fertigen. Es wird hierzu ein Überblick über vorläufige Chromosomenzählungen bei *Ps. ntenziesii* gegeben.

Die Vermutung von Frau DURRIEU-VABRE, daß die richtige somatische Chromosomenzahl bei *Ps. menziesii* 24 ist und daß lediglich 2 der 26 jetzt überall verzeichneten Chromosomen Fragmente sind, die durch Bruch von einem Chromosomenpaar mit besonders zerbrechlichem Centromer durch die Präparation entstehen, wird diskutiert.

Résumé

Titre de l'article: *Chromosomes de Pseudotsuga macrocarpa et Pseudotsuga menziesii.*

On a déterminé le nombre chromosomique de *Ps. macrocarpa:* 2 n = 24.

On pense qu'il existe une relation étroite entre *Pseudotsuga* et *Larix,* non seulement pour le mécanisme de la pollinisation et de la fecondation, mais aussi pour la morphologie des garnitures chromosomiques.

Bien qu'il existe une forte presomption pour que *Ps. menziesii* ait pu parfois présenter 24 chromosomes, la preuve n'est pas encore suffisante pour justifier la modification du nombre chromosomique actuel de 2 n = 26. On donne une liste des comptages des chromosomes faits jusqu'ici pour *Ps. menziesii.*

On discute l'hypothèse faite par Madame DURRIEU-VABRE. selon laquelle le nombre exact de chromosomes est 24, et 2 des 26 chromosomes ne sont que des fragments venant de la cassure, au cours de la préparation, d'une paire de chromosomes à centromeres particulierement fragiles.

Literature Cited

(1) BARNER, H., and CHRISTIANSEN, H.: The formation of pollen. the pollination mechanism, and the determination of the most favourable time for controlled pollination in Pseudotsuga *menziesii.* Silvae Genetica **11,** 89–124 (1962). — (2) DARLINGTON, C. D.: Chromosome Botany. London 1956. — (3) DOYLE, J., and O'LEARY, M.: Pollination in Tsuga, Cedrus, Pseudotsuga, and ***Larix.*** Sci. Proc. Roy. Dublin Soc., Vol. **21,** No. 21 **(N.** S.), 1935. — (4) DURRIEU-VABRE (Mme): Chromosome de Pseudotsuga douglasii CARRIÈRE. Comtes-rendus Séances de l'Acad. Sci. **246,** (4) 3660—3663 (1958). — GÖHRE, K.: Die Douglasie und ihr Holz. Berlin, 1958. — (6) LANGLET, O.: Svenska Skogsvårdsfören. Tidskr. **32,** 1–41 (1934). — (7) SAX, K., and SAX, H. J.: Chromosome number and morphology in the conifers. J. Arnold Arboretum **14,** 356–375 (1933). -- (8) SEITZ, F. W.: Chromosomenzahlenverhältnisse bei Holzpflanzen. Zeitschr. Forstgenetik **1,** 22–32 (1951). — (9) ZENKE, U.: Untersuchungen über den Ablauf der Meiosis bei Pseudotsuga *taxifolia* BRITTON. Zeitschr. Forstgenetik **2,** 96–102 (1953).

Microsporogenesis in Pinus echinata and Pinus taeda

By **F.** MERGEN, G. R. STAIRS, and E. B. SNYDER[1])

(Received for publication June 11, 1963)

This paper presents photomicrographs of major stages in pine microsporogenesis that are generally illustrated in forest botanical literature only by drawings. It also includes original data on the phenology of these stages in *Pinus echinniu* MILL. (loblolly pine) and *P. taeda* L. (shortleaf pine).

Strobili were collected on January 25 and 27, February 9 and 16, and March 13, 1962, from trees of both species, growing sympatrically in two natural forests near the Institute of Forest Genetics in southern Mississippi. Specimens were fixed in 3:1 propionic acid-alcohol and smeared in acetocarmine. With the exception of *Figure* 1 D, showing diakinesis in F. *taeda,* photographs of *P. echinata* illustraie the various stages.

Microsporangiate strobili of P. *echinata,* collected in late January, contained archesporial cells in the microsporangium *(Figure* 1 *A).* These cells had angular outlines and large nuclei. On February 9, meiosis had started. A variety of stages were present and, depending on the maturity of the bud, some of the cells were still in the microspore mother cell (MMC) stage while others had progressed to anaphase I. The MMC appeared rounded, as is illustrated by the meiotic prophase at zygonema *(Figure* 1 B).

By pachynema (1 *C),* chromosome pairing was complete, and the chromosomes appeared as dark-stained, bead-like structures. During diakinesis (1 D) staining was dark and chiasmata wcre visible. Contraction of the chromosomes during early and late metaphase (1 E, 1 *F)* and alignment at the metaphase plate were well defined. A late anaphase, a telophase, and a dyad are illustrated in 1 G, 1 ***H,*** and ***1*** I. The synchronous condition of metaphase II is shown in 1 J, anaphase II in 1 K, and telophase 31 in 1 L.

After the latter stage, interphase nuclei are formed in the microspores and the four young pollen grains comprising the tetrad begin to separate *(2 A).* In some of the microspores, rudimentary air sacs were already visible under phase illumination while they were still within the wall of the original MMC (photograph not shown). *Figures 2* B *and 2 C* are illustrations during expansion of the air sacs after the pollen grains were freed from the MMC wall. First vegetative divisions of the pollen grains were

Table 1. — Comparative phenology of developmental stages in pine microsporogenesis in southcrn Mississippi in 1962.

Date	Pinus *echinata*	Pinus taeda
January 25	Archesporial cells	Microspore mother cells, meiotic prophase, metaphase I, anaphase I, telophase I
February 9	Microspore mother cells, and in advanced buds up to telophase I	
March 6		Mature pollen (dehiscence)
March 13	Anaphase II, tetrad, free microspores, first vegetative division of microspores, and mature microspores in advance buds	
April 2	Mature pollen (dehiscence)	

[1]) MERGEN and STAIRS are on the staff of the Yale University School of Forestry, New Haven. Connecticut. SNYDER is a member of the Institute of Forest Genetics, which is maintained at Gulfport, Mississippi, by the Southern Forest Experiment Station, Forest Service, U. S. Department of Agriculture. The research was carried out cooperatively.

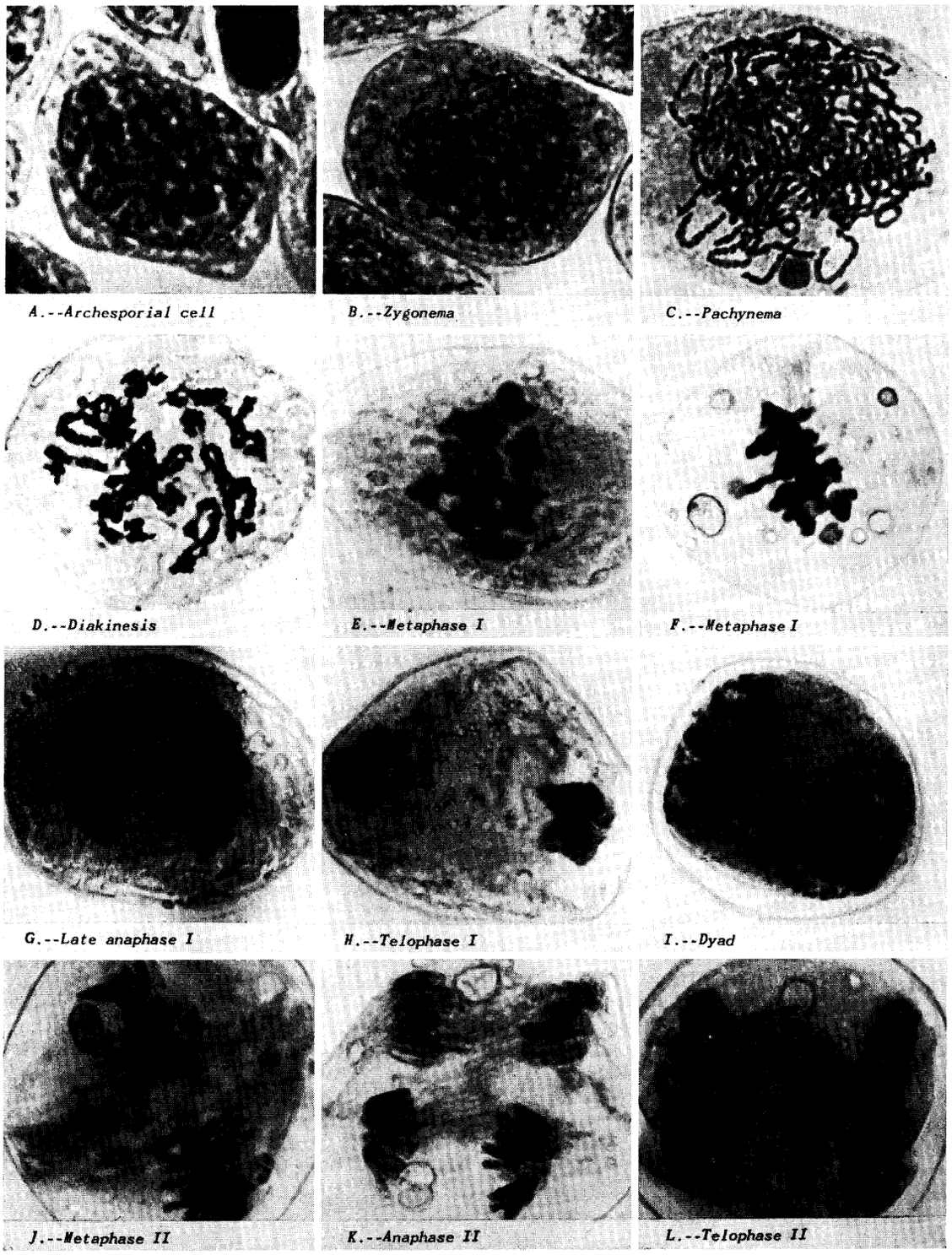

Figure 1. — Cytology of microsporogenesis.

observed in collections of March 13 *(2 C, 2 D, and 2 E)*. This was followed by the second vegetative division, which resulted in two vegetative nuclei flattened against the dorsal intine *(2 F)*. Mature pollen started to dehisce on April 2.

Table 1 compares the phenology of microsporogenesis in *P. echinata* and *P. taeda* during 1962 in terms of dates averaged within and among 10 or more trees. It should be realized that genetic differences cause a considerable range of variation among trees, and that microclimatic differences cause variations among trees, among strobili on one tree, and even within strobili. In addition, extreme precocity for individual strobili may be stimulated by insect attacks, and pollen shedding is influenced strongly by weather. Normal shedding over a 9-year period at the Institute's Harrison Experimental Forest, Saucier, Mississippi, ranged from February 11—21 (1957) to March 19-April 10 (1958) for *P. taeda*. For *P. echinata* the range was from March 19-April 5 (1957) to April 13—20 (1958).

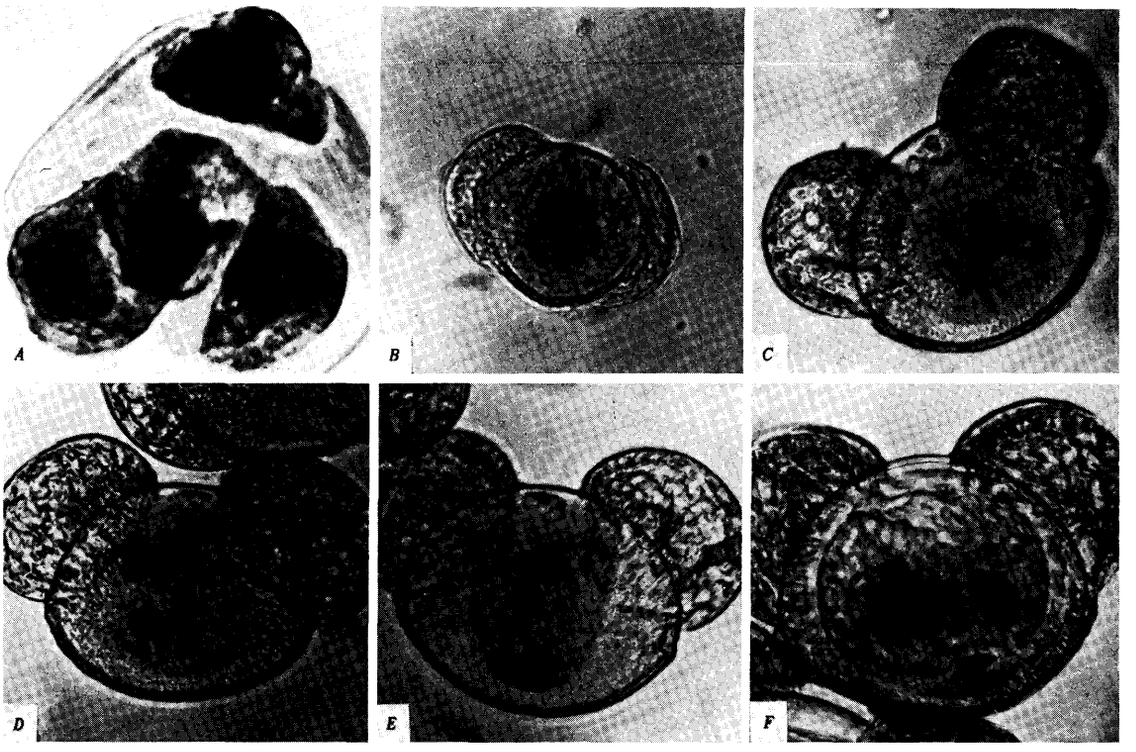

Figure 2. — Cytology of microsporogenesis: — *(A)* Quartet of pollen grains contained within the walls of MMC; — *(B)* Microspore after release from MMC; — *(C), (D), (E)* Metaphase, anaphase, and telophase of first vegetative division; — *(F)* Mature pollen grain following second vegetative division.

Dwarf Seedlings from Broomed Douglas-Fir

By J. W. Duffield and J. G. Wheat*)

(Received for publication June 4, 1963)

Introduction

Brooming of Douglas-fir *(Pseudotsuga taxifolia* [Poir.] Britt.), in the absence of attack by insects or plant pathogens, is occasionally found in the forests of the Pacific northwest (Buckland and Kuijt, 1957). The brooming may affect whole trees or, more commonly may involve only a single branch. The brooming occurs as a result of shortened annual shoots and multiplication of buds, usually accompanied by shortening of needles and sometimes by chlorosis and gradual decline and ultimate death of the affected portion.

There is a rather large literature on brooming of forest trees, particularly conifers of the family *Pinaceae*. The paper by Buckland and Kuijt (1957) refers to some of the more important contributions. The present study is concerned with the reproductive biology of Douglas-fir brooms, some progenies from open pollination of brooms, and possible implications for tree improvement technology, horticulture, and Christmas tree culture.

Description of brooms

The paper by Buckland and Kuijt (1957) shows photographs of the general habit of upper-crown brooms in Douglas-fir.

Figure 1 shows the top of a completely broomed tree (IFA 86) among normal (younger) trees, at Matlock. This tree was cut in Mason County, Washington, the winter of 1960-61, by a logger who evidently had a market for one short knotty log. The stump showed approximately 180 rings and was 51 cm. in diameter, a size normally attained at about this age on site IV. The height of the tree, approximately 20 meters, was considerably below the 27 meters expected on Site V. Cones had been collected from the tree in 1959, and at this time it was noted that few internodes were as long as 30 cm.

Figure 2 shows a small, completely broomed tree, found on the west slope of the Cascades near Springfield, Oregon by Mr. Fred Sandoz and eventually transplanted to the experimental area of the Forest Research Laboratory of Oregon State University at Corvallis. This tree is notable not only for its compact pyramidal habit, but for its short, blunt needles and blunt buds, both of which resemble those of some *Abies* species.

Figure 3 shows a large tree, about 1.5 meters d. b. h. growing in the Pack Demonstration Forest of the University of Washington at LaGrande. This tree (IFA 29) has a single large branch, about 61 cm. in diameter, which is noticeably different from the other branches in that it is markedly sinuous, ascends rather sharply, and is covered with typically broomed foliage. *Figure 4* shows a 5-year-old graft from this broom.

*) Respectively, Technical Director and Research Forester, Col. W. B. Greeley Forest Nursery, Industrial Forestry Association, Nisqually, Washington. — Duffield is at present Professor of Silviculture, School of Forestry, North Carolina State College, Raleigh.