

Host suitability of a mutualistic bark beetle-fungal complex implies an ecological adaptation to fringe habitat

Xia Shi^{1,2#}, Jiaying Fang^{1#}, Huicong Du^{1,3}, Sufang Zhang¹, Fu Liu¹, Zhen Zhang¹, Xiangbo Kong^{1*}

(1. Key Laboratory of Forest Protection of National Forestry and Grassland Administration, Ecology and Nature Conservation Institute, Chinese Academy of Forestry, Beijing 100091;

2. Environment and Plant Protection Institute, Chinese Academy of Tropical Agricultural Science, Haikou 571101;

3. Jiangsu Key Laboratory for Bioresources of Saline Soils, Jiangsu Synthetic Innovation Center for Coastal Bio-agriculture, Jiangsu Provincial Key Laboratory of Coastal Wetland Bioresources and Environmental Protection, School of Wetland, Yancheng Teachers University, Yancheng City, 224002)

Abstract: 【Objective】 The Asian larch bark beetle, *Ips subelongatus* (Coleoptera: Curculionidae: Scolytinae), can pose a serious threat to larches, and occasionally to other conifers, like pines and spruces, showing a strong host expansion potential in the coniferous forest. *Endoconidiophora fujiensis*, a strongly virulent fungus to larches, has formed a stable association with *I. subelongatus* in northeastern China. However, host suitability of *I. subelongatus* on novel hosts and to what extent the *E. fujiensis* is involved in host range expansion process of its beetle vector remain unknown. 【Method】 In this study, we selected Sandy spruce (*Picea mongolica*), Korean pine (*Pinus jezoensis*), and Khingan fir (*Abies nephrolepis*) as potential novel hosts to test the host suitability of the *I. subelongatus*–*E. fujiensis* complex, with historical host Dahurian larch (*Larix gmelinii*) being as a control. The development performance and pheromone production of *I. subelongatus* on these four tree species indoors as well as the infection ability of *E. fujiensis* on these four vigorous trees outdoors were measured firstly. We then analyzed the differences in defensive chemicals (e.g., monoterpenes and phenolics) of these four tree species induced by *E. fujiensis*, and determined the nutrient contents (e.g., nitrogen and ergosterol) accumulated on the phloem lesion after *E. fujiensis* infection over a period of time. Finally, beetle tunneling/fungi growth performances in media amended with monoterpenes and phenolics were tested. 【Result】 Based on the development indices and aggregation pheromone productions of *I. subelongatus* as well as infection ability of *E. fujiensis*, both *I. subelongatus* and *E. fujiensis* showed relatively well host suitability on *P. mongolica* when compared to the historical host of *I. subelongatus*, *L. gmelinii*, followed by novel host *P. jezoensis*, whereas exhibited weak host suitability on *A. nephrolepis*. Further, the nutrient accumulation (e.g., nitrogen and ergosterol) and chemical induction defenses (e.g., monoterpenes and phenolics) after *E. fujiensis* infection were clarified to assess the fungal assistance capability to beetle vectors on four trees. Generally, *E. fujiensis* supplied nutrient and exhausted defense the most on *L. gmelinii*, followed by *P. mongolica*, *P. jezoensis* and *A. nephrolepis*. Finally, the key monoterpenes and/or phenolics were amended in culture media, wherein phenolics generally showed stronger inhibiting effect on the tunnelling

behaviors of *I. subelongatus* and fungal growth of *E. fujensis* than those of monoterpenes.

[Conclusion] *I. subelongatus*-*E. fujensis* complex can establish populations on novel hosts *P. mongalica* and *P. jezoensis*, instead of *A. nephrolepis*. Although the assistance effects of *E. fujensis* to *I. subelongatus* on host adaptability varied among tree species, the nutrient production and defense exhaust of *E. fujensis* on *L. gmelinii* are stronger than those on novel hosts, suggesting a closer coevolutionary relationship between “*I. subelongatus*-*E. fujensis*” complex and the historical host *L. gmelinii*.

Key words: *Ips subelongatus*; *Endoconidiophora fujensis*; host suitability; nutrient accumulation; chemical induction defenses