論文内容の要旨

Diversity in life history strategies among liana species in cool-temperate forests in Japan

(日本の冷温帯林における木本性つる植物の多様な生活史戦略)

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Lianas are large woody vines that climb other plants toward the forest canopy. Although lianas play significant roles in various aspects of forest ecosystems, studies on liana ecology have been relatively few and therefore we have limited information about their life history and diversity therein. In this thesis, I elucidated diversities in several life history traits among five sympatric liana species (*Actinidia arguta*, *Celastrus orbiculatus*, *Akebia trifoliata*, *Schisandra repanda*, and *Schizophragma hydrangeoides*) in a cool temperate forest in Nikko, Japan. In the first study (Chapter 1), I evaluated the relationship between preferences in regeneration habitat and shoot production patterns in the five species. The habitat preferences were assessed by comparing frequency of plants in an old forest, a young developing forest, and forest edges. In *A. arguta* and *C. orbiculatus*, small and middle-sized plants (< 8 m in height) were frequently found in the forest edges but were scarce in the forest understory, while in *S. repanda* and *S. hydrangeoides*, those plants were more frequent in forest understory. The result suggested that the former and the latter species were more successfully regenerated in the forest edges and understory, respectively. In *A. trifoliata*, plants were frequent both in the understory of the young forest and forest edges, but was absent in the old forest. I next examined biomass allocation between "searcher shoots," which have the ability to attach external structures with twining stems or adventitious roots and show extension-oriented morphology, and "ordinary shoots," which are self-standing short shoots without any specialization for support acquisition and show leaf

display-oriented morphology, in young plants (3–8 m in height) that were climbing toward the forest canopy. The proportion of searcher shoots in total current-year shoot mass was varied among species from 6% in *S. hydrangeoides* to 60% in *A. arguta*. The species that favored the forest edges (*A. arguta* and *C. orbiculatus*) showed significantly higher proportions of searcher shoots than those favored the forest understory (*S. repanda* and *S. hydrangeoides*). Because proportion of leaf in shoot mass (leaf mass ratio: LMR) was much lower in searcher shoots than in ordinary shoots, LMR of whole current-year shoots were lower in the forest edge species. Leaf area per leaf mass (specific leaf area: SLA) was greater for the forest understory species and, consequently, leaf area per shoot mass (leaf area ratio: LAR) for the species were about twice as high as those for the forest edge species. A model simulation indicated that a plant with increased allocation to searcher shoots attained more rapid extension early in the growth period, while late in the growth period, a plant with increased allocation to ordinary shoots showed a greater total extension length because of the increased assimilation product due to the increased leaves. Accordingly, the forest edge species were suggested to aim the rapid improvement of light environment by short-term, large extension in the places with large variation in light availability, while forest understory species were suggested to aim steady growth by increasing assimilation in the environment with scarce variation in light availability.

In the nest study (Chapter 2), canopy dynamics of lianas in the forest canopy (about 15 m in height) and their impacts on growths and survivals of host trees were examined in four species (the species in Chapter 1 other than *A. trifoliata*) to elucidate how lianas cope with a dilemma associated with competitions with their host trees: interception of more light on the host canopies will lead not only to a larger benefit in photosynthesis, but also to a higher risk of fall from the forest canopy due to increased mortality of host trees. Main locations for leaf display greatly varied among the liana species from well-lit upper surface to under the shade of host canopies. A large part of leaves received more than 80% PPFD relative to that above the host canopy in *A. arguta*, 40–80% in *C. orbiculatus*, less than 40% in *S. repanda*, and less than 20% in *S. hydrangeoides*. In *A. arguta*, canopy mass, leaf mass, and axis (stems that formed the framework of a canopy) length of sample plants increased linearly with canopy age (years since the liana reached the forest canopy, which was estimated from number of annual rings of the basal stem at 8 m in height), while in the other species, leaf mass and axis length did not increase with the age, suggesting that these species spent for decades in the forest canopy without marked changes in canopy scales. The species that spread in upper positions in host canopies acquired larger number of host trees, and

only *A. arguta* had a tendency to spread to more host trees as it grew in the forest canopy. The two species that distributed leaves in better-lit positions near the upper surface of host canopies, *A. arguta* and *C. orbiculatus*, generally decreased annual-ring widths of the host trees, while the two species that distributed leaves in more shady positions within host canopies, *S. repanda* and *S. hydrangeoides*, did not show significant effects on the ring widths of hosts. To evaluate potential impact of lianas on survivals of host trees, the length of the basal stem from rooting point to the attachment point to the current host tree (which was expected to depend on number and sizes of former host trees, on which the liana once attached before reaching the current host tree, and which have died and disappeared in the past) was examined for lianas in the forest canopy. The length was larger in the species that spread in upper positions of the host canopies, suggesting that host trees of the lianas that spread in upper positions may have higher mortality than those of the lianas that were located in more shady positions. The results suggested a strategic differentiation among the liana species in behaviors in the forest canopy. *Actinidia arguta* could be regarded as parasitic in that it intercepted a large amount of light on host canopies. In this species, however, the resultant risk of fall could be decreased by keeping on spreading into many host crowns. On the contrary, *S. repanda* and *S. hydrangeoides* were regarded to adopt a strategy close to a commensalism, in which they do not take much of the benefit in light acquisition and instead reduce the risk of fall caused by deaths of host trees.