

AS WE SEE IT

Climate change and large-scale degradation of spruce: common pattern across the globe

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ABSTRACT: Massive degradation of spruce *Picea* spp. forests, due to increased temperatures, has been reported from many parts of the world. We have detected large-scale yellowing of *Picea smithiana* Boiss. in the western Himalayas, where temperatures have increased by 0.6°C in the last 3 decades. Large-scale degradation of *P. smithiana* has never been observed in the Himalayan region to date.

KEY WORDS: *Picea smithiana* · Spruce · Himalayas · Forest conservation · Global warming · Temperature

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Forests of spruce *Picea* spp. are widely distributed in the Northern Hemisphere between 71°N in North America to 23°N in Southeast Asia (Mark et al. 2007). Spruce has great ecological and economic importance and is receiving high conservation attention. Globally, climate change affects growth and distribution of spruce forests (Tallantire 1972, Barber et al. 2000). Degradation of spruce forests, due to pest attacks, primarily *Ips typographus*, *Pityogenes chalcographus*, *Polygraphus poligraphus* and *Rhizosphaera kalkhoffii*, has been reported from Slovakia (Jakuš 1998), Japan (Yamaoka et al. 2000), Germany (Siefermann-Harms et al. 2004), Poland (Grodzki 2004), France (Gilbert et al. 2005), Slovenia (Jurc et al. 2006), Sweden (Jönsson et al. 2007), Norway (Diamondis 1978), Canada (Gray 2008) and Turkey (Sariyildiz et al. 2008). In Alaska alone more than 450 000 ha of spruce forest is severely damaged as a result of infestation by *Dendroctonus rufipennis* (Werner et al. 2006). Though diseases in spruce have been reported earlier, their intensity and frequency have now increased manifold. Spruce diseases in different parts of the world have been linked to increasing winter temperatures and erratic weather conditions (Jurc et al. 2006).

Until recently, reports of spruce degradation were primarily limited to Europe and America. Large-scale yellowing of *Picea smithiana* Boiss. was observed during 2008 for the first time in the western Himalayas. The needles of *P. smithiana* turn yellow, giving the tree a charred appearance (Fig. 1). More than 160 ha of good *Picea* forest is under heavy infestation, and at many places the symptoms are just starting to appear. Increased activities and range expansion of pests due to rising temperatures and other environmental changes have been reported from UK, Australia, Switzerland, China and Spain (Collier et al. 1991, Cannon 1998, Roques et al. 2003, Hódar & Zamora 2004, Greenslade 2008, Wermelinger et al. 2008) (Fig. 2).

During the last 3 decades, temperature increases have been recorded at a Himalayan weather station near the site of spruce infection. Mean monthly temperature has increased, by 0.13°C in September to 1.53°C in February, from 1979–1988 to 1999–2008 (Fig. 3). On the other hand, the months of June, July and August have shown a decrease in temperature; these are months of heavy rainfall in the area. The number of rainy days in the area has increased from

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Fig. 1. *Picea smithiana*. Left: yellowing needles; right: closeup of yellowing

97 d yr⁻¹ in 1999 to 111 d yr⁻¹ in 2007, thus favouring a general cooling during these months. Overall, mean annual temperature has increased from 17.95 ± 1.59°C in the decade 1979–1988 to 18.55 ± 1.42°C in the decade 1999–2008. Winter temperature increase can be fatal for spruce, as it makes it susceptible to pest attacks (Jackson et al. 2007). Large-scale yellowing of spruce in the Himalayan region is of great concern, as the Himalayas not only shape the climate regime of Asia, but also support the livelihood of nearly 60 million people. Forests of *P. smithiana* play an important role in the hydrology of the mountain ecosystem (Negi 2002) and are of immense importance in harbouring and sustaining native plant diversity. Also, since similar patterns of spruce degradation have been reported across the globe (Fig. 2), spruce appears to be a potent indicator species of changing environmental conditions.

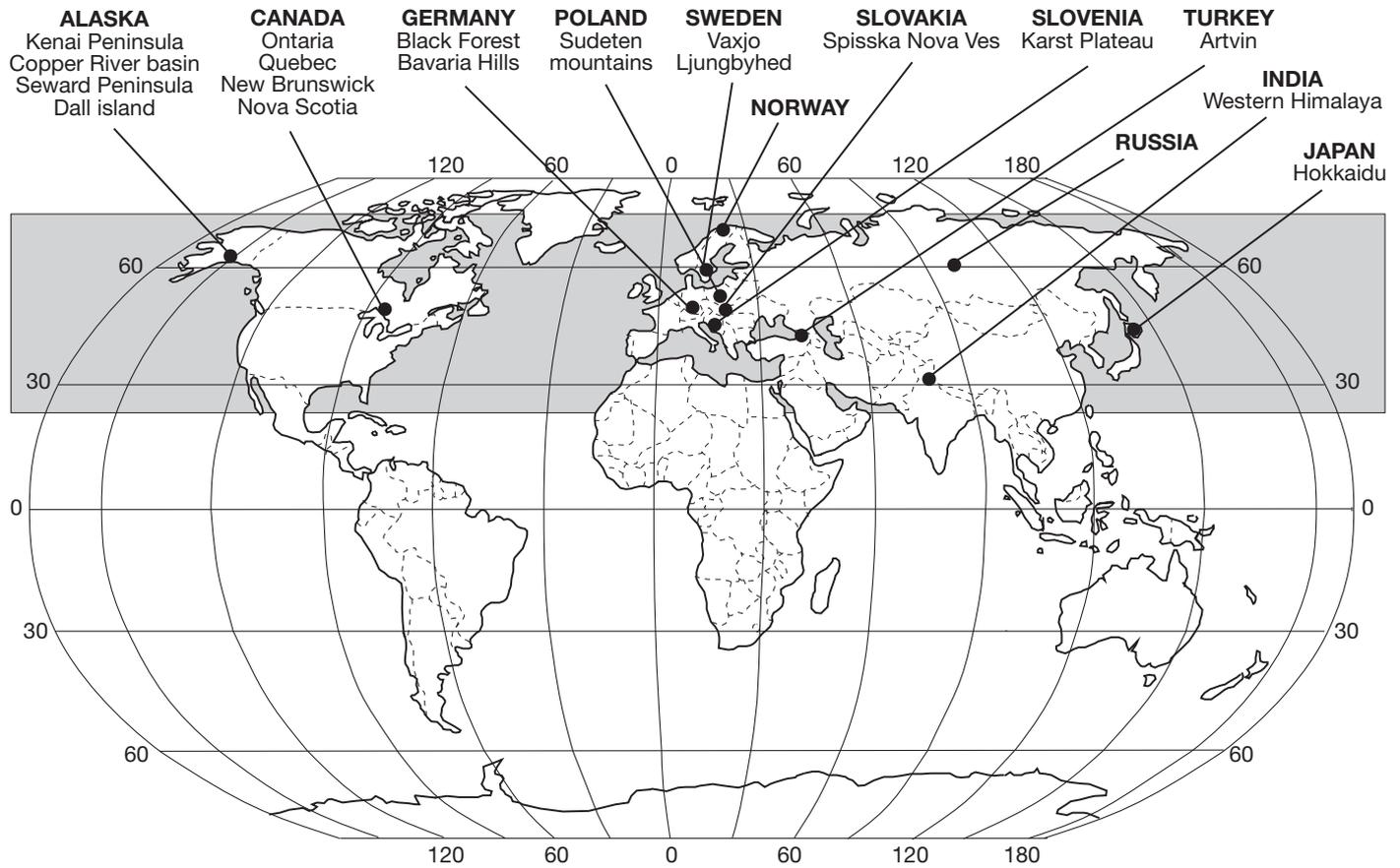


Fig. 2. Areas of reported spruce degradation . Grey: range of spruce

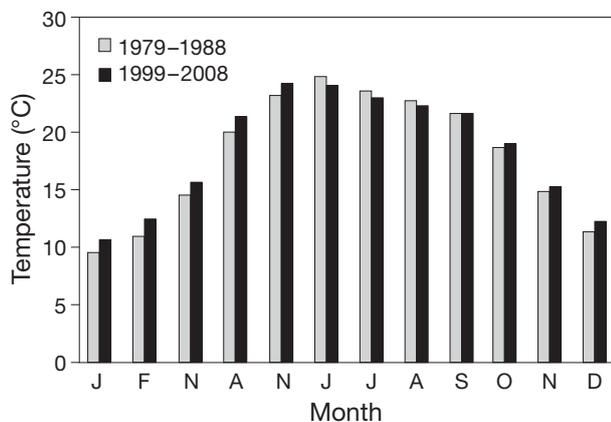


Fig. 3. Mean monthly temperatures near the site of severe spruce yellowing

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