RAPID BIODIVERSITY ASSESSMENT (RBA): ANTS AS A MODEL

JULIA KUNAI @ GEORGE

SCHOOL OF SCIENCE AND TECHNOLOGY
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JULIA KUNAI @ GEORGE

SEKOLAH SAINS DAN TEKNOLOGI
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DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries, each of which have been fully acknowledged.

Julia George Kunai
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ABSTRAK

RAPID BIODIVERSITY ASSESSMENT (RBA): ANTS AS A MODEL

Kajian ini mengenai penilaian biodiversiti secara cepat (RBA) menggunakan semut sebagai peraga yang dijalankan selama lapan bulan di antara bulan Disember 2000 hingga Julai 2001. Kawasan kajian ialah di Rizab Hidupan Liar Tabin, Lahad Datu Sabah. Tiga kawasan hutan dengan status gangguan berbeza (hutan dipterokap tanah rendah yang belum dibalak, hutan dipterokap tanah rendah yang sudah dibalak (1960an hingga 1980an dan ladang kelapa sawit yang berusia 10 tahun) di bandingkan. Objektif kajian ialah; (1) menilai enam kaedah yang digunakan dan mencadangkan satu kaedah ataupun kombinasi kaedah yang terbaik untuk penilaian biodiversiti yang cepat. (2) melihat status kepelbagaian semut di setiap jenis hutan yang berbeza. (3) membuat satu koleksi rujukan semut di Rizab Hidupan Liar Tabin. Enam kaedah yang digunakan dalam kajian ini ialah: (1) kaedah lubang berumpan sepanjang transek 100m (2) kaedah pungutan semut secara manual sepanjang transek 100m (3) kaedah lubang berumpan secara kuadrat dalam plot 50m X 50m (4) kaedah pungutan secara manual dalam plot 50m X 50m (5) kaedah Beg Winkler (6) kaedah corong Berlese. Sepanjang tempoh kajian, 2 plot bagi setiap jenis hutan telah dibuat. Parameter yang di lihat dalam kajian ini ialah kekayaan, kepelbagaian, kesamarataan dan kesamaan semut. Ujian bagi menentukan kaedah yang paling lengkap menangkap spesies semut juga dibuat dengan menggunakan empat jenis penganggar kekayaan spesies (ICE, Chao2, Jack1 dan MMMean). Kaedah penangkapan secara manual transek mencatat bilangan spesies yang terbanyak (179 spesies) dan merupakan kaedah yang termurah. Walau bagaimanapun, gabungan kaedah lebih menggambarkan perwakilan semut di sesuatu kawasan berbanding dengan hanya satu kaedah. Gabungan kaedah pengutipan secara manual dan beg Winkler merupakan gabungan yang terbaik di kawasan hutan yang belum dibalak (142 spesies) dan kawasan hutan yang telah dibalak (165 spesies). Bagi kawasan ladang, gabungan kaedah umpan berlubang sepanjang transek dan beg Winkler merupakan kaedah yang terbaik (101 spesies). Spesies semut yang berjaya dikumpul di hutan yang telah dibalak lebih banyak (199 spesies) berbanding dengan kawasan hutan yang belum dibalak (186 spesies) dan kawasan ladang (135 spesies). Tidak terdapat perbezaan secara bererti dari segi statistik di kawasan hutan yang telah dibalak dengan kawasan hutan yang belum dibalak ($P>0.05$). Indeks kepelbagaian Shannon-Weiner menunjukkan hutan yang belum dibalak mempunyai semut yang lebih pelbagai ($H'=1.864$) dan kelimpahan semut lebih sekata berbanding dua kawasan yang lain ($E=0.357$). Pertindihan dan kesamaan bagi kelimpahan spesies semut tinggi di kawasan hutan yang belum dibalak dengan kawasan hutan yang telah dibalak ($C_s=0.717$).

ABSTRACT

RAPID BIODIVERSITY ASSESSMENT (RBA): ANTS AS A MODEL

This study on the rapid biodiversity assessment (RBA) using ant as model was carried out over a period of eight months between December 2000 to July 2001. The study site is at Tabin Wildlife Reserve (TWR) in Lahad Datu, Sabah. Three different habitat types (unlogged lowland dipterocarp rainforest, logged lowland dipterocarp rainforest (1960's to 1980's) and oil palm plantation (10 years after planting) were compared to see the diversity of ants. There were three main aims for this study: (1) to evaluate the six sampling methods used and to recommend the best method or combination of methods in rapid biodiversity assessment using ants. (2) to relate the status of biodiversity of the ant fauna to different degrees of forest disturbance. (3) to produce a reference collection of ants from TWR. Six different methods were used: (1) baited pitfall trapping along a 100m transect (2) manual collecting along a 100m transect (3) pitfall trapping in a 50m X 50m quadrat (4) manual collecting in a 50m X 50m plot (5) Winkler's bag (6) Berlese funnel. For the whole study, there were 2 plots in each forest site. The parameters studied were the ant species richness, diversity, evenness and similarity. Test of completeness of sampling methods for collecting ants was done by using four different kinds of species richness estimator (ICE, Chao2, Jack1 and MMMean). For the whole sampling, the manual transect method captured the highest number of species (179 species) and the least effort needed. The test of species richness estimator also showed the similar results. Nevertheless, combination of methods will ensure a comparatively complete representation of the ant fauna. Combination of manual transect and Winkler was the best in unlogged (142 species) and logged (165 species) forest, whereas in plantation combination of pitfall transect and Winkler was the best (101 species). The number of species captured in logged forest recorded the highest value (199 species) compared to unlogged forest (186 species) and plantation (135 species) but there was no significant difference between logged and unlogged forest ($P>0.05$). The value of Shannon-Weiner index showed that the unlogged forest is most diverse ($H'=1.864$) compared to the logged forest and oil palm habitat. Furthermore, the ant abundance in unlogged forest was more evenly distributed ($E=0.357$) than in logged forest and plantation. There was a high overlap and similarity of ant fauna in logged and unlogged forest ($C_s=0.717$), which indicated that selectively logged forests can support an assemblage of species similar to that found in undisturbed forests.

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LISTS OF ABBREVIATIONS

RBA	: Rapid Biodiversity Assessment
TWR	: Tabin Wildlife Reserve
PT	: Baited pitfall trapping along a 100m transect
PP	: Baited pitfall trapping quadrat in a 50m X 50m plot
MT	: Manual collecting along a 100m transect
MP	: Manual collecting in a 50m X 50m plot
W	: Winkler's bag
B	: Berlese funnel
ICE	: An incidence-based coverage estimator of species richness
Chao2	: An incidence-based estimator of species richness
Jack1	: The incidence-based coverage estimator of species richness
MMMean	: A Michaelis-Menten Means asymptotic based estimator of species richness
CPI	: Crown Position Index
DBH	: Diameter-Breast-Height
U	: Unlogged forest
L	: Logged forest
OP	: Oil palm plantation
H'	: Shannon-Weiner Index
E	: Evenness Index
C_s	: Similarity Index

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KEYWORDS: Ants, Rapid, method, Assessment, Protocol, Sabah

CHAPTER 1

INTRODUCTION

1.1 BIODIVERSITY ASSESSMENT

This project is about assessing and choosing one protocol or methodology that can provide a reasonably quick and sound results for assessment of biodiversity at Tabin Wildlife Reserve, Lahad Datu, Sabah. Inventories of species at particular sites provide essential data sets for conservation and resource management. However there are major problems with the deceptively simple task to produce them. Nowadays, we face many conservation problems but there is insufficient resource, such as time and money to tackle them. With the rapid loss of habitat and biodiversity, there is an urgent need for Rapid Biodiversity Assessment (RBA) ideally to be carried out prior or at least, during the conservation planning process. Resources for conservation such as time, money and taxonomic expertise are always limited and prohibit a complete survey of all taxonomic groups. Hence, several rapid strategies for measuring biodiversity have been implemented (Schulenberg and Awbrey 1997; Mack 1998). As a result, scientists have selected taxonomic groups, and refer to them as indicator taxa (Lawton *et al*., 1998), priority taxa (New, 1987), surrogate taxa (Oliver and Beattie, 1996), predictor sets (Kitching, 1993), focal groups (Di Castri *et al*., 1992), or target taxa (Kremen, 1992).

1.2 IMPORTANCE OF STUDY

Humans depend on biological resources for food, energy, construction, medicine, inspiration among others for their existence. Indeed, biodiversity and humans have had a close supportive bounding for tens of thousands of years. The biological resources upon which people depend have the critical character of being renewable; at least when they are managed well; but biological resources that are abused can also become extinct (McNeely *et al*., 1995). The way societies have managed their resources determines how much diversity survives and the way that societies manage biological diversity determines the productivity of important resources and ecological services.

Presently environmental changes are mostly treated as negative impact of unsustainable human activities. The 'Global Biodiversity Strategy' (WRI, IUCN, UNEP, 1992) identified both direct mechanism that affect current levels of biodiversity, nearly all of which have significant human components. The direct mechanism, following Soulé and Wilcox (1980), Diamond (1985) and Sutherland (2000) include:

a. Exploitation of wild resources
b. Expansion of agriculture, forestry and aquaculture
c. Habitat loss and fragmentation
d. Indirect negative effects of species introduced by humans
e. Indirect positive effects of species introduced by humans
f. Pollution of soil, water and atmosphere
g. Global climate change

The indirect mechanisms identified in the 'Global Biodiversity Strategy' and elsewhere are arguably more significant and indicates the foundations of the human impact on biodiversity:

a. Human social organization
b. The growth of the human population

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The indirect mechanisms identified in the 'Global Biodiversity Strategy' and elsewhere are arguably more significant and indicates the foundations of the human impact on biodiversity:

a. Human social organization
b. The growth of the human population

c. Natural resource consumption patterns

d. Global trade

e. Economic systems and policies that fail to value the environment and its resources

f. Inequity in the ownership, management and flow of benefits from both the use and conservation of biological resources

A growing number of countries are now party to the 1992 Convention on Biological Diversity and are taking steps to implement various articles of the treaty. An up-to-date assessment of a wide range of technical, social economic and legal approaches available to achieve conservation and sustainable use, therefore, provides a timely contribution to conservation planning effort around the world.

There is a need to monitor how the environment is changing as results of phenomena as mentioned above. RBA is seen as tool for the monitoring purposes. Oliver (1996) suggested that RBA could overcome the problems of the application of conventional taxonomic approaches to large and poorly known invertebrate faunas especially when there are large demands placed on time, funds and expertise to assess the diversity at particular sites. There are three purposes of RBA: to assess the status of particular species, to assess overall biodiversity and to assess the 'sustainability' or 'healthy functioning' of a particular ecosystem, biological system or environment.

Oliver and Beattie (1993) used mostly invertebrates as test organisms in their study. This is because there is some evidence (Brooker, 1982; Yen, 1987; Burbridge *et al.*, 1992) indicating that flowering plants and vertebrate biodiversity are not accurate indicators of the species richness of invertebrates. As the result of these studies, Oliver and Beattie (1993) draw the conclusion that it is important to include invertebrates in biodiversity inventories. Measurements of the species richness or diversity of such indicator groups have been proposed as a representative measure of the species richness or diversity of other taxa, and therefore as an indicator of the overall diversity of an area (Alonso, 2000)

In this research six methods were used at three sites with different degrees of disturbance: logged forest, unlogged forest and oil palm plantation. Ants were used (as a biological indicator) to produce a sampling method or protocol for RBA in the forest by comparing the six methods in sampling efficiency. The six methods were:

a. Baited pitfall trapping along a 100m transect
b. Manual collecting along a 100m transect
c. Baited pitfall trapping quadrat in a 50m X 50m plot
d. Manual collecting in a 50m X 50m plot
e. Winkler's bag
f. Berlese funnel

1.3 OBJECTIVES

This study was carried out with three objectives:

a. To evaluate the six methods used and recommend the best method or combination of methods in rapid biodiversity assessment using ants as a model;
b. To relate the biodiversity of ant fauna with different degrees of forest disturbance and conversion; and
c. To produce a reference collection of ants from Tabin Wildlife Reserve.

CHAPTER 2

LITERATURE REVIEW

2.1. BIODIVERSITY

The term “Biodiversity” has a long history of usage in a variety of contexts. Lovejoy (1980a, 1980b) did not give a formal definition of biodiversity but used it essentially in sense of the number of species present. Norse and McManus (1980) employed it to include ‘two related concepts: genetic diversity and ecological diversity’. The latter authors equated ecological diversity with species richness, ‘the number of species in a community of organisms’. It is just a simple collection of species but refers to the diversity of life (Wilson, 1988, 1992). Species can be counted and the number of species that are present at one location might be a quantitative measure of biodiversity and allow comparison with other sites (Hawksworth, 1995).

Norse *et al.* (1986) and Noss, (1990), say that biodiversity is the variety of life forms such as different plants, animals and microorganisms, including their genomes and the ecosystems they form. Conservation of biodiversity is one of the key issues of worldwide environmental policy (Lenders *et al.*, 2001). For practical purposes, ‘biodiversity’ can be considered as synonymous with ‘biological diversity’ as defined by Norse *et al.* (1986). This was reinforced by the official definition in Articles 2 of the ‘Convention on Biological Diversity’, at the United Nations Conference on the Environment and Development, ‘The Earth Summit’ (1992), which closely mirrors the concept of Norse *et al.* (1986):

> “Biological diversity means the variability among living organisms from all sources including *inter alia,* terrestrial, marine and other aquatic systems and the ecological complexes of which they are part including the diversity within species, between species and of ecosystems.”

Within the context of the convention, biodiversity has many dimensions among which are social, medical, economic and political (Groombridge, 1992, Putterman, 1994; Olembo, 1995; Orlove and Brush, 1996; Pearce *et al.*, 1996; Pimentel *et al.*, 1997; Swanson, 1997; Edwards and Abivardi, 1998). Furthermore, the issue of biodiversity plays a role on many different spatial-temporal scales, and is, as a synthetic concept, inextricably linked to ecological constructs such as succession, path dynamics and connectivity. The concept draws upon disciplines such as biogeography, (population) genetics, evolutionary science and (landscape) ecology (Lenders *et al.*, 2001).

'Biodiversity' represents a broad and integrated perspective (Huston, 1994; Schulze and Mooney, 1994; Rosenzweig, 1995) and a heightened concern for threats to gene pools, species and habitats on a global scale (Wilson, 1992; Ricklefs and Schluter, 1993; Mooney *et al.*, 1996). As emphasized by Noss (1990), conservation of biodiversity involves 'more than just a species diversity or endangered species'.

At the global level, 1.7 million species have been described to date; current estimates for the total number of species in existence vary form five to nearly 100 million (Read, 1991). Ecosystem diversity encompasses the broad differences between ecosystem types, and the diversity of habitats and ecological processes occurring within each ecosystem type. It is harder to define ecosystem diversity than species or genetic diversity because the 'boundaries' of communities (association of species) and ecosystems are more fluid (DEST, 1993). The highest number of undescribed life forms on earth lives in tropical moist forest and our knowledge about this ecosystem is fragmentary (Wilson, 1988). A basic requirement for understanding the functioning of tropical biotas is ecosystem analysis.