SURVEY OF JUNIPER DWARF MISTLETOE IN SASNAMANA STATE FOREST OF BALUCHISTAN

by

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Summary. *The incidence of mistletoe infection in Sasnamana Juniper forest of Baluchistan was* 36 *percent among all the study trees, average infection rating for infected trees was* 4.6 *according to the* 6*-class mistletoe rating system of Hawksworth and Lusher* (1956). *The highest incidence of infection was found at* 2900-300 *metres elevation, and south-western aspect. The proportion of infected trees was higher in older trees as compared to the younger; the incidence being significantly lower in trees below* 30 *cm diameter and ten metre height, corresponding to the age of about* 180 *years.*

Introduction. The dwarf mistletoes (Arceuthobium) are highly specialized aerial dicotyledonous parasites occurring on conifers of the Pinaceae in the Old and New Worlds and on Cupressaceae in the Old World (Hawksworth and Wiens, 1972). Mistletoes are short, ranging in length from about 1.25 to 20 cm. They are dioecious (Fig. 1) and flower in spring to late summer. The fruits require from a single season to a full year to reach maturity. Seeds are explosively expelled from the fruits at initial velocities of about 28 metres per second for distances upto 15 m. although the average distance is considerably less (Hinds, Hawksworth and McGinnies, 1963; Hinds and Hawksworth, 1965; Hawksworth, 1961a). Seed dispersal occurs from midsummer to late fall. Seeds are viscous coated (Fig. 2) and readily adhere to the objects they strike. The seeds of most of the species germinate immediately after seed dispersal. The germinating radicle forms a holdfast when it contacts an obstruction on the host branch (Bonga, 1969b). The holdfast develops a penetrating wedge of tissues into the host (Scharpf and Parmeter, 1967) thereby initiating the infection process.

In a wide-spread form, the mistletoes cause severe reduction in growth among infested trees. Seedlings, saplings and young trees are often killed. On the whole, the damage caused by dwarf mistletoes ranks second to that caused by fungi. Pathologists and foresters feel that it may, in time, surpass fungi as an enemy of the coniferous forests.

Juniper (*Juniperus macropoda*) forms Dry Juniper Forests, included in the Dry Temperate Forest type (Champion, Seth and Khattak, 1965) covering about 56000 hectares in Baluchistan. The Average elevation of Juniper forests varies from about 2000 to 3000 m. with optimum growth between 2500 and 2700 m. Juniper forests are pure and show wide variation in density (Ishaque, 1955).

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Arceuthobium oxycedri M. Beib; the Juniper dwarf mistletoe, parasitizes the Junipers growing in Sasnamana State Forest (Abdullah, 1973). The present study is an attempt to survey the severity of infestation and determine its limits.

Review of Literature. Brandis (1906) first reported *A. oxycedri* on *J. macropoda* growing in Lahoul on the north slope of the main Himalayan Range (Stewart, 1961). Parker (1918, 1956) collected *A. oxycedri* from the same locality on *J. macropoda* and thought it to be more common as it might easily be overlooked due to its mimicry. He further observed that the parasite usually attacked large trees in groups and seemed to do little harm to its host.

No information on its occurrence in Baluchistan was available till Jamal (Pakistan Forest Institute) collected mistletoe plants parasitizing the junipers in Sasnamana forest and got them indentified from Stewart Herbarium, Rawalpindi (Abdullah, 1973). Later on, Jamal and Beg (1974) recorded their observations on the natural infection of juniper dwarf mistletoe. The rate of mortality was about 50 percent. The mistletoe was found common and damaging on all the sites.

Method. 3 equidistant lines were drawn running North-South on the map of Sasnamana Forest (1:50,000). On each line, plots were marked at intervals of 753 m. The plots were located in the forest by pacing and hand compass. At each plots tation, a circular plot of .05 hectare was established (Fig. 3). Elevation and aspect were recorded for each plot. All the trees in a plot were numbered. The data on d.b.h., tree height and mistletoe rating were recorded for each study tree.

The 6-class infection-rating system described by Hawksworth and Lusher (1956) was adopted to record the incidence of infection. The live crown of the tree was divided into three parts from top to bottom and each third rated as: (0) no visible infection; (1) light infection (1/2 or less of total number of branches in the third infected); (2) heavy infection (more than 1/2 of total number of branches in the third infected). The ratings of each third were added to obtain a total for the tree. Mistletoe ratings for all the infected trees in a plot were averaged. The infection centres on all the 3 lines were located on the map. High ridges, on three sides of the forest: north, east and south constitute its natural boundary. The areas on the ridges were critically examined to detect areas from where the mistletoe had either already crossed or was about to cross the limits of the forest.

Results. Out of 36 plots studied, trees in 17 were infected (47%). The total number of trees in the 36 plots was 297. Out of these, 106 (36%) were infected. The infected trees were studied and the average infection rating was determined as 4.6.

Elevation and incidence of attack. Of the 36 plots established, 14 were located between 2700-2900 m. elevation, 11 between 2901-3000 m. and 11 above 3000 m. Table-1). The highest infection percentage (64) was recorded in the 2901-3000 m. elevation range, followed by 50% in the 2700-2900 m. range. The lowest incidence (27%) occurred in plots above 3000 m. elevation.

Fig. 1 *Arceuthobium oxycedri* on *Juniperus macropoda*. Staminate plant (left) and pistillate plant (right), collected in October.

Fig. 2 Mature fruits and seeds of *A. oxycedri*, collected in October.

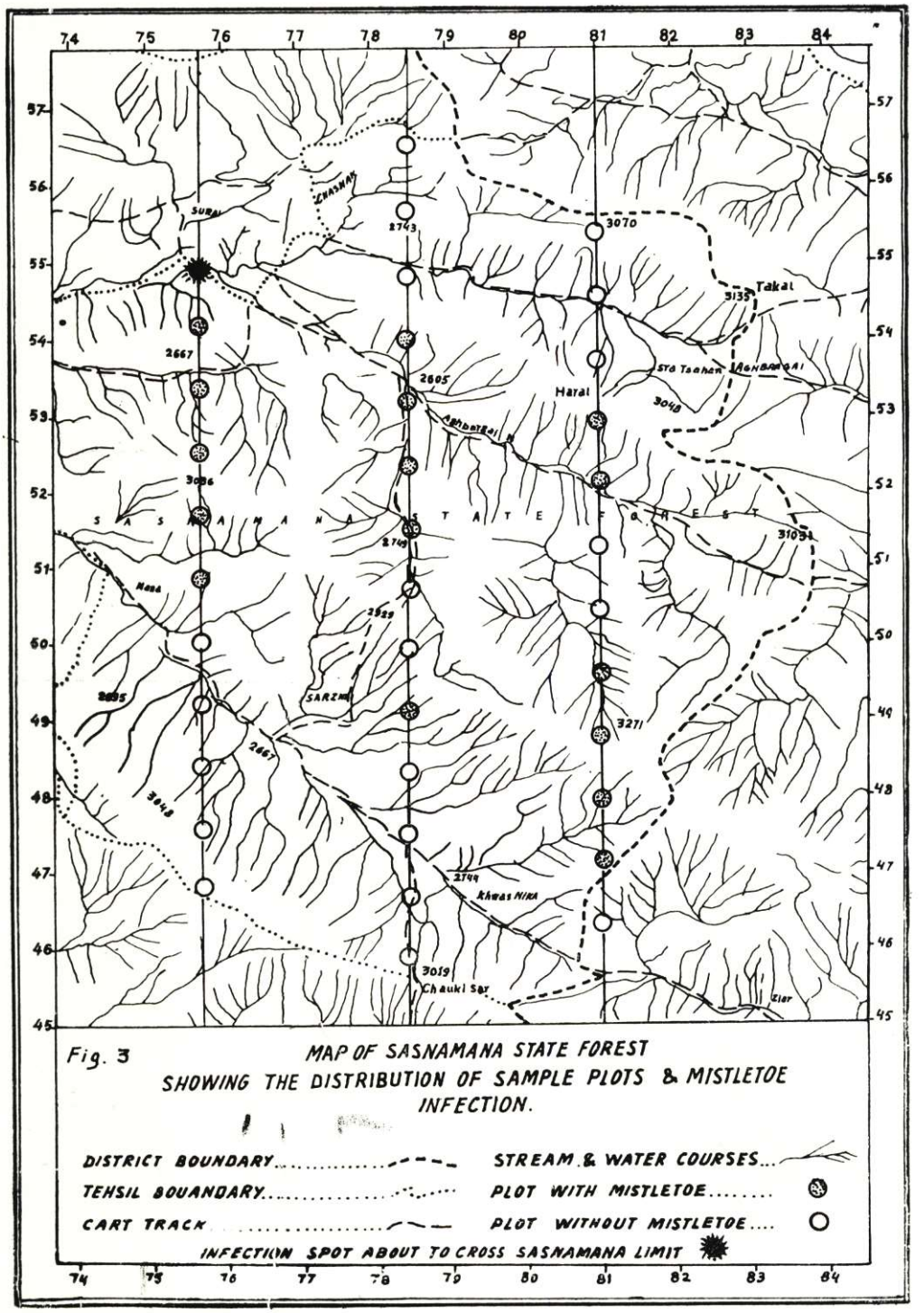

Fig. 3 MAP OF SASNAMANA STATE FOREST SHOWING THE DISTRIBUTION OF SAMPLE PLOTS & MISTLETOE INFECTION.

DISTRICT BOUNDARY..... STREAM & WATER COURSES...

TEHSIL BOUNDARY..... PLOT WITH MISTLETOE.....

CART TRACK..... PLOT WITHOUT MISTLETOE....

INFECTION SPOT ABOUT TO CROSS SASNAMANA LIMIT

TABLE 1

Relationship between elevation and mistletoe infection

Elevation range (metres)	Number of plots	Number of plots with mistletoe		Number of trees	Number of trees with mistletoe		Infection* rating
		No.	%		No.	%	
2700—2900	14	7	50	122	47	39	4.4
2901—3000	11	7	64	95	47	50	5.0
3001+	11	3	27	80	12	15	4.2
Total:	36	17	..	297	106	..	..
Average (all classes)	..	..	47	..	..	36	4.6

*Based on the 6-class system (Hawksworth and Lusher, 1956).

Aspect and incidence of attack. Out of the 36 study plots, 9 were located on the northern aspect, 8 on the southern, 3 on the eastern, 10 on the western and 6 on the south-western aspect (Table-2). The percentage of mistletoe infection was the highest (83) in plots established on south-western aspect, followed by 60 on the western, 50 on the southern and 33 on the eastern aspect. The lowest incidence (11) was recorded in plots on the northern aspect.

TABLE 2

Releationship between aspect and mistletoe infection

Aspect class	Number of plots	Number of plots with mistletoe		Number of trees	Number of trees with mistletoe	
		No.	%		No.	%
Northern	9	1	11	67	16	24
Southern	8	4	50	74	29	39
Eastern	3	1	33	23	2	9
Western	10	6	60	81	32	40
South-Western	6	5	83	52	27	52
Total:	36	17	..	297	106	..
Average (all classes)	..	..	47	..	..	36

Tree size and incidence of attack. As indicated below, the incidence of attack increases with increase in height and diameter of trees:

Height class (metres)	Number of trees infected	Number of trees observed	% of trees infected
0—5	6	54	11.1
5—10	29	120	24.2
10—15	31	75	41.3
15—20	25	31	80.6
20—25	7	9	77.8
25—30	8	8	100.0

d.b.h., class (cm)	Number of trees infected	Number of trees observed	% of trees infected
0—10	1	17	5.9
10—20	8	52	15.4
20—30	11	58	19.0
30—40	22	56	37.5
40—50	25	39	64.1
50—60	15	28	53.5
60—70	12	28	42.8
70—80	5	9	55.6
80—90	4	6	66.4
90—100	3	3	100.0
100—110	—	1	—

The incidence is significantly lower in trees below 30 cm d b h and 10 metres height, corresponding to an approximate age of 180 years (Khattak, 1963).

Means of spread and intensification of dwarf mistletoe. During the survey, it was observed that the spread of mistletoe is generally from tree to tree. The affected trees were found, most often, in long strips of dead and dying trees (Fig. 4).

Mistletoes are also known to spread through birds and mammals (Gill and Hawk sworth, 1961). The authors came across a thrush (Fam: Turdidae), a bird most common in the area, locally known as "Obusht Khore" (Fig. 5). They feed on Juniper seeds and thus may help carry the sticky mistletoe seeds alongwith their feet to healthy trees soon after visiting the infected ones.

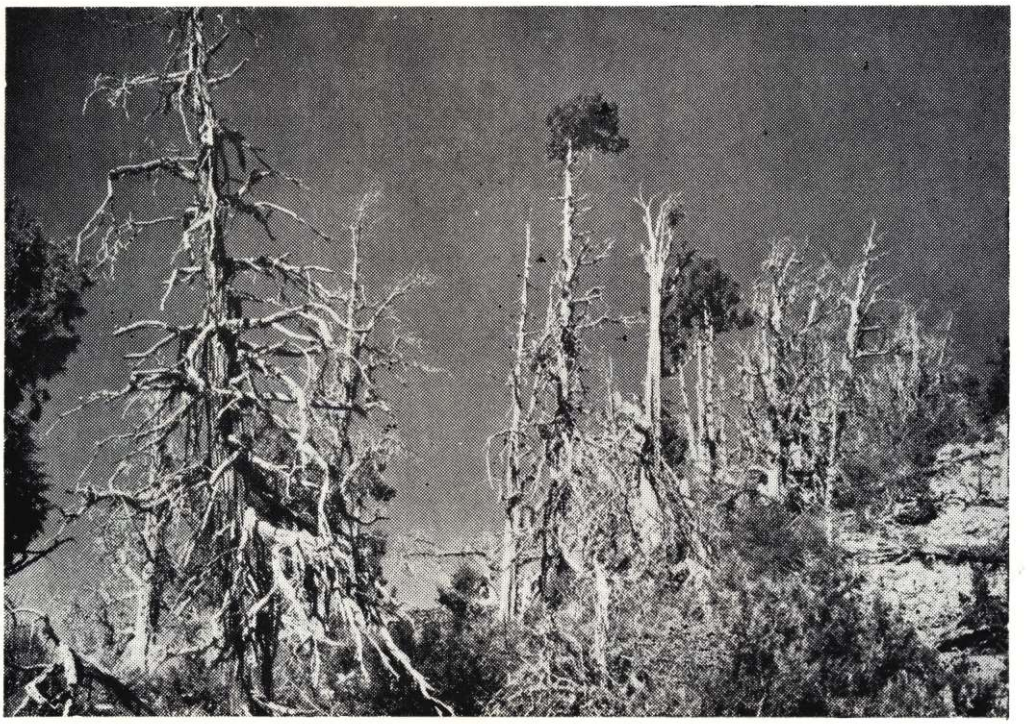

Fig. 4 A wide-spread attack of juniper dwarf mistletoe occurring in long strips showing tree to tree infection.

Fig. 5 A bird "Obusht Khore" as a mean of mistletoe spread.

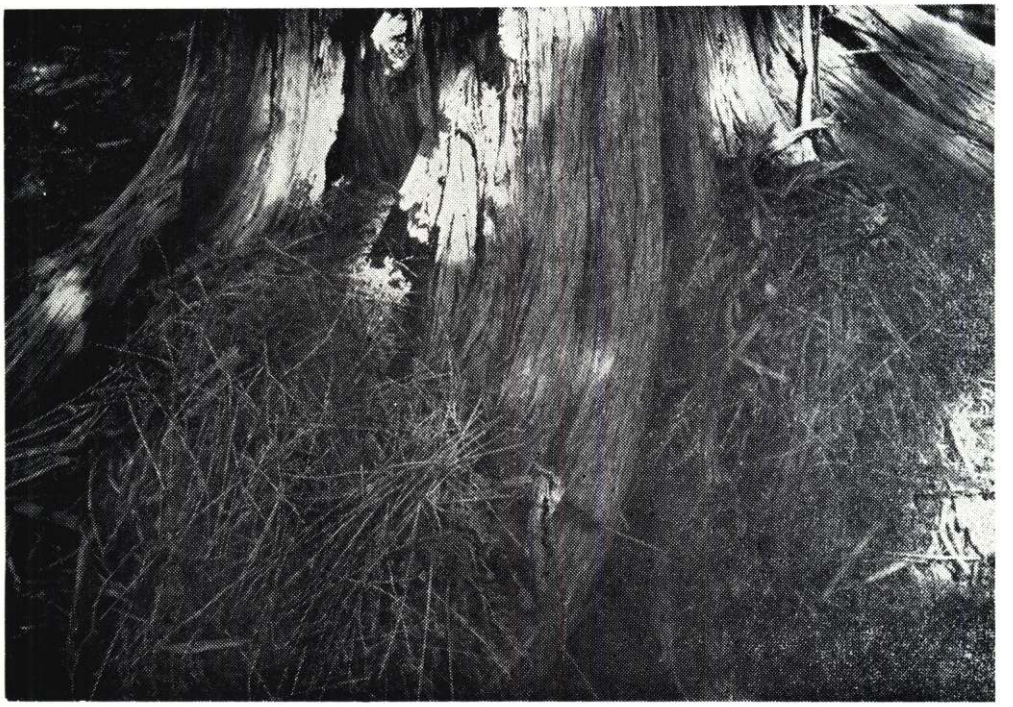

Fig. 6 A heap of green and dry Juniper shoots near a rat-hole.

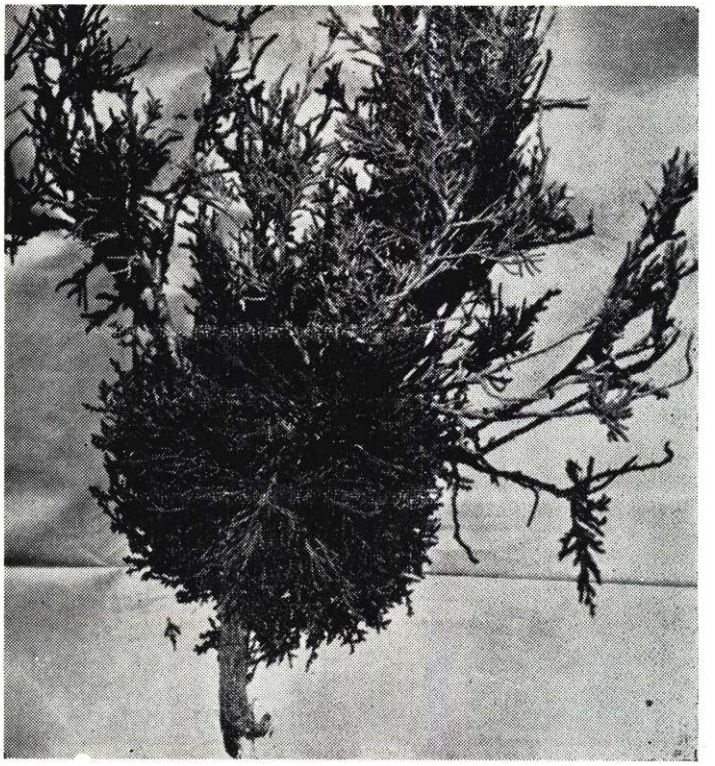

Fig. 7 A group of pistillate mistletoe shoots showing a sign of mistletoe infection.

The possibility of mistletoe spread through field rats cannot also be ruled-out. Rat holes were found in a great numbers in the root zone and main trunk of the tree. A heap of small Juniper shoots lying close to the rat-hole was a common feature (Fig. 6). The lower most branches of the healthy trees may get infected from the infected shoots collected during Oct.-Nov., the fruit maturity period of the mistletoe (Hawksworth and Wiens, 1976).

The mistletoe plant is relished by goats and sheep. The shepherds usually cut mistleoe infected shoots of Juniper for feeding to their animals at site or may carry them to their hamlets in the forest. The latter practice, if continued from middle of August to November can help in introducing the mistletoe to new areas.

Wind may be another important factor in transporting the forcibly expelled mistletoe seeds to distances longer than normal. High wind velocity is a common feature of the area.

The mistletoe was found on the northern ridge (x, Fig. 3) which indicates that it has either already crossed into Chasnak Forest or is likely to do so soon.

Discussions and Conclusions. The study shows 36 percent incidence of mistletoe infection among all the sample trees. The mistletoe infection ratings average 4.6 for the infected trees. This indicates that the infection is present in a fairly abundant form and has great potential for development and further spread.

Elevation range 2900-3000 m. and south-western aspects appeared to favour the incidence of infection.

Most of the infection appears to have occurred from an infected tree to a healthy one growing within the range of forcibly expelled seeds. The spread through birds and mammals also seems to be a possiblity. 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.

Suggestions for mistletoe control. The control practices have been based on the recommendations made by Hawksworth et al (1968).

The goal need not be complete eradication of the parasite. This may require cutting all the trees. Instead, if mistletoe is reduced sufficiently the trees can continue to live for many years.

The trees growing in and around the infection centres should be examined for the presence of the mistletoe. The easiest way to detect the infection is to look for the mistletoe shoot (Fig. 7). Branch swellings caused by the mistletoe and "Witche's-broom" or bunched growth of the branches are good indicators of infection (Fig. 8). The infected trees would need pruning or cutting depending upon the severity of the infection. The guide-lines for control procedures are suggested below:

(1) Control work should be done from about the end of April to the middle of August since mistletoe shoots can be seen more easily at this time. Seed dispersal starts about the middle of August, so control work should be completed by then.

(2) Trees that show severe infection of misteletoe, especially in the upper branches, should be cut. Such trees prove dangerous as dead branches or tops may break and fall. Moreover, high and unreachable infected branches will continue to serve as a source of infection to the nearby trees.

(3) Pruning infected branches reduces the amount of mistletoe and can also improve the health of the trees. Even trees that have deteriorated to the point where the tops are thin and discoloured can be saved by pruning if there are enough live branches remaining on them.

All live branches to be pruned should be cut off flush with the trunk. Cut off the entire branch. Do not try to remove individual mistletoe plants, because small mistletoe plants are liable to be over-looked which will grow out later.

Cut off the infected branches including the highest infected ones. Isolated living branches should not be left even though dwarf mistletoe may not be apparent in such branches, they almost invariably contain incipient infections.

If there are plenty of live branches above the highest infected one, cut off such branches for about 0.60 m. above this point. This will help eliminate many young infections that would show up later.

(4) Mistletoe root systems extend for several centimetres beyond the mistletoe shoot. Thus, if an infection on a branch is very close to the trunk, the infection may have already entered the trunk and mistletoe shoots will come out even if the branch is removed. Therefore, if mistletoe shoots are 25-30 cm from the trunk the entire tree should preferably be cut.

(5) Examine the trees every year and prune the infected branches and brush off trunk shoots. This follow-up is very important; if it cannot be done, the initial pruning should not be attempted at all.

(6) Dwarf mistletoe shoots die as soon as the branches are cut. Therefore, it is unnecessary to burn or destory the cut branches. Trees and large branches removed during sanitations should not be piled near living trees because they provide ideal breeding material for destructive insects.

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Fig. 8 A live "Witche's-broom" caused by *A. oxycedri* on *J. macropoda*.

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