Chapter 3 Introduction

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In Chapter 2, the changes in forest utilization during the past 50 to 100 years were revealed for each study site. Based on this understanding, we will discuss the effects of forest utilization on the biological community at each study site in section 3.1 and the effects of human activities on ecosystem functions in section 3.2.

In section 3.1, we discuss the effects of forest utilization on communities or populations of living organisms at each study site. At Lambir, species diversity and the species composition of plants (Momose *et al*.), insects (*i.e.* butterflies (Itioka *et al*.), beetles (Kishimoto-Yamada *et al*.), ants (Matsumoto *et al*.)), mammals (*i.e.* bats (Fukuda *et al*.), small mammals (Nakagawa *et al*.)), and macrofungi (Yamashita *et al*.) were compared among several forest types (*i.e.* rubber plantation, secondary forest after swidden agriculture, isolated natural forest, and primary forest). In every biological community except for the beetle community, species diversity was highest in the primary forest and generally decreased with increasing disturbance of the forest. At Sabah, species diversity and the species composition of plants (Aiba *et al*.), insects (*i.e.* flies (Akutsu *et al*.)), soil animals (Ito *et al*.) and mammals (Onoguchi & Matsubayashi) were compared between forest managed under reduced-impact logging, forest managed under conventional logging, and primary forest. Species diversity of plants and mammals was higher in forest managed under reduced-impact logging than in forest managed under conventional logging methods. On Yaku Island, the species diversity and biomass of plants (Aiba *et al*., Tsujino *et al*.) and insects (*e.g.*, beetles, horseflies, wasps (Yamauchi *et al*.)) and the density of the Japanese macaque (Hanya *et al*.), were surveyed in primary forest, plantations of Japanese cedar, and secondary forest. Species diversity of plants and insects was lower in the plantation forest than in the primary forest. At Abukuma, the community structure of the forest-floor vegetation (Tanaka *et al*., Nagaike *et al*.) and of arthropods (*e.g.*, butterflies, moths, wasps, beetles, springtails, mites (Makino *et al*.)) was surveyed in several different forest types (*e.g.*, plantations of Japanese cedar and secondary and old growth broadleaved deciduous forest) for a range of forest ages. Species diversity of the forest-floor vegetation was higher in young stands than in intermediate-aged and old stands in both the secondary forest and the plantation forest. Species composition differed among the forest types. Arthropods could be divided into three groups based on the response of their species diversity to the age of the forest: in one group, species diversity decreased with increasing forest age (*e.g.*, butterflies, longhorn beetles); in the second group, species diversity increased with increasing forest age (*e.g.*, mycophagous mites); and in the third group, species diversity did not change with increasing forest age (*e.g.*, moths, ground beetles).

In section 3.2, we discuss the effects of human activities on ecosystem functions. Here, we define ecosystem functions as the functions that are necessary for the growth or sustenance of the ecosystem, such as pollination, the food chain, and matter and energy flows. Recently, the area of forest has decreased rapidly, accompanied by fragmentation of large stands into smaller stands, as was seen in Chapter 2. We hypothesized that fragmentation of forests would reduce the size of plant populations, leading to reductions in visitation by pollinators, reductions in the number of individuals capable of reproduction, and inbreeding depression. In section 3.2.1., we discuss the results of some basic studies of plant ecology at Lambir (Aiba &

Nakashizuka, Kenzo *et al*., Ichie *et al*.) and Yaku island (Tanabe *et al*.). In section 3.2.2., we introduce studies on plant reproductive ecology (Momose *et al*.) and plant–pollinator interactions (Kumano & Yamaoka, Ushimaru *et al*.), and then we discuss the effects of forest fragmentation caused by human activities on plant community. Studies of one tree species at Lambir (Takeuchi *et al*.) and two tree species at Abukuma (Matsuki & Isagi, Tateno *et al*., Kikuchi *et al*., Shibata *et al*.) revealed that forest fragmentation does not always have a negative influence on tree reproduction.

In section 3.2.3., we discuss the results of studies of changes in seed-dispersal systems in response to changing human utilization of the forest. At Lambir, the pattern of fruit utilization by bird communities is described (Kamoi *et al*.). At Sabah, the loss of large mammal seed-dispersers after conventional logging appeared to have detrimental effects on the regeneration of two *Durio* species (Nakashima & Matsubayashi). On Yaku Island, the restoration of a *Ficus* species population after logging conducted 60 years ago is not yet complete (Otani & Sei-ichi). The behavior of the Japanese macaque determines the spatial distribution of the tree *Myrica rubra* (Terakawa *et al*.), and seeds of *M. rubra* was attacked by lepidopteran insects before dispersal (Fujita *et al*.). At Abukuma, forest fragmentation positively affected the growth of seedlings of plant species that are dispersed by birds (Naoe *et al*.).

The second and third sections of this chapter show that the effects of human activities on plant regeneration are highly variable. The effects on species interactions might affect plant–seed disperser systems, plant–pollinator systems, or some other combination of these systems described in section 3.2.4. (Tanaka *et al*., Handa *et al*., Tzuchiya & Itioka, Okubo & Itioka). At Lambir, swidden cultivation reduced the species diversity of ants and plants, which means that simplification of the species composition also simplified the interspecific interactions, and the effects were still detectable at least 20 years after the initial disturbance (Tanaka *et al*.).

Some studies of the effects of human activities on interspecific interactions have pointed out that human activities sometimes affects these interactions and that the response of the system differs depending on a range of factors. Such changes in community structure might affect matter and energy flows through the forest ecosystem. In section 3.2.5., we focus on matter flows, especially through the decomposition system (Wagai *et al*.). At Sabah, the decomposition rate of leaf litter was highest in the forest managed under conventional logging (Hasegawa *et al*.).

In this report, we will present an assessment method for evaluating the level of sustainable forest use. The results permit an assessment of the ecological situation at the study sites. The results clearly demonstrate the different responses of species diversity of various organisms and of ecological functions to human activities, and suggest that understanding the traits of individual organisms is needed before evaluation can occur.