Table 1. Platelet levels in normal, oophorectomized, and pregnant women.

	Normal			Oophorectomized	Pregnant
	Control	Ovulation	Menstruation		
Number	537	49	140	95	19
Range	100,000–390,000	230,000–430,000	100,000–380,000	70,000–400,000	120,000–290,000
Mean	217,000	303,000	215,400	186,400	190,200
Standard deviation	± 49,200	± 53,800	± 53,400	± 60,200	± 51,200

tion. Therefore, in 35 cycles (68.6 percent) the platelet peaks coincided with the temperature shift from the low to the high phase. In nine cycles (17.7 percent) the platelet values were highest 24 hours after the temperature shift. In four cycles (7.8 percent) the platelet peaks followed the temperature shift by 48 to 72 hours, and in three cycles (5.9 percent) the platelet peak preceded the temperature shift by 48 to 72 hours. Thus, in 86.3 percent of cycles the platelet peak occurred during the thermal shift or within the following 24 hours.

Two women recorded both monophasic and biphasic temperature graphs. In the biphasic cycles, the platelet peaks coincided with the temperature shift. When the temperature graphs were monophasic, generally assumed to indicate an anovulatory cycle, the platelets also reached a peak during the mid-cycle, a finding suggesting that ovulation may have occurred. In four cycles, *Mittelschmerz* occurred in mid-cycle on the day of the platelet peak. Four oophorectomized and two pregnant women showed no cyclic pattern of platelet counts done daily or bidaily.

The ranges, mean values, and standard deviations of the platelet counts during the ovulatory peaks and during the menstrual dips were determined. The same was done with the remainder of the platelet counts which were considered control values (Table 1). There were no significant differences between the control values and those during menstruation. Although there were no significant differences between the control levels and those of pregnant women ($T = 1.62$, $P = 0.25$), the control levels of normal women were significantly higher at the 5-percent level ($T = 3.65$, $P = 0.05$) than those of oophorectomized women. The ovulation levels were significantly higher at the 1-percent level ($T = 7.96$, $P = 0.015$) than the control levels.

It has been generally accepted that the basal temperature shift from the low to the high phase is indicative of ovulation and that ovulation may immediately precede or follow the temperature shift. Since the platelet peaks occurring in every mid-cycle were sharp and were usually characterized by a sudden rise in a 24-hour period, platelet levels may be of greater value in establishing the time of ovulation than the basal temperature graphs, especially when the temperature shift to the high phase is gradual and prolonged for several days. The close association of the platelet peaks and the temperature shift suggests that the platelet peak may be coincidental with ovulation in the vast majority of menstrual cycles. Platelet levels are currently being determined in a number of sterile patients, and intercourse or artificial insemination are planned to coincide with the platelet peaks in mid-cycle.

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12 April 1956

Multiple Glaciation since the Ice Age

The proposal that there has been a number of distinct glacial periods since the retreat of the Wisconsin glaciation is relatively new (*1*), although moraines corresponding to an age older than our present glaciers, but younger than Wisconsin age, have been recognized for some time (*2*). It is the purpose of this report to acquaint others working in this field of study with the availability of a tremendous amount of unevaluated data on this subject in the Sierra Nevada Range in California.

The existence of moraines a few thousand feet down-valley from some of the ice-cored moraines in the Sierra Nevada, but several miles up-valley from the nearest Wisconsin moraines, was recognized in 1949 (*3*). The significance of these moraines did not become apparent until 1951, when the same pattern of a series of moraines a short distance below the ice-cored moraines was observed at two glaciers on the north side of Dana Plateau, just outside Yosemite National Park. The interesting observation was the similarity between the modern, ice-cored moraines associated with the advances during the last 5 centuries (*4*) and the pattern of the older moraines in the canyon a short distance below. A series of closely spaced morainal loops suggested that the earlier glaciation had followed the same pattern as the present glaciation, with a number of advances of almost equal intensity.

Inspection of a collection of aerial photographs (*5*) of the Sierra Nevada crest from Mount Conness to the Middle Palisade indicates that this pattern of multiple glaciation since the ice age is typical of the Sierra Nevada. This conclusion seems unquestionable after stereoscopic examination of approximately 300 of an estimated total of 500 cirques for the entire range, most of which contain moraines with the characteristic form and appearance that indicates the presence of an ice core. The cirques usually contain active glaciers or small ice accumulations indicative of recently extinct, modern glaciers. Older moraines, distinctly separate from the modern ice-cored moraines, occur in 94 of these cirques. In 28 additional cirques, the older moraines are present, but modern ice-cored moraines are either absent or their existence is doubtful. It is likely that the percentage of cirques containing older moraines is higher than indicated, for many may exist which cannot be identified in the aerial photographs.

The criteria used for estimating that the second group of moraines is older than the group of modern, ice-cored moraines are their form, appearance, and position with respect to ice-cored moraines. The latter are readily identified by their fresh appearance, thickness, evidence of instability and avalanching at their margins, proximity to an active glacier, or similarity in appearance to other moraines that can be identified with little doubt. Only two of the older moraines have actually been inspected in the field by me. Their stratigraphy or the development of soil profiles has not been studied, although there is soil and plant growth on one of the two moraines visited.

Two cirques near Mather Pass in the southwest corner of the Bishop (California) quadrangle have three distinctly different sets of moraines, including modern, ice-cored moraines. Other cirques at Ragged Peak and Mount Wallace have two sets of moraines of apparently different ages, and the youngest of the moraines do not appear to have any ice core. The cirques are partially filled with talus. Crandell and Waldron (*6*) report moraines of three different ages at Emmons Glacier on Mount Rainier, Washington. I have observed moraines of three different ages at Carbon Glacier, Mount Rainier, and moraines of two separate periods of comparable intensity at the Nisqually Glacier.

The tentative interpretation of this evidence suggests that at least two periods of glaciation occurred in this country before the most recent advance and that the age of these glaciations is more than 500 years and probably no older than the Cochrane advance in Canada.

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5. The aerial photographs were taken for the U.S. Geological Survey in 1947, 1948, and 1951. They were made available by a grant-in-aid of research by Sigma Xi, and the assistance of this grant is gratefully acknowledged.
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4 June 1956

Penetration of Slow Electrons through Spore Walls of Bacillus megaterium

Electrons in the energy range of from a few hundred to a few thousand electron volts serve as a probe for studying surface features of biological organisms (*1*). The work described in this report was undertaken to study the coats of spores of *Bacillus megaterium* by slow-electron bombardment (*2*). The apparatus used was that described by Davis (*3*), who studied spores of *Bacillus subtilis.*

Electrons from a hot tungsten filament, which are accelerated by voltage from a variable power supply, strike the dry spores on a stainless-steel disk in an evacuated bombardment chamber. Subsequently, the disk with 12 bombarded samples and four controls is layered with nutrient agar and incubated for 6 hours or more. Colonies formed by the surviving spores are counted under a low-power microscope, and the number of colonies in a bombarded sample compared with the number of those in controls on the same disk is taken as the survival ratio. The rate of electron flow from disk to ground, which is indicated by a galvanometer, is held constant, so that the dose, in electrons per unit area, can be calculated from the time of exposure and the area bombarded.

Table 1. Dose in electrons per square micron for 37-percent survival of *B. megaterium* spores as a function of voltage.

Volts	Dose (10^3 electrons)
800	270,000
1000	30,000
1200	8,000
1400	1,600
1600	800
1800	500
2000	300
2200	150
2600	30
2800	30
3000	14
3200	8
3400	7

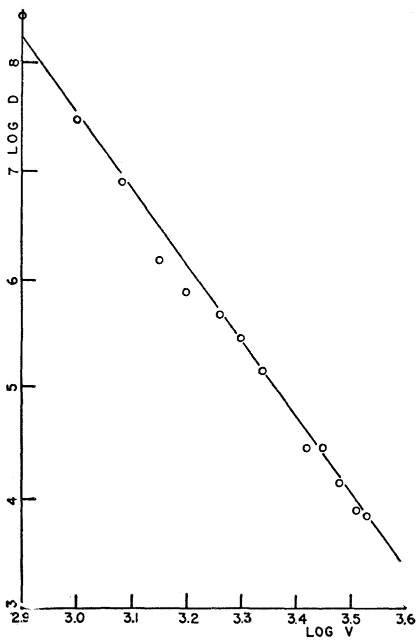

Fig. 1. Log dose in electrons per square micron for 37-percent survival versus log voltage. The line is represented by the equation $DV^{7.26} = 10^{29.38}$.

The percentage of survival was plotted on a logarithmic scale as a function of dose, with voltage as a parameter. The points generally lay on straight lines typical of single-hit killing except that, at the lower voltages and below about 10-percent survival, points were obtained on a second straight line with a smaller slope than the first. The presence of bacterial debris on a small fraction of the spores might be inferred from their survival in spite of a large dose.

Bombardments were made at 200-v intervals from 400 to 3400 v. From the plotted survival curves, the 37-percent survival dose D, in electrons per square micron, was found for each voltage V. Typical data are presented in Table 1.

Inspection shows that, on a plot of log D versus log V (Fig. 1), the experimental points lie rather close to a straight line represented by the equation, $DV^{7.26} = 10^{29.38}$. The interpretation offered is that this function represents the probability of electron penetration through the spore wall with enough residual energy to produce a fatal ionization. At the highest voltage used, about 7000 electrons strike a square micron, which is the order of magnitude of a cross-sectional area of a spore. The portions of the spore that are sensitive to killing by ionization, assumed to be distributed at random inside the spore wall, appear to occupy an area of about 1.4×10^{-4} μ^2 each.

The absorption of 600- to 2000-v electrons has been studied by Davis (*4*) in invertase for comparison with theoretical values for tissue which were calculated by Lea (*5*). In neither case was the probability of penetration expressed as a function of electron energy, but their results indicate that the spore wall in the experiments reported here probably has a thickness of about 0.15 to 0.2 μ. The lower value is in better agreement with electron-microscope pictures of spore sections obtained by Robinow (*6*), which themselves must be interpreted in the light of possible dimensional distortion by the treatment required to prepare the specimens for the electron microscope.

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References and Notes

1. See discussion by F. Hutchinson, *Ann. N.Y. Acad. Sci.* 59, 494 (1955).
2. This work was done at Yale University while I was on sabbatical leave from the University of Connecticut, Storrs. I wish to express thanks for the many courtesies extended.
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15 May 1956

There was nothing wrong with the old inference that if I know all about the present I can forecast the future exactly; the trouble was the impossibility of knowing the present. Once this is seen, the whole argument becomes obvious, but nobody saw it until Heisenberg.—C. G. Darwin (*1938*).