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Comparative Study on Presence of Fusiform Rays per mm^2 in Some Coniferous Woods from Markets of Himachal Pradesh

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ABSTRACT

The wood rays are strips of short horizontal cells that extend in a radial direction and serve to store food and distribute it horizontally. They are also responsible for the transfers of water, nutrients, and chemicals occuring up and down in a tree. The sap, containing water and nutrients, is transported horizontally to the cambium through structures called wood rays. The wood rays are more complex structures in hardwoods while, in softwoods usually uniseriate and fusiform rays are observed. The fusiform rays are complex structure, usually present in the resin yielding trees i.e. Conifers. The imperative taxonomic characteristic in conifers is resin ducts, which are enclosed in fusiform rays in tangential section of the wood specimen. Comparative studies on fusiform rays predicted variation in number as well as structure of fusiform rays in the studied coniferous species.

Key words: *Fusiform rays, Conifers, Himachal Pradesh.*

INTRODUCTION

Conifers or softwood trees usually form a diverse group which has become very imperative in the world's economy as they grow fast on poor soils even under harsh climates, and yield timbers that are suitable for wood industry. Botanically, they are classified as Gymnosperms, or "naked seeded" plants, because their ovules, which later become seeds, are borne exposed on the scales of immature cones or female flowers. These ovules are fertilized, as with other plants, by pollen carried from male flowers. As the cones develop, their scales become tightly shut to protect the seeds. But after ripening, the cone-scales open in dry weather, and then the winged seeds drift away. Most conifers flower in spring season; their cones may ripen during the following autumn, the following spring, or in some species eighteen months after pollination.

In India, coniferous forests grow in the Himalayan mountain region, where the temperature is low. These forests have tall stately trees with needle-like leaves and downward sloping branches, so that the snow can slip off the branches. They are usually found in the steep dry slopes of the Shivalik hills, Western and Central himalayas, Khasi, Naga, and Manipur hills.

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The trees predominantly found in hilly areas are oak, rhododendron and pine whereas, in the lower regions sal, sandan, amla and laburnum are found. The most common coniferous species in these forests are fir (*Abies pindrow* (Royle ex D.Don) Royle), blue pine (*Pinus wallichiana* A. B. Jacks), himalayan cedar (*Cedrus deodara* Royal ex D. Don), spruce (*Picea smithiana* wall. Boiss), himalayan cypress (*Cupressus torulosa* Don) and Himalayan yew (*Taxus baccata* Linn.).

The wood rays are strips of short horizontal cells that extend in a radial direction and serve to store food and distribute it horizontally. Rays are responsible for the transfers of water, nutrients, and chemicals occuring up and down in a tree. However, there is some transfer across the tree. Sap moves down the tree through the phloem. The sap, containing water and nutrients, is transported horizontally to the cambium through structures called wood rays. Wood rays also act as storage areas for the carbohydrates that the tree uses as food. The rays in hardwoods are much more diverse than those found in softwood. In some species, including willow (*Salix*), cottonwood, and koa (*Acacia koa*), the rays are exclusively uniseriate and are much like the softwood rays.. Rays in hardwoods are composed of ray parenchyma cells that are either procumbent or upright. As the name implies, procumbent ray cells are horizontal and are similar in shape and size to the softwood ray parenchyma cells. The upright ray cells are ray parenchyma cells turned on end so that their long axis is vertical. Upright ray cells are generally shorter and sometimes nearly square. Rays that have only one type of ray cell, typically only procumbent cells, are called homocellular rays while, rays having procumbent and upright cells are called heterocellular rays. The number of rows of upright ray cells varies from one to more than five. The great diversity of hardwood anatomy is treated in many sources throughout the literature[1,2,3,4,6,,7,9]. The softwoods usually possess uniseriate and fusiform rays whereas this study was done to found the presence of the fusiform rays in different coniferous species.

MATERIALS AND METHODS

The present investigation was carried out in the Department of Forest Products, College of Forestry, Dr Y S Parmar university of Horticulture and Forestry, Nauni, Solan (HP). The wood samples of 5 species for the present work were procured from the local markets of Chamba, Sundernagar and Solan. Fresh wood samples, each of dimensions 2 x 2 x 2 cm^3 were sliced out separately from each site and thin microscopic sections of size 15 to 20 µm were taken using "Sliding Microtome (Model: RMT-45)". Permanent slides of tangential sections were stained using saffranine as per the procedure outlined by Johansen[5]. Later, the sections were washed through a series of alcohol solutions at different concentrations (70 %, 90 % and 95 %) to ensure complete dehydration. Sections were subsequently dipped in acetone followed by xylene and finally mounted in DPX mountant to prepare permanent slides. Permanent slides were subjected to measurements and photography using "Trinocular research microscope (Model: CH20iBIMF Olympus)" attatched to digital camera and PC (Personal Computer) were taken. The presence of fusiform rays was estimated by using an ocular micrometer fitted in the eyepiece of a microscope at 10X magnification, standardized with the help of stage 5 micrometer. Permanent slides were prepared and the sectioned images were studied. Twelve observations each were taken for all the characters.Experimental materials included 5 species of Pinaceae and locations are as follows (Table-1).

Table 1: Experimental site and planting material

SPECIES	SITES
1. *Pinus roxburghii* (S_1)	Chamba(L_1), Sundernagar(L_2) and Solan(L_3)
2. *Pinus wallichiana* (S_2)	Chamba(L_1), Sundernagar(L_2) and Solan(L_3)
3. *Abies pindrow* (S_3)	Chamba(L_1), Sundernagar(L_2) and Solan(L_3)
4. *Picea smithiana* (S_4)	Chamba(L_1), Sundernagar(L_2) and Solan(L_3)
5. *Cedrus deodara* (S_5)	Chamba(L_1), Sundernagar(L_2) and Solan(L_3)

RESULT AND DISCUSSION

The statistically analysed data related to number of fusiform rays (Plate-1) per mm^2 in wood for all the species and market locations are presented in Table 2. The examination of data depicted significant difference in number of fusiform rays per mm^2 in wood among different species and locations at 5 per cent level of significance. The maximum number of fusiform rays per mm^2 was recorded as 10.583 in S_2 (*Pinus wallichiana)* and minimum value of 0.000 was noticed in S_3 (*Cedrus deodara*). The analysis predicted non- significant values for locations which ranged from 6.614 to 7.276. The interactions between species and locations were also found to be non significant and ranged between 0.000 and 10.583.

Table 2: Variation in number of Fusiform rays per mm^2 of coniferous wood from different market locations

Species (S)	Locations (L)			Mean
	L_1 (Chamba)	L_2 (Sundernagar)	L_3 (Solan)	
S_1(*Pinus roxburghii*)	7.937	7.937	7.937	7.937
S_2(*Pinus wallichiana*)	10.583	10.583	10.582	10.583
S_3(*Cedrus deodara*)	2.646	0.000	0.000	0.882
S_4(*Picea smithiana*)	7.937	7.937	7.937	7.937
Mean	7.276	6.614	6.614	
$CD_{0.05}$				
Species (S)	2.574			
Location (L)	N.S			
Species×Location (S×L)	N.S			

The fusiform rays have been observed in tangential sections of few species, having radial resin canals surrounded by epithelial cells. The results revealed fusiform rays in *Pinus roxburghii*, *Pinus walluchiana* and *Picea smithiana* while, traumatic canal was present in *Cedrus deodara* and was absent in *Abies pindrow* (Figure 1). Panshin and de Zeeuw[9] reported the similar results in four genera of Pinaceae that have normal resin canals such as *Pinus*, *Picea*, *Larix*, and *Pseudotsuga* while, *Cedrus* usually possess traumatic resin ducts and fusiform rays were rarely observed. Fusiform rays are less than 1 per cent of the volume in softwoods[8].

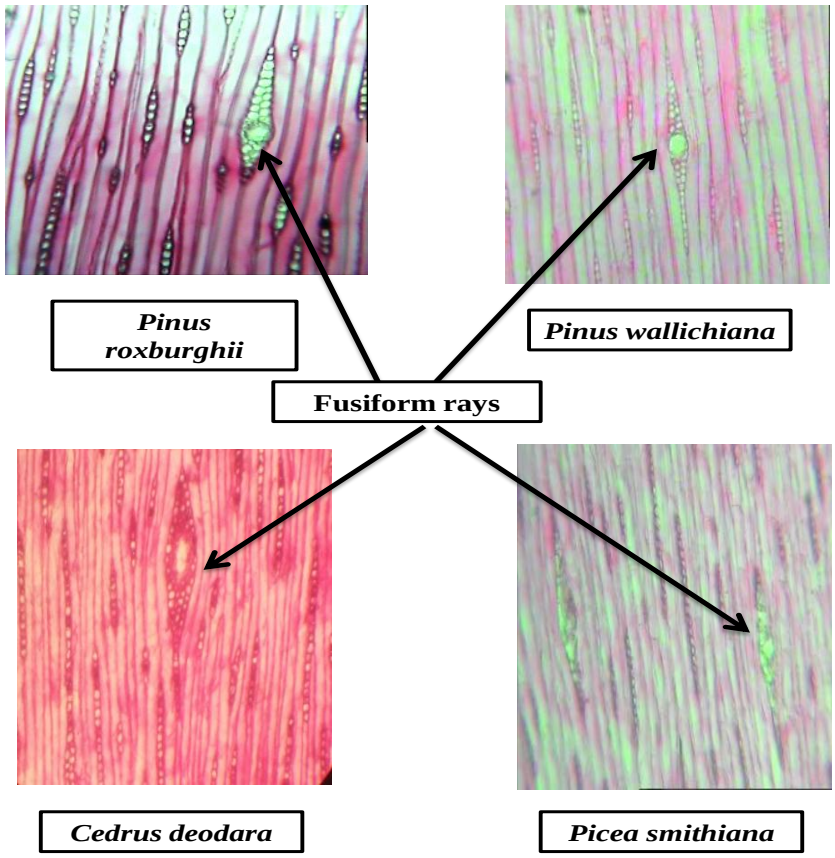

Plate-1: Fusiform Rays in coniferous woods

Fig. 1: Fusiform rays in coniferous woods

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