVERAGE PER HECTARE (Bah Jambi and Bukit Maradja estates North Sumatra 2003)

Estates planting year / Birds av./ha	Bah Jambi			Bukit Maradja		
	2000	1995	1975	2001	1998	1985
Obs. I	16.97	8.77	26.53	9.22	9.85	14.49
Obs. II	28.80	18.49	46.60	12.39	14.61	18.88
Av./ha	22.88	13.63	36.07	10.80	12.23	16.68

TABLE 6. DENSITY OF THE MAIN INSECTIVOROUS BIRDS IN OIL PALM PLANTATIONS (*Parus major*, *Prinia/0rthotomus*, *Pycnonotus goiavier*; average per hectare) (Bah Jambi and Bukit Maradja Estate, North Sumatra 2003)

Estate planting year / Birds av./ha	Bah Jambi								
	2000			1995			1975		
	Pm	P/0	Pg	Pm	P/0	Pg	Pm	P/0	Pg
Obs. I	0.38	0.76	7.06	1.14	4.19	1.72	3.81	14.14	5.72
Obs. II	1.14	0.76	14.50	0.76	8.96	4.19	5.88	22.09	9.22
Av./ ha	0.76	0.76	10.78	1.26	6.58	2.95	4.85	18.11	14.94
Estate planting year / Birds av./ha	**Bukit Maradja**								
	2001			1998			1985		
	Pm	P/0	Pg	Pm	P/0	Pg	Pm	P/0	Pg
Obs. I	0	1.91	4.93	0.48	1.59	2.86	4.00	5.91	0.76
Obs. II	0	1.91	5.24	1.43	2.85	4.13	3.05	8.77	0.19
Av./ ha	0	1.91	5.08	0.95	2.22	3.50	3.53	7.34	0.48

Notes: Pm : *Parus major.*
P/0 : *Prinia/Orthotomus.*
Pg : *Pycnonotus goiavier.*

Ecological and Feeding Behaviour

According to their ecological and feeding behaviour, we have tried to classify the birds observed in oil palm plantations into birds of prey, granivores, frugivores and insectivores. However, several of them do not have a strict food specificity but are both granivores and frugivores, or insectivores and frugivores, or omnivores, *i.e.* eating all of the above.

Birds of prey. Two of these species, both Accipitridae, the black-shouldered kite *Elanus caeruleus* and the eagle *Spilornis cheela* have been regularly observed in the blocks in very small numbers. These large birds measuring 30 cm for the former and 60 cm for the latter are seen perching solitarily on higher fronds of old palms or scattered trees remaining in the area in BJ.

In the census, only two *E. caeruleus* have been recorded in BM and five in BJ in the planting 2000 and 2001, mostly in open areas needed by these birds. They catch small mammals, snakes, lizards and sometimes *Valanga nigricornis*, if present, in new planting.

In contrast, *S. cheela* rests on large palms in plantations, in the canopy at the lower fronds in dark shade and flying when disturbed. Like eagles they fly in the sky looking for snakes, frogs, small mammals and even some large grasshoppers.

Therefore, the two species are more carnivorous rather than insectivorous tending to have nearly no impact on the insect pest populations. Nevertheless, due to their predation on some rats, it is worthwhile to encourage them in plantations, retaining some old trees to facilitate perching and nesting.

Two other birds recorded in plantations are linked to the presence of water: the Grey Heron, *Ardea cinerea* (Ardeidae) and the White-Breasted Waterhen, *Amaurornis phoenicurus* (Rallidae). A pair of these large herons was seen in BM near large water drainage, feeding mostly on fishes and animals living in the water. This predator has nothing to do with oil palm pests. The other species *A. phoenicurus* was seen only in BJ living near drainage or small rivers deep inside the new planting. A frequent sight and well established in plantations, although hiding amongst thick vegetation, this omnivorous bird feeds on small fishes, worms and insects living on aquatic weeds but not on the pests of oil palm.

Granivorous birds. In the birds listed and found in the plantations, some are feed particularly on grass seeds and can be considered granivores. The main one is the White-Headed Munia weaver, *Lonchura maja* (Ploceidae), living gregariously in BM and BJ inside old planting where there are missing palms and spots of Gramineae.

Another family, the Columbidae with two doves species, *Geopelia striata* and *Streptopelia chinensis* are more numerous in plantations than the aforementioned granivores. Found on the harvesting paths in the interrows or the roads bordering the blocks, they pick up seeds of grasses on the ground. Although frequently perching on the oil palm fronds, they feed only occasionally on some insects not related to oil palm pests.

Frugivorous birds. Some birds such as the parrots, *Loriculus galgulus*, *Psittacula longicauda*, *Psittinus cyanurus* reported damaging oil palm fruit mesocarp in Malaysia, are present in North Sumatra. Some specimens were recorded feeding on palm bunches 30 years ago. These parrots which do not cause damage such as those reported in Malaysia, are no longer found here in plantations.

The house crow, *Corvus splendens*, Corvidae, introduced to Malaysia and there feeding on oil palm wastes, has never been seen in oil palm plantations in North Sumatra although this species is now resident in Java.

The common Myna, *Acridotheres tristis*, Sturnidae, introduced also to Malaysia and reported to damage oil palm fruit mesocarp, is present in North Sumatra and in BM. After its first occurrence in Riau islands in 1982, it has therefore considerably increased its range. But so far no damage has been found on the bunches. As for the other native species here, *A. javanicus* and *A. tristis* seem to be omnivorous in their feeding mostly on insects, seeds and wastes.

Insectivorous birds. Apart the birds recorded above, all the other birds recorded in our inventories in BM and BJ are fully or partly insectivores. Therefore 21 species, 72.4% of the species found, are feeding on insects in the oil palm plantations. This percentage is even greater if one considers the number of birds found, with the insectivores accounting for 86.57% in BM and 93.58% in BJ, much more than the maximum of 61% reported in the literature on mixed crops regarded as a better habitat (Sody, 1955; Balen, 1989).

According to their general behaviour of all the 29 species found in our investigations, up to 89.65% of birds are feeding on insects, 24.13% on vertebrata, 20.69% on seeds, 10.34% on insects and spiders, 10.34% on fruits, and 6.90% on worms. Therefore, the insectivorous birds are clearly the most numerous (*Table 7*).

TABLE 7. FEEDING BEHAVIOUR OF BIRDS FOUND IN OIL PALMS

Preys/birds	Vertebrata	Insecta	Arachnoidea	Crustacea	Annelida	Fruits	Seeds
Elanus caeruleus	*	*	-	-	-	-	-
Spilornis cheelsa	*	*	-	-	-	-	-
Halcyon chloris	*	*	-	-	*	-	-
Halcyon smyrnensis	*	*	-	-	-	-	-
Ardea cinerea	*	*	-	*	-	-	-
Tephrodornis virgatus	-	*	-	-	-	-	-
Geopelia striata	-	-	-	-	-	-	*
Streptopelia chinensis	-	-	-	-	-	-	*
Clamator coromandus	-	*	*	-	-	-	-
Centropus bengalensis	-	*	-	-	-	-	-
Centropus sinensis	*	*	-	-	-	-	-
Dicrurus aeneus	-	*	-	-	-	-	-
Lanius schach	-	*	-	-	-	-	-
Lanius tigrinus	-	*	-	-	-	-	-
Merops philippinus	-	*	-	-	-	-	-
Anthus novaeseelandiae	-	*	-	-	-	-	-
Dendronanthus indicus	-	*	-	-	-	-	-
Motacilla cinerea	-	*	-	*	-	-	-
Parus major	-	*	-	-	-	-	-
Lonchura maja	-	-	-	-	-	-	*
Pycnonotus goiavier	-	*	-	-	-	*	-
Amaurornis phoenicurus	*	*	-	-	*	-	*
Acridotheres javanicus	-	*	-	-	-	-	*
Acridotheres tristis	-	*	-	-	-	*	-
Orthotomus ruficeps	-	*	*	-	-	-	-
Prinia atrogularis	-	*	-	-	-	-	-
Prinia flaviventris	-	*	*	-	-	-	-
Turnix suscitator	-	*	-	-	-	*	*
Copsychus saularis	-	*	-	-	-	-	-
Total: 29	7	26	3	2	2	3	6
%	24.13	89.65	10.34	6.90	6.90	10.34	20.69

For the 21 species of insectivores, there is a preference for grasshoppers and beetles each comprising 41.38% of consumption, then caterpillars at 34.48%, wasps and dragonflies at 6.90%, and termites at no more than 3.45%. Indeed for termites flying at night, there is no coincidence with the activity of the diurnal birds, but the nightjar, *Caprimulgus macrurus* feeds particularly on nocturnal beetles and termites in the blocks observed (*Table 8*).

TABLE 8. FEEDING BEHAVIOUR OF THE INSECTIVOROUS BIRDS IN OIL PALM PLANTATIONS

Insects/birds	Coleoptera	Hemiptera	Hymenoptera	Isoptera	Lepidoptera	Mantodea	Odonata	Orthoptera	Others insects
Halcyon chloris	-	-	-	-	-	-	-	-	* Large
Halcyon smyrnensis	-	-	-	-	-	-	-	-	*
Tephrodornis virgatus	*	-	-	-	-	*	*	*	*
Clamator coromandus	*	-	*	-	*	*	-	*	-
Centropus bengalensis	-	-	-	-	*	-	-	*	*
Centropus sinensis	-	*	-	-	*	-	-	*	*
Dicrurus aeneus	*	-	-	*	*	-	*	*	*
Lanius schach	*	*	-	-	-	-	-	*	* Large
Lanius tigrinus	*	-	-	-	-	-	-	*	*
Merops philippinus	*	-	*	-	-	-	*	*	-
Anthus novaeseelandiae	-	-	-	-	-	-	-	*	*
Dendronanthus indicus	-	-	-	-	-	-	-	*	-
Parus major	*	-	-	-	*	-	-	*	-
Pycnonotus goiavier	*	-	-	-	*	-	-	*	-
Amaurornis phoenicurus	-	-	-	-	-	-	-	*	*
Acridotheres javanicus	-	-	-	-	-	-	-	-	*
Acridotheres tristis	-	-	-	-	-	-	-	-	*
Orthotomus ruficeps	*	-	-	-	*	-	-	-	* Small
Prinia atrogularis	*	-	-	-	*	-	-	-	* Small
Prinia flaviventris	*	-	-	-	*	-	-	-	* Small
Copsychus saularis	*	-	*	-	*	-	-	*	*
Total:	12	2	3	1	10	2	3	12	18
%	41.38	6.90	10.34	3.45	34.48	6.90	10.34	41.38	62.07

Furthermore in their ecological behaviour, the Coucals are the first species to colonize new oil palm plantings, establishing themselves inside the cover-crop. Early in the morning, they can be seen perching on the fronds before searching for insects at ground level. They are difficult to observe as upon being disturbed, they fly only a short distance before hiding again among the legume cover-crop.

Then come the Prinias and Tailorbirds, increasing in numbers when the inflorescences attract *Elaeidobius kamerunicus* on which they feed.

Other birds such as the Bulbuls invade the palms only after several years when these are big enough to harbour insects in the canopy and the lower strata is sufficiently diversified in plants and insects.

Those birds living at the ground level, Mynas, Magpie Robins and Doves need diversification of plants and insects at the lower strata in order to find enough food.

The Tits establish themselves initially on taller palms before spreading to younger plantings, always moving towards the extremities of the fronds in search of caterpillars on and between the leaflets.

IMPACT ON OIL PALM PESTS

It is difficult to assess the impact of birds on pests in oil palm plantations but through determination of gut contents, we have been able to qualify and quantify the insects caught by the birds and to see if these have any correlation with the pests of oil palms. Furthermore with the use of nesting boxes, at least for one of the species, it has been possible to accurately evaluate the impact of a small diurnal bird on caterpillars.

Analysis of Gut Contents

Thirteen species of birds have been dissected. These are mainly the insectivores in the oil palm plantation blocks. Two or three specimens per species were dissected and the average result per bird is given herewith. The insects found in the gut have been grouped according to the orders and main families. Spiders were recorded as well as molluscs, and seeds too if present. Many insects that had already been digested could not be identified, even more so the less chitinised insects such as Diptera (*Table 9*).

The bird species that were studied were feeding mostly on Coleoptera (beetles), with eight species involved, and they accounted for 39.91% of gut contents. This is due to the feeding habits developed by the small Sylviidae species which are now found to have adapted to preying on Curculionidae.

In the cases of *Copsychus saularis* and *Merops philippinus*, Hymenoptera involving six species account for 21.13% of gut contents, due particularly to their habit of feeding on ants.

Similarly, caterpillars, (Lepidoptera), and grasshoppers, (Orthoptera), are food for respectively nine and seven species of birds, accounting for 19.72% and 18.31% respectively.

Others insects found in the guts in very small numbers, such as flies and dragonflies are not counted, although flies must be more numerous in plantations. More dissection of the birds living in oil palm plantations needs to be carried out in order to complete these preliminary data.

Observations of the Feeding Specificity

Regarding the feeding specificity of the 13 species dissected, it can be seen from these samples taken directly from the two plantations that:

- the Dove, *Geopelia striata*, has only seeds inside the gut. This bird is not an insectivore but strictly a granivore, confirming its behaviour at the ground level searching for these seeds.

- the Myna, *Acridotheres javanicus*, was feeding during our observations, on grasshoppers, Tettigoniidae and Acrididae. Most of the Acrididae found were *Valanga nigricornis*. This proves that this species is looking for food exclusively at the level of the ground in young plantings.

- the Oriental Magpie Robin, *C. saularis* is according to the food found in its gut, a generalist bird feeding on all kind of insects, caterpillars, beetles, grasshoppers, flies, dragonflies and for a great part on ants (Formicinae). This shows that this species is looking for food mostly at ground level.

- *Merops philippinus*, which catches in mid-flight, flying beetles during the day, is also picking up mostly flying ants, Ponerinae, most probably during the swarming of this species.

- the Kingfisher, *Halcyon smyrnensis* feeds on beetles and grasshoppers, probably caught in mid-flight. This species perches on higher fronds of palms and often on electric lines scanning for prey.

TABLE 9. INSECTS FOUND IN THE GUT CONTENTS OF DIFFERENT BIRD SPECIES (Bah Jambi and Bukit Maradja)

Contents/ species	Lepidoptera			Coleoptera				Hymenoptera		Orthoptera			Diptera		Odonata	Araneida	Mollusca	Seeds
	Pyr.	Lim.	N.id	Chry.	Cur.	Scar.	N.id.	Pon.	Form.	The.	Acri.	N.id.	Chl.	N.id.				
A. javanicus	-	-	-	-	-	-	-	-	-	**5**	**4**	**3**	-	-	-	3	1	-
A. novaeseelandiae	3	-	-	-	-	-	-	-	1	**9**	-	3	-	-	-	-	-	-
C. sinensis	-	**1**	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-	-
C. saularis	-	-	5	-	1	4	7	2	**16**	3	1	-	1	-	1	-	-	-
C.bengalensis	-	**13**	2	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
G. striata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**55**
H. smyrnensis	-	-	-	-	-	-	3	-	-	-	-	4	-	-	-	-	-	-
L. schach	-	-	1	-	1	-	-	-	1	-	-	2	-	-	-	1	-	-
M. philippinus	-	-	-	-	-	**10**	5	**21**	2	-	-	-	-	-	-	-	-	-
O. ruficeps	3	-	-	-	**28**	-	2	-	-	-	-	-	-	-	-	2	-	1
P. atrogularis	1	-	-	-	**14**	-	**3**	-	-	-	-	-	-	-	-	-	-	-
P. goiavier	-	-	2	-	1	-	1	-	1	-	-	-	-	-	-	-	-	**14 b + 1**
P. major	-	**9**	2	2	-	-	3	-	1	-	-	-	-	-	-	-	-	1
Total	7	**23**	12	2	**45**	14	**24**	**23**	**22**	**19**	8	12	1		1	6	1	**14b + 58**

Notes:

Pyr. : Pyralidae Chry.: Chrysomelidae Pon.: Ponerinae The.: Tettigoniidae Chl.: Chloropidae
Lim.: Limacodidae Cur.: Curculionidae Form.: Formicinae Acri.: Acrididae
N.id : Non identified Scar.: Scarabaeidae

- the Bulbul, *Pycnonotus goiavier*, also one of the main species in the plantations reaching 28.32% and 34.74% of bird population in BM and BJ respectively, is omnivorous feeding on caterpillars, small beetles, wasps and fruits. Many seeds of berries were found in its gut from *Clidemia*, *Melastoma*, *Rubus* fruits, but although very numerous in oil palms these birds do not appear to be feeding on the oil palm fruits.

- the Sylviidae, *Orthotomus ruficeps* and *Prinia atrogularis* are also strictly insectivores feeding among young and older palms on the Curculionid pollinator of oil palm, *Elaeidobius kamerunicus*. This weevil seems to be their main food, accounting for 77.8% to 80% of their food. The presence of *E. kamerunicus* may explain why these small birds are now predominant in the oil palm plantations, comprising up to 42.19% in BJ and 28.32% in BM of the population of the more common birds in the plantations. It raises the question as to whether these birds have modified their behaviour and are becoming increasingly monophagous on *Elaeidobius* with the possibility of having a greater impact on the oil palm pollinator.

- two species, the Coucal, *Centropus bengalensis*, and the Great Tit, *Parus major* feed on Limacodidae, the former at the level of the soil, the latter at the level of the canopy. In the gut of *C. bengalensis* we have found *Setothosea asigna* (pupae 53.85%, pre-pupae 38.46% and only 7.69% of last instar due to the larva's spines). This means that this species is feeding mostly on pupae and pre-pupae which are inside the cocoons. This bird has to dig for the cocoons which are at 1-2 cm in the soil and to break the hard shell of the cocoons in order to reach *S. asigna* already pupating inside. The consumed larvae are probably those already inside the cocoons and not yet in pre-pupal or pupal stage. The other species *C. sinensis* also feeds on limacodid pupae. Unfortunately for the control of *S. asigna,* this bird is declining in the oil palm estates.

- the Great Tit, *Parus major* is in North Sumatra, the third most common bird in the plantations, reaching 11.53% to 11.95% of total bird population in BJ and BM respectively. This bird can be observed even on the tallest palms actively looking for food in the fronds, exploring each leaflet at the extremity of the leaves, hanging upside down to catch insects. *P. major* is able to catch even big nettle *S. asigna* caterpillars, cutting the skin and eating the internal parts, as well as to separate leaflets stuck together in order to catch the caterpillars and pupae hiding in between the leaf blades. (*Tables 10* and *11*).

In the gut analysis of birds collected from plantations that were attacked by the nettle caterpillars, *S. asigna*, the majority of young caterpillars of this pest are found in the gut of this Tit reaching more than 50% of gut contents. The whole of the young nettle caterpillars is eaten including the skin.

In artificial nesting boxes for this species as described in the following section, it has been possible to evaluate the impact of the insectivore *P. major* in a nesting box established in oil palms with presence of *S. asigna*. From early morning until late evening, in only feeding the nestlings, both the male and the female of the Tit were bringing food 139 times in the day, each time with a *S. asigna* caterpillar in instar 2-3. Therefore in a day, 60 and 79 caterpillars were collected by the male and female respectively. It is not yet clear if this species can breed twice a year, but *P. major* is present in plantations throughout the year. Thus, the impact of this bird on the control of caterpillars, even if not at its maximum consumption during the breeding season of *P. major*, must be of the magnitude of several tens of young caterpillars per bird each day.

Therefore in terms of specificity for these main insectivorous birds, the Coucals are feeding mostly on the pupae and pre-pupae inside the cocoons of nettle caterpillars if present in plantations. The Tits are also specialized on limacodid and other caterpillars. The Sylviidae species, *O. ruficeps* and *P. atrogularis* seem to have changed their behaviour and now feeding increasingly on *Elaeidobius*.

The Bulbul, *P. goiavier*, feeding on insects as well as on small berries and fruits, is active foraging from the canopy of the tallest palms down to the lower strata under the palms. The Magpie Robin, *C. saularis,* also feeding on any kind of insect has a tendency to catch many ants due to its behaviour of looking for insects at the ground level. *Merops philippinus,* in contrast, collects many flying ants and other insects caught in flight, and similarly for the Kingfisher, *H. smyrnensis*.

TABLE 10. IMPORTANCE OF THE MORE FREQUENT BIRD SPECIES AND THEIR BEHAVIOUR IN OIL PALMS (Bah Jambi 2003)

Blocks/ species	1975			1995			2000			Total	Feeding
	1	2	3	1	2	3	1	2	3	(%)	behaviour
Acridotheres tristis	-	1	-	-	-	-	-	5	-	6 (0.88)	Insects
Anthus novaeseelandiae	-	-	-	-	-	-	1	-	-	1 (0.15)	Insects
Centropus bengalensis	-	-	-	-	-	-	-	-	1	1 (0.15)	Insects/mostly carterpillars
Copsychus saularis	-	-	-	1	-	-	4	-	-	5 (0.73)	Insects/caterpillar/beetle
Elanus caeruleus	-	-	-	-	-	-	1	-	-	1 (0.15)	Insects/vertebrata (lizards, snakes)
Geopalia striata	-	-	-	-	-	-	2	2	3	7 (1.02)	Seeds/insects
Halcyon smyrnensis	2	1	2	1	1	1	3	1	-	12 (1.75)	Insects/vertebrata (frogs, lizards)
Lanius schach	-	-	-	-	-	-	-	4	2	6 (0.88)	Insects
Motacilla cinerea	-	2	-	-	-	-	-	-	-	2 (0.29)	Insects
Merops philippinus	-	-	-	-	-	-	-	6	-	6 (0.88)	Insects (in flight : beetles, butterflies, wasps…)
Prinia atrogularis	66	79	73	36	21	6	2	2	4	289 (42.19)	Insects
Pycnonotus goiavier	38	44	12	14	11	6	27	55	31	238 (34.74)	Insects/small fruits
Parus major	21	30	10	4	4	2	-	4	4	79 (11.53)	Insects/mostly carterpillars
Streptopelia chinensis	2	-	-	-	-	4	1	8	-	15 (2.19)	Seeds (Gramineae)
Tephrodornis gularis	1	2	3	3	-	-	1	3	4	17 (2.84)	Insects/grasshoppers, beetles…
Total	130	159	100	59	37	19	42	90	49	685	

TABLE 11. IMPORTANCE OF THE MORE FREQUENT BIRD SPECIES AND THEIR BEHAVIOUR (Bukit Maradja 2003)

Blocks/ species	1985			1998			2001			Total	Feeding
	10	17	16	A 27	A 29	A 31	D 11	D 13	E 13	(%)	behaviour
Acridotheres tristis	-	-	-	2	-	-	-	-	-	2 (0.44)	Insects
Centropus bengalensis	-	-	-	4	3	2	8	5	5	27 (12.61)	Insects/mostly carterpillars
Copsychus saularis	9	13	8	2	-	7	-	-	1	40 (8.85)	Insects/caterpillars/beetles
Elanus caeruleus	-	-	1	-	-	-	-	-	1	2 (0.44)	Insects/vertebrata (lizards, snakes..)
Geopalia striata	7	-	-	-	-	2	-	-	2	11 (2.43)	Seeds/insects
Halcyon smyrnensis	4	5	2	5	5	9	-	2	-	32 (7.08)	Insects/vertebrata (frogs, lizards)
Lanius schach	-	-	-	-	1	-	-	4	7	12 (2.65)	Insects
Lonchura maya	3	2	2	4	-	-	-	2	-	13 (2.88)	Seeds (Gramineae)
Prinia atrogularis	20	30	26	4	11	13	14	6	4	128 (28.32)	Insects
Pycnonotus goiavier	-	-	5	16	11	17	40	10	14	113 (25.00)	Insects/small fruits
Parus major	12	12	18	3	5	4	-	-	-	54 (11.95)	Insects/mostly carterpillars
Streptopelia chinensis	-	-	-	2	-	5	-	2	4	13 (2.88)	Seeds (Gramineae)
Tephrodornis gularis	-	-	-	-	1	-	1	3	-	5 (1.11)	Insects/grasshoppers, beetles …
Total	55	62	62	42	37	59	63	34	38	452	

NATURAL AND ARTIFICIAL NESTING

Besides food, the bird population in oil palm plantations is dependent upon the availability of nesting sites for breeding. If there are no nesting possibilities, there are also very few birds.

Some species nest in the lower strata of the plantation among the cover-crop at the level of the ground, others on ferns or shrubs, but most of them establish their nests directly on the oil palms. Several of these birds build their nests towards the extremity of the fronds in between the leaflets or at the petiolar bases, or even in the crown.

Yet other species are *secondary cavity nesters*. Unable by themselves to create the cavities they need to nest, these species make use of available cavities in the plantation. These natural cavities are found between the petiolar bases and in the stems, in existing holes inside the petiolar bases or dead stems both still standing or fallen to the ground. These holes were previously made by the *Oryctes* beetles.

But when the availability of natural nesting sites are reduced such as in young planting, or after excessive cleaning of the older stems, artificial nesting boxes are necessary in order to conserve or increase the population and diversity of useful diurnal birds that assist in the biocontrol of oil palm pests.

Adaptation to Oil Palm Nesting Possibilities

a. Inside the soil

- The Kingfisher, *Halcyon smyrnensis*, nests directly in the ground, inside the holes that are created by the decay of large roots under road banks on the borders of the blocks or drainage walls. The eggs, two or three, rounded and whitish are laid twice a year, March-May and September-November.

- Another bird, *Merops philippinus*, can be seen nesting communally on the slopes of earthy banks, but this species is marginal in plantations and is not adapted to the oil palm environment.

b. Ground level and vegetation

- *Orthotomus* and *Prinia*, small Sylviidae birds, very numerous with *O. ruficeps*, *P. flaviventris* and *P. atrogularis* in oil palm plantations, nest among the ferns in the lower strata vegetation.

O. ruficeps builds its nest inside the vegetation of tall ferns, *Diplazium asperum* and *Nephrolepis biserrata*, nesting under the shade of oil palms. These nests are found attached in between two fronds of *N. biserrata*, fixed to the middle of one and concealed in the pinnae. The pouch-shaped nests are at a height of 1 m to 1.20 m above the ground. The loose nest is made of oil palm fibres woven together with yellowish sticky spider threads of *Gasterancantha*, and measures 10.15 cm long and 7.75 cm wide, with an entrance 4.75 cm by 2.95 cm. Three eggs are laid, oval in shape and more inflated at one extremity, finely flecked with brownish spots that are more dense towards the top. The average size of an egg is 17.32 mm long by 12.25 mm wide (observed 23 April 2005).

Another nest of a related species (or possibly the same species) was found in a similar condition attached to the middle of a *D. asperum* frond, built with oil palm fibres woven with *Nephila* white sticky spider threads, and measured 9.5 cm long by 7.7 cm wide with a large entrance.

There were three eggs inside as well which were more elongated with almost parallel sides. The average size of an egg was 17.26 mm long by 11.27 mm wide (observed 25 April 2003).

- Bulbul, *Pycnonotus goiavier*. A nest of this species was found concealed among smaller *Nephrolepis biserrata* ferns mixed with *Clidemia hirta* and grasses at only 35 cm to 50 cm above the ground in the lower strata in a more open area. The nest shaped like an open cup is 3 cm thick, 12 cm high, 10 cm wide at the top, with an internal cup of 7 cm diameter and 5.5 cm deep.

The nest was built with dried twigs and leaves, and the internal part of the cup was lined with oil palm fibres and leaves of *Mikania micrantha*. Only two eggs were laid (observed 22 May 2005). Another nest with the eggs was observed nearly one month earlier, found inside dense *N. biserrata* vegetation. This means that the Bulbul eggs are laid at least over a two-month period in April and May (observed 16 April 2003).

This species is able also to nest in small shrubs in plantations, *Melastoma malabathricum*, at 1 m from the ground at the intersection of two branches. The nest is always in the characteristic form of a cup, 3 cm thick, 8.6 cm high, 9.1 cm wide at the top, with inside diameter 6.2 cm x 6 cm. The nest is built with pieces of oil palm leaflets and midribs mixed with fibres. The two laid eggs are whitish in colour with an increasing density of brownish spots towards the more enlarged and rounded extremity of the egg which measures 21.3 mm long by 15.45 mm wide (observed 28 April 2003).

c. Oil palm fronds

- The Coucal, *Centropus bengalensis*, nests outside oil palm plantations in open grass land, close to the ground and hidden in the

vegetation or in shrubs. The ball-shaped nest is made from grass leaves. In oil palm, the nesting takes place at the base of the fronds near the spear, not deep inside, forming also a rounded mass of pieces of oil palm leaflets woven tightly together mixed with grasses and dried leaves from the legume cover-crop. The nest is always in young palms of three to four years old, generally at the level of fronds 7-9, protected from too much light. The whole mass can be mistaken for the nest of a squirrel. This particular nesting in young oil palm planting seems to be an adaptation of this bird to its new environment in oil palms. Two or three whitish eggs are laid, and breeding occurs in March-July (observed 22 April 2003).

- Bulbul, *Pycnonotus goiavier*, nesting was also observed directly on an oil palm frond, level F. 33, planting year 1995. The nest is built at one-third from the end of the frond, established at 5 m high on the upper part and the base of the leaflets. The structure is maintained in position by the leaflets above and made of dried fibres from the sheaths of the petiolar fronds woven together in a rounded cup. The nest is 6 cm high, 11 cm wide, with an internal diameter 6 cm x 7.5 cm. Two nestlings with feathers already out of their sheaths were observed, therefore ready to fly in a few more days (observed 4 April 2005). This proves that *P. goiavier* is a very adaptable bird in the oil palm plantation nesting at the lower strata in the ferns or shrubs or directly on the fronds.

- The long-tailed Shrike, *Lanius schach*, is well adapted to oil palm plantations nesting also on the fronds in the same manner as the Bulbul, *goiavier*, but in younger planting of four to five years old.

The nest is in the form of an open cup established at about one-third from the end of the frond level F.9, placed on the upper part of the frond in between four leaflets. The nest is strongly built with petiolar sheath fibres from the fronds, each fibre intertwined so as to form a rounded structure. No other material is used. The size of the nest is 8 cm high, 10 cm wide, with generally two eggs, sometimes three, white with grey brownish spots (observed 12 April 2003).

Several nests are sometimes present on palms nearby as this species lives in small gregarious populations.

d. Oil palm stems

- Kingfisher, *Halcyon smyrnensis*, is also well adapted to the oil palm environment, nesting inside holes in the ground or in existing holes in dead oil palm stems that are still standing or already fallen on the ground, enlarging the old galleries made by the *Oryctes* larvae for nesting. In a standing dead palm, the nest is situated at about 2 m above the ground (observed 1 April 2003).

- The oriental Magpie-Robin, *Copsychus saularis*, is well adapted to living in plantations. Nesting occurs on living oil palms at the level of the crown. Observations of nests have been made on planting 1995 at 7 m high, but nests have also been found on higher palms to a height of 12 m. The nest is established in the top of the crown at the base of frond 17, above the bunches. At this level, there are sheaths for each petiolar frond, very large and smooth, with the fibres not yet dry and covered by a velvety layer. The space between the fronds 9 and 17 is very narrow and deep, convenient for the bird to build its nest here in a loose manner with only some dried oil palm fibres arranged in a layer measuring 20.3 cm long and 8 cm wide. The central part of this layer is a slight concave of 14 cm depth where the eggs are laid. The structure of the nest is not elaborated but the nesting place, well isolated, is protected against predators by the aggressiveness of the bird. On 4 July, the nestlings were ready to fly away (observed 4 July 2005). Generally only two eggs are laid, pale bluish green in colour and slightly spotted with reddish brown marks (observed 1 April 2003).

- The Great Tit, *Parus major*, uses the dried petiolar bases on the stems for nesting. Sometimes a half rotted petiolar base with old remaining holes made by *Oryctes* is chosen because the size of the hole allows the tit to have access to a kind of cavity in between the petiolar base and the stem. The size of the hole is large enough for the Tit, but prevents other birds or squirrels from accessing the nest.

Often too, a long crevice in the petiolar base forming a narrow space between the petiolar base and the stem is used as a natural cavity for the nest. Nesting occurs inside the blocks on palms of 15-16 years and up to 18-20 years old where there is dense canopy. The nest is built 5 m above the ground, approximately at the height of the middle of the stem.

The nest in the form of a cup measures 11.35 cm in diameter and 4.6 cm high, uncovered at the top with diameter of 6.65 cm x 6.25 cm.

Oil palm fibres are used for the frame of the nest and mixed with any kind of soft material which can

be found by the bird such as moss, feathers, cotton, pieces of wool *etc*. Three eggs are laid, white in colour with reddish brown spots, of size 13 x 17 mm (observed 26 April 2003).

- **Other birds**

Nests in the form of a ball with just an entrance in the middle are also found in planting year such as 1995. The nests hang on the petiolar base at 4 m high. The nest partly built between the petiolar base and the stem is generally dissimulated into the fern vegetation growing on the stem.

The nest, of a small cup shape, is made of grass leaves mostly *Panicum* tightly packed together with a hard crust of mud mixed with faecal material inside at the bottom. The nest measures diameter 13 cm, height 15 cm, entrance 4.5 cm x 5 cm. Although the bird was not directly observed, such a nest with grasses probably belongs to the Motacillidae, *Anthus novaeseelandiae*, which adapts to the oil palms but at a low density.

Artificial Nesting

Due to the fact that several of these diurnal insectivorous birds need holes for nesting and that these suitable natural cavities are limited in oil palms, especially in younger planting, it seems worthwhile to establish artificial nesting boxes in order to increase the population of these beneficial birds in plantations.

A successful attempt has been made with nesting boxes that we have designed for the Great Tit, *Parus major*. The size of the box is 12 cm x 12 cm for the floor, 12 cm x 20 cm for the front, 12 cm x 20 cm x 22 cm for each side to allow for a sloping roof. The roof is wider at 16 cm x 16 cm to protect the entrance and the box, supplied with an additional cover in the form of a zinc plate. The entrance is 3.4 cm diameter. It is established that with a 4 cm diameter, squirrels can enter or other competitor birds can settle in the box. Laterally at the upper part are holes for ventilation, 1 cm diameter. At the base of the front panel are holes for drainage, 0.5 cm diameter. The nesting box is attached to a palm or pole with a zinc guard to deter snakes and to prevent other predators from climbing up to the nesting box. Grease or glue is applied to the mounting pole to prevent ants. Wasps can be repulsed using vegetable grease or pyrethrin at a low concentration (*Figure 1*).

Under such conditions nesting is easily achieved. Prospecting for the nesting boxes by *P. major* starts in North Sumatra at the end of January. At the beginning of February, the nest is built and requires 26 days.

After a period of resting, the laying of eggs occurs in early March, 12 days for three eggs, incubation from 14-22 days, and the feeding period occurs until end of March or early May.

During this feeding period of one month, both male and female are actively looking for food. In monitoring the activities of this pair at a nesting box with only two nestlings, it was observed that the adults were bringing food 139 times per day.

This means that from 6.55 am in the morning, when the activity of the Tits begins, until 18.15 pm in the evening when activity stops, the male and female birds were catching 60 to 79 caterpillars respectively. Our check found that these were nettle caterpillars, *Setothosea asigna*, in instars 2-3-4, from an outbreak in the oil palms nearby.

The birds present in plantation, *Acridotheres javanicus*, *Acridotheres tristis*, *Copsychus saularis*, *Halcyon smyrnensis* and even *Merops philippinus* have been observed to be nesting in holes and cavities. Prototypes of nesting boxes have to be designed and tested for these first three species, *C. saularis*, *A. javanicus*, *A. tristis*. These very important insectivorous birds are on the brink of extinction in oil palm plantations due to poaching and the commercial trade.

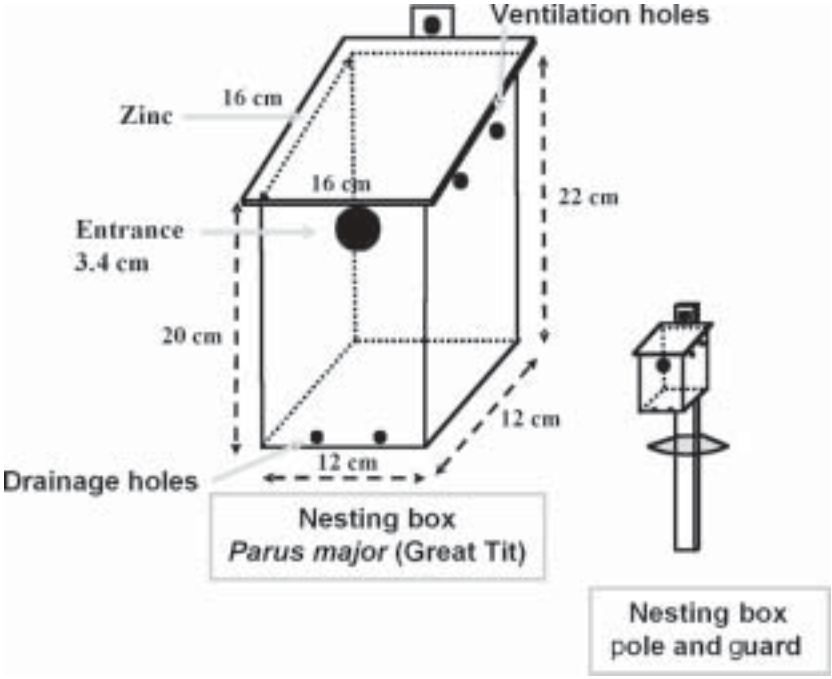

Figure 1. Nesting box for the Great Tit, Parus major.

Threats to the Birds in Oil Palm Plantations

As usual, children and adults look for bird nests in oil palm plantations for their nestlings. More professional poachers also catch birds using calling birds in cages and different devices with glue or traps. Nowadays, air-rifle use is again a common pastime and the plantations are a ground for hunting.

These activities are increasing at a fast rate in Indonesia due to the high demand for birds to keep in cages. The main species living in oil palms are sold at lucrative prices: doves from Rp 5000 to 10 000, the common Mynas for Rp 30 000 and the Magpie Robin up to Rp 150 000. Now even the Tits, the small Prinias and Tailorbirds, and the Bulbuls are caught intensively for trade.

They are sold everywhere along roads and at bird markets in towns. In these places, the birds are kept inside small crowded cages, *i.e.* 26-30 *Acridotheres* adults per cage of only 60 cm x 30 cm x 40 cm. In such conditions, the mortality of the birds is very high. As a result of this trade, the Mynas which were very common 10 years ago are becoming very rare in oil palm plantations. The Magpie Robin is disappearing from the plantations, and the threat of extinction will extend to the Tits, Prinias and Bulbuls.

Furthermore, the overuse of powerful pesticides in oil palm cultivation has led to the decrease of birds that are more susceptible to be affected due to their ecological and feeding behaviour such as the Coucals and the majority of these diurnal insectivore birds.

These beneficial and useful insectivore birds will become extinct, unable to exercise their beneficial impact on oil palm pests, if urgent steps are not taken to ban the use of air-rifles for hunting, and the catching of birds on a commercial scale in the oil palm plantations, and to control the excessive applications of pesticides. Positive action must also be implemented to preserve the ecological conditions for bird conservation and increase the bird population through the use of nesting boxes or else, the oil palm plantations will have no birds and be prone to more insect outbreaks on the palms.

CONCLUSION

During our investigations, 29 species of birds observed have adapted to the oil palm environment. The dominant ones in two plantations are the Prinias and Tailorbirds reaching 27.6% to 34.4% of the population, followed by the Bulbul goiavier 24.4% to 28.7%, then the Great Tits with 9.5% to 10.6%, the Magpie Robin 4.5% to 8.6% and the White-Throated Kingfisher 5.1% to 6.9%. The others, although less numerous also have a significant impact on the pests.

Different species inhabit different spaces in the oil palm plantations of various planting ages. The Tits and Bulbuls are found in taller palms, Magpie Robins and Prinias in younger planting, Bulbuls and Prinias-Tailorbirds in both older and younger palms, Coucals are found at the lower strata in the cover-crop, and the Mynas at the level of the ground. Density varies from 13.2 to 46.6 birds per hectare. Several species forage in big communities or mixed flocks, moving to plantations where food is available.

Of the species observed, 86.6% to 93.6% are partly or completely insectivores, 21 species fully insectivores feeding on adults and larvae of small beetles, caterpillars, grasshoppers, flies or ants. For instance, a pair of Great Tits providing food to the nestlings collect up to 139 young nettle caterpillars per day from 6.55 am to 18.15 pm, the male and the female catching 60 and 79 limacodid larvae respectively.

Through analyses after dissection of the gut contents, particular feeding behaviour has been observed for the Coucals and Prinias. The Coucals at the ground level, dig for and break nettle caterpillar cocoons in order to eat the pre-pupae and pupae. Up to 12 *S. asigna* have been found in the gut of a single bird. Bulbuls and Magpies Robin are less specific, feeding in the canopy or at the level of the ground, on a wide range of insects. Kingfishers and Merops pick up large insects such as grasshoppers and beetles in flight.

One Sylviid bird, *Orthotomus ruficeps*, has modified its feeding behaviour catching mostly *E. kamerunicus*. Due to the increasing population of this bird and other Prinias, its damaging impact on the pollinator, already reduced in number with less male inflorescences in the initial years of oil palm production, will result in a decrease in fruit-setting.

Nesting locations have been observed. Tits nest directly in the oil palms stems in the older and dried petiolar bases, the Magpie Robins nest at the level of the crown in between the fronds, the Bulbuls and Shrikes on the fronds, the Kingfishers in holes of *Oryctes* or rats in dead palms still standing or fallen on the ground, the Coucals in the oil palm spear in young planting, the Prinias in the lower strata on ferns and Bulbuls, very adaptable birds, in also small bushes.

Considering that the size of the bird population is dependent on the availability of breeding sites, experiments with artificial nesting boxes 12 cm x 12 cm x 20 cm with an entrance 3.4 cm placed on poles in the plantations were successful for the Great Tit. Therefore, it is possible to increase the bird population with nesting boxes to be adapted for each species of birds as well as for those facing a shortage of nesting holes such as the Mynas, Kingfishers or other diurnal birds.

In the North Sumatra oil palm plantations, general bird activities are the following: prospecting for suitable breeding site at the end of January after the rainy season, building of the nest structure in February-March, laying of eggs at the end February-March, incubation until mid March or early April, hatching in April and completed development of the nestlings through April-May for the Tits, and until July for the Magpie Robin and Bulbuls. During this entire period, there is a high correlation between these main nesting or breeding activities of the birds and the increase of pest populations in oil palms of the leaf-eating caterpillars at this time of the year.

With the disappearance of lowland rain forests, the oil palm plantations are the remaining refuge for these beneficial diurnal birds. But due to bird poachers and hunters using air-rifles for commercial trade, many insectivore species which previously were very numerous in oil palms are disappearing. Examples of these are the Javan Myna, the Magpie Robin, the Tits and several other species. Therefore, poaching and hunting must be banned in oil palm plantations particularly during the breeding period.

For better conservation of the ecological conditions for the birds while maintaining the general agronomic standards, it is necessary to keep the biodiversity of plants in the lower strata, avoid the destruction of all the epithytes on the stems to favour shelter and to encourage nesting, using more biopesticides, and installing nesting boxes that are customized for each species in order to improve or rehabilitate the habitat of these birds in the oil palm monoculture. In addition, reserved forests in areas not suitable for oil palm cultivation must be maintained.

Therefore the mostly insectivorous diurnal birds, often quite specific in their feeding habits on several pests, are a very useful component in the general ecosystem of the oil palm plantations. Their population needs to be maintained by adequate cultural practices, and their habitats increased or their possibilities for breeding rehabilitated through artificial nesting boxes so that these birds can be included in an integrated pest management programme.

REFERENCES

BALAN, S V (1989). The role of birds in the biological control of insect pests in Java. *Seameo-Biotrop*. Biotrop Special Publication No. 36. p. 217-225.

CHUA, T H; SIEW, Y C; NG, S M; FONG, F W and LEE, T H (1980). Oil palm, a source of food for some large-billed crows. *The Planter, 56 (647)*: 44-45.

DESMIER de CHENON, R (1982). *Field Guide for Oil Palm Pests and Plantation Sanitary Protection*. Medan, Indonesia. 244 pp.

DESMIER de CHENON, R; SIPAYUNG, A and SUDHARTO Ps (1990). Leaf-eating caterpillars of secondary importance on oil palm, a potential risk in plantations. 3rd International Conference on Plant Protection in the Tropics. 20-23 March 1990, Malaysia. 22 pp.

JEPSON, P and OUNSTED, R (eds.) (1997). *Birding Indonesia*. Periplus editions (HK), Ltd, Singapore. 318 pp.

KING, B; WOODCOCK, M W and DICKINSON, E C (1975). *A Field Guide to the Birds of South-East Asia*. Collons, London. 480 pp.

MACKINNON, J (1991). *Field Guide to the Birds of Java and Bali*. Printed by Gadjah Mada University Press. 391 pp.

SIEW, Y C; NG, S M; POON, S K and FONG, F W (1979). The house crow – a pest of oil palm? *The Planter, 55 (637)*: 185-186.

SAML, M C (1989a). Barn owls (*Tyto alba*) for the control of rats in agricultural crops in the tropics. *Seameo-Biotrop.* Biotrop Special Publication No. 36. p. 255-275.

SAML, C M (1989b). Research on the use of barn owls, *Tyto alba*, for biological control of rats in oil palm plantations: 1986-1989. *Proc. of the 1989 PORIM International Palm Oil Development Conference – Agriculture Conference.* PORIM, Bangi. p. 342-356.

STRANGE, M (2001). *A Photographic Guide to the Birds of Indonesia*. Periplus Editions (H.K) Ltd, Singapore. 416 pp.

WARD, P and WOOD, B J (1967). Parrot damage to oil palm fruit in Johore. *The Planter*, *43(3)*: 101-103.

WOOD, B J (1968). *Pests of Oil Palm in Malaysia and their Control*. Incorporated Society of Planters, Kuala Lumpur. 204 pp.

WOOD, B J (1969). The extent of vertebrate attacks on the oil palm in Malaysia. *Progress in Oil Palm* (Turner, P D ed.). Incorporated Society of Planters, Kuala Lumpur. p. 162-183.