

in well-nourished animals, such as our dogs, and in the debilitated. Even though the *P* value may indicate *no difference* resulting from starvation, this finding of no difference is of importance and against current opinion. The notation of Chang and Schaeffer of the length of time for the transportation of spermatozoa—beyond the period of starvation—poses another problem, that of the mechanism of the effect of starvation. Chang and Schaeffer emphasize the need for knowledge and the lack of clarity in this unsettled problem.

W. HORSLEY GANTT
HARRY A. TEITELBAUM

Pavlovian Laboratory, Phipps Psychiatric Clinic, John Hopkins University, Baltimore, Maryland

7 November 1956

Rigidity of the Earth's Core

The rigidity of the earth's core is significantly less than that of the mantle. This is confirmed by the apparent absence on earthquake seismograms of shear waves that have traversed the core. Additional evidence cited by Honda et al. (1) is based on the amplitude of earthquake-generated shear waves reflected from the core (*ScS*) relative to the amplitude of direct-arriving shear waves (*S*). Since some assumptions concerning the radiation pattern of shear waves from an earthquake focus must be made, the latter method is useful for order of magnitude determinations only.

A quantitative estimate of the rigidity of the core may be obtained by a difficult computation involving the known rigidity of the mantle and the data for bodily tides and pole movements. Takeuchi (2) found a maximum value of core rigidity of 10^9 to 10^{10} dyne/cm² by this method. More recently, Molodenskiy (3) gives $\frac{1}{2} \times 10^{12}$ dyne/cm².

In this paper (4) the rigidity of the core is determined from the amplitude ratio of twice reflected shear waves, *ScS*_{II} to once reflected waves *ScS*_I under conditions of near vertical incidence. This procedure minimizes the number of

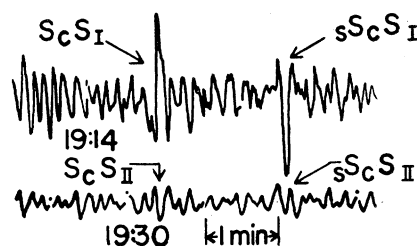


Fig. 1. Core phases from the earthquake of 22 December 1940.

assumptions required to interpret the data. Five occurrences of *ScS*_{I, II} pairs suitable for amplitude-ratio determinations were found on Huancayo seismograms of near earthquakes with intermediate focal depths (see Table 1). The identification of these phases is made certain by the presence of their surface images *sScS*_{I, II} (see Fig. 1).

To interpret the amplitude-ratio data, we use the approximate relationship

$$ScS_{II}/ScS_I = [Rc \exp(-2\sigma d)]/2 \quad (1)$$

where σ is the average absorption coefficient for shear waves in the mantle, d is the depth of the core, and Rc is the reflection coefficient for shear waves vertically incident on the mantle-core interface. The dimensionless dissipation parameter $1/Q$ is related to σ by $1/Q = \beta T \sigma / \pi$, where β and T are the velocity and period of shear waves, respectively. Rc is given by

$$Rc = [(\mu_m \rho_m)^{1/2} - (\mu_c \rho_c)^{1/2}] / [(\mu_m \rho_m)^{1/2} + (\mu_c \rho_c)^{1/2}] \quad (2)$$

where μ and ρ are rigidity and density respectively, and the subscripts *m* and *c* refer to mantle and core in the neighborhood of the boundary. Implicit in the use of Eq. 1 are the assumptions that spherical divergence and the plane-wave, steady-state reflection coefficient are applicable. Since the wavelengths and focal depths are small compared with the radii of curvature of the boundaries, these assumptions are reasonable. They are partially validated by the identical amplitudes of *ScS* and its surface image *sScS* as shown in Fig. 1. The mean ratio of *ScS*_{II}/*ScS*_I for five earthquakes was 0.3.

As indicated by Eq. 1, this decrease in amplitude may be ascribed both to absorption of the shear waves in traversing the mantle and to loss on reflection from the core boundary. On the assumption of a perfectly elastic mantle in which $\sigma = 0$, Eqs. 1 and 2 yield a maximum value of core rigidity: $\mu_c < \mu_m \rho_m / 16 \rho_c$. Using $\rho_m / \rho_c \sim 4/7$ and $\mu_m = 3 \times 10^{12}$ dyne/cm² (5), we find $\mu_c < \mu_m / 30 \sim 10^{11}$ dyne/cm². Assuming a vanishing rigidity in the core, and taking $T = 11$ sec. and $\beta = 6.2$ km/sec, we find that the maximum value for the average dissipation constant in the mantle is $1/Q \sim 200 \times 10^{-5}$. This is sufficiently close to values of $1/Q$ found by other methods (6) to indicate a rigidity in the core between zero and at least an order of magnitude smaller than 10^{11} dyne/cm². Since the incompressibility in the core is of the order of 10^{13} dyne/cm², the ratio of rigidity to incompressibility is smaller than 10^{-3} , indicating a state unlike that of a normal solid.

FRANK PRESS

Seismological Laboratory, California Institute of Technology, Pasadena

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24 September 1956

Effect of a Severe Storm on Electric Properties of a Tree and the Earth

For more than a decade, virtually continuous measurements have been made of the relatively steady-state standing potential of a tree. The potential difference is determined between two reversible, nonpolarizable silver-silver chloride electrodes imbedded in the cambium in the long axis of the tree, and separated by about 3 feet. These potentials show diurnal, monthly, and seasonal variations of considerable interest and, over the years, a suggestion of a correlation with sunspot activity.

It seemed worthwhile, therefore, to begin the study of the electric environment of the tree as measured by earth and atmospheric potentials recorded simultaneously with the potentials of the tree in order to determine the possibility of an interrelationship.

Table 1. Huancayo observations of amplitude ratio *ScS*_{II}/*ScS*_I. The average amplitude ratio is 0.29.

Earthquake date	Origin time (hr:min:sec)	Distance (deg)	Focal depth (km)	Magnitude	Amplitude ratio
6 May 1936	03:38:55	4	160	6	0.25
16 Feb. 1943	07:28:35	4	190	7	0.42
26 Feb. 1952	11:31:00	5	260	7	0.25
19 Sept. 1935	09:55:47	7	250	6½	0.29
22 Dec. 1940	18:59:46	8	230	7	0.25

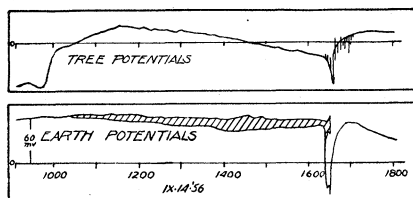


Fig. 1. Tree and earth potentials (millivolts) during a severe storm (Eastern Standard Time). The potential difference above the base line is positive for the upper electrode in the tree and for the south electrode in the earth.

A test run on earth potentials was started last summer, using exactly the same technique as was used in the tree, with silver-silver chloride electrodes buried in the moist earth, high-impedance input amplifiers, and photoelectric recorders. It is thus possible to obtain continuous and simultaneous records of the changing potentials.

On Friday, 14 Sept. 1956, between 4 and 6 P.M., Lyme, Conn., as well as many other New England areas, was hit by a severe squall. Very high winds and torrential rain, lasting for roughly half an hour, were observed. Examination of the photoelectric records from both the tree and the earth showed the rather remarkable phenomenon shown in Fig. 1. In the tree, the upper of the two electrodes was positive 40 or 50 mv, and in the ground the south electrode on the north-south axis was positive about 60 mv for several hours before the onset of the storm.

Prior to the onset of the storm, there was, for 4 or 5 hours in the earth record, an oscillation of the standing potential, the 10-mv envelope of which appears in Fig. 1 (cross-hatching). Then, quite suddenly, the positive potential of the south electrode dropped to zero and became the negative potential of 20 or 30 mv. As the storm passed, this excursion was reversed, and the relatively steady-state standing potential reappeared as a positive potential of 60 mv. During the succeeding 3 or 4 hours, the magnitude of this potential decreased to that characteristic of the early hours of the day.

A very similar change occurred in the tree potentials prior to the storm, with the development of a reversed polarity paralleling that in the earth, beginning somewhat sooner, and taking a little longer to develop.

Since this is a pilot experiment, no interpretation can be made at this time, but it is hoped to continue these studies, including not only north-south potentials in the earth, but also east-west potentials. As soon as funds are available with which to install the necessary equipment, atmospheric potentials will also be re-

corded simultaneously. Since it has been adequately demonstrated that a living organism, the tree, is an electric system exhibiting all the properties of an electric field, one may reasonably expect that changes in the electric environment will show some interrelationship with the field properties of the tree. Over many years, for example, thunderstorms have shown characteristic changes in the standing potential of the tree. Sharp spikes appear in the tree record during the storm. It should be noted that corresponding spikes did not occur in the earth record. Adequate controls have shown that these are not instrumental artifacts caused by interference in the power supply. Instead, they are evidence of very considerable changes in the tree potential associated with the very profound changes in earth and atmospheric electricity.

H. S. BURR

Section of Neuro-Anatomy,
Yale University School of Medicine,
New Haven, Connecticut

4 October 1956

Isolation of a Cardiac-Active Principle from Mammalian Tissues

It is known that the isolated mammalian heart, even though it is maintained under physiological conditions, gradually loses contractile force. This failure, which in many respects resembles chronic congestive heart failure, can be reversed by digitalis. It can also be overcome by inclusion of the liver in the circulatory pathway of the mammalian heart lung preparation (1). Failure of the isolated frog heart that has been induced by perfusion with Ringer's solution can be reversed by addition of mammalian serum to the heart (2, 3). These observations have suggested the possible presence in mammalian tissues of material that resembles digitalis in its physiological effects (1, 3).

A search was undertaken for the active principles in mammalian tissue, using a bioassay based on the staircase phenomenon in the frog heart (4). Deproteinized acetone extracts of tissue were defatted with petroleum ether, and the active material was fractionated by chromatography on Florisil. The most abundant source examined was beef adrenal medulla, which contained activity equivalent to 1000 μ g of strophanthidin per kilogram; others were beef liver, 200 μ g/kg and plasma, 180 μ g/kg. Little or no activity was found in adrenal cortex, red blood cells, or skeletal muscle.

The active component has been crystallized from extracts of adrenal tissue

and identified as monopalmitoyl glycerylphosphorylcholine (palmitoyl lysolecithin). On a molar basis, this material had 1/60 the activity of strophanthidin, 1/40 the activity of digitoxin and one-third that of digitoxigenin. Several lysolecithins prepared synthetically (5) have also been shown to have activity qualitatively similar to that of digitalis on the frog heart.

In addition to the known hemolytic activity of lysolecithin, the following biological effects of the isolated material have been observed. It increases the tension of the hypodynamic frog heart, abolishes the staircase phenomenon in the frog heart, increases the tension of the isolated squab ventricular muscle, and causes contracture of the isolated carotid artery strip. In all these respects, the action of digitalis is similar. Furthermore, this lysolecithin resembles the glycosides by virtue of its strong affinity for the heart, a quality not shared by other substances, such as the catecholamines and certain cortical steroids that have also been shown to be cardiotoxic in the frog heart (3).

Although the isolated material appeared to be chemically pure, it exerted two biological effects; (i) the characteristic digitalis-like action on the staircase and (ii) a toxic activity resembling that of the saponins and characterized by rapid onset of contracture. The former effect was found to be associated with β -lysolecithin, while the toxic factor was identified as an isomer arising by intramolecular rearrangement of the ester bond to the α -carbon of the glycerol. The toxic substance appears to be an artifact formed during isolation. It may be destroyed by hydrolysis with the phospholipase A of *Crotalus adamanteus* venom.

Approximately 50 percent of the active substance in the adrenal medulla and 80 percent or more of that in liver and serum occurs in the form of an inactive precursor, which is somewhat more lipid soluble than the lysolecithin and from which the latter is liberated on standing for a few hours at pH 2. This precursor appears to be a hemiacetal derivative of the lysolecithin with a long-chain fatty aldehyde. A substance of this structure has been identified in heart muscle by Klenk and Debuch (6).

What role palmitoyl lysolecithin might play in normal mammalian physiology cannot be decided on the basis of tests in the frog heart. If the mechanism by which it acts on the staircase phenomenon in this heart is the same as that of the cardiac glycosides, it would appear to serve as a regulator of membrane permeability to potassium (4).

The hemiacetal precursor might serve as a nonhemolytic form in which lyso-