DIWPA: DIVERSITAS in the Western Pacific and Asia

DIWPA News Letter

Office: Center for Ecological Research, Kyoto University, Otsu, Shiga, Japan

September 2023

No. 49

Message from the chairperson

Shin-ichi Nakano

One of the main functions of DIWPA is capacity building of scientists in particular young scientists from developing countries. Therefore, we organize DIWPA International Field Biology Course (IFBC) where graduate and undergraduate students and post-docs in the Western Pacific and Asia. In the present year 2023, we conducted IFBC in Lake Biwa and its satellite lakes from 20 to 26 August. We made the call-for-application to IFBC in our website previously, and many students and post-docs applied it. After careful review, we determined one excellent winner student from Thailand, Ms. Pattama Jitrabiab (Pat), a Ph.D. student from Valaya Alongkorn Rajabhat University (see Pat's article in the present newsletter). Besides Pat, two undergraduate students from Kyoto University joined and learned together aquatic ecology including basic limnology in lakes, fundamental ecological and/or biodiversity studies on plankton, benthic invertebrates, data analyses and database preparation. All the students, together with CER staffs, enjoyed collaborating ecology, limnology and biodiversity in those lakes. Finally, the students gave oral presentations in English and had discussions on what the data collected by themselves scientifically indicated. The IFBC was quite successful! We expect the next IFBC 2024 on forests would also be the case in hope that you will enjoy ecology and biodiversity together.

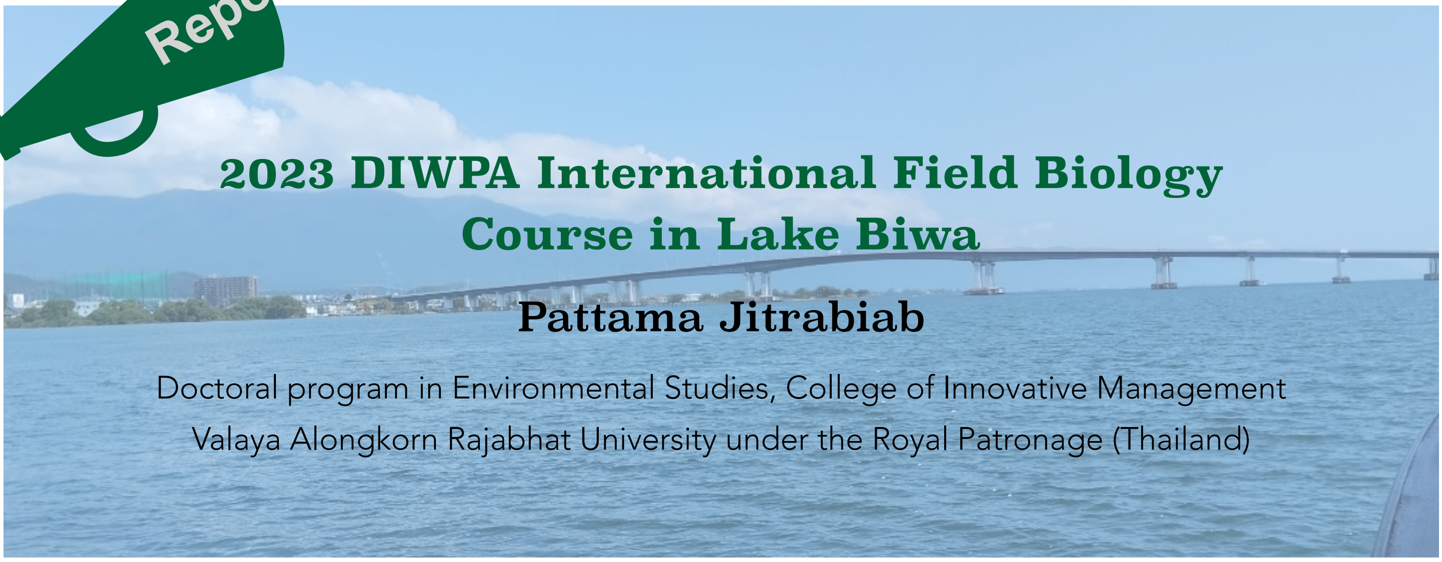
Message from the Secretary General

Atsushi Ishida

Due to the impact of the COVID-19 pandemic, we were unable to hold the DIWPA Field Biology Course for three years. However, in this summer, we invited a doctoral student from Thailand and were able to conduct the DIWPA International Field Biology Course at Lake Biwa in Japan. The report from this student is currently published in this DIWPA newsletter. Although the COVID-19 infections are frequently found in Japan, our lives are gradually returning to normal and we are seeing an increase in foreign visitors to Kyoto in Japan. We believe that we will be able to host the DIWPA Field Biology Course again in next year (2024). Probably, the next Field Biology Course is conducted on forests, we will be able to inform it in 2024 on DIWPA homepage.

To examine biodiversity in the physiological function of trees in tropical seasonally dry forests, I collected leaf ecophysiological data in Thailand as a collaboration with DIWPA members. The analyzed results were published in the journal "Scientific Data" on September 8, 2023. In this paper, I illuminate the variations of leaf traits related to differences in soil properties among the forest types. This finding indicates the existence of a mechanism for niche segregation among forest trees (forest types) based on edaphic factors in soils. We store the raw data in the "Dryad Digital Repository" (Ishida *et al.* 2022; DOI: 10.5061/dryad.12jm63z10), for making it freely accessible for meta-analysis and other research purposes. I believe that the close relationship between forests and soils offers essential insights for predicting forest responses to future environmental changes and for the restoration of degraded forests. I provide more details in this DIWPA Newsletter.

Report 1



2023 DIWPA International Field Biology Course in Lake Biwa

Pattama Jitrabiab

Doctoral program in Environmental Studies, College of Innovative Management
Valaya Alongkorn Rajabhat University under the Royal Patronage (Thailand)

I am currently pursuing Doctor of Philosophy Environmental Studies Course at the College of Innovative Management, Valaya Alongkorn Rajabhat University under the Royal Patronage, Thailand.

2023 DIWPA International Field Biology Course in Lake Biwa has given me the opportunity to learn and gain experience in water resource ecology. This is also relevant to my Ph.D. research on microplastic contamination in tributaries of the lower Chao Phraya River.

Professor Shi-ichi Nakano (Supervisor of the summer program), Associate Professor Takuya Sato, and others provided me knowledge of theoretical studies of aquatic ecology. I also experienced practical training in Lake Biwa, which is the largest freshwater lake in Japan, locate in Shiga prefecture on the island of Honshu, Japan. This 670 square kilometer lake is an important water resource that supplies city and industrial water for 13 million residents in Osaka, Kyoto and Kobe megalopolis.

On the second day, we visited the offshore area in Lake Biwa. I boarded a research vessel “Hasu” owned by Center of Ecological Research Center (CER), Kyoto University (Fig. 1). I learned how to use tools to collect samples of plankton and benthic fauna and the CTD Profiler (the Conductivity, Temperature and Depth), an integrated instrument package designed to measure the water column's conductivity, temperature, and pressure (depth). The instrument is lowered via cable through the water column. It permits scientists to observe the physical properties in real time via a conducting cable, which is typically connected to a CTD to a deck unit and a computer on the vessel (Figs. 2 and 3). For this study, we measured water transparency at the depths of 11, 24 and 50 meter in the lake using a Secchi Disk. Water samples at depths of 11, 24, and 50 meters were taken to determine the amount of dissolved oxygen (Dissolved Oxygen, DO) which is important for the life of aquatic organisms. The oxygen in water was analyzed by Winkler method using MnSO4 alkali-iodide-azide reagent. The results of analysis will be compared with the results from measuring Dissolved Oxygen with the RINKO-Profiler. Furthermore, we collected the plankton samples at the surface of the water with a plankton net tool and the benthic samples with sediment sampling

Fig. 1. A research vessel “Hasu”

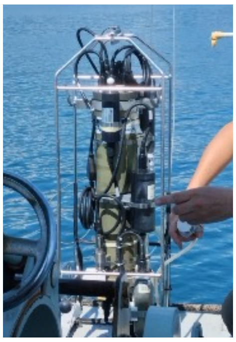


Fig. 2 & 3. A deck unit and a computer on the ship

equipment. All examples of plankton and benthic fauna were brought back the laboratory at CER and examined to determine their species (Fig. 4).

On the 3rd day, we visited Okishima Island in Lake Biwa, the largest island in the lake and the only populated island, to study the amount of Dissolved Oxygen, DO, and environmental data in the water body. Since the depth of water is shallow, there was only one sampling point in vertical distribution, and we used the mode of measuring at 1-second interval. Because the water depth was approximately 1 m, the measurement was conducted at the depth of approximately 0.5 m. Although Chlorophyll-A concentration and turbidity data were highly variable, they could not be measured well. The diversity and abundance of plankton, benthic fauna, and cyanobacteria collected in Okishima Island were examined. To determine the foods of fishes, we examined the stomach contents with a microscope. The number of bacteria was counted using the DAPI Fluorescent Staining method. (Figs. 5 and 6).

Fig. 4. Laboratory work at CER

On the last day of the training, we were assigned the presentation to share the study results. I gave a presentation of the topic “Relationships between bacteria and factors affecting bacterial abundance”. The objectives were as follows: 1) to examine the relationship between the amount of Dissolved Oxygen and the various depths of water, and 2) to examine the amount of Chlorophyll the various depths of water.

This training allowed me to gain knowledge and experience in water ecology to be useful in my doctoral research as well as good friendships from the training participants. I would like to thank Professor Shi-ichi Nakano, Associate Professor Takuya Sato, and everyone who helped and gave advice to me during the training from the first day until the last. I will never forget these memories and our friendship.

Fig. 5. Collecting samples at Okishima Island

Fig. 6. At the pier in Okishima Island

Report 2

DIWPA Collaboration: Inventory data on the leaf ecophysiology of canopy trees in dry evergreen and two drought-deciduous forests in Thailand

Atsushi Ishida
Center for Ecological Research, Kyoto University (Japan)

The inventory data on leaf ecophysiology of canopy trees in lowland Thailand and related data analysis are released in “Scientific Data” on September 8 in 2023. “Scientific Data” is a peer-reviewed, open-access journal of Springer Nature Group for descriptions of scientifically valuable datasets and research, and is a new type of publication that focuses on helping others reuse data crediting those who share. The title of the published paper is ”Comparative physiology of canopy tree leaves in evergreen and deciduous forests in lowland Thailand” (Ishida *et al.* 2023), and the raw dataset is deposited in “Dryad Digital Repository” (Ishida *et al.* 2022), which is available for own analysis, such as Meta-analysis.

In the depository data, any persons can obtain 21 ecophysiological traits of the top/sunlit leaves of trees in three forest types: 1) mixed deciduous forest (MDF) in the Mae-Klong Watershed the Mae-Klong Watershed Research Station (14°34′ N, 98°50′ E, 400 m above sea level) in Kanchanaburi Province and 2) dry evergreen forest (DEF) and dry dipterocarp forest (or dry deciduous forest) (DDF) in the Sakaerat Environmental Research Station (14°29′ N, 101°55′ E, 1610 m above sea level) in Nakhon Ratchasima Province, Thailand (Fig. 1). The Mae-Klong Watershed Research Station is located at approximately 250 km northwest of Bangkok, and the Sakaerat Environmental Research Station is located at approximately 180 km northeast of Bangkok (Fig. 2). The number of sampled trees is 107, 65 and 51 tree species in MDF, DEF and DDF, respectively. Approximately 70%, 95% and 95% of canopy tree species which consist of MDF, DEF and DDF are sampled, respectively. The dataset was collected by the members of my laboratory and DIWPA members from research institutes and universities in Thailand.

In Thailand, the Chao Phraya River flows from north to south, and on either side of the river there are different topography and geologies (Fig.

Fig. 1. Photos of (A) Mixed deciduous forest (MDF; July 2007) at the Mae-Klong Watershed Research Station, and (B) Dry evergreen forest (DEF; July 2007) and (C) Dry deciduous forest or Dry dipterocarp forest (DDF; September 2010) at the Sakaerat Environmental Research Station. The top-canopy heights of MDF, SEF and DDF are approximately 30m, 35m and 15m high above the ground, respectively.

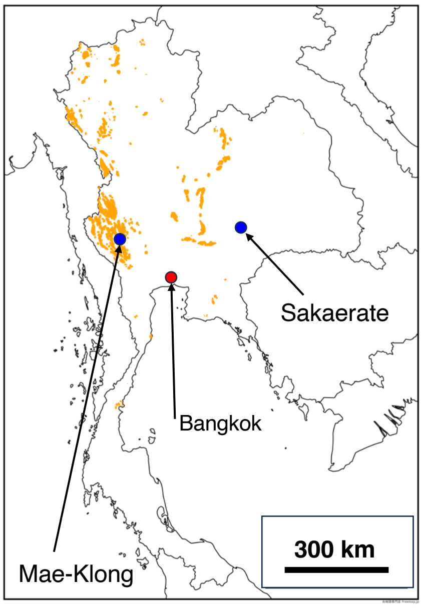


Fig. 2. The limestone area (orange color) in Thailand and the positions of Bangkok and two study sites, the Mae-Klong Watershed Research Station (Mae-Klong) and the Sakaerat Environmental Research Station (Sakaerat).

3). In climate, there is a distinct dry season lasting several months from December to February in overall Thailand and adjacent areas of Southeast Asia. The mechanisms for overcoming the severe dry season are evolutionally resultant for trees in this area. The analyzed results (Ishida *et al.* 2023) show a high biodiversity of leaf traits among the forest types, and the specific leaf traits related to soil properties in each forest type. This fact indicates that there is the mechanism of niche segregation in forest trees (forest types) based on edaphic factors, such as soil thickness and available nutrients. The mountain range in north-western Thailand along the border with Burma is steep and rugged and cuts into narrow valleys. Few peaks exceed an elevation of 1800 m. The Himalayan orogenic movement formed these steep mountains, and the resulting soil in this area originated from the limestone of the Mesozoic Era. Tsutsumi *et al.* (1996) and Rundel and Boonpragob (1995) showed that the soils of limestone areas have high phosphate (P) concentrations. In this area, DDFs are scattered on mountain ridges where the soil is extremely shallow. The Himalayan orogenic movement caused a north-south division through the Chao Phraya River, promoting speciation of trees between the eastern and western parts of Thailand. The north-eastern Thailand consists of the Khorat Plateau (located on the eastern side of the Chao Phraya River), which covers nearly one-third of the country's area. This area is drained by a tributary of the Mekong River, and the soil originated from sandstone created in the Cenozoic Era. Several hills with gentle slopes from elevations of 650 to 250 m are scattered on this plateau. The tops of hills generally have deep sandy soil extending from the ground surface to the bedrock, while the foots of hills have shallow sandy soil

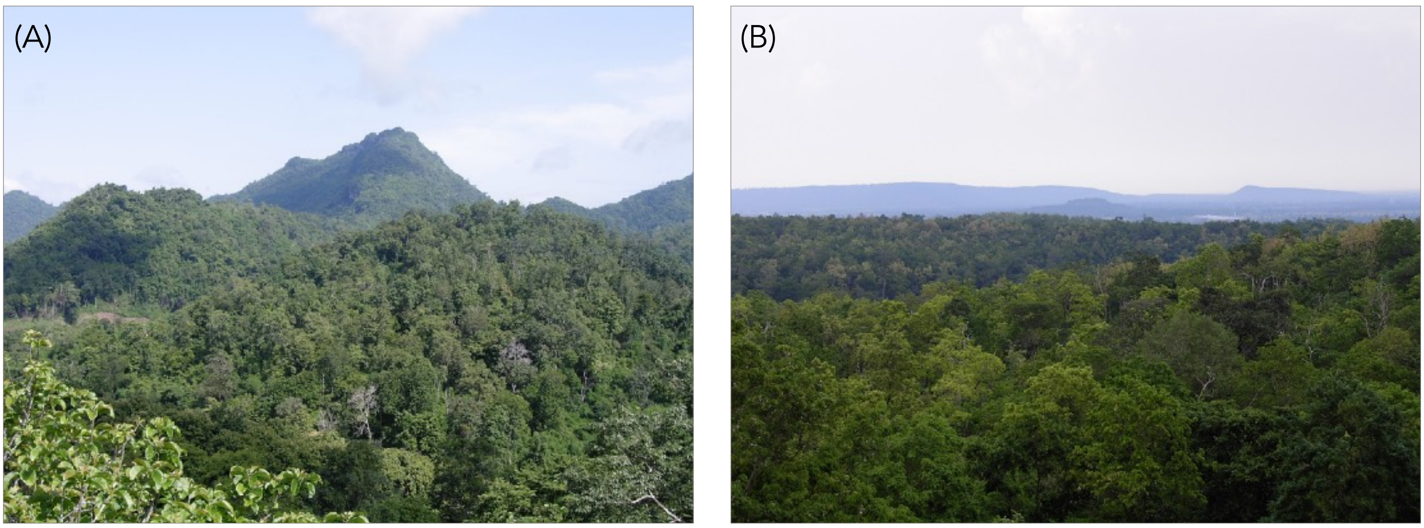


Fig. 3. The landscape of (A) the east side and (B) the west side of the Chao Phraya River in Thailand. (A) A limestone mountain and Mixed deciduous forest (MDF) including bamboo forests. In the north-eastern Thailand, Myanmar and India on the east side of the Chao Phraya River, the Himalayan orogenic movement formed these steep mountains, and the resulting soils originated from the limestone of the Mesozoic Era. (B) The Khorat Plateau and Dry deciduous forest or Dry dipterocarp forest (DDF). In the eastern Thailand and Laos on the east side of the river, it is less affected by this movement and there is a widespread Khorat Plateau with sandstone bedrock created in the Cenozoic Era. This Plateau is drained by a tributary of the Mekong River.

because of soil erosion. These sandy soils have poor nutrient concentrations. In the Khorat Plateau, DEFs usually develop on hill tops with deep sandy soil, whereas DDFs usually develop on foothills with shallow sandy soil. Therefore, the evergreen forests (DEFs) and deciduous forests (DDFs) have separately established within the same hills along the soil thickness gradient in the topography.

In Thailand, drought-deciduous trees are predominant in MDF and DDF, whereas evergreen trees are predominant in DEF. The canopy leaves of MDF (at the Mae-Klong) are significantly thinner and have significantly higher P concentrations and lower photosynthetic water use efficiency (net photosynthetic rates/stomatal conductance ratio) than those of DDF and DEF (at the Sakaerat). These leaf traits and deciduous phenology indicates less conservative resource use strategy (especially in P and water) adapting to the eutrophic, liming soils of MDF, because of contributing to a high carbon gain during a short growing period (Ishida *et al.* 2006, 2010, 2014). It has also been reported that on the island of Borneo, P concentrations within leaves increases and leaf thickness decreases with increasing P availability in soils (Hidata and Kitayama 2011, Bartholomew *et al.* 2022). Both DDF and DEF develop in sandy soil sites with poor nutrients at the Sakaerat; DDF establishes at thin soil sites, whereas DEF establishes at thick soil sites (Murata *et al*. 2009). Thus, the differences of soil thickness are dependent on deciduous phenology (DDF) and evergreen phenology (DEF) of canopy trees, adapting to soil water availability to overcome the dry season. If the canopy leaves use water even in the dry season due to thick soil, evergreen phenology are more adaptive to deciduous phenology, because approximately 50% nutrients within leaves are lost when leaf falling (Vergutz *et al.* 2012). Our data provide evidence supporting the pivotal role of topography and edaphic factors (soil nutrients and water) in determining the habitat associations of diverse forest types and corresponding leaf functional traits within the seasonally dry tropical forests. This fact indicate that there is the mechanism of niche segregation

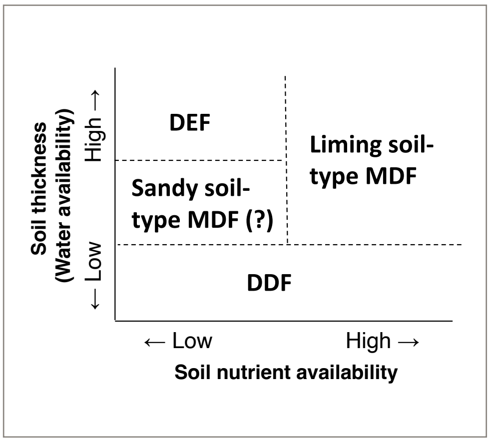


Fig.4. Schematic diagram of the distribution of three different forest types, DDF (Dry dipterocarp forest or Dry deciduous forest), MDF (Mixed deciduous forest) and DEF (Dry evergreen forest), along the axes of soil thickness (soil water availability) and soil nutrients availability as the forest establishment factors. More research is needed to recognize sandy soil-type MDFs.

along the axes of soil thickness (water availability) and soil nutrient availability (Fig. 3). Nevertheless, at the Sakaerat with sandy soil, the top-canopy heights of tree gradually increase with soil thickness from DDF to DEF sites, forming ecotone forests. Leaf and forest function of MDF in sandy soil sites could be different from the MDF examined in the current study (limestone site), suggesting that MDFs include two forest types of sandy soil-type MDF (or ecotone-type MDF) and liming soil-type MDF (Fig. 4). More research is needed to compare the tree physiology and forest function of MDFs in Southeast Asia.

In Thailand and adjacent areas in Southeast Asia, forest trees and types are separated by niche segregation due to the difference of soil properties and topology, such as soil thickness and bed rock types, resulting from the ancient history of plate tectonics and river drain. Similar to Thailand forests, such edaphic niche segregation among tree species has been reported in Bornean rainforests (e.g., Jucker *et al.* 2018, Bartholomew *et al*. 2022) and Neotropical dry forests in South America (e.g., Powers and Tiffin 2010, DryFlor 2016). Recently, anthropogenic impacts have been increasing globally in tropical dry forests, requiring a high priority for conservation. The accelerated development of agricultural land progresses forest fragmentation, resulting in vegetation changes particularly in the peripheral areas of the forest in Thailand (Ppopradit *et al.* 2015). The amounts of sulfur oxides deposited from the atmosphere to plants and soil has been increasing in Thailand, resulting in changes in the chemical properties of forests (Sase *et. al.* 2016). Such enhanced anthropogenic influences and climate change may significantly impact the forest function and their habitat associations in future. The current dataset will not only be relevant to the response of forests to environmental changes but also provide insights into the restoration of degraded forests.

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