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Extended Abstract

Himalayan dwarf mistletoe (*Arceuthobium minutissimum*) and the leafy mistletoe *Taxillus kaempferi* on blue pine (*Pinus wallichiana*) in Bhutan

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Blue pine, *Pinus wallichiana*, is an important tree species in temperate conifer forests in Bhutan. Disease surveys have shown that Himalayan dwarf mistletoe, *Arceuthobium minutissimum*, and the leafy mistletoe, *Taxillus kaempferi*, are important damaging factors on *P. wallichiana* in this Himalayan country. The knowledge on these two parasitic flowering plants in Bhutan is reviewed. A dwarf and leafy mistletoe survey in a study area in Western Bhutan documented high levels of mistletoe infection on *P. wallichiana*, especially by *A. minutissimum*. Recommendations for disease management, consisting mainly of sanitation, are given.

Key words: Parasitic flowering plants, Himalayas, temperate conifer forests, disease surveys, disease incidence.

INTRODUCTION

Blue pine or Himalayan blue pine, *Pinus wallichiana*, is an ecologically and socio-economically important tree species in many parts of the Himalayas and adjacent mountain ranges in Southern Asia. In Bhutan, it occurs in temperate conifer forests at elevations between 2100 and 3100 m asl. (Grierson and Long, 1983; Rosset, 1999). Blue pine is the preferred and most valuable softwood in this Himalayan country, being used for an array of purposes (Rosset, 1999). Forest tree disease surveys have shown that in some parts of Bhutan *P. wallichiana* is commonly and often severely infested with two parasitic flowering plants, Himalayan dwarf mistletoe, *Arceuthobium minutissimum*, and the leafy mistletoe, *Taxillus kaempferi* (Donaubauer, 1986; Chhetri, 1990, 1995; Tshering and Chhetri, 2000; Kirisits et al., 2002, 2007; Dorji, 2007). In this report, knowledge on these two parasitic flowering plants in Bhutan, emerging from collaborative studies since the 1980s (Kirisits et al., 2007), is briefly summarized.

GENERAL INFORMATION ON *A. MINUTISSIMUM* AND *T. KAEMPFERI* IN BHUTAN

A. minutissimum (Figures 1 and 2; Hawksworth et al., 1996) is widespread and very damaging in dry blue pine forests in the districts Paro, Ha and Thimphu in Western Bhutan (Donaubauer, 1986; Chhetri, 1990, 1995; Tshering and Chhetri, 2000; Kirisits et al., 2002; Dorji, 2007). As is true for all dwarf mistletoes *A. minutissimum* is a holoparasite. Infections are therefore a severe nutrient sink to *P. wallichiana* trees. Pathogenic effects of this parasitic flowering plant on the host include deformations (Figure 1A), stunted growth (Figure 2B), dwarfing

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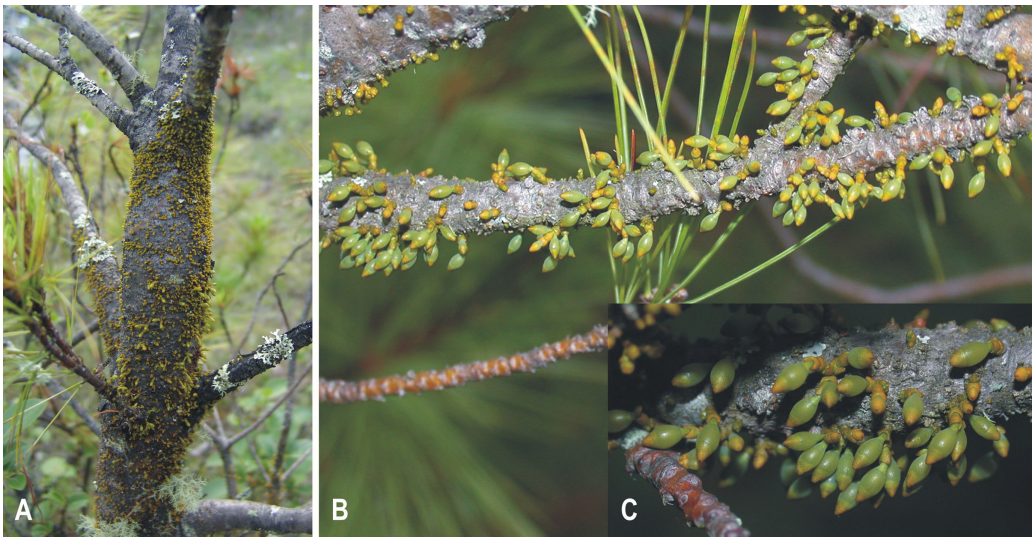

Figure 1. Himalayan dwarf mistletoe, *A. minutissimum* on *P. wallichiana*: (A) Stem swelling as symptom of dwarf mistletoe infection and shoots of *A. minutissimum*, (B) Pistillate (Female) plants of *A. minutissimum*, (C) Female *A. minutissimum* plants at higher magnification than in B. Shoots of this dwarf mistletoe species are on an average only 5 mm high.

Figure 2. Blue pine trees infected by *A. minutissimum*: (A) Mature tree with systemic witches' brooms, (B) Pole-sized tree showing stunted growth, (C) Sapling showing dwarfed growth and a 'bonsai-like' habit.

Figure 3. The leafy mistletoe *T. kaempferi* on *P. wallichiana*: (A) *T. kaempferi* plant with conspicuous red flowers, (B) Mistletoe bush in the crown of a Blue pine tree, (C) Infection of a blue pine stem by *T. kaempferi.*

(Figure 2C), systemic witches' brooms (Figure 2A), strong reduction of diameter and height growth, impaired wood quality, reduced cone production and mortality (Hawksworth et al., 1996; Dorji, 2007). Because of its severe impact on the host tree *A. minutissimum* is the most important pathogen of *P. wallichiana* in Bhutan. Even where insect pests and microbial pathogens are considered, it is most probably still the most important biotic damaging factor on this conifer species.

T. kaempferi (Figure 3) occurs most frequently on blue pine, but it also infests Himalayan hemlock, *Tsuga dumosa*, and Eastern Himalayan spruce, *Picea spinulosa* (Grierson and Long, 1983; Donaubauer, 1986; Chhetri, 1990; Kirisits et al., 2002; Dorji, 2007). It has a larger distribution range than *A. minutisimum*, occurring in Western and Central Bhutan, in the districts Thimphu, Wangdi Phodrang, Trongsa, Bumthang and Mongar (Grierson and Long, 1983; Donaubauer, 1986; Dorji, 2007). As a hemiparasite, the pathogenic effects of *T. kaempferi* on infected host trees are less serious than those caused by *A. minutissimum*. However, *T. kaempferi* infections weaken trees and can contribute to tree mortality, especially on dry sites, where prevalence of this parasitic plant is highest.

DWARF AND LEAFY MISTLETOE SURVEY IN A STUDY AREA IN WESTERN BHUTAN

In August 2004, a forest inventory incorporating a dwarf and leafy mistletoe survey was conducted in a 156-hectare-large area of blue pine forests on xeric sites at elevations between 2604 and 3024 m asl. in the district of Thimphu in Western Bhutan (Dorji, 2007). The inventory was based on 7-m-diameter, fixed-sized, systematic sample plots. Horizontal distance between plots was 100 m and the total number of plots was 98. At each sample plot all trees with a height exceeding 1.3 m above the ground were recorded. Various biometric characteristics, particularly diameter at breast height, were measured for each sample tree and subsequently processed for forest inventory calculations. Blue pine trees were also inspected for infections by *A. minutissimum* and *T. kaempferi*. In addition, various site characteristics were recorded.

The study area was occupied by open, degraded, cattle-grazed, low-stocked forests dominated by blue pine (Dorji, 2007). Admixed species included *Rhododendron arboreum*, *Populus* sp., oak species (mainly *Quercus semecarpifolia*), *Salix* sp. and *Picea spinulosa*. The mean number of trees per hectare was 2286, among which 66%

were *P. wallichiana*. Mean basal area per hectare was 12.6 m^2, approximately 79% of which being blue pine. Mean standing timber volume of blue pine in the study area was about 90.5 m^3 per hectare.

High levels of mistletoe infection on *P. wallichiana*, especially by *A. minutissimum* were recorded in the survey (Dorji, 2007). *A. minutissimum* occurred on 58%, *T. kaempferi* on 52% and both mistletoes on 30% of the 97 sample plots containing blue pine. Of the 2282 blue pine trees evaluated, 29.4% were infested with *A. minutissimum* and 4.9% with *T. kaempferi*, with both species occurring on 1.5% of the trees. Incidence of *A. minutissimum* increased slightly with tree diameter, however, it was also prevalent on small trees, exemplified by the smallest diameter class (0.1 to 5.0 cm diameter at breast height), in which 25.3% of the trees were infected. Incidence of *T. kaempferi* also increased with tree diameter, and highest infection levels were recorded on pine trees in larger diameter classes. Incidence of *A. minutissimum* was higher on blue pine trees growing on ridges (37%) and lower slopes (43%) than on trees occurring on sites at other topographic positions (valley bottom - 21%, middle slope - 19%, upper slope - 24%). There were no clear relationships between dwarf mistletoe infection levels and other site characteristics.

CONCLUSIONS

Mistletoes, especially Himalayan dwarf mistletoe, are serious forest pathogens in Bhutan. The high levels of incidence and infection severity caused by *A. minutissimum* and *T. kaempferi* on blue pine in parts of Western Bhutan suggest that past and present forest management has favoured infestation of *P. wallichiana* with these parasitic flowering plants. This is because it is common practice to preferentially cut uninfected trees with good wood quality and to leave infested residual trees. We recommend incorporating principles of disease management, particularly sanitation in a silvicultural system to treat blue pine forests heavily affected by these parasitic plants in Bhutan (Donaubauer, 1986; Chhetri, 1990; Tshering and Chhetri, 2000; Dorji, 2007).

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REFERENCES

Chhetri DB (1990). Some tree diseases and insect pests of forests of Bhutan. Tsenden 2(1): 72-79.

Chhetri DB (1995). Observation trial on dwarf mistletoe infestation on Blue pine. Tsenden 5(1): 22-24.

Donaubauer E (1986). Technical advisory services for forest development, Bhutan, Forest Pathology. Department of Forests, Ministry of Trade, Industry and Forests, Thimphu, Bhutan and Food and Agriculture Organization of the United Nations, Rome, Italy. FO/DP/BHU/83/022, Field Document 11, 37 p.

Dorji S (2007). Himalayan dwarf mistletoe (*Arceuthobium minutissimum*) and the leafy mistletoe *Taxillus kaempferi* on Blue pine – a case study in Western Bhutan. Institute of Forest Entomology, Forest Pathology and Forest Protection, University of Natural Resources and Applied Life Sciences, Vienna (BOKU), Vienna, Austria. Diploma thesis, 127 p.

Grierson AJC, Long DG (1983). Flora of Bhutan. Royal Botanic Garden, Edinburgh, UK. Volume 1, Part 1, 186 p.

Hawksworth FG, Wiens D, Geils BW (Techn. ed.), Nisley RG (Manag. ed.) (1996). Dwarf mistletoes: Biology, pathology and systematics. U. S. Department of Agriculture, Forest Service, Washington, D. C., USA. Agricultural Handbook 709, 410 p.

Kirisits T, Wingfield MJ, Chhetri DB (2002). Studies on the association of blue-stain fungi associated with the Eastern Himalayan spruce bark beetle (*Ips schmutzenhoferi*) and with other bark beetles in Bhutan. Renewable Natural Resources Research Centre, Yusipang, Bhutan. Yusipang Report, YREP/2002/02, 88 p. Download: www.boku.ac.at/h912/fored/f2.htm.

Kirisits T, Donaubauer E, Konrad H, Dorji S, Barnes I, Meier W, Wingfield MJ, Gyeltshen N, Chhetri DB (2007). Common needle, shoot, branch and stem diseases of conifer trees in Bhutan. Acta Silv. Lign. Hung., Special Edition: 241-245. Download: http://www.nyme.hu/fileadmin/dokumentumok/fmk/acta_silvatica/cikkek/VolE3-2007/30_kirisits_et_al.pdf.

Rosset J (1999). Temperate conifer forests of Bhutan: A review of forestry research activities until June, 1998. Renewable Natural Resources Research Centre, Jakar, Bhutan. Special Publication No. 3, 95 p.

Tshering G, Chhetri DB (2000). Important forest insect pests and diseases of Bhutan with control measures. Renewable Natural Resources Research Centre, Yusipang, Bhutan and Natural Resources Training Institute, Lobesa, Bhutan. MoA, Field Guide 2000/1, 57 p.