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NEW SPREAD OF DWARF MISTLETOE (*ARCEUTHOBIUM OXYCEDRI*) IN JUNIPER FORESTS, ZIARAT, BALOCHISTAN, PAKISTAN

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Abstract

Juniperus excelsa (DC.) M. Bieb. (Cupressaceae) is long-lived tree that provides many benefits to regional ecosystems and local economies of surrounding communities. However, relatively little is known about the insects, diseases and other factors that affect the health and productivity of *Juniper* forests in Ziarat district of Balochistan Province, Pakistan. In this study the incidence of wide spread threat to *J. excelsa* by obligate parasite *Arceuthobium oxycedri* (DC.) M. Bieb (Viscaceae) is reported. This disease has been recently discovered in four new locations in Ziarat forest. In the infested regions of Salam Valley, trees were severely infected, the majority having a DMR (Dwarf Mistletoe Rating) of 6. In contrast, severity of infection in the Ziarat valley was light, the majority having a DMR of 1. In the infested portions of Salik Sakhobi, infection was moderate. 50% of the infected trees were severely infected (DMR 6) and an equal percentage were less infected (DMR 1 or 2). The most effected area was Narai Valley that contained the most severely infected trees. In this area DMR of infected trees were high (4-6). It is therefore concluded that the infection was recent because we did not observe trees in the sampling area that had been completely killed by *A. oxycedri*. The spread by wind, birds and small mammals is the most likely vector of rapid spread of this parasite. *A. oxycedri* infestation in the newly infected areas appeared to be the extensions of the main area of infestation in Chasnak and Sasnamana Valleys.

Introduction

Juniper forests and the associated diversity of plants and animals constitute a unique ecosystem, in arid mountains with harsh climatic conditions in Balochistan, Province, Pakistan. These forests are considered to be one of the worlds largest, oldest and extremely slow growing and long lived (>3000 years). They are often termed "Living Forest Fossils". Balochistan has approximately 141,000 hectors of *Juniperus excelsa* forests, out of which approximately 86,000 hectors of these are found in Ziarat and Loralai districts. *J. excelsa* typically grows as pure stands, and are characteristically open and multi-storied forests between elevations 2000 to 3000 meters (Sheikh, 1985). These forests are an important source of fuel wood for local residents and offer protection from soil erosion to the district's watersheds. These forests also provide grazing pastures, summer recreation, bark for roofing, essential oils, "berries" for flavoring and are used as remedy for kidney and many other diseases.

Little is known about the impact of dwarf mistletoe infestation in Pakistan's forests; including economically important, widely distributed species. Juniper dwarf mistletoe (*A. oxycedri*) is an obligate parasitic seed plant which is entirely dependent on the host plant (*Junpierus excelsa*) for protection, nourishment and reproduction. Seed dispersal takes place by means of explosive propulsion from the fruit (Johnson, 1888; Heinricher, 1915; Thoth & Kuijt, 1978). The practice of using mistletoe shoots as fodder might also spread the parasite (Zakaullah & Badash, 1977). Signs of infestation in host trees include growth loss, deformities (witches' brooms) and tree mortality (Ceisla, 1997).

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In the New World, 34 taxa infect various species of Pinaceae, while in the Old World, eight species of *Arceuthobium* infect members of the Pinaceae and Cupressaceae (Hawksworth & Weins, 1996). Three species, *A. azoricum*, *A. juniperi-procera* and *A. oxycedri* infect species of *Juniperus*. *A. oxycedri* has the widest geographical distribution of any dwarf mistletoe, ranging from Spain to Morocco, North Africa, Southern Europe, Eastern Asia, and the near East to Western China (Hawksworth & Weins, 1996). Two species of *Arceuthobium* occur in Pakistan: *A. minutissimum*, which infects *Pinus wallichiana*, and *A. oxycedri*, which infects *J. excelsa*. Beg (1973) first reported *A. oxycedri* in the juniper forests of Sasnamana Valley near Ziarat as part of a forest disease survey. At the time of discovery, 50% mortality was attributed to dwarf mistletoe infection. A second report (Jamal & Beg, 1974; Zaidi et al., 2007) suggests that the parasite had been present in the area for a long time but had been overlooked because the aerial shoots tend to mimic the foliage of the host plant. More recently, detailed assessments of the Ziarat forest dwarf mistletoe infestation conducted by Ceisla (1993 & 1997) and Atta (2000) indicated that the area of heaviest infestation was the south side of Chasnak Valley.

The objectives of the assessment were to (a) estimate the level of intensity of infection and their negative affects on the health and survival of these unique forests, and (b) to recommend methods to reduce further losses.

Materials and Methods

Juniperus excelsa is distributed between 20° 9´N and 30° 37´N and between 67° 1´E and 68° 3´E, as well as in some isolated dry valleys from 1200 m to 3000 m above sea level (Rafi 1965). The area chosen for the present investigation is situated in and around the Chasnak and Sasnamana Valleys of Ziarat District, Balochistan Province (Fig. 1). The area includes irregular and rugged ridges with steep terrain. According to Champion *et al*., (1965), the juniper tract falls within the dry temperate forest region. The average annual rainfall is recorded 269 mm with maximum of 74 mm in July and a minimum of 3 mm in January. The hottest month is July mean temperature 27.4ºC, and the coldest is January (mean temperature 7.9ºC). Relative humidity ranges from 35% to 60%. Snow occurs between November and April with a maximum (68 cm) in February (Ahmed *et al*., 1990).

Field surveys were conducted in September and October 2006 in four areas of Ziarat forest Balochistan: Salam Valley (East of Chasnak), Ziar Valley (East of Sasnamana), Salik Sakhobi (South of Sasnamana), and Narai Valley (East of Chasnak). These four areas are extensions of the main areas (Chasnak and Sasnamana) where dwarf mistletoe infection has been already reported (Ceisla, 1997). Transects were established across representative areas of infection and 0.5 ha sample plots, usually consisting of groups of 5 to 15 dominant junipers, were established through the four Valleys. In the Salam Valley, 25 plots were established, and a total of 210 trees were examined. Ziar Valley contained 15 plots with 145 trees, Salik Sakhobi contained 10 plots with 105 sample trees, and Narai Valley contained 8 plots with 120 sample trees. Each individual sample tree was examined for the presence of dwarf mistletoe and infected trees were rated using Hawksworth 6-class rating system (Hawksworth, 1977). Individual tree DMRs were averaged to obtain plot DMR and an area DMR for the portion of each valley.

Fig.1. Map of the Study area.

Results

Detection of infected trees: The earliest symptoms of infection of *A. oxycedri*, observed during the study was the development of fusiform shaped swelling at the point of infection. Severely infected trees were indicated with crown dieback, profuse branches, witches, brooms and tree mortality both in the live and dead portions of the crown of the infected trees.

In Salam Valley, 15 plots (119 trees) of the 25 sample plots were infected with dwarf mistletoe (33.6%), having an area mean Dwarf Mistletoe Rating (DMR) of 0.63 (Table 1). Nearly half of the heavily infected trees occurring in the plots had a DMR rating. In Ziar Valley, 10 plots (77 trees) of the 15 sample plots were infected (23.2%), with a mean DMR of 0.46 (Table 1). Nearly half of the infected trees were DMR class 1, and corresponding lower proportions of trees occurred in the more severe DMR classes (Fig. 2). In Salik Sakhobi, 6 plots (82 trees) out of 10 sample plots were infected (18.2%), with a mean area DMR of 0.73 (Table 1). Except for DMR classes 4 and 5, intensity of infection was almost the same in rest of the classes. In Narai Valley, 6 plots (55 trees) out of 8 sample plots were infected (21.2%), with a mean area DMR of 0.57 (Table 1). High intensity of infection was recorded in the DMR classes.

Table 1. Comparison of *Arceuthobium oxycedri* on *Juniperus excelsa* in four valleys of Ziarat Forest, Balochistan, Pakistan.

S. No.	Name of valley	Plots established	Plots infested area	% Infected	Mean DMR
1.	Salam Valley	25	15	33.61	0.63
2.	Ziar Valley	15	10	23.17	0.46
3.	Salik Sakhobi	10	6	18.19	0.73
4.	Narai Valley	8	6	21.18	0.57
	Total	**58**	**37**	**63.79**	**0.57**

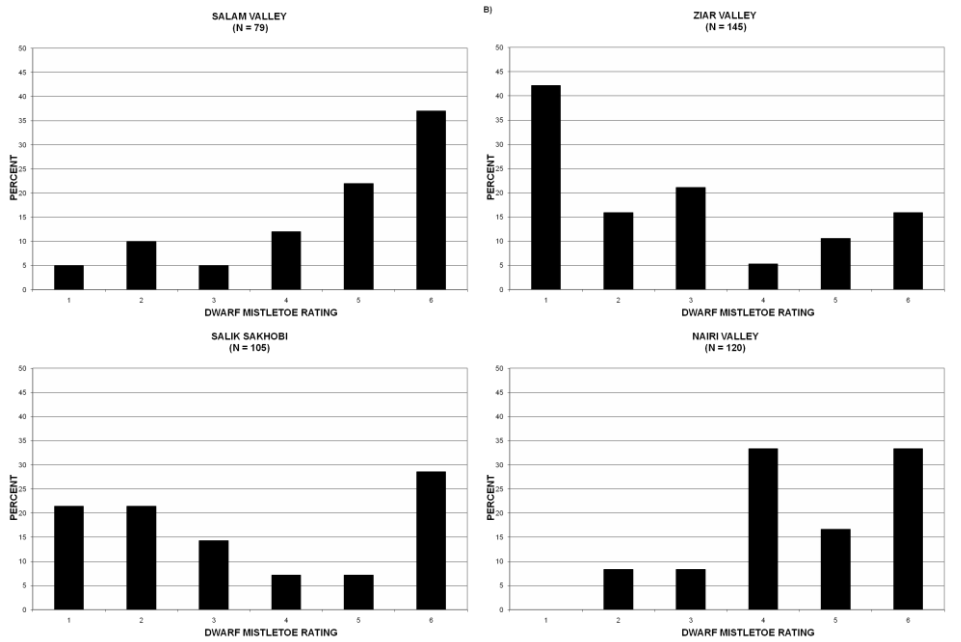

Fig. 2. Frequency distribution of Dwarf Mistletoe Rating (DMR) in different Localities from Ziarat Juniper forest Balochistan.

Discussion

In the Salam Valley, the juniper woodland is found in a few areas of fairly level terrain. The potential for significant eastward spread is limited by the lack of host material of a suitable stand density. The entire Ziar Valley is reasonably well-stocked with juniper forest. Because of the relatively continuous area of forest in this Valley, there is high potential for eastward spread of dwarf mistletoe infection. In Salik Sakhobi, the infection poses a high potential for spread south, east and west. In Narai Valley, fairly well stocked juniper woodland continues eastward and gives way to open rangeland and a scattering of single trees. The relative lack of host trees should limit the eastward spread of dwarf mistletoe.

Although pests, human, livestock and a number of parasitic plants, fungi, insects and abiotic factors are the components of natural ecosystems but they are acting either alone or in combination have been effecting on the health, survival and productivity of these forests. *Arceuthobium oxycedri* infestation in the newly infected areas appeared to be the extensions of the main area of infestation in Chasnak and Sasnamana Valleys. The spread through birds and small mammals seems to be a possibility. The velocity and direction of the wind may be other important factors that help carry the mistletoe infection to longer distances and to a particular direction.

In the associated areas of these four valleys, infections occur in relatively well stocked forests and there is high potential for tree to tree spread. Several methods exist for control of the dwarf mistletoe spread in related species, including mechanical, chemical, and biotic controls. However, biotic controls, such as the use of fungi (*Neonectria neomacrospora*), have not been shown conclusively to be effective against dwarf mistletoe (Rietman *et al*., 2005). Chemical applications, such as that of ethephon, have been effective (Johnson, 1992) but the monetary cost in treating tree in Ziarat are prohibitive. Manual removal of infected individuals by pruning or removing infected trees has also shown to limit the rate of spread of dwarf mistletoe (Johnson, 1998). However, this method is very labor intensive. In Pakistan, as the cost of biological and chemical treatment is the most limiting factor, pruning and cutting of the heavily infected trees and or their branches is the only cultural remedy.

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