# DECAY IN THE STANDING TEMPERATE CONIFERS OF KAGAN

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**Abstract.** *A study of* 203 *conifer trees revealed that the incidence of decay was* 16.3% *and extent of volume .loss* 1.7% *among all the sample trees.* Phaeolus schweinitzii *and* Phellinus pini *were the two major decay fungi causing brown cubical and red ring rot respectively. They accounted for* 94% *of the total decay volume. No consistent relationship was indicated between decay and age of the tree. Decay volume percent was higher on northern as compared to southern aspects. Mechanical basal injuries and dead branch stubs were the important infection courts for the decay pathogens.*

**Introduction.** Decay is the most important cause of volume loss in the mature and over-mature standing forest crops. In a decay study carried out in the temperate conifers of Swat district (Zakaullah, Jamal and Beg, 1974), about 27% trees exhibited decay resulting in 15% loss of timer.

Coniferous forests of Kagan occupy an area of about 56801 hectares out of which more than 75% is covered by Temperate Forests including Moist and Dry Temperate Forest types (Champion, Seth and Khattak, 1965). Most of these are mature and over-mature. Four important timber species viz. blue pine (*Pinus wallichiana*) ,deodar (*Cedrus deodara*), silver fir (*Abies pindrow*) and spruce (*Picea smithiana*) are found naturally growing in the area. They frequently occur as mixed crop. However, they may occasionally be found to grow as pure stands. The present study aims at providing a reliable information on the extent and principal causes of decay.

**Review of literature.** The decay fungi: *Fomitopsis pinicola* (=*Fomes pinicola*), *Fomitopsis rosea* (=*Fomes roseus*), *Phaeolus schweinitzii* (=*Polyporus schweinitzii*) and *Phellinus pini* (=*Fomes pini*) have been reported (Lughmani, 1961; Khan, 1970; Ahmad, 1972; and Beg and Jamal, 1974) as occurring on temperate conifers of Kagan.

**Material and Method.** 10 localities were selected by using stratified cluster sample design distributed in the Kagan Forest Division (Fig. 1). Two concentric plots were taken per locality, one on northern and one on southern aspect. The study areas ranged in elevation from 1830 to 2990 metres.

Each plot consisted of concentric circles .02, .04 and .08 ha in size.

General information about location, topography, aspect, age and stand history were recorded in respect of each plot. The trees meeting specifications for the plot were tallied

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and numbered. The dbh, crown class and tree conditions were noted. Dead trees were recorded but not included in the study.

The numbered trees were felled at an average height of .3 m from the ground level. The main stem and merchantable branches were cut into 4.9 m logs. Total height was recorded. The nature, extent and location of all surface defects were noted. Each log was further cut into 1.2 m bolts upto .1 m top diameter (inside bark). Defects previously noted were examined and if decay was associated with them, this was recorded on the tally sheet. Where decay appeared, its extent and dimensions were determined by dissecting the bolts longitudinally.

The diameter inside bark at 4.9.m intervals from stump height to .1 m merchantable top was recorded. Top and bottom diameters and lengths of merchantable limbs were noted. Lengths of decay columns were measured in both directions from the maximum diameter and were noted to the nearest .15 m. Cubic metre volume of logs and decay columns were computed by Smalian's formula.

Cultures were prepared from decay samples as soon as possible to determine the fungi responsible for decay. The samples were split, and from the freshly exposed faces of the infected wood six small bits of wood were extracted with a sterilized scalpel and placed in test tubes containing 2% malt extract agar. If the decay organism was not isolated on the first attempt, additional reisolations were made from the decay sample. The isolates, thus obtained, were grown into pure cultures. These were determined by comparing them with the standard cultures maintained in the laboratory.

Altogether, 203 coniferous trees were felled: 76 blue pine, 55 deodar, 52 silver fir and 20 spruce.

**Results.** Out of 20 plots studied, trees in 15 had decay in them (75%). Of the 203 study trees 33 (16.3%) were found attacked by decay-causing fungi. The total volumes of the sample trees and the decay volumes were determined. Relationship of decay losses to infection courts, age of the tree and aspect were studied.

**The decay fungi.** 4 species of fungi: *P. schweinitzii, P. pini, F. rosea* and *F. pinicola* were found in association with decay in the conifers of Kagan. *P. schweinitzii* and *P. pini* were found responsible to cause over 93% of the total decay volume as follows:

| Fungus species | Volume of decay | |
|---|---|---|
| | $m^2$ | % |
| *Phaeolus schweinitzii* (Fr.) Pat. | 6.03 | 60.6 |
| *Phellinus pini* (Thore ex Fr.) Ames | 3.31 | 33.2 |
| *Fomitopsis rosea* (A. & S. ex Fr.) Cke. | 0.24 | 2.4 |
| *Fomitopsis pinicola* (Sw. ex Fr.) Karst. | 0.35 | 3.5 |
| Unknown and undetermined. | 0.03 | 0.3 |
| Total: | 9.96 | 100.0 |

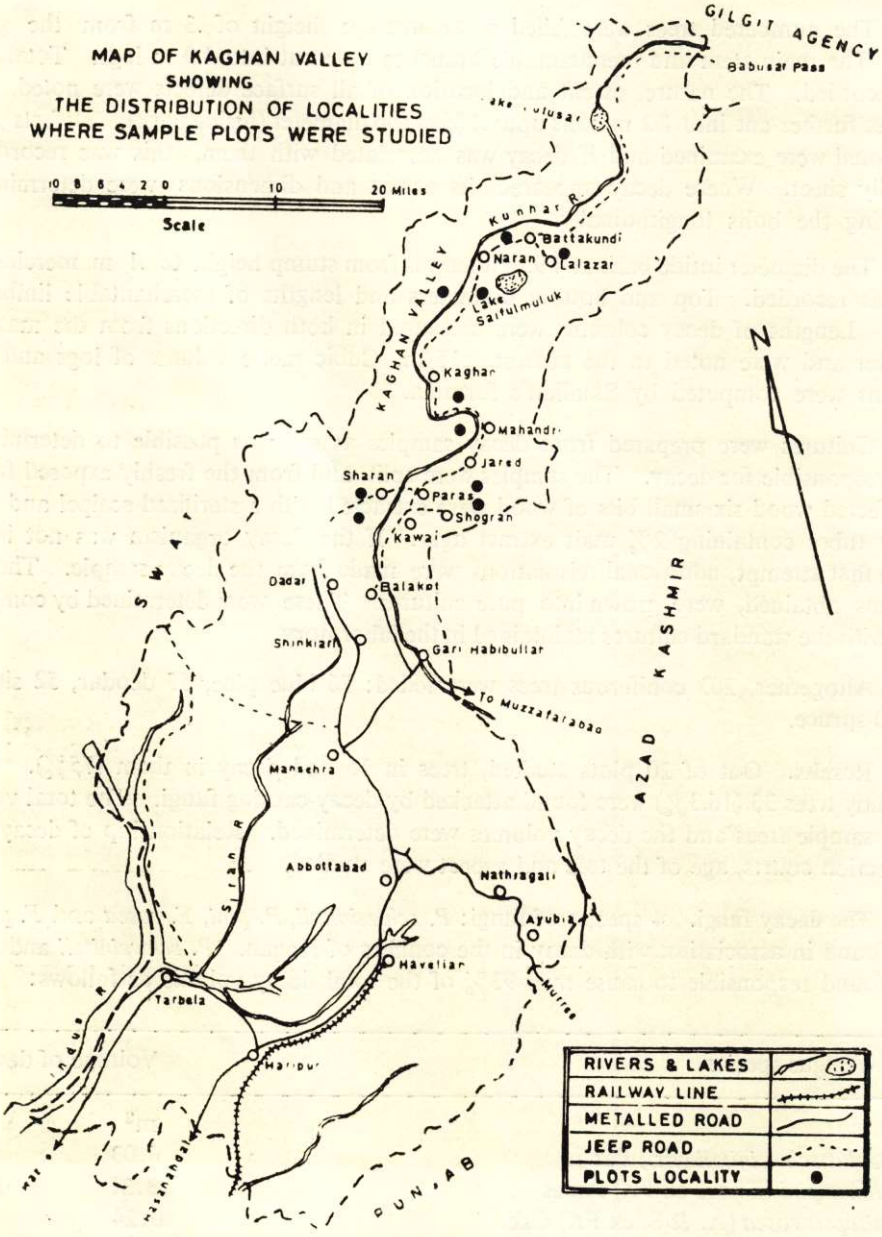
MAP OF KAGHAN VALLEY
SHOWING
THE DISTRIBUTION OF LOCALITIES
WHERE SAMPLE PLOTS WERE STUDIED
10 8 6 4 2 0 10 20 Miles
Scale
GILGIT AGENCY
Babusar Pass
Kunhar R.
Battakundi
Naran
Lalazar
Lake Saifulmuluk
KAGHAN VALLEY
Kaghan
Mahandri
Jared
Sharan
Paras
Shogran
Kawai
Balakot
Dadar
Shinkiari
Gari Habibullah
To Muzzafarabad
AZAD KASHMIR
SWAT
Mansehra
Siran R.
Abbottabad
Nathiagali
Ayubia
Havelian
Tarbela
Indus R.
Haripur
PUNJAB
RIVERS & LAKES
RAILWAY LINE
METALLED ROAD
JEEP ROAD
PLOTS LOCALITY

**Fig. 2**
**Sporophore of *Fomitopsis rosea* on a living silver fir**

Many of the decay columns yielded bacteria and non-decay fungi while other, remained sterile. The close association of bacteria and non-hymenomycetous fungi suggests that all these organisms are important in the decay process (Shigo, 1967).

**Indicators of decay.** The fungi associated with decay rarely produce sporophores on living trees (Fig. 2) making it often impossible to determine the causal fungus from the type of decay alone. Therefore, to identify the decay fungi, it was necessary to grow them into pure cultures.

**Type of rot.** *P. schweinitzii* was found to cause a brown cubical butt and root rot in the heartwood of all the tree species studied. The affected wood, in the early stages, may show a light-yellowish to pale reddish brown discolouration in the shape of spires running ahead of the advanced decay for a few inches to several feet (Boyce, 1961). The colour intensifies and the wood becomes soft and cheesy. In the advanced stage, the wood becomes yellowish-brown to red-brown in colour, brittle, breakes into large cubes on drying and can be easily crumbled into a fine powder (Fig. 3).

*P. pini*, the second important decay pathogen, caused a typical white pocket rot in the blue pine and deodar stems (Fig. 4). *F. rosea* and *F. pinicola* were of little importance as decay pathogens of silver fir associated with yellow-brown top rot and brown rot respectively.

**Tree species and decay.** The incidence of decay was the highest (55%) in spruce followed by silver fir (21.2%) and blue pine (10.5%). It was the lowest (5.5%) in deodar. The comparative resistance of coniferous species to decay is as follows:

| Host species | Number of trees | Number of trees infected | | Gross volume | Gross decay volume | |
|---|---|---|---|---|---|---|
| | | No. | % | $m^3$ | $m^3$ | % |
| Spruce | 20 | 11 | 55.0 | 58.82 | 1.78 | 3.2 |
| Silver fir | 52 | 11 | 21.2 | 184.87 | 3.37 | 1.8 |
| Blue pine | 76 | 8 | 10.5 | 234.54 | 4.13 | 1.7 |
| Deodar | 55 | 3 | 5.5 | 109.68 | 0.68 | 0.6 |
| Total: | 203 | 33 | .. | 587.91 | 9.96 | .. |
| Average: | .. | .. | 16.3 | .. | .. | 1.7 |

**Entry courts and decay.** Fungi that caused decay in the standing trees penetrated the host mostly through mechanical injuries (58.1%) and dead branch stubs (33.8%). The relationship between decay and infection courts is presented below:

| Infection courts | Infection | | Volume of decay | |
|---|---|---|---|---|
| | No. | % | $m^3$ | % |
| Mechanical basal injuries | 60 | 50.0 | 5.78 | 58.1 |
| Dead branch stubs | 22 | 18.4 | 3.37 | 33.8 |
| Damaged tops | 8 | 6.6 | 0.24 | 2.4 |
| Roots | 6 | 5.0 | 0.25 | 2.5 |
| Insects | 6 | 5.0 | 0.03 | 0.3 |
| Unknown | 18 | 15.0 | 0.20 | 2.0 |

**Age and decay.** From the size of the sample taken there does not appear to be a relationship between age of tree species and decay volume as follows:

| Age* class (years) | blue pine | | deodar | | silver fir | | spruce | |
|---|---|---|---|---|---|---|---|---|
| | Trees | Decay volume | Trees | Decay volume | Trees | Decay volume | Trees | Decay Volume |
| | No. | % | No. | % | No. | % | No. | % |
| 41— 60 | 5 | — | 9 | — | — | — | — | — |
| 61— 80 | 16 | 5.5 | 25 | — | — | — | — | — |
| 81—100 | 10 | 1.8 | 9 | 0.1 | 3 | — | 1 | — |
| 101—120 | 16 | — | 3 | — | 8 | 2.8 | 1 | 1.9 |
| 121—140 | 12 | 0.5 | 2 | — | 13 | 1.7 | 8 | 1.0 |
| 141—160 | 6 | — | 4 | 5.5 | 18 | 2.8 | 3 | 0.2 |
| 161—180 | 7 | 7.4 | — | — | 3 | 2.3 | 3 | 0.2 |
| 181—200 | 1 | — | — | — | — | — | 1 | 12.7 |
| 201—220 | 2 | — | — | — | 2 | 1.7 | 1 | 6.7 |
| 220+ | 1 | — | 3 | — | 2 | — | 2 | 7.5 |

*Age was determined by counting the annual rings at .3 m stump height of the felled trees.

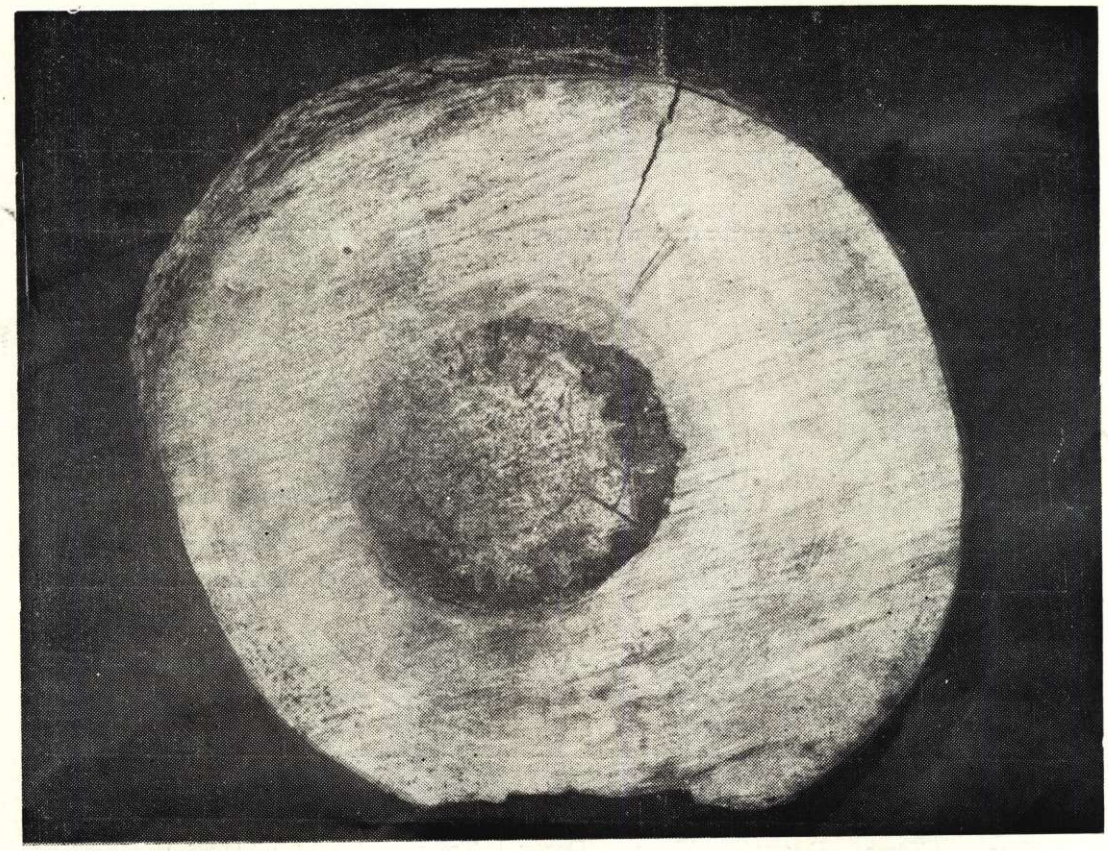

Fig. 3
Heartwood of the butt of a spruce completely destroyed by brown cubical rot caused by *Phaeolus schweintzii*.

Fig. 4

Radial view of a blue pine stem showing the advanced stage of rot caused by *Phellinus pini*

**Aspect and decay.** The decay volume was higher in trees growing on northern aspect than those on the southern as indicated below:

| Tree species | Aspect | | | |
|---|---|---|---|---|
| | Northern | | Southern | |
| | Trees | Decay volume | Trees | Decay volume |
| | No. | % | No. | % |
| Blue pine | 30 | 3.7 | 46 | 1.2 |
| Deodar | 17 | 0.5 | 38 | 0.2 |
| Silver fir | 33 | 1.9 | 38 | 0.2 |
| Spruce | 20 | 3.2 | — | — |

**Discussion and conclusions.** The study indicates 16.3 percent incidence of decay among all the study trees. The extent of decay volume as 1.7 percent of the total volume of the sample trees shows that decay is not serious in the temperate conifers of Kagan. This may be because 60.6 percent of the total volume loss occurred due to the attack of *P. schweinitzii*, causing rot generally confined to heartwood of the roots and butt (Boyce, 1961). Furthermore, the infected trees may become predisposed to wind throw and were therefore not included in the study.

The decay volume was the highest (3.2%) in spruce followed by silver fir (1.8%) and blue pine (1.7%). It was lowest (0.6%) in deodar.

Among the decay fungi, *P. schweinitzii* and *P. pini* caused 93.8 percent of the total volume loss.

The decay volume usually increases with age of the tree (Wagener and Davidson, 1954). The results of the study, however, show that there is no consistent relationship between decay and age of the tree as reported for Engelman spruce (Aho, 1971) and Douglas fir (Boyce and Wagg, 1953). The sample of trees over 180 years age is too small to enable the drawing of valid conclusions.

Mechanical injuries and dead branch stubs were the major entry points for the decay causing fungi.

Northern aspect appeared to favour the incidence of decay. Generally, dry sites are more favourable for the progress of heart rots than wet sites (Boyce and Wagg, 1953; Basham, 1958; Etheridge; 1958), though higher incidence of heart rots on mesic sites is reported in *Picea* spp. (Etheridge, 1956).

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