treatment on November 16 and 24. Owing to the failure of the electric cable shortly before the second pulling of slips, the experiment was terminated on December 14, the roots were dug and washed, and the number of sprouts over 1 in. long was recorded in Table 1.

There was a highly significant reduction in total number of sprouts produced per root between the roots that were treated with 8000 or 16,000 ppm and those that were treated with the four lower concentrations of maleic hydrazide (Table 1). There were no significant differences among the four lowest or between the two highest concentrations. The striking increase in sprout production on November 16 at the 4000-ppm concentrations (Table 1) was partly due to the retarded proximal dominance of some of the roots (*6*).

The growth of sprouts on most of our present sweetpotato varieties and breeding lines is confined largely to the proximal end of the root. This proximal dominance of roots, like apical dominance in stems, can be broken by either chemical or mechanical means (*6*).

Thimann (*7*) has demonstrated that apical dominance in plants is controlled primarily by auxin and that stems, buds, and roots all react in a comparable way to auxin, their growth being inhibited by relatively high, and promoted by relatively low, auxin concentration. Leopold and Klein (*8*) have shown maleic hydrazide to be an anti-auxin, and many investigators have observed the loss of apical dominance and increases in lateral bud breaks in stems following treatment with this chemical.

Since the sweetpotato slip or sprout arises from adventitious buds on a structure that is morphologically a root (*9*), one should need relatively high concentrations of maleic hydrazide to retard proximal dominance on this root and still higher concentrations to completely inhibit bud development (*7, 8*). Simons and Scott (*5*) have reported a significant increase in the total number of sprouts produced by bedded Porto Rico sweetpotato roots that had been sprayed 6, 4, and 2 wk before harvest with maleic hydrazide at 500 and 2500 ppm. These same investigators also reported a distortion of the stem and leaves of the sprouts similar in appearance to the effects produced by 2,4-D in plants.

A similar reaction of sweetpotatoes to maleic hydrazide occurred in the present study. Relatively low concentrations of maleic hydrazide (1000 to 4000 ppm) induced a distortion of the stem and leaves similar to the one described in the preceding paragraph and, in some instances, reduced proximal dominance over the entire sweetpotato root. The foregoing two phenomena did not always occur together, nor did either one or both occur on all of the treated roots. Relatively high concentrations of maleic hydrazide (8000 to 16,000 ppm), on the other hand, increased the severity of this 2,4-D-like injury and gave a highly significant reduction in the total number of sprouts produced per root (Table 1).

Sprout inhibitions and reduced proximal dominance similar to that described in the preceding paragraph have been obtained with preharvest foliage sprays of maleic hydrazide on a fall crop of sweetpotatoes in 1953. Further studies are currently being conducted on slip production and the storage behavior of these treated roots.

References

1. E. J. Kennedy and Ora Smith, *Proc. Am. Soc. Hort. Sci.* **61**, 395 (1953).
2. E. R. Marshall and Ora Smith. *Botan. Gaz.* **112**, 329 (1951).
3. D. R. Paterson, *et al., Plant Physiol.* **27**, 135 (1952).
4. S. H. Wittwer, *et al., Plant Physiol.* **25**, 539 (1950).
5. H. M. Simons and L. E. Scott, *Proc. Am. Soc. Hort. Sci.* **59**, 426 (1952).
6. R. Michael and P. G. Smith, *Proc. Am. Soc. Hort. Sci.* **59**, 414 (1952).
7. K. V. Thimann, *Am. J. Botany* **24**, 407 (1937).
8. A. C. Leopold and W. H. Klein, *Physiol. Plantarum* **5**, 19 (1952).
9. H. E. Hayward, *The Structure of Economic Plants.* (Macmillan, New York, 1948), pp. 485–513.

Received February 1, 1954.

A New Technique for the Study of Avian Chromosomes[1]

Gunnar C. Sandnes

Department of Biology,
Alfred University, Alfred, New York

The study of avian chromosomes presents considerable difficulty because of the large number of small units lying in close proximity to one another. In the case of avian hybrids (*1–3*), there is an additional impediment; the use of embryos or testes for cytological material reduces even further the small yield of specimens obtained from individual matings. Furthermore, in some instances it might be desirable to be able to study the chromosomes of individual adult hybrids or other phenotypically interesting birds without the necessity of sacrificing them. The new techniques circumvent this difficulty by making available for study the chromosomes of growing feathers.

Pin-feather technique. It is well known that the most actively proliferating region of a growing feather is in the proximal epithelium at the base of the feather shaft, the so-called collar. Serial sections of a pin feather or of a growing feather whose tip has already emerged from the sheath also reveal some mitotic configurations in the proximal part of the feather pulp. The latter are fewer in number but larger in size than those in the collar.

By slitting the feather sheath, it is a simple matter to remove collar or pulp tissue under a dissecting microscope. Aceto-orcein squash preparations can then be made in the usual manner. The tissue may be prefixed with Carnoy's fixative (glacial acetic acid and absolute alcohol in a ratio of 1 : 3). Only small pieces should be used, and it is best to avoid any of the tough feather sheath.

[1] A considerable part of this work was done while I was a graduate student in the Department of Anatomy at Stanford University. I acknowledge my indebtedness to members of that department and, particularly, to Professor C. H. Danforth for his friendly and helpful counsel.

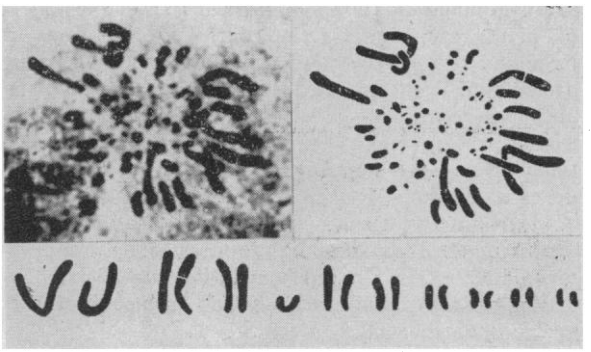

FIG. 1. Chromosomes of a cell in metaphase from a pin feather of a golden pheasant hen. Top left, photomicrograph. Top right, camera lucida drawing of the same cell. Bottom, serial alignment of major elements.

Preculturing technique. It has been found that a brief culturing of growing feather tissue in a hypotonic balanced salt solution results in a marked separation of the chromosomes. This procedure seems to result in an increase in the number of dividing cells, particularly of cells in late prophase. This increase is probably caused by an inhibition or slowing down of cells in metaphase and anaphase, as shown by the work of Hsu and Pomerat (*4*), who studied the chromosomes of mammalian material in hypotonic media (*4, 5*). The addition of paradichlorobenzene to the salt solution appears to enhance the spreading effect, as previously noted for guayule and numerous other plants by Meyer (*6*).

In actual practice, the procedure has been as follows. Holtfreter's solution is saturated with *p*-dichlorobenzene and filtered, then diluted to half strength with distilled water and heated to 41°C. Air or oxygen bubbles are passed through the medium while culturing. The latter process has been found to improve the resulting preparation, probably by supplying sufficient oxygen and by increasing the diffusion of toxic waste products through the stirring action of the rising bubbles. The temperature can be held constant by the use of a water bath.

Tissue is prepared for culturing in the following manner. The sheath of a freshly plucked pin feather is slit lengthwise for a distance of ½ to 1 cm. With a clean scalpel, the proximal millimeter or two of the feather base is gently scraped off the feather sheath and placed in the culture medium.

After culturing for 10 to 20 min, the material is transferred to a deep depression slide containing aceto-orcein, and is stained from 1 to 2 hr. Small pieces of this stained specimen can then be removed and prepared for examination.

In addition to the increased spreading of the chromosomes and the increase in the number of mitotic configurations, the chromosomes appear to be shorter and thicker. Stainability is probably somewhat reduced but not seriously so. The majority of dividing cells appear to be in late prophase. Although the prophase chromosomes are typically rod-shaped, the primary constrictions of the larger ones are clearly evident. A number of excellent metaphase configurations also can be found. These are generally better for study than cells in prophase, because in the latter the chromosomes are spread apart to such an extent that those of adjacent cells often overlap.

The chromosomes of a cell in metaphase from a pin feather of a golden pheasant hen are shown in Fig. 1. The tissue had been cultured for 10 min and was examined as a fresh aceto-orcein squash preparation. A Leitz apochromatic oil-immersion objective (60× N. A. 1.4) was used. The photograph suggests the presence of a helix in some of the chromosomes, due probably to the fixation.

The technique is definitely usable and will, undoubtedly, be improved by further experimentation. It is to be hoped that these methods will facilitate an elucidation of the cytogenetic affinities of recent avian species.

References

1. C. H. Danforth and Gunnar Sandnes. *J. Heredity* **30**, 537 (1939).
2. C. H. Danforth. *Evolution* **4**, 301 (1950).
3. Gunnar C. Sandnes. Ph.D. Dissertation, Stanford Univ., 1952.
4. T. C. Hsu and C. M. Pomerat. *J. Heredity* **44**, 23 (1953).
5. T. C. Hsu and C. M. Pomerat. *J. Morphol.* **93**, 301 (1953).
6. J. R. Meyer. *Stain Technol.* **20**, 121 (1945).

Received February 5, 1954.

The Appearance of Starch Grains of Potato Tubers of Plants Grown Under Constant Light and Temperature Conditions

Edith A. Roberts and Bernard E. Proctor

Department of Food Technology, Massachusetts Institute of Technology, Cambridge

The external markings of the starch grain have been described as "striations" (*1*), "lamellae" (*2*), "striations" (*3*), "laminations or rings" (*4*), "lamellae or layered" (*5*), "striations or lamellations" (*6*), "layerings" (*7*), and "layers and laminations" (*8*).

Van de Sande-Bakhuyzen (*4*) was the first to ascribe these markings to the effect of external conditions. He noted that when the external conditions, illumination and temperature, are constant, "lamination" of wheat starch grains did not occur. Statements found by the writers which claim that these markings are absent in starch grains of plants growing under constant conditions of light and temperature refer only to the work of Van de Sande-Bakhuyzen (*4*).

For this study, Dr. John M. Arthur, of Boyce Thompson Institute of Plant Research, kindly offered to grow plants of the Katahdin variety of potato in a Constant Condition Light Room. These plants were under an AH-9 G.E. 3000-w lamp, which burned continuously from November 12, 1952 to June 3, 1953. The light intensity at soil level (about 42 in. from the lamp) was 450 ft-candles, as measured by a General Electric light meter. At a distance of 24 in. from the lamp tube, the meter reading was 650 ft-candles of 0.15 gram-cal/cm² min, as measured by a General