*Tropical Ecology* **59**(1): 157–161, 2018 ISSN 0564-3295

www.tropecol.com

# Large scale infestation of blue pine by Himalayan dwarf mistletoe in the Gangotri National Park, Western Himalaya

ISHWARI DATT RAI*, MANISH BHARDWAJ, GAUTAM TALUKDAR, GOPAL SINGH RAWAT & SAMBANDHAM SATHYAKUMAR

*Wildlife Institute of India, P.O.Box#18, Chandrabani, Dehradun, Uttarakhand, 248002*

**Abstract:** Large scale forest degradation and mortality associated with dwarf mistletoes infestation has been reported across the world. During recent surveys in the Gangotri National Park, Western Himalaya, we recorded infestation on Blue pine, *Pinus wallichiana* over large area by Himalayan dwarf mistletoe, *Arceuthobium minutissimum*. The infestation was never recorded in this landscape. Long term climate data indicates trends of change in minimum and average temperature during last two decades which may serve as suitable conditions for growth and intensify pathogenicity of the dwarf mistletoe in future scenarios.

**Key words:** *Arceuthobium minutissimum,* Climate change, Infestation, Pathogen, *Pinus wallichiana*.

The forest ecosystems are affected by several anthropogenic and natural disturbance including fire, drought, landslides, avalanches, insect pests and other pathogens. The extent and severity of these disturbances are also influenced by climatic factors which may trigger extreme events and outbreak of insects and diseases (Walther *et al*. 2002: McNulty & Aber 2001). Susceptibility of forests to pathogens depends on the interaction among the hosts, pathogens and environmental conditions such as extremes of temperature and moisture, which may increases host susceptibility or fitness of pathogens (Burdon *et al*. 2006). Among the forest pathogens, parasitic plants have special adaptations and profound effects on the hosts. About 4000 species of parasitic plants have been recorded all over the world across various biomes (Press & Phoenix 2005). Among them, dwarf mistletoe (*Arceuthobium* spp; Viscaceae) play a significant role in tree mortality and the genus includes species that are among the most damaging parasites of important conifers across the world (Fig. 1). These parasites cause reduction in tree growth, loss of seed and cone production and increased tree mortality and susceptibility. All species of this genus induce 'Witche's brooms' which cause their hosts retarded growth and mortality (Hawksworth & Wiens 1970).

*Arceuthobium* comprises 42 species across the world distributed in northern hemisphere (Fig. 1). In the Himalayan region, three species *viz. Arceuthobium minutissimum, A. oxycedri* and *A. sichuanense* are reported, of which first two are distributed in Western and north-western Himalaya and last one in Bhutan, eastern Himalaya (Naithani & Singh 1989). *Arceuthobium minutissimum* Hooker is the smallest known dicotyledonous plant as described by J. D. Hooker (1886). The visible part above the bark of host is *ca.* 5mm high and often resemble with needle scars on the stem. Flowers are unisexual except one report of presence of hermaphrodite flower in one specimen (Datta 1951). In India, *A. minutissimum* is reported from cold arid regions of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. In the Himalayan region it occurs only in the inner dry ranges on its principal host blue pine, *Pinus wallichiana* (Gorrie 1929) except one record of infestation on another commercially important conifer, *Pinus gerardiana* in Pakistan (Chaudhary & Badshah 1984). Its global distribution extends from Pakistan to Bhutan. Extensive tree mortality

*Corresponding Author*; e-mail: ishwari.rai@gmail.com

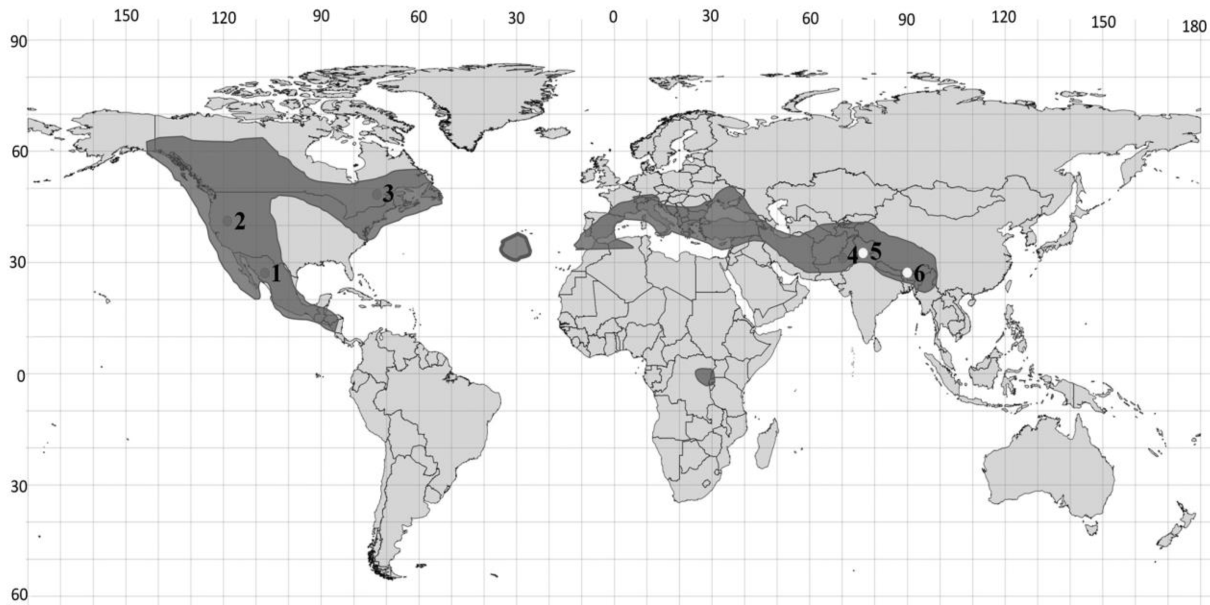


**Fig. 1.** World distribution of *Arceuthobium* spp. (after Hawksworth & Wiens 1996) with records of severe forest damages and infestation. Records for *A. minutissimum* are denoted with white dots. Sources: 1. Mexico: Roldan 1924; 2. USA: Andrews 1957; 3. Canada: Baker *et al.* 1992; 4. Pakistan: Jamal & Beg 1974, Sarangzai *et al.* 2010; 5. India: Gorrie 1924; Bagchee 1952, Bor 1953; 6. Bhutan: Chhetri 1990, 1995; Dorji 2007; Hawksworth & Wiens 1996).

due to infestation by *Arceuthobium* has been reported from the Himalayan region in the past (Bagchee 1952).

During a recent ecological survey in the Gangotri National Park, authors recorded infestation by *A. minutissimum* over large areas on the *Pinus wallichiana* forest. Intensive survey on the extent of spread of this pathogen reveals that over 250 ha area from Gangotri to Devgad area was infested sporadically on both slopes of the valley. It is noteworthy that this area has been extensively studied in terms of eco-floristics (Chandola 2009; Pusalkar & Singh 2012) in the past and there is no report on the occurrence of Himalayan dwarf mistletoe from the Park. The present report indicates fresh infestations in new areas in the Western Himalaya. We recorded the infestation on the mature trees of *Pinus wallichiana* in the Gangotri National Park between 3000 to 3400 m elevation. Symptoms of heavy infestation were evident in the form of Witches broom, yellowing of needles and dying branches and entire trees (Fig. 2).

Surveys of occurrence, slope association, and severity of infestation of several dwarf mistletoe species across various parts of globe revealed that the spread of dwarf mistletoes is limited by low temperature which reflects differences in incidence and severity among geographic areas (Williams 1971). The upper elevational limits in which several species of mistletoe reported indicates that the growing season is not long enough for the fruits to mature towards autumn and, warming could prolong growing season and allow for geographic range expansion. Long term climatic data reveal an increase of 0.98 °C in annual maximum temperature over the Western Himalaya (Dash & Hunt 2007), where greater Himalaya shows an increase in maximum and minimum temperatures of 1 and 3.48 °C, respectively (Shekhar *et al.* 2010). The present study area is devoid of long-term climatic data and we used two decadal data (1986–1995 and 1996–2005) obtained from NASA (https://eosweb.larc.nasa.gov/sse/) which revealed that minimum and average temperature of the infestation site has been increased during February to April (Fig. 3) and in the post monsoon season (September and October). Relative humidity during April to July also showing decreasing trends. These extended warm and dry conditions are likely to create conditions favourable for growth and maturity towards end of growing period. Warming associated forest pest and pathogen outbreak and large scale degradation of coniferous forest has been already reported across the globe as well as in the Western Himalaya (Uniyal & Uniyal 2009). The interactive effects of *Arceuthobium* infestation, fungal diseases

**Fig. 2.** *Arceuthobium minutissimum* Hooker: The infected *Pinus wallichiana* tree with dying and dried branches (left); heavy infestation on infected branch (right top) and close-up of the pistillate plant (right bottom).

and insect pests are reported to cause high pine mortality during years of average precipitation which is more frequent in the presence of other stress factors, such as drought (Schultz & Allison 1982). The annual as well as monsoon rainfall has been declined in high altitudes of Western Himalaya during last 5–6 decades and negative trends of post monsoon and winter precipitation is also evident (Singh & Mal 2014). These conditions may favour maturity and dispersal of seed of the dwarf mistletoe which is limited by the cold temperature towards the end of growth period.

Upward shift in elevation range of mistletoes due to climate change has been reported from elsewhere (Dobbertin *et al.* 2005). Climatic limits for distribution of *A. minutissimum* also depends on the distribution and population density of its principal host. Interestingly, large scale regeneration and elevation range shift of *P. wallichiana* is reported from the Western Himalaya (Dubey *et al.* 2003). These conditions may serve as suitable precursor of further spread of dwarf mistletoe at higher elevation. Current patterns of unusual and extreme climatic conditions in Western Himalaya may cause eruptions of mistletoe populations leading to mass mortality of host species (Jenkinson 1990). Blue pine contributes significantly to the forest cover in the high altitudes where climatic uncertainty and trends of long dry season may favour infestation over large areas and its dense patches may help in rapid spread. Increasing period of dry season may favour spread of the species and increase in its pathogenicity (Dore 2005). Climate change associated extreme events in this region

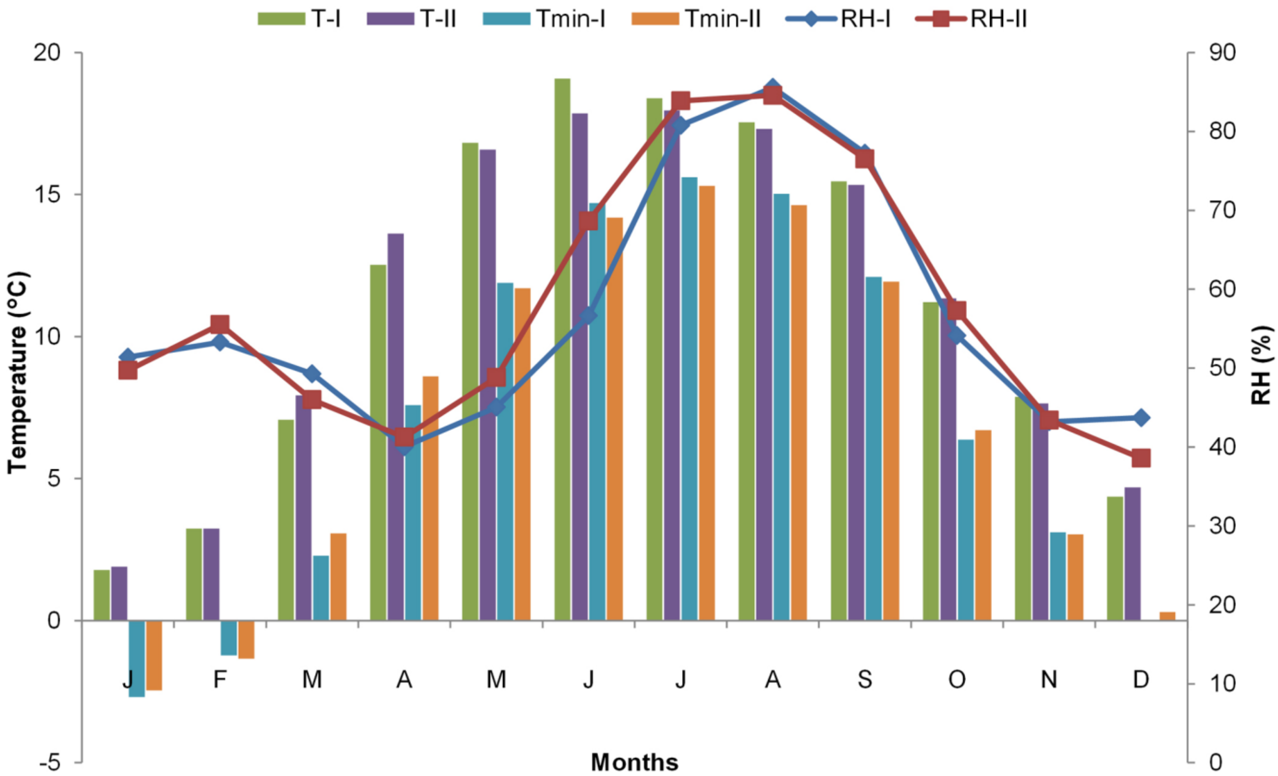


**Fig. 3.** Patterns of average temperature (T), minimum temperature (Tmin) and relative humidity (RH) in the infestation site for last two decades (I, 1986–1995 and II, 1996–2005). (Source: https://eosweb.larc.nasa.gov/sse/).

such as long dry periods in summer and post monsoon season may provide ideal condition for the spread of this pathogen. It may also make the infested trees more vulnerable to attack by other diseases and insect pests. Therefore, it is feared that rapid spread of this species in the park might become detrimental to the growth and regeneration of blue pine. Further, detailed studies on the patterns of infestation and extent of Himalayan dwarf mistletoes are important because they are serious pathogens of coniferous trees which are valuable ecologically and economically in the Himalayan region. Also, this species can serve as indicator of changes in environmental conditions over time where long term monitoring with past records will be important to track impacts of climate change on these ecosystems.

## Acknowledgements

Department of Science and Technology, Govt. of India for funding under NMSHE Project (DST/SPLICE/CCP/NMSHE/TF- 2/WII/2014[G]) and Uttarakhand Forest Department for giving permission to work in the Gangotri National Park.

## References

Andrews, S. R. 1957. Dwarf mistletoe of ponderosa pine in the southwest. Forest Pest Leaflet 19. U.S. Department of Agriculture and Forest Service, Washington, DC.

Bagchee, K. 1952. A review of work on Indian tree diseases and decay of timber and methods of control. Prepared for the 6th British Commonwealth Forestry Conference, Canada. Forest Research Institute, Dehradun, India.

Baker, F. A., M. Slivitsky & K. Knowles. 1992. Impact of dwarf mistletoe on jack pine forests in Manitoba. *Plant Diseases* **76**: 1256–1259.

Bor, N. L. 1953. *Manual of Indian Forest Botany*. Oxford University Press, London.

Burdon, J. J., P. H. Thrall & L. Ericson. 2006. The current and future dynamics of disease in plant communities. *Annual Review of Phytopathology* **44**: 19–39.

Chandola, S. 2009. *Vegetational Inventory of Cold Desert of Nelang Areas of Jadh Ganga Catchment (Uttarkashi) in Garhwal Himalaya.* Ph. D. Thesis, HNB Garhwal University, Srinagar, Garhwal, India.

Chaudhary, Z. & K. Badshah. 1984. *Pinus gerardiana*: A new host of *A. minutissimum*. *European Journal of*

*Forest Pathology* **14**: 123–125.

Chhetri, D. B. 1990. Some tree diseases and insect pests of forests of Bhutan. *Tsenden* **2**: 72–79.

Chhetri, D. B. 1995. Observation trial on dwarf mistletoe infestation on Blue pine. *Tsenden* **5**: 22–24.

Dash, S. K. & J. C. R. Hunt. 2007. Variability of climate change in India. *Current Science* **93:** 782–788.

Datta, R. M. 1951. Occurrence of a hermaphrodite flower in *Arceuthobium minutissimum* Hook.f., the smallest known dicotyledonous plant. *Nature* **167**: 203–204.

Dobbertin, M., N. Hilker, M. Rebetez, N. E. Zimmermann, T. Wohlgemuth & A. Rigling. 2005. The upward shift in altitude of pine mistletoe (*Viscum album* ssp. *austriacum*) in Switzerland-the result of climate warming? *International Journal of Biometeorology* **50**: 40–47.

Dore, M. H. I. 2005. Climate change and changes in global precipitation patterns: What do we know? *Environment International* **31**: 1167–1181.

Dorji, S. 2007. *Himalayan Dwarf Mistletoe (*Arceuthobium minutissimum*) and the Leafy Mistletoe* (Taxillus kaempferi) *on Blue Pine- A Case Study in Western Bhutan.* Diploma thesis. University of Natural Resources and Applied Life Sciences, Vienna (BOKU), Austria.

Dubey, B., R. R. Yadav, J. Singh & R. Chaturvedi. 2003. Upward shift of Himalayan pine in Western Himalaya, India. *Current Science* **85**: 1135–1136.

Gorrie, R. M. 1929. A destructive parasite on the Himalayan blue pine. *Indian Forester* **55**: 613–617.

Hawksworth, F. G. & D. Wiens. 1970. Biology and taxonomy of the dwarf mistletoes. *Annual Review of Phytopathology* **8**: 187–208.

Hawksworth, F. G. & D. Wiens. 1996. *Dwarf Mistletoes: Biology, Pathology, and Systematics.* Agriculture Handbook 709. U.S. Department of Agriculture, Forest Service, Washington, DC. http://www.rmrs.nau.edu/publications/ah_709/

Hooker, J. D. 1890. *Flora of British India*, Vol. 5. Reeve and Co., Kent.

Jamal, S. M. & A. R. Beg. 1974. Natural infection of mistletoe in Pakistan. pp. 187–189. *In: Proceedings of the Pakistan Forestry Conference.*

Jenkinson, J. L. 1990. *Pinus jeffreyi* Grev. and Balf. Jeffrey pine. *In: Silvics of North America. Vol. 2 Conifers.* Department of Agriculture and Forest Service, Washington DC.

McNulty, S. G. & J. D. Aber. 2001. United States national climate change assessment on forest ecosystems: an introduction. *BioScience* **51**: 720–723.

Naithani, H. B. & P. Singh. 1989. Note on the occurrence of genus *Arceuthobium* M. Bieb. in eastern Himalaya. *Indian Forester* **115**: 196.

Press, M. C. & G. K. Phoenix. 2005. Impacts of parasitic plants on natural communities. *New Phytologist* **166**: 737–751.

Pusalkar, P. & D. K. Singh. 2012. *Flora of Gangotri National Park, Western Himalaya, India*. Botanical Survey of India, Ministry of Environment and Forests, Govt. of India.

Roldan, A. 1924. Los arboles indígenas que ataca el muérdago en el Valle de Mexico. *Mexico Forestal* **2**: 61–63.

Sarangzai, A. M., N. Khan, M. Wahab & A. Kakar. 2010. New spread of dwarf mistletoe (*Arceuthobium oxycedri*) in Juniper forests, Ziarat, Balochistan, Pakistan. *Pakistan Journal of Botany* **42**: 3709–3714.

Schultz, D. & J. Allison. 1982. *Tree Mortality in the Cleveland National Forest.* Forest Pest Management Report 82–12. US Department of Agriculture and Forest Service, Washington DC.

Shekhar, M. S., H. Chand, S. Kumar, K. Srinivasan & A. Ganju. 2010. Climate-change studies in the Western Himalaya. *Annals of Glaciology* **51**: 105–112.

Singh, R. B. & S. Mal. 2014. Trends and variability of monsoon and other rainfall seasons in Western Himalaya, India. *Atmospheric Science Letters* **15**: 218–226.

Uniyal, S. K. & A. Uniyal. 2009. Climate change and large-scale degradation of spruce: common patters across the globe. *Climate Research* **38**: 261–263.

Walther, G. R., E. Post, P. Convey, A. Menzel, C. Parmesan, T. J. C. Beebee, J. M. Fromentin, O. Hoegh-Guldberg & F. Bairlein. 2002. Ecological responses to recent climate change. *Nature* **416**: 389–395.

Williams, W. T. 1971. Distribution of three species of dwarf mistletoe on their principal pine hosts in the Colorado Rocky Mountain Front Range. *Phytopathology* **61**: 1324–1325.

(Received on 28.05.2017 and accepted after revisions, on 24.03.2018)