WATER RELATIONS OF DWARF MISTLETOE (*ARCEUTHOBIUM OXYCEDRI* M. Bieb.) IN RELATION TO THAT OF ITS HOST: *JUNIPERUS EXCELSA* M. Bieb.)

by

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Summary. *Arceuthobium oxecedri M. Bieb is an aerial dicotyledonous parasite on branches or stems and is an important forest pathogen. It is the most widely distributed dwarf mistletoe in the northern hemisphere, and among hosts it mainly infects the species of Juniperus* (*Hawksworth* 1972). *During British India, Brandis* (1906) *and Parker* (1924) *reported it on juniper but its pathological significance was brought up recently by Jamal and Beg* (1974) *while conducting a survey of the diseases of forest trees. According to Zaka* (1977) *about* 36 *percent of the trees in Sasna-mana forest are infected.*

The only known control method for the control of the parasite is pruning of infected branches. But this causes damage to the host. To develop new methods of control efforts are being made all over the world to collect basic physiological information about the host-parasite relationship. The present investigation is in the same direction and aims to explore the diurnal fluctuations in water balance parameters of this mistletoe in relation to those of its host, under natural conditions

Review of Literature. Scholander *et al.*, (1965) compared the sap-pressure relationship of California juniper to that of its parasite mistletoe (*Phoradendron bolleanum*). They found that the mistletoe was capable of out sucking its host by 10 to 20 atm. Fisher and Reid (1974) had investigated the effect of water stress on the water potential levels of ponderosa pine; lodgepole pine and their respective dwarf mistletoes, *Arceuthobium vaginatum* and *A. Americanum* under field and laboratory conditions. They observed that dwarf mistletoes had lower water potentials than their hosts and that this gradient steepend with stress. They also found out that the transpiration of parasite was primarily responsible for maintaing the water potential gradient and in this respect they investigated the transpiration of *A. Americanum* and an 18-year-old lodgepole pine seedling subjected to substrate potentials of 0, -3, -6, -9, -12 and -15 bars. Transpiration of the parasite was found to be 2 to 3 times that of the host on a surface area basis and reached a maximum at -9 bars substrate potential. The host maximum was reached at -3 bars. Transpiration of the host, however, showed steady decrease with incresed stress after the -3 bar substrate level had reached,but this was not observed for the parasite.

Material and Methods. The experiment was conducted on September 17, 1976 on a heavily infected single tree of *Juniperus excelsa* M. Bieb., situated at Sasna-mana forest

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(Ziarat, Baluchistan); Longitude 67° 44′ E., Latitude 30° 23′ N., and at an altitude of about 3,000 m above sea level. The candidate tree was about 15 m in height, 45 cm in diameter at breast height and partially dead. The soil was shaly and moist as an unusual heavy rain had occured a week before (79 mm as recorded at Ziarat). The under-wood consisted of *Caragana ambigua*, *Rosa* sp., *Salvia* sp., and cushion plants. To determine different factors; observations were taken by three workers observing simultaneously at 10 a.m., 12 noon and 3 p.m.

Transpiration measurements were made by the method of rapid-weighing with a torsion balance (HUBER). Details of the technique used can be found in our recent publication (1977). All values are calculated on fresh weight basis (mg transpiration/g fresh-weight/min.).

The method employed to establish the form of curves representing stomatal reaction in shoots without regular supply of water was as follows: The shoot was cut from the plant and hung on one arm of the balance and its initial weight established within a few seconds. Further measurements were made at different time intervals: 15 minutes, 30 min., 45 min., one hour, tow hours and so on. Later these specimens were oven-dried at 105°C and the water contents for respective reading was expressed as percent of oven dry weight. Thus, the difference between the two successive readings divided by the time elapsed, gave the rate of water loss during that time interval.

The behaviour of the stomatal opening and closing was determined by examining the freshly pealed off strips of epidermis under microscope without fixing. An average value of ten stomata was calculated to represent the state of stomatal opening.

The water contents of the shoots were determined by the following formula and expressed as percent of the oven dry weight:

$$\%\text{water content} = \frac{\text{Fresh weight} - \text{oven dry weight}}{\text{Oven dry weight}} \times 100$$

Water deficit in shoots was determined by WEATHERLEY's method of relative mechaturgidity as described by SLATYER and MCLLROY (1961).

Temperature and relative humidity at time of obsservation were measured by a mechanically operated psychrometer and were as follows:

Time	*Temperature* (C°)	*Relative humidity* (%)
10 a.m.	21	11
12 noon	19	21
3 p.m.	20	17

Water potential of the plant tissues was established by using SHARDAKOV's change of density method as described by SLARTYER and MCLLROY (1961).

Results. Transpiration: The observations on the rate of transpiration are plotted in Figure 1. The trend of mistletoe curve is independent as compared to that of juniper; at 12 noon, when the juniper had decreased rate of transpiration than morning, the mistletoe had the maximum one. The rate of transpiration in mistletoe varied from 2.0 to 2.7 mg/gm fresh weight/min., during forenoon, while that of the host remained comparatively at much lower level during this period, ranging from 0.8 to 1.3 mg/gm fr.wt./min. This type of behaviour remained operating even afterwards and the parasite maintained a higher rate than its host.

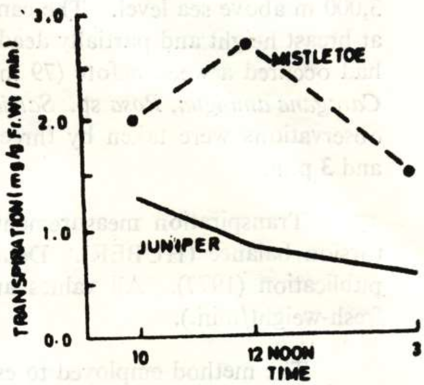

Fig. 1. Daily march of transpiration

Stomatal reaction in cut shoots: The results of the stomatal reaction in cut shoots taken from the plant and hung on the arm of the balance are plotted in Figure 2. The stomata, in both host and parasite show a general pattern of response and the curves are therefore well defined into three phases of transpiration: stomatal phase, closing phase and cuticular phase. The parasite lost about 11% of its total water contents, during peak hours of transpiration while it was only 2.6% for the host. The cuticular loss is low and its magnitude is of the same order (0.2%) in both host and parasite.

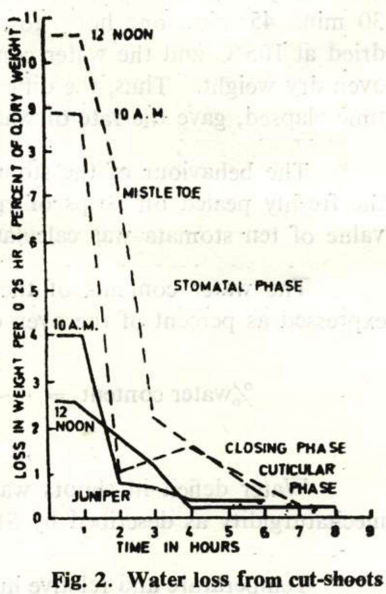

Fig. 2. Water loss from cut-shoots

Stomatal behaviour: The stomatal behaviour in both host and parasite is plotted in Figure 3. The curve for the parasite shows wide open apperture during the whole day while in that of the host, where the stomata being widely open in the forenoon started partially closing afterwards.

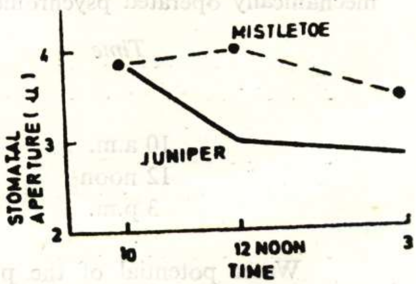

Fig. 3. Daily march of stomatal behaviour.

Water contents: The data regarding water contents is represented in Figure 4. The water contents of the parasite remained extremely high as compared to that of its host during the whole day. The values of water contents fluctuated inbetween 168 to 178% in the mistletoe while for the host these ranged from 106 to 116%.

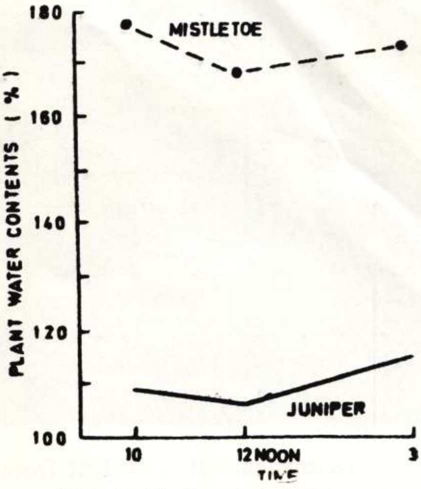

Fig. 4. Plant water contents.

Water deficit: The water deficit curves plotted in Figure 5 show that mistletoe had lower water-deficit (5%) in the morning which started increasing during the day and by 12 noon developed a peak value of 12%. This value persisted till 3 p.m. in the afternoon. The juniper, on the other hand represents a linear type of curve with a low deficit in the morning and increasing gradually during the whole day attaining a peak value of about 18% by afternoon. At 12 noon, the magnitude of deficit in both host and parasite was of the same order had beyond that the parasite did not let it develop further as compared to that of its host.

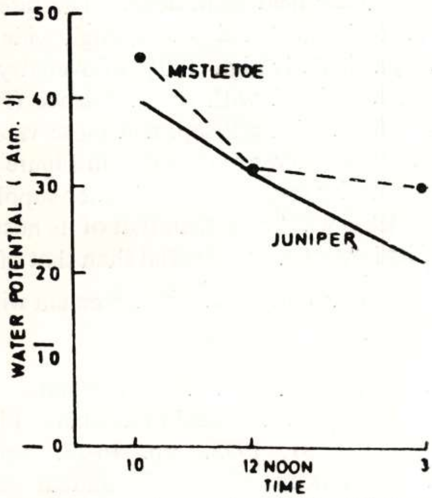

Fig. 5. Daily march of warter-deficit.

Water potential: The water potential data are)plotted in Figure 6 and the curve representing the parasite is placed at a more negative potential side than that of its host, except at 12 noon where the values for both coincide. In the morning, a value of -45 atm., was exhibited by the mistletoe which decreased to about -33 atm by 12 noon and that continued till 3 p.m. The juniper took a start with a value of about -40 atm in the morning which gradually lowered during the day time and attained a value of about -18 atm., by 3 p.m.

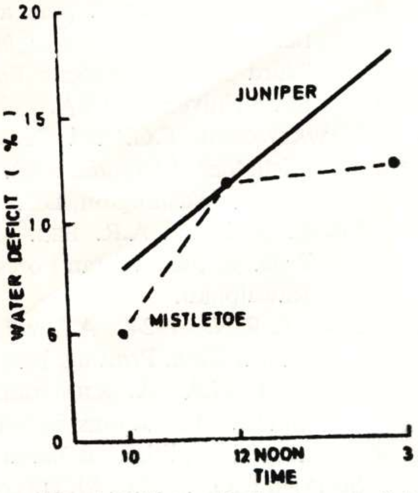

Fig. 6. Daily march of water-potential.

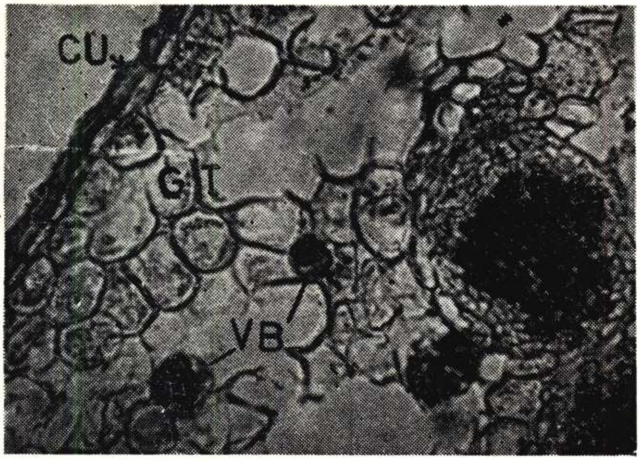

Fig. 7. Transvsrse section through stem of *Arceuthobium oxyecdri*. X 150. Cu—cuticle; VB — vascular bundles; GT—ground tissue (Parenchyma).

Discussion. It is evident from the results that a marked difference exists between the water relations of *Arceuthobium oxycedri* M. Bieb and its host: *Juniperus excelsa* M. Bieb under field conditions. The rate of transpiration was found to be about four times that of its host and was through wide open stomata. The water contents of the parasite are particularly high (180% of oven dry weight) which it maintains by high rate of transpiration associated with its succulence (Figure 7), thick cuticle, large sized parenchymatous cells filled with cell sap, and loose vascular bundles. It is also apparent from the trend of water loss curves represented in Figure 2, that the mistletoe has no restrictions on water loss even under severe stress of water supply, as compared to juniper. The water deficit in the mistletoe was lower than that of its host and this superior type of water balance is a function of its lower water potential than that of its host, which makes up the water loss quickly.

Our findings are in agreement with those of Scholander (1965); Fisher and Reid (1974).

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