



Molecular and morphological diagnostic markers for the Himalayan *Ips* DeGeer species (Coleoptera: Curculionidae: Scolytinae)

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Abstract

Morphological and molecular analyses of *Ips* bark beetles collected in the eastern and northwestern Himalayan area resulted in the diagnosis of three species—*Ips stebbingi*, *I. longifolia* and *I. schmutzenhoferi*. These three species can be distinguished by morphological characters, including the frontal setae, the body size and the shape and position of the spines on the elytral declivity. DNA sequences of the mitochondrial Cytochrome Oxidase I gene were analyzed to detect haplotype variation within each of the species. A phylogenetic analysis was performed on our data plus data from GenBank. Considerable amount of intra-specific sequence divergence was found in *I. longifolia*, ranging between 0.2%–2.5%. Intra-specific sequence divergence in *I. stebbingi* ranged from 0.2%–1.1% and in *I. schmutzenhoferi* it varied by 0.2%. Interspecific sequence divergence was high among the three species: 7.4–8.6% between *I. longifolia* and *I. stebbingi*, 11.9–12.2% between *I. stebbingi* and *I. schmutzenhoferi*, and 11.5–12.6% between *I. longifolia* and *I. schmutzenhoferi*. Phylogenetic analyses revealed Himalayan *Ips* species to be monophyletic and unrelated to other Asian species. *Ips stebbingi* and *I. longifolia* were sister taxa and *I. schmutzenhoferi* was distinguished from *I. stebbingi*.

Key words: Himalayan *Ips*, taxonomic key, mt-DNA, phylogeny

Introduction

The entire Himalayan region is renowned for its intact forest resources which are of immense socioeconomic and ecological importance. The eastern Himalaya occupies Bhutan and Sikkim, the central Himalaya includes Nepal and the northwestern Himalaya covers the northern territory of India including the states of Himachal Pradesh and Jammu and Kashmir.

Bark beetles (Scolytinae) are among the most economically important pests of the world forests. Conifer forests and broad-leave tree species in the temperate regions of the northern hemisphere are in particular very vulnerable to damage by these insects. Some of the most aggressive of these insects are species of *Ips* DeGeer (Postner 1974; Wood & Bright 1992; Pfeffer 1995). This genus is composed of 36 species distributed in North America, Europe, Asia and introduced into Australia and Africa (Faccoli 2004, Cognato & Sun 2007). Fourteen *Ips* species occur in the Palearctic region (Knizek 2011) of which only eight are endemic to Asia and display a variation of aggressiveness and host use (Table 1). The Himalayan species attack mainly living trees or infest freshly felled logs in the pure or mixed conifer forests (Schmutzenhofer 1988; Tshering & Chhetri 2000). *Ips stebbingi* Strohmeier and *I. schmutzenhoferi* Holzschuh are suggested as primary pests and more aggressive than *I. longifolia* (Stebbing). These species can build up high population levels when there is excessive supply of breeding material and favorable environmental conditions. However, when population levels are sufficiently high, these aggressive species can also attack standing vigorous trees and are able to overcome their defense mechanisms. *Ips longifolia* seems to be a secondary bark beetle that can occasionally cause outbreaks.

Additional research is needed to increase the knowledge of *Ips* biodiversity in the Himalayan region. Asia has large regions of conifer habitat and extensive mountain ranges (Critchfield & Little 1966). The isolation due to historical fragmentation of similar habitats is known to have occurred in the Palearctic. The species diversity in Asia