of the cut cells. Macronuclear activity is induced by cutting cells either before or after irradiation; such a reorganization does not occur in uncut irradiated cells, that is, irradiation by itself does not induce macronuclear reorganization. It is therefore conceivable that the block to division in uncut irradiated cells observed as a "stasis" has its locus in the synthetic ribosomes of the cells. When macronuclear reorganization is induced by cutting, new ribosomes may be liberated into the cytoplasm of the cut animals making possible synthesis of new cytoplasmic material. The cut blepharisma, upon regeneration, therefore, grow and later divide with little or no stasis. This hypothesis should be susceptible to test with some of the cytochemical methods now available.

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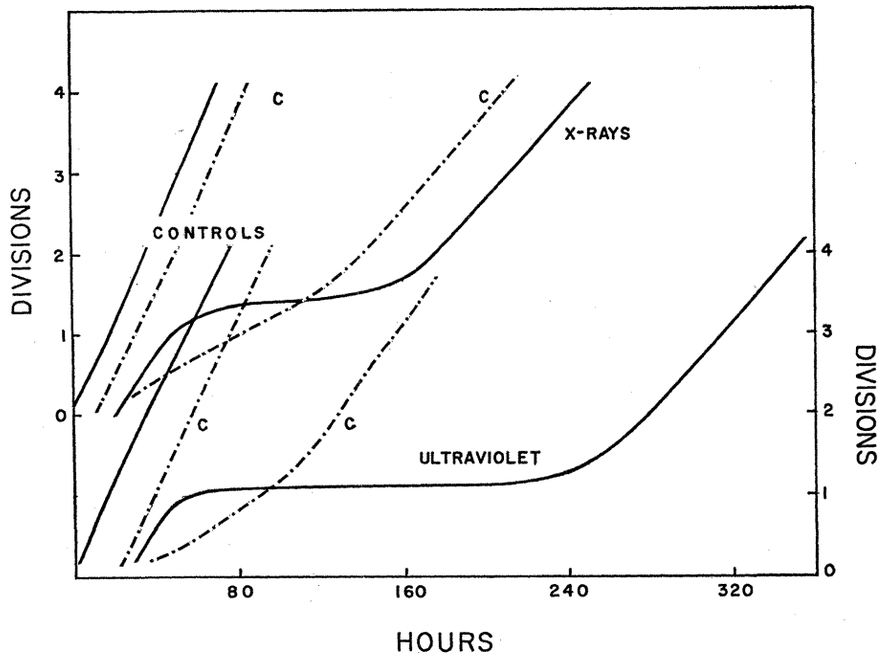

Fig. 1. Illustrative experiments showing the effects of cutting on the recovery of blepharisma from radiation injury (4600 erg/mm² of ultraviolet light at λ 2654 A and 84,600 r of 40-kv x-rays). The smoothed curves were drawn through 7 to 15 points for each experimental series. The example shown of the differential effect of ultraviolet on cut and uncut blepharisma is the most extreme observed. *C* stands for cut, hours refers to hours after treatment and isolation for tests.

Table 1. Stimulation of division of irradiated blepharisma by cutting. Part of the variability in the last four columns results from use of a nonsynchronized population, part from variation in position of the cut.

Dosage		Cut minus uncut (hours)			
		Control		Irradiated	
Ultraviolet (erg/mm²)	X-ray (r)	Div. 1	Div. 3	Div. 1	Div. 3
4025		19.0	17.5	+14.0	+5.5
4025				+14.5	−25.0
4600		26.0	29.0	+33.0	+25.0
4600		18.5	16.5	+14.5	−18.5
4600		10.0	8.5	−35.0	−26.5
4600		24.0	24.0	+46.0	−16.3
4600		18.0	20.5	+28.0	−54.5
4600*		17.0	19.5	+27.0	+1.0†
4600*‡		20.0	22.0	+37.5	−14.0
4025		14.0	18.0	+59.0	−58.0
4025‡				+90.0	+9.0†
3450		19.0	20.0	+20.0	−11.0
3450‡				+80.0	−47.0
4025		17.0	19.0	+16.0	−45.0
4025‡				+49.0	−46.0
4025		13.0	14.0	+6.0	−109.0
4025‡				+49.0	−91.0
4025		13.0	14.0	+1.0	−106.0
4025‡				+55.0	−89.0
	86,400	10.0	10.5	+17.5	−19.0
	86,400	13.0	16.0	+36.0	−34.0
	86,400	16.0	18.0	+44.0	−30.0

* Cut after irradiation; in all other ultraviolet experiments blepharisma were cut ½ to 1 hour before irradiation. † The differences became negative in the fourth division after irradiation. ‡ Refers to flashing ultraviolet. Dark periods of 0.03 to 0.05 second broke the flashes of light; otherwise continuous ultraviolet was used.

References and Notes

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13 June 1960

Verification of Earth's "Pear Shape" Gravitational Harmonic

Abstract. Predictions of the orbit of the Transit 1B satellite were systematically in error until account was taken of a third-order gravitational harmonic. The amplitude deduced for this harmonic by O'Keefe from the Vanguard I orbit serves very well, even though the orbits and the methods of observation and orbit fitting for the two satellites are quite different.

From the motion of the earth satellite 1958β (Vanguard I) O'Keefe, Eckles, and Squires (*1*) recognized and evaluated the amplitude of the third-order zonal harmonic in the earth's gravitational field. This odd-order harmonic produces a north-south asymmetry in the earth's field and corresponds to a "pear shaped" figure of the earth. The existence and amplitude of this harmonic have now been confirmed by analysis of the motion of the satellite 1960γ (Transit 1B). This satellite is part of the Transit navigation system under development by the Applied Physics Laboratory of The Johns Hopkins University for the U.S. Navy and was launched by the Air Force on 13 April 1960. The confirmation of the third order harmonic is remarkable in itself, and further remarkable because the satellite orbit, the observation method, and the orbit-fitting procedures were all different from those used in the earlier study of Vanguard. It is also remarkable because data from a very short period of time, 1 month, sufficed for the confirmation.

Table 1 brings out the differences between the investigations of 1958β

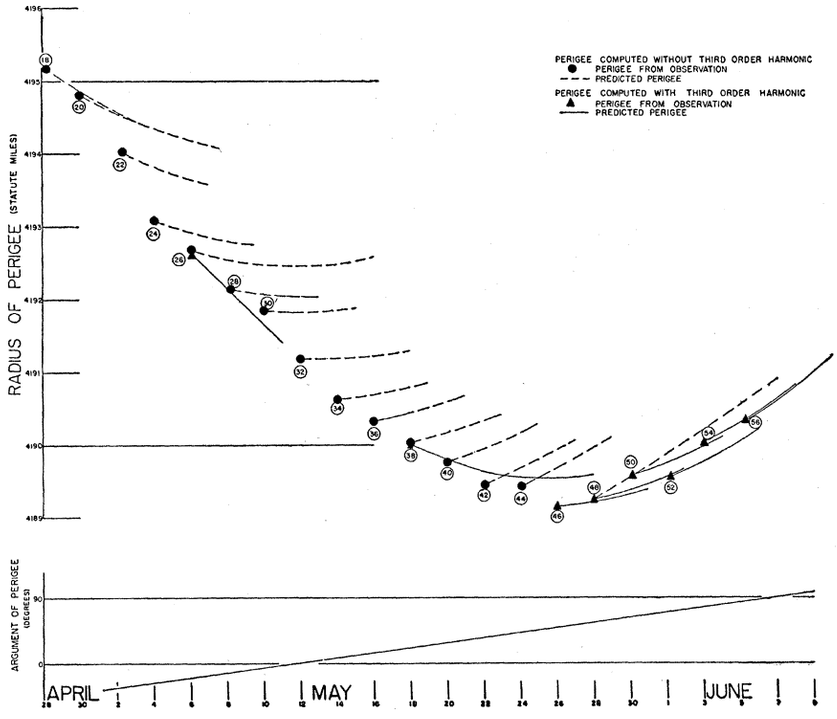

Fig. 1. Perigee observation and prediction for Transit 1B.

and of 1960γ. The Doppler observations of 1960γ at five of the six tracking stations were on the 324-to-54 Mcy/sec coherent frequencies radiated by the satellite. The received frequencies were combined in the data processing to eliminate the first-order effects of ionospheric refractions. One of the stations observed on the 216-to-162 Mcy/sec coherent frequencies with an analog combination to eliminate the first-order ionospheric refraction effects. The numerical integration for the Transit orbit takes account of various gravitational harmonics and of atmospheric drag, the air density being taken as a function of height only.

The story of the confirmation of the third-order harmonic is much like that of the original discovery. Without the third-order harmonic, the predicted perigee distance was found to deviate systematically from the distance deduced from subsequent observations. However, with a third-order harmonic of 0.24 $Mm^6/ksec^2$, as an average of O'Keefe's 0.25 and Kozai's (*2*) 0.228, the bias between the predicted and subsequently determined perigee distances is essentially removed.

This is shown in Fig. 1. The encircled numbers are the day numbers. The solid circles represent the perigee distances every 2 days as determined from the various Doppler measurements obtained during one day. The measurements were used to estimate first the orbital position and velocity vectors at an epoch shortly before the first observation of the day. The perigee distance given is the perigee distance computed from this position and velocity for the osculating Keplerian orbit at the first ascending equator-crossing after epoch. (It is not the osculating value at epoch, nor a mean osculating value over a revolution, as was used in the preliminary Vanguard analysis.) The dashed curves forward of the circles are the loci of the predicted perigee distances at subsequent ascending equator-crossings. Both the circles and the dashed curves are based on orbits estimated without a third-order gravitational harmonic. It is apparent that the predictions deviate systematically from those found through subsequent observation.

In Fig. 1 the triangles represent perigee distances determined when the third-order harmonic is used in the computations, and the solid lines represent the corresponding predictions. It is seen that the errors of prediction are now close to the noise level. A measure of the accuracy of the third-order harmonic based on our data is therefore the ratio of the uncertainty in the slope of the curve through the observed values to the difference in slope between the dashed and solid curves. This is roughly 5 percent. The lower plot shows the argument of perigee corresponding to the perigee distances.

Variations in the observed eccentricity of the Transit orbit are also accounted for, just as dramatically, by the same third-order harmonic.

The results presented here are based on limited operational computations. By special analyses over longer periods of time there is promise of much greater refinement in the determination of gravitational and geodetic parameters from the Transit system.

Table 1. Data on 1958β and 1960γ earth satellites.

Feature	1958β	1960γ
Perigee height	410 mi	230 mi
Apogee height	2450 mi	470 mi
Inclination	34°	51°
Tracking system	IGY Minitrack system	Doppler data from six Northern-Hemisphere stations
Orbit computation	General oblateness perturbation	Numerical integration

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Temperate Pollen Genera in the Eocene (Claiborne) Flora, Alabama

Abstract. Pollen, spores, hystrichospherids, dinoflagellates, and the fresh-water alga *Pediastrum* occur in marine clays at the classic Claiborne Bluffs locality, Alabama. The presence of *Ephedra* pollen provides the first documented Tertiary record of this genus from the southeastern states. The occurrence of several characteristically temperate genera lends support to the idea that a deciduous hardwood forest was present in the Appalachian uplands during the Eocene.

Thanks to the prodigious work of E. W. Berry, the fossil floras of the Coastal Plain and Mississippi Embayment, largely preserved in near-shore marine sediments, provide a unique record of successive change through time of strand and lowland vegetation. Among the most prolific, with remains throughout many of the South Atlantic and Gulf states, is the triad of well-known Eocene floras: Wilcox (Lower), Claiborne (Middle), and Jackson (Upper). From these Berry described about 200 genera of plants (many common