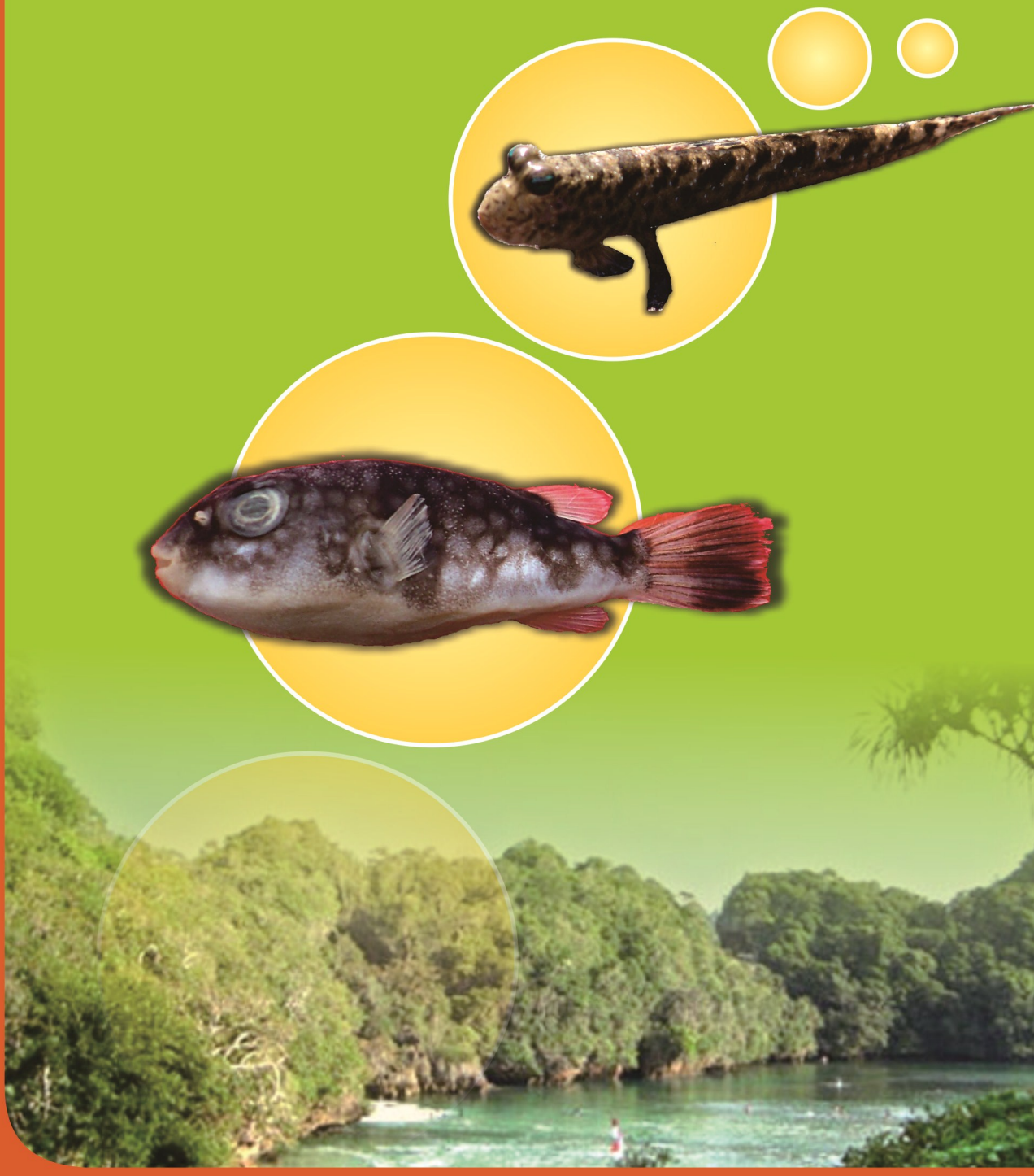
ISSN 0215-191X

Masyarakat Zoologi Indonesia

Volume 21, Nomor 01, Juli 2012

ZOO INDONESIA

Jurnal Fauna Tropika



Akreditasi : 374/AU1/P2MBI/07/2011 (Predikat B)

LIPI

Masyarakat Zoologi Indonesia
MZI

Keterangan foto cover depan: *Boleopthalmus boddarti*; *Chelonodon patoca* (Foto oleh: Wahyudewantoro 2009), lanskap Segara Anakan-Cilacap

Penerbitan Zoo Indonesia merupakan kegiatan bersama antara Organisasi Profesi Masyarakat Zoologi Indonesia (MZI) dengan Pusat Penelitian Biologi - LIPI

Kami mengucapkan terima kasih dan penghargaan yang setinggi-tingginya
kepada mitra bestari

Zoo Indonesia
Volume 21 No. 01, Juli 2012

Ir. Wirdateti, M.Si. (Pusat Penelitian Biologi-LIPI)
Dr. Siti Nuramaliati Prijono (Pusat Penelitian Biologi-LIPI)
Dr. Wartika Rosa Farida (Pusat Penelitian Biologi-LIPI)
Ir. Zahid Ahmad Hilmie, M.Si. (Fakultas Perikanan dan Ilmu Kelautan-IPB)
Dr. Dewi M. Prawiradilaga (Pusat Penelitian Biologi-LIPI)
Dr. Yeni A. Moeljono (Fakultas Kehutanan-IPB)
Prof. Dr. Erri Noviar Megantara (Jurusan Biologi Fakultas MIPA-UNPAD)

OBITUARI

Dr. Ir. H. Dede Irving Hartoto APU (Ahli Peneliti Utama) merupakan sosok peneliti limnologi yang dikenal tegas dan lugas. Beliau banyak melakukan penelitian yang berkaitan langsung dengan pengelolaan wilayah perairan darat khususnya di wilayah Kalimantan, Sumatra, Sulawesi dan Jawa. Lulusan dari Fakultas Perikanan IPB tahun 1980, melanjutkan pendidikan formalnya langsung ke jenjang doktoral Bidang Bioscience Environmetal Earth Science, University Hokkaido di Jepang dan lulus tahun 2007. Masa bakti sebagai peneliti di Lembaga Ilmu Pengetahuan Indonesia (LIPI) dimulai di Lembaga Biologi Nasional, yang berubah menjadi Pusat Penelitian dan Pengembangan Biologi dan akhirnya di Pusat Penelitian Limnologi di Cibinong. Penghargaan yang telah didapatkan dari negara adalah Satya Lencana Karya Satya 10, 20 dan 30 tahun. Dalam kancah organisasi profesi, Beliau merupakan sesepuh dan inisiator dari berdirinya perhimpunan Masyarakat Zoologi Indonesia (MZI) pada tahun 1982 dan sempat memimpin organisasi ini pada tahun 1999 hingga 2005. Selain itu pula Beliau sebagai salah satu inisiator dari lahirnya jurnal ilmiah Zoo Indonesia, sebagai wadah komunikasi ilmiah bagi para anggota MZI. Jabatan sebagai Dewan Redaksi Zoo Indonesia dipegangnya dari tahun 1983 hingga 1984 dan dari tahun 1993 hingga 1994. Kemudian, jabatan sebagai Ketua Dewan Redaksi dipegangnya sejak tahun 2006 sampai akhir hayatnya. Kepergian Beliau untuk selamanya di bulan Pebruari 2012 sangat dirasakan oleh organisasi MZI dan jurnal Zoo Indonesia sebagai suatu kehilangan sosok ilmuwan bidang limnologi yang sangat besar. Untuk itu, penerbitan Zoo Indonesia kali ini merupakan penghargaan kami kepada Beliau atas segala usaha yang telah dirintis dan dibangunnya dalam upaya untuk menyuarakan pentingnya zoologi dan demi keberlanjutan zoologi sebagai suatu ilmu dasar di Indonesia. Semoga jasa dan amal ibadah Beliau diterima di sisi Tuhan YME. Amin.

DAFTAR ISI

A PRELIMINARY STUDY ON MACRO-MOTH DIVERSITY AT THE BASE OF FOJA MOUNTAIN NATURE RESERVE: KWERBA VILLAGE, MEMBRAMO RAYA, PAPUA

Hari Sutrisno

Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences
Widyasatwaloka Building, Jl. Raya Jakarta-Bogor Km. 46, Cibinong 16911, Indonesia
Email: *hari.sutrisno@lipi.go.id*

ABSTRAK

Sutrisno, H. 2012. Kajian awal diversitas ngengat di kaki suaka Margasatwa Pegunungan Foja, Desa Kwerba, Membramo Raya, Papua. ***Zoo Indonesia*** **21(1) 1-7.** *Kajian awal ngengat berukuran besar telah dilakukan di desa Kwerba, Kaki Pegunungan Foja, Membramo Raya tanggal 1 sd. 29 November 2008 (10 malam). Tujuan dari kajian ini adalah untuk mengumpulkan informasi tentang keragaman ngengat dan juga untuk mengetahui komposisi jenis ngengat di kawasan ini. Hasil penelitian menunjukan bahwa dalam waktu yang singkat hanya diperoleh sekitar 83% dari total yang ada atau sekitar 178 dari total perkiraan 214 jenis. Indeks diversitas Fisher's α relatif rendah yaitu 83,17. Demikian juga jumlah famili yang ditemukan di kawasan ini juga rendah hanya 19 famili atau sekitar 1/3 dari total famili yang ada di Indo-Malaya. Secara umum, Pyralidae, Geometridae, dan Noctuidae mendominasi kawasan tersebut. Rendahnya diversitas di kawasan ini berhubungan dengan jenis tanaman yang ada. Pembukaan lahan dan pembalakan liar telah menyebabkan turunnya jumlah jenis pohon tetapi di sisi yang lain kerapatan tumbuhan muda dan jumlah tumbuhhan merambat meningkat. Hanya terdapat sekitar 300 species tumbuhan dikawasan ini. Tentu saja kalau menuju ketinggian yang lebih tinggi dari kawasan kaki gunung ini kemungkinan jenisnya tumbuhan akan lebih banyak karena lebih jauh dari jangkauan penduduk. Sehingga diversitas ngengat di kawasan ini belum dapat digunakan untuk menyimpulkan keragaman ngengat di Pegunungan Foja. Kajian yang lebih intensif yang meliputi seluruh lokasi pegunungan dari dataran rendah sampai puncak masih perlu dilakukan.*

Kata Kunci: *diversitas, Pegunungan Foja, Kwerba, Ngengat besar*

ABSTRACT

Sutrisno, H. 2012. A preliminary study on macro-moth diversity at the base of Foja mountain nature reserve: Kwerba village, Membramo Raya, Papua. ***Zoo Indonesia*** **21(1) 1-7.** *A preliminary study on moth diversity with focus on macro-moths was conducted at Kwerba, the base of Foja mountain, Membramo Raya from 1st to 29th November, 2008 (10 night effectives). The aims of the study were to acquire information of macro-moth diversity and to access the composition of the species at this area. The result showed that a short collecting time records (10 nights) only about 83% of estimated value in this area (178 of 214 species). Index diversity based on Fisher's α was low, 83.17. In addition, the number of families recorded from this forest was also low, 19 families, or about one third of the moth families that occur in Indo-Malayan region. In general, Pyralidae, Geometridae, and Noctuidae dominated at this area. This low diversity correlates with plant species in this area. Land clearing and illegal logging have caused the decrease on species tree but increase on its density since young trees and liana trees grow everywhere. Only about 300 species trees were recorded in this area. Off course, there are more species of plants if we go up to the Foja mountain since there are more conserved area and less disturbed area at the higher altitude due to its geographical position, and its access limitation. So, this diversity of this area should not be used to conclude the moth diversity on the Foja mountain area. More study is needed to cover all the whole Foja mountain from the lowest up to the top forest of the mountain.*

Keywords: *diversity, Foja Mountain, Kwerba, macro-moths*

INTRODUCTION

The change of habitat due to human activity such as land clearing, illegal logging change of land use is one of the factors that directly influent to the ecosystem. But, this impact is not always easy to be measured, even to determine clearly what level of

the degradation occurs in a certain area needs a comprehensive study based on a certain taxon that its response can representatively indicate to any environmental changes. Among them, moths is one of the best candidate bio-indicator which fulfill all requirements such as ease and objective in sampling, taxonomic tractability, ecological generality combined with fine-grained habitat fidelity (including low blurring of pattern through mobility and rapid response to disturbance). In addition, they can be collected in a large number by using a light trap and also can be found in numbers in most vegetation types. So, it is possible to quantitatively calculate any statistical analysis to measure various parameters. Moreover, the larvae indeed often show a great specifity to host plants (Holloway 1976, 1984; Hebert 1980; Heppner 1989). Thus, this group is more suitable than other insects or vertebrate as indicator of the forest ecosystem and for monitoring the impact of changes. The importance of moths and their value as indicators is discussed by Brown (1991), and Holloway & Stork (1991).

The data of the base line study is very important to evaluate any impact of human activity to the natural reserve/conservation area. The impact of human activity to the ecosystem can be evaluated by comparing the data of the biodiversity before and after human activity occurring in the conservation area. Thus, without these data, it is impossible to measure any change of the ecosystem. But collecting those data is very hard, almost impossible to be conducted within a large nature reserve or a remote area in one time. It needs efforts continuously to inventory and populate the data of the biodiversity in that area.

The moth diversity in different habitat has been repeatedly reportedly by numerous authors (Holloway 1998; Beck *et al.* 2002; Fielder & Schulze 2004; Sukara 2005; Sutrisno 2010). However, most studies were conducted in Kalimantan, Sumatra, Sulawesi and Java. To complete the data on moth diversity in Indonesia, therefore, we conducted a preliminary study with focused on macro-moths at Kwerba Village (base of

Table 1. Species richness of Lepidoptera collected at Kwerba village, Foja Mountain Nature Reserve from 1 to 23 November 2008 (S= Species number of taxa)

No	Taxa	S	%	Species with 1 individual	Species with > 2 individual	Species Estimated	Fisher Alpha index
1	Aganaidae	2	1.12	2	0		
2	Arctiidae	5	2.80	3	2		
3	Cossidae	4	2.24	1	3		
4	Drepanidae	3	1.68	2	1		
5	Dudgeoneidae	1	0.56	0	1		
6	Eupteroptidae	2	1.12	2	0		
7	Geometridae	34	19.10	22	12		
8	Hepialidae	2	1.12	2	0		
9	Herminiidae	2	1.12	0	2		
10	Lasiocampidae	4	2.24	3	1		
11	Lymacodidae	6	3.37	2	4		
12	Lymantriidae	9	5.0	7	2		
13	Noctuidae	23	12.92	21	2		
14	Nolidae	2	1.12	1	1		
15	Notodontidae	2	1.12	1	1		
16	Pyralidae	60	33.70	16	44	85	214	86.35
17	Sphingidae	11	6.79	4	7		
18	Thyrididae	6	3.37	3	3		
19	Uraniidae	1	0.56	1	0		

Nature Reserve of Foja Mountain) during a month (1st to 29th November 2008).

RESEARCH METHODS

The research was conducted at the base of the Foja mountain, Kwerba village, which is located on a sharp of the Wiri, a tributary of the Membarmo (Fig.1). This is a mountainous region and the village at 80 m a.s.l. Along one side of the village, is a small and usually clear stream (the kali Buerat). The area is a part of a large complex of nature reserve, together with the Mamberamo and Rouffaer Reserves. Samplings were conducted at 10 sites in Kwerba village. The positions of the ten sites in Kwerba are near to the CI's base camp at S. 02° 38. 822′ E. 138° 24 981′.

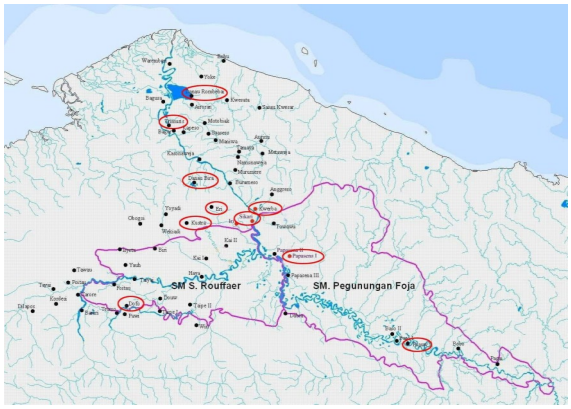


Figure 1. Site of study: Kwerba Village at base of Foja Mountain (indicated by a red arrow)

Directly surrounding the village are garden (cultivated: sweet potato, cassava, sugar cane, coconut, banana and other cultivated crops) or (temporarily) abandoned (bekas kebun). Otherwise Kwerba is surrounded by forest with several trees that are very common such as *Licuala* spp, *Pandanus conoideus*, *Hopea novoguineensis*, *Anisoptera thurifera* and *vatica rassak*. More over, Zingeberaceae, Orchidaceae, *Begonia* spp, and *Pandanus* spp are also very common in this forest.

Sampling has been conducted using light traps equipped with a 160 watt mercury vapor light and a 2 X 2.5 m white screen from 18.00 to 24.00 during 10 nights at 10 sites. The light trap is set up at the open area within this forest. Moths attracted to the light trap and lied at the white screen were collected into an ethyl acetate-killing bottle. For the large moths (wing span > 5 cm) were collected by using an insect net and then injected at the thorax with a small amount of absolute ammonia. All specimens collected at the night and then were pined using insect pins no. 3 and 4 at the next morning, while the specimens are still in fresh condition.

Preservation of the specimens was conducted at the laboratory of Entomology, Division of Zoology, Research Center for Biology, Cibinong. All moth specimens were labeled based on the field collection data. Their wings were spread and then dried up using oven at 45-50°C for 3-5 days, depends on the condition of specimens. All the materials were deposited at the Museum of Zoologicum Bogoriense, the Indonesian Institute of Sciences, Cibinong.

Measuring the diversity for species-richness based on α –statistic of Fisher (Fisher *et al*. 1943). Fisher's alpha diversity index, defined implicitly by the formula: $S=a \ln(1+n/a)$ where S is the number of taxa, n is the number of individuals and a is the Fisher's alpha. Justification for this on grounds of the frequent approximation of light-trap moth samples to a log-series distribution of abundance among the species is given by Taylor, Kempton and Woiwod (1976) and, within a South East Asian context is given by Barlow and Woiwod (1989). Wolda (1983) demonstrated that this statistic was the most sample-size independent of a number of frequently used of diversity measure

In addition, I have chosen an extrapolation method, which given an estimate of the total number species from empirical samples. N: the total number of individuals in the sample, s: the total number of species, and Ni: the number of individuals of

species *i*. The expected number of species $E(S_n)$ in a sample of size *n* and the variance $V(S_n)$ are then given:

$$E(S_n) = \sum_{i=1}^{s}\left[1 - \frac{\binom{N-N_i}{n}}{\binom{N}{n}}\right]$$

$$V(S_n) = \sum_{i=1}^{s}\left[\frac{\binom{N-N_i}{n}}{\binom{N}{n}}\left(1 - \frac{\binom{N-N_i}{n}}{\binom{N}{n}}\right)\right] + 2\sum_{j=2}^{s}\sum_{i=1}^{j-1}\left[\frac{\binom{N-N_i-N_j}{n}}{\binom{N}{n}} - \frac{\binom{N-N_i}{n}\binom{N-N_j}{n}}{\binom{N}{n}\binom{N}{n}}\right]$$

All this methods were implemented in "methodological ecology" software (Krebs, 1998).

RESULTS AND DISCUSSION

The record of species collected of the study is available on request and all specimens are deposited at Museum of Zoologicum Bogoriense. These results in Table 1 showed that the short collecting time spent across all sites in this forest makes the results only a fragment of the actual existing Lepidoptera fauna. We do not know after what time the diversity values stabilizes. However, there is a statistical procedure which estimates the actual number of a community or taxocenosis from empirical samples (Krebs 1998). Based on this method, only about 83% of the existing moth fauna has been collected in this study (only 178 of 214 species). Based on the scatter plot between the species accumulation versus sampling efforts showed that after 10 nights, the species accumulation is still gradually increase (Figure 2). This result was lower compared with the previous study that was conducted in Dabra area by Mastrigt & Rosariyanto (2002). They collected about 480 species in over 112 genera.

Family Pyralidae, Geometridae and Noctuidae were dominant among other families in this area, they were 60 species (33.70 %), 34 species (19.10 %) and 23 species (12.92 %), respectively. It is not surprising since the same phenomenon has been repeatedly reported by numerous researchers. These three families are the most divers in Papua

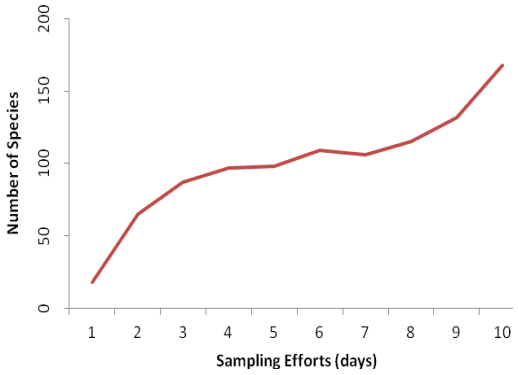


Figure 2. Graph of species accumulation versus sampling efforts (day)

region with the number species are 2764, 2520, 1641 species, respectively (Holloway et al. 2001).

The results also showed that family number found in this site is very low, less than half of the total families on this region (19 of 45), even some families that have been reported to divers in this region was not collected such as family Saturnidae and Notodontidae. The previous study in Dabra area also resulted no single sphingid has been collected (Mastrigt & Rosariyanto 2002). It has been reported that there were about 28 and 155 of these families to occur in Australian region (Holloway *et al.* 2001). On the other hand, some families which have a small number of species to distribute in this region were found in this study such as Hepialidae and Dudgeoneidae. The second family only contains a single genus *Dudgeonea* but they distribute from Africa, Madagaskar, India, South East Asia, New Guinea and Australia. There are about six described species of *Dudgeonea* (Zborowski & Edwards 2007; Edwards 1996).

The results showed that the index diversity based on Fisher's alpha is very low, 86.35. In addition the number of species with more than two individuals was slightly lower than the number of species with 1 individual, they were 85 (47.75%) and 93 (52.24%). Compared with montane forest such as in Gunung Halimun-Salak National Park

(West Java) and in Gunung Patuha Protected forest (West Java), the value of index diversity in Kwerba village was lower. But, if we compare with other low land ecosystem such as in Nusa Barong Nature Reserve (East Java), and in Giam Siak Nature Reserve (peat swamp forest) Riau, Kwerba was slightly higher (Sutrisno 2005; 2007; 2009). There are many factors that determined the diversity of macro-moths in a certain region, such as a floral diversity, altitudes, and seasons.

A floral diversity will determine the composition and diversity of macro-moths because their larvae of moths indeed often show great specificity to host plants even though their adults can use many kinds of flowers as sources of their nutrition. The larvae are mainly defoliator, but there are also leaf miners (several micro-moth families such as Nepticulidae and Gracillaridae), stem borers (for instances in Noctuidae and Pyralidae), flower feeders (Noctuidae and Geometridae), and timber borers (Cossidae and Hepialidae). Therefore, there is no doubt that more varies vegetations resulted more divers on moth fauna as has been reported on the study of Pyraloid and Sphingid moth diversity (Beck *et al*. 2002; Fiedler & Schulze 2004).

Kwerba has a lot of disturbed area as results of land clearings or illegal loggings as of other low land areas in Indonesia. Even though hunting and fishing is the main way to fulfill their food but there is a tradition in general society in Kwerba village, each family to have farming area of cassava, sweet potato and sugar cane to support their food. They do land clearings by rotation from one area to another area to open a new farming area to get the most fertilized soil. Land clearing and illegal logging have caused the decrease on species tree but increase on its density since young trees and liana trees grow everywhere. So it is not surprising that number of plant species at this low land area is low, only about 300 species (Wayne. pers.comm). Off course, there are more species of plants if we go up to the Foja mountain since there are more conserved area and less disturbed area at the higher altitude due to its geographical position, and its access limitation. In general, an accumulation curve of plant species will increase along with gradient altitude and it will reach an asymptote after reaching a certain altitude (normally after 2000 m a.s.l. the vegetation becomes homogeneous). This phenomenon is also occurred at Gunung Halimun-Salak National Park in Java. Its position at high altitude has made Gunung Halimun-Salak National park is undisturbed or less disturbed compare to other low land areas in Java. The ecosystem of this park is also more complete than other parks because this park occupies various altitudes from 500 to 2000 m a.s.l. More than 700 species of floral plants and more than 850 of macro-moths has been discovered at this park (Sutrisno 2008).

The results showed that family Pyralidae is the most dominant among other groups. The similar phenomenon also has been reported from the previous study in Dabra Area, Membramo basin by Mastrigt & Rosariyanto (2000). They reported that about 30% of them was Pyralidae (145 of 480 species). Pyralidae is mostly medium size moths which its larvae has various behaviors such as stem borer, leaf roller and leaf eater. These larvae frequently occur in open habitat areas (grasses or Poaceae). It seems that the vegetation at Kwerba village which has a lot of open area is more suitable for this group than geometrid. Most Geometrid are phytophagus that inhabit the green canopy of the trees at primer forest. Thus, this group is lower than pyralids in this area. This phenomenon also has been reported by Sutrisno (2009) at the study a comparison on macro-moths diversity at the low land forest between Nature reserve forest Giam Siak Kecil and a private conservation forest in Riau, Sumatra. The study showed that Pyralids was dominant at Nature reserve forest Giam Siak Kecil in where this forest

has been illegal logged for a long time. On the other hand Geometridae was dominant at private conservation forest. The vegetation at this second forest was less disturbed and relatively more conserved as indicated by domination of large tree Dipteropcarpaceae. This group is as the main supporting component of the vegetation at the peat swamp forest in Sumatra. There is no doubt that some species of moths apparently restricted by geographical boundaries and some others may be restricted to particular forest types associated with a particular climatic regime and may well reflect distribution of their host plants (Beck & Kitching 2007; Sutrisno 2010). In addition, there is distinct altitudinal zonation in the Lepidoptera of SE Asia i.e. the fauna of lowland and hill dipterocarp forest of Borneo has few species in common with that the montane forest 1000 meters or more. Large Geometrids and Noctuids are more common to be found at high altitude. They are able to survive at the high altitude (>1500 m a.s.l.) with temperature vary from 15 to 20°C (Holloway 1976; Robinson & Tuck 1993; Mey & Speidel 2003). Indeed, moth composition can tell us the natural condition of vegetation of a certain area and can be used to evaluate the change of forest vegetation (Beck *et al.* 2002).

Thought the Foja mountain is a huge nature reserve covering area about 2 million Ha ranging from low land up to about 2193 m a.s.l., this study on moth diversity at Kwerba at the base of the Foja mountain, Membramo, Papua within 10 nights through a rapid assessment presented in this report should be regarded as a preliminary work. To get more comprehensive results, more sampling sites need to be established to represent the gradient altitudes and varies of the vegetation types in the future study.

CONCLUSION

Based on our finding, we concluded that the diversity of macro-moths at the base of Foja Mountain Nature Reserve is low. Land clearings by rotation from one area to another area to open a new farming area to get the most fertilized soil caused in decreasing of plant diversity. It is one of the main reasons for way the macro-moth diversity in a low land of Foja Mountain Nature Reserve is low since most of macro-moths have specific host-plants.

ACKNOWLEDGEMENT

Grateful thanks are due to the head of BKSDA I, Papua for his permission to access this park. Special thanks to Michael, Yagi, Irvan and all the staffs Conservation Indonesia for organizing of this research. Many thanks also go to Darmawan, for helping me in preserving of the materials. This research is supported by Conservation International, without its support it is impossible to conduct this research successfully.

REFERENCES

Barlow, H.S. & I.P. Woiwod. 1989. Moth diversity of a tropical forest in Peninsular Malaysia. Journal of Tropical Ecology, 5: 37-50.

Beck, J. & I.J. Kitching. 2007. The latitudinal distribution of Sphingidae species richness in Continental South East Asia: what cause the biodiversity 'hot spot in northern Thailand. Raffles Bulletin of Zoology, 55: 179-185.

Beck, J., C.H. Schulze, K.E. Linsemair, K. Fiedler. 2002. From forest to farmland: diversity of Geometrid moth along two habitat gradients on Borneo. Journal of Tropical Ecology, 18: 33-51.

Edwards, E.D. 1996. Dugeoneidae. In: E.D ENielsen, E.D. Edwards , V. Rangsi (edits). Checklist of the Lepidoptera of Australia. CSIRO Publishing.

Fiedler, K & C.H. Schulze. 2004. Forest modification affect diversity (but not dynamics) of speciose tropical pyraloid moth communities. Biotropica, 36: 615-627.

Fisher, R.A., A.S. Cobert, C.B. William. 1943. The relation between the number of species and the number of individuals in a random sample of animal population. Journal of Animal Ecology, 12: 42-58.

Hebert, P.D.N. 1980. Moth communities in montane Papua New Guinea. Journal of Animal Ecology, 49: 593-602.

Heppner, J.B. 1989. Lepidoptera diversity in North Sulawesi. Orient insects, 23: 349-364.

Holloway, J.D. & N. Stork. 1991. The dimension of biodiversity: The use of invertebrates as indicators of Man's impact. London: Royal Entomological Society London.

Holloway, J.D, G. Kibby, D. Peggie. 2001. The families of Malesian moths and butterflies. Fauna Malesiana Handbook 3. Leiden: Brill,

Holloway, J.D., G.S. Robinson, K.R. Tuck. 1990. Zonation in the Lepidoptera of Northern Sulawesi. In: W.J. Knight & J. D. Holloway (edits): Insects and the rain forest of South East Asia. Royal Entomological Society London.153-166.

Holloway, J.D. 1976. A survey of the Lepidoptera, biogeography and ecology of New Caledonia. Series Entomology, 15:1-50.

Holloway, J.D. 1984. The larger moths of the Gunung Mulu National Park: a preliminary assessment of their distribution. Sarawak Malayan Journal, 30: 149-190.

Holloway, J.D. 1993. Aspects of the biogeography and ecology of the Seram moth fauna. In: I.D. Edwards, A.A. Macdonald & J. Proctor. (edits). Natural History of Seram, Maluku, Indonesia. Intercept Ltd., Andover. 91-114.

Krebs, CJ. 1998. Software program for ecological methodology, 2nd Edition, ver.5.1. Vancouver: Department of Zoology, Vancouver, University Canada.

Mastrigt, H. & E.M. Rosariyanto. 2002. Butterflies and moths of the Dabra Area, Membramo River Basin, Papua, Indonesia. In: S.J. Richards & S. Suryadi (edits). A biodiversity assessment of Yongsu - Cyclops mountain, and Southern. Membramo Basin, Papua, Indonesia. RAP. Bulletin of biological assessment 25. Conservation International.

Mey, W. & W. Speidel. 2003. Lepidoptera diversity at high and low altitudes in Taiwan and Luzon–a comparison. Journal of Zoological Society Wallace, 1: 29-42.

Robinson, G.S. & K.R. Tuck. 1993. Diversity and faunistics of small moths (Microlepidoptera) in Bornean rainforest. Ecological Entomology, 18: 385-393.

Sutrisno, H. 2005. Moth Diversity at Sebangau Peat Swamp and Busang River Secondary Rain Forest, Central Kalimantan. HAYATI (Journal of Biosciences), 12(3): 121-126.

Sutrisno, H. 2007. Rapid assessment on macromoth faunas at Nusa Barong Nature Reserve: a low diversity. Hayati (Journal of Biological Researches). 12(2): 1-7.

Sutrisno, H. 2008. Moth Diversity at Gunung Halimun-Salak National Park. HAYATI (Journal of Biosciences) , 15(3): 111-117.

Sutrisno, H. 2009. Comparison on biodiversity between private conservation and wildlife reserve forests in Riau by using macro-moths as an indicator. Biodiversitas (Journal of Biological Diversity). 10(1): 34-39.

Sutrisno, H. 2010. The impact of human activity to dynamic of insect communities: a case study in Gunung Salak, West Java. HAYATI (Journal of Biosciences), 17(4): 161-166

Taylor, L.R., R.A. Kempton, I.P. Woiwod. 1976. Diversity statistics and the log-series model. Journal of Animal Ecology 45: 255-271.

Wolda, H. 1983. Diversity, diversity indices and tropical cockroaches. Oecologia, 58: 290 -298.

Zborowski, P. & E.D. Edwards. 2007. A guide to Australian Moths. CSIRO Publishing.

RAGAM IKAN MANGROVE DI MUARA SUNGAI BOJONG LANGKAP DAN SUNGAI CIPERET, SEGARA ANAKAN-CILACAP

Gema Wahyudewantoro

Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences
Widyasatwaloka Building, Jl. Raya Jakarta-Bogor Km. 46, Cibinong 16911, Indonesia
Email**:** *gema_wahyudewantoro@yahoo.com*

ABSTRAK

Wahyudewantoro, G. 2012. Ragam Ikan Mangrove Di Muara Sungai Bojong Langkap Dan Sungai Ciperet, Segara Anakan-Cilacap *Zoo Indonesia* 21(1), 9-15. *Telah dilakukan penelitian di Muara sungai Bojong Langkap dan Ciperet,Segara Anakan Cilacap. Penelitian ini bertujuan untuk menentukan ragam jenis ikan mangrove. Dari hasil penelitian tersebut berhasil ditemukan 28 jenis ikan yang termasuk ke dalam 24 marga dan 19 suku. Suku Gobiidae tergolong dominan, dengan 5 anggota jenisnya yang tersebar diseluruh stasiun penelitian. Sebanyak 37 % jenis ikan berpotensi sebagai ikan hias*

Kata Kunci: *Mangrove, Segara Anakan, Ikan, Gobiidae, Ikan hias*

ABSTRACT

Wahyudewantoro, G. 2012. Diversity of Mangrove Fish in Bojong Langkap And Ciperet Estuaries, Segara Anakan-Cilacap. *Zoo Indonesia* 21(1), 9-15. *The research was conducted in the estuary of the river Bojong Langkap and Ciperet, Segara Anakan-Cilacap. The study aim to determine the composition Mangrove fish species. From these study 28 species belongs to 24 genera and 19 families were found. In this record Gobiidae was the dominant family with 5 species that are spread throught the research station. As many as 37% of fish species has potential as an ornamental fish.*

Keyword: *Fish, mangrove, Segara Anakan, Gobiidae, ornamental fish*

PENDAHULUAN

Mangrove merupakan suatu kawasan peralihan antara darat dan laut yang terjadi interaksi positif diantara komunitas yang mendiaminya. Fungsi keberadaan mangrove yang nyata dilihat dari aspek fisik, yaitu dapat menahan laju kerusakan atau pengkikisan pantai, sedangkan peranan penting lain diantaranya sebagai tempat memijah dan mengasuh beberapa biota akuatik (Bengen 2004). Pola perakaran mangrove yang unik sangat efektif dalam hal meredam dahsyatnya gelombang laut, sehingga kawasan mangrove menjadi tenang dan relatif stabil. Hal tersebut menjadikan beragam jenis ikan dari stadia larva sampai dewasa memanfaatkannya sebagai habitat baik sementara, menetap ataupun hanya sekedar mencari makan (Wang 2009; Mwandia *et al.* 2010).

Kawasan mangrove Segara Anakan merupakan salah satu yang terbesar di Pantai Selatan Jawa, yang terletak di belakang Pulau Nusakambangan. Segara Anakan berupa laguna yang dikelilingi oleh hutan mangrove dan daratan intertidal, dan dihubungkan dengan Samudra Hindia melalui dua terusan. Terusan barat memiliki kontur wilayah yang pendek, dalam dan lebar yang berbatasan dengan Pantai Pangandaran, Kabupaten Ciamis. Sebaliknya terusan timur memiliki kontur panjang, dangkal dan sempit, yang termasuk dalam wilayah administratif Kabupaten Cilacap (Yuwono *et.al.* 2003).

Segara Anakan mempunyai potensi bagi masyarakat sekitar diantaranya sebagai sumber produksi akuatik, pelindung erosi dan sumber produksi kayu. Namun keadaan tersebut sudah

terkikis, dan ironisnya hal itu akibat perilaku dari masyarakat sekitarnya. Menurut data yang diperoleh dari Badan Pengelola Kawasan Segara Anakan (BPKSA) bahwa pada tahun 1970-an luas hutan mangrove masih 15.000 ha, namun dalam kurun waktu 37 tahun luasnya menyusut 6100 ha (Supriyanto 2007). Perhutani (2008) melaporkan bahwa 4.000 hektar hutan mangrove di Segara Anakan, beralih fungsi menjadi lahan pertanian. Hal itu menjadikan kerusakan ekologi di kawasan hutan mangrove terluas di Jawa itu, ditambah dengan adanya proses sedimentasi atau pengendapan lumpur yang mengakibatkan pendangkalan. ECI (1994) melaporkan bahwa Sungai Citanduy dan Cikonde pada setiap tahun, masing-masing mengangkut 5 juta m_3 dan 770,000 m_3 sedimen, dimana 740,000 m_3 dan 260,000 m_3 diantaranya diendapkan di Segara Anakan.

Apabila tidak cepat ditanggulangi keadaan ini jelas mengganggu keseimbangan komunitas yang mendiami, khususnya ikan. Kemungkinan yang akan terjadi yaitu berkurangnya populasi ikan yang mendiami kawasan tersebut. Padahal kawasan mangrove Segara Anakan telah menyumbang produksi perikanan pantai dalam setahun lebih dari 62 milyar rupiah (Budiman 2007). Bhagawati *et al.* (2001) menginformasikan bahwa terdapat 22 jenis ikan yang tergolong ekonomis diantaranya jenis sidat *Anguilla* spp. dan Kakap *Lutjanus* spp.

Sehubungan dengan permasalahan itu, maka penelitian yang dilakukan bertujuan untuk mendapatkan data ragam jenis fauna ikan mangrove di Muara Sungai Bojong Langkap dan Ciperet di perairan Segara Anakan. Hasil yang diperoleh diharapkan dapat sebagai informasi yang terbaru dan dapat menjadi data ilmiah bagi pemerintah daerah setempat, sehingga dapat diteruskan sebagai upaya pengelolaan kawasan tersebut.

METODE PENELITIAN

Penelitian telah dilaksanakan pada bulan April-Mei 2009 di kawasan perairan Segara Anakan. Kawasan ini terletak di sebelah selatan pantai Cilacap pada koordinat 108º44'T109º03'T dan 08º35'S-08º48'S dengan luas 83.530 ha (White *et al*. 1989; Yuwono *et al*. 2003). Pengkoleksian contoh ikan dilakukan di lima stasiun yaitu 1. Muara Sungai Bojong Langkap; 2. S. Bojong Langkap (ke arah hilir); 3.Muara S. Ciperet; 4. Areal pertambakan (dihilir S. Ciperet); 5. Sungai Ciperet (ke arah hilir).

Pengkoleksian ikan dilakukan dengan mempergunakan jala dan jaring insang/gillnet berdiameter mata jala berukuran 1-2 cm, sedangkan jaring insang berdiameter ¾, 1 dan 1,5 inch. Ikan yang tertangkap diawetkan menggunakan formalin 4% dan diberi label. Selanjutnya di Laboratorium Ikan di Museum Zoologi Bogor yang terletak di Cibinong, formalin tersebut dicuci dengan air mengalir, kemudian digantikan alkohol 75% sebagai awetan tetap. Selanjutnya ikan-ikan tersebut diidentifikasi dengan mengacu Weber dan de Beaufort (1913), (1916), Allen dan Swainston (1988), De Beaufort (1940), Kottelat *et al*. (1993) dan Peristiwady (2006). Data distribusi merupakan persentase dari jumlah stasiun yang dijumpai jenis ke-i dibagi jumlah stasiun keseluruhan.

HASIL DAN PEMBAHASAN

Jumlah spesimen yang tertangkap selama penelitian adalah 172 spesimen. Keragaman fauna ikan di perairan Segara Anakan relatif sedang yaitu 28 jenis dari 19 suku, 24 marga (Tabel 1). Hasil tersebut lebih tinggi dibandingkan pada penelitian terdahulu di Sungai Donan dan S. Sapuregel yang hanya terkoleksi 15 jenis ikan (Djamali 1995). Subiyanto *et al.* (2008) menginformasikan bahwa di kawasan estuari Pelawangan Timur Segara Anakan terkumpul data 15 suku dari larva ikan. Hasil tersebut cenderung berbeda dengan yang terdapat di kawasan mangrove sebelah Utara P. Jawa, yaitu di kawasan mangrove Taman Nasional Ujung Kulon diperoleh 58 jenis ikan yang tergolong dalam 34

suku dan 43 marga (Wahyudewantoro 2009). Banyaknya jenis yang terkoleksi di TNUK dikarenakan kawasan perairan mangrove relatif lebih baik dibandingkan di perairan Segara Anakan. Tingkat kesadaran yang tinggi dari masyarakat sekitar Taman Nasional yang peduli akan kelestarian mangrove, karenanya dapat dijadikan penghasilan tambahan (sebagai pemandu wisata).

Kerusakan mangrove Segara Anakan dapat dikatakan tinggi, akibat dari pembukaan hutan oleh masyarakat setempat, untuk pemukiman, perkebunan dan pertambakan (Supriyanto 2008). Hal tersebut diperparah oleh adanya pendangkalan sebagai akibat sedimentasi lumpur yang terbawa dari Sungai Citanduy, yang mencapai 1 juta ton lebih setiap tahunnya (Rubiyanto 2007). Polusi air juga turut memperburuk kualitas perairan sekitar, air berwarna hitam berminyak dan mengandung oli yang merupakan sisa-sisa kapal pengangkut batu bara. Dampak yang terjadi ekosistem mangrove dan fauna yang mendiami kawasan tersebut terganggu, khususnya jumlah ikan baik jenis maupun individu relatif sedikit.

Tabel 1. Keragaman Jenis Ikan di Perairan Segara Anakan-Cilacap

No. Suku	Suku	No. Jenis	Jenis	Lokasi	Jumlah spesimen	Distribusi (%)
1	Moringuidae	1	*Moringua javanica*	3	1	20,00
2	Engraulididae	2	*Thryssa baelama*	1	1	20,00
3	Bagridae	3	*Mystus gulio*	3,4,5	13	60,00
4	Batrachoididae	4	*Halophryne ocellatus*	1	1	20,00
5	Chandidae	5	*Ambassis interrupta*	2,3,4	34	60,00
6	Serranidae	6	*Epinephelus sexfasciatus*	3,4	4	40,00
7	Carangidae	7	*Caranx sexfasciatus*	4	2	20,00
8	Leiognathidae	8	*Leiognathus equulus*	1,4	4	40,00
9	Lutjanidae	9	*Lutjanus argentimaculatus*	5	1	20,00
10	Sparidae	10	*Acanthopagrus berda*	3,5	2	40,00
11	Monodactylidae	11	*Monodactylus argenteus*	3	2	20,00
12	Scatophagidae	12	*Scatophagus argus*	1,5	3	40,00
13	Mugillidae	13	*Mugil cephalus*	1,3,4	38	60,00
14	Belonidae	14	*Strongylura strongylura*	1	1	20,00
15	Eleotrididae	15	*Butis butis*	2,3	2	40,00
		16	*B. gymnopomus*	3	1	20,00
16	Gobiidae	17	*Acentrogobius viridipunctatus*	1,4	13	40,00
		18	*Boleopthalmus boddarti*	2,3,4,5	4	80,00
		19	*Periopthalmus argentilineatus*	1,2,3,4,5	12	100,00
		20	*P. novemradiatus*	2	2	20,00
		21	*Pseudogobius javanicus*	4	2	20,00
17	Acanthuridae	22	*Acanthurus grammoptilus*	2,3,4,5	12	80,00
18	Cynoglossidae	23	*Cynoglossus waandersi*	1,2	2	40,00
19	Tetraodontidae	24	*Arothron immaculatus*	3	1	20,00
		25	*A.reticularis*	3,4	2	40,00
		26	*Tetraodon nigroviridis*	1,3	6	40,00
		27	*Tetraodon* sp.	3	1	20,00
		28	*Chelonodon patoca*	1,2,3,5	5	80,00

Keterangan: Lokasi penelitian di perairan sekitar Segara Anakan Cilacap 1. Muara S. Bojong Langkap; 2. S. Bojong Langkap; 3. Muara S. Ciperet; 4. Areal pertambakan; 5. Sungai Ciperet;

Selanjutnya terlihat bahwa suku Gobiidae dan Tetraodontidae memiliki anggota jenis tertinggi yaitu dengan 5 jenis (17,85%), Eleotrididae dengan 2 jenis (7,14%). Sedangkan untuk suku-suku lainnya hanya terkoleksi 1 jenis (3,57%). Di Pelewangan Timur, didominasi oleh suku Pomacentridae (29,84%), Atherinidae (28,66%) dan Gobiidae (20,31%) (Subiyanto *et al.* 2008).

Ikan-ikan dari suku Gobiidae dan Tetraodontidae yang tertangkap mempunyai kemampuan adaptasi baik di kawasan mangrove, hal ini dikarenakan kawasan tersebut merupakan sumber makanan dan memiliki sistem perakaran yang unik sehingga mampu memberikan perlindungan dari pemangsanya (Subiyanto *et al.* 2008; Wang *et al.* 2009). Pramudji (2008) menginformasikan bahwa suku Gobiidae dapat dijumpai dalam stadia larva dan juvenile di kawasan pesisir Delta Mahakam. Bahkan beberapa jenis diketahui merupakan penghuni tetap kawasan ini, yaitu ikan belodok/*Boleopthalmus boddarti* dan *Periopthalmus argentilineatus* (Gobiidae), juga ikan buntal / *Chelonodon patoca* (Tetraodontidae) (Gambar 1). Di hampir seluruh stasiun penelitian terdapat ikan belodok dan buntal. Ikan belodok memiliki perilaku yang unik, belodok terlihat berjalan dan memanjat akar-akar mangrove dan apabila dalam keadaan terancam belodok akan segera masuk ke dalam lubang-lubang persembunyiannya. Hal ini diperkuat oleh Burhanuddin dan Martosewojo (1978) yang berpendapat jenis-jenis belodok berasosiasi erat dengan ekosistem mangrove. Di TNUK jenis-jenis belodok menempati hampir di seluruh muara sungai (Wahyudewantoro 2009).

Karakter unik lain ditunjukkan oleh ikan buntal, dengan warna yang begitu indah dan pergerakkan relatif lambat namun jangan sampai terkecoh dengan penampilannya. Jenis buntal dalam keadaan yang terdesak akan menggelembungkan diri menyerupai bola, dan memiliki duri-duri tajam. Nontji (1993) menginformasikan bahwa secara umum duri-duri dari jenis buntal mengandung racun.

Gambar 1. *Boleopthalmus boddarti* (1); *Periophthalmus argentilineatus* (2); *Chelonodon patoca* (3) (Foto oleh Wahyudewantoro 2009)

Distribusi Jenis

Selanjutnya dilihat dari sebaran masing-masing stasiun penelitian, tampak Muara Sungai Ciperet dihuni oleh 11 suku dan 17 jenis ikan. Kemudian areal pertambakan dengan 9 suku dan 12 jenis dan muara S. Bojong Langkap dengan 9 suku dan 11 jenis (Gambar 2). Ketiga area tersebut memiliki vegetasi mangrove lebih baik dibandingkan lainnya, ditambah dasar perairan mengandung lumpur. Substrat lumpur merupakan habitat berbagai nekton, yang menandakan daerah tersebut kaya akan sumber pakan (Franco *et al.* 2006), bahkan di muara sungai Suwanne di Florida, jumlah Mugil spp lebih banyak dibandingkan di daerah lamun (Tuckey dan Dehaven 2006 dalam Mwandya *et al.* 2010).

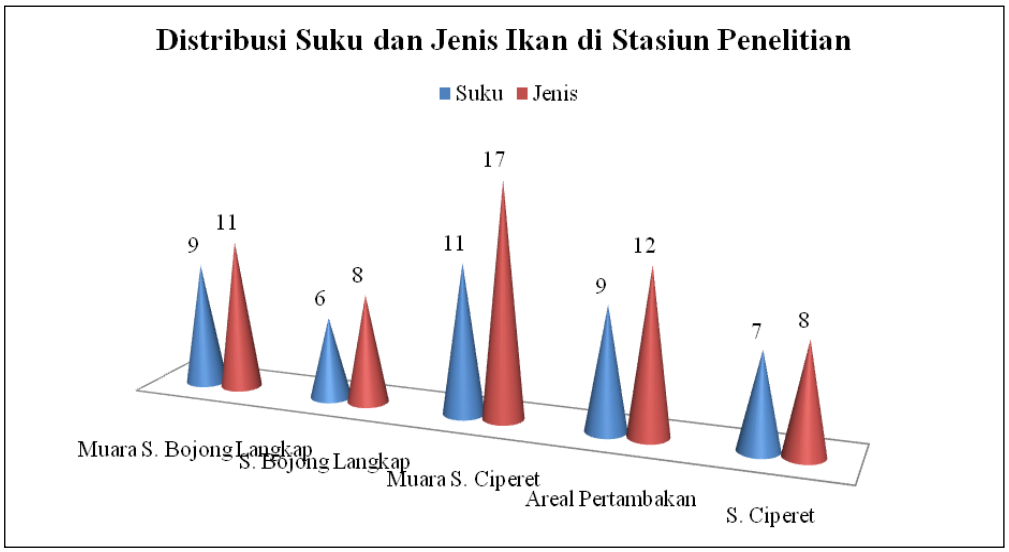
Selain itu daun-daun mangrove yang berguguran ke air, akan segera membusuk dan menambah kesuburan perairan. Odum (1971) berpendapat bahwa serasah mangrove yang jatuh, akan menghasilkan nutrien berkisar 35-60% terlarut ke dalam ekosistem mangrove. Selama proses dekomposisi, serasah mangrove akan semakin diperkaya oleh protein yang merupakan pakan bagi berbagai biota akuatik (Pramudji 2008). Salah satu jenis ikan yang tergolong detrivor mangrove yaitu belanak (*Mugil* spp.), hal ini diperkuat oleh Morton (1990) bahwa belanak juga merupakan detrivor di wilayah mangrove Australia. Beberapa juvenile ikan menyukai larva dari kepiting sesarmid yang juga merupakan pemakan detritus (Robertson 1986 *dalam* Pramudji 2008).

Muara sungai Ciperet memiliki vegetasi mangrove tertutup (kerapatan pohonnya) dan dianggap masih baik dibandingkan yang lainnya. Mulut muara langsung mengarah ke Nusakambangan, yang secara otomatis jenis-jenis ikan yang diperoleh relatif lebih banyak dan beragam karena dimungkinkan bercampur dengan jenis yang berasal dari Samudra Hindia.

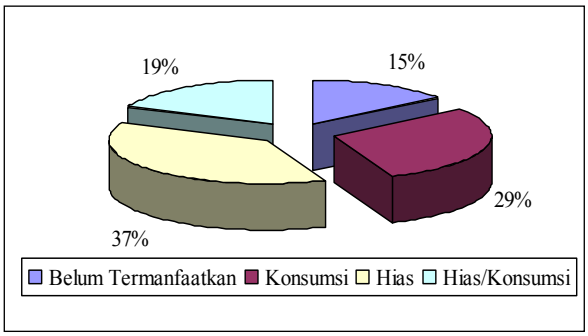
Untuk kondisi Sungai Bojong Langkap, yaitu berada di sekitar pertamina dan lalu lintas kapal yang mengakibatkan diperoleh jenis yang sedikit baik dalam hal jumlah dan ragamnya, hal ini kuat dugaan akibat kondisi perairannya yang lebih kotor dan terlihat berminyak.

Jenis Ekonomis

Ditinjau dari segi potensi ikan yang terkoleksi, 18 jenis (37%) berpotensi sebagai ikan hias, 14 jenis (29%) sebagai ikan konsumsi, 9 jenis (19%) sebagai ikan hias dan konsumsi, sedangkan 7 jenis (18%) belum termanfaatkan secara optimal (Gambar 3). Dari hasil tersebut dapat dimungkinkan bahwa S. Ciperet dan S. Bojong Langkap memiliki ragam potensi ikan hias.



Gambar 2. Distribusi Suku dan Jenis Ikan di Stasiun Penelitian



Gambar 3. Potensi Ikan di Kawasan Segara Anakan (S. Ciperet dan S. Bojong Langkap)

Beberapa ikan merupakan jenis ikan konsumsi penting dan memiliki nilai jual tinggi. Ikan tersebut yaitu jenis-jenis ikan kerapu *Epinephelus sexfasciatus* dan kakap *Lutjanus argentimaculatus.* Satyono (2006) menginformasikan harga ikan kerapu di pasar dunia dapat mencapai US$ 8,0/kg. Harga jenis kakap di pasar Asia, khususnya di Hongkong harga jenis kakap mencapai US$ 5,5/kg (Sugama & Priono, 2003).

Selain itu jenis ikan konsumsi lain yang tidak kalah penting adalah *Thryssa baelama*, *Mystus gulio*, *Acanthopagrus berda* dan *Mugil cephalus*. Jenis ikan yang termasuk dalam kelompok ikan hias antara lain *Monodactylus argenteus, Pseudogobius javanicus* dan jenis-jenis ikan buntal diantaranya *Chelonodon patoca, Tetraodon nigroviridis*. Kelompok ikan yang dapat dimanfaatkan sebagai ikan hias dan konsumsi antara lain *Mystus gulio, Scatophagus argus* dan *Ambassis interrupta*. Ada pula jenis ikan yang menambah keunikan ekosistem mangrove di Segara Anakan, seperti ikan *Moringua javanica*. Jenis ini memiliki tubuh menyerupai ular, namun tidak membahayakan (tidak beracun). Di lokasi penelitian, ikan ini sulit ditangkap dikarenakan warna tubuhnya menyerupai lumpur. Di Jepang jenis ini tercatat sebagai pendukung sektor perikanan (Kottelat *et al*. 1993).

Setelah dilakukan pemahaman lebih lanjut berdasarkan literatur (Allen dan Swainston 1988; Kottelat *et al*. 1993; Peristiwady 2006) diperoleh beberapa jenis ikan yang terkoleksi termasuk katagori dewasa (*adult*), yaitu *Thryssa baelama* (Engraulididae); *Boleopthalmus boddarti*, *Periopthalmus argentilineatus* (Gobiidae). Bahkan ikan kating/ *Mystus gulio* diperkuat dengan adanya telur setelah dilakukan pembedahan. Dari hasil tersebut diduga jenis-jenis ikan tersebut akan memanfaatkan area mangrove untuk proses pemijahan.

KESIMPULAN

Ikan yang terkoleksi sebanyak 28 jenis dan sebagian besar didominasi oleh suku Gobiidae, yang merupakan salah satu penetap yang berasosiasi dengan mangrove. Jenis ikan kerapu *Epinephelus sexfasciatus* dan kakap *Lutjanus argentimaculatus* banyak dicari dan diburu di perairan ini walaupun keberadaannya sudah jarang dijumpai.

UCAPAN TERIMA KASIH

Penelitian ini dibiayai oleh anggaran DIPA tahun 2009. Penulis juga mengucapkan terima kasih kepada nelayan kampung Ciperet yang membantu selama penelitian di lapangan.

DAFTAR PUSTAKA

Allen, G.R., & R. Swainston, 1988. The marine fishes of North Western Australia. Western Australian Museum, Australia.

Bengen, D.G. 2004. Pedoman Teknis Pengenalan dan Pengelolaan Ekosistem Mangrove. PKSPL. Institut Pertanian Bogor.

Budiman, P.A. 2007. Kajian Mata Pencaharian Alternatif Masyarakat Nelayan Kecamatan Kampung Laut Kabupaten Cilacap. Jurusan Perencanaan Wilayah Dan Kota Fakultas Teknik Universitas Diponegoro Semarang.

Burhanuddin, S. Martosewojo. 1978. Pengamatan terhadap ikan gelodok, *Periopthalmus koelreuteri* (Pallas) di Pulau Pari. Prosiding Seminar I Ekosistem Mangrove, 86-92. Jakarta 27 Februari-1 Maret 1978.

Bhagawati, D., S. Suryaningsih, P.H. Tjahya. 2001. Kematangan Gonad Ikan ekonomis Yang Tertangkap di Perairan Segara Anakan Cilacap. Biosfera, 18 (3): 91-97.

De Beaufort, L.F. 1940. The fishes of the Indo-Australian Archipelago VIII. Percomorphi (Continued), Cirrhitoidea, Labriformes, Pomacentriformes. Brill, Leiden. 508 hal.

Djamali, A. 1995. Komunitas Ikan di Perairan Sekitar Mangrove (Studi kasus di: Muara Sungai Berau, Kalimantan Timur; Cilacap, Jawa Tengah dan Teluk Bintuni, Irian Jaya). Prossiding Seminar V Ekosistem Mangrove, Jember 3-6 Agustus 1994: p 160-167.

ECI (Engineering Consultant Inc.). 1994. Segara Anakan Conservation and Development Project. Jakarta: Asian Development Bank.

Franco, A., P. Franzoi, S. Malavasi, F. Riccato, P. Torricelli, D. Mainardi. 2006. Use of shallow water habitats by fish assemblages in a Mediterranean coastal lagoon. Estuarine, Coastal and Shelf Science, 66: 67-83.

Kottelat, M., A.J. Whitten, S.N. Kartikasari & S. Wirjoatmodjo. 1993. Freshwater Fishes of Western Indonesia and Sulawesi. Periplus Editions Limited.Jakarta.p 229.

Morton, RM. 1990. Community Structure, Density and Standing Crop of Fishes in a Subtropical Australian Mangrove Area. Mar. Biol. 105 : 385-394.

Mwandya, AW., M. Gullström, M.H. Andersson, M.C. Ohman, Y.D. Mgaya & I. Bryceson. 2010. Spatial and seasonal variations of fish assemblages in mangrove creek systems in Zanzibar (Tanzania). Estuarine, Coastal and Shelf Science, 89: 277-286

Nontji A. 1993. Laut dan Nusantara. Djambatan. Jakarta.

Odum, E.P. 1971. Fundamentals of Ecology. 3rdEdition. WB Saunders. Philladelphia.

Peristiwady, P. 2006. Ikan-Ikan Laut ekonomis Penting di Indonesia. LIPI Press. Jakarta.

Rubiyanto. 2007. Menyelamatkan Hutan Mangrove Cilacap. http://cilacap-online.tripod.com/hutanbakau.htm. Diakses tanggal 10 Oktober 2009.

Satyono E. 2006. Ekspor Kerapu, Masih Banyak Perdu.http://www.trobos.com show_article. php?rid=14&aid=245. Majalah Trobos. 1 November 2006. Diakses tanggal 15 September 2009.

Subiyanto, Ruswahyuni, D.G. Cahyono. 2008. Komposisi dan Distribusi Larva Ikan Pelagis Di Estuaria Pelawangan Timur, Segara Anakan Cilacap. Jurnal Saintek Perikanan Vol. 4 (1): 62-68.

Sugama, K., B. Priono. 2003. Pengembangan Budidaya Ikan Kerapu di Indonesia. Warta Penelitian Perikanan Indonesia edisi Akuakultur, 9(3): 20-22.

Supriyanto. 2008. Luas Segara Anakan Tinggal Kurang dari 800 Hektar. www.kompas.com. Diakses tanggal 10 Oktober 2009.

Wahyudewantoro, G. 2009. Keanekaragaman Fauna Ikan Ekosistem Mangrove di Kawasan Taman Nasional Ujung Kulon, Pandeglang Banten. Berita Biologi, 9:88-97.

Wang M., Z. Huang, S. Shi, W. Wang . 2009.Wenqing Wang Are vegetated areas of mangroves attractive to juvenile and small fish? The case of Dongzhaigang Bay, Hainan Island, China. Estuarine, Coastal and Shelf Science 85: 208–216.

Weber, M., L.F. de Beaufort. 1913. The fishes of the Indo-Australian Archipelago. II. Malacoptergii, Myctophoidea, Ostariophysi: I. Siluroidea. Brill Ltd. Leiden. 404 hal.

Weber, M., L.F. de Beaufort. 1916. The fishes of the Indo-Australian Archipelago. III. Ostariophysi: II. Cyprinoidea, Apodes, Synbranchii. Brill Ltd. Leiden. 455 hal.

White, A.T., P. Martosubroto, M.S.M. Sadorra. 1989. The coastal environmental profile of Segara Anakan-Cilacap, South Java, Indonesia. ICLARM Technical Report 25, 82 p. Int. Center for Living Aquatic Resources Management, Manila, Philippines.

Yuwono, E., T.C. Jennerjahn, I. Nordhaus, E.A. Riyanto, M.H. Sastranegara, R. Pribadi. 2003. Ecological status of Segara Anakan, Indonesia: a mangrove-fringed lagoon affected by human activities. Asian Journal of water, 4 (1): 61-70.

AVIFAUNA DIVERSITY AT CENTRAL HALMAHERA NORTH MALUKU, INDONESIA

Mohammad Irham

Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences
Widyasatwaloka Building, Jl. Raya Jakarta-Bogor Km. 46, Cibinong 16911, Indonesia
Email: *irham.mzb@gmail.com*

ABSTRAK

Irham, M. Keanekaragaman Avifauna at Weda Bay, Halmahera, Indonesia. 2012 *Zoo Indonesia* 21(1), 17-31. *Survei burung dengan menggunakan metode titik hitung dan jaring telah dilakukan di Halmahera, Maluku Utara di empat lokasi utama yaitu Wosea, Ake Jira, Tofu Blewen dan Bokit Mekot. Sebanyak 70 spesies burung dari 32 famili dijumpai selama penelitian lapangan. Keragaman burung tertinggi ditemukan di Tofu Blewen yaitu 50 spesies (Indeks Shannon = 2.64) kemudian diikuti oleh Ake Jira (48 spesies, Indeks Shannon = 2,63), Wosea (41 spesies, Indeks Shannon = 2,54) dan Boki Mekot (37 spesies, Indeks Shannon = 2,52). Berdasarkan Indeks Kesamaan Jaccard, komunitas burung di Wosea jauh berbeda dibandingkan lokasi lain. Gangguan habitat dan ketinggian memperlihatkan pengaruh pada keragaman burung terutama pada jenis-jenis endemik dan terancam seperti komunitas di Wosea. Beberapa jenis burung, terutama paruh bengkok seperti Kakatua Putih, menunjukkan hubungan negatif dengan ketinggian .*

Kata Kunci: *keragaman burung, Halmahera, gangguan habitat, ketinggian*

ABSTRACT

Irham, M. Avifauna diversity at Weda Bay, Halmahera, Indonesia. 2012 *Zoo Indonesia* 21(1), 17-31. *Bird surveys by point counts and mist-nets were carried out in Halmahera, North Moluccas at four locations i.e. Wosea, Ake Jira, Tofu Blewen and Bokit Mekot. A total of 70 birds species from 32 families were recorded during fieldworks. The highest bird diversity was found in Tofu Blewen with 50 (Shannon index= 2.64) species then followed by Ake Jira (48 species, Shannon index=2.63), Wosea (41 species, Shannon index= 2.54) and Boki Mekot (37 species, Shannon index=2.52). Jaccard Similirity Index showed that bird communities in Wosea were the most different. Habitat disturbance and change in elevation influenced birds diversity and abundance, especially to endemic birds and threatened species. Some parrots, such White Cockatoo, showed negative relationship with high elevation.*

Keywords: *birds diversity, Halmahera, habitat disturbance, elevation*

INTRODUCTION

Wallacea region consists of the main island of Sulawesi, group of islands forming Moluccas and Lesser Sunda. Because of its geographic location between Oriental to the west and Austro-papua realms to the east, the avifauna within these region had been influenced from both sides. Moreover, due to the complex origin and geology, many unique species evolve independently and are different from either oriental nor Austro-papua forms. Therefore, this area become the center of endemism with an estimated of more than 256 species are restricted ranged to the islands (Whitten *et al.* 2005).

Halmahera of North Moluccas is the biggest island in Moluccas Archipelago. It has 254 species of birds from which 64 species are endemic to Moluccas. Twenty-eight endemic species of Moluccas, including four endemic genera, have restricted range on North Moluccas only (Coates & Bishop 1997, Dickinson 2003). By having such endemicity, Halmahera and its neighboring islands are recognized by BirdLife International as North Maluku Endemic Bird Areas (EBA) (Stattersfield et al. 1998).

Apart from having high endemicity, North Maluku EBA is also a home of ten threatened species of which three species are Endangered

(Japanese Night-heron (*Gorsachius goisagi*), Moluccan Woodcock (*Scolopax rochussenii*) and Chattering Lory (*Lorius garrulous*)); and seven species are Vulnerable (Moluccan Megapode (*Eulipoa wallacei*), Invisible Rail (*Habroptila wallacii*), Caruncculated Fruit-dove (*Ptilinopus granulifrons*), White Cockatoo (*Cacatua alba*), Sombre Kingfisher (*Todiramphus funebris*), Purple Dollarbird (*Eurystomus azureus*) and Dusky Friarbird (*Philemon fuscicapillus*)) (BirdLife International 2003).

This fascinating island had attracted many naturalists and ornithologists since the era of Alfred Russel Wallace. During the Dutch administration, De Haan departed to Moluccas and collected some specimens that published on the paper of Van Bemmel and Voous (1953) (Mees 1982). After him, several other visitors subsequently came to the North Moluccas including Heinrich A. Bernstein who contributed significantly on the knowledge of birds of Moluccas and Papua. Not only European naturalist, this island also attracted Japanese famous ornithologist, Nagamichi Kuroda who made notes of 27 species and subspecies based on the collection of Mr. Watanabe (Kuroda 1938).

Most of the earlier exploration and collection were made around coastal area such as Weda, Kao, Lelilef, and neighboring islands of Ternate, Obi, Batjan and Morotai. Very few records come from the area of Central Halmahera. This survey was carried out to explore the birds of Halmahera from central region between Ake Tajawe and Lolobata National Park. Habitat characters such as disturbance and altitude were explored if these could influenced birds communities in Central Halmahera. The results from this study were important to bridge the avifauna paucity information from central area of Halmahera and to be incorporated into environment management for stakeholders as this area was potentially exploited by mining and logging company.

RESEARCH METHODS

Survey sites

Bird surveys were conducted in Halmahera, North Moluccas from January to February 2010. There were four main sites i.e. Wosea (N0 29.716 E127 56.782), Ake Jira (N0 36.937 E127 54.990), Tofu Blewen (N0 48.210 E128 01.924) and Boki Mekot (N0 36.659 E128 02.437) (Figure 1). These four sites varied in elevation: 40-75 m asl for Wosea, 50-125 m asl for Ake Jira, 450-660 m asl for Tofu Blewen and the highest sites were Boki Mekot that located at 750-900 m asl. Forest type in all sites generally consisted of primary forest, secondary forest and open area from flat landscape to hilly area.

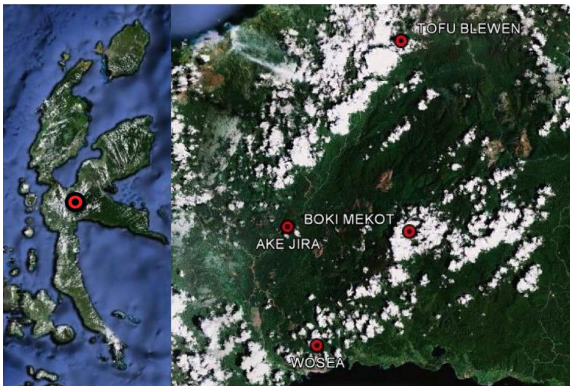


Figure 1. Survey sites located in central Halmahera which administratively divided by Central Halmahera District and East Halmahera District (Source: Google Earth 2012)

Wosea and Ake Jira were flat covered with mozaic of primary forest, secondary forest and cultivated area. The largest open area was the riverbank of Wosea that was cleared just before the survey was conducted. Local people cleared the area by slash and burn techniques. Tofu Blewen and Boki Mekot were hilly with predominantly primary forest. Tofu Blewen had relatively large open road connecting some villages around the area. There were some area closed to the study sites that had been logged. Boki Mekot was inaccessable by road so most of the area were still intact hill primary forest.

Data Collection

I applied two methods in order to obtain a comprehensive bird list i.e. observation by means of opportunistic surveys and point count; and mist-netting (Bibby et al. 1998). Opportunistic surveys were done to allow as many species as possible to be found. I searched for birds in a range of terrestrial habitat following main roads, tracks, and forest trails across the area. While opportunistic surveys were done randomly, point counts were conducted in systematic manner. During the walk following tracks, I set a point count every 200 m between points. The total point counts on every site were nine for Wosea (1.6 km transect length, one transect), 17 for Ake Jira (3.2 km transect length, two transects), 16 for Tofu Blewen (three km transect length, two transects) and 13 for Boki Mekot (2.4 km transect length, two transects).

I observed birds with Nikon 12x25mm Travelite binocular. Observation was conducted for 10 minutes at every point counts. I recorded the birds that encountered within and beyond 50 m radius. Only birds found within 50 m were included in the analysis of species richness. Upon an encounter with birds, the following data were collected i.e. species, number of individuals, habitat type, behavior, and location. Whenever possible, bird calls were recorded with Sony PCM-Recorder and bird photographs were taken with Canon Powershot S3 IS.

For catching birds, I used 15 mist-nets of 12 x 2.6 m mesh 34 on each location for three days replicates. Because of the field restriction and limitation, I set up 15 mist-nets only at Wosea and Ake Jira while on the other sites I put only 10 mist-nets. All caught birds were identified, photographed and measured. Several bird species were taken for specimens. All samples and specimens were deposited at Museum Zoologicum Bogoriense (MZB) Cibinong.

Additional data collections were conducted by interviewing local people. I showed pictures of birds to them. Fieldworks started at 05.30 – 18.00 everyday. Bird identification followed Coates and Bishop (1997) and scientific names followed Sukmantoro dkk. (2007).

Analysis

Shannon and Jaccard index was applied for evaluating bird species richness by quantifying index of diversity and similarity index, respectively (Nur *et al.* 1999). Since the effort of point counts were different among sites, rarefaction function was used to examine a total species across all study sites. The abundance of birds was taken as the maximum number of individuals of a species present in each habitat types during three observations replicates. Regression analysis was carried out to examine the influence of elevation to birds distribution. All data were checked whether or not they departed significantly from a normal distribution. If the data was not normally distributed, it was transformed to approach a normal distribution more closely (Sokal & Rohlf 1995). Statistical analysis conducted with SPSS software (SPSS Inc. 2002).

RESULTS & DISCUSSION

Species Account

A total of 70 birds species from 32 families were recorded during fieldworks (Appendix 1). The highest number of bird species was found in Tofu Blewen (50 species) then followed by Ake Jira (48 species), Wosea (41 species) and Boki Mekot (37 species). Most of the birds were recorded from observation. There were only five species of which obtained from mist-netting. These species account represent 29% of the whole known species occurred on Halmahera.

Of these species account, 16 birds were endemic to Halmahera (North Moluccas) from which three endemic genera out of four were observed i.e. *Semioptera wallacei* (Standardwings Birds of Paradise), *Lycocorax pyrrhopterus* (Paradise Crow) and

Melitograis gilolensis (White-streaked Friarbird). The endemic genera missing from observation was *Habroptila wallacii* (Invisible Rail). Combine with other endemic birds which had larger distribution area, a total of endemic birds found were 27 species. Based on the conservation status, there were 23 species that protected by Indonesian law (UU No.5/1990 and PP.No. 7/1999), 19 species were under Appendix II CITES and two species were on the red list of IUCN. The distribution of species under regulation apparently were not too different across survey sites nevertheless Tofu Blewen held more species than others (Figure 2). However, it was very obvious that endemic bird diversity and numbers of threatened species were lower in Wosea.

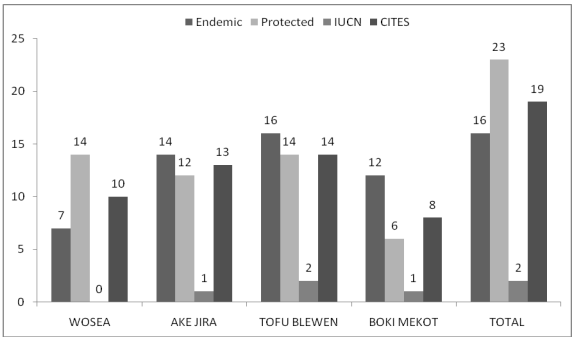


Figure 2. Distribution of recorded birds that holds specific status across survey sites

In the following I presented information on species which had special interest from an ornithological perspective and conservation.

Accipitridae

Six species of birds of prey were detected on survey sites i.e. Moluccan Goshawk (*Accipiter hennicogramus*), Chinese Goshawk (*Accipiter soloensis*), Osprey (*Pandion haliaetus*), Brahminy Kite (*Haliastur Indus*), Gurney's Eagle (*Aquila gurneyi*) and Black Eagle (*Ictinaetus malayensis*). Moluccan Goshawk is an endemic raptor in Halmahera and Gurney's Eagle holds Near Threatened status by IUCN. All the raptors are resident except Chinese Goshawk is a winter visitor from northern hemisphere.

Moluccan Goshawk was recorded at all sites in various kind of habitat from forest edge of Wosea until primary forest of Boki Mekot. Mostly, they were observed in pairs. Their presence was rather easy to detect due to their vocal behaviour, especially during breeding season.

Osprey and Brahminy Kite are known as wetland raptors because they mostly hunt on fish at the river bank or coastal area. A single osprey, apparently sub-adult individual stage, was detected perched on the dead tree next to the Wosea River at dawn. Meanwhile, Brahminy Kite was observed at Ake Jira and Tofu Blewen. The largest flock of Brahminy Kite was counted at Tofu Blewen as 8 individuals were soaring over hilly terrain close to the Camp 8.

A Chinese Goshawk, a Black Eagle and three Gurney's Eagle were observed only at Tofu Blewen. All of them were seen around weather station, logging road and Camp 4 soaring above the forest and headed up to the west. While Chinese Goshawk was the only migratory raptor present at the site which could be identified convincingly, another unidentified raptor that looked like a migratory Harrier was detected in Tofu Blewen.

Megapodidae

Halmahera is inhabited by two megapodes i.e. Moluccan Scrubfowl (*Eulipoa wallacei*) and Dusky Scrubfowl (*Megapodius freycinet*). However, during this survei the first megapode which is vulnerable endemic species to Moluccas was not found. Dusky Scrubfowl is common in Halmahera and they probably prefer flat terrain on low elevation over undulating landscapes. In addition, they were encountered mostly at secondary or primary forest and sometimes wandering up till the forest edge.

The most abundant scrubfowl was recorded at Ake Jira. They were very vocal so that their presence was easily detected. Their mound were rather abundant and easily found in the forest.

Wosea was also a habitat for Dusky Scrub-fowl. However, since the forest around Wosea River was severely disturbed, they were found only at the remaining fragmented forest and up river. This species was not observed in Tofu Blewen and Boki Mekot.

Columbidae

Nine species of Columbidae had been recorded on surveyed area. Three of them have restricted distribution only on North Moluccas i.e. Cinnamon-bellied Imperial Pigeon (*Ducula basilica*), Scarlet-breasted Fruit-dove (*Ptilinopus bernsteinii*) and Grey-headed Fruit-dove (*Ptilinopus hyogastra*). The White-eye Imperial Pigeon (*Ducula perspicillata*) has extended distribution to Papua. The other five species: Emerald Dove (*Chalcophaps indica*), Pied Imperial Pigeon (*Ducula bicolor*), Superb Fruit-dove (*Ptilinopus superbus*), Slender-billed Cuckoo-dove (*Macropygia amboinensis*) and Spotted-turtle Dove (*Streptopelia chinensis*) were widely distributed in Indonesia and some of its extremities.

Most of the pigeons and doves were observed in the forested area. It was only Spotted-turtle Dove, which is adaptive to open area, encountered in Wosea. Emerald Dove was seen only at Wosea and Ake Jira, and it was absent in Tofu Blewen and Boki Mekot. The undulating landscapes at the latest two locations probably were the restriction features for Emerald Dove as it was fast flyers on low level ground. Pied Imperial Pigeon has the most widespread altitudinal distribution among others, although it was absent in Wosea presumably due to recently forest disturbance around the area.

Some species such as Pied Imperial Pigeon and Grey-headed Fruit Dove could be found in a flock of five individuals up to 15 individuals. However, the other species were spotted singly or in pairs.

Psittacidae

The numbers of Psittacidae family recorded were eight species i.e. Moluccan King Parrot (*Alisterus amboinensis*), Red-cheeked Parrot (*Geoffroyus geoffroyi*), Eclectus Parrot (*Eclectus roratus*), White Cockatoo (*Cacatua alba*), Moluccan Hanging-parrot (*Loriculus amabilis*), Chattering Lory (*Lorius garrulus*), Violet-necked Lory (*Eos squamata*), Great-billed Parrot (*Tanygnathus megalorynchos*). All of them are listed on the CITES Appendix II, Eclectus Parrot is protected by Indonesian law (PP No.7/1999) and Chattering Lory is categorized as Endangered species by IUCN.

All species were found in Ake Jira, whereas, in other sites, one or two species were missing from observation. Encountered birds were recorded, most of the time, in a flock of four up to ten or more individuals. This flock was not only formed by small sized parrots but also larger size such as Cockatoo or Eclectus Parrot. They foraged on the fruiting trees and usually perched at the top of canopy.

Bucerotidae

Blyth's Hornbill (*Rhyticeros plicatus*) is the only member of Bucerotidae that present in Moluccas and it occurs from Moluccas to Papua. Blyth's Hornbill was found in a flock of 15 individuals at Ake Jira. They were perching and foraging on the fruiting fig tree next to the river. On the other occasion they were usually seen flying alone or in a pair. This hornbill was not encountered in Boki Mekot.

Pittidae

Three species of Pittas are present on the Moluccas archipelago from which one of them, Elegant Pitta (*Pitta elegans*), occurs from Sulawesi down to Lesser Sunda. The North Moluccan record of Elegant Pitta came from the neighbouring island, Ternate, and, up to now, none of them had ever been observed on Halmahera. Therefore, none of this in-

dividual was put up on the record list. Whereas two other species, Red-bellied Pitta (*Pitta erythrogaster*) and Ivory-breasted Pitta (*Pitta maxima*), were observed on the area.

A Red-bellied Pitta was caught in the mistnet over a small hill close to the Wosea River. It was the only record for this species as neither sound nor sight was made afterwards. An Ivory-breasted Pitta was also caught in Ake Jira. Unlike Red-belied Pitta, Ivory-breasted Pitta was rather vocal birds. Most observation of its presence was based on calls. One individual was seen perching at fallen logs holding worm on its beak at Tofu Blewen. Another individual was seen at Boki Mekot.

Meliphagidae

Two species of Meliphagidae, White-streaked Friarbird (*Melitograis gilolensis*) and Dusky Myzomela (*Myzomela obscura*), were recorded at Ake Jira, Tofu Blewen and Boki Mekot. The latest was common all over the area, although, it was not observed in Wosea. They were usually foraging on the flowers in the canopy together with the sunbird. Like sunbird, they sometimes flew down to middle stratum where some of them were caught in the mistnets at Tofu Blewen.

White-streaked Friarbird is the endemic genus of Friarbirds in Halmahera. Other Friarbird from another genus occurs in North Moluccas is Dusky Friarbird (*Philemon fuscicapillus*). This species is also endemic to North Moluccas but occurs only in Morotai Island, north tips of Halmahera.

White-streaked Friarbird was rather common at survey sites. Some of the sightings were made at Ake Jira where a pair foraging around the bushes down to the ground. Whereas another pair, still at Ake Jira, was observed flying back and forth from a tree to another the opposite next to the road. In Tofu Blewen, a pair of White-streaked Friarbird was caught on mist-net at the forest edge.

Oriolidae

There is only one species of oriole present in Halmahera i.e. Dusky Oriole (*Oriolus phaeochromus*) which is endemic to this island, while the other orioles occur in South Moluccas. They are common birds which can be found at all sites. Like other oriole, Dusky Oriole is vocal bird and usually takes higher up on the canopy.

Paradisidae

From about forty-three species of birds of paradise that are mainly present in Papua island and Australia, two endemic genera of birds of paradise are disjunctly inhabited North Moluccas skipping South Moluccas due to the tectonic action in the past (Heads 2002). They are Standardwings Birds of Paradise (*Semioptera wallacei*) and Paradise Crow (*Lycocorax pyrrhopterus*).

Both species were found in all sites but Standardwings was absent in Wosea. They usually flew in flock of two to four of each species. These species were rather common and could be present from secondary forest to primary forest. BirdLife surveys showed that Paradise Crow and Standardwing were the most fifth and sixth frequently recorded passerine on Halmahera (Frith & Poulsen 1999). They were found both at primary and logged forest, and their density were c. 0.4 birds per ha (Frith & Poulsen 1999).

Mist-netting and Observation Records

Current research indicated that from a total numbers of recorded birds, data obtained from direct observation were of the most prominent than those of mist-netting. Mist-netting could only cover around 41 % of total birds recorded meanwhile observation yielded 92%. Although mist-nettings have been used many decades for counting relative abundance, some disadvantages occur that the proportion of avian community examined were restricted to many factors (Remsen & Good 1996). Capture rates

as the basic information may have been different according to forest structure, community structures or season. Moreover, this methods were suited for specific and long term monitoring such as understorey communities and demography studies (Redfern & Clark 2001). Nonetheless, using mist-nets allowed us to get species that skulk around bushes, shrubs or nocturnal birds that normally difficult to be observed such members from Kingfishers family and Moluccan Owlet-nightjar (*Aegotheles crinifrons*). Mist-nets data from current study were not suitable to be incorporated onto abundance assessment rather than complementary effort for inventory, collecting specimens and samples for molecular works.

Bird Communities

The observed bird species and index of species richness on every habitat types were relatively similar (Table 1). Nevertheless, the results showed the indication that bird diversity at Tofu Blewen and Ake Jira was slightly higher than other locations.

Table 1. Comparison of observed species richness, Shannon diversity index and Shannon Eveness

NOMINATOR	WOSEA	AKE JIRA	TOFU BLEWEN	BOKI MEKOT
Species Richness	41	48	50	37
Family Richness	23	25	24	21
Shannon	2.54	2.63	2.64	2.52
Eveness	0.95	0.93	0.94	0.96

While the overall communities did not show the significant differences betwen sites, rarefaction function showed that expected number of species could reach the plateu as the numbers of birds increase (Figure 4). From this plots, it was seen that the birds diversity in Tofu Blewen was higher and it seemed that the number of species still increase. Bird diversity in Ake Jira was less rich compare to Tofu Blewen and it almost reached the plateu already compared to bird communitiy in Tofu Blewen. Similar trend was showed in Boki Mekot. While the point counts was differ for only three points, expected numbers of species were far less as the number of birds counts were fewer than those in Tofu Blewen and Ake Jira. Interesting results was shown in Wosea.

Although number of point counts were only nine and the number of expected species was the lowest, the rarefaction plots showed that the birds richness in Wosea could be higher. The rarefaction plot did not reach the plateu yet as the other three sites and the expected number was just a little higher than in Boki Mekot. This results gave the indication that Wosea as the lowland area could contained the most diverse birds communites if the habitat were still intact.

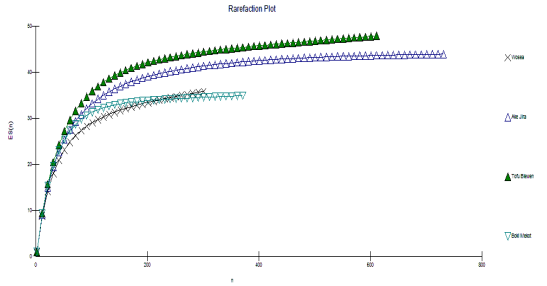


Figure 4. Rarefaction plot showed the expected species as function of numbers of birds counts

Several species demonstrated the tendency of changed in abundance towards the gradient of altitude despite of low correlation values. Three species of parrots: White Cockatoo (*Cacatua alba*), Eclectus Parrot (*Eclectus roratus*) and Red-cheeked Parrot (*Geoffroyus geoffroyi*) decreased in numbers as the altitude increasing (R^2=0.25, R^2=0.16, R^2=0.12, $p<0.05$, respectively). The other species that showed similar trend were Dusky Megapode (*Megapodius freycinet*) (R^2=0.31, $p<0.05$) and Blyth's Hornbill (*Rhyticeros plicatus*) (R^2=0.11, $p<0.05$). On the other hand some species increased in abundance towards the higher elevation. Superb Fruit Dove (*Ptilinopus superbus*) showed positive relationship in high altitude (R^2=0.20, $p<0.05$). Standardwing (*Semioptera* wallacei), Spectacled Imperial Pigeon (*Ducula perspicillata*) and Ivory-

breasted Pitta (*Pitta maxima*) showed similar trend as Superb Fruit Dove.

Shared species varied between sites (Figure 5). The biggest numbers of shared species were shown between Ake Jira - Tofu Blewen and Tofu Blewen – Boki Mekot which more than 50% of species were present at each sites. However, less than half of the species from Tofu Blewen and Boki Mekot were similar to those in Wosea.

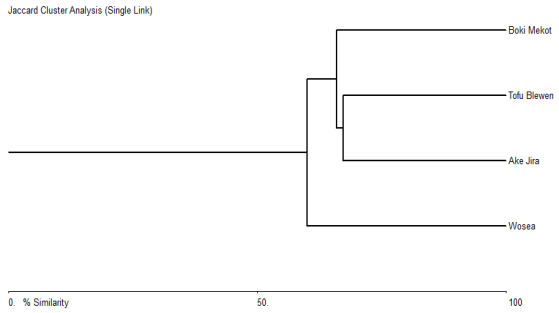


Figure 5. Shared species across survey sites. Wosea showed less similar communities in comparison to the other three sites

Breeding and Migratory Birds

Some species were observed to have eggs on their nest such as Willy Wagtail and Spangled Drongo. One specimen of female Scarlet-breasted Fruit Dove still had an egg on its reproductive tracks. However, other species were still at the stage of building nest such as Red-cheeked Parrots. Several recruits were recorded to join the flock, especially, from the group of monarchs and flycatchers such as Spectacled Monarch (*Monarcha trivirgatus*) and Shinning Monarch (*Myiagra alecto*).

The recent records of migratory birds in Halmahera were scarce. If it was available, it could probably be based on the migratory waterbirds. However, since these surveys did not cover coastal and swampy area, the chance to records them was none. However, two migratory passerine, one kingfisher and at least one species of raptor were detected in Wosea, Ake Jira, Tofu Blewen and Boki Mekot. An invidual of Yellow Wagtail (*Motacilla flava*) was recorded both in Ake Jira and Tofu Blewen and the individual from Ake Jira was caught on the mist-net. A Common Kingfisher (*Alcedo atthis*) was trapped on the mist-net at Wosea. Grey-streaked Flycatchers (*Muscicapa griseisticta*) were frequently seen on the open area of Tofu Blewen and Boki Mekot.

Conservation and Threat

Bird communities in Central and Eastern Halmahera were the most abundant and diverse at the lowland. Some species were declining in numbers as the elevation increased. However, immediate threats were very apparent at the lowland for example the land clearing in Wosea area. Deliberate land clearing had taken place just recently around the rivers. These activities obviously pushed the birds moving upstream where the forest was still in good condition. Therefore, the number of birds being observed was low compare to Ake Jira which had similar landscape and vegetation features. Moreover, habitat disturbance in Wosea negatively influenced the presence of birds with specific status such as endemic and threatened species. Endemic species observed in Wosea were only half of numbers of other sites.

The loss of fruiting trees showed immediate impact on bird communities in this area especially during breeding season where birds need more food either for reproduction or rearing chicks. In the long term, forest ecosystem will suffer from the lack of seeds dispersal agents by which, in some degree, can speed up forest regeneration. This situation was best explained by the birds' community in Ake Jira where many birds, especially the frugivores such as Parrots, Hornbill, Doves and Pigeons, congregated on Figs and other fruiting trees.

On the other places such as Tofu Blewen and Boki Mekot, fruiting trees might also be strong factors for bird's richness and distribution. If the forest was good, undulating landscapes and higher altitude influenced the vegetation communities. The rarity of fruiting trees due to, possibly, altitudinal effect,

might have the role to restrict the size of frugivores flocks. Since Halmahera was formed by different type of rock formation, it influenced the vegetation structures as such rainforest on ultrabasic rock appeared to be impoverished in comparison with rainforest on other rock formations, in particular supporting very low numbers of two species of threatened parrot (Poulsen & Lambert 1999).

Whilst the frugivores less numerous in Tofu Blewen and Boki Mekot, the diversity in bird of preys was the opposite. Primary forest in the hill and mountainous area were safe heaven for raptors for nesting and roosting due to the difficulty of being raid by nest raiders. Many records showed that raptors, especially large species such as Black Eagle and Gurney's Eagle, usually take the upper branch on trees that grow on steep hills for nesting. High place was also meant that they would get enough warm air and height for long-distance flying, either for migrating or searching food.

Some birds of Halmahera especially parrot were the most aftersought birds for market. In the past, White Cockatoo, Chattering Lory (*Lorius garrulus*) and Violet-eared Lory (*Eos squamata*) were the most psittacine pet in the North Moluccas for both domestic and international trade (Lambert 1993). Since the outbreak the Avian Influenza, legal international trade were stopped so birds from this area were mostly trade for domestic market although many of them were still smuggled to other country. Although during fieldwork, no hunting activities were observed, according to locals parrots were still the main target for bird collectors especially for cockatoo. Hunters would observe the nesting tree and collected either the young or adult birds. Nowadays, the level of hunting may have decrease due to stronger law enforcement applied by the police.

Conservation action is the best applied both for slowing the rate of forest conversion and stop illegal trading of parrots and other birds. Land conversion for mining, plantation and logging will diminish all forest resources needed by birds and other animals. In addition, it will also influence the hydrology of the island since good forests were almost around the riparian area. Appropriate habitat management were strongly needed and urgent to be applied in Halmahera since many stakeholders both goverment and private have their agenda to exploit the land for short-term profit. Threats from hunting would give immediate impact on bird populations and in the long term, combine with land conversion, local extinction could be predicted. It will need a lot of effort and energy by all stakeholders and local communities to prevent biodiversity loss by well land management and strong law enforcement.

Conclusion

Bird communities in Central and East Halmahera were considerably rich. All study sites showed similar trend of bird diversity, however, disturbed and high elevation area showed less diversity. Several species, especially parrots, showed signicant relationship with elevation gradient where the abundance would decrease as the altitude increase. Migratory birds and breeding birds were detected in several sites. Threats to birds of Halmahera mainly come from land conversion to mining, cultivation and logging. Hunting activities were not observed but it still goes on by the locals. Conservation action should focus on reducing land conversion and hunting to prevent biodiversity loss in Halmahera, especially at the lowland area.

ACKNOWLEDGEMENTS

Birds survey was part of biodiversity assesment in Weda Bay Nickel (WBN) concession area. I would like to thanks to Mr. Gavin (WBN) for facilitating the surveys. Thank you to Dr. Gono Semiadi (Museum Zoologicum Bogoriense, LIPI) as a coordinator of biodiversity surveys. Bapak Alwin Marakarmah (MZB-LIPI) for preparing specimens. Bapak Melky for helping in the field. Lastly, thanks to all field staff of Weda Bay Nickel.

REFERENCE

Bibby, C., M. Jones, S. Marsden. 1998. Expedition Field Techniques: Bird Surveys. London: Royal Geographic Society.

BirdLife International. 2003. Saving Asia's Threatened Birds: A Guide for Government and Civil Society. Cambridge, UK: BirdLife International.

Coates, B.J., K.D. Bishop. 1997. A Guide to The Birds of Wallacea: Sulawesi, the Moluccas and the Lesser Sunda Islands, Indonesia. Alderley, Queensland, Australia: Dover Publications.

Dickinson, E.C. (editor). 2003. The Howard and Moore Complete Checklist of the Birds of the World. 3rd Edition. London: Christopher Helm.

Frith, C.B.,M.K. Poulsen. 1999. Distribution and Status of the Paradise Crow Lycocorax pyrrhopterus and Standardwing Bird of Paradise Semioptera wallacii, with Notes on Biology and Nidification. Emu, 99(4) 229 – 238.

Heads, M. 2002. Birds of paradise, vicariance biogeography and terrane tectonic in New Guinea. Journal of Biogeography, 29: 261-283.

Kuroda, N. 1938. A Collection of Birds from Halmahera and North Celebes. Tori, (X) 47: 113-126.

Lambert, F.R. 1993. Trade, status and management of three parrots in the North Moluccas, Indonesia: White Cockatoo *Cacatua alba*, Chattering Lory *Lorius garrulus* and Violet-eared Lory *Eos squamata*. Bird Conservation International 3:145-168.

Mees, G.F. 1982. Bird Records From The Moluccas. Zoologische Mededelingen, (56) 7: 91-111.

Nur, N., S.L. Jones, G.R. Geupel. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Department of the Interior, Fish and Wildlife Service, BTP-R6002-1999, Washington, D.C.

Redfern, C.P.F & Clark, J.A. 2001. Ringers' Manual. BTO, Thetford.

Remsen, J.V. Jr., D.A. Good. 1996. Misuse of data from mist-net captures to assess relative abundance of bird population. Auk, 113: 381-398.

Sokal, R.R., F.J. Rohlf. 1995. Biometry: The Principles And Practice Of Statistic In Biological Research. New York: W.H. Freeman & Company.

SPSS Inc. 2002. SPSS for Windows Release 11.5.0.

Stattersfield, A., M.J. Crosby, A.J. Long,D.C. Wege. 1998. Endemic Bird Areas of the World: Priorities for Biodiversity Conservation. BirdLife Conservation Series No. 7. Cambridge, UK.

Sukmantoro, W. M. Irham, W. Novarino, F. Hasudungan, N. Kemp, M. Muchtar. 2007. Daftar Burung Indonesia No. 2. Indonesian Ornithologists' Union. Bogor.

Van Bemmel, A.C.V, K.H. Voous. 1953. Supplement to the faunal list of the birds of the Molucca Islans. Beaufortia 32: 1-7.

Whitten, T., J. Supriatna, R. Saryanthi, P. Wood. 2005. Wallacea in R.A. Mittermeier, P. Robles Gil, M. Hoffmann, J. Pilgrim, T. Brooks, C. Goettsch Mittermeier, J. Lamoreux, and G.A.B. da Fonseca. 2005. Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Cemex Books on Nature No. 2.

Appendix 1. Checklist of birds observed in the region around Weda Bay up to East Halmahera (W: Wosea, AJ: Ake Jira, TB: Tofu Blewen, BM: Boki Mekot, D: Distribution, N: Migratory, EH: Endemic of Halmahera, E: Endemic of Indonesia, I: IUCN status, C: CITES status, RI: Indonesian protected status, A: UU No.5/1990, B: PP No. 7/1999, C: PP No.8/1999)

No	Species	Indonesia	English	Locations				D	I	C	RI
				W	AJ	TB	BM				
	Accipitridae										
1	*Pandion haliaetus* (Linnaeus, 1758)	Elang Tiram	Osprey	P				N		II	AB
2	*Haliastur indus* (Boddaert, 1783)	Elang Bondol	Brahminy Kite		P	P				II	AB
3	*Accipiter soloensis* (Horsfield, 1821)	Elangalap Cina	Chinese Sparowhawk			P		N		II	AB
4	*Accipiter henicogrammus* (G.R. Gray, 1860)	Elangalap Halmahera	Moluccan Goshawk	P	P	P	P	EH		II	AB
5	*Ictinaetus malayensis* (Temminck, 1822)	Elang Hitam	Black Eagle			P				II	AB
6	*Aquila gurneyi* G.R. Gray, 1860	Rajawali Kuskus	Gurney's Eagle			P			NT	II	AB
	Falconidae										
7	*Falco moluccensis* (Bonaparte, 1850)	Alapalap Sapi	Spotted Kestrel	P						II	AB
	Anatidae										
8	*Tadorna radjah* (Lesson, 1828)	Umukia Raja	Raja Shelduck		P						
	Megapodidae										
9	*Megapodius freycinet* Gaimard, 1823	Gosong Kelam	Dusky Megapode	P	P			E			AB
	Columbidae										
10	*Ptilinopus bernsteinii* (Schlegel, 1863)	Walik Dada-merah	Scarlet-breasted Fruit Dove	P	P	P	P	EH			
11	*Ptilinopus superbus* (Temminck, 1810)	Walik Raja	Superb Fruit Dove			P	P				
12	*Ptilinopus hyogastra* (Temminck, 1824)	Walik Kepala-kelabu	Grey-headed Fruit Dove		P	P	P	EH			
13	*Ducula perspicillata* (Temminck, 1824)	Pergam Mata-putih	Spectacled Imperial Pigeon		P	P	P	E			
14	*Ducula basilica* Bonaparte, 1854	Pergam Boke	Cinnamon Imperial Pigeon	P	P	P	P	EH			
15	*Ducula bicolor* (Scopoli, 1786)	Pergam Laut	Pied Imperial Pigeon		P	P	P				
16	*Macropygia amboinensis* (Linnaeus, 1766)	Uncal Ambon	Brown Cuckoo Dove	P	P	P	P				
17	*Streptopelia chinensis* (Scopoli, 1786)	Tekukur Biasa	Spotted Dove	P							
18	*Chalcophaps indica* (Linnaeus, 1758)	Delimukan Zamrud	Common Emerald Dove	P	P	P					

No	Species	Indonesia	English	Locations				D	I	C	RI
				W	AJ	TB	BM				
	Psittacidae										
19	*Eos squamata* (Boddaert, 1783)	Nuri Kalung-ungu	Violet-necked Lory		P	P		E		II	
20	*Lorius garrulus* (Linnaeus, 1758)	Kasturi Ternate	Chattering Lory		P	P	P	EH	EN	II	
21	*Cacatua alba* (P. L. S. Müller, 1776)	Kakatua Putih	White Cockatoo	P	P	P		EH	VU	II	
22	*Eclectus roratus* (P. L. S. Müller, 1776)	Nuri Bayan	Eclectus Parrot	P	P					II	AB
23	*Geoffroyus geoffroyi* (Bechstein, 1811)	Nuri Pipi-merah	Red-cheeked Parrot	P	P	P	P			II	
24	*Tanygnathus megalorynchos* (Boddaert, 1783)	Betetkelapa Paruh-besar	Great-billed Parrot		P					II	
25	*Alisterus amboinensis* (Linnaeus, 1766)	Nuriraja Ambon	Moluccan King Parrot	P	P	P	P	E		II	
26	*Loriculus amabilis* Wallace, 1862	Serindit Maluku	Moluccan Hanging Parrot	P	P	P	P	E		II	
	Cuculidae										
27	*Cuculus saturatus* Blyth, 1843	Kangkok Ranting	Oriental Cuckoo	P				N			
28	*Surniculus lugubris* (Horsfield, 1821)	Kedasi Hitam	Asian Drongo-Cuckoo			P					
29	*Centropus goliath* Bonaparte, 1850	Bubut Goliath	Goliath Coucal		P	P		EH			
	Strigidae										
30	*Ninox squamipila* Bonaparte, 1850	Pungguk Maluku	Moluccan Boobook				P	E		II	
	Aegothelidae										
31	*Aegotheles crinifrons* Bonaparte, 1850	Atoko Maluku	Moluccan Owlet-Nightjar				P	E			
	Caprimulgidae										
32	*Caprimulgus macrurus* Horsfield, 1821	Cabak Maling	Large-tailed Nightjar	P							
	Apodidae										
33	*Collocalia fuciphagus* Thunberg, 1821	Walet Sarang-putih	Edible-nest Swiftlet	P							
34	*Collocalia esculenta* (Linnaeus, 1758)	Walet Sapi	Glossy Swiftlet	P	P	P	P				
	Hemiprocnidae										
35	*Hemiprocne mystacea* Lesson, 1827	Tepekong Kumis	Moustached Treeswift	P	P	P	P				

No	Species	Indonesia	English	Locations				D	I	C	RI
				W	AJ	TB	BM				
	Alcedinidae										
36	*Alcedo atthis* (Linnaeus, 1758)	Rajaudang Erasia	Common Kingfisher	P							AB
37	*Alcedo azurea* Latham, 1801	Rajaudang Biru-langit	Azure Kingfisher	P							AB
38	*Ceyx lepidus* Temminck, 1836	Udangmerah Kerdil	Chameleon Dwarf Kingfisher	P	P						AB
39	*Halcyon diops* Temminck, 1824	Cekakak Biru-putih	Blue-and-white Kingfisher			P		EH			B
40	*Tanysiptera galatea* G. R. Gray, 1859	Cekakakpita Biasa	Galatea Paradise Kingfisher	P	P	P					AB
	Bucerotidae										
41	*Rhyticeros plicatus* J. R. Forster, 1781	Julang Irian	Blyth's Hornbill	P	P	P				II	AB
	Pittidae										
42	*Pitta erythrogaster* Temminck, 1823	Paok Mopo	Red-bellied Pitta	P							AB
43	*Pitta maxima* Müller & Schlegel, 1846	Paok Halmahera	Ivory-breasted Pitta		P	P	P	EH			AB
	Hirundinidae										
44	*Hirundo tahitica* Gmelin, 1789	Layanglayang Batu	Pacific Swallow	P	P						
	Motacillidae										
45	*Motacilla flava* Linnaeus, 1758	Kicuit Kerbau	Western Yellow Wagtail		P	P					
	Camphepagidae										
46	*Coracina papuensis* (Gmelin, 1788)	Kepudangsungu Kartula	White-bellied Cuckooshrike	P	P	P					
47	*Coracina tenuirostris* (Jardine, 1831)	Kepudangsungu Miniak	Common Cicadabird	P	P	P	P				
48	*Lalage aurea* (Temminck, 1827)	Kapasan Halmahera	Rufous-bellied Triller					EH			
	Pycnonotidae										
49	*Thapsinillas affinis* (Hombron & Jacquinot, 1841)	Brinji Emas	Golden Bulbul	P	P	P	P	E			
	Muscicapidae										
50	*Muscicapa griseisticta* (Swinhoe, 1861)	Sikatan Burik	Grey-streaked Flycatcher			P	P				

No	Species	Indonesia	English	Locations				D	I	C	RI
				W	AJ	TB	BM				
	Monarchidae										
51	*Monarcha pileatus* Salvadori, 1878	Kehicap Tengkuk-putih	White-naped Monarch	P	P	P	P	E			
52	*Monarcha trivirgatus* (Temminck, 1826)	Kehicap Kacamata	Spectacled Monarch	P	P	P	P				
53	*Myiagra galeata* G. R. Gray, 1860	Sikatan Kelabu	Moluccan Flycatcher			P	P	E			
54	*Myiagra alecto* (Temminck, 1827)	Sikatan Kilap	Shining Flycatcher	P	P	P	P				
	Rhipiduridae										
55	*Rhipidura leucophrys* (Latham, 1801)	Kipasan Kebun	Willie-wagtail	P	P						
56	*Rhipidura rufifrons* (Latham, 1801)	Kipasan Dada-hitam	Rufous Fantail		P	P	P				
	Pachycephalidae										
57	*Pachycephala phaionotus* (Bonaparte, 1850)	Kancilan Pulau	Island Whistler	P	P	P	P	E			
58	*Pachycephala pectoralis* (Latham, 1801)	Kancilan Emas	Australian Golden Whistler	P	P	P	P				
	Nectarinidae										
59	*Leptocoma sericea* (Lesson, 1827)	Burungmadu Hitam	Black Sunbird	P	P	P	P				AB
60	*Cinnyris jugularis* (Linnaeus, 1766)	Burungmadu Sriganti	Olive-backed Sunbird	P							AB
	Zosteropidae										
61	*Zosterops atriceps* G. R. Gray, 1860	Kacamata Halmahera	Cream-throated White-eye			P	P	EH			
	Meliphagidae										
62	*Myzomela obscura* Gould, 1843	Myzomela Remang	Dusky Myzomela			P	P				AB
63	*Melitograis gilolensis* (Bonaparte, 1850)	Cikukua Halmahera	White-streaked Friarbird		P	P		EH			AB
	Ploceidae										
64	*Passer montanus* (Linnaeus, 1758)	Burunggereja Erasia	Eurasian Tree Sparrow		P						

No	Species	Indonesia	English	Locations				D	I	C	RI
				W	AJ	TB	BM				
	Sturnidae										
65	*Aplonis mysolensis* (G. R. Gray, 1862)	Perling Maluku	Moluccan Starling			P		E			
	Oriolidae										
66	*Oriolus phaeochromus* G. R. Gray, 1861	Kepudang Halmahera	Dusky-brown Oriole	P	P	P	P	EH			
	Dicruruidae										
67	*Dicrurus bracteatus* Gould, 1843	Srigunting Lencana	Spangled Drongo	P	P	P	P				
	Paradisidae										
68	*Lycocorax pyrrhopterus (*Bonaparte, 1850)	Cendrawasih Gagak	Paradise-crow	P	P	P	P	EH		II	ABC
69	*Semioptera wallacei* (G. R. Gray, 1859)	Bidadari Halmahera	Standardwing		P	P	P	EH		II	ABC
	Corvidae										
70	*Corvus validus* Bonaparte, 1850	Gagak Halmahera	Long-billed Crow	P	P	P	P	EH			

DIVERSITY AND ROOSTING CHARACTERISTIC OF BATS IN BUNI AYU CAVE, SUKABUMI LIMESTONE AREA, WEST JAVA

Sigit Wiantoro

Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences
Widyasatwaloka Building, Jl. Raya Jakarta-Bogor Km. 46, Cibinong 16911, Indonesia
E-mail: *wiantoro@gmail.com*

ABSTRAK

Wiantoro, S. 2012. Penelitian keanekaragaman dan karakteristik tempat bertengger kelelawar di Gua Buni Ayu, Desa Cipicung, Kecamatan Nyalindung, Kabupaten Sukabumi, Jawa Barat. *Zoo Indonesia* 21(1), 33-37. *Penelitian keanekaragaman dan karakteristik tempat bertengger kelelawar di Gua Buni Ayu, Desa Cipicung, Kecamatan Nyalindung, Kabupaten Sukabumi, Jawa Barat dilakukan untuk mengetahui keanekaragaman jenis kelelawar dan karakter spesifik tempat bertenggernya. Metode yang digunakan dalam penelitian ini antara lain jaring kabut, jaring bertangkai dan observasi. Selain itu, pengukuran suhu dan kelembaban relatif juga diukur di setiap tempat bertengger. Dari penelitian ini diketahui sebanyak 504 individu kelelawar yang terdiri dari empat jenis yaitu Hipposideros diadema, Hipposideros galeritus, Rhinolophus affinis dan Miniopterus magnater berada di Gua Buni Ayu. Bentuk fisik lorong gua diketahui merupakan faktor penting yang mempengaruhi jenis-jenis kelelawar dalam menentukan tempat bertenggernya. Rerata suhu udara berkisar antara 26.67-28.46 ^{0}C, sedangkan kelembaban udara berkisar antara 81.5-84.48%. Perbedaan suhu dan kelembaban udara yang relatif kecil tersebut tidak mengindikasikan adanya pengaruh terhadap perilaku pemilihan tempat bertengger di Gua Buni Ayu dan kisaran tersebut masih dalam kisaran normal bagi kelelawar untuk tetap bisa bertahan hidup.*

Kata Kunci: *Kelelawar, tempat bertengger, gua, Buni Ayu*

ABSTRACT

Wiantoro, S. 2012. A study on the diversity and roosting characteristic of bats in Buni Ayu Cave, Cipicung village, Nyalindung District, Sukabumi, West Java. *Zoo Indonesia* 21(1), 33-37. *A study on the diversity and roosting characteristic of bats in Buni Ayu Cave, Cipicung village, Nyalindung District, Sukabumi, West Java was conducted to see if there were any specific characteristics of species' roosting sites. Misnetting, hand collecting and observations were used to identify species and observe their roosting sites. Temperature and relative humidity was recorded at each roost site. A total of 504 individuals from four species of bats were recorded. The species were Hipposideros diadema, Hipposideros galeritus, Rhinolophus affinis and Miniopterus magnater. The physical shape of the cave passage was found to be the main factor for the choice of a roosting site. Microclimate results showed that the mean air temperature was around 26.67-28.46 ^{0}C and the relative humidity was 81.5 to 84.48 %. The small range in the temperature and relative humidity indicated that they did not influence the roosting behavior and were within the range shown to be suitable for bats.*

Keywords: *bats, roosting, cave, Buni Ayu*

INTRODUCTION

Buni Ayu Cave is one of the tourist attractions of the Sukabumi limestone area. Administratively, this cave is located in Cipicung Village, Nyalindung District, Sukabumi Regency, West Java Province. The presence of bats in the cave is one of the features for cave tourism as well as cave ornaments such as stalactites, stalagmites and gordyns.

Ecologically, bats have an important role inside as well as outside of the cave ecosystems. The bat faeces (guano) is a primary source of food for organism in the cave and contains a rich source of nutrients for obligate invertebrate cave inhabitants (Welbourn 1999). Guano is one of the best fertilizers for agricultural crops because it has organic material which is rich in phosphates and nitrates (Werner &

Dindal 1987). Bats have also an important role in the ecosystem outside of the cave. Insectivorous bats are one of the primary predators for night-time insects including some that are potential pests, and bats are regarded as controlling agents for regulating insect populations (Kunz 1998). In addition, fruit bats which are also found in the area, and that choose fruit, nectar and pollen as their food, also have an important role as seed disperser and pollinator, and play an important part in the forest ecosystem (Nowak 1995).

Many bat species are obligate cave-dwellers and the existence of caves is needed for these bats as roosting sites. More than half of Indonesian microchiropterans choose caves as their roosting area (Suyanto 2001). Bats that roost in caves also chose caves as nursery sites. They leave their babies inside the cave when they go out to feed at night (Nowak 1995).

Previously it seems that no published report about the bats in Buni Ayu Cave. This has caused a lack of information on their diversity and population numbers, which is necessary for manage this tourist cave. The objective of this study was to see if different species of bats selects its preferable roosting place within the cave, and species count and its individual number encountered in the cave.

RESEARCH METHODS

Study area

The study was conducted in Buni Ayu Cave, Sukabumi Limestone area, West Java (S 07°02'08.3" E 106°54'20.5") (Figure 1). Administratively, this cave is located in Cipicung Village, Nyalindung District, Sukabumi Regency, West Java Province. This cave is also known as Cipicung Cave. Buni Ayu Cave is a long horizontal cave which has three passages (total length of approx. 1500 m) with various chambers and a river system (Figure 1).

Diversity of bats

The diversity of bats in Buni Ayu Cave was surveyed using three methods: mistnetting, hand

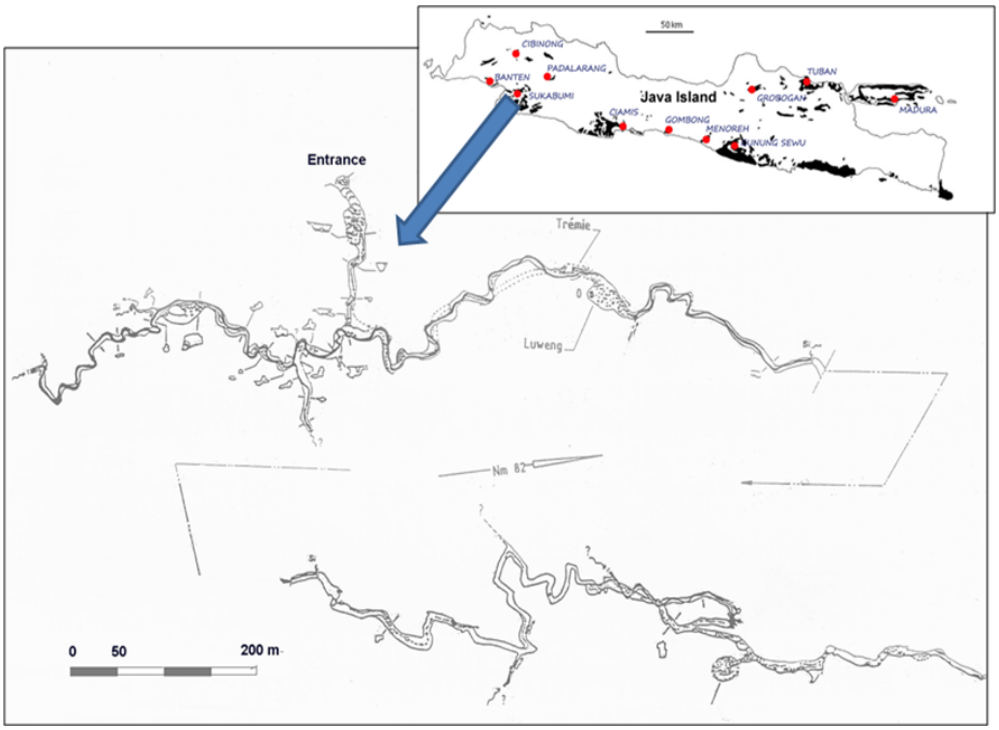


Figure 1. Map of the Buni Ayu Cave in Sukabumi limestone area, West Java

collecting, and observation. A mist net (two ply polyester 75d with 31 mm mesh size; 2.7 m in height; 12 m in lengths) was set up in front of the cave at the commencement of the bat fly out at 1730 hours and maintained until 2000 hours. Hand collecting using a long-handled net was used to collect bats at their roosting site inside the cave. Observations using bright headlamps were used to locate the position of roost sites and to estimate the population numbers for each species. Body measurements of captured bats were taken using a digital caliper for variables of weight (W), head and body length (HB), tail length (T), ear length (E), tibia length (Tb), forearm length (FA) and hind foot length (HF). Sex and age were also determined. Specimens were identified and deposited in the Museum Zoologicum Bogoriense (MZB)-LIPI.

Roost characteristics

Characteristic features for the roost site for all species were recorded by measuring the physical dimentions and microclimate parameters in each roost. Physical parameters measured were the width and height of the cave passage, while the microclimate recording were air temperature and humidity.

RESULTS AND DISCUSSION

A total of 504 individuals, comprising four species from three families of bats were recorded in the cave. All four species were members of the microchiroptera (Table 1). All microchiropterans have the ability to echolocate and use this ability to navigate, forage for food and occupy a niche where there are many insect available for their prey (Hill & Smith 1984). This ability to echolocate also gives them capability to choose their roosts in an area of total darkness, such as caves.

Species Accounts

***Hipposideros diadema* (E. Geoffroy, 1813) (Diadem Leaf-nosed Bat)**

Body measurements: W 48-71 gram, HB 85.49-95.90 mm, E 23.75-30.65 mm, FA 80.80-89.65 mm, Tb 34.52-37.91 mm, HF 17.99-25.70 mm, T 44.47-52.03 mm.

Roosting characteristic: Colonies of this species occupied big chambers which have the widest and highest passages in the cave. A previous study of this species on Bismarck Island recorded that this species roosted in a big chamber inside the cave (Werner & Dindall 1987). *H. diadema* is one of the largest microchiropterans which may require more space for a roosting site. The air temperature at the roost sites ranged from 25.3-28.2^{o}C, whereas the humidity ranged from 76-89%. These microclimate parameters are within the optimum microclimate for a bat suggested by Kunz (1998).

Note: This species has wide range of distribution start from Burma and Vietnam through Thailand, Laos, W Malaysia and Indonesia (including Sumatra, Borneo, and Bali) to New Guinea, Bismarck Arch., Solomon Isls and NE Australia; Philippines; Nicobar Isls.

Tabel 1. List of bat species and the estimation of population size in Buni Ayu Cave

Family	Species	∑ Colony	Population estimation (indv)
Hipposideridae	*Hipposideros diadema*	3	300
	Hipposideros galeritus	2	49
Rhinolophidae	*Rhinolophus affinis*	3	108
Vespertilionidae	*Miniopterus magnater*	3	47
TOTAL		11	504

***Hipposideros galeritus* Cantor, 1846**
(Cantor's Leaf-nosed Bat)

Body measurements: W 7-9 gram, HB 49.08-53.02 mm, E 11.59-12.19 mm, FA 50.36-52.07 mm, Tb 20.86-21.50 mm, HF 6.94-7.38 mm, T 37.29-43.90 mm.

Roosting characteristic: *H. galeritus* is much smaller than *H. diadema*. This species roosted in cave passages which were wider compared to the roosting area of *R. affinis* and *M. magnater*, but had a lower roof compared to the roosting site of *H. diadema*. The width of passage ranged from 6-15 m and the roof height ranging from 1-1.5 m. The air temperature and humidity of this species' roosts were slightly higher but in the same range as measured for *H.diadema*.

Note: distribution of this species start from Sri Lanka and India through SE Asia (including Burma, Thailand, and Peninsular Malaysia) to Java and Borneo; Sanana Isl (Sula Group, Moluccas Isls).

***Rhinolophus affinis* Horsfield, 1823**
(Intermediate Horsheshoe Bat)

Body measurements: W 13-18 gram, HB 49.52-59.08 mm, E 18.62-21.34 mm, FA 51.67-54.72 mm, Tb 23.37-25.27 mm, HF 9.83-11.00 mm, T 19.92-26.45 mm.

Roosting characteristic: In Buni Ayu Cave, three colonies of this species were found in narrow passages with a low roof. The width and height of the passages that were used by this species was almost the same as the roosting sites of *M. magnater*, but observations showed that the roosts of *R. affinis* contained a lot of cave ornaments in the roosting sites, such as stalagtites. A lot of individuals roosted in the spaces between the cave ornaments and some bats roosted on the tip of the stalagtites. This species is known to have a slow flight speed with high maneuver ability (Hill & Smith 1984), so this would favour the species easily roosting in the narrower passages with a lot of obstacles.

The temperature and humidity of the roosts for this species were in the same range as measured for other species (Table 2).

Note : distribution of this species start from India and Nepal to S. China and Vietnam, through Malaysia to Borneo and Lesser Sunda Isls; Andaman Isls (India); perhaps Sri Lanka.

***Miniopterus magnater* Sanborn, 1931**
(Western Long-fingered Bat)

Body measurements: W 12-17 gram, HB 50.75-63.6 mm, E 9.4-10.42 mm, FA 48.76-51.65 mm, Tb 20.35-23.13 mm, HF 9.26-10.91 mm, T 53.95-63.34 mm.

Roosting characteristic: Roosting sites of this species were almost the same as with the roosting sites of *R. affinis*. It differs for *M. magnater* by having no cave ornaments such as stalactites. Some individuals of this species roosted in crevices at their roosting sites. Members of the genus *Miniopterus* are known as fast flyers with low maneuverability. So, this species prefers to choose cave passages with no cave ornaments as their roosting site.

Temperature and humidity of the roost sites for this species was in a similar range to those recorded for the other three species (Table 2).

Note: distribution of this species start from NE India, SE China, Burma, Thailand, Laos, and Vietnam to Malaysia, Sumatra, Java, Timor (Indonesia), Borneo, Moluccas, and New Guinea including the Bismarck Arch.

Bats need a roosting site which has a suitable environment for their physiology, social activities, morphological characters and predator avoidance (Kunz 1998). Caves are one of the primary choices for bats as their roosting site. The shape of cave passages was found to have no effect on the condition of the cave environment, but did have an effect on the diversity of bats (Kencana 2001). Based on the physical and microclimate parameters recorded in the present study in Buni Ayu Cave (Tabel 2),

Tabel 2. Physical and microclimate parameters in bat roosting sites in Buni Ayu Cave.

Physical and microclimate parameters	*H. diadema*	*H. galeritus*	*R. afinis*	*M. magnater*
Width of passage (m)	6.6 (5-10)	8.12 (6-15)	3 (2-5)	3.62 (2-7)
Height of roof (m)	5.4 (4-8)	1.71 (1-1.5)	1.41 (1-2)	1.83 (0.5-3)
Air temperature (^oC)	26.67 (25.3-28.2)	28.46 (28.1-28.7)	26.68 (25.7-28.7)	28.13 (26.6-29.2)
Relative humidity (%)	84.11 (76-89)	81.50 (78-85)	84.48 (78-88)	84.11 (77-90)

values in the parentheses indicate minimum and maximum values

bats preferred to colonize in groups consisting of one species only, as indicated by the fact that all bats recorded were found only in single species groups.

Based on the microclimate condition, roosting sites in almost all sites had a similar range in each roosting site. The air temperature ranged in all sites ranged from 25.3-29.2^oC and humidity ranged from 76-90%. According to Kunz (1998) the normal condition for a roosting site of bat is where the air temperature ranges from 20-30^oC and the relative humidity ranges from 60-90%. The air temperature inside large caves approximates the outside mean annual temperature (Hall & Richards 2003). The mean annual temperature at Cipicung is 28.5^oC which is within the range measured and expected in Buni Ayu Cave. On the other hand, it is not known the impact of the numbers of visitors and electric lighting can affect the microclimate of tourist caves or disturb the roosting behavior of bats.

Findings of this study indicated that *H. diadema* which has the biggest body size compared to the other three species, utilizes the roosting sites in the cave with the largest dimensions of chamber. *M. magnater* which has limited of flight maneuverability tended to choose roosting sites with no obstacles such as no cave ornaments, while *R. affinis* with more agile maneuverability prefers roost in sites with cave ornaments. Interspecific competition may also be a factor affecting roost site selection in Buni Ayu Cave as indicated by no mixed species colonies being found.

ACKNOWLEDGMENTS

This survey is a part of the Cave Fauna of Java Project supported by Nagao NEF and The Rufford Small Grants Foundation. I would like to thank Mr. Cahyo Rahmadi as the leader of this survey. I would also like to thank Mr. Nanang Supritana for helping during this survey and Dr. Warsito for his comments on this manuscript.

REFERENCES

Hall, L.S., G.C. Richards. 2003. Flying Around Underground. Chapter 4. In: B. Finlayson and E. Hamilton-Smith (eds) Beneath the Surface – A Natural History of Australian Caves. University of NSW Press, Sydney.

Hill, J.E., J.D. Smith. 1984. Bats A Natural History. British Museum (Natural History) Cromwell Road. London.

Kencana, B.E. 2001. Distribusi Jenis Kelelawar Penghuni Gua Di Kawasan Karst Gunung Sewu. Bachelor Thesis. Gadjah Mada University. Yogyakarta

Kunz, T.H. 1998. Ecological and Behavioral Methods for the Study of Bats. Smithsonian Institute Press. Washington D.C.

Nowak, K.M. 1995. Walker's Bats of the World. John Hopkins University Press, Baltimore and London.

Suyanto, A. 2001. Kelelawar Di Indonesia. Pusat Penelitian dan Pengembangan Biologi LIPI. Bogor.

Welbourn, W.C. 1999. Invertebrate Cave Fauna of Kartchner Caverns, Arizona. Journal of Cave and Karst Studies, 61: 93-101.

Werner, M.R, D.L. Dindall. 1987. Nutritional Ecology of Soil Arthropods. *In:* F. Slansky & S.G. Rodny (eds) Nutritional Ecology of Insects, Miter Spider and Related Invertebrates. John Willey and Sons. New York.

POLA AKTIVITAS DAN STRATIFIKASI VERTIKAL OLEH MONYET EKOR PANJANG (*Macaca fascicularis* RAFFLES, 1821) DI FASILITAS PENANGKARAN SEMI ALAMI PULAU TINJIL, PROPINSI BANTEN

Azhari Purbatrapsila, Entang Iskandar, Joko Pamungkas

Pusat Studi Satwa Primata
Lembaga Penelitian dan Pengabdian kepada Masyarakat - Institut Pertanian Bogor
Jl. Lodaya II No. 5, Bogor, Jawa Barat
e-mail: *trap.azh@gmail.com*

ABSTRAK

Purbatrapsila, A., E. Iskandar, J. Pamungkas. 2012. Pola aktivitas dan stratifikasi vertikal oleh monyet ekor panjang (*Macaca fascicularis* Raffles, 1821) di fasilitas penangkaran semi alami Pulau Tinjil, Propinsi Banten. *Zoo Indonesia* 21(1), 39-47. *Monyet ekor panjang merupakan jenis primata yang memiliki kemampuan adaptasi yang tinggi untuk bertahan hidup pada berbagai tipe habitat yang berbeda. Kemampuan ini berkaitan dengan bagaimana jenis ini memanfaatkan sumberdaya yang terbatas di habitatnya selama waktu aktif untuk memenuhi kebutuhan hidupnya di alam. Tujuan penelitian ini adalah untuk menentukan pola aktivitas dan penggunaan strata vertikal oleh kelompok monyet ekor panjang yang sudah terhabituasi dengan baik di fasilitas penangkaran semi alami Pulau Tinjil, Propinsi Banten, Indonesia. Kelompok monyet ekor panjang diamati menggunakan metode Scan Sampling dengan interval lima menit antara bulan Maret dan September 2011. Berdasarkan hasil penelitian ini, kelompok monyet ekor panjang menggunakan waktu aktifnya paling banyak untuk berpindah (36,01%) dan beraktivitas paling banyak pada ketinggian 1-5 meter diatas tanah (31,98%).*

Kata Kunci: *Macaca fascicularis, pola aktivitas, stratifikasi vertikal, Pulau Tinjil*

ABSTRACT

Purbatrapsila, A., E. Iskandar, J. Pamungkas. 2012. Activity pattern and vertical stratification by the long tailed macaque (*Macaca fascicularis* Raffles, 1821) on Tinjil Island semi natural habitat breeding facility, Banten Province. *Zoo Indonesia* 21(1), 39-47. *The long tailed macaque is a primate species which has a high adaptation ability to survive on various types of different habitat. This ability is related to how this species utilize limited resources in their habitat during active time to provide their need in the wild. The purpose of this study was to determine activity pattern and vertical strata use by a well habituated group of the long tailed macaque on Tinjil Island semi natural habitat breeding facility, Banten Province, Indonesia. The group were observed using Scan Sampling method at five minutes interval between March and September 2011. According to the results of this study, the group spent most of their active time for moving (36,01%) and spent most of their activities at 1-5 meters height above the ground (31,98%).*

Keywords: *Macaca fascicularis, activity pattern, vertical stratification, Tinjil Island*

PENDAHULUAN

Monyet ekor panjang (*Macaca fascicularis*) merupakan jenis primata yang memiliki kemampuan adaptasi yang tinggi untuk bertahan hidup pada berbagai tipe habitat yang berbeda (Malaivijitnond & Hamada 2008; Hadi *et al.* 2007). Kemampuan tersebut berkaitan dengan bagaimana jenis satwa ini memanfaatkan sumberdaya yang terbatas di habitatnya selama waktu aktif untuk memenuhi kebutuhan hidupnya di alam. Hal ini membuat monyet ekor panjang tersebar cukup luas pada berbagai tipe habitat, seperti di hutan dataran rendah primer, hutan sekunder, hutan riparian, hutan rawa, hutan pantai, hutan bakau, hingga dekat pemukiman manusia (Crocket & Wilson 1980; Fooden 1995; Malaivijitnond dan Hamada 2008). Selain beberapa tempat alami tersebut, terdapat tempat lain yang menjadi habitat monyet ekor panjang hasil introduksi manusia, seperti Pulau Angaur, Micronesia (Poirier & Smith, 1974) dan Pulau Mauritius

(Sussman & Tattersall, 1981). Di Indonesia, pulau yang menjadi habitat monyet ekor panjang hasil introduksi, salah satunya adalah Pulau Tinjil. Penyebaran monyet ekor panjang meliputi daratan Asia Selatan hingga semenanjung Asia Tenggara, mulai dari Bangladesh bagian selatan hingga Filipina dan Pulau Timor, Indonesia (Fooden 1995; Fooden 2006; Eudey 2008).

Pulau Tinjil dimanfaatkan oleh Pusat Studi Satwa Primata LPPM-IPB sebagai lokasi penangkaran semi alami monyet ekor panjang untuk penelitian biomedis, terutama yang berkaitan dengan AIDS (Pamungkas *et al.* 1994; Kyes *et al.* 1997; Leeson *et al.* 2004; Iskandar *et al.* 2009). Sejak tahun 1988 hingga tahun 1990 telah dilepaskan sebanyak 475 induk monyet ekor panjang ke pulau ini (Kyes 1993). Pada tahun 1994, jumlah induk yang telah dilepaskan mencapai 520 ekor (Kyes *et al.* 1997; Leeson *et al.* 2004). Kegiatan pelepasan induk di Pulau Tinjil dilakukan secara periodik untuk menunjang perkembangan populasi monyet ekor panjang yang ada. Total induk yang telah dilepaskan hingga tahun 2007 adalah sebanyak 603 induk monyet ekor panjang yang terdiri dari 61 ekor jantan dan 542 ekor betina (Iskandar *et al.* 2009). Selama lebih dari 20 tahun dari pelepasan pertamanya, monyet ekor panjang yang dilepaskan kemudian menyebar dan membentuk kelompoknya masing-masing, baik membentuk kelompok-kelompok kecil maupun bergabung dengan kelompok yang sudah terbentuk (Iskandar *et al.* 1996).

Monyet ekor panjang yang ditangkarkan di Pulau Tinjil dibiarkan hidup bebas di dalam hutan sehingga dapat beraktivitas dan berkembang biak seperti di habitat alaminya. Kondisi hutan yang masih terjaga dengan baik dan tidak adanya jenis satwa primata lain, menjadikan populasi monyet ekor panjang di pulau ini memiliki relung yang luas dalam memanfaatkan sumber daya. Pola aktivitas dan stratifikasi vertikal merupakan dua aspek penting dalam perilaku satwa yang dapat menggambarkan pemanfaatan sumberdaya yang terbatas oleh suatu jenis satwa untuk menunjang kelangsungan hidup di habitatnya. Dua aspek ini sangat berguna untuk memahami bagaimana populasi monyet ekor panjang yang ada dapat beradaptasi dan menyesuaikan diri terhadap kondisi lingkungan di Pulau Tinjil. Penelitian ini bertujuan untuk mengamati pola aktivitas dan penggunaan ketinggian oleh kelompok monyet ekor panjang yang sudah terhabituasi di Pulau Tinjil. Manfaat dari penelitian ini adalah sebagai data pendukung bagi kegiatan penangkaran yang dilakukan di Pulau Tinjil.

METODE PENELITIAN

Penelitian ini dilakukan selama 20 hari antara bulan Maret dan September 2011 di Pulau Tinjil 6° 56'97" S, 105°48'70" E (Leeson *et al.* 2004). Pulau Tinjil berada di Kecamatan Cikeusik, Kabupaten Pandeglang, Propinsi Banten dengan jarak lebih kurang 16 Km sebelah selatan Pulau Jawa. Objek penelitian yang diamati adalah monyet ekor panjang kelompok M26 yang berjumlah sekitar 38 ekor. Kelompok ini merupakan kelompok monyet ekor panjang yang sudah terhabituasi terhadap kehadiran manusia. Kelompok M26 memiliki luas wilayah jelajah berkisar antara 3,45 Ha (Yusuf 2010) hingga 13 Ha (Prasetyo 1992) yang berada disekitar areal *basecamp* Pulau Tinjil, terutama di kandang nomor tiga (K-3). Alat yang digunakan selama pengambilan data, yaitu pengukur waktu, buku catatan lapangan, dan teropong binokuler.

Pengambilan data dilakukan selama delapan jam per hari (8.00-16.00 WIB) menggunakan metode *Scan Sampling* (Altmann 1974; Martin & Bateson 1986) dengan pencatatan data secara *continuous recording* (Martin & Bateson 1986) pada interval lima menit. Data yang diambil meliputi aktivitas kelompok (makan, istirahat, berpindah, *grooming*, main, dan agonistik) dan posisi

ketinggian saat beraktivitas (0m, 1-5m, 6-10m, 11-15m, 16-20m, 21-25m, dan >25m).

Batasan dari tiap kriteria aktivitas yang digunakan dalam penelitian ini, yaitu :

1. Makan: Aktivitas mencari, memanipulasi, memasukan makanan ke dalam mulut, memakan makanan dari kantung pipi, dan minum. Juga termasuk berjalan maupun berpindah sambil mencari atau membawa makanan, baik di permukaan tanah maupun di pohon.
2. Istirahat: Aktivitas diam atau tidur tanpa disertai aktivitas lain.
3. Berpindah: Aktivitas berjalan, berlari, melompat atau memanjat tanpa disertai aktivitas lain.
4. *Grooming*: Aktivitas mencari dan mengambil parasit atau kotoran di tubuh menggunakan tangan atau mulut, baik terhadap diri sendiri maupun terhadap individu lain.
5. Main: Aktivitas berkejaran, akrobatik atau bergelantungan, serta pura-pura berkelahi, baik dilakukan sendiri maupun bersama individu lain.
6. Agonistik: Aktivitas berkelahi, mengejar, menggigit, mengusir, menghindari kejaran, serta menyeringai (*grimace*) yang dilakukan terhadap individu lain dalam kelompok, individu lain dari kelompok berbeda, atau terhadap manusia. Aktivitas ini dapat dibedakan dengan jelas dari aktivitas main dengan mengamati ekspresi muka, gerakan tubuh, vokalisasi, maupun reaksi anggota kelompok.

Data aktivitas dan stratifikasi vertikal kelompok M26 yang diperoleh, selanjutnya dihitung nilai persentase frekuensinya tiap hari/jam dengan rumus:

$$F = (X/Y) \times 100\%$$

Keterangan:

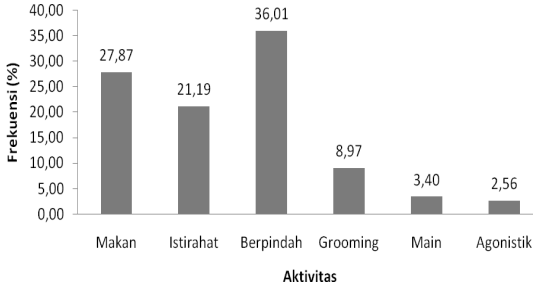
F = persentase frekuensi
X = frekuensi aktivitas/penggunaan strata dalam n hari/jam
Y = total frekuensi aktivitas/penggunaan strata dalam n hari/jam

Untuk mengetahui hubungan keterkaitan antar aktivitas, dilakukan uji korelasi Spearman. Selain itu, dilakukan juga uji Kruskal-Wallis untuk mengetahui perbedaan pola aktivitas dan stratifikasi vertikal tiap jamnya. Baik uji korelasi Spearman maupun uji Kruskal-Wallis dilakukan pada taraf nyata 0,05 menggunakan perangkat lunak SPSS *for Windows*.

HASIL DAN PEMBAHASAN

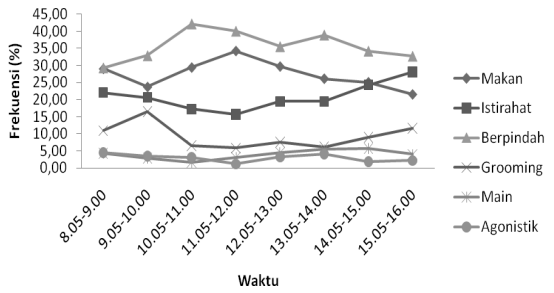
Aktivitas kelompok

Hasil penelitian ini menunjukkan adanya tiga aktivitas utama monyet ekor panjang kelompok M26 di Pulau Tinjil yang memiliki rata-rata persentase frekuensi cukup besar, yaitu berpindah, makan, dan istirahat. Sedangkan aktivitas *grooming*, main, dan agonistik memiliki nilai rata-rata persentase yang rendah (Gambar 1).



Gambar 1. Persentase frekuensi aktivitas monyet ekor panjang kelompok M26 di Pulau Tinjil.

Kelompok M26 melakukan aktivitas berpindah dengan frekuensi yang tinggi, sehingga mengurangi waktu istirahatnya secara nyata. Hal ini tampak pada terdapatnya korelasi negatif dan signifikan antara aktivitas berpindah dan istirahat (Spearman r_s=-.451, n=20, p=0.46). Keterkaitan antar aktivitas lainnya memiliki korelasi yang tidak signifikan, baik yang memiliki arah korelasi negatif maupun positif. Berdasarkan sebaran aktivitas tiap jamnya (Gambar 2), diketahui beberapa aktivitas lebih sering terjadi pada waktu-waktu tertentu sepanjang waktu pengamatan.



Gambar 2. Aktivitas harian tiap jam monyet ekor panjang kelompok M26 di Penangkaran Semi Alami Pulau Tinjil.

A. Aktivitas Berpindah

Aktivitas berpindah memiliki persentase yang paling tinggi dan memiliki perbedaan yang signifikan (Kruskal-Wallis H=18.687, df=7, p=.009). Aktivitas berpindah berada pada titik paling rendah pada awal pengamatan, yaitu pada pukul 08.05-9.00 WIB. Aktivitas berpindah sangat dominan dilakukan kelompok M26, terutama di siang hari. Puncak aktivitas berpindah terjadi pada pukul 10.05-11.00 WIB dan 13.05-14.00 WIB dengan kecenderungan semakin menurun hingga akhir pengamatan.

Untuk mendapatkan makanan, kelompok M26 melakukan aktivitas berpindah yang cukup tinggi. Hal ini berdampak pada berkurangnya waktu untuk aktivitas istirahat. Perilaku ini merupakan salah satu adaptasi yang dilakukan kelompok M26 untuk mendapatkan asupan makanan yang cukup. Banyaknya pohon pakan yang berbuah atau berbunga yang letaknya tidak berjauhan memungkinkan aktivitas berpindah dilakukan cukup tinggi oleh kelompok M26 untuk bergerak dari satu pohon pakan ke pohon pakan yang lain. Dengan wilayah jelajah yang tidak terlalu luas, membuat kelompok M26 terus bergerak untuk mendapatkan makanan yang tersedia dengan mendatangi beberapa lokasi yang sama hingga beberapa kali setiap hari.

B. Aktivitas Makan

Aktivitas makan mencapai puncaknya di tengah hari pada pukul 11.05-12.00 WIB. Pada jam berikutnya hingga akhir pengamatan, aktivitas makan cenderung semakin menurun. Titik paling rendah aktivitas makan terjadi pada sore hari di akhir pengamatan pada pukul 15.05-16.00 WIB. Secara statistik aktivitas makan tidak menunjukkan perbedaan yang signifikan tiap jamnya (Kruskal-Wallis H=12.258, df=7, p=.092).

Sebaran waktu aktivitas makan kelompok M26 pada penelitian ini berbeda dengan hasil penelitian yang dilakukan terdahulu. Hasil penelitian Sugiharto (1992) menunjukkan waktu makan berkisar antara pukul 08.00-11.00 WIB dan 16.00-17.00 WIB. Pada penelitian ini puncak aktivitas makan terjadi pada pukul 11.05-12.00 WIB. Perubahan aktivitas makan ini diduga terjadi karena adanya perbedaan ketersedian pakan. Hal ini mengakibatkan terjadinya pergeseran aktivitas makan pada kelompok M26. Hasil penelitian Santoso (1996) mengenai potensi pakan di Pulau Tinjil juga menunjukkan adanya perubahan aktivitas makan yang dilakukan oleh kelompok M26 karena faktor ketersediaan pakan. Menurut Santoso (1996), ketersediaan pakan monyet di Pulau Tinjil dipengaruhi oleh musim, dimana pada musim hujan tersedia pakan yang melimpah sedangkan pada musim kemarau jumlahnya berkurang.

Monyet ekor panjang diketahui memiliki fleksibilitas dalam mencari dan mendapatkan makanan (Crocket & Wilson, 1980). Pakan monyet ekor panjang di Pulau Tinjil terdiri dari dua sumber, yaitu pakan alami yang berasal dari hutan dan pakan tambahan berupa pisang yang rutin diberikan setiap pagi hari. Sebagian besar sumber pakan monyet ekor panjang di Pulau Tinjil berupa buah-buahan (Santoso, 1996). Hal ini serupa dengan hasil penelitian Yeager (1996) terhadap populasi monyet ekor panjang di Kalimantan Tengah yang lebih bersifat frugivora.

C. Aktivitas Istirahat

Aktivitas istirahat menunjukkan perbedaan yang signifikan tiap jamnya (Kruskal-Wallis

H=25.509, df=7, *p*=.001). Aktivitas istirahat menurun dari awal pengamatan hingga siang hari dan berada pada titik paling rendah pada pukul 11.05-12.00 WIB. Setelah itu, aktivitas istirahat berangsur meningkat hingga mencapai puncaknya pada pukul 15.05-16.00 WIB diakhir pengamatan. Aktivitas istirahat terlihat berlawanan dengan aktivitas makan maupun berpindah. Pada waktu sore hari, aktivitas istirahat lebih sering terlihat dan mudah diamati karena pada waktu tersebut kelompok M26 berada disekitar *camp*. Aktivitas ini umumnya dilakukan sebelum kembali menuju pohon tidurnya menjelang matahari terbenam.

Rendahnya aktivitas istirahat pada siang hari mengindikasikan bahwa populasi monyet ekor panjang di Pulau Tinjil dapat beradaptasi dengan baik terhadap kondisi cuaca yang ada. Pada siang hari dengan intensitas cahaya matahari yang cukup tinggi, aktivitas kelompok M26 lebih banyak dilakukan di dalam hutan dari pada di sekitar *camp*. Rapatnya tutupan tajuk membuat suhu udara di dalam hutan lebih dingin dibanding di areal *camp* sehingga selama berada di dalam hutan, kelompok M26 dapat meminimalkan faktor kehilangan energi karena cuaca panas. Hal ini membuat kelompok M26 dapat memaksimalkan waktunya untuk melakukan aktivitas berpindah dan makan sepanjang siang hari serta menurunkan frekuensi istirahatnya.

D. Aktivitas *Grooming*

Aktivitas *grooming* terjadi cukup sering pada waktu pagi dan sore hari. *Grooming* umumnya dilakukan kelompok M26 disela-sela aktivitas istirahat. Aktivitas ini mencapai puncaknya pada pukul 9.05-10.00 WIB. Namun, selama tengah hari aktivitas *grooming* relatif jarang teramati. Terdapat perbedaan yang signifikan pada aktivitas *grooming* tiap jamnya (Kruskal-Wallis *H*=18.730, df=7, *p*=.009). Aktivitas *grooming* memiliki arti penting bagi monyet ekor panjang dan jenis satwa primata lainnya. Selain untuk membersihkan diri dari parasit, *grooming* juga berfungsi sebagai sarana untuk mempererat hubungan sosial antar anggota kelompok. Berdasarkan Hemerlijk (1994) dan Schino (2007), *grooming* juga berperan terhadap pemberian dukungan dalam aktivitas agonistik.

Pada kelompok M26, *grooming* banyak dilakukan oleh induk betina dan betina remaja, baik terhadap individu lain maupun terhadap diri sendiri. Betina remaja sering terlihat melakukan *grooming* terhadap induk betina yang memiliki bayi. Perilaku ini dilakukan oleh betina remaja untuk mendapatkan kesempatan menyentuh atau bahkan menggendong bayi dari induk yang menerima *grooming*. Hasil penelitian Gumert (2007a) menunjukkan bahwa kontak yang dilakukan betina remaja terhadap bayi lebih tinggi setelah melakukan *grooming* terhadap induknya. Selama penelitian berlangsung, aktivitas *grooming* teramati beberapa kali dilakukan juga oleh jantan dominan beberapa saat sebelum maupun setelah melakukan kopulasi dengan betina. Menurut Gumert (2007b), terdapat hubungan yang signifikan antara *grooming* dan aktivitas seksual yang dilakukan individu jantan terhadap betina.

E. Aktivitas Main

Aktivitas main yang dilakukan kelompok M26 cenderung merata dan tidak berbeda secara signifikan tiap jamnya (Kruskal-Wallis *H*=11.394, df=7, *p*=0.122). Aktivitas main lebih banyak dilakukan oleh anakan jantan, baik dengan anakan jantan lain, maupun dengan bayi. Selain itu, aktivitas main pada monyet ekor panjang juga dilakukan antara jantan dewasa dengan anakan jantan, jantan dewasa dengan bayi, serta bayi dengan bayi (Caine & Mitchell, 1979). Saat pagi dan sore hari, aktivitas main teramati disela-sela aktivitas istirahat. Aktivitas main sangat berguna bagi anakan monyet ekor panjang. Melalui aktivitas main, anakan monyet ekor panjang dapat meningkatkan kemampuan fisik, menumbuhkan hu-

bungan sosial, mempelajari cara menghindari predator, hingga mempelajari cara berinteraksi dengan anggota kelompok lainnya saat dewasa, terutama dengan anggota kelompok yang berbeda hirarki.

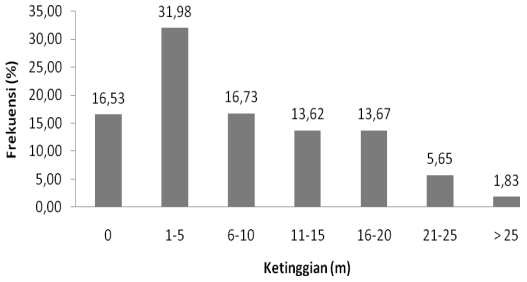
F. Aktivitas Agonistik

Aktivitas agonistik memiliki perbedaan yang signifikan tiap jamnya (Kruskal-Wallis H=14.612, df=7, p=0.041). Aktivitas agonistik sering teramati pada pagi dan siang hari. Aktivitas ini terjadi pada saat yang relatif bersamaan dengan aktivitas makan. Pada kelompok M26, selain dilakukan oleh jantan dominan, aktivitas agonistik juga sering dilakukan induk betina terhadap individu lain yang memiliki hirarki lebih rendah. Jantan dewasa berperilaku agonistik lebih sering, baik terhadap anggota kelompoknya maupun terhadap manusia. Kondisi serupa juga ditemukan pada populasi monyet ekor panjang di Hutan Wisata Alam Kaliurang, Yogyakarta (Djuwantoko *et al.* 2008). Perilaku ini menunjukkan adanya dominansi oleh jantan dewasa untuk menguasai sumberdaya yang ada.

Stratifikasi Vertikal

Ketinggian 1-5 meter merupakan level ketinggian yang paling sering digunakan kelompok M26 untuk beraktivitas dengan rata-rata persentase sebesar 31,98%. Penggunaan ketinggian 6-10 meter memiliki nilai yang relatif sama dengan penggunaan ketinggian 0 meter (permukaan tanah), rata-rata persentasenya masing-masing sebesar 16,73% dan 16,53%. Terdapat dua level ketinggian yang juga memiliki rata-rata persentase yang hampir sama, yaitu ketinggian 11-15 meter (13,62%) dan 16-20 meter (13,67%). Kelompok M26 sangat jarang memanfaatkan pohon yang tinggi untuk beraktivitas. Ketinggian 21-25 meter dimanfaatkan sebesar 5,65%, sedangkan ketinggian pohon diatas 25 meter hanya dimanfaatkan sebesar 1,83% (Gambar 3).

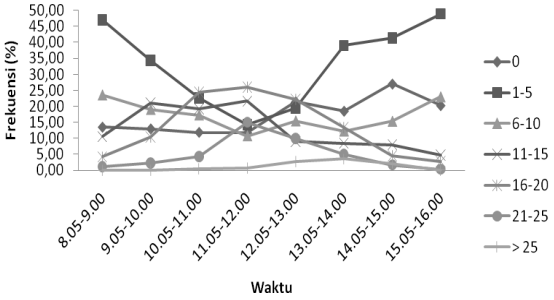
Hasil ini menunjukkan bahwa aktivitas kelompok M26 lebih banyak dilakukan di atas pohon



Gambar 3. Persentase frekuensi stratifikasi vertikal monyet ekor panjang kelompok M26 di Pulau Tinjil.

daripada di permukaan tanah. Hal ini sesuai dengan Medway (1978) bahwa monyet ekor panjang lebih bersifat arboreal. Hasil penelitian ini juga sesuai dengan Crocket dan Wilson (1980) pada populasi monyet ekor panjang dan beruk (*Macaca nemestrina*) di Sumatera yang menunjukkan bahwa monyet ekor panjang lebih sering melakukan aktivitas berpindah secara arboreal, sedangkan beruk lebih banyak melakukan aktivitas berpindah di permukaan tanah. Namun, hasil penelitian ini berbeda dengan hasil penelitian yang dilakukan Gusnia (2010) yang menyatakan bahwa kelompok M26 lebih banyak beraktivitas di permukaan tanah (terrestrial).

Aktivitas makan lebih banyak dilakukan pada ketinggian 0 meter (permukaan tanah) dengan persentase sebesar 30,68%. Sedangkan aktivitas istirahat, berpindah, *grooming*, main, dan agonistik lebih banyak dilakukan pada ketinggian 1-5 dengan persentase masing-masing sebesar 55,46% (istirahat), 35,25% (berpindah), 47,77% (*grooming*),



Gambar 4. Stratifikasi vertikal tiap jam monyet ekor panjang kelompok M26 di Penangkaran Semi Alami Pulau Tinjil.

41,63% (main), dan 42,03% (agonistik). Kelompok M26 jarang beraktivitas pada ketinggian lebih dari 25 meter sehingga presentase frekuensinya jauh lebih kecil dibandingkan level ketinggian lainnya (Gambar 4).

Terdapat penggunaan strata vertikal tiap jam yang cukup bervariasi oleh kelompok M26 (Gambar 4). Penggunaan ketinggian 1-5 meter oleh kelompok M26 tiap jam menunjukkan perbedaan yang signifikan (Kruskal-Wallis H=35.456, df=7, p=.000). Perbedaan yang signifikan juga ditunjukkan pada penggunaan ketinggian 11-15 meter (Kruskal-Wallis H=15.152, df=7, p=.034), 16-20 meter (Kruskal-Wallis H=37.089, df=7, p=.000), dan 21-25 meter (Kruskal-Wallis H=35.450, df=7, p=.000). Sedangkan penggunaan ketinggian 0 meter (permukaan tanah), 6-10 meter, serta ketinggian diatas 25 meter tidak menunjukkan perbedaan yang signifikan (Kruskal-Wallis H=12.520, df=7, p=.085 untuk ketinggian 0 meter; H=13.887, df=7, p=.053 untuk ketinggian 6-10 meter; H=11.742, df=7, p=.109 untuk ketinggian diatas 25 meter).

Ketinggian 0 meter (permukaan tanah) digunakan oleh kelompok M26 dengan persentase frekuensi yang hampir sama pada pagi hingga siang hari, yaitu pada pukul 8.05-12.00 WIB. Menjelang sore hari, penggunaan ketinggian 0 meter meningkat dan mencapai puncaknya pada pukul 14.05-15.00 WIB. Ketinggian 1-5 meter digunakan paling banyak pada pagi dan sore hari dengan persentase frekuensi yang cukup tinggi. Puncak penggunaan ketinggian 1-5 meter, yaitu pada pukul 8.05-9.00 WIB dan 15.05-16.00 WIB. Pada siang hari (pukul 11.05-12.00 WIB), ketinggian 1-5 meter mencapai titik paling rendah.

Monyet ekor panjang lebih banyak mengunakan level ketinggian yang rendah di pohon (Aldrich-Blake 1980; Crocket dan Wilson 1980). Hal ini tampak pada perilaku kelompok M26 yang memanfaatkan level ketinggian 1-5 meter lebih sering dibandingkan dengan ketinggian lainnya. Pada ketinggian 1-5 meter, selain terdapat banyak cabang pohon yang digunakan sebagai tempat beristirahat atau berlindung, juga memudahkan untuk berpindah dan mencari makanan di permukaan tanah. Penggunaan level ketinggian yang rendah ini digunakan juga sebagai tempat untuk melakukan aktivitas sosial oleh kelompok M26. Aldrich-Blake (1980) menduga bahwa penggunaan level ketinggian yang rendah tersebut salah satunya merupakan hasil dari pemilihan yang secara aktif dilakukan oleh monyet ekor panjang.

Ketinggian 6-10 meter memiliki persentase yang tidak jauh berbeda tiap jamnya. Puncak penggunaan ketinggian ini terjadi pada pukul 8.05-9.00 WIB dan 15.05-16.00 WIB. Kelompok M26 terlihat memanfaatkan strata vertikal yang lebih tinggi menjelang siang hari, yaitu pada ketinggian 11-25 meter. Ketinggian 11-25 meter meningkat penggunaannya oleh kelompok M26 menjelang siang hari. Setelah pukul 12.00 WIB, ketinggian 11-25 meter jauh berkurang penggunaannya dan mencapai titik terendah pada pukul 15.05-16.00 WIB. Sedangkan, ketinggian diatas 25 meter digunakan oleh kelompok M26 dengan persentase yang sangat rendah sepanjang hari.

Kelompok M26 menggunakan ketinggian 11-25 meter untuk mendapatkan makanan alami di hutan. Selain itu, ketinggian 11-25 meter dimanfaatkan untuk mendeteksi kehadiran predator. Pada level ketinggian ini, kelompok M26 dapat lebih mudah melihat daerah sekelilingnya, sehingga dapat mendeteksi kehadiran predator lebih awal dan lebih mudah mencari tempat perlindungan dengan cepat.

Pada beberapa kesempatan, teramati adanya jenis burung pemangsa, yaitu burung elang, yang terbang rendah di atas pohon yang digunakan kelompok M26 untuk beraktivitas. Burung elang merupakan predator potensial bagi populasi monyet ekor panjang di Pulau Tinjil selain ular sanca. Perilaku

waspada terhadap kehadiran predator ini tampak dari reaksi yang ditunjukkan oleh kelompok M26. Saat burung elang terbang melintas, sebagian besar anggota kelompok mengeluarkan suara gaduh sebagai peringatan (*alarm call*) adanya bahaya. Hal yang sama juga dilakukan saat terlihat ular sanca berada dekat dengan kelompok M26.

Secara umum, strata vertikal di Pulau Tinjil dapat digunakan dengan lebih leluasa oleh kelompok M26. Hal ini dipengaruhi oleh tidak adanya jenis satwa primata lain yang ada di pulau ini, sehingga tidak ada persaingan interspesifik yang terjadi. Kondisi ini membuat tekanan yang diterima kelompok M26 dalam persaingan menggunakan sumberdaya, baik dalam hal pakan maupun relung ketinggian, lebih rendah dibandingkan bila terdapat satwa primata lain di pulau ini.

KESIMPULAN

Terdapat tiga aktivitas dengan persentase yang tinggi dilakukan oleh kelompok M26 di Pulau Tinjil, yaitu berpindah, makan, dan istirahat. Aktivitas berpindah merupakan aktivitas dengan persentase tertinggi dibandingkan aktivitas lainnya. Kelompok M26 lebih banyak beraktivitas di atas pohon daripada di permukaan tanah, namun pada level/ strata ketinggian yang rendah. Ketinggian 1-5 merupakan level ketinggian yang paling sering digunakan kelompok M26 untuk beraktivitas, terutama pada pagi dan sore hari. Aktivitas yang lebih banyak dilakukan pada ketinggian ini, yaitu istirahat, berpindah, *grooming*, main dan agonistik. Sedangkan aktivitas makan lebih sering dilakukan di permukaan tanah.

DAFTAR PUSTAKA

Aldrich-Blake, F.P.G. 1980. Long-tailed macaques. *In*: Chivers, D.J. (Ed.): Malayan forest primates. Ten years study in tropical rain forest. New York: Plenum Press. p.147-165.

Altmann, J. 1974. Observational study of behavior: Sampling methods. Behaviour, 49: 227–267.

Caine, N., G. Mitchell. 1979. A review of play in the genus *Macaca:* Social correlates. Primates, 20(4): 535-546.

Crockett, C.M., W.L. Wilson. 1980. The ecological separation of *Macaca nemestrina* and *Macaca fascicularis* in Sumatra. *In*: D.G. Lindburg. (Ed.): The macaques: Studies in ecology, behavior and evolution. New York: Van Nostrand Reinhold. p.148-81.

Djuwantoko, R.N. Utami, Wiyono. 2008. Perilaku agresif monyet, *Macaca fascicularis* (Raffles, 1821) terhadap wisatawan di Hutan Wisata Alam Kaliurang, Yogyakarta. Biodiversitas, 9(4): 301-305.

Eudey, A.A. 2008. The crab-eating macaque (*Macaca fascicularis*): Widespread and rapidly declining. Primate Conservation, 23: 129–132

Fooden, J. 1995. Systematic review of Southeast Asian longtail macaques, *Macaca fascicularis* (Raffles, [1821]). Fieldiana: Zoology, 81: 1–206.

_____. 2006. Comparative review of *fascicularis* -group species of macaques (primates: *Macaca*). Fieldiana: Zoology, 107: 1-44.

Gumert, M.D. 2007a. Grooming and infant handling interchange in *Macaca fascicularis*: The relationship between infant supply and grooming payment. International Journal of Primatology, 28: 1059-1074.

_____. 2007b. Payment for sex in macaque mating market. Animal Behaviour, 74: 1655-1667.

Gusnia, N. A. 2010. Perilaku seksual monyet ekor panjang (*Macaca fascicularis* Raffles 1821) di penangkaran semi alami Pulau Tinjil, Kabupaten Pandeglang, Provinsi Banten. [Skripsi]. Bogor: Departemen Konservasi Sumberdaya Hutan dan Ekowisata Fakultas Kehutanan Institut Pertanian Bogor.

Hadi, I., B. Suryobroto, D. Perwitasari-Farajallah. 2007. Food preference of semi-provisioned macaques based on feeding duration and foraging party size. Hayati Journal of Biosciences, 14(1): 13-17.

Hamelrijk, C.K. 1994. Support for being groomed in long-tailed macaques, *Macaca fascicularis*. Animal Behaviour, 48: 479-481.

Iskandar, E., R.C. Kyes, R. Siregar, R.P.A. Lelana. 1996. Pembentukan kelompok monyet ekor panjang (*Macaca fascicularis*) yang diintroduksi ke Pulau Tinjil, Jawa Barat. Media Konservasi, V(I): 35-39.

Iskandar, E., S.D. Riendriasari, W. Sinaga. 2009. Dua dekade penangkaran monyet ekor panjang (*Macaca fascicularis* Raffles, 1821): Tinjauan aspek populasi, habitat dan manajemen. Laporan Penelitian. Bogor: Pusat Studi Satwa Primata LPPM IPB.

Kyes, R.C. 1993. Survey of the long-tailed macaques introduced onto Tinjil Island, Indonesia. American Journal of Primatology, 31: 77-83.

Kyes, R.C., D. Sajuthi, W.R. Morton, O.A. Smith, R.P.A. Lelana, J. Pamungkas, D. Iskandriati, E. Iskandar, C.M. Crockett. 1997. The Tinjil Island natural habitat breeding facility: A decade of operation. Jurnal Primatologi Indonesia, 1(1): 1-8.

Leeson, C., R.C. Kyes, E. Iskandar. 2004. Estimating population density of the longtailed macaques (*Macaca fascicularis*) on Tinjil Island, Indonesia, using the line transect sampling method. Jurnal Primatologi Indonesia, 4(1): 7-14.

Malaivijitnond, S., Y. Hamada. 2008. Current situation and status of long-tailed macaques (*Macaca fascicularis*) in Thailand. The Natural History Journal of Chulalongkorn University, 8(2): 185-204.

Martin, P., P. Bateson. 1986. Measuring behavior: An introductory guide. Cambridge: Cambridge University Press.

Medway, L. 1978. The wild mammals of Malaya (Peninsular Malaysia) and Singapore. Second Edition. Kuala Lumpur: Oxford University Press.

Pamungkas, J., D. Sajuthi, P.A. Lelana, D. Iskandriati, B. Joeniman, R.C. Kyes, G.H. Knitter, R.A. Watanabe. 1994. Tinjil Island, a natural habitat breeding facility of simian retrovirus-free *Macaca fascicularis.* American Journal of Primatology, 34: 81-84.

Poirier, F.E., E.O. Smith. 1974. The crab-eating macaques (*Macaca fascicularis*) of Angaur Island, Palau, Micronesia. Folia primatol, 22: 258-306.

Prasetyo, A. 1992. Studi penggunaan habitat monyet ekor panjang (*Macaca fascicularis* Raffles 1821) di Pulau Tinjil, Pandeglang, Jawa Barat. [Skripsi]. Bogor: Jurusan Konservasi Sumberdaya Hutan Fakultas Kehutanan Institut Pertanian Bogor.

Santoso, N. 1996. Analisis habitat dan potensi pakan monyet ekor panjang (*Macaca fascicularis*, Raffles) di Pulau Tinjil. Media Konservasi, V(1): 5-9.

Schino, G. 2007. Grooming and agonistic support: A meta-analysis of primates reciprocal altruism. Behavioral Ecology, 18: 115-120.

Sugiharto, G. 1992. Studi perilaku makan monyet ekor panjang (*Macaca fascicularis*) di Pulau Tinjil, Jawa Barat. [Skripsi]. Bogor: Jurusan Konservasi Sumberdaya Hutan Fakultas Kehutanan Institut Pertanian Bogor.

Sussman, R.W., I. Tattersall. 1981. Behavior and ecology of *Macaca fascicularis* in Mauritius: A Preliminary Study. Primates, 22(2): 192-205.

Yeager, C.P. 1996. Feeding ecology of the long-tailed macaque (*Macaca fascicularis*) in Kalimantan Tengah, Indonesia. International Journal of Primatology, 17(1): 51-62.

Yusuf, T.M.M. 2010. Karakteristik wilayah jelajah monyet ekor panjang (*Macaca fascicularis* Raffles 1821) di Pulau Tinjil, Pandeglang, Banten. [Skripsi]. Bogor: Departemen Konservasi Sumberdaya Hutan dan Ekowisata Fakultas Kehutanan Institut Pertanian Bogor.

PETUNJUK PENULISAN ZOO INDONESIA

Zoo Indonesia hanya menerima naskah utama yang merupakan hasil penelitian utuh dan belum pernah dipublikasikan. Bidang pembahasan dalam Zoo Indonesia meliputi semua aspek keilmuan yang menyangkut fauna. Tata cara penulisan adalah sebagai berikut:

1. Naskah ditulis dalam bahasa Indonesia atau Inggris. Diketik pada format kertas A-4 dengan jarak spasi 1.5, times new roman, font 12. Ukuran margin kiri, kanan, atas dan bawah adalah 3 cm.
2. Pada waktu pengiriman naskah, dilengkapi dengan surat permohonan penerbitan, yang didalamnya menyatakan bahwa naskah tersebut belum pernah diterbitkan dan benar-benar merupakan hasil karya si penulis.
3. Baris dalam naskah harus diberi nomor yang berlanjut sepanjang halaman naskah.
4. Istilah dalam bahasa asing untuk naskah berbahasa Indonesia harus dicetak miring.
5. Setiap naskah harus terdiri dari bagian: (i) Judul, (ii) Nama dan alamat penulis, (iii) Abstrak, (iv) Pendahuluan, (v) Metode penelitian, (vi) Hasil dan pembahasan, (vii) Kesimpulan, (viii) Ucapan terima kasih, (ix) Daftar pustaka, dan (x) Lampiran (bila ada). Judul bagian ditulis dalam huruf kapital tebal, times new roman, font 12, tanpa indeks dan tanda titik.

i. JUDUL

Judul harus singkat dan jelas, ditulis dengan huruf kapital, times new roman, font 14 dan ditulis dalam posisi rata tengah dan dicetak tebal. Penyertaan anak judul sebaiknya dihindari, apabila terpaksa harus dipisahkan dengan titik dua. Anak judul ditulis dengan huruf kecil, times new roman, font 14 dan hanya awal kata pertama yang menggunakan huruf kapital. Nama latin yang terdapat dalam judul ditulis sesuai dengan kaidah penulisan nama latin.

ii. NAMA DAN ALAMAT PENULIS

Nama semua penulis ditulis lengkap tanpa menyertakan gelar, times new roman, font 12, tebal, dan rata tengah. Jika penulis lebih dari satu dan berasal dari instansi yang berbeda, untuk mempermudah dan memperjelas penulisan alamat maka dibelakang nama penulis disertakan *footnote* berupa angka yang dicetak *superscript*. Alamat yang dicantumkan adalah nama lembaga, alamat lembaga dan alamat email dicetak miring. Nama lembaga dan alamat lembaga ditulis lengkap diurutkan berdasar angka di *footnote*. Untuk mempermudah korespondensi, hanya satu alamat email dari perwakilan penulis yang ditulis dalam naskah.

Gleni Hasan Huwoyon[1] dan Rudhy Gustiano[2]

[1)] Balai Riset Perikanan Budidaya Air Tawar
Jl. Sempur No 1, Bogor, Jawa Barat
[2)] Jurusan Budidaya Perikanan, Fakultas Perikanan, Universitas Brawijaya, Malang, Jawa Timur
e-mail: *rgus@yahoo.com*

iii. ABSTRAK

Abstrak merupakan intisari dari naskah, mengandung tidak lebih dari 200 kata, dan hanya dituangkan dalam satu paragrap. Abstrak diawali dengan nama penulis, tahun, judul, *Zoo Indonesia* xx(x), *xx-xx* dan dicetak tebal. Nama penulis ditulis seperti penulisan nama pada daftar pustaka. Abstrak disajikan dalam Bahasa Indonesia dan Inggris, ditulis rata kanan kiri dan miring. Di bawah abstrak disertakan kata kunci maksimal empat kata. Kata kunci disajikan dalam Bahasa Indonesia dan Inggris dan dicetak miring. Nama latin dalam kata kunci digaris bawah terputus antar kata.

Yuwono, G. H. & R. Gustiano. 2008. Pengaruh pemberian hormon terhadap perubahan jenis kelamin ikan guppy (*Poecilia reticulata*). *Zoo Indonesia* xx(x), xx-xx. *Ikan hias jantan memiliki bentuk .....*

Kata kunci: *rasio kelamin, reproduksi, hormon, ikan guppy.*

iv. PENDAHULUAN

Pendahuluan harus mengandung kerangka berpikir (*justification*) yang mendukung tema penelitian, teori, dan tujuan penelitian. Pendahuluan tidak lebih 20% dari keseluruhan isi naskah.

v. METODE PENELITIAN

Metode penelitian menerangkan secara jelas dan rinci tentang waktu, tempat, tata cara penelitian, dan analisis statistik, sehingga penelitian tersebut dapat diulang. Data mengenai nomor aksesi spesimen, asal usul spesimen, lokasi atau hal lain yang dirasa perlu untuk penelusuran kembali, ditempatkan di lampiran.

vi. HASIL DAN PEMBAHASAN

Hasil dan pembahasan digabung menjadi satu sub bab, yang menyajikan hasil penelitian yang diperoleh, sekaligus membahas hasil penelitian, membandingkan dengan hasil temuan penelitian lain dan menjabarkan implikasi dari penelitian yang diperoleh. Penyertaan ilustrasi dalam bentuk tabel, gambar atau sketsa berwarna. Judul tabel ditulis di atas tabel. Judul dan format tabel seperti contoh di bawah ini. Sedangkan judl gambar diletakkan di bawah gambar, seperti pada contoh di bawah. Pada saat akan diterbitkan, penulis harus mengirimkan file gambar yang terpisah dari naskah, dalam format .tiff. Masing-masing gambar disimpan dalam 1 file.

Sitiran untuk menghubungkan nama penulis dan tahun terbitan tidak menggunakan tanda koma, apabila penulisnya dua, antar penulis dihubungkan dengan tanda "&" seperti (Hodkinson & Jackson 2005). Sitiran untuk sumber dengan penulis lebih dari dua, maka hanya penulis pertama yang ditulis diikuti dengan *et al.* termasuk untuk jurnal lokal, seperti (Hodkinson *et al.* 1999). Bila ada beberapa tahun penulisan yang berbeda untuk satu penulis yang sama, digunakan tanda penghubung titik koma, seperti (Hilt & Fiedler 2006; Hodkinson 1999; Hodkinson 2005).

vii. KESIMPULAN

Kesimpulan merupakan dari keseluruhan hasil penulisan. Penulisan ditulis dalam bentuk paragraf.

viii. DAFTAR PUSTAKA

Daftar pustaka mengikuti format seperti contoh di bawah ini.

ix. UCAPAN TERIMA KASIH

Bagian ini tidak harus ada. Bagian ini sebagai penghargaan atas pihak-pihak yang dirasa layak diberikan.

Contoh Tabel

Table 1. Results of ANCOVAs on *L. sativae* and *L. huidobrensis* density per leaf related to host, sampling time and altitude of collection site. *L. sativae* samples were collected below 700 m, *L. huidobrensis* samples above 1100 m, and parasitoids from all altitudes.

Species	Source	*df*	Mean square*	F	*P*
L. sativae	Altitude	1	1.554	0.100	0.759
	Host	3	96.496	2.065	0.175
	Sampling time	4	166.368	2.671	0.102
L. huidobrensis	Altitude	1	0.049	0.027	0.871
	Host	5	15.397	8.412	<0.001
	Sampling time	4	5.097	2.785	0.045

Contoh Gambar

Gambar 1. Metode koleksi imago *Liriomyza* spp. dengan cara menangkap langsung menggunakan tabung reaksi (A) dan larva *Liriomyza* spp. dan parasitoidnya dengan cara mengkoleksi daun tanaman yang terserang (B).

Contoh Daftar Pustaka

Hilt, N., K. Fiedler. 2006. Arctiid moth ensembles along a successional gradient in the Ecuadorian montane rainforest zone: how different are subfamilies and tribes? Journal of Biogeography, 33:108-120.

Hodkinson, I..D., J. Bird, J.E. Miles, J.S. Bale, J.J. Lennon. 1999. Climatic signals in the life histories of insects: the distribution and abundance of heather psyllids (*Strophingia* spp.) in the UK. Functional Ecology, 13:89-95.

Rohlf, F.J. 2007. TPSRelW version 1.24, Vol. 2007. http://life.bio.sunysb.edu/morph/. Tanggal akses.

Tantowijoyo, W. 2008. Altitudinal distribution of two invasive leafminers, *Liriomyza huidobrensis* (Blanchard) and *L. sativae* Blanchard (Diptera: Agromyzidae) in Indonesia (Thesis). The University of Melbourne, Melbourne.

Naskah lengkap dapat dikirimkan melalui pos atau elektronik, dengan alamat:

Redaksi Zoo Indonesia
d/a Bidang Zoologi – Puslit Biologi LIPI
Jl. Raya Jakarta-Bogor Km. 46
Cibinong 16911
zooindonesia@gmail.com

DAFTAR ISI