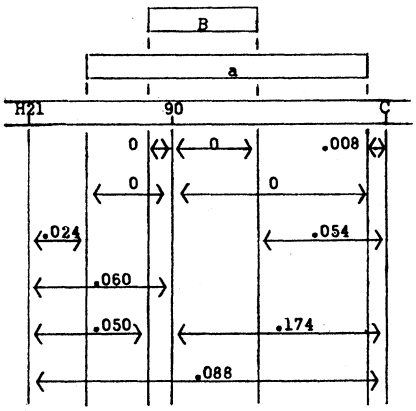

Fig. 1. Preliminary map of the *Wx/wx* locus constructed from the data in Table 1. The value for any cross is corrected for the frequency of *Wx* microspores appearing in the parental stocks and doubled for the purpose of map construction.

incidence of *Wx* pollen grains, a large number of single anther preparations have been scored. In each instance, the distribution of numbers of *Wx* pollen grains per anther showed good agreement with a Poisson distribution. There was no indication of bursts of *Wx* pollen grains in a particular anther, or glume, or tassel sector, such as might result from somatic crossing-over or premeiotic mutation.

Where more than one cross between two mutants was made, the progeny from each cross was sampled. In each cross, there was good agreement between the different progenies. In some cases, reciprocal crosses were available. The data again showed good agreement.

A small population (nine plants) from the backcross progeny $(90 \times C) \times C$ has been sampled in 1959 in the greenhouse. Five of the plants had frequencies of *Wx* pollen grains which were no higher than the parental stocks. Four plants had high frequencies of *Wx* pollen grains, with a mean of 63×10^{-5}. Under greenhouse conditions, the F_1 plants $(90 \times C)$ had 75×10^{-5} *Wx* pollen grains. Such a segregation into approximately equal numbers of plants with high and low frequencies of *Wx* pollen grains would be expected if heterozygosity at the *Wx/wx* region were a prerequisite for the appearance of high frequencies of *Wx* pollen grains.

Table 1. Estimates of incidences of *Wx* microspores in the mutant strains and in the crosses between them. The means shown in column 3 have been calculated from preparations each containing about 50×10^3 pollen grains.

Strain	Estimated No. of microspores sampled (in thousands)	$\bar{x}$ No. *Wx* $\times 10^{-5} \pm s\bar{x}$
a	522	1.4 ± 0.4
B	472	3.8 ± 1.2
C	444	0.7 ± 0.4
H21	559	2.7 ± 0.8
90	353	0.3 ± 0.4
H21 × *B*	987	28.1 ± 2.2
H21 × *90*	1168	31.8 ± 2.7
C × *H21*	1218	46.0 ± 2.7
90 × *B*	717	1.4 ± 0.6
90 × *C*	596	88.0 ± 5.7
C × *B*	1077	29.5 ± 2.9
Rec. C × *C* (*6*)	252	1.3 ± 0.9
C × *a*	575	5.5 ± 0.9
a × *H21*	533	13.6 ± 1.9
a × *90*	646	0.9 ± 0.5

Considering the above data, one is forced to conclude that each mutant tested differs from every other mutant and that there is a characteristic, reproducible frequency of *Wx* pollen grains for the cross between any two *wx* mutants. Heterosis, per se, cannot account for the *Wx* microspores, as witness the frequencies in $90 \times B$ and *Rec.* $C \times C$ (*6*). A logical corollary of these conclusions is that the *Wx* pollen grains arising in the crosses are the result of recombination within the *waxy* region. If so, it should be possible to establish a linear order for the mutants within the region. This can be done, since only one arrangement will satisfy the data. This arrangement is given in Fig. 1. It is necessary to assume that two mutants, *B* and *a*, occupy considerable portions of the region. Note further that the additivity of distances is not good. This may be a consequence of the occurrence of these five mutants in quite different genetic backgrounds. To investigate genetic fine structure it would seem essential that the mutants be induced in the same strain. This is now being attempted.

The size which it is necessary to assume for mutants *B* and *a* may also be a consequence of the heterogeneous backgrounds for the mutants. Alternatively, it may be real. One possibility for *B* is a deficiency of the genetic material for the area which the mutant is indicated as occupying. For *a* this is less probable, since *a* is a functionally intermediate allele allowing the synthesis of 10 to 20 percent of the amount of amylose found in *Wx* starch. If the genesis of a mutant were functional region plus "gene-controlling element" within the region, as McClintock (*7*) has shown to be possible, then the mutant would appear as a block in studies of this type, assuming that recombination to reconstitute a functional region would have to take place outside the area of the "gene-controlling element." A *waxy* mutant which is known to have had such an origin is being studied presently.

The *Wx/wx* region also governs the type of starch produced in the triploid cells of the endosperm. If functional complementation occurs, it should be detected in the endosperm of seeds produced by a cross of two mutants. Analyses (*8*) of amylose in the crosses do not reveal large increases over the mutant stocks. Therefore the mutants would appear to be located in a single cistron (*9, 10*).

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References and Notes

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5. This investigation has been supported by the National Science Foundation on grant G-5531.
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8. Analyses of amylose content have been made by the Shuman Laboratories, Brookston, Ind., under a grant from the Corn Industries Research Foundation.
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10. This is journal paper No. 1419 of the Purdue University Agricultural Experiment Station.

27 April 1959

Time-Lapse Motion Picture Technique Applied to the Study of Geological Processes

Abstract. Light-weight, battery-operated timers were built and coupled to 16-mm motion-picture cameras having apertures controlled by photoelectric cells. The cameras were placed adjacent to Emmons Glacier on Mount Rainier. The film obtained confirms the view that exterior time-lapse photography can be applied to the study of slow-acting geologic processes.

The usefulness of time-lapse motion-picture photography for certain purposes is well known. For the most part the technique has been restricted to interior installations with controlled light facilities. Recent developments in photographic equipment have made possible the application of fully automatic time-lapse photography in natural settings.

A 16-mm motion-picture camera that has automatic aperture control coupled to a photoelectric cell appeared on the market in 1957. With the addition of timing and shutter-tripping mechanisms, such a camera can take single-frame exposures at regular preselected intervals over long periods. The possibility that such equipment might be installed in remote areas without requiring continual care suggested that the time-lapse technique might be adapted for use in the study of extremely slow-acting geologic processes. In order to determine the usefulness of this equipment in such

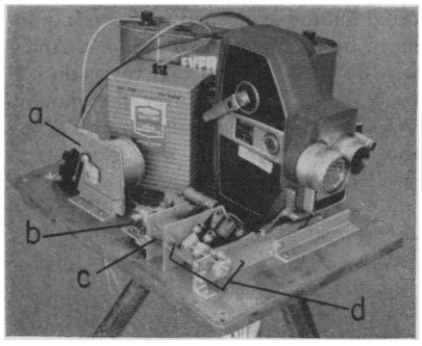

Fig. 1. Camera and timing mechanism showing (*a*) clock and timing cam, (*b*) electric motor, (*c*) gear reduction case, and (*d*) shutter tripping and reset cams.

a study, the U.S. Geological Survey obtained two such cameras and coupled them to battery-operated timing devices designed and constructed by Ernest Parshall of the Geological Survey. Each of these devices is operated by a small electric motor that rotates a cam, which in turn trips the shutter mechanism of the camera (Fig. 1) once every 15 minutes. The timing cam on the clock can be changed easily, and the present range of the interval cam is from 2 minutes to 1 hour. Slight modification of the reset cams could increase the interval to one frame every 24 hours.

We decided to apply the technique to a study of glacier motion. Emmons Glacier in Mount Rainier National Park, Washington, was chosen because of its accessibility and because it is known that some glaciers on Mount Rainier have been advancing since 1946.

The objectives of the initial study were to photograph the forward movement of a glacier terminus and the ablation of the glacier, together with the resulting movement and accumulation of debris on and in the ice.

On 21 June 1958, members of the Geological Survey and personnel of the National Park Service under the supervision of Vernon R. Bender, park naturalist, back-packed the disassembled shelters and cameras to sites adjacent to Emmons Glacier. Mark M. Meier, of the Geological Survey, surveyed the front of the glacier at the time the cameras were installed and erected control stakes for precise measurements of glacier movement. One camera was placed on debris-covered stagnant ice, to one side and about ¼ mile away from the terminus of the glacier. The site was abandoned for reasons of safety on 16 August, because of excessive melting of the stagnant ice during the summer. The other camera was installed on debris-covered stagnant ice about 300 feet in front of the glacier (Fig. 2) and was not removed until 9 October. During the summer the cameras and timers were serviced once every 10 days by Park Service personnel.

Fig. 2. Camera shelters and front of Emmons Glacier.

The results of the first season's operation were disappointing, owing to mechanical breakdowns of the shutter mechanisms of both cameras and to failure of one electric motor. Unseasonably warm weather, moreover, resulted in less forward movement of the glacier than had been anticipated. The film obtained does confirm the view that exterior time-lapse photography can be applied to the study of glacier motion, but the results of the summer's study are incomplete. After modifications had been made in the timing mechanisms and in the construction of light, easily portable shelters, the cameras were reinstalled in new locations near Nisqually Glacier on Mount Rainier in June 1959 (*1*).

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Notes

1. Publication of this report was authorized by the director of the U.S. Geological Survey.

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Mammalian Cytochrome b

Abstract. Digestion of a preparation of cytochromes *b* and c_1 with pancreatic protease followed by ammonium sulfate precipitation resulted in a soluble cytochrome *b* uncontaminated by cytochrome c_1. This preparation, which was free of succinic dehydrogenase and cytochrome oxidase activity, had an estimated $\Delta E_{1\,cm}^{1\,g/ml}$ of 102 for its alpha-peak. In the reduced form absorption maxima were found at 560 to 562, 530 to 532, and 427 to 428 mμ, and in the oxidized form, at 413 mμ.

Since 1948, when Wainio and his coworkers (*1*) first reported on the use of 4-percent sodium deoxycholate to solubilize cytochrome *b* from mammalian heart muscle, there have been several attempts to purify this material. By lowering the deoxycholate concentration, Eichel *et al.* (*2*) were successful in removing most of the cytochrome oxidase contaminant and characterizing the cytochrome *b* spectrum. The major absorption maxima in the reduced form were demonstrated at 560, 530, and 428 mμ, and in the oxidized form, at 414 mμ. In 1954 Hubscher, Kiese, and Nicolas (*3*) reported on a soluble preparation of cytochrome *b*, showing reduced absorption maxima at 564, 530, and 431 mμ. However, this material contained a contaminating component absorbing at 554, 525, and 418 mμ which these investigators considered a denaturation product of cytochrome *b* but which is now recognized as cytochrome c_1. In addition, considerable succinic dehydrogenase activity was present. Widmer, Clark, Neufeld, and Stotz (*4*) purified cytochrome