Management of Forest : The Effect of Global Warming Towards Insect Fauna on Forest Area

Ibnu Sina
Universitas Pamulang
ibnu.sina@unpam.ac.id

Iskandar Zulkarnaen
Universitas Pamulang
dosen01748@unpam.ac.id

Abstract
Study of insect fauna on forest area was conducted from July to August 2019 to determine the diversity and abundance of beetle fauna at Burni Geureudong Forest, Takengon, Central Aceh. The study was conducted at two sites namely trail I and trail II. The beetles were sampled using 2 light traps, 2 malaise traps and 20 pitfall traps. Total of 219 beetle specimens comprising of 67 species from 24 families were collected. Light trap collected the most number of beetles (N=117) and Margalef index showed that the most abundant beetle was collected by light trap (Margalef index, 27.551). Shannon-Weiner index shows that the most specious beetle was caught by light traps (4.399). The most abundant family caught was Staphylinidae (Margalef index : 2.667) and specious beetle family caught was the Chrysomelida (Shannon Weiner : 1.846) followed by the ground beetle family Scarabaeidae (Shannon Weiver:1.828). Result of this findings showed that Burni Geureudong Forest is an undisturbed forests and has been preserved well.

Keywords: beetle, diversity, abundance

1.0 Introduction

Tropical rain forests are one of the most species-rich and functionally important terrestrial ecosystems supporting over half of global biodiversity (Myers *et al.*, 2000). Although rain-forest modification andconversion has generally a strong negative effect on biodiversity, responses to anthropogenic disturbancesvary between taxonomic groups (Lawton *et al.*,1998; Schulze *et al.*, 2004). The loss of biodiversity is not only a conservation issue but also can have important ecological consequences. For example, a decline in species richness can negatively affect ecological services suchas pollination and the natural control of pests (Klein *et al.*, 2002; Klein *et al.*, 2003). Therefore, studies on the response of functional groups, which provide important ecosystem services to anthropogenic disturbance are urgent when aiming to maintain a high sustainability of tropical land-use systems.

Forest management in temperate and boreal regions is often based on a strong foundation of applied ecological research. Increasingly, this has allowed the needs of dead wood associated insects to be addressed. However, there has been very little equivalent research in tropical forests, where insect faunas are likely to be much richer and where forestry is usually subject to weaker environmental controls. As in temperate regions, tropical beetles are likely to be highly specious, and to exhibit a wide range of life-histories. Coupled with their relative ease of capture, storage and identification (compared to many other invertebrates), these attributes make beetles potentially valuable in detecting impacts of tropical rainforest management that should equally be felt by many other groups of more cryptic forest-dwelling organisms sharing an association with the mature timber habitat (Simon Grove, 2001).

Insect plays significant role in ecosystem dynamics such as at forest, freshwater lakes, ponds, rivers, mountain and agricultural and also in our life. Tropical forest insect dominate the number of described and estimated species on earth. Understanding the degree of insect specialization to vertical zones, host plants and other resources within tropical forests is of central importance to global species richness estimates (Erwin, 1982; Stork, 1988; Hammond, 1995; Odegaard, 2000; Novotny et al., 2002). Tropical beetles are likely to be highly specious, and to exhibit a wide range of life-histories. Coupled with their relative ease of capture, storage and identification (compared to many other invertebrates), these attributes make beetles potentially valuable in detecting impacts of tropical rainforest management that should equally be felt by many other groups of more cryptic forest-dwelling organisms sharing an association with the mature timber habitat.(Grove, 2001). Beetles are well represented in all terrestrial habitats by many species, genera, and families, which are often used as indicators of environmental change because of their great habitat specificity (Forsythe, 1987; Lovei and Sunderland, 1996). Due to their small length, diversity and sensitivity to environmental stress have been considered as good indicators of habitat heterogeneity.

The tropical forest is one of the richest habitats for plant and animal diversity (Prance, 1982) and some simple but informative work can be undertaken comparing animal or plants diversity across different habitats especially for habitat was disturbance cause of deforestation, agriculture, plantation or climate change. A study on abundance and diversity of beetles Burni Geureudong forest was conducted to determine that the beetles have not been affected by disturbed environment caused by global warming.

2.0 Material and methods

2.1 Study area and sampling duration

The study area is located in at Burni Geureudong forest area, about 50 km east of Takengon city. The margins of the park are characterizedby a mosaic of near-primary forest, human-modified forests, forest gardens and plantings of lemon grass, coffee and few vegetables, as the most important crops (Gerold *et al.*, 2004). The study sites are located in at Burni Geureudong forest area (4°48'51.8"N 96°48'54.2"E) In the period June 2018–July 2019, precipitation at forest area was 1889 mm y^{-1}, mean daily temperature, relative humidity, wind speed, and global radiation were 23.6^{0}C, 82.0%, 0.92 $ms^{-1}$and 17.7 MJm^{-2}, respectively (BMKG Stasiun Melikul Saleh, unpublished data). Samplings were made at two sites namely trail I and trail II area.

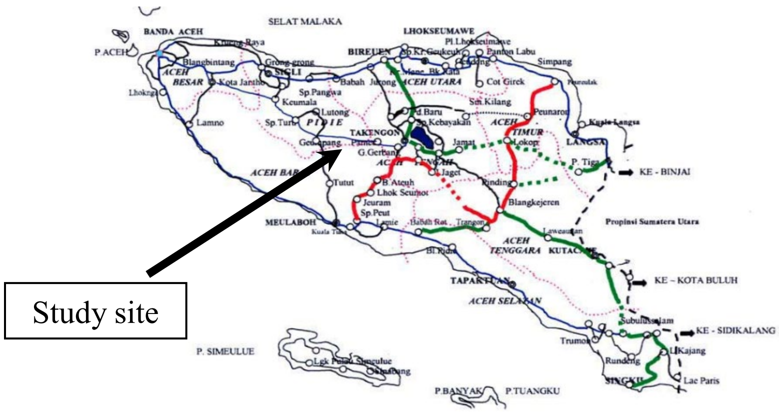

Figure 1: Location of study

2.2 Sampling methods

To ensure maximum assemblage, several methods of collection were employed following Fauziah and Ibnu Sina (2009). Throughout the expedition, a total of four malaise traps and five pitfall traps were set up in the morning at 0800 h for 24 hours at each sampling site in total of 3 days sampling. Six light traps were set up before nightfall and generator was switched on at 1900 to 2400 to collect beetles attracted to light.

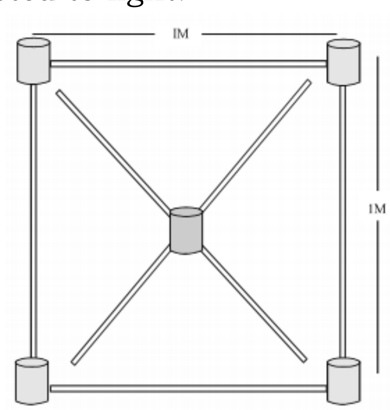

Figure 2: Set up pit fall for each trail (Fauziah *et al.*, 2008)

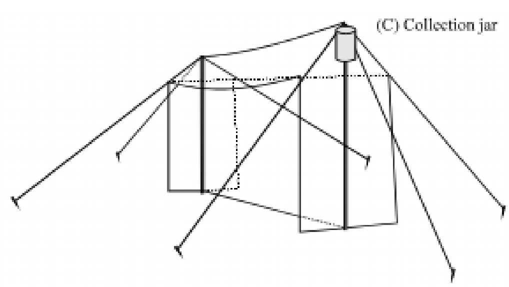

Figure 3: A malaise trap set up one meter froum ground (Fauziah *et al.*, 2008)

2.3 Sorting, preservation and identification

Specimens were sorted to family level according to Borror and Delong (1974) and Triplehorn and Johnson (2004) and the specimens were preserved in 70% alcohol in scintillation vials. The specimens were brought back to Jakarta, pinning and drying in oven. The beetle species were identified using key identification (Borror and Delong, 1974)

Figure 4: Sorting beetle into families, genus and species level

2.4 Ecological indices calculation.

Species richness and abundance of beetle fauna were determined using Margalef index and the diversity was calculated using Simpson index and Shannon-Weaver index.

$$R = \frac{S-1}{\ln N}$$

S: the number of species recorded in a sample; with that of sample size N (Waite, 2000). Abundance increased proportionately with the value of Margalef index.

The diversity of each different family of beetle and the overall for Coleoptera was determined using Shannon-Weaver Index,

$$D = 1 - \sum_{i=1}^{N}(p_i)^2$$

This index assumes that each species was represented in each sample and that there was random sampling of individuals from an infinitely large population. Diversity increases with the increase in the value of the index. Shannon-weaver index has a maximum value of 5.

Based on the probability that two unrelated strains sampled from the test population will be placed into different typing groups. This probability can be calculated by Simpson's index of diversity, which was developed for the description ofs pecies diversity within an ecological habitat. This index can be

$$D = \frac{\Sigma\, n(n-1)}{N(N-1)}$$

derived from elementary probability theory and is given by the following equation:

3.0 Results

A summary of beetles sampled at Burni Geureudong forest is given in Table 1. Total of 219 beetle specimens comprising of 67 species from 24 families were collected. The checklist of the beetles collected at Burni Geureudong forest shown in Table 2. The beetles were abundant at all trails locations as shown by the values of Margalef index (Table 3). Light trap collected the most number of beetles (N=117) and Margalef index showed that the most abundant beetle was collected by light trap (Margalef index, 27.551). Shannon-Weiner index shows that the most specious beetle was caught by light traps (4.399). The results showed that the most efficient trap was light trapping. Trail I has the most abundance (Margalef Index: 18.572) but trail II was the most specious (Shannon Weiner Index: 4.176) beetle fauna, whereas trail II has the least abundance (Margalef Index: 17.295) and Campsite has least diverse (Shannon Weiner Index: 3.769).The most abundant family caught was Staphylinidae (Margalef index : 2.667) and specious beetle family caught was the Chrysomelida (Shannon Weiner : 1.846) followed by the ground beetle family Scarabaeidae (Shannon Weiver:1.828).

Table 1:A summary of beetles collected from three study sites in Burni Geureudong Forest

Sites	**Individual**	**Family**	**Species**	**Margalef index**	**Shannon Weiner index**
Trail I	102	11	28	15.145	0.938
Trail II	117	13	39	16.573	0.954
Total	219	24	67	31.718	0.958

Table 2: Checklist of beetles at Burni Geureudong forest and value of ecological indexes according to family.

Family	**Morpho-sp**	**Ind**	**Margalef Index**	**Simpson Index**	**Shannon-Weaver Index**
Anobiidae	Ano A	1			
Anthribidae	*Litocerus deyrol*	1	1,442695041		0,69315
	Litocerus payiei	1			
Bostrichidae	*Sinoxylon conigerum*	1	1,442695041		0,69315
	Bost B	1			
Byrrhidae	*Byrrhus* sp	1	1,442695041		0,69315
	Byrr B	1			
Carabidae	*Brachinus* sp	7			
	Clivina sp	15	0,943973941	0,456521739	0,91797
	Nebria rufescens	1			
	Adelioides sp	1			

Cerambycidae	*Pterolophia* sp	1			
Chrysomelidae	*Ochrales nigripes*	3			
	Nodostoma sp.	2			
	Smaragdina sp	1	2,502194349	0,090909091	1,84622
	Chrysolina sp	2			
	Phratora sp	1			
	Luperus sp	1			
	Chry F	1			
Cicindelidae	*Cicindela versicolor*	1			
Cleridae	Cle A	1	0,910239227	0,333333333	0,63651
	Cle B	2			
Coccinelidae	Cocci A	2		1	
Curculionidae	Cucu A	1			
	Curcu B	2			
	Curcu C	2	2,055593369	0,095238095	1,54983
	Curcu D	1			
	Curcu E	1			
Dystiscidae	Dys E	1			
Elateridae	*Alaus nubilus*	1			
	Monocrepidus paradigophorus	1			
	Ela C	1	2,164042561		1,38629
	Ela D	1			
Erotylidae	*Megadolacne* sp	1			
Hydrophilidae	*Merosternum species*	1			
Lampyridae	*Photinus* sp	1			
Lucanidae	*Lucanus* sp	1			
Lycidae	*Lygistopterus sanguineus*	1			
Nitidulidae	*Carpophilus* sp	1	1,442695041		0,69315
	Niti B	1			
Platypodidae	*Platypus linearis*	15		1	
Scarabaeidae	*Anomala cusripes*	1			
	Anomala sp	1			
	Anomala sp2.	1			
	Oryctes sp	1	2,652462272	0,142857143	1,82884
	Phyllopaga sp	3			
	Scara F	1			
	Scara G	5			
	Scara H	1			
Scolytidae	*Xyleborus affinis*	11	0,306927676	0,492307692	0,68127
	Xyleborus sp	15			
Staphylinidae	*Paederus* sp	66			
	Orphnebius sp	5			

	Acylophorus sp	2			
	Eleusis kraatzi	7			
	Bledius sp	1			
	Orphnebius bakerianus	1	2,660246896	0,532356532	1,18264
	Lispinus sp	3			
	Pachycarimus sp	1			
	Philontus ventralis	1			
	Paederus sp	1			
	Stenomastax sp	1			
	Tachnimorphus fulvipes	1			
	Staphy M	1			
Tenebrionidae	*Eucyrtus pretiosus*	2			
	Melanimon tibialis	1	1,242669869	0,2	1,05492
	Alobates sp	2			
24	**67**	**219**	**12,24700715**	**0,108709313**	**3,14954**

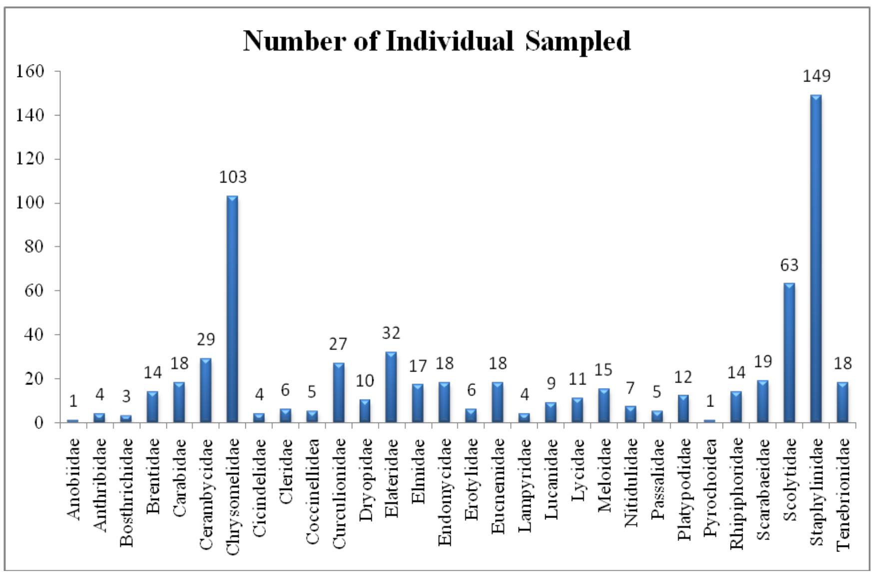

Figure 5: Number of individual of each family of beetle sampled at BurniGeureudong forest

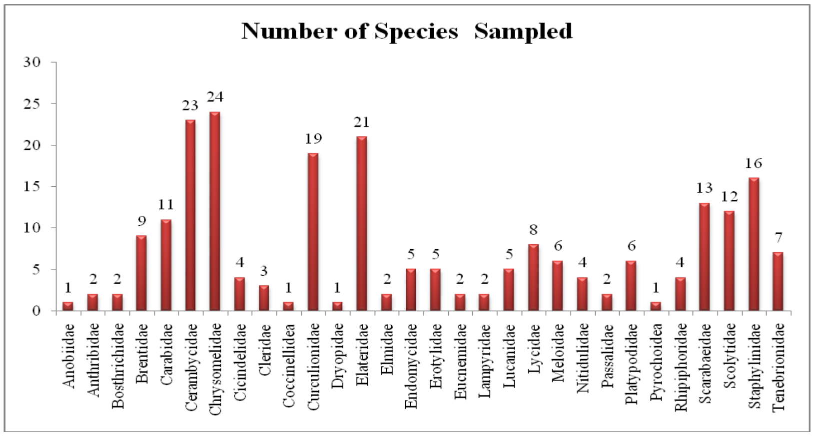

Figure 6: Number of species sampled from each family of Beetle at Burni Geureudong forest

Figure 5 shows that most of the beetle specimens collected belongs to family Staphylinidae (N=149) followed by Chrysomelidae (N=103) and Scolytidae (N=63). Figure 3 gives the number of species collected from each beetle family. The most number of species collected were from family Chrysomelidae (N=24) followed by family Cerambycidae (N=23) and Elateridae (N=21)

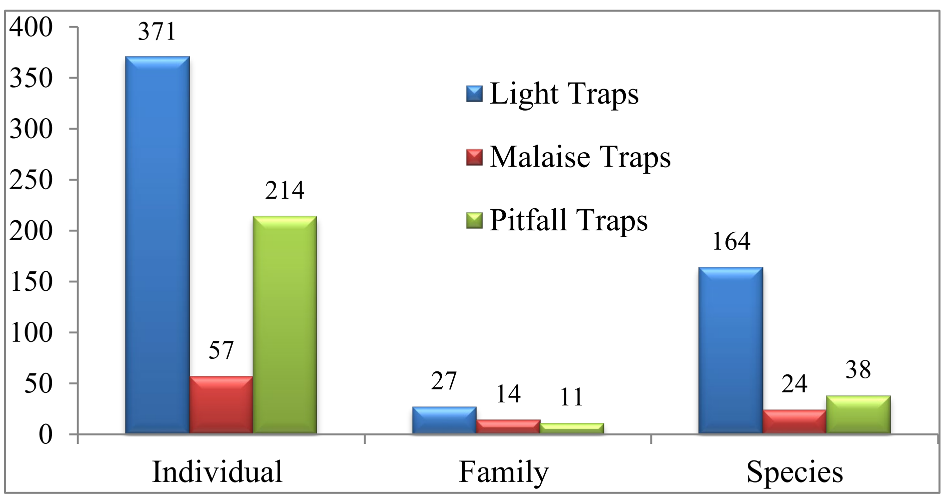

Figure 7: Number of species sampled using different traps between sites at Burni Geureudong forest

Figure 6 shows that the highest number of beetle family (N=29) collected was from trail Chamah followed by the sampling from Campsite (N=26) whereas the least number of beetle family sampled were at trail Royal Dakota (N=23). Figure 7 shown that, number of species sampled using different traps between sites. Light trap collected the most for individual, species and family compared to malaise trap and pitfall trap.

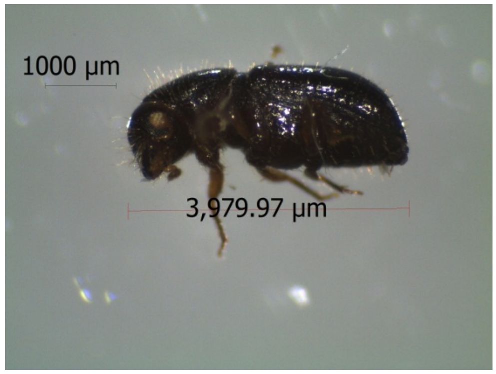

Figure 7: *Poecilips varabilis*

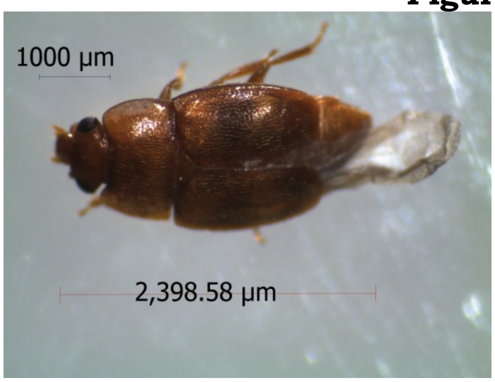

Figure 8: *Brachypeplus orientalls*

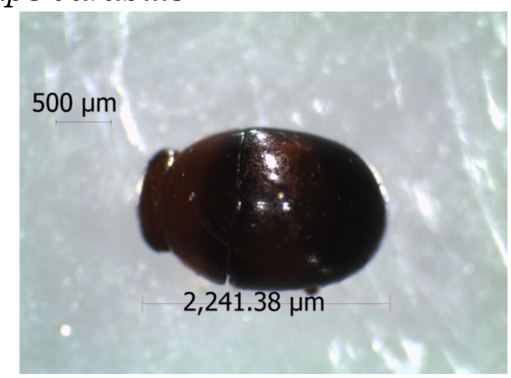

Figure 9: *Byrrhinus* sp.

4.0 Discussion

Combining all study sites, there was a high abundance (Margelef index, 33.885) and high diversity (Simpson diversity index, 0.968: Shannon Weiner index, 4.534) of beetle fauna sampled at Burni Geureudong forest, Central Aceh. This is because the forests were still intact with no human activities no development.

The findings of this study shown that, the most efficient trap was light trapping. Light trap method used light as an attraction to the insect approaching. According to Melbourne (1999), vegetation structure influences trap capacity to capture insects.

The most abundant and specious beetle family caught was Cerambycidae (29 individual from 23 species, Margalef index : 6.533; Simpson diversity : 0.953; Shannon Weiner : 2.994) followed by the click beetle family Elateridae (32 individual from 21 species, Margalef index : 5.771; Simpson diversity : 0.967; Shannon Weiner : 2.913). Dagobert et al. (2010) reported family Chrysomelidae are the most abundant family followed by Cerambycidae cause of this family are phytophagous and are generally found on the foliage.

Result of this findings show that Gayo Lues forest is an undisturbed forests which have been preserved well. Tropical rainforest are home to a rich diversity of plants, birds, insects and other animals and they also play an important role in our global climate and provide aesthetic, recreational and medical benefits. For these reasons and others, it is critical that we understand how these forests generate and sustain their diversity and what we can do to help conserve them.

Refferences

Borror, D.J. & D.M DeLong,. (1971). An Introduction to the Study of Insects (3rd ed). New York : Holt, Rinehart and Winston.

Dagobert K. K., Mamadou D. & Jan K. (2010). Assessment of beetle abundance and diversity by four methods of capture in the west-central part of Oume, Ivory Coast. *Journal of Animal and Plant Sciences*, *6*, 579-588.

Erwin, T. L. (1982). Tropical forests: their richness in Coleoptera and other arthropod species. *Coleopt. Bull*, *36,* 74-82.

Fauziah Abdullah & Ibnu Sina. 2009. Rove Beetles (Coleoptera: Staphylinidae) of Lanjak Entimau, Sarawak, East Malaysia. *International Journal of Zoological Research, 5*(3), 126-135.

Fauziah Abdullah & Kamarulnizam Shamsulaman. (2008). *Beetle fauna of royal belum in*: Proceeding of Seminar of Scientific Expedition on Biological Diversity of Royal Belum 2008 Hotel Syuen, Ipoh (pp 30)

Fauziah Abdullah & Kamarulnizam Shamsulaman. (2010). Ground beetle (coleoptera: carabidae) at Lanjak Entimau, Sarawak. *Journal of Entomology* 7 (1): 44-53, 2010

Fauziah Abdullah, Ibnu Sina & Fatmahjihan Fauzee. (2008). The ground beetle fauna (coleoptera: carabidae) of kenyir water catchment, Terengganu, peninsular Malaysia. *Parkistan Journal of Biological Sciences, 11* (21), 2478-2483.

Fauziah Abdullah, Kamarulnizam Shamsulaman & Ibnu Sina. (2009). *Beetle fauna of Lanjak Entimau , Sarawak, Malaysia*. Seminar Biodiversity of Eastern Lanjak Entimau. Kuching Sarawak

Fauziah Abdullah, Kamarulnizam Shamsulaman & Suwati Mat Isa. (2008). *beetle fauna at cameron highlands montane forest* . Seminar Scientific Montane Expedition of Cameron Highland (pp 31) Pahang.

Fauziah Abdullah, Kamarulnizam Shamsulaman, Fatmahjihan Fauzee & Suwati Mat Isa. (2008). *Diversity of beetles (insecta:coleoptera) at angsi mountain and berembun mountain reserved forests, Negeri Sembilan.* Seminar Scientific Expedition on Angsi Mountain. (pp 22). Seremban, Negeri Sembilan

Forsythe T. G. (1987). The relationship between body form and habit in some Carabidae (Coleoptera). *J. Zool. Soc. London, 211*, 643-666.

Grove S.J. (2001). The influence of forest management history on the integrity of the saproxylic beetle fauna in Australian lowland tropical rainforest. *Biol. Conservation*, *104* (2), 146-171.

Hammond, P. M. (1995). *Microbial diversity and ecosystem function* . Wallingford, UK: CAB International.

Idris A. B., Ismail S., Haron Y. & Suhana Y. (2009). Insects of tasik Chini with special emphasis on ichneumonid wasps. *Sains Malaysiana*, *38* (6), 813-816.

Klein, A. M., Steffan-Dewenter, I & T. Tscharntke. (2002). Fruit set of highland coffee increases with the diversity of pollinating bees. *Proceedings of The Royal Society of London,* 955-961.

Klein, A. M., Steffan-Dewenter, I & T. Tscharntke. (2002). Predator-prey ratios on cocoa along a land-use gradient in Indonesia. *Biodiversity and Conservation 11*, 683-693

Lawton, J.H., Bignell, D.E., Bolton, B., Blomers, G.F., Eggleton, P., Hammond, P. M., Hodda, M., Holt, R.D., Larsen, T.B., Mawdsley, N.A., Stork, N. E., Srivastava, D.S. & A. D. Watt. (1998) . Biodiversity inventories, indicator taxa and effects of habitat modification in tropical rain forest. *Nature*, *392*, 72-76.

Lovei G. L. & Sunderland K. D. (1996). Ecology and behavior of ground beetles (Coleoptera: Carabidae). *Annu. Rev. Entomol.* 41:231-256.

Melbourne B. A. (1999). Bias in the effect of habitat structure on pitfall traps: An experimental evaluation. *Australian Journal of Ecology*, *24*, 228-239.

Myers, N., Mittelmeier, R.A., Mittelmeier, S.G., Fonseca, G.A. & J. Kent. (2000). Biodiversity Hotspots for Conservation Priorities. *Nature*, *493,* 853 – 858.

Novotny V., Basset, Y., Miller, S. E., Weiblen, G. D., Bremer, B., Cizek, L. & Drozd, P. (2002). Low host specificity of herbivorous insects in a tropical forest. *Nature*, *416*, 841-844.

Odegaard, F. (2000). How many species of anthropods? Erwin's estimate revisited. *Boil. J. Linn. Soc. 71*, 583-597.

Prance G. T. (1982). *Biological diversification in the tropics*. New York: Columbia University Press.

Schulze, S.H., Waltert, M., Kessler, P.J.A., Pitopang, R., Shahabuddin, Veddeler, D., Steffan-Dewenter, I., Muhlenberg, M., Gradstein, S.R. & T. Tscharntke. (2004). Biodiversity indicator groups of tropical and-used systems : comparing plants, birds and insects. *Ecological Application ,14*, 1321 – 1333.

Stork, N. E. (1988). Insect diversity: facts, fiction and speculation. *Biol. J. Linn. Soc.,35*, 321-337.

Triplehorn, C.AS. & N.F. Johnson. (2004). *Borror and delong's introduction to the study of insects*. Brooks Cole.