fungi, some of which were obviously contaminants obtained during culturing. The single culture obtained from a living branch was included with the miscellaneous group of fungi and possibly represents an air contaminant.

The larger number of infections occurring in the heartwood of broken branches than in the corresponding region of intact dead branches suggests that the physical condition of the wood, for instance, moisture content, may be decisive in determining when infection takes place. There is also evidence that the condition and age of the branch determines which species of fungi may enter the succession. In the table it is interesting to note that *Libertella* sp., *Phoma* sp., and *Cytospora chrysosperma* are among the pioneer organisms which colonize intact branches soon after their death. The occurrence of Unknown No. 9 and *C. polygonium* and perhaps some species of bacteria mainly in broken branches might indicate that the presence of exposed heartwood or drier conditions are necessary for the sucessful invasion of the stem by these organisms. *Fomes igniarius* var. *populinus* appears to be relatively late in entering the fungal succession since only branches which had recently healed over yielded this fungus.

A similar association of fungi was found in the two dead trees, except for the absence of *C. polygonium* and *F. igniarius* var. *populinus*. An investigation of the moisture content of the heartwood revealed that the imperfect fungi occurred in wood having a moisture content in the range 21 to 130 per cent of the oven dry weight. But the two wood-destroying fungi were confined to wood having a moisture content ranging from 50 to 120 per cent with 70 per cent of the infections by these two fungi occurring in wood having a moisture content of from 80 to 100 per cent. The dead trees possessed a moisture gradient ranging from 85 per cent at the butt to 16 per cent at the top, whereas the gradient in the living trees ranged from 73 per cent at the butt to 137 per cent at top. The lack of adequate moisture in the dead trees might therefore explain the absence of wood-destroying fungi in these trees.

The two wood-destroying fungi and two of the imperfect fungi occur also on mature aspen in Alberta. The two wood-destroying fungi undoubtedly are among the most important organisms causing decay in older trees; thus, it is significant that their presence has been observed at such an early age. The two imperfect fungi, *C. chrysosperma* and *Libertella* sp. are also associated with decay in mature aspen but their importance in the heartrot problem has yet to be determined. Although the former is well known as a normal inhabitant of the bark of poplar, becoming parasitic and producing cankers if the host is weakened, this appears to be the first record of its presence in the heartwood as a saprophyte. *Libertella* predominated among the isolates obtained from both sound and decayed wood and in this respect its association with decay appears similar to that of *Coryne sarcoides* (Jacq.) Tul. with heartrot in conifers. As reported for *C. sarcoides*, this fungus does not appear to be capable of causing decay under laboratory conditions and therefore its status as a decay pathogen is not altogether certain.—D. E. Etheridge and J. Laut.

## BRITISH COLUMBIA

***Winter Injury and Subsequent Mortality to Douglas Fir.***—Considerable damage and mortality occurred in stands of Douglas fir in the Cariboo region following unusually great temperature differences during the winter months of 1951 and 1952. While there were no reports of widespread damage in 1952, many thousands of acres of Douglas firs between the Fraser River and Horsefly Lake were reported in 1953 to be in various stages of decline. Parts of the affected area were examined in 1955 by forest entomologists who reported Douglas-fir beetle activity of outbreak proportions. Since only a few of the trees examined in 1955 had been infested before 1953, it was concluded that the increased beetle population of 1955 was a reflection of 1952-53 winter injury (J. Walters, Bi-Mon. Prog. Rept. 11(4). 1955).

By 1956 many of the damaged trees had recovered to the extent that they had regained a normal complement of foliage. On the other hand, sufficient trees had died in some localities to warrant observations being made on the nature and rate of deterioration of killed Douglas fir. A study was begun for this purpose in 1956 and is continuing. In the course of this study it was possible to determine the year of death of individual trees and therefore to establish the sequence of mortality following winter injury. The techniques used to ascribe a year of death to individual trees were those described by Ghent (For. Chron. 28(4). 1952). Prior to their use in the present study, however, these techniques were tested in the region concerned for their application to dead Douglas fir.

One hundred dead Douglas firs within the area of suspected winter injury were examined during 1956 and 1957. Although 7 of these trees had died before 1952, none had died in 1950 and 1951. The death of 15 trees following the 1952 growth period, but prior to the 1953 growth period, together with the death of even a larger number of trees in subsequent years, substantiates the fact of severe injury having occurred sometime during the 1952-53 winter. The trend of mortality following this injury is shown in Table I, which also shows the condition of dead trees in regard to Douglas-fir beetle activity. Since 10 of the dead trees showed no signs of beetle attack and 7 others had sustained only light attacks, some trees were apparently killed outright by frost despite the rapidity with which Douglas-fir beetles attack weakened trees. Thus, at least 18 per cent of the trees sampled had probably died directly as the result of winter injury.

TABLE I

Relation of Douglas-Fir Beetles to Mortality Following Winter Injury to Douglas Fir

| Year of death | Number of dead trees | | | |
|---|---|---|---|---|
| | Free from beetles | Beetle infested[1] Light | Beetle infested[1] Heavy | Total |
| 1952 | 4 | 1 | 10 | 15 |
| 1953 | 6 | 6 | 48 | 60 |
| 1954 | — | — | 16 | 16 |
| 1955 | — | — | 1 | 1 |
| 1956 | — | — | 1 | 1 |
| Total | 10 | 7 | 76 | 93 |

[1] Based on the number of galleries per square foot anywhere on the trunks of trees, namely, *Light* = less than 4 and *Heavy* = 4 or more.

TABLE II

The Effect of Crown Position on Winter Injury and Subsequent Mortality to Douglas Fir

| Crown class | Number of trees | Condition class | | |
|---|---|---|---|---|
| | | Un-damaged | Damaged | Dead |
| | | | Per cent | |
| Dominant and codominant | 142 | 30 | 10 | 60 |
| Intermediate | 117 | 41 | 39 | 20 |
| Overtopped | 77 | 60 | 35 | 5 |
| Total | 336 | 40 | 26 | 34 |

Mortality in Douglas fir, whether the result of direct killing by frost or the killing of frost-injured trees by Douglas-fir beetles, occurred in a relatively consistent pattern throughout the damaged area. This pattern is indicated in Table II, which gives the results of a complete tally of Douglas firs made in 1956 on 5 acres of heavily damaged timber near Lac la Hache. While the degree of damage demonstrated by this sample approximates the maximum level of mortality for the region, the relative susceptibilities of trees of different crown classes is considered to be consistent with that sustained in other parts of the region. Thus, dominant and codominant trees appear to be much more susceptible to winter injury and subsequent killing than are intermediate and overtopped trees.—G. P. Thomas and H. M. Craig.

***A Technique for Measuring Flight Muscle Changes in the Douglas-fir Beetle, Dendroctonus pseudotsugae.***—Degeneration of flight muscles has been known to occur in ant and termite queens for many years and has been reported more recently in Diptera, Hemiptera, water beetles, and bark beetles. In recent studies on the flight response and capacity of the Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopk., flight muscle changes have been noted similar to those described by Chapman (Nature 177: 1183. 1956) for the ambrosia beetle, *Trypodendron lineatum* (Oliv.).

The following technique has been used successfully to determine quantitatively the extent of flight muscle changes at various periods of the life of this beetle.

The beetles were killed and fixed in Duboscq-Brasil (Alcoholic Bouin's) modified by the addition of 5 per cent glycerine and 0.4 per cent Fisher "Aerosol". The head, elytra, membranous wings, and tip of the abdomen were removed to allow better fixation, dehydration, and infiltration. To improve infiltration of the tissue with the wax ("Tissuemat") the beetles were subjected to reduced pressures of 15 to 25 lb. during this process.

From the fixative the material was placed in 80 per cent ethyl alcohol and dehydrated with isobutyl alcohol containing 5 per cent glycerine. The first step in infiltration was carried out at 52-54°C. in a vacuum of 15 lb. with 1:1