# CHROMOSOME COUNTS IN CULTIVATED JUNIPERS

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SAX AND SAX (1933) showed the base chromosome number in the gymnosperms, with the exception of the Gnetales, to be $n(x) = 12$. Variations from the base number were postulated to be the results of gain of a chromosome by duplication ($n = 13$ *Pseudotsuga*), loss of a chromosome and autoploidy ($n = 22$ in *Pseudolarix*), and loss of a chromosome following translocation of segments in the Cupressaceae and Taxodiaceae ($n = 11$ in *Juniperus*, *Taxodium*, and *Taiwania*). Further variations in number are the result of polyploidy, presumably autopolyploidy, but to only a minor extent. Sax and Sax studied either somatic or meiotic chromosomes in 53 species and 16 genera of Coniferales.

Mehra and Khoshoo (1956) briefly reviewed the cytology of the conifers and presented chromosome counts and other observations from somatic and meiotic preparations for 41 species in 14 genera in the Pinaceae, Taxodiaceae, and Cupressaceae. Their conclusions were generally in agreement with Sax and Sax; moreover they were careful to determine number and positions of secondary constrictions and the regularity of meiosis in *Juniperus phoenicea*, *J. bermudiana*, and *J. scopulorum*. They showed counts for *Cunninghamia* and *Cryptomeria* ($n = 11$) for the Taxodiaceae and numbers ($n = 11$) for *Actinostrobus*, *Callitris*, *Widdringtonia*, *Tetraclinis*, *Thuja*, *Cupressus* in the Cupressaceae. They supplied counts for *Juniperus procera*, *J. phoenicea*, and *J. bermudiana* ($n = 11$).

In a recent paper Evans and Rasmussen (1971) illustrated a compilation of documented chromosome counts for *Juniperus* L. In their *Table I* they show nine species (or 10 if *J. virginiana* var. *scopulorum* is considered to be *J. scopulorum*), and they list the count by Jensen and Levan, 1941, for *J. squamata* 'Meyeri' ($2n = 44$) for a total of 11 species or cultivars of species.

We are surveying the cultivated junipers of the Morton Arboretum for chromosome counts. Those currently documented are shown in TABLE 1 where they are arranged by sections. In section OXYCEDRUS we show counts of chromosomes for two species, two varieties, and four cultivars. In section SABINA we present counts for two varieties and ten cultivars.

## MATERIALS AND METHODS

The 20 different plant taxa listed in TABLE 1 are a small portion of the living juniper collections at the Arboretum. We believe that spring wood after adequate hardening is best for use as propagation material from junipers. Therefore, the cuttings were taken in mid-summer and propagated

TABLE 1. **Chromosome Counts in Cultivated Junipers.**

| SPECIES, VARIETIES, AND CULTIVARS | ARBORETUM ACCESSION NUMBER | CHROMOSOME COUNTS OBTAINED | CHROMOSOME COUNTS RECORDED IN THE LITERATURE |
|---|---|---|---|
| Section OXYCEDRUS | | | |
| 1. *Juniperus communis* L. var. *communis* | 990–62 | $2n = 22$ | 1. Sax & Sax (1933) |
| 2. *Juniperus communis* L. var. *depressa* Pursh | 616–44 | $2n = 22$ | 1. Löve & Löve (1933) |
| 3. *Juniperus communis* L. 'Candelabriformis' | 356–62 | $2n = 22$ | |
| 4. *Juniperus communis* L. 'Hibernica' | 14–61 | $2n = 22$ | |
| 5. *Juniperus communis* L. 'Suecica' | 399–51 | $2n = 22$ | |
| 6. *Juniperus communis* L. 'Suecica Nana' | 16–42 | $2n = 22$ | |
| 7. *Juniperus formosana* Hayata | 439–54 | $2n = 22$ | |
| 8. *Juniperus rigida* S. & Z. | 519–53 | $2n = 22$ | 8. Sax & Sax (1933) |
| Section SABINA | | | |
| 9. *Juniperus chinensis* L. var. *chinensis* | 714–56 | $2n = 44$ | |
| 10. *Juniperus chinensis* L. 'Blaauw' | 708–56 | $2n = 22$ | |
| 11. *Juniperus chinensis* L. 'Pfitzeriana' | 25–60 | $2n = 44$ | 11. Sax & Sax (1933) |
| 12. *Juniperus chinensis* L. 'Shimpaku' | 606–60 | $2n = 22$ | |
| 13. *Juniperus horizontalis* Moench 'Alpina' | 945–62 | $2n = 22$ | |
| 14. *Juniperus horizontalis* Moench 'Variegata' | 340–57 | $2n = 22$ | |
| 15. *Juniperus horizontalis* Moench 'Wiltonii' | 311–57 | $2n = 22$ | |
| 16. *Juniperus scopulorum* Sarg. 'Moffetii' | 609–60 | $2n = 22$ | |
| 17. *Juniperus scopulorum* Sarg. 'Silver King' | 612–60 | $2n = 22$ | |
| 18. *Juniperus squamata* Lamb. var. *Fargesii* Rehd. & Wils. | 444–54 | $2n = 44$ | |
| 19. *Juniperus virginiana* L. 'Cupressifolia' | 436–61 | $2n = 22$ | |
| 20. *Juniperus virginiana* L. 'Pseudocupressus' | 619–60 | $2n = 22$ | |

in mist chambers with a medium of well-washed sharp sand. Minimal nutrient leaching occurs for junipers with their heavy cuticles, so that no compensatory treatment was required. Efficacy of rooting is a function of growth form; the horizontal types root rapidly and well while the upright kinds root slowly and poorly.

The successful cuttings were potted and for the study those cuttings that had thick, whitish, shiny root tips were chosen. It was determined through periodic sampling that the mitotic divisions accumulated from 9:00 a.m. to 11:00 a.m. Root tips 3 mm. in length were collected during this time period for pre-treatment and fixation. Several kinds of pre-treatment solutions were employed for mitotic arrest, but a saturated solution of aesculine proved best, provided pre-treatment lasted no more than six hours. After the six hours of pre-treatment, the tips were hydrolysed for five minutes in a mixture of concentrated hydrochloric acid and 95% ethanol (1:3), and the tissue hardened and fixed in modified Carnoy's solution (absolute ethanol: chloroform: glacial acetic acid, 6:3:1 by volume) for 15 to 20 minutes.

The fixed root tips were then squashed on glass slides with 2% acetic-orcein and mounted in a 1% solution of the dye, gently heated, and sealed with paraffin wax. Sufficient numbers of preparations were examined to obtain characteristic and accurate chromosome counts. Photomicrographs were taken for a permanent record, and camera lucida drawings were made for greater clarity. Voucher slides were also made available in permanent mounts.

## Results and Discussion

The three species so far counted in the section Oxycedrus are diploids ($2n = 22$), as are all the counts from the literature involving species of this section. These chromosomes are isobrachial with no apparent distinguishing characteristics between the species from root tip preparations. Similarly a tentative count for *Juniperus conferta* Parl. suggests it is diploid, but not enough material has been seen to establish the count definitely. *Juniperus rigida*, *J. conferta*, and *J. communis* form a close species group on the basis of morphological characters and the chromosome data agree. Likewise morphological data indicate that *J. formosana* forms a second species group in section Oxycedrus along with *J. taxifolia*, *J. macrocarpa*, *J. cedrus*, *J. oxycedrus*, and *J. brevifolia*, but the chromosome data do not appear distinctive for each of these two groups, at least from preliminary studies.

Section Sabina is large in number and diversity of species. Most of the counts in the literature for species of section Sabina indicate that they are diploid ($2n = 22$), e.g., *Juniperus bermudiana*, *J. horizontalis*, *J. horizontalis* 'Plumosa Compacta,' *J. phoenicea*, *J. procera*, *J. sabina*, *J. sabina* 'Von Ehren,' *J. scopulorum*, and *J. virginiana*. Of these diploids all have more or less isobrachial chromosomes except *J. horizontalis* which has one chromosome pair with subterminal centromeres. The authors have

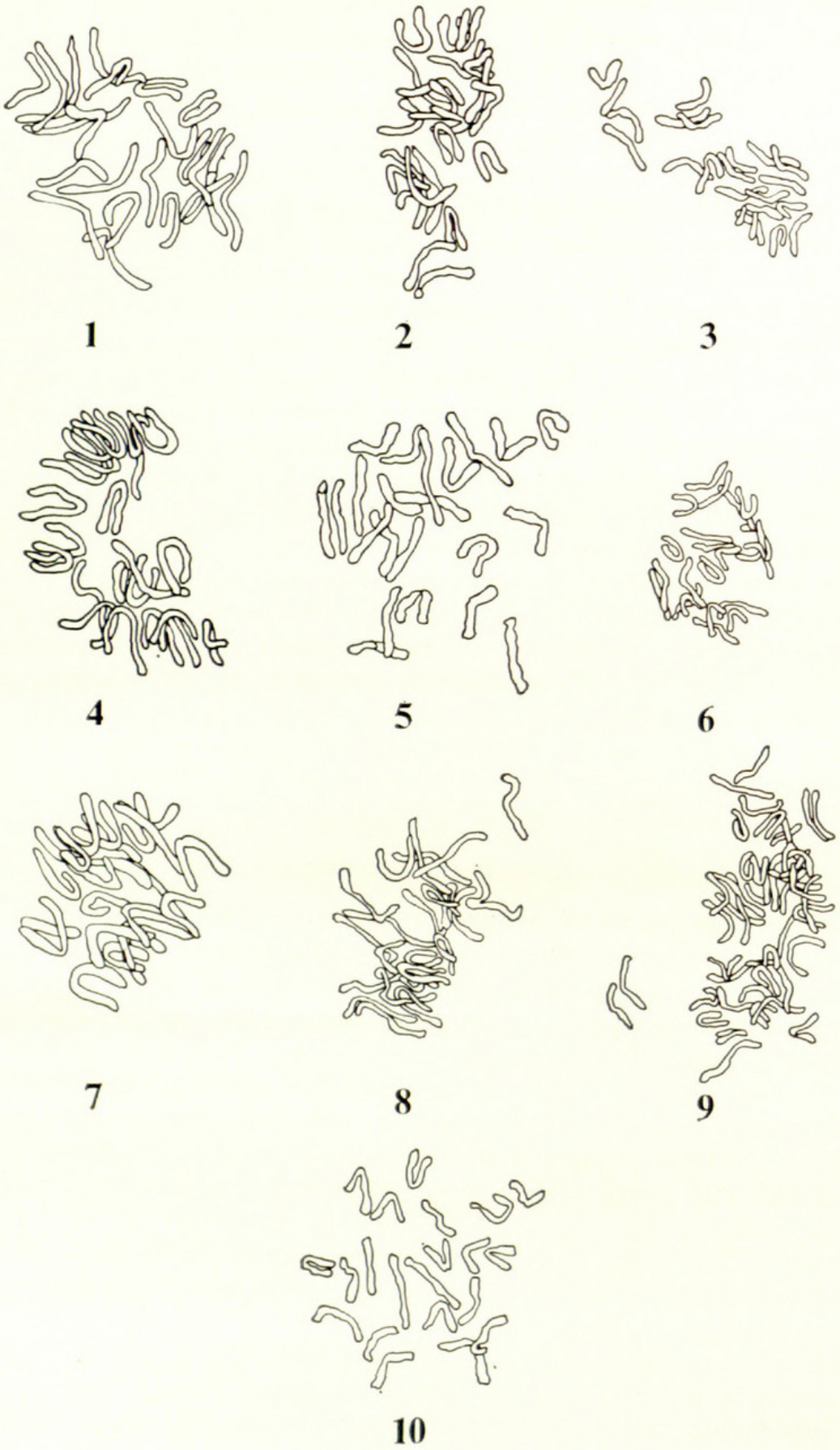


FIGURE 1. Drawings of the chromosome complement of junipers numbered 1 through 10 in TABLE 1. Drawings numbered 3, 6, and 9 are approximately × 750; those numbered 1, 2, 4, 5, 7, 8, and 10, are × 1000.

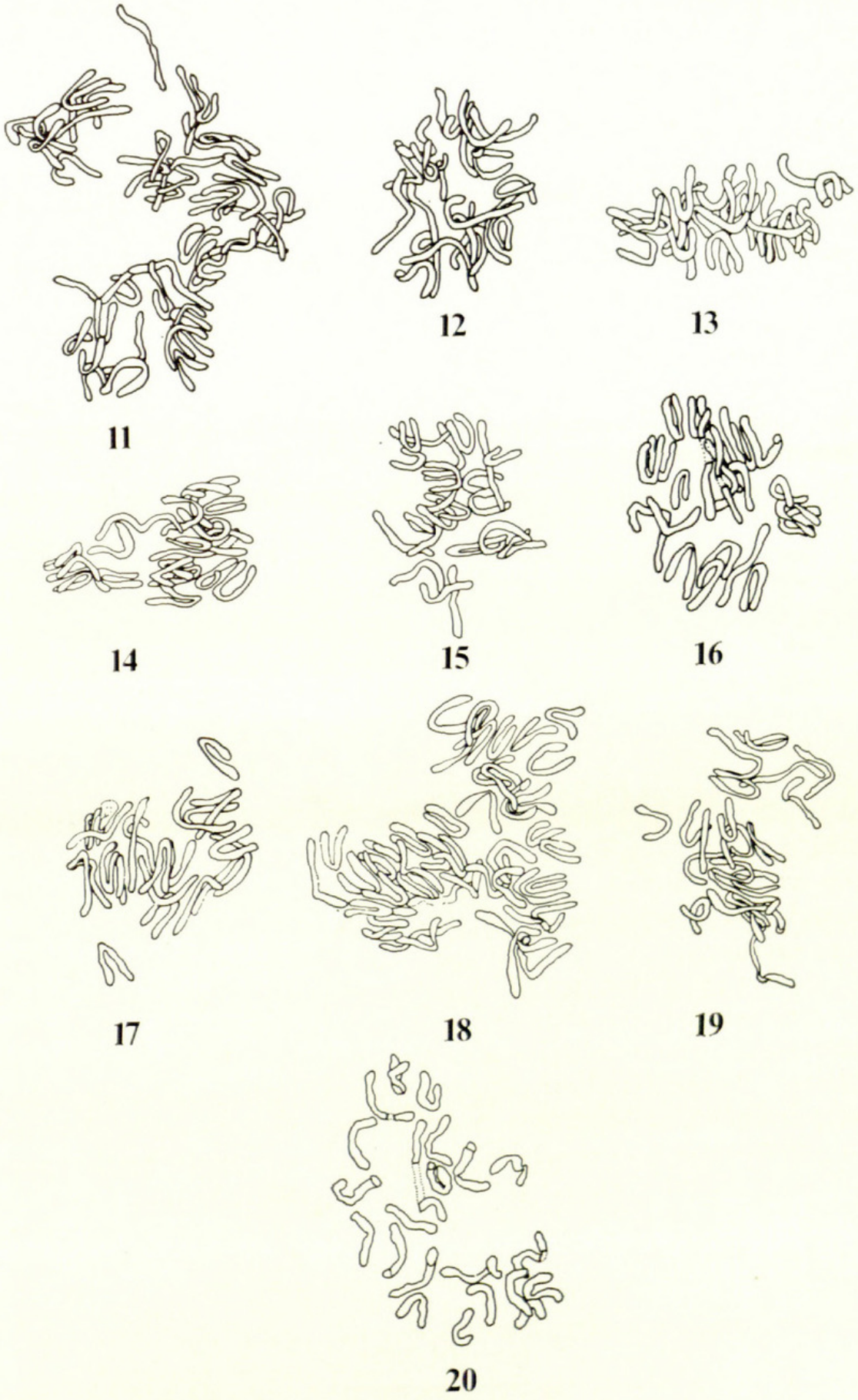


FIGURE 2. Drawings of the chromosome complement of junipers numbered 11 to 20 in TABLE 1. All drawings are approximately × 1000.

preliminary counts for *Juniperus Ashei*, *J. virginiana* (wild type from the Ozarks), and *J. monosperma* all with the diploid number ($2n = 22$). *Juniperus monosperma*, like *J. horizontalis*, shows one pair of chromosomes with subterminal centromeres.

A look at our TABLE 1 indicates that *Juniperus chinensis* 'Blaauw' and 'Shimpaku' (Plumosa group) are diploids. The two cultivars each of *J. scopulorum* and *J. virginiana* are diploids. Three cultivars of *J. horizontalis* are diploids.

From those species of which chromosomes have been examined, polyploidy is the most obvious factor in their differentiation. Triploidy has been reported in *J. virginiana* by Stiff (1951) who found one triploid in an open-pollinated wild population of red cedar growing at Blandy Farm. It resembled the diploids in growth habit and general appearance but had larger stomata. Evans and Rasmussen (1971) have found *J. chinensis* 'Hetzii' to be triploid.

Jensen and Levan (1941) reported *J. squamata* 'Meyeri' to be a tetraploid. We show that *J. squamata* var. *Fargesii* is also tetraploid ($2n = 44$). Sax and Sax (1933) reported *J. chinensis* 'Pfitzeriana' to be tetraploid and our material of cv. Pfitzeriana at the Morton Arboretum is also tetraploid ($2n = 44$). Our data show also that our cultivated material of *J. chinensis* var. *chinensis* is tetraploid ($2n = 44$). It will be interesting to determine if all the cultivated var. *chinensis* is actually tetraploid and if there are, then, diploid wild populations of *J. chinensis* var. *chinensis*. While *J. chinensis* 'Blaauw' and 'Shimpaku' are diploids they differ markedly in morphology from other variants of *J. chinensis*, that is, all those not members of the Plumosa group. Enough data are available to repudiate van Melle's (1946) effort to place the Pfitzeriana group and the Plumosa group in a new species *J. media*. If these two groups belong in a species other than *J. chinensis*, they certainly do not belong together.

It appears to us that careful chromosome studies when combined with other available data may offer no more than minor assistance in indicating relationships between cultivars, varieties, and in some cases, species of *Juniperus*. Nevertheless, counts should be made available in all juniper species, varieties, and cultivars as quickly as possible. With additional data chromosome studies may prove to be more useful. For example, *J. chinensis* 'Hetzii' has been said to be an interspecific hybrid. Since it is triploid, successful efforts in synthesizing the cultivar under controlled conditions, might produce interesting data to confirm or refute earlier reports.

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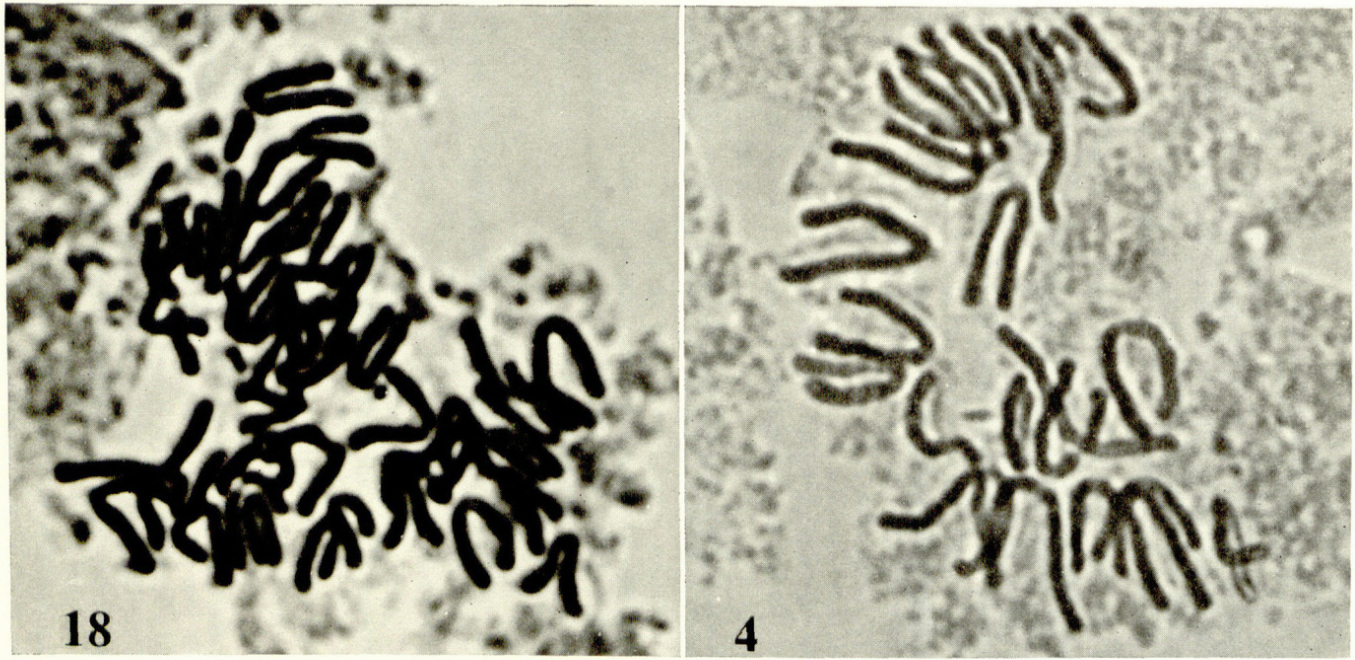


FIGURE 3. Photomicrograph of the chromosome complement of a diploid juniper, no. 4 (as in TABLE 1), *Juniperus communis* 'Hibernica,' and of a tetraploid, *J. squamata* var. *Fargesii*, no. 18 (as in TABLE 1).

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