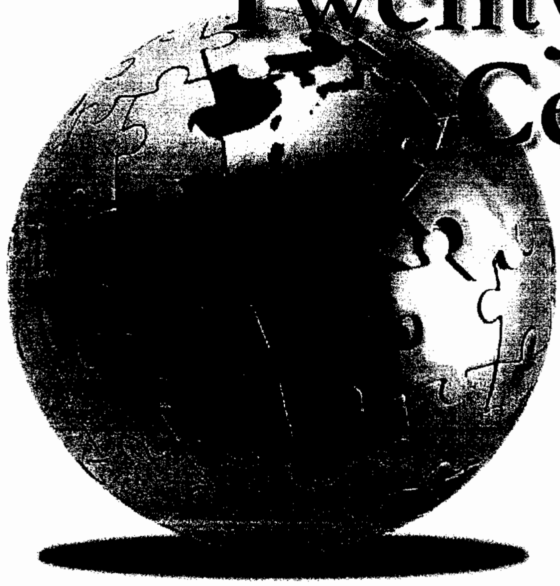
Innovative Indonesia:

Facing the Challenges of the Twenty First Century



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FOREWORDS

I very much welcome the publication of this Proceedings, documenting papers presented at the National Conference on "Innovative Indonesia—Meeting the Challenges of the 21st Century", together with an associated workshop, organized by a select group of Indonesian young scientists, on various current scientific issues in meeting such challenges. These events had been organized in October 2010, in commemoration of the 20th anniversary of the Indonesian Academy of Science (AIPI—Akademi Ilmu Pengetahuan Indonesia).

Twenty years is a very young age for an academy of science, and for AIPI it has been a particularly trying existence. Established in 1990 by a Law of the Republic of Indonesia (No. 8/1990), AIPI has strived to fulfill its mission as an independent body that "gives opinions, suggestions, and advice to the government and society on the acquisition, development and application of science and technology". In its first ten years, the Academy functioned quite effectively through partnership with the National Research Foundation (DRN—Dewan Research Nasional). During the most exiting decade of the development of science and technology in Indonesia, members of AIPI were also members of DRN by design, and thus contributed directly to the shaping of the national science development. But together with the Indonesian science and technology at large, AIPI had to struggle for its survival during the darkest years of the socio-political turmoil that followed the Asian financial crisis in the first half of the last decade.

Marking its revival, the Academy took the lead in the worldwide commemoration of 150 years of the theory of evolution two years ago, by organizing an international conference focusing on the legacy of its often forgotten co-discover, Alfred Russel Wallace—and the contribution of the biodiversity of Indonesia in inspiring the formulation of arguably the most significant scientific ideas of the 19^{th} century. This event celebrated the rich and unique biodiversity of the island Southeast Asia that now carries his name—The Wallacea region. Today, together with increasing confidence in fulfilling its roles in science advocacy and diplomacy, the Academy actively promotes science through scientific conferences and policy discussion forums, publications, and national and international relations; in a marine nation of 17,560 islands and 240 million people.

I wish to thank all my colleagues at the Academy, in particular Satryo Soemantri Brodjonegoro—as well as all the invited speakers at the National Conference—for all their generous efforts and contributions that have made our twenty years commemoration a success. To Budhi Suyitno, Ida Yara and all the staffs of AIPI Secretariat General—thank you for all your hard work and contribution; I am most aware that providing the administrative support for the multitude of events this year had been very challenging. But, I should specifically express my gratitude to all the young scientists who have contributed so much to this special anniversary year, and to Rika Raffiudin, Ismunandar, Ocky Karna Radjasa, Fenny Dwivany and Heni Rachmawati, who have worked so hard to produce this Proceedings; I am thankful for their never ending optimisms and enthusiasms. This Proceedings serves as a record and acknowledgement, of the critical role played by Indonesian young scientists in the future development of the Indonesian science and technology, and thus in the future of Indonesia.

Jakarta, 15 April 2011

Sangkot Marzuki
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Molecular Approach for Studying Insect Mating and Foraging Behavior

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Abstract

Insect perform tremendous variety of behavior, both in their solitary and social life style. In this paper briefly review several molecular approach used as the tool for studying insect behavior. The first approach is characterizing the pheromone binding protein gene expressed in the antenna of rice stem borer. The study was aimed to disrupt the mating behavior of this important rice pest in Indonesia. Subsequently, this paper dwell several complex behavior of honey bees and termites as social insect. Worker honey bees elaborate a fascinating behavior in food recruitment known as "waggle dance" and in their defensive behavior. The evolution of honey bee waggle dance was mapped in honey bee phylogenetic tree constructed based on several mitochondrial and nuclear genes. The result revealed that the horizontal dance performed by the dwarf honey bee is the most primitive behavior. Defensive behavior in Asian honey bee *Apis cerana*, showed another complex social behavior and it was encoded by *sting*_1 and 2 genes. The most interesting social behavior in termites is their foraging behavior that damage huge numbers of cellulose products. The ability of termites to digest the cellulose is due to the existence of endoglucanase enzyme in their gut for cellulose digestion. In the future, this enzyme is potential as one of the main component for bioethanol production. The last example of molecular approach for insect behavior is the use of molecular marker to detect invasive alien species such as the Africanized honey bee in Indonesia apiaries.

Keywords: rice stem borer, sex pheromone, honey bee, waggle dance, termites, endoglucanase

1. Insect sex pheromone as biocontrol

Yellow rice stem borer, *Scirpophaga incertulas*is the important rice pest in Indonesian and in other Asian countries. In West Java, *S. incertulas*particularly found in Karawang, Subang, Indramayu and Cirebon. The use of insectiside unresolved this pest problems, since the stem borers has already resistant to the insecticides. A sustainable biocontrol in pest handling is needed, i.e. by using sex pheromone as the attractant to the male moth. This mating disruption method will lower the copulation behaviour; therefore, will decrease the pest population.

The male rice stem borer antenna has pheromone binding protein (PBP) that selectively bind the sex pheromone release from the female moth. Hence, PBP can be a selective filter to bind the sex pheromone. Of all the PBP found in insect, none was reported from *S. incertulas.* A characterization of genomic PBP of from rice stem borers is currently in progress (Raffiudin and Samudera 2009). We aim to characterize the protein structure and explore certain molecule that block the protein toinhibit the moth female pheromone binding process. This biocontrol method has been used in corn stem borerby using trifluoromethyl ketones (TFMKs)as inhibitors of the pheromone activity of the corn stalk borer *Sesamia nonagrioides* (Lepidoptera: Noctuidae). This biocontrol technique showed a significant decrease in the number of male corn stem borer catchesin traps baited with mixtures with the pheromone (Riba et al. 2001).

2. Social Insect Molecular Behaviour: honey bee waggle dance and defensive behaviour

Insect is the most success organism therefore we can find them in any types of ecosystems. Social insects that live in a colony perform a fascinating behavior. Honey bees, termites and ants are groups of social insect that evolve a highly collaboration behavior; each caste has a different task. Queen or queens in social insect is the leader in the colony by secreting her queen pheromone for the united of the colony. The workers of social insect caste are the major and powerful caste; fulfill the needed of the colony through their complex behavior such as foraging (Hunt *et al.* 1995), nest building, colony defense (Breed et al. 2004.), and hygienic cleaning behavior (Spivak and Gilliam 1998).

Figure 1. Queen, worker and drone in honey bee *Apiscerana* colony

As other phenotype, behaviour is shaped by a gene or a group of genes usually known as Quantitative Trait Locus or QTL (Lobo *et al.* 2003). Hence, it is inherited and one can predict the evolution of a certain behavior. Honey bee waggle dance behavior is one example of complex behavior perform by worker honey bee that provide information about the distance and the direction of the nectar and pollen to the other workers in the colony. Environment is also factor that influence behavior. In the case of dance behavior there are two types of dance behavior evolve based on the bee nest construction; honey bee dance in vertical direction while several bees that has a platform in their nest perform a horizontal dance behavior. It was revealed based on the DNA sequences from three

"*Sting* gene", one of the gene responsible for this aggressive behavior, were characterized in *A. cerana* (Raffiudin *et al.* 2008). We amplified *Apis cerana* putative genes and EST1 based on published *Apis mellifera* QTL *sting-2* i.e 36L17.15,36L17.14, EST1, which had 97%, 93%, and 81% homology with *Apis mellifera,* respectively

3. Termites cellulase: a prospect for bioindustry

The ability of worker termites to digest cellulose and lignocellulose is due to the endo-beta-1,4-glucanase (EGase) enzyme secreted from the termite saliva as well as midgut and EGase contribution from protozoa and microbe simbionts. Molecular properties of EGase was extensively explored in the subtropics worker termites such as *Reticulitermes, Coptotermes formosanus*, and *Nasutitermes takagoensis* (Tokuda et al. 1999). However, lack of EGase data from tropical termites, such as *Coptotermes curvignathus* the most destructive termites in Java. Several studies based on *C. formosanus* in Japan showed that EGas can digest the cellulose *in vitro*. Here we characterize genomic and structure of endo-beta-1,4-glucanase from worker termites *C. curvignathus*. This data will serve as the basic knowledge for further cDNA characterization and endoglucanase activity researches of *C. curvignathus*. Our current study obtained partial regions of the endo-beta-1,4-glucanase gene from *C. curvignathus* that showed high similarity with the endo-beta-1,4-glucanase gene from the *C. formosanus* (Raffiudin *et al.* 2010).

Since termites are special adapted to survive on lignocelluloses, in the future we can produce bioethanol as bioenergy from the process of lignocelluloses by the endo-beta-1,4-glucanase gene from termites *C. curvignathus*. Currently, many studies have been explored termite lignocellulase digestion. Recent findings from termite research revealed candidate biomass enzymes to convert simple sugars to bioethanol production (Scharf and Boucias 2010).

4. Molecular marker for invasive species detection

The beekeepers in many nations mostly used *Apis mellifera* for their apiaries. This bee species comprises of 24 subspecies. The most favourable for the beekeepers is *A. m. ligustica* subspecies, due to its tame behaviour and high honey produced. *A. mellifera* currently found in Australia, America, and mostly in Asia (included Indonesia) are imported from Europe, Africa and Middle East (Ruttner 1988).

Apis mellifera scutellata is one of aggressive African honey bee (AHB) that was imported to Brazil in the mid-1950. That imported of AHB begun the spread of this honey bee through the continental. Since the introduction of an African subspecies into Brazil in the mid-1950's, descendent 'Africanized' honey bees have spread throughout the Neotropics and into temperate North America (Schiff and Sheppard 1993). It inbred with the European Honey Bee (EHB = *A. m. ligustica* or *A. m. mellifera*) and became a killer Africanized Honey Bee (AHB). AHB was characterized as having deadly sting (Castro et al. 1994), highly wing beat frequency (Spangler 1994), sensitive to *Varrhoa* parasitic mites (Guerra et al. 2000) and very quick in multiplying the colony.

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