JSPS RONPAKU (Dissertation Ph.D.) Program
Abstracts of Dissertation for FY 2008

Asian Program Division, JSPS

Japan Society for the Promotion of Science
Message from JSPS

The RONPAKU (Dissertation PhD) Program was inaugurated in 1978 as a centerpiece initiative within JSPS menu of activities directed to Asian countries. Under it, support is given to excellent Asian researchers who wish to earn a doctorate from a Japanese university by submitting a dissertation, without matriculating a doctoral course. From the 2010 fiscal year, the program will be expanded to include African as well as Asian researchers, with an eye to promoting even wider scientific exchange.

Up to FY 2008, some 547 researchers have obtained their PhDs through the RONPAKU Program. This booklet contains abstracts from the 28 RONPAKU fellows who “graduated” from the program in FY 2008. We will be happy if this collection of their abstracts is of encouragement to current RONPAKU fellows and researchers from Asia and Africa who will be eligible to enroll in the program from next year. We look forward to the ties cultivated among RONKAKU fellows and Japanese researchers through participation in this program accruing to the building of a robust researcher network within the Asian and African community.

Finally, it is with great expectation that we look forward to the future activities and contributions of the researchers who have earned their PhDs through this program.

January 2010

Akie Hoshino
Head
Asian Program Division
International Program Department
Japan Society for the Promotion of Science
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The aim of JSPS's RONPAKU (Dissertation PhD) Program is to provide tutorial and financial support to promising young researchers in Asia and Africa who wish to obtain their PhD degrees from Japanese universities through the submission of a dissertation without going through a doctoral course. Grantees under the program (RONPAKU Fellows) are given the opportunity to visit their Japanese advisor once a year to receive direct supervision at the Japanese university where they will submit their PhD thesis.

Since the program launched in 1978, 547 RONPAKU Fellows have obtained their PhDs under the program. The number of such fellows by country is as follows:

<table>
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<tr>
<th>Country</th>
<th>Counterpart Organizations</th>
<th>Number of Ph. D. Awardees</th>
<th>Number of Current Fellows as of April 2009</th>
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<td><strong>Total</strong></td>
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</table>

* Indian counterpart organization (DST) is off the list nominating organization from FY 2008.
* Singapore counterpart organization (NUS) is off the list nominating organization from FY 2001.
Eligibility Country

This program is offered to researchers in the following countries:

**ASIA (including Middle East countries)**
Afghanistan, Armenia, Azerbaijan, Bahrain, Bangladesh*, Bhutan, Brunei, Cambodia, China*, Georgia, India, Indonesia*, Iran, Iraq, Israel, Jordan, Kazakhstan, South Korea*, Kuwait, Kyrgyz, Laos, Lebanon, Malaysia*, Maldives, Mongolia*, Myanmar, Nepal, Oman, Pakistan, the Philippines*, Qatar, Saudi Arabia, Singapore, Sri Lanka, Syria, Thailand*, Tajikistan, Timor-Leste, Turkey, Turkmenistan, UAE, Uzbekistan, Vietnam*, and Yemen.

**AFRICA (From the FY2010 call, applicable countries was enlarged to African countries.)**
Algeria, Angora, Uganda, Egypt*, Ethiopia, Eritrea, Ghana, Cape Verde, Gabon, Cameroon, Gambia, Guinea, Guinea-Bissau, Kenya, Cote d'Ivoire, Comoro, Republic of the Congo, Democratic Republic of the Congo, Sao Tome and Principe, Zambia, Sierra Leone, Djibouti, Zimbabwe, Sudan, Swaziland, Seychelles, Equatorial Guinea, Senegal, Somalia, Tanzania, Chad, Central African Republic, Tunisia, Togo, Nigeria, Namibia, Niger, Burkina Faso, Burundi, Benin, Botswana, Madagascar, Malawi, Mali, South Africa, Mozambique, Mauritius, Mauritanian, Morocco, Libya, Rwanda and Lesotho

*These ten countries have JSPS counterpart organizations that assist in applicant nomination and program implementation.

Eligibility

Each applicant for the Program must be a researcher who
- belongs to a university or research institute in the above-listed countries
- already holds a full-time position as a researcher in a university or research institution in his/her home country or will likely be appointed to such a position by 1 April of the starting year of the fellowship. (JSPS also treats Taiwanese and Palestinian researchers in this manner.)
- is under age 49 as of 1 April of the starting year of the fellowship.

**Number of Fellowships**
About 30~40 per year

**Duration of Fellowship**
Up to 5 years
JSPS Support

- RONPAKU Fellows may visit their Japanese host university once a year for a maximum period of 90 days for the purpose of studying under the supervision of their Japanese advisor.
- JSPS provides RONPAKU Fellows with a roundtrip international air ticket (economy class), maintenance allowance and medical/accidental insurance, and covers expenses related to dissertation submission during their stays in Japan.
- The Japanese advisor may visit the RONPAKU fellow’s home university or research institution once a year for a maximum period of 30 days for the purpose of supervising RONPAKU Fellow’s study.
- JSPS provides Japanese Advisors with a roundtrip air ticket (economy class) and maintenance allowance, and covers their visa issuance fees and supervising expenses during their stays in the fellow’s country.
- During the fellow’s stay in Japan, JSPS provides the Japanese Advisor with an allowance for supervising his/her study at the host institution.

Contact Information

We are happy to receive news of post-fellowship activities expanding their own initiative and opinion of our RONPAKU Program. Please email your comments to the JSPS RONPAKU Program.

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The study focused at examining the capacity building of the farmers with a special reference to minor crops producers in Bangladesh. There are many crops grown in all over the Bangladesh. Among these crops pulses, oilseeds, vegetables, fruits, spices are considered as minor crops. Vegetables are taken as representative of minor crops and therefore, the present study is concentrated on capacity building of farmers through vegetable production. The study explored that vegetables are being an important component of crop production in Bangladesh in terms of area, production, value addition to GDP and export earnings. There was a structural change in vegetable production in the post policy reform period (1984-85 to 2003-04) due to research, extension and export promotion activities. As we have found positive growth in area and production vegetables in Bangladesh it is necessary to assess its role in increasing different capitals of farmers like natural, technical, human, social and financial. The increments of these capitals is therefore, considered as capacity building ability of the farmer.

It is proven that in developing countries like Bangladesh experts from different countries can play a vital role in increasing the capacity of a community towards its development. Therefore, this study examines the comparative capacity building ability of vegetable and rice producers in Bangladesh resulting from the intervention of a group of experts from the Japan International Cooperation Agency (JICA). The results show that both vegetable and rice producers in the project area experienced a significant increase in profitability compared to farmers outside the project area. Also, both vegetable and rice producers in the project area have significantly increased their capacity in terms of technical, social, human, natural and financial capital when compared to farmers outside the project area.

In addition the study examines the influence of capacity building on technical efficiency of the farmers and found that the vegetable and rice farmers inside and outside the project area are far behind the maximum obtainable total return using the same level of available resources for their inefficiency. The study identified that the components of capacity building play a significant role in increasing technical efficiency and inefficiency can be reduced significantly and actual return
can be obtained up to maximum level by increasing different capitals of capacity building. Further, the study found that producers who were most responsive to modern production technologies were better at building capacity than less responsive producers. Producers who were located near a wholesale market were better at building capacity than producers who were located further away.

Moreover, the study found that majority of the marginal and small farmers are well ahead in improving physical and technical skills at a high level than the medium farmers and therefore, they enter into the Gehilfen stage of capacity building. In addition, they have started to build these skills independently at the early age of their farming and hence, they can continue their farming for a long time with high skills. The study also found that physical skill is the dominant factor followed by technical skill for increasing capacity of the farmers in Bangladesh. The marginal and small farmers could make agricultural productivity better than the medium farmers owe to skill development.

Further, this study examines the role of physical, technical and communication skill variables of the farmers in achieving maximum obtainable return with a high level of technical efficiency and found that the farmers with low physical, technical, and communication skills, and the farmers who built up these skills at later life stages are far behind in achieving maximum obtainable return. Hence, it is vital to build up skills at early stages of the lifespan of the farmers in developing countries to obtain maximum achievable return using same level of resource.

Finally, the study explored that the farmers with high capacity building changes their household expenditure pattern towards up taking of a balanced nutrition. They are able to uptake balanced nutrition redistributing their consumption expenditure and invest their money in productive areas which increases their per capita income and standard of living, which is the ultimate goal of the farmers of developing country like Bangladesh.
Potato production from true potato seed (TPS) is highly promising, and may put remarkable contribution for increasing potato production in Bangladesh. A series of experiments and thousands of demonstration trials of TPS during 1993 to 1997 have generated great enthusiasm among the potato farmers as well as consumers of Bangladesh. Still there are major problems associated with the use of this technique such as poor germination percentage, lack of uniform germination, poor survival rate of seedlings, lack of uniformity of tubers in terms of shape, size, and color. In order to exploit the merits of TPS a number of experiments have been undertaken.

Nutrient conditions in the potato mother plants directly affect the production of quality TPS. Therefore, experiments were conducted during 2004-2007 to examine the effects of combinations of different levels of nitrogen (N), phosphorus (P), and potassium (K) on yield and quality of TPS using crosses of \( ^\varphi \) MF-II and \( ^\sigma \) TPS-67. Four levels of each of N (0, 150, 225, and 300 kg ha\(^{-1}\)) and P (0, 60, 120, and 180 kg ha\(^{-1}\)) were applied to MF-II for obtaining better flowering, berry setting, and TPS production. Out of the 16 treatment combinations, the highest 100-TPS weight (84.1 mg) was obtained with 300 kg N and 120 kg P ha\(^{-1}\), while the highest TPS yield (136.1 kg ha\(^{-1}\)) was obtained with 225 kg N and 120 kg P ha\(^{-1}\). Considering the findings of the previous study, 2 levels of N (225 and 300 kg ha\(^{-1}\)) and a fixed value of P (120 kg ha\(^{-1}\)) were selected as promising for TPS production. Twelve combinations of 3 N (0, 225, and 300 kg ha\(^{-1}\), respectively) and 4 K (0, 125, 175, and 225 kg ha\(^{-1}\), respectively) levels were also applied to MF-II to investigate the effects of yield components of TPS. The weight of 100-TPS increased with increasing N rate but decreased with increasing K rate. The highest 100-TPS weight (83.8 mg) and maximum quantity (113.0 kg ha\(^{-1}\)) of quality (> 1.18 mm) TPS were obtained with the application of 300 kg N and 125 kg K ha\(^{-1}\), while 225 kg N and 125 kg K ha\(^{-1}\) produced the highest TPS yield (145.3 kg ha\(^{-1}\)).

TPS that was produced from above mentioned 12 different fertilizer combinations were then used for nutritional analysis, germination tests in vitro, and growth performance in nursery beds. Large size TPS (>1.18 mm) produced from 300 kg N and 125 kg K ha\(^{-1}\) gave the highest emergence rate (94%), seedling vigor
(4.8), and dry matter content (10.5%) of seedling in nursery beds. Considering the present results together with those of the previous studies, it can be concluded that the combination of 300 kg N, 120 kg P and 125 kg K ha⁻¹ was the most suitable for the production of high quality TPS.

A field experiment was also carried out to evaluate the relative economic return as influenced by supplemental N (0-250 kg ha⁻¹) and planting density (8-16 haulms m⁻²) in MF-II. Most parameters showed maximum values when 0 to 150 kg N ha⁻¹ was applied, but the values decreased thereafter as supplemental N application increased. Although only the weight of 100-TPS showed a maximum value at 250 kg N ha⁻¹, the value was similar to that at 200 kg N ha⁻¹. A positive effect of higher planting density was detected only in the number of berries plant⁻¹ and yield of TPS. The combination effect of supplemental N and planting density on the yield of berries and TPS was significant. Although the total yield of TPS was the highest at the combination of 150 N kg ha⁻¹ and 16 stems m⁻², the yield of high quality TPS, was the highest at the combination of 200 N kg ha⁻¹ and 12 stems m⁻². The benefit cost ratio also showed that the combination of 200 kg supplemental N ha⁻¹ and 12 stems m⁻² was the optimal growth conditions to harvest high quality TPS. Therefore, in the commercial aspect, 200 kg N ha⁻¹ of supplemental application in 7 separate installments at 7 day intervals starting from just before blooming along with basal application (150-120-125-120-12-6 kg ha⁻¹, N-P-K-Gypsum-ZnSO₄-Borax, and 10 t ha⁻¹ farm yard manure) and 12 stems m⁻² is the most suitable combination to produce high quality TPS from ♀ MF-II X ♂ TPS-67.
Phylogenetic Analysis of Rotaviruses with Genotypes G1, G2, G9 and G12 in Bangladesh: Evidence for a Close Relationship between Rotaviruses from Children and Adults.

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Japanese Advisor : Nobumichi KOBAYASHI
Professor, Sapporo Medical University

Group A rotaviruses are one of the major etiological causes of severe gastroenteritis in infants and young children worldwide. It is estimated that rotavirus accounts for more than a third of all diarrhea-related hospital admissions, causing about 527,000 deaths per year in children less than 5 years of age mostly in developing countries. To reduce the burden of severe diarrheal illness associated with rotavirus infections, an effort to develop a safe and effective rotavirus vaccine has been made. Despite the low frequency, group A rotaviruses cause gastroenteritis in adults, which has been described as epidemic outbreaks, travel-related gastroenteritis, and endemic cases. However, epidemiologic and genetic information of rotaviruses causing sporadic gastroenteritis cases in adults is limited. Phylogenetic relatedness of rotaviruses between children and adults has not yet been well studied, except for a recent report in China, in which close relationship of predominant G3 rotaviruses were demonstrated between children and adults. In Bangladesh, genetic characteristics of rotaviruses from adults have never been investigated, therefore the significance of rotavirus diarrhea in adults and its possible influence on rotavirus infection in children are still unknown. The present study was carried out to analyze genetic characteristics and phylogenetic relatedness of rotaviruses causing sporadic diarrhea in both children and adults in Bangladesh.

An epidemiologic investigation was conducted in Mymensingh, Bangladesh, during a period between July 2004 and June 2006, to clarify phylogenetic relatedness of rotaviruses causing gastroenteritis in children and adults. A total of 2540 stool specimens from diarrheal patients from three hospitals were analyzed. Overall rotavirus-positive rates in children and adults were 26.4% and 10.1%, respectively. Among the representative 155 rotavirus specimens examined
genetically from both children and adults, most frequent G genotype was G2 (detection rate: 54.0% and 47.6%, respectively), followed by G1 (21.2% and 26.2%, respectively), and G9 (15.9% and 9.5%, respectively). G12 was detected in five specimens (3.2% in total; four children and an adult). Between rotaviruses from children and adults, sequence identities of G2 rotavirus VP7 genes were more than 97.8%, while these Bangladeshi G2 viruses showed generally lower identities to G2 rotaviruses reported elsewhere in the world, except for some strains reported in African countries. Similarly, extremely high sequence identities between children and adults were observed for VP7 genes of G1, G9 and G12 rotaviruses, and also for VP4 genes of P[4], P[6], and P[8]. Rotaviruses from children and adults detected in this study were included in a single cluster in phylogenetic dendrograms of VP7 or VP4 genes of individual G/P types. Rotaviruses with two emerging types, G9 and G12, had VP7 genes which were phylogenetically close to those of individual G-types recently reported in Bangladesh and India, and were included in the globally spreading lineages of these G types. These findings suggested that genetically identical rotaviruses, including those with emerging types G9 and G12, were circulating among children and adults in city and rural areas of Bangladesh. In a recent study in Equador, asymptomatic carriage of rotavirus in adults has been also documented despite of low frequency. Moreover, it has been hypothesized that rotaviruses excreted from asymptomatic adults may be a source of infection for susceptible children in a hospital environment. Therefore, for prevention of rotavirus diarrhea in children, control of rotavirus transmission from adults should be also considered.
The conversion of bicycle/rickshaw, motorcycle, passenger car and truck tire wastes, which are found in abundance in Bangladesh as well as all over the world, into liquid fuels and chemicals by fixed-bed fire-tube heating pyrolysis technology has been taken into consideration in this study. The solid tire wastes were characterized through proximate and ultimate analysis, gross calorific values and thermogravimetric analysis to investigate their suitability as feedstock for this consideration. Pyrolysis kinetics of the selected tire wastes have been investigated thermogravimetrically under nitrogen atmosphere at heating rates of 10 and 60 °C/min over a temperature range of 30-800 °C. The percentage weight loss was higher for truck tire and was lower for bicycle/rickshaw tire for both heating rates. An overall rate equation for the tire wastes has been modeled satisfactorily by one simplified equation from which the kinetic parameters of unreacted materials based on Arrhenius form can be determined. The predicted rate equation was found to fit the measured TG and DTG data fairly well. DTA curves for all of the samples show that the degradation reactions are three main exotherms and one endotherm.

Two types of fluid dynamics experiments were carried out on a cold model of the fixed-bed fire-tube heating reactor: first to determine the char ejection pressure, which was conducted with the aid of an air compressor and artificial solid char while second to determine flow pattern in the reactor chamber during the ejection of solid char that was conducted by LDV measurement and flow visualization test. For complete removal of char product from the reactor, the ejection pressure should be sufficient enough to create 9% higher upward force than the weight of the char. The spiral shaped char exit port was unable to initiate a rotational flow inside the reactor during ejection of char.

Four types of tire wastes were pyrolysed in the fixed-bed fire-tube heating reactor under different pyrolysis conditions to determine the role of final
temperature, sweeping gas flow rate and feed size on the product yields and liquid product composition. The highest liquid product yield was 46-55 wt% of solid tire wastes, which was obtained at 475°C for feed size of 4 cm³ and apparent vapor residence time of 5 sec. Liquid products obtained under these conditions were characterized by physical properties, elemental analysis, FT-IR, ¹H-NMR and GC-MS techniques. The results show that it is possible to obtain liquid products that are comparable to petroleum fuels and valuable chemical feedstock from the selected tire wastes if the pyrolysis conditions are chosen accordingly.

A preliminary investigation was carried out on a DI diesel engine with the pyrolysis oil-diesel blends and neat diesel fuels. The results support the statement “the pyrolytic liquids may be a potential alternative for diesel fuel” after treatment.

A study was conducted to develop a comparative techno-economic assessment of three different-scale plants of capacity 18 kg/day, 2.4 ton/day and 24 ton/day of tire waste feed converted to crude pyrolysis oils. For the large-scale plants, the capital cost, the feedstock cost and the operating labor cost were found to be the major cost items influencing the Unit Production Costs. The greater the plant capacity the lower was the Unit Production Cost.
Chemical Treatment on Indonesian Pine Oleoresin and Rosin in Making Fortified Rosin Used for Sizing Agent in Paper Making Process

Bambang WIYONO
Senior Research Scientist 〈Coordinator of Non Wood Forest Products Research〉, Ministry of Forestry of Indonesia, The Forest Products Research and Development Center

Japanese Advisor : Sanro TACHIBANA
Professor, Ehime University

*Pinus merkusii* generate pine oleoresin as raw material for producing rosin and turpentine oil. This entire product is mostly for export purpose, and only small amount for domestic demand. Moreover, Indonesia also exports gum oleoresin. Relating to rosin utilization, rosins will probably be exported back to Indonesia in the form of fortified rosin of fortified rosin size. As the third biggest rosin producing country, Indonesia should have such technology to fulfill domestic needs and possibly for export. This study is focused on identifying main chemical compound in rosin and pine resin which can react with maleic anhydride or fumaric acid to produce fortified rosin and fortified rosin size, and the size was applied in papermaking.

Experiment result showed that acidic and neutral fractions made up about 13-23 % and 66-79 %, respectively, of pine oleoresin samples obtained from several Rosin and Turpentine Industries in Indonesia. The neutral fraction and turpentine oils mostly comprised Δ-3-carene and β-pinene with α-pinene the major component. Based on the locations of merkusii pine stands, the difference in sites appears to follow a pattern according to where the samples were from, with the proportion of α-pinene increasing in neutral fractions or palustric acid in acidic fractions increasing from East to West, but decreasing in turpentine oils. Meanwhile, the main constituents of acid fractions and rosins were sandaracopimaric acid, isopimaric acid, palustic acid, dehydroabietic acid, abietic acid, neoabietic acid and merkusic acid. Palustic acid was the most abundant in
Acidic fractions and rosins of Indonesian Pinus merkusii do not contain levopimaric acid. GLC and GC-MS analysis of the reaction product of abietic acid (AA) and maleic anhydride (MA) or fumaric acid (FA) showed that the maleo-pimaric acid (MPA) contained endo-maleopimaric acid and endo-maleopimaric tri carboxylic acids; while the fumaro-pimaric acid (FPA) contained FPA adduct, fumaro-pimaric tri carboxylic acids; and endo-MPA. After being fractionated using silica gel column chromatography (SCC) followed by recrystallization, identification of the Diels-Alder adduct, as methyl ester derivative, using a DIEI (Mass spectrometry) revealed that the product still contained endo-maleopimaric acid methyl ester with endo-maleopimaric acid tri methyl ester, but more pure. Further, using rosin instead of AA, the best condition to make MPA from rosin was at molar ratio of 1:6.2 and at temperature of 200°C for one hour, even using large amount of rosin. Using small amount of rosin, the best condition to produce FPA was at molar ratio of 1:5.8 and at temperature of 200°C for one hour. However, using a large amount of rosin, the molar ratio did not applied; where the highest yield of this product was not obtained at the molar ratio of 1:5.8 as being predicted from the equation. Further, when maleo-pimaric rosin (MPR) and fumaro-pimaric rosin (FPR) were converted into their size, based on the properties of free rosin and pH, the MPR and FPR sizes have met the requirement of the Indonesian national standards for paste rosin size. In terms of the free alkali property, the sizes of made MPR and FPR from this study were better compared to the free alkali of the commercial one. When, the MPR sizes were applied in the paper making, and compared to the commercial MPR size, Cobb values of paper using rosin from East, Central and West Java were better than the Cobb value of paper using commercial MPR size. Similarly, the Cobb values of paper using molar ratio of 1:5.2; 1:6.2 and 1:7.2 or using sizing level at 0.5%, 1.0% and 1.5% were higher than Cobb value of the paper using commercial MPR size. Among the rosin from various regions, molar ratio and sizing level used in this study, MPR size (using molar ratio of 1:6.2) and FPR size (using molar ratio of 1:5.8) made of rosin from Central Java with sizing level at 0.5% was the best sizing in paper making, indicated by the lowest Cobb value of paper.
A Study on Convection over Sumatra and Its Relationship to Large-scale Disturbances Based on Coordinated Observations with the Equatorial Atmosphere Radar

Tri Handoko SETO
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Japanese Advisor: Hiroyuki Hashiguchi
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Convection and wind features over Sumatra and its relationship to large-scale disturbances were studied using both horizontal and vertical winds observed by the Equatorial Atmosphere Radar (EAR). Tropospheric observation over Sumatra was also carried out using other equipment such as a Boundary Layer Radar (BLR), an X-band Doppler weather radar (XDR), and radiosonde. Data obtained by these equipment were also used. Further, data provided by the Geostationary Meteorological Satellite (GMS), and National Center for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalysis were used.

To investigate the relationship between convective activity over Sumatra and intraseasonal variation (ISV), a case study during June 2002 was carried out. In June 2002, convective activities over the Indian Ocean, Indonesia Maritime Continent (IMC), and the western Pacific were significantly modulated by ISV. Blackbody brightness temperature (TBB) observed by GMS showed that two super cloud clusters (SCCs) developed over the Indian Ocean (70 - 90°E) in the first half of June 2002, and propagated eastward from the Indian Ocean to the western Pacific without significant diminution. Zonal wind observed by EAR and surface pressure observed at the observation site suggested the existence of Kelvin-wave-like structure of ISV. From temporal variations of TBB, zonal wind at 850 hPa, and vertical shear of horizontal wind between 700 and 150 hPa, the observation periods were classified into the inactive phase (1-9 June), active phase (10-19 June), and postwesterly wind burst phase of ISV (20-26 June). During the inactive phase of ISV, convective activities caused by local circulation were prominent over Sumatra. Results of radar observations indicated the dominance of convective rainfall events over the mountainous area of Sumatra. During the
active phase of the ISV, cloud clusters (CCs) which developed in the convective envelope of SCC with a period of 1-2 days mainly induced the formation of convective activities over Sumatra. Results of radar observations indicated that both of convective and stratiform rainfall events occurred over the mountainous area of Sumatra. In the postwesterly wind burst phase of ISV, convective activities were suppressed over Sumatra. Previous studies pointed out that local circulation induced by the Sumatra’s topography causes development of deep convection with a diurnal cycle. Further, this study points out that this deep convection with a diurnal cycle is dominant during the inactive phase of ISV, and is suppressed during the postwesterly wind burst phase.

The first observation campaign by the Coupling Processes of the Equatorial Atmosphere (CPEA) project (CPEA-I campaign) was carried out during March - May 2004. While other studies focused on convective events associated with rainfall, this study focused on westerly wind burst (WWB) event, when convective activity was suppressed. WWB occurred by eastward propagation of SCC moved from the Indian Ocean to the western Pacific. The convective envelope of the SCC reached Sumatra from the Indian Ocean on 5 May, then passed over Sumatra on 7 May. Intensification of the westerly wind occurred over Sumatra below 5.5-6.0 km as the SCC passed over it. On 7 May, the 2.5-4.0 km westerly wind at Kototabang (0.20°S, 100.32°E, 865 m MSL) was identified as a WWB. Precipitating clouds around Kototabang were suppressed after 7 May, as drier air (lower than 60% relative humidity) was transported by lower-tropospheric westerly wind from the Indian Ocean over Sumatra. Non-precipitation clouds were observed at 5-8 km by the lidar after 7 May.

After 7 May, the vertical wind at 2.5-5.5 km showed the oscillatory motion with a timescale of about 12 hours. Contrary to the radiosonde-derived downward wind with a horizontal scale of several hundred km, daily-averaged vertical wind at Kototabang showed upward motion of 0.07-0.08 m/s on 7 and 8 May, when westerly winds larger than 10 m/s prevailed at 2.5-4.0 km. The vertical wind oscillation was suppressed in the upper part of westerly wind region (above 3.0-5.5 km), where the Richardson number was smaller than 0.45 and westerly wind changed to easterly wind with large vertical shear (greater than 10 m/s/km). This fact implies that shear instability and horizontal wind change inhibited upward propagation of vertical wind oscillations. This study describes the detail of vertical wind motions over the mountain region of Sumatra during the WWB event for the first time. The observational results suggest that topography of Sumatra plays a
role in generating vertical wind motions, and that background horizontal wind is also important for modulation of vertical wind.

Many studies investigated large-scale wind and convective disturbances over the Indian Ocean, IMC, and the western Pacific using global objective reanalyses. However, routine upper-air soundings over IMC assimilated into global objective reanalyses are scarce. Therefore, evaluation of reanalysis wind by observed wind is necessary. In this study, lower-tropospheric horizontal wind reproduced by NCEP/NCAR reanalysis was evaluated using horizontal wind observed by EAR during 2001-2007. As a representative of lower-tropospheric wind, wind at 700 hPa was selected. First, it was shown that EAR wind and radiosonde wind at Padang (0.88° S, 100.35° E) agreed well and hence EAR wind is able to be used as representative of winds around (0° N, 100° E). This agreement also showed that radiosonde wind well represents large-scale wind. Next, NCEP/NCAR wind was compared with EAR wind. Though NCEP/NCAR-reanalysis wind was smaller than EAR wind, they showed good agreement. For zonal wind, correlation coefficient was 0.84 and slope of regression line was 0.74. For meridional wind, correlation coefficient was 0.69 and slope was 0.88.

At West Sumatra, radiosonde observations at Padang have been reported through Global Telecommunication System (GTS). Therefore they have chance to be assimilated into NCEP/NCAR reanalysis. The agreement between NCEP/NCAR and EAR winds improved in the group when radiosonde observations at Padang were reported through GTS (Group A) than when they were not reported (Group B). For zonal wind, all of correlation coefficients, standard deviation, and amplitude of NCAR/NCEP-reanalysis zonal wind improved. Correlation coefficient in Group A (0.90) was better than in Group B (0.79). Standard deviation in Group A (1.58 m/s) was better than in Group B (2.07 m/s). Slope of regression line in Group A (0.82) was also better than in Group B (0.66). For meridional wind, all of the correlation coefficients, standard deviation, and amplitude of NCEP/NCAR-reanalysis meridional winds also improved. Correlation coefficient in Group A (0.77) was better than in Group B (0.63). Standard deviation in Group A (1.25 m/s) was better than in Group B (1.62 m/s). Slope of regression line in Group A (0.96) was also better than in Group B (0.80). Number of radiosonde observations has increased since 2006 not only at Padang but also at other places in Indonesia (Medan, Jakarta, and Pangkal Pinang). Because the result of this study demonstrates that upperair observations over IMC improve the quality of NCEP/NCAR reanalysis, efforts to maintain and extend upper-air observations in IMC are necessary for understanding and predicting large-scale disturbances in this region.
Full-2D to Quasi-3D Sediment Transport Models in Surf Zones

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The mechanism of accretion beach has been subject of extensive studies as the mode of sediment transport is more sophisticated that bed-load transport only. These studies have suggested a high concentration of suspended sediment near the free surface induced by strong plunging breakers. However, predictions by models have not been successful because of the localized interactions among the plunging jet, turbulent production, and sediment movement. This study proposes a new calculation model for turbulent flow and suspended sediment transport in the surf zone.

A numerical model was developed to simulate the flow and sediment motion in connection with plunging breakers in the surf zone. The Reynolds-Averaged Navier-Stokes (RANS) equations in two spatial dimensions were employed to simulate the flow field together with a k-ε model for the turbulence and the Volume of Fluid (VOF) method for multiple free-surface tracking. In quasi-3D, the Boussinesq equations were utilized to simulate the flow together with a k-ε model for the turbulence and bottom boundary layer thickness method for bottom shear stress estimation. An advection-diffusion equation was used for the suspended sediment concentration with a bottom boundary condition following the reference concentration formulation. Performance of the suspended sediment transport model under plunging breaking waves were examined through the comparison with experimental data.

Good agreement between the model and experimental data was obtained for the surface elevation and velocity, turbulent kinetic energy, eddy viscosity, bottom shear velocity and bottom
shear stresses and suspended sediment concentration. The overturning waves, plunging jet and transport of high concentration of suspended sediment near the free surface are reproduced by the present model with selected fine mesh resolution. The study shows the applicability of the present model in the turbulent and suspended sediment dominated region induced by strong plunging breakers. The applicability of the new computational model is further tested in the broad coast with extreme and regular waves conditions. Incorporating bed-load, suspended load and seabed evolution formulation in the present model, the performance of the new model in predicting the erosion and accretion area around coastal structures is presented and discussed.
"Species Relationships within the Medicinal Ochrosia sensu lato (Apocynaceae)"

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**Ochrosia sensu lato** species are regarded as important medicinal plants for containing anti-cancer agent, ellipticine. The study on phylogenetic relationships within the genus is one of the basic important steps to further explore its great potential as medicinal plants.

**Ochrosia s.l.** (*Ochrosia sensu stricto* + *Neisosperma*) belongs to the Vinceae, the Rauvolfioideae, Apocynaceae. The genus consists of approximately 40 species and mostly occurs in Malesia and Pacific region.

The present study is the first attempt to elucidate phylogenetic relationships within *Ochrosia s.l.*, and also to collect more information concerning chromosome numbers of its species.

Phylogenetic analysis was conducted using internal transcribed spacer (ITS) of nuclear DNA and ribosomal protein small subunit 16 (*rps*16) intron of chloroplast DNA, as well as morphological data. Maximum Parsimony and Bayesian approaches were performed on sequences of 19 species (23 accessions); consist of 9 *Neisosperma* species and 10 *Ochrosia s.str.* species. Species from the closest genera (*Kopsia*, *Rauvolfia*, and *Vinca*) were chosen as the outgroup.

The ITS region was amplified using ITS5 forward primer (5’-GGAAGTAAAAAGTCGTAACAAGG-3’) and ITS4 reverse primer (5’-TCCTCCGCCTATTGATATGC-3’). The *rps*16 intron region was amplified using *rps*F forward primer (5’-GTGGTAGAAAGCAACGTGCGACTTT-3’) and *rps*R2 reverse primer (5’-TCGGGATCGAACATCAATTGCAAC-3’). For combined molecular + morphological data sets, the data obtained from analysis on the 14 morphological characters were incorporated.

For chromosome preparation root tips were collected. Pretreatment was done by immersing the root tips in 0.002 M 8-hydroxyquinoline solution for 3.5 hours at room temperature. They then were fixed in 3:1 ethanol-acetic acid solution at 4 °C overnight. They were rinsed in distilled water and 45% acetic acid for 10 minutes.
each at room temperature before macerated in 3:1 HCl 1N - 45% acetic acid solution, at 60°C, for 5 minutes. They then were washed in distilled water for 5 minutes, stained with 2% aceto-orcein, and squashed in one drop of 45% acetic acid on glass slide.

General results can be summarized as follows: 1). The monophyletic Ochrosia s.str. is nested within paraphyletic Neisosperma. They both then formed a strongly supported monophyletic clade of Ochrosia s.l. 2). The ITS tree was more resolved than the rps16 tree. But, rps16 data yielded tree with higher Consistency and Retention Indices. 3). Within the ITS, in terms of informativeness, ITS-1 was found to be the highest (contributing 53.6% of the total informative characters of the ITS). 4). Although the result was not very convincing, rps16 intron was proved to be sufficiently informative to infer phylogenetic relationships within Ochrosia s.l. 5). In the present study, adding morphological characters increased the tree resolution. 6). In the present study, Parsimony tree was more resolved than Bayesian tree. However, Bayesian tree yielded more reliable clades. 7). The subdivision of Ochrosia s.l. into sections based on fruit morphology - as had proposed by De Mueller (1871) - was not supported phylogenetically. 8). Fibrous endocarp was considerably plesiomorphic within Ochrosia s.l., altered to massive and stony endocarp. 9). Chromosome numbers of N. glomerata (2n=22) and N. citrodora (2n=23) are reported here for the first time; whilst chromosome numbers of the other two (O. coccinea, 2n=22 and O. oppositifolia, 2n=22) verified previous counts. In Ochrosia s.l. it seems that there is no indication of a correlation between chromosome numbers and morphological appearances, and between chromosome number and molecular-based phylogeny.

To conclude, from the phylogenetic point of view genus Neisosperma - because of its paraphyly - should be rejected. Thus, species of Neisosperma and Ochrosia s.str. are best united into a single genus - Ochrosia s.l.
Magnetocardiography (MCG) and magnetoencephalography (MEG) have recently been used to diagnose heart and brain diseases, and to analyze brain activities. In order to measure time varying very weak magnetic fields from hearts or brains reliably in a short time, a multichannel Superconducting QUantum Interference Device (SQUID) system should have a sufficient number of sensors enough to cover an essential field distribution. Multichannel SQUID systems consisting of typically over 60 channels for MCG and over 128 channels for MEG require higher performance for SQUID sensors than for systems consisting of a few channels. As Double Relaxation Oscillation SQUIDs (DROSs) have a larger flux-to-voltage transfer coefficient than dc SQUIDs, one can use direct readout electronics for them which is an important feature of DROSs for building compact and economical biomagnetism systems. In this research, reference junction-DROS (RJ-DROS) sensors fabricated with a first-order or a second-order differential pickup coil, compact and low-noise readout electronics, and optimization scheme for the input-bias current and the reference current for RJ-DROSs have been developed for accurate and low-cost multichannel SQUID biomagnetism systems. Furthermore, practical combinations of biomagnetism system with first-order gradiometer or second-order gradiometer, and three kinds of magnetically shielded rooms (MSRs) which are heavy, moderate, and thin MSR, are proposed.

In chapter 3, RJ-DROS sensors are developed for a multichannel SQUID system, which endure from an external noise environment. Two planar pickup coils are fabricated photolithographically for the first-order (base line 40 mm) and the second-order (base line 50 mm) gradiometer SQUID sensor by which the tangential component of the magnetic field is measured clearly. By using these sensors, two inserts accommodating 64-channel first-order and second-order RJ-DROS sensors are constructed for MCG measurement. For the case with first-order gradiometer sensors, an average noise is 4.6 fT/√Hz, and for the case with second-order gradiometer sensors, an average noise is 8 fT/√Hz.

In chapter 4, 62-channel readout electronics are designed and constructed to detect RJ-DROS sensor outputs without degrading the sensor sensitivity. An ultra-low noise preamplifier has been developed for the readout electronics by
paralleling several sets of matched bipolar transistors. The equivalent input noise of the preamplifier is as small as 0.6 fT/√Hz. A great caution was paid in designing digital control electronics, where the interference from spark like noise is suppressed and data transfer is disabled while MCG measurement is going on. These electronics are automatically controlled by the operating software, allowing for setting up 62 DROS sensors to optimal conditions within 15 s.

In chapter 5, input-bias current controller is designed and fabricated with a matched bipolar transistor preamplifier for RJ-DROS sensors with a low reference critical-current, which reduces an input-bias current of the preamplifier that may distort the reference junction current. An additional current controller developed to regulate a reference critical current in RJ-DROS sensors, maintains a sensitivity of 5 fT/√Hz at 100 Hz without degrading sensors, and adjusts their modulation voltages to an optimal range with a small variation range; the maximum modulation depth and width variations are 11% and 16%, respectively. The readout electronics with the additional reference current controller are suggested, to optimize RJ-DROS sensors to hold similar modulation voltages which support similar sensitivities and easy/quick operation to a multichannel SQUID system.

In chapter 6, three MSR types; heavy, moderate, and thin MSR, have been combined with a first-order gradiometer system and a second-order gradiometer RJ-DROS system. The moderate-MSR with a shielding factor of about 200 at 1 Hz provides first-order gradiometer DROS sensors with the best combination of a signal-to-noise ratio (SNR) of 140, and the thin-MSR with the factor of 30 provides a second-order gradiometer sensors with the best SNR of 110. 64-channel DROS MCG systems are developed with low-noise planar gradiometer RJ-DROS sensors, with low-cost MSRs, with direct readout electronics, and control/analysis software. For an application to cardiac disease diagnoses, 64-channel MCG system has been used to diagnose an ischemia patient.
Fabrication and Evaluation of Transparent Conducting Oxide Films on Polymer Substrate for Display Applications

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Advanced substrate materials are essential for the realization of flexible OLEDs. The plastic substrates have undoubtedly a great potential as advanced one for flexible OLEDs. Therefore, development of transparent conducting oxide (TCO) films on plastic substrates is strongly requested in flexible OLED development and commercialization over the next decade. Optical transmittance higher than 85% at wavelength of 550 nm and electrical resistivity lower than $3 \times 10^{-4} \Omega \cdot \text{cm}$ are required for TCO films as an electrode in flexible OLEDs.

In this study, for the application in flexible OLEDs, the fabrication of TCO films with good transparency and low resistivity was carried out using RF-superimposed DC magnetron sputtering method with indium tin oxide target (ITO, $\text{In}_2\text{O}_3$ : $\text{SnO}_2 = 90 : 10 \text{ wt\%}$) and indium zinc oxide target (IZO, $\text{In}_2\text{O}_3$ : $\text{ZnO} = 90 : 10 \text{ wt\%}$). The influence of process parameters such as substrate temperature, discharge condition, and ambient gas were examined. As a result, a set of optimized conditions for either ITO or IZO film was suggested. With optimized ITO and IZO films, the flexibility in cyclic bending condition and the performance in OLED device were systematically demonstrated.

Crystallinity of ITO films was found to be strongly dependent on substrate temperature. It was observed that the films deposited on heated substrate (95°C) showed crystalline peaks in X-ray diffraction pattern, whereas the films deposited on unheated substrate (50°C) showed amorphous one. Optical transparency of ITO films showed a strong dependence on not only the substrate temperature but also superimposed RF power and oxygen potential. Both higher superimposed RF power (> 50 W) and oxygen potential lead to highly transparent ITO films (near 90% at wavelength of 550 nm). Electrical conductivity of the films was enhanced with an increase in substrate temperature up to 95°C due to improvement of crystallinity and microstructure which may result in the improvement of carrier transportation in the film. As a result, a set of parameters consisting of substrate temperature of 95°C, superimposed RF power 150 W and pure Ar atmosphere is suggested as an optimal condition for the high transparency (over than 90%) and the lowest electrical resistivity ($2.7 \times 10^{-4} \Omega \cdot \text{cm}$) of the ITO film.

Crystallinity of IZO films was found to be independent on given parameters in this study. Optical transparency of the films was affected by superimposed RF power and oxygen potential rather than the substrate temperature. Both higher
superimposed RF power (> 100 W) and oxygen addition led to highly transparent films (near 90% at wavelength of 550 nm). Electrical resistivity slightly decreased with an increase in substrate temperature, superimposed RF power, and oxygen potential. However, a difference in optical transmittance and electrical resistivity of the IZO films were not remarkable at substrate temperature within 100°C in comparison with ITO films. High quality film with good optical transparency and low electrical resistivity could be obtained with suggested optimal condition which consists of substrate temperature of 50°C, superimposed RF power of 150 W, and pure Ar atmosphere. Consequently, it was confirmed that the IZO film with the properties comparable to those of ITO film can be fabricated using RF-superimposed DC magnetron sputtering method.

Mechanical robustness for flexible devices and performance as an electrode of OLEDs were evaluated by cyclic bending test with TCO films optimized in this study. For the flexibility evaluation, the resistance change (ΔR/R₀) during cyclic bending was monitored as a function of the number of bending cycle. A commercialized c-ITO film on glass substrate as well as indium oxide films (c-ITO and a-IZO) on plastic substrate was used as an electrode of conventional phosphorescent OLEDs for the evaluation and comparison of their performance in OLED device. The failure behavior of the TCO samples revealed that crack was initiated at the very initial stage of test period (number of cycle, N < 5) during cyclic bending. Initiated cracks on the film surface were grown as an increase in number of bending cycle. Hence, the resistance change (ΔR/R₀) increased drastically at initial stage of cyclic bending test and then was diminished as further increase in number of bending cycle. The failure behavior of the films was found to be strongly dependent on not only the substrate thickness, but also the residual-compressive stress in the as-deposited films.

From the results of performance evaluation with OLED device, it was confirmed that both a-IZO and c-ITO films show good performance compared with a commercialized c-ITO anode on glass substrate (used as a reference). Even though a-IZO film had relatively higher electrical resistivity than the c-ITO film, the result of current density-to-voltage revealed that the highest current density and luminance, the smallest leakage current density (< 10⁻⁶ mA/cm²) could be found in OLED device based on a-IZO film. Furthermore, it is noteworthy that OLED device based on a-IZO film showed external quantum efficiency (EQE) superior to a commercialized c-ITO anode and the highest power efficiency (PE). As a conclusion of the thesis, high quality ITO and IZO films with good transparency and low electrical resistivity can be fabricated using RF-superimposed DC magnetron sputtering method with ITO target and IZO. And the adoptability of these films for the application in flexible OLEDs was successfully confirmed through the flexibility evaluation by cyclic bending test and the performance evaluation with OLED device. The evaluation results of flexibility and performance in OLED device reveal that IZO film is the most promising transparent conducting electrode material, replacing ITO for flexible displays.
Several FEM models were developed to determine the mechanical and rheological parameters (such as elastic modulus, Poisson’s ratio, relative modulus, relaxation time, and dynamic viscosity, etc.) of biomaterials based on homogeneous and heterogeneous structures by using F-D curves from compression experiments and FEM optimization algorithms, and to provide fundamental viscoelastic data, which are necessary a) in comparing measurements carried out at different laboratories with high reliability without considering experiment types, b) in analyzing and predicting various mechanical behaviors by FEM simulation with reliable data, c) in case of having structural problems of soft tissues in making specimens because of their weak texture, and d) in analyzing the properties carried out in nano- and micron-scale experiments as a suggestion.

The three determination algorithms of FEM optimization with validation and an application of FEM simulation with experimental and numerical approaches were summarized as specific conclusions:

1) An FEM algorithm was developed to determine the viscoelastic properties of soft-homogeneous tissue of agar/agar-gelatin gels based on the averaged data of F-D curves from stress relaxation experiment of parallel plate compression and by applying an FEM optimization technique. This approach enabled more realistic and pertinent expression of the mechanical behavior of the homogeneous gels based on geometry than conventional methods and allowed simultaneous and logical characterization of all viscoelastic parameters relating to both Prony series and Maxwell model. The reliability of the FEM optimization method was
confirmed by small stress deviation within 4.7% between experimental data and the FEM simulation using optimized parameters for stress-relaxation evaluation of agar/agar-gelatin gels and by strain deviation within 3.4% for creep prediction of 1% agar gel.

2) A binary-phase FEM model has been developed to determine the viscoelastic properties of frozen-thawed agar/agar-gelatin gels by treating the micro-column structure of frozen-thawed tissues as simplified-quadrilateral macro-columns. The prediction errors lied within 12.5% for nonlinear regression analysis and within 3.1% for FEM optimization, confirming the validity of the binary-phase FEM model developed in this research.

3) Short-term simple compression tests and long-term relaxation tests were performed with cylindrical specimens of apple flesh to measure the mechanical properties, and the viscoelastic behavior was predicted using the developed FEM optimization model. Through short-term optimization, the difference in elastic modulus between experiment and the FEM were high by 7.8%. By adding the second optimization with a weighted function approach and utilization of Poisson’s ratio obtained from the short-term optimization, the long-term mechanical behavior of stress-relaxation was more closely predicted within 1.5 % error.

4) The generally adapted protocol of ASAE S368.4 for predicting the apparent modulus of elasticity and the maximum contact stress for convex-shape food and fruit materials was evaluated for its appropriateness. The model apple for FEM analysis was composed of approximately 35,000 geometry elements that closely resemble the surface of an actual apple. The deviations of FEM model geometries in dimension from the actual apples were considerably low within 1.6 %. Through FEM simulation, the average elastic modulus of 7.732 MPa was obtained at the loading condition of 0.5 BP, which was 8.3% smaller than the average apparent modulus of elasticity predicted by the ASAE standard. The maximum von Mises stress at the points of initial contact with the compression target plates evaluated by FEM simulation was about 37% smaller than the maximum contact stress determined by the ASAE standard, and a poor correlation was found between the results of the two methods.
The Design and Analysis of a Hybrid Power Generation System for Buoys

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These buoys must receive electric power from a renewable energy system such as a solar-powered system. The solar power system for a buoy is influenced by weather conditions, so the power systems designed can become very complicated. This power problem can be solved with a hybrid power system. Electric power supply for buoys in areas isolated from the main grid can be provided by means of stand-alone systems based on renewable energy sources such as solar, wind, and wave. There exist many different topologies of the hybrid generation system. In this paper, a PV-Wave hybrid system for buoys is suggested, and this paper includes the analysis and test results of this hybrid system, such as performance of the electric power generation and power quality. The impacts on voltage fluctuation with the proposed hybrid power generation system can be minimized and furthermore, the network voltage control may also be improved by the proposed converter algorithm. A power conversion system is required to control the conversion switch for decreasing fluctuations of the power generation system.

To reduce fluctuations of the power source, a solar and wave hybrid power generation system is designed in this paper, and the results of the design and the tests with the simulator are presented. The output power of PV is affected by environmental factors such as solar irradiance, cell temperature, cell efficiency. The output of WEC is changed with the height and period of a wave.

The proposed PV energy conversion system includes a MPPT algorithm, conversion switch for a hybrid power generation system, and buck converter. The proposed system offers advanced features for a hybrid power generation system; the excellent performance of the proposed system is verified from both simulated and experimental results.

If designed properly, the cavity resonance technique for buoys can take advantage not only of cavity resonance, but also of the heaving motion of the buoy. WEC is most effective for waves near the resonant period of the buoy and water column system. From the theory and simulation data presented in this paper, we will see that the characteristics of a buoy are related to the variation of each parameter. Furthermore, by conducting an experiment, we confirmed that generating power with a given period and height of oscillating water column
worked. For converting power, the air velocity excited by both buoy heaving and wave motion is proportional to the wave height. The mass increasing with water column length will eventually result in an optimum length of the water column for which maximum power will be obtained near the heaving resonance period of the buoy. So, the designer of a wave energy conversion system should first determine which wave period range is of interest, i.e. the low period range surrounding the heaving period of the buoy, or the high period range of the surge chamber resonance.

During one part of the 24-hour day, the power production and load is changed. The design optimization of any hybrid system for buoys is must be based upon the resource availability of the site. In the case of buoys, the size and capacity of the PV system has to be reduced for installation and reliability.

Finally, this paper includes discussion on system reliability, power quality and effects of the randomness of wave and solar energy on the hybrid power system design. This paper also provides a summary of general and specific conclusions and recommendations concerning the hybrid power system potential for buoys. The conclusions drawn from the analysis are the following:

First, a PV-wave hybrid power generation system with battery storage forms a complementary power system for ocean facilities.

Second, though the wave is a more dynamic source than solar, it also provides energy at night and during periods of little or no sunshine. This complementary feature is favorable to system reliability and battery lifetime.

Third, this hybrid system decreases the battery capacity requirements for buoy systems, and has many additional benefits related to but not limited to installation, cost, efficiency and reliability in the buoy.

Perhaps the most important of design criteria is the efficiency of a hybrid power generation system and the performance of switching, monitoring and control. The test results of the performance of MPPT, WEC, CB and switch for a hybrid generation system under real sea conditions show that the system has high efficiency, stability and reliability.
On the Development of an Autonomous Collision Avoidance System for Ship Using Changeable Action Spaces

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Although navigational support systems such as radar, Electronic Chart Display Information System (ECDIS) and Automatic Identification System (AIS) have been developed for safe navigation of ship, maritime accidents have not been decreased. According to the statistics of maritime accidents, more than 70% of maritime accidents are due to human error. Surprisingly, about 30% of maritime accidents are due to ships’ colliding and more than 95% of colliding accidents are due to human error. Problem is that most colliding accidents can cause catastrophic casualties and sea pollution. Therefore, in order to reduce human error and prevent colliding accidents in ship, it is necessary to develop collision avoidance support system, in which collision risk can be automatically recognized in advance and the route calculated for collision avoidance can be informed to crewmembers.

In this study, an autonomous collision avoidance system (ACAS) is developed by using fuzzy algorithm and the concept of changeable action space searching. Collision risk is estimated by using fuzzy algorithm in order to calculate collision risk in real time against multiple traffic ships. Although action space in previously study is fixed or only the directional range of branch can be changed, the number of node, the range of branch, and the distance between layers can be fully changed according to the level of collision risk, in order to search safe routes more precisely in dangerous situation in this study. Through simulator experiments, the estimation procedures of collision risk based on fuzzy algorithm are evaluated comparing with the results of environmental stress. In order to search the safest route effectively, the route for collision avoidance can be decided real-timely by using optimization considering the collision risk. In order to consider the geographical restriction in confined waterway, virtual searching antenna (VSA) is defined in this study. So, the route for collision avoidance can be calculated considering the fairway constraints.

In order to validate a newly-designed ACAS, 9,000TEU large container vessel is chosen for performance test. In order to carry out numerical simulation, maneuverability of 9,000TEU container vessel is investigated in deep water and shallow water by using free running model test and Kijima model, respectively. The maneuvering characteristics of 9,000TEU container vessel from free running tests are compared with sea trial data of conventional vessels.
In order to test the performance of ACAS against multiple traffic ships according to the change of approaching direction, both free running model tests and simulations are carried out on the scenarios in open sea. And, in order to test the performance of ACAS in shallow confined waterway (H(depth)/d(draft)=1.2), numerical simulations are also carried out on the scenarios of actual significant traffic situation such as fairway share and fairway crossing in the game area of Gwang-yang, Korea, including the actual environmental conditions, such as wind, wave and current.

This paper consists of six chapters.
In chapter 1, “Introduction”, the background and purposes of this paper are introduced.
In chapter 2, “Estimation of maneuverability of 9,000TEU container vessel by using free running model test and Kijima model”, mathematical models are introduced, which are used to investigate maneuvering characteristics of 9,000TEU container vessel in deep water and shallow water.
In chapter 3, “Design of an autonomous collision avoidance system (ACAS)”, the procedures of ACAS and main algorithms, which are waypoint tracking algorithm (WTA) and collision avoidance algorithm (CAA), are newly designed. New concepts of CAA, which includes changeable action space (CAS) flexible according to collision risk and virtual searching antenna (VSA) for the consideration of fairway constraints, is also described with the procedure of calculation. Simulator experiments for validation on the estimation procedure of collision risk by using fuzzy algorithm are described.
In chapter 4, “Validation of an autonomous collision avoidance system (ACAS) in open sea”, free running model tests and numerical simulations for performance test of CAS are carried out on 9,000TEU large container vessel against multiple traffic ships in the scenario of open sea. Experimental results of autonomous collision avoidance by using CAS are compared to simulation results. Both of them are also discussed comparing to the manual collision avoidance by crewmember.
In chapter 5, “Validation of an autonomous collision avoidance system (ACAS) in shallow confined waterway”, actual traffic problem in game area of Gwang-yang and the modeling of harbor and environments are introduced. The results of simulations in shallow passage, considering external force of wind, wave and current are discussed.
In chapter 6, “Conclusion”, the results in this paper are summarized.
In this study, effects of rare-earth element (Y, Nd and Sm) additions on microstructure and mechanical properties of Mg-5Al-3Ca based alloys fabricated by casting and hot extrusion process have been investigated. On the RE (Y, Nd and Sm) elements to Mg-Al-Ca based alloy, excellent strength was obtained at room and elevated temperature because of grain refinement and fine second phase distribution using casting and extrusion process.

RE addition to Mg-5Al-3Ca based alloys results in the formation Al₂RE intermetallic compounds (Al₂Y, Al₂Nd or Al₂Sm) in and α-Mg matrix grains and eutectic regions. By adding different rare-earth elements, the size, volume fraction and distribution of Al₂RE intermetallic compounds was changed. The size of Al₂Y in as-cast Y-added alloy is larger than that of those of Al₂Nd and Al₂Sm in the as-cast Nd- and Sm-added alloys. Also, the clustering of Al₂Y occurs in the as-cast Y added alloys. However, Al₂Sm and Al₂Nd intermetallic compounds homogeneously distributed in α-Mg matrix and eutectic regions. In the microstructure of the as-cast alloys with RE additions, two kinds of eutectic phase are observed: coarse irregular-shape one consisting of (Mg, Al)₂Ca (C36) phase and fine lamellar one consisting of Mg₆Ca (C14) phase. The area fraction of fine lamellar eutectic regions with RE additions increases. Y added alloys have higher area fraction of fine lamellar regions than Nd and Sm added alloys. The different RE (Y, Nd and Sm) addition to the as-cast Mg-5Al-3Ca based alloys resulted in the changes of microstructural morphology. The microstructure of Y added alloys shows dendritic α-Mg morphology, while the microstructures of Nd and Sm added alloys change from dendritic to equiaxed α-Mg grains with increase in Nd and Sm contents. Sm addition exhibits better grain refinement efficiency than Y and Nd addition to the cast Mg-5Al-3Ca alloys. Grain refinement efficiency of Sm by Al₂Sm intermetallic
compounds as nucleation center for magnesium grains are found to be in the range from 1 to 5 \( \mu \text{m} \).

During hot extrusion, the distributions of second phase particles and grain size are drastically changed from the initial as-cast microstructures. Grain size is well refined by RE additions through hot extrusion because of dynamic recrystallization and the homogeneous distribution of second phase particles. The Eutectic phases of the extruded alloys are broken into small particles and elongated to extrusion direction because of severe deformation by hot extrusion. However, \( \text{Al}_x\text{RE} \) intermetallic compounds were not crushed during hot extrusion. In the as-extruded 3\%Y added alloy, the particle size of eutectic phase size was changed to finer below about 1 \( \mu \text{m} \) with wide band structure. It is suggested that fine particles resulted from the fragmentation of fine lamellar eutectic phase consisting of C14 distributing in the as-cast alloys. The majority of grains are oriented such that their (0001) basal planes are parallel to the extrusion direction. With increasing RE content, the maximum intensity of (0001) basal plane was decreased because of the increase in recrystallized grain formed around \( \text{Al}_x\text{RE} \) intermetallic compounds and fine eutectic particles.

By RE addition and hot extrusion process, strength was improved by grain refinement and fine second particles. Especially, yield strength of as-extruded RE-added alloys was above 300MPa. Elongation of as-extruded 1wt\%RE-added alloys was higher than that of no-RE addition alloy. In Y-added alloy, yield strength and ultimate tensile strength was increased and maximum value of yield strength and ultimate strength was 326MPa and 331MPa at 3wt\%Y-added alloy, respectively. Maximum value of yield strength and ultimate strength in Nd-added alloy was 322MPa and 335MPa at 2wt\%Nd-added alloy, respectively. In Sm-added alloy, maximum values of the yield strength and tensile strength were 313MPa and 330MPa for the 2wt\%Sm-added alloy, respectively. Fine \( \text{Al}_x\text{Sm} \) and \( \text{Al}_x\text{Nd} \) was effectively contributed to improvement of strength due to homogeneous distribution of these intermetallic compounds. On the other hand, fine C14 particle is higher efficiency to improvement of strength comparing with coarse \( \text{Al}_x\text{Y} \) in Y-added alloys. Particle fracture is main fracture mode in RE added alloys. Spherical or small C14 particles are more resistant to cracking comparing with C36 eutectic particles with coarse-rectangle type morphology. Therefore fine C14 phase was effectively contributed to improvement of strength and ductility.
Arsenic is ubiquitous in the environment in the form of inorganic and organic compounds, with different properties and uses. Speciation of arsenic is routinely performed with HPLC coupled to ICP-MS. The quantification of arsenic species is difficult because of the low concentration of the species in environmental samples. Insufficient selectivity and sensitivity of the separation media lead to the present study. High efficiency ion exchange monolithic silica capillary columns have been developed that showed superior performance compared to particle packed columns. An anion exchange monolithic silica capillary column having a quaternary ammonium salt functionality showed an improved performance for the separation of common inorganic anions and arsenic species. A hybrid monolithic silica modified by on-column copolymerization of N-[3-(dimethylamino) propyl] acrylamide methyl chloride-quaternary salt (DMAPAA-Q) with 3-methacryloxypropyl moieties showed a μHPLC separation of common inorganic ions and arsenic species using 50 mM phosphate buffer at pH 7 as a mobile phase. The performance with the inorganic anions provided ca. 40,000 theoretical plates (33 cm column length), but poorer performance for arsenic species. Although reduced efficiency was observed for an anion that was retained for a long time, the results of this study shows the potential utility of the DMAPAA-Q stationary phase for anions separation. Evaluation by capillary
electrochromatography (CEC) was also performed to compare the performance of this column, using 50 mM phosphate buffer at pH 7. CEC produced better performance of up to ca. 90,000 theoretical plates. A weak cation-exchange (WCX) and HILIC modes columns were also prepared and evaluated for the separation of proteins.
Rainfed lowland rice is grown in bunded fields of over 46 M out of 132 M hectares of world rice area. Drought stress is common, with yields averaging only 2.3 Mg ha⁻¹. The ecosystem is characterized by fluctuating water, with soil hydrology ranging from flooded and anaerobic to droughted and aerobic. Root systems have to cope with too much and too little water at different growth stages. Previous research has demonstrated that cultivars differed in their patterns of adaptation to various types of rainfed environments, and this was associated in part with patterns of root and shoot behavior under drought.

In the first study, doubled haploid lines (DHLs) from the cross of CT9993 and IR62266 were used to examine responses to drought and rewatering in controlled rainfed lowland conditions, in order to determine whether confounding by unrelated traits would be less than has been reported previously for contrasting cultivars that differ in genetic background. IR62266 and four DHLs (DHL-32, -51, -54 and -79) were grown in pots and subjected to two water regimes (well-watered and drought) in the greenhouse during the 2000 dry and wet seasons at IRRI, Los Baños, Philippines. Genotypic variation was observed in root traits and water extraction, with the latter being slower in DHL-32 and faster in DHL-79, especially in deeper soil layers. An upper bound relationship between water extraction from a soil layer and root length density (RLD) in that layer was readily apparent over DHLs and soil depths, suggesting a critical value of RLD for water extraction of 0.30 cm cm⁻³ in these conditions. Because soils in the
field would not be as homogenous as the puddled soils used in these greenhouse experiments, this critical RLD for water extraction from a soil layer is a reference for ideal conditions, and requires careful validation in the field. Use of DHLs permitted comparisons with reduced confounding by genetic background, and with consequent improvements in precision.

The second study focused on the shoot dynamics of IR62266 and four DHLs, under drought and following rewatering. Genotypic variation in leaf and tiller development, transpiration, water use efficiency, osmotic adjustment and leaf water potential were examined in relation to dry matter production. Results revealed that greater seedling vigor through continued leaf expansion in early drought, was associated with greater dry matter production after rewatering. Higher water use efficiency was related to a greater increase in dry matter production during drought. Leaf water potential correlated strongly with dry weight, not only during drought, but even more so after rewatering. Apparently, the ability to continue leaf expansion, maintain higher water use efficiency and greater osmotic adjustment (OA), for maintenance of leaf water potential as drought progressed, were desirable traits for improved performance under drought and improved ability to recover upon rewatering. These relationships could be analyzed precisely using such genetically-related materials as DHLs, with less confounding effects of plant size and genetic background.

The role of root signals in water deficit responses of rice is important in the alternate flooding and drying conditions encountered in rainfed lowlands, where the abundant roots in the shallow soil layers may generate signals when droughted, with consequent reduction in stomatal conductance ($g_s$) and growth, despite the likelihood of additional water in deeper soil layers. Thus, the third study was conducted to confirm the presence of root signals, explore their nature and plant responses, consider the suitability of the methods, and discuss implications for adaptation to rainfed lowland drought. A split-root technique was used in greenhouse studies, whereby roots were divided into two sections: flooded and droughted. The decrease in $g_s$ and transpiration rate (Tr) due to drying of a portion of the roots, and their apparent recovery upon severing of this root portion, were consistent with the role for root signals. The field study confirmed the evidence for root signals during progressive soil drying, whereby $g_s$ and Tr decreased before leaf water potential ($\Psi_L$) started to decline. The increase in leaf ABA concentration under field drought, and its strong association with soil moisture tension and $g_s$, suggested its involvement in mediating stomatal responses during early drought in rice. The recovery in $\Psi_L$ after severing of droughted roots in the greenhouse was attributed to increased hydraulic conductance. These responses implied a role for both chemical and hydraulic signals in rice, which have important implications for adaptation and crop performance in contrasting rice ecosystems.
After proving that root tips in drying soil communicate with shoots for stomatal closure in rainfed lowland rice, despite water being available at further depth, the fourth study examined variation between two lines in root signals. Rice lines CT9993 and IR62266 were grown in the field and in the greenhouse using the split-root, root-sever, wax-layer system, to investigate their responses to mild and severe water deficit by monitoring $g_s$, $\Psi_t$, and leaf ABA concentration. In the greenhouse, root systems were divided, withholding water from one portion, and in some cases, severing the droughted portion of roots to remove the source of the signal. Wax layers differing in strength were placed at hardpan depth. Roots of CT9993 were better able to penetrate the wax layers. IR62266 exhibited stronger responses than CT9993, with IR62266’s stomatal conductance dropping sharply under water deficit, and recovering at slower rates but less completely, when roots subjected to drying soil were severed. The greater stomatal response in IR62266 was associated with a higher leaf ABA concentration during early water deficit, which in turn, was associated with its greater number of roots in drying soil. In the field, a second reduction in $g_s$ was observed under severe water deficit, with stronger signals in IR62266 associated with more conservative water use as soil drying intensified. To better exploit subsoil water in mild or transient water deficit, selection for reduced root signals might be warranted.

In conclusion, the use of DHLs contributed to the precise evaluation of shoot and root trait responses to drought and recovery. Root signals seemed to involve ABA-mediated responses during the early stages of drought, whereas hydraulic signals commenced as drought intensified. Genotypic differences found in IR62266 and CT9993 in root signals fundamentally account for the differential adaptive behavior of these contrasting lines under water deficit. These drought-response strategies may assist in the development of cultivars with greater drought resistance for targeted environments within the rainfed lowlands.
Water buffalo is a very important livestock in Southeast Asian countries providing milk, meat, and draft power. There are two types of buffalo, the river type (2n=50) which is use mainly for milk and meat and the swamp type (2n=48) which is use mainly for draft and only secondary for milk and meat. In swamp buffalo-dominated countries like Philippines, upgrading the swamp buffalo by crossbreeding with imported river buffaloes have resulted to production of crossbreds that provided additional income and nutrition to rural farmers through improved milk and meat production. The improved production potentials have increased the farmers’ interest to raise and own crossbreds, especially purebred river buffaloes. However, live animal importation is risky and expensive, hence, to expand the breeding program and produce purebred river buffaloes, there is a need to develop the reproductive biotechnology to produce river buffaloes by embryo transfer using swamp buffaloes as surrogate mothers. In view of the above, series of experiments was conducted to develop and improve the systems for embryo in vitro production (IVP) and cryopreservation in water buffalo and the efficiency of these techniques was examined for propagating water buffaloes of superior genetics. In the first experiments, establishment of the embryo IVP following the systems used on cattle and studies on vitrification for embryo cryopreservation were carried out. Viability of in vitro produced-cryopreserved embryos (2n=50) after embryo transfer was assessed in river and swamp buffalo recipients. In experiment 2, factors affecting the production of water buffalo embryos in vitro were examined. The effects of the length of ovary storage, length of in vitro maturation, and the components of the in vitro maturation medium for oocytes were evaluated. The incidence of chromosome abnormalities among early stage embryos was examined
to determine factors causing failure of cleaved zygotes to develop to the blastocyst. Experiment 3 was designed to improve the *in vitro* systems for efficient production of viable embryos. Selection parameters of developmentally competent oocytes were established. Furthermore, the use of density gradients of silica particles to isolate motile sperm cells for *in vitro* fertilization (IVF), the effect of supplementation of energy substrates pyruvate and lactate, and the use of stage-dependent culture system using increasing concentrations of fetal bovine serum to cater the changing requirement of the embryos for improved blastocyst development were assessed.

Results showed that following the systems developed in cattle, success rate in water buffaloes is sub-optimal with average cleavage rate of 53.5% and blastocysts development of 11.4%, suggesting a need to refine the systems to suit the water buffalo requirements. Embryos vitrified by in-straw vitrification using EFS40 (40% v/v Ethylene glycol, 18% w/v Ficoll & 0.3 M Sucrose) as cryoprotectant and 10% ethylene glycol as pre-equilibration medium survived at 0.5 min exposure time but the success rate was low (25%) and fracture damage was observed. It was found that using the same cryoprotectant, pre-equilibration medium and exposure time, the ultra-rapid vitrification techniques using open-poled straw resulted to successful vitrification with an average of 83% post-warming hatching rate in all pre-implantation embryo stages. *In vitro*-produced-vitrified embryos transferred to river and swamp buffalo recipients undergoing natural estrus showed 8.1% and 20.0% full-term development, and 16.1% and 40.0% calving rates, respectively. The results demonstrated viability of the resultant embryos, development of the techniques and potential application of embryo transfer in water buffaloes.

Factors affecting the success rate of *in vitro* embryo production showed that the length of ovary storage at 30-33°C and the duration of *in vitro* maturation had significant effects on the developmental competence of the oocytes. Shorter storage period (3-4 h) of ovaries is better than longer (4-6 h) storage period. Length of *in vitro* maturation varies among oocyte, with optimum time appeared to be between 22 to 25 hours. Examination of chromosomes of the early stage embryos revealed 47.7% incidence of chromosome anomalies suggesting that ovary storage, length of IVM, components of the IVM medium, and incidence of chromosome anomalies are factors affecting blastocyst development in buffaloes.

Selection of homogeneous population of oocytes showed that the compactness of cumulus cells, the diameter of the ooplasm, and the size of donor follicles are important indicators of oocytes with developmental competence. Oocytes with loosened cumulus cells requires shorter period (20-22 h) while those with compact cumulus cells longer period (24-26 h) of *in vitro* maturation. Highest developmental competence were observed in oocytes surrounded by >3 layers of cumulus cells, with >120 μm in diameter, and from ≥6 mm follicles. On the other hand, density gradients sperm separation utilizing silica particles was found
effective in enhancing significantly higher cleavage and blastocyst development with three discontinuous layers (45/65/90%) found most effective. On in vitro culture of embryos, results showed that the addition of pyruvate and lactate in the in vitro culture medium improved embryo development to the pre-implantation stage. The stage dependent culture system utilizing increasing concentration of serum had no beneficial effect in improving blastocyst development. Of the 52 vitrified embryos produced by IVF system using sperm cells separated by density gradient and cultured for development in a stage dependent culture system with pyruvate and lactate, full term development of embryos after non-surgical transfer to recipient animals was 13.5% (7/52), or 23.1% (6/26) calving rate including a twin suggesting an improved efficiencies in the IVP of viable embryos in buffaloes.

Results of these studies demonstrated that method of IVP of embryo in bovine works in water buffalo but success rate is sub-optimal. Refinement of the systems such that minimize long storage of ovaries, select homogeneous population of oocyte for IVM and apply the desired IVM culture medium and period, use pure motile sperm cells separated by gradients of silica particles for IVF, and supplement energy substrates in the IVC medium improved the production of embryos.
With increasing global water scarcity, water that is once diverted for agricultural production will be shifted to supply domestic and industrial sectors. Rice culture requires tremendous amount of water compared to other crops. Hence, there is a need to reduce water use in rice production. Field experiments were conducted in the Philippines, Malaysia and China to quantify water balance components at different stages of rice culture and to identify methods to save water in rice production.

The effect of straw mulching and shallow surface tillage on crack formation during the fallow period, and on water flow components during land preparation was investigated in field experiments in the Philippines. Straw mulching helped conserve moisture in the soil profile and reduced the mean crack width compared to no soil management treatment. It also reduced the soil saturation requirement but did not significantly reduce the amount of water input during land soaking. Shallow tillage formed soil aggregates which blocked the cracks and reduced total water input for land preparation by 31-34%.

Rice crop is established either by transplanting (conventional way) or by dry seeding (DS) or wet seeding (WS). The effect of crop establishment methods on irrigation input and water productivity (weight of produce per unit volume of water used) in three irrigation units (IU), ranging from 30 to 50 hectares, from 1988 to 1994 in the Muda Irrigation Scheme, Malaysia was investigated. Yields in TP were higher than in wet-seeded (WS) and those in WS higher than in dry-seeded (DS), but the difference was significant only between TP and DS. Land preparation duration was significantly reduced in DS and WS compared with TP, resulting to reduced total water input (rainfall and irrigation) before crop establishment. However, during the crop growth period in the main field, TP had a significantly shorter crop growth duration and lower total water input than DS and WS. Relative advantage between DS or WS rice versus TP rice has to be considered to achieve reduction in total water input and increase water productivity.

The effect of water management using alternate wetting and drying irrigation (AWD) was studied and compared with continuous flooding (CF) irrigations at different N-fertilizer split management treatments on rice yield, water productivity,
and fertilizer-use efficiencies in 1999 and 2000 at two lowland rice sites in China with shallow groundwater tables. During the drying cycles of AWD irrigation, the water table depths was shallow and never went below -20 cm below soil surface, making the soil moist most of the time. Thus, the yield did not significantly differ between AWD and CF. The productivity of irrigation water in AWD was about 5-35% higher than in CF, but differences were significant only when the rainfall was low and evaporation was high. Apparent Nitrogen recovery (ANR) increased as the number of splits increased. ANR was lower in most cases in AWD than in CF which indicates higher N losses in AWD are incurred. The results suggest that AWD can reduce water input without affecting rice yields and does not require N-fertilizer split management differently from CF.

Results of low N-recoveries in AWD in previous experiments and other reports show that AWD might incur more nitrogen losses than CF. Chlorophyll meter-based N-management, proven to successfully increase N-use efficiency of rice grown under continuous flooding, may be applicable but has not been tested under AWD. This study was carried out to test whether chlorophyll meter (that detects the greenness of leaves) can be used for real time N management of rice subjected to AWD. Experiments were conducted in the 2004 and 2005 dry seasons at IRRI, Philippines. CF was compared with different levels of AWD: AWD-10 (irrigation when soil water potential at 15 cm soil depth reaches -10 kPa), AWD-20, AWD-50 and AWD-80. N-management treatments were: zero N (N0), 180 kg N ha⁻¹ (N180) fixed timing, and real-time N-managements where N fertilizer was applied when SPAD value of the youngest fully expanded leaf equaled or less than a critical value of 32 (NSPAD32), 35 (NSPAD35), 38 (NSPAD38), and 41 (NSPAD41). AWD-10 had similar yield with CF but decreased when soil water potential drops below -20 kPa. AWD treatments had significantly lower irrigation water input ($P<0.05$) compared with the CF treatments, but water productivity was increased ($P<0.10$) only in AWD-10. Despite lower N application rates, NSPAD38 gave similar yield as N180 in all water treatments. Yield of NSPAD35 was statistically lower, but in the range of 90% of that of N180. The agronomic nitrogen use efficiency (ANUE) and ANR of NSPAD38 and NSPAD35 were consistently higher than that of N180. The relationship between N-content and SPAD reading was not significantly different between CF and AWD.
suggest that -10 kPa is a safe threshold value for AWD and chlorophyll meter can be used to manage N fertilizer application in rice grown under AWD using threshold values of 35 - 38.

Water can be saved at different stages of rice culture using dry shallow tillage before land soaking and soil mulching to conserve moisture at the fallow period and reduce soil saturation requirement. DS and WS has the advantage of early crop establishment compared to conventional TP. But TP, when modified, can save water if seedlings are grown elsewhere, not in the main field, and land preparation is done when the seedlings are ready for transplanting. AWD save water compared to CF by effectively reducing seepage and percolation losses. Nitrogen management by chlorophyll meter can be used in AWD using 35-38 as threshold value. Development of new water resources to increase water supply and increase production requires huge investments. Management of soil, water, and fertilizer is a less costly option to increase water productivity and mitigate water scarcity.
On Zeta Polynomials of Type IV Codes over Rings of Order 4

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The concept of zeta functions and zeta polynomials for linear codes over finite fields was first introduced by I. Duursma. He conjectured that the Riemann Hypothesis Analogue (RHA) is true for some divisible codes with minimum distance satisfying the Mallows-Sloane bounds. In fact, he was able to show that extremal Type IV codes (over $F_4$ with Hamming weights divisible by 2) with length divisible by 6 indeed satisfy RHA. On the other hand, S. T. Dougherty, et. al., defined Type IV codes over a ring $R$ of order 4 to be self-dual codes with even Hamming weights. They considered the finite ring $R$ to be any of $\mathbb{Z}_4$, $F_2 + uF_2 = \{0, 1, u, 1 + u\}$ with $u^2 = 0$, and $F_2 + vF_2 = \{0, 1, v, 1 + v\}$ with $v^2 = v$. A number of actual Type IV codes over these rings were given in the papers authored by Betsumiya, Bouyu, Dougherty, Gulliver and Harada. The basis of this dissertation are the papers mentioned above with the objective of studying the behavior of zeta polynomials of codes defined over rings of order 4 - $\mathbb{Z}_4$, $F_2 + uF_2$, and $F_2 + vF_2$. In this dissertation, we extend the definition of zeta function and zeta polynomial to codes defined over finite rings with respect to a specified weight function. Moreover, we also investigate the Riemann Hypothesis Analogue for Type IV codes over any of the rings $\mathbb{Z}_4$, $F_2 + uF_2$, and $F_2 + vF_2$. Although for small lengths, there are only a few actual Type IV codes over $\mathbb{Z}_4$, $F_2 + uF_2$, and $F_2 + vF_2$. Although for small lengths, there are only a few actual Type IV codes over $\mathbb{Z}_4$, $F_2 + uF_2$, and $F_2 + vF_2$. Although for small lengths, there are only a few actual Type IV codes over $\mathbb{Z}_4$, $F_2 + uF_2$, and $F_2 + vF_2$. 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$F_2 + uF_2$, and $F_2 + vF_2$ that satisfy the Hamming distance upper bound $d = 2\left(1 + \lfloor n/6 \rfloor\right)$ we will show that zeta polynomials corresponding to these weight enumerators that meet this bound satisfy the Riemann Hypothesis Analogue property. In addition to this, computations of zeta polynomials of all self-dual codes of length at most 16 defined over these rings will be shown. More importantly, we will also prove that the RHA property holds for any extremal Type IV code over a ring of order 4 when its length is $n = 6k$ or $n = 6k - 2$ for any integer $k > 0$. Another interesting result that will be discussed here involves the zeta polynomial of Klemm codes defined over $\mathbb{Z}_4$ and $F_2 + uF_2$. Finally, we include the implications of all these results to the field of coding theory.
This dissertation consists of six chapters. Chapter 1 introduces, in particular, the meaning of international migration and reviews related theories and research.

Chapter 2 highlights the socio-economic impacts of international migration on the place of origin in Thailand. Chapter 3 explains the research methodology and its objectives. The author aims to identify the two major aspects of international migration, namely the social and economic effects on migrants’ households and on their communities. The research adopts two research techniques; a questionnaire survey for quantitative analysis and an in-depth interview for qualitative analysis. The first two sets of questionnaires were prepared for the return migrants and also for their relatives with similar questions in each regarding economic and social dimensions. The economic aspect focuses on the financial status of migrants and their families, including consumption, debts and savings, household appliances, occupations, investment in land or business and working skills learnt while abroad.

Concerning social aspects, this identifies the impacts of migration on such social matters as children’s education, community recognition and its relationship to the migrants, quality and way of life, family ties, health conditions, role of family members and so on. It also covers the demographic aspect as measured in terms of household size. Both versions include an open-ended section for the respondent’s comments or recommendations on the issues of international out-migration. In addition, the third set of questionnaires, for non-migrants, is designed to make comparison between migrant and non-migrant groups. On-site surveys were conducted between 2005-2007 at seven villages in two provinces, namely Khon Kaen and Udon Thani. Respondents were selected on a random sampling basis from the lists of villagers supplied by the head of each village. In total, 450 questionnaires were distributed. An equal number of questionnaires were applied to each area.

Chapter 4 describes findings from the surveys in the two study areas. It was found that most of the migrants were male while migrants’ relatives were, in general, female. A majority of the respondents had an agricultural background with primary level of education. Married men and women became migrants in order to earn much higher incomes in foreign countries than were available in Thailand. Single migrants were inspired by the attractive income as well as by the expectation of the experience that they would gain in foreign countries. Males were more apt to become oversea migrants in both study areas because of their role as the leader of the family, they go abroad at a young age in order to have a longer
period to earn higher incomes to support their families.

The oldest return migrants in Khon Kaen and Udon Thani were 61 and 60 years old respectively. This would suggest that they had migrated to work abroad almost 30 years previously as the early migrants from both areas were in the 34-35 year old age group at the time of migration. Social problems deriving from international migration were very few in migrants’ families, particularly in Khon Kaen, because they received a lot of help and support from close relatives and also from wives who managed to take on more household tasks than normal. These wives acted on behalf of their husbands to sustain their families. Most migrants had established their families before migrating overseas, and this indicates an incentive to migrate for the benefit of their families. Child delinquency was found in Udon Thani although the number of cases seemed too insignificant to be of harm to the community as a whole. This problem was not found in the Khon Kaen area. Some migrant relatives responded that they felt lonely when their spouses were away from home, while some migrants reported that they felt homesick.

Regarding community recognition and relationship, the migrants did not feel rebuffed by their communities in both areas. They maintained their level of relationships or they were even more highly acknowledged than before. This implies that they became a symbol of successful people who earned high income from overseas.

Modern and effective systems of communication such as mobile phones and the ability to transfer money through banks or other similar kinds of service enables close contact between migrants and their family or community to be maintained. The family ties seemed to be largely unaffected by overseas working owing to the use of modern communication tools. Remittance donated to the communities’ activities, by the previously named means, can easily and quickly reach its destination. This helps strengthen the cohesiveness of community and create high recognition of migrants in both areas.

The level of education of migrants’ children and dependents were found to be higher than that of non-migrants because the overseas remittances may be used to support the expense of formal education. The amounts of money from abroad are larger and more reliable than could be earned domestically. Obtaining higher education may lead to fewer social problems within the family and community. In terms of quality and way of life, migrants’ households and their communities benefited from purchasing luxury items that improve their lifestyle. They believe that these items would make their lives more comfortable and convenient.

Concerning economic conditions, most respondents of the two areas had no
debt and had accumulated a certain amount of savings which may be invested in various ways. Land purchase and an occupational change to become a local politician or trader were observed in the survey. Nevertheless, most households did not have a high level of savings probably because they had spent much of the remittance on purchasing property, or building and renovating their houses. The household size and birth rate did not change when compared before and after migration. This means that the families had already made a decision on the number of expected children before going abroad, thus the household size increased only slightly and only a very small number of children were born to the returnees’ families.

Most of the non-migrant respondents were married and living with their spouses although a number were widowed. More than half in the Khon Kaen area were females, which was in contrast to the case of Udon Thani. In Khon Kaen, about half of respondents were the head of family while the percentage was much higher in the case of Udon Thani. Most were farmers with a low level of education. The vast majority of the group did not have any savings or debt although the non-migrants of Khon Kaen were comparatively poorer than those of Udon Thani.

The analysis in Chapter 5 reveals that work in an oversea country can produce higher income when compared to that of the place of origin this induces the villagers to leave home and so can be described as functioning as a strong pull factor. However, due to high commission fees for migration, the migrants cannot save much money for a long initial period because they have to pay back debt during at least their first two years in foreign countries. Even though the remittances sent back home may be quite regular, it is not clear that migrants can afford to remit sufficient funds for their family. They would not hesitate to send money, regardless of the source, because they feel responsible for their family. This situation causes serious psychological stress which leads to many problems being found extensively in the migrants themselves rather than in their families. This unavoidably affects their families in negative ways and it may increase the debt or lead to a loss of confidence among their family members.

Finally, chapter 6 presents conclusion and recommendations. Although a large amount of remittance seems helpful to the national economy on a macro scale, it is necessary to raise more concern about the problems arising from negative impacts of overseas work on both economic and social aspects. The negative impacts are to be considered as critical so as to strengthen the capability of the nation to send laborers abroad. In this respect, the Government to Government policy of international labor migration should be appreciated and implemented in order to eradicate the problems of deception by the middle men who charge extremely high commission fees to job seekers. The system of international migration should be evaluated with more careful and fruitful strategies at a national level so that its improvement will benefit the migrants, their families and their communities in all aspects.
The present thesis aims to produce feedstock materials of wrought Al-Mg-Si based alloys for the semi-solid process. Nowadays, the semi-solid process is becoming an attractive technology to produce light-weight products with superior mechanical properties. The use of Al-Mg-Si wrought alloys as the light-weight structural materials in automotive industries is becoming increasingly important. In Al-Mg-Si alloys, it is generally difficult to produce and control favorable semi-solid microstructures. Therefore, the development of a new forming technology and feedstock materials is highly required.

In this work, the deformation-semi-solid-forming (D-SSF) process for several Al-Mg-Si-Mn and Al-Mg-Si-Cr alloys has been successfully developed in order to produce refined spheroidized \( \alpha \)-Al phase in the semi-solid state. The spheroidization of the \( \alpha \)-Al phase is strongly accelerated by heavy deformation using 60% cold-rolling. It is found that the rapid heating rate of homogenization process coarser and rod-like particles of the Mn containing dispersoid, while the slow heating rate produces finer and homogeneously distributed particles. In the D-SSF process, coarse Mn containing dispersoid particles are effective to introduce strain by deformation and to refine recrystallization and spheroidized grains of \( \alpha \)-Al phase. The grain size of the high Mn (0.7Mn) containing alloy is much smaller than that of the low Mn (0.4Mn) containing alloy. The rapid heating to the semi-solid state is effective to refine the semi-solid microstructure. The grain size of the alloy heated at 644 degree is finer than that heated at 637 degree with shorter holding times. The complete die-filling for the disk shaped products is successfully achieved in the alloys semi-solid heated at 646 degree. The 0.2% proof stress and UTS (ultimate tensile strength) of the fabricated D-SSF products in this work are in the ranges of 300-350MPa and 330-390MPa, respectively. Especially, the high Mg containing alloy exhibits high strength and high ductility compared with other alloys.

Further development of alloys with controlled composition and optimized process conditions has been performed. In new Al-Mg-Si-Mn alloys, it is found
that the small grains of 80 - 90 mm are successfully obtained in the high Si and Mg alloys even by 30% cold-rolling. In these alloys, low semi-solid temperatures about 625 - 630 degree are effective to produce refined spheroidized $\alpha$-Al phase, being useful for fabrication.
**Host β-globin Gene Fragments of Crevicular Fluid as a Biomarker in Periodontal Health and Disease**

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**Background and Objective**: Leukocytes and epithelium are the first lines of defense in preventing bacterial invasion into periodontium. Some of these cells die in gingival crevicular fluid (GCF) so their DNA is spilled out. The present study was designed to investigate the profile of host β-globin-gene fragments in the GCF of various periodontal conditions.

**Material and Methods**: GCF from 40 teeth with chronic periodontitis, 30 with gingivitis, and 22 with clinical health were centrifuged (3,000g, 10min). The supernatant (cell-free-GCF) was centrifuged again (13,000g, 10min) resulting in the pellet and the supernatant as debris and debris-free fractions, respectively. Specific primers for amplifying 110bp, 536bp and 2kb amplicons of human β-globin-gene were used to investigate host DNA by quantitative and qualitative polymerase chain reaction.

**Results**: The periodontitis group showed the highest amount of host β-globin-gene fragments while the healthy group had the lowest. In the debris and debris-free fractions, the 536bp and 2kb amplicons were more often detected in the periodontitis group than in the other groups. Interestingly, the presence of 2kb amplicon in the debris fraction would rather discriminate periodontitis from gingivitis and healthy groups because we found it in 85% of periodontitis, while only in 13% of gingivitis, and absent in the healthy groups.
Conclusions: This study showed the different DNA profiles of cell-free-GCF in periodontal health and disease. It suggested that both quantity and quality of host DNA were dependent on the disease conditions. Therefore, the $\beta$-globin-gene fragments in cell-free-GCF may be a potential biomarker of periodontal disease progression.
Spotted babylon, *Babylonia areolata*, one of the most important species in terms of culture potential and commercial values, currently, the most common practice in spotted babylon culture in Thailand is flow-through indoor system. The main goal of this study was to develop the large-scale operation of juvenile spotted babylon in earthen ponds providing the new culture technique in lower investment and higher production, which had special emphasis on studies of following three topics: 1) investigate affect of stocking density and water management on growth performance of spotted babylon; 2) determine growth and production in monoculture and polyculture system; and 3) evaluate the cost and benefits from both system with their feasibility for commercial application.

The study was partially investigated the effect of water exchange regimes in recirculating system on growth, survival and shell abnormality of spotted babylon under controlled laboratory conditions over 120 days. The experiment was done with juvenile (0.33 g body weight) at 300 snail m$^{-2}$ and various different water exchange regimes (no exchange, 15, 30, and 60 day). Higher growth in body weight and shell length were observed in snails held at 15 and 30 day interval, compared with those held at 60 day interval and no exchange ($P<0.05$). A similar results were verified for the final survival rate and shell abnormalities. Next, to examine the combined effects of calcium carbonate additions and water exchange regime, juvenile spotted babylon were held in indoor recirculating tank at four calcium carbonate additions of 0, 100, 250, and 500 g tonne$^{-1}$ with four water exchange regimes of 0, 15, 30, and 60 day intervals, was studied. The results clearly showed that growth was greatest in 15 and 30 day intervals with all calcium carbonate additions. This study showed water exchange regimes had a stronger influence on the growth of juvenile spotted babylon than calcium carbonate additions. It is recommended that *B. areolata* juveniles should be maintained within the water exchange regimes range of 15-30 day intervals with calcium carbonate addition between 0 and 250 g tonne$^{-1}$, providing optimum conditions for production of this species in a recirculating grow-out system.

Then, growth and survival of spotted babylon were evaluated at five stocking...
densities (100, 200, 300, 400 and 500 snails m\(^{-2}\)) in experimental earthen pond over 4 months period. Fifty percent of seawater was exchanged every 7 days. The average growth rates in body weight were 0.63, 0.58, 0.60, 0.41, and 0.39 g mo\(^{-1}\), respectively. Final survival was 98.5, 98.0, 97.5, 94.5, and 94.5\% for snails held in density of 100, 200, 300, 400, and 500 snails m\(^{-2}\), respectively. The results showed that the stocking densities affected growth and survival of spotted babylon. At 100-300 snails m\(^{-2}\) stocking density, growth and survival were higher than 400 and 500 snails m\(^{-2}\).

There is an additional need for more information on growing-out spotted babylon in earthen pond. Water exchange regime, a key factor to consider for maintaining water quality, was studied. Growth and water quality were determined at three water exchange regimes (7, 15, and 30 day interval) in earthen pond using 200 snails pond\(^{-1}\) stocking density over a 5 month period. Results showed that growth was significantly different among the treatments \((P<0.05)\). The higher growth was observed in 7 and 15 day water exchange intervals. At the end of the experiment, growth in body weight rate was 0.84, 0.74, and 0.55 g mo\(^{-1}\) and final survival was 83.6\%, 80.9\%, and 74.2\% in 7, 15, and 30 day water exchange intervals, respectively. Water quality in terms of temperature, salinity, pH, Dissolve oxygen, nitrite-nitrogen and ammonia-nitrogen showed slightly changed throughout the culture period for all treatments except the total alkalinity showed the greatest change (58.67-97.50 mg L\(^{-1}\)). This study concluded that a suitable water exchange regime was 7 day intervals.

Moreover, growth and production of spotted babylon in large-scale earthen pond (20x20x1.5 m) were investigated. Each pond was stocked with juvenile (0.3 g initial weight) at 200 snails m\(^{-2}\), 50% water was renewed at 15 day intervals. The babylon snail was fed once a day at 15-20\% body weight. The growth rate, food conversion ratio and final survival of spotted babylon in monoculture trials after 7 months were 0.78 g mo\(^{-1}\), 2.69 and 84.9\% respectively, compared to polyculture with seabass \((Lates calcarifer)\), 37.2 g initial weight at 5 fish m\(^{3}\), were 0.61 g mo\(^{-1}\), 2.71 and 84.3\% respectively and for polyculture with milkfish \((Chanos chanos)\), 1.5 g initial weight at 5 fish m\(^{3}\), were 0.58 g mo\(^{-1}\), 2.86 and 81.2\% respectively. The total yield of spotted babylon in monoculture, polyculture with seabass and with milkfish was 10,525, 10,450, and 9,875 kg ha\(^{-1}\) respectively. These results have basically demonstrated that it is possible to culture the spotted babylon in both monoculture and polyculture system in earthen pond.

An economic analysis was performed with proposed 4 earthen ponds (20x20x1.5 m), based on the actual cost and production data from pilot commercial-scale farm including farm gate price in 2003 ($9.00 kg\(^{-1}\)). A total farm area (0.8 ha) was comprised of grow-out earthen ponds (0.3 ha), seawater reservoir (0.4 ha) and office with accommodation (0.08 ha). The total cost per production cycle and the net return of the monoculture and polyculture with seabass and with
milkfish were $19,184, $23,245, and $20,742, respectively, and $11,124, $14,691, and $10,448, respectively. Although returns are small, production with 80% survival is economically feasible under the assumptions used. This study presented a positive net return and return and payback period of <5 years is often used as business investment criteria.

The development of spotted babylon farming in coastal areas depended upon the enterprise becoming more economically attractive and ecologically acceptable. The data obtained in this dissertation showed that it is possible to grow spotted babylon in earthen pond, recommended to use a 300 snails m⁻² with water exchange at least every 15 days. However, further research is required to develop the economically viable operation of cultivation of this species, such as enhancement of growth and survival and improvement of the existing management practices.
Information on ambient levels of volatile organic compounds (VOCs) is necessary to evolve a proper strategy to maintain healthy air quality. The behaviors of selected VOCs in the ambient air in Thailand were investigated in this study because increases of VOCs in urban areas in Thailand have serious implications for human health and the environment. Moreover, characteristics of benzene, toluene, ethylbenzene and isomers of xylene, namely m-, p-, o-xylene (BTEX) and 1,3-butadiene in Tokyo, Japan were also examined in this study. International comparisons were intended to give them some interpretation for the better understanding their chromatistics in ambient air.

As a result, the following findings were compiled in this study:
Concentrations of ambient BTEX in Bangkok and Tokyo was examined. The additional other sources of toluene than traffic sources must give intensive influences to the air quality in Bangkok area. On the other hand, in Tokyo, the ratios ranged between 3.5 and 12.9 which were influenced by the reduction of benzene content in gasoline in Japan. Cluster analysis on ambient BTEX in Bangkok and Tokyo was conducted. It was concluded that most of ambient BTEX were derived from automobile exhaust gases. Both o-xylene and m, p-xylene exhibited a very good correlation in the ambient air in both of Bangkok and Tokyo. The slopes of the regression equation between them were around 3 which consisted with a previous reported value of 3.12 in many sites in developed and developing countries. However, it was also pointed out that the ratios between m,p-xylene to o-xylene were observed to be changed in some cases when photochemical reactions were prevailing.

The distributions of BTEX concentration occurrence seemed to be in the form of logarithmic normal distribution in Bangkok and Tokyo. It is made sure that the frequencies distributions were not a simple normal form.

The relationships between xylene isomers in Bangkok vicinity and Map Ta Phut were discussed as follows: the depletion of m-xylene caused by photochemical reactions would occur in a suburban area through the longer residential time. In addition, similar depletion was observed in Tokyo. The ratios
between m,p-xylene to o-xylene were observed not to be constant in summer. It is considered that m-xylene will disappear due to the reaction with OH radical produced under strong sunlight, causing a decrease in its amount. Moreover, the relationships between benzene and 1,3-butadiene concentrations at both the roadside site and the residential site were examined. Clearer results were obtained in summer, when light intensities are stronger and temperatures higher. These results were considered a direct evidence of the photochemical decomposition of 1,3-butadiene in the atmosphere, not in a chamber experiment.

Air pollutants with the enforcement of air quality standard (AQS) in Thailand were measured in Bangkok in the duration of November 2006 to September 2007. Concentrations of each air-quality standard compound are as follows: seven compounds of vinyl chloride, dichloromethane, chloroform, 1,2-dichloroethane, trichloroethylene, 1,2- dichloropropane, and tetrachloroethylene satisfied their AQS at the sites in Bangkok central area. However, the concentrations of benzene and 1,3-butadiene did not satisfy the AQS there. These compounds were discussed to be mainly derived from motor vehicles. Most of them were considered to be comparable to the ones in Tokyo.
Vietnam is located in the tropical and subtropical zone, and has a long coast line of about 3,260 km extending from 8°30’ to 24°50’N, where there is a rich algal flora with about 1,000 estimated and 639 identified species including 269 Rhodophyta, 143 Phaeophyta, 151 Chlorophyta, and 76 Cyanophyta. In addition, several carrageenophytes and agarophytes have extensively been cultivated in Vietnam as edibles, or the sources of useful polysaccharides through the year. These algal species may be potential sources of biologically active compounds. At present, however, there is no report on lectins from Vietnamese marine algae. Lectins, or carbohydrate-binding proteins, are ubiquitous in nature, and play important roles as recognition molecules in cell-cell or cell-matrix interactions. Some lectins are available as useful tools in biochemical and biomedical research fields, because they can discriminate the differences in carbohydrate structures and exhibit various biological activities. Recent investigations reveal that algae are a good source for novel lectins that have unique molecular structures, carbohydrate-binding specificities and biological activities, suggesting the applications of algal lectins as biochemical and biomedical reagents.

This study was designed to investigate the Vietnamese marine algae for the survey of lectins, and to exploit novel and useful lectins from the cultivated algae as carrageenophytes, such as *Kappaphycus alvarezii*, *K. striatum* and *E. denticulatum*, and from an agarophyte, *Gracilaria salicornia*.

First, Vietnamese marine algae inhabiting in the tropical zone were surveyed for hemagglutinins (lectins). Of 44 species examined, including 15 Chlorophyta, 18 Rhodophyta and 11 Phaeophyta species, the extracts from 41 species, including 12 Chlorophyta, 16 Rhodophyta and 11 Phaeophyta species, showed hemagglutination activity toward at least one type of totally 18 kinds of erythrocytes tested. Of these positive species, 9 Chlorophyta, 12 Rhodophyta and
10 Phaeophyta species were newly found to contain hemagglutinins. The crude hemagglutinins, recovered from the extracts by ammonium-sulfate precipitation, of 7 Chlorophyta and 8 Rhodophyta species, were preliminary characterized for carbohydrate-binding specificity, stability for pH and temperature, and divalent cation-independency of hemagglutination. None of the hemagglutinins had affinity for monosaccharides, except the *Codium arabicum* and *Gracilaria euchematoides* hemagglutinins, both activities of which were inhibited by N-acetyl-D-galactosamine and N-acetyl-D-glucosamine. On the other hand, all of the hemagglutinins activities were inhibited by some of glycoproteins tested, including those bearing high mannose N-glycans, complex N-glycans, or O-glycans. All the hemagglutinins were stable in a wide range of pH and temperature, and independent on divalent cations. Thus, Vietnamese marine algae could be considered as a good source of lectins.

The red alga, *K. alvarezii* is an economically important species as edibles or a source of *kappa*-carrageenan and has extensively been cultivated on a large scale. The *K. alvarezii* sample, collected on the pacific coast of Japan, contained a large amount of lectins that are useful for basic research and applications. However, an issue had remained as for how to supply the lectins because there is no cultivation of the alga in Japan. With respect to this issue, the extract from the cultivated *K. alvarezii* in Vietnam showed strong hemagglutination activity. To contribute to the supply of the lectin, seasonal changes in the lectin content, as well as the growth rate and carrageenan yield, of the cultivated *K. alvarezii* (brown color strain) in CamRamh Bay, Vietnam, were investigated throughout the year. The average lectin content and growth rate of the brown strain of *K. alvarezii* were higher in the season from August to next March (during northeast monsoon) than from April to July (during southwest monsoon). The negative correlations were also found between temperature of seawater and both growth rate and lectin content. The environmental factors such as temperature and nutrients appear to be responsible for the change in the growth rate and lectin content of the alga. Thus, *K. alvarezii* can be grown in the tropical waters, especially during the northeast monsoon months with the good production of lectins. The above results were also supported by the culture experiments in the laboratory. This alga was separately cultured for 20 days in each tank under several different conditions for temperature, salinity, light intensity, or nutrients. After the cultures, the harvested algal samples were extracted and compared for hemagglutination activity. The laboratory culture experiments showed that the highest activity was obtained at the following environmental factors: seawater temperature of 26-28°C, light intensity of 10,000-
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15,000 lux, salinity of 30-33% and nutrients rich in ammonium and phosphate.

The occurrence of three different color strains of the cultivated *K. alvarezii* has been reported for decade at cultivation sites in the world. The carrageenan content differs dependent on the color strains. However, there is no report on the comparison of biochemical properties of the isolated lectins from the three different color strains of the alga. Therefore, lectins were isolated and characterized from brown, red, and green strains of *K. alvarezii*, for evaluation of biochemical properties. Each color strain commonly contained the three isolectins, named KAA-1, KAA-2 and KAA-3, which shared the same hapten-inhibition profile of hemagglutination, 20 N-terminal amino acid sequence, and equivalent molecular mass with a range of 28,016 ± 1.2 to 28,021 ± 1.8 Da, but differed in the yield with the highest yield of KAA-2. These properties of the three isolectins were also comparable among the three color strains, irrespective of difference in color. Binding assay with a variety of fluorescence-labeled oligosaccharides indicated that KAA-2 was strictly specific for high mannose type N-glycans. These indicate that the lectins of *K. alvarezii* could be applicable as unique biochemical and medicinal reagents, independently of difference in the color strains.

Lectins were also isolated and characterized from two other cultivated carrageenophytes, *Kappaphycus striatum* and *Eucheuma denticulatum*, both of which belong to the family *Solieria* and produce kappa- and iota-carrageenan, respectively. Both species contained three isolectins, named KSA-1, KSA-2 and KSA-3 for *K. striatum* and EDE-1, EDE-2 and EDE-3 for *E. denticulatum*, respectively. The isolated isolectins shared the same properties in hemagglutination activity, hapten-inhibition profile of hemagglutination, identical sequence of 20 N-terminal amino acids, and equivalent molecular mass of a monomeric protein (about 28,000 Da). As for *E. denticulatum*, isolectins were isolated from both brown and green color strains and characterized as almost the same lectins independently of the color strains, respectively. The highly yielded KSA-2 and EDA-2 exclusively bound to high-mannose N-glycans, and did not bind other glycans including complex N-glycans and a core pentasaccharide of N-glycans, suggesting that they commonly recognized the branched oligomannoside. Interestingly, however, they did not bind to free oligomannoses, which are the constituent of branched oligomannosides. This implies that the reducing terminal disaccharides, GlcNAc(β 1-4)GlcNAc, are essential for the binding of these lectins. These binding properties resembled well with those of high-mannose N-glycan-specific lectins from other carrageenophytes including *K. alvarezii*. Thus,
two other cultivated carrageenophytes, *K. striatum* and *E. denticulatum*, are also considered as the good sources for a strictly specific probe for high-mannose N-glycans. It is suggested that the lectins from both species may show some important biological activities, like other high-mannose N-glycan specific lectin from algae.

Lastly, as an agarophyte, lectins were isolated and characterized from the red alga, *G. salicornia* collected at Nhatrang Bay, Khanhhoa Province, Vietnam. The alga is not yet the target species for cultivation due to its low growth rate. The isolated lectins, GSA-1 and GSA-2, are glycoproteins composed of dimmer of a subunit of about 22,500 Da, which is linked by a disulfide bond(s). The hemagglutination activities of GSA-1 and GSA-2 were not inhibited by monosaccharides, like those of the other lectins from red algae. Both activities were commonly inhibited by glycoproteins bearing complex N-glycans and/or O-glycans, but not by yeast mannan bearing high-mannose N-glycans. The most inhibitory glycoprotein was bovine submaxillary mucin bearing O-glycans. However, in the binding experiment with 22 fluorescence-labeled oligosaccharides, GSA-2 significantly interacted with only the oligosaccharides originated from glycolipids and weakly with bi- and tri-antennary complex N-glycans, but did not with the other oligosaccharides examined. Thus, GSA-2 showed the oligosaccharide-binding specificity distinct from the lectins isolated from carrageenophytes mentioned before, suggesting the novelty of the binding specificity of the lectin.

In this study, I first detected the presence of hemagglutinins in 41 Vietnamese marine algae including cultivated species, and succeeded in the isolation of many isolectins from three cultivated species, including different color strains, of carrageenophytes and one species of agarophytes. Characterization studies demonstrated that the lectins from three carrageenophytes share their biochemical properties such as the strict binding specificity for high-mannose N-glycans, independently of difference in color strains. On the other hand, the lectins from an agarophyte showed the different biochemical properties from those of carrageenophytes. In addition, this study clearly showed that there existed a seasonal change of lectin content in the cultivated *K. alvarezii*, in connection with environmental factors, especially temperature of seawater. In conclusion, Vietnamese marine algae were found to be a good source of novel lectins for application in biochemical and biomedical research fields.
**Paragonimus spp. in Vietnam: Morphology, Molecular Phylogenetic Relationship and Epidemiology**

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The lung flukes of the genus *Paragonimus* are parasites, which cause a dangerous disease called paragonimiasis, of the lungs of animals and human. The genus composes of about 50 reported species. However, only one species, *P. heterotremus*, has been previously proven to be found in Vietnam. Based on morphological and molecular phylogenetic study on metacercariae obtained during recent investigations and adults derived from them, my study clearly showed that at least five *Paragonimus* species exist in Vietnam; including *P. heterotremus* as the dominant species, one new species as *P. vietnamensis* sp. nov., and new records of *P. proliferus*, *P. westermani* and *P. bangkokensis*.

Among all, *P. vietnamensis* sp. nov. was discovered first as the large (nearly 800 μm in diameter) metacercariae. The adult is covered with single arrangement of cuticular spines and has the ventral sucker slightly larger than oral one. Although this new species has some morphological similarities with some other *Paragonimus* species, it is not completely identical to any other species. The molecular phylogenetic analyses of ITS2 and CO1 sequences revealed that *P. vietnamensis* sp. nov. greatly differed from any other known *Paragonimus* species to form a distinct cluster. Morphological and molecular analyses confirmed its validity as a new species.

*P. heterotremus* appeared as the smallest metacercariae (about 200 μm) with two closed cyst wall layers in crabs. The adult of *P. heterotremus* is characterized by the oral sucker nearly 2 times larger than the ventral one and single arrangement of cuticular spines in the whole body surface. Genetically, ITS2 and CO1 sequences of *P. heterotremus* isolates from Vietnam were highly similar to those from China and Thailand.

Metacercariae of *P. bangkokensis* were medium in size (about 450 μm) with thin outer and inner cyst walls. The adult of *P. bangkokensis* is covered with grouped cuticular spines and has ventral sucker slightly larger than oral sucker. Genetically, *P. bangkokensis* from Vietnam showed very high homology with *P. bangkokensis* and also with *P. harinasutai* from Thailand and Lao to construct a single clade as the species complex.

Metacercariae of *P. westermani* are also medium in size (about 400 μm), but
have a thin outer and a very thick inner cyst wall. The adult of *P. westermani* is covered with single arrangement of cuticular spines and also has ventral sucker slightly larger than oral one. Molecular analyses showed that Vietnamese *P. westermani* was genetically closer to isolates from East Asia group (Japan, Korea, China and Taiwan) than those from Southeast Asia (Thailand, Malaysia and the Philippines) or South Asia (India and Sri Lanka) group.

In contrast, *P. proliferus* were found as extremely large excysted metacercariae (about 2.5 mm in length). The adult is covered with grouped cuticular spines and has ventral sucker about 2.7 times larger than oral sucker. Because of the high similarities of ITS2 and CO1 sequences of *P. proliferus* from Vietnam and China with those of *P. hokuoensis* in the DNA data base, *P. hokuoensis* would be a synonym of *P. proliferus* to form a distinct clade in *P. skrjabini* complex.

In this study, *Paragonimus* metacercariae were found in mountainous crabs of the genus *Potamiscus*: *P. mieni*, *P. tannanti* and *Potamiscus* sp. To date, *P. heterotremus* was commonly found in northern Vietnam; *P. vietnamensis* in 3 provinces (Laocai, Yenbai and Quangninh); *P. bangkokensis* in 2 provinces (Laichau and Quangninh); *P. westermani* in 2 provinces (Yenbai and Quangtri); and *P. proliferus* only in Laichau province.

In terms of the prevalence, *P. heterotremus* is the most abundant and is usually found concurrently with other species. The prevalence and percentages of *P. heterotremus* metacercariae are much higher than those of other species, except for the heavy infection of exclusive *P. westermani* in Talong commune of Quangtri province.

In the crab hosts, metacercariae of more than one *Paragonimus* species were found in the same crabs. Those of *P. heterotremus*, *P. westermani*, *P. bangkokensis* and *P. proliferus* were found in all parts of crabs. However, a higher number of *P. westermani* and *P. heterotremus* were found in leg muscles, followed by body muscles, gills and fewer in liver; *P. bangkokensis* was mainly found in the liver, whereas a greater part of *P. proliferus* was found in the body muscles. *P. vietnamensis* was located mainly in the liver, and very few in the body muscles.

In experimental infections in mammal hosts, *P. heterotremus* became mature in dogs and cats after 45-60 days after infection, which is compatible with that of *P. bangkokensis* (50 days), but shorter than that of *P. proliferus* (75 days), *P. vietnamensis* (75-105 days) or *P. westermani* (170 days). *P. heterotremus*, *P. bangkokensis*, *P. proliferus* and *P. vietnamensis* developed well in dogs, cats with quite high developmental rates. In contrast, dog and rat seemed not to be suitable hosts of *P. westermani*, this species could become mature in cat after long period of time with very low rate.

By molecular identification based on analyses of ITS2 sequences of eggs collected from local people in endemic areas, to date only *P. heterotremus* was...
proven to infect to human in northern Vietnam.

Thus, the results of my study provided a comprehensive taxonomy and epidemiology of Vietnamese *Paragonimus* spp., and gave the new insights on molecular phylogenetic relationship between the genus *Paragonimus*.
This thesis dedicated to preparation of high performance separation membranes by low temperature plasma modification method.

Plasma treatments using oxygen and inert gases have been carried out to modify polyacrylonitrile ultrafiltration membrane surface. The influence of plasma treatment effects on the membrane characteristics was investigated. The results show that membrane surfaces become more hydrophilic and membrane fouling reduces significantly after plasma treatments. With the short plasma treatment duration, the separation property of ultrafiltration membranes could be improved by clearly increasing membrane flux meanwhile the protein retention is almost maintained.

Plasma polymerization using vaporized allylamine and acrylic acid monomers has been carried out to form the plasma deposited polymer films. The deposition rate of plasma polymer highly depends on the plasma polymerization conditions such as monomer flow rate, discharge power input and discharge pressure. The plasma polymer formed from allylamine monomer contains the primary amine groups and there is a conversion of primary amine groups into imine and nitrile groups in allylamine plasma polymer. Whereas oxygen-containing functional groups such as hydroxyl, carbonyl and
carboxyl present in plasma polymer formed from acrylic acid monomer.

The deposition of plasma polymerized films onto microporous substrate surfaces lead to the formation of plasma polymerized composite membranes. The characteristics and separation efficiency of these membranes strongly depend on the plasma polymerization conditions. The results showed that the thickness of membrane top-layer is proportional with plasma polymer deposition rate and plasma polymerization time. Meanwhile, the cross-linking degree of this layer relies on an effective plasma energy, which relates to monomer flow rate and discharge power input during plasma polymerization. There is an optimum range of monomer flow rate, a critical discharge power input, a proper discharge pressure and a suitable polymerization time so that the formed composite membranes could have the best selectivity. By the overlap deposition of plasma polymer top-layer in which the first layer (sublayer) prepared at lower effective plasma energy and the second one (barrier layer) formed at higher effective plasma energy, the higher cross-linked top-layer, yet thinner, has been formed and thus, the separation efficiency of the multilayer plasma polymerized composite reverse osmosis membranes could be improved in comparison with that of the dual layer plasma polymerized composite membranes.
### Sustainable Approach to Preventing Osteoporosis in Vietnam

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Nowadays, osteoporosis (OP) is an increasing public health problem worldwide. It has been proved that early detection and prevention is very necessary to minimize the effect of OP. High risk population usually are elderly people should be paid much attention.

In Vietnam, life expectancy is increasing as the economy improves, and with an increased lifespan, there is concern about an increased prevalence of OP. So far, there were few studies where characterize the prevalence of OP in Vietnam, whereas calcium intake in Vietnamese was very low (<500 mg/day) and local calcium rich foods is cheap and available. For those reasons, we conducted studies to determine the prevalence of OP in Vietnam, and to research on approaches to control this problem in Vietnamese population. The results of our studies are as following:

**Study 1**: A cross-sectional study to determine the prevalence of osteoporosis in 2,232 Vietnamese adult women aged from 20 and above was carried out in 2003. We discovered the overall prevalence of osteoporosis in our subjects was 9%, and the prevalence in postmenopausal women was 28.3%, relatively higher than those in other surrounding countries. The study confirmed the fact that osteoporosis has been public health problem in Vietnam.

**Study 2**: A study to develop and validate a food frequency questionnaire (FFQ) for assessing calcium intake of Vietnamese women was conducted in 2004. The results showed that our developed FFQ is useful and reliable for estimating calcium intake in population-based epidemiological studies in Vietnamese women.

**Study 3**: An intervention study
was conducted to examine the effect of community-based nutrition education intervention during 18 months on calcium intake and bone loss in Vietnamese postmenopausal women.

Two communes of Hai Duong province were selected and assigned randomly to be intervention place or control place. In each commune, women who were aged 55-65 years, with low calcium intake (<400 mg/day), and more than 5 years postmenopausal were screened for the study. Subjects were excluded if they had diseases affecting to bone metabolism. After screening, 70 women eligible for participation were randomly recruited for the study in intervention commune. Then, in control commune, total of 70 women who met the criteria were selected and matched with those in intervention group about age, years of postmenopause, educational level, life-long occupation, current weight bearing exercise, weight, height and calcium intake.

Subjects in intervention group were given nutrition education to improve calcium intake up to 800 mg/day, whereas those in control group kept usual diet. Calcium intake and bone mass were evaluated every 6 months. Anthropometric indices and serum parathyroid hormone (PTH) were determined at baseline and the end of intervention.

The results indicated that calcium intake in intervention group increased significantly from 345 ± 54 mg/day at baseline to 657 ± 64 mg/day after 18 months (p< 0.01), while it had no significant changes in controls. Bone mass values were not changed significantly in intervention subjects while it decreased significantly by 0.5% in controls (p< 0.01). The intervention led to a decrease in serum PTH by 12% (p<0.01). In the controls, there was an increase in PTH by 32% (p<0.001).

In conclusion, nutrition education intervention was effective in improving calcium intake and retarding bone loss in Vietnamese postmenopausal women. Therefore, it will be prospective approach to control osteoporosis in Vietnam.