A Natural Chimera of Douglas-fir

By KIM K. CHING and ALLAN DOERKSEN

In gymnosperms, the number of chromosomes is usually constant for most genera. In the genus Pinus for example, the haploid number (n) of chromosomes is 12, and the somatic number 2n = 24. In the genus Pseudotsuga, however, observations of three species showed differences in the number of chromosomes in the haploid sets. Douglas-fir (Pseudotsuga menziesii [Mirb.] Franco) has 13, but big-cone Douglas-fir (P. macrocarpa Mayr) and Formosan Douglas-fir (P. wilsoniana Hayata) both have 12 chromosomes (CHRISTIANSEN 1963, THOMAS and CHING 1968). Reports of natural aneuploidy are rare in coniferous species. The occurrence of an abnormal slash pine (Pinus elliottii Engelm.) seedling with several aneuploid cells with chromosome counts of 54 was reported by MERGEN (1958) and an aneuploid Norway spruce (Picea abies [L.] Karst.) with 2n = ±28 chromosomes was found by KIILLANDER (1950). The existence of chromosomal aberrations in Douglas fir was also revealed recently by OWENS (1967). This note reports the discovery of one sectional chimera of Douglas-fir, with separate parts of the plant having diploid (2n) and trisomic (2n + 1) tissue.

Materials and Methods

When the 2-0 mixoploid Douglas-fir was first observed in the nursery, it was only 12.3 cm in height, about one-half the height of normal Douglas-fir seedlings. A few normal-appearing needles were attached to the lower portion of the stem, but the rest of the crown had 14 branches bearing short, thick, normal needles. In its fourth growing season, the plant doubled in height and produced 31 branches. Only the three nearest the base had normal needles (Figure 1).

The cytological preparations were made from vegetative buds. The buds were placed in a saturated aqueous solution of monobromo naphthalene (O’MARA 1948) for 4 hours to shorten the chromosomes, and then killed and fixed in FARMER’S solution (100% alcohol-acetic acid, 3:1) for 24 hours. The buds were then hydrolyzed in 1.0 N hydrochloric acid, Feulgen stained, and squashed in a drop of acetocarmine (THOMAS and CHING 1968) and a drop of Hoyer’s mounting medium (BEEKS 1955). Observations and photographs were made with a phase-contrast microscope.

Results

Twenty-seven chromosomes were counted in each of 10 cells from vegetative buds of the trisomic branches. Chromosomes of these cells differ from the normal specimens of Douglas-fir (BARNER and CHRISTIANSEN 1962, THOMAS and CHING 1967) in having five metacentric pairs, seven sub-metacentric pairs, one pair of telocentric chromosomes, and one extra-short metacentric chromosome. In contrast, the normal Douglas-fir has five metacentric pairs, six sub-metacentric pairs, and two pairs of telocentric chromosomes.

Although bud tissues taken from the normal-appearing shoots of the chimeric plant showed cells with 26 chromosomes, the karyotype was also different from the normal Douglas-fir in having one additional pair of submetacentric-
Table 1. — Comparison of the relative unit lengths of chromosomes for normal and aberrant Douglas-fir.

<table>
<thead>
<tr>
<th>Reference</th>
<th>1</th>
<th>2</th>
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<th>4</th>
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<td>Normal Douglas-fir (P. menziesii var. menziesii)</td>
<td>144</td>
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<td>120</td>
<td>99</td>
<td>92</td>
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<td>57</td>
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<td>Chimeric Douglas-fir</td>
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<td>Normal-looking branch</td>
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<td>136</td>
<td>130</td>
<td>126</td>
<td>120</td>
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<td>92</td>
<td>89</td>
<td>84</td>
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<td>75</td>
<td>70</td>
<td>55 extra</td>
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<tr>
<td>Aberrant branch</td>
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<td>135</td>
<td>133</td>
<td>128</td>
<td>127</td>
<td>100</td>
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<td>87</td>
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</table>

Fig. 2. — Chromosomes from tissues of mutant buds (top) and from a normal-appearing branch of the Douglas-fir chimera. The arrow indicates the extra chromosome.

trics and one fewer pair of telocentrics. Table 1 and Figure 2 compare the relative lengths of chromosomes of the haploid set and the diploid idiogram of the chimera with that reported by several investigators for normal and aberrant Douglas-fir chromosomes. Figure 3 contains photomicrographs of chromosomes from bud tissues of the trisomic and the normal-looking branches of the studied plant.

Discussion

Another type of trisomic Douglas-fir was recently reported by Owens (1967). It also has 27 chromosomes (2n + 1), which include 11 long metacentric, 11 submetacentric, 4 short telocentric chromosomes and a single short metacentric chromosome, contrasted to the accepted karyotype of normal Douglas-fir with the 10-12-4 sequence. Owens suggested that a trisomic could be produced either by a misdivision of the centromere in a subtelocentric chromosome or by a reciprocal translocation between two chromosomes with subterminal centromeres, followed by a non-disjunction of the altered chromosomes and fusion with a normal gamete.

In the karyotype of the trisomic tissue of the chimera in our study, besides the extra metacentric chromosome, there were 10 long metacentric, 14 submetacentric, and 2 telocentric chromosomes, which was quite different from that of Owens. Evidently many types of chromosomal aberrations are possible in nature, possibly caused by inversion, nondisjunction, or other phenomena.

This and other chimeras collected in subsequent years by us may possibly be used for development of dwarving rootstock and bonzai culture. Further studies on mitotic behavior and metabolic changes of these aberrant specimens will undoubtedly shed more light on somatic segregation in long-lived organisms.

Literature Cited