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## Establishment of an ecological research network involving Taiwan and Japan: developing a better understanding of ecological phenomena unique to East Asia

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### The strengths of Taiwan and Japan in ecological studies

The ecosystems of East Asia are unique and are associated with high-level biodiversity (Nakano et al. 2012). Seasonal changes are pronounced. The human population is large and natural disasters (e.g., major typhoons, heavy rains, and earthquakes) are more frequent in East Asia than in other regions of the world (Wu et al. 2005; Urabe and Nakasizuka 2016). Taiwan and Japan are both in East Asia but at different latitudes, and so have different climatic zones, ranging from subarctic to tropical monsoon. The average annual temperature varies greatly within and

across both countries (Fig. 1). Consequently, the region is ideal for comparisons of ecosystems at different latitudes, minimizing or managing confounding factors. Thus, Taiwan and Japan enjoy mutual advantages when cooperating in research. The average temperature has risen by 1–2 °C during the past 100 years, although with some site dependence (Table 2.1–2 of Climate Change Monitoring Report 2015; Fig. 10b of Hsu et al. 2011). We anticipate that ecosystems at varying latitudes may respond in very different ways to environmental changes. However, there have been few collaborative ecological studies that have explored responses at different latitudes at a regional level.

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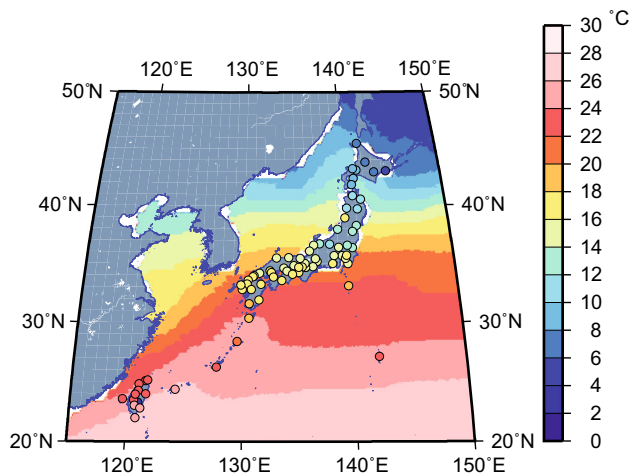
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### History of the Taiwan-Japan Ecology workshop

Since 2008, a Taiwan–Japan Ecology Workshop has been organized every other year alternately in Taiwan and Japan (three times in Taiwan, twice in Japan; Table 1). This relationship has lasted almost 10 years. Specific purposes of the workshops include facilitating research co-operation and comparative studies between Taiwan and Japan, encouraging students and scientists to participate in such cooperation, exchanging ideas among scientists and students, and discussing important ecological and environmental issues of the 21st century. The workshops have featured various themes chosen by the organizers (Table 1). The goals of these workshops are to serve as conduits for research cooperation between Taiwan and Japan, and to increase our understanding of ecological phenomena unique to East Asia.

### Filling gaps in ecological studies

Ecology embraces all biological processes and patterns including evolution, populations, communities, and



**Fig. 1** Site variation of annual temperature ( $^{\circ}\text{C}$ ) in Taiwan and Japan. Data are from National Oceanic and Atmospheric Administration, World Meteorological Organization, Japan Meteorological Agency, and Central Weather Bureau of Taiwan. Color figure online

ecosystems. In addition, many different research approaches are taken (theory, field observations and experiments), many materials are studied (from bacteria to mammals and tropical to boreal systems, and from the ocean depths to forest canopies), and many conceptual frameworks are used. Although such diversification is inevitable and it certainly effectively advances the ecological sciences, it tends to be associated with the generation of conceptual gaps and imbalances in the development of various subfields. To advance the ecological sciences by filling conceptual gaps in ecological studies, and to elucidate ecological phenomena unique to Taiwan and Japan, this special issue includes nine articles, described briefly below.

A paper on perspectives focuses on two different types of gaps in studies of socio-ecological systems (Chen et al. 2017). Some gaps are specific to the East Asia region whereas others are more general in nature. The authors emphasize the need to fill the gaps and the next challenges.

Nakadai (2017) seeks to bridge conceptual gaps between the generation and maintenance processes of various herbivorous insects. The brief review highlights the roles and importance of host plants in terms of

herbivore diversity (both generation and maintenance), viewed from the perspectives of niche and ecological neutrality.

New analytical and statistical methods are required to understand complex ecosystems exhibiting high-level diversity, such as those in East Asia. Ecosystems often show complex (i.e., nonlinear) dynamics, and these are difficult to understand if we rely on linear statistical approaches. In recent decades, nonlinear statistical methods have been developed to recognize complex nonlinear behaviors in empirical time series. These methods are collectively called empirical dynamic modeling (EDM). Chang et al. (2017) provided a step-by-step tutorial for EDM applications using example model data and R codes. In addition, Liu et al. (2017) proposed a new statistical method of food web analysis that inferred web parameters, using the concept of regular equivalence (Borgatti and Everett 1993). When the new method was applied to datasets from Taiwan and the United States, it was clear that it performed better than existing methods.

Long-term observations are indispensable when they are used to help understand the ecological and environmental problems of lakes in Taiwan and Japan. Itoh et al. (2017) summarized the achievements of long-term observation study since 2004 at Feitsui Reservoir in Taiwan, focusing on seasonal and interannual variation of methane dynamics and their contributions to the pelagic food web. They addressed the specificity of methane dynamics in a subtropical deep lake and the importance of metabolic diversity of methane-oxidizing bacteria. The publication of long-term data is essential prior to further analysis (e.g., a meta-analysis). Iwayama et al. (2017) reported long-term data on the abundance of phytoplankton species (sampled biweekly from 1986 to 2016) in Lake Inba, one of the most eutrophic lakes in Japan. This dataset encourages research cooperation between Taiwan and Japan.

In recent decades, the influence of Moso bamboo (*Phyllostachys pubescens*) expansion on forest ecosystems in Taiwan has become a concern. Such expansion may impact local carbon and water cycling. Lin et al. (2017) showed net primary production and net ecosystem production based on four-year measurements in Taiwan, suggesting a high potential for Moso bamboo as a major carbon sink. Laplace et al. (2017) showed

**Table 1** History of Taiwan and Japan workshops since 2008

Year	Location	Theme
2008 (1st)	Taipei (Taiwan)	Taiwan-Japan Ecology Workshop
2009 (2nd)	Taipei (Taiwan)	International Symposium on Quantitative Ecology
2012 (3rd)	Sapporo (Japan)	Program for promoting participation in the ecological research network between Japan and Taiwan: toward better projection of ecological responses to climate changes
2014 (4th)	Hualien (Taiwan)	Latitudinal variation of ecosystem responses to environmental changes: ecosystem comparative studies
2016 (5th)	Kyoto (Japan)	Filling the Gaps: What's missing in the genotype-phenotype-population-ecosystem continuum?

greater stand transpiration in Moso bamboo forests than that in a surrounding Japanese cedar plantation in both Taiwan and Japan, although their seasonality was very different across the two countries.

Weng et al. (2017) examined a weak association between seedling distribution and environmental factors in a montane cloud forest of Taiwan. They showed a stronger link to habitat association of seedling assemblages using the spatial structure of understory plants. Such plants covary with seedlings and shape seedlings in specific regeneration patches. The authors suggested that fine-scale heterogeneity produced by neighborhood bio-interactions in the understory is important in regeneration niches.

This special issue adds valuable knowledge that helps fill conceptual gaps in ecological studies and promotes understanding of ecological phenomena unique to Taiwan and Japan. We believe that the special issue will encourage continued research cooperation between those two countries. However, it is just the starting point. We must all face the continuous challenges posed by research cooperation, focusing on the strengths of both Taiwan and Japan to advance the ecological sciences.

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