mals were sacrificed and the kidneys were removed and frozen in a carbon dioxide-ether mixture. The frozen kidneys then were powdered and extracted with trichloroacetic acid, and aliquots of the extract were taken for determination of the phosphorus fractions. The radioactivity of the various fractions was measured by means of a Geiger-Müller counter (designed by Dr. W. F. Bale, University of Rochester). The activity of the phosphorus compounds was determined likewise in a control group of animals, treated in an identical manner except that sodium bicarbonate instead of phlorhizin was injected intravenously.

In the kidneys of the phlorhizinized rats the turnover of the pyrophosphate fraction (that hydrolyzed in 7 minutes by N acid) was found to be decreased. This was determined by comparing, per mg of P, the radioactivity of the pyrophosphate fraction with that of the inorganic phosphorus. The other fractions of the acid-soluble phosphorus determined apparently were not affected. In a control group of 9 animals the pyrophosphate fraction in the kidney displayed radioactivity which was 70 per cent. of that of the inorganic phosphorus in the kidney. In the group of 9 phlorhizinized rats, the radioactivity of the pyrophosphate fraction was only 33 per cent. of that of the inorganic phosphorus. Thus, the turnover of the pyrophosphate fraction in the kidneys appears to be less in the phlorhizinized animal than in the normal animal, indicating that phlorhizin exerts *in vivo* an inhibitory effect on some phases of the phosphorylating mechanisms of the kidney.

These findings can not be regarded as conclusive evidence that the blocking of glucose reabsorption is due to an inhibition of phosphorylating processes in the kidney. All that can be stated at the present time is that the inhibition of glucose reabsorption in the kidney coincides with a decrease in the turnover of one fraction of the acid-soluble phosphorus. Studies are now in progress to determine whether a more definite correlation between the two phenomena does exist.

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AN INVERSE DISTANCE VARIATION FOR CERTAIN SOCIAL INFLUENCES

1. THE GEOGRAPHICAL DISTRIBUTION OF COLLEGE UNDERGRADUATES

THIS study began with an examination of the geographical clustering around the alma mater of the residences of undergraduates in recent classes at Princeton and Harvard, and of alumni of Harvard, Princeton, Vassar and Yale. The examination uncovered a remarkable inverse distance "law" or statistical regularity.[1] *The number of undergraduates or alumni of a given college who reside in a given area is directly proportional to the total population of that area and inversely proportional to the distance from the college.*

This rule holds with reasonable closeness as far as Texas for the four colleges studied. The 11 Rocky Mountain and Pacific Coast states, however, are represented by about half a dozen times more alumni, and two or three times more undergraduates, than the trend with distance "entitles" them to.[2]

I define the "potential" of the population of a given area, at a given point, as the population of the area, in millions, divided by the average distance, in miles, from the point to the area. Evidently the above "law" is equivalent to the statement that the contribution of a given state to the quota of undergraduates (or alumni) of a given college is proportional to the state's "potential" at the college town.

For particular purposes the "potential" of a *special group* of the state's total inhabitants may be used. Thus for eight recent consecutive undergraduate classes at Princeton the accumulated percentage of undergraduates, p, who have residences closer to Princeton than a given radius is well represented, in percentage points, by[3]

$$p = 7.3 + 482\,U \qquad (1)$$

Here U is the accumulated "potential" out to any given radius of the *native white male populations,* state by state, in the order of increasing distance (Table 1):

TABLE 1

COMPARISON OF NATIVE WHITE MALE "POTENTIALS" WITH THE GEOGRAPHICAL DISTRIBUTION OF THE RESIDENCES OF PRINCETON UNDERGRADUATES

Distance from Princeton, N. J., in miles	Accumulated "potential" U millions/mile	Actual percentage of undergraduates within given radii	Computed percentage p of undergraduates	Percentage of total population
95 (N.Y.) .	0.085	48	48	17
150 (Md.) .	.130	70	70	31
380 (N.C.) .	.149	78	79	45
515 (Mich.)	.160	83	84	58
950 (Mo.) .	.177	93	93	70
1,500 (Tex.) .	.185	97	97	90

[1] *The Princeton Alumni Weekly,* 40: 409–410, February 9, 1940.

[2] Four Princeton undergraduates assisted in the examination of alumni distribution: C. D. MacCracken, Philip Wilkie, M. S. Dillon, R. B. Snowden. A somewhat more detailed discussion of this distribution will appear in the *Bulletin of the American Association of University Professors.*

[3] Theoretically p should reduce to zero for U zero. However, the average distances when small can be found only with considerable labor. Furthermore, beyond Texas the rule breaks down. It is fair therefore to adjust, as in (1), for the intermediate range of 1,400 miles.

2. An "Equipotential" Map for the Total Population of the United States

Encouraged by this success I constructed an "equipotential" map of the United States, using total census populations of 1930. The country was divided arbitrarily into twenty-four districts and the population of each district, as regards the "potential" elsewhere, was assumed concentrated at some particular point within the district. The 24×23 distances between the districts were scaled off in miles and divided into the population in millions.

Each district's "potential" on itself was determined by a suitable approximation, and summation gave the total "potentials" at the 24 adopted central points. These were numerous enough to permit the graphing of "lines of equipotential." The New York Philadelphia area proves to be the peak for the entire country. The "potential" in New Jersey averages 0.5 millions per mile; thence the "potentials" fall off in general in all directions. Within New York City the "potential" rises to 1.75 or so. There are many local smaller peaks in other large cities (Chicago and Philadelphia perhaps 1.1; Boston, Detroit, Pittsburgh, Cleveland, Baltimore, Buffalo, 0.8 to 0.7; San Francisco and Los Angeles, 0.5 or 0.4). These are of little consequence on the smoothed small-scale map.

A ridge of relatively high but diminishing "potential" extends westward through Pittsburgh and St. Louis and on, much diminished, toward Santa Fe. Routes of communication which have been important since pioneer days tend to lie, as might be expected, at right angles to "equipotentials." At distances of 1,000 miles or so from New Jersey the "equipotentials" tend to become circles centered near that state. There is, however, a slight general rise in California. At the extremities of Maine, Washington, Arizona and Florida the "potential" is down to 0.10 millions per mile or less (not counting contributions from Mexico or Canada).

From this chart I scaled off average "potentials," V, for the 48 states. These are reproduced in the second column of Table 2, in decreasing order.

These results are interesting in themselves, but now comes quantitative proof of their significance. In column three of Table 2 are actual densities of population in rural areas by states, in persons per square mile. These values were got by multiplying the densities (U. S. Census of 1930), state by state, by the corresponding Census percentages of rural population. This procedure is justified even in Rhode Island, because the cities occupy negligible area.

Column four gives corresponding rural densities computed from the formula

$$D_r = 425\,V^2 \qquad (2)$$

This therefore is *an empirical relation between the rural density at a point and the "potential,"* at the same point, of the whole population of the country. It represents the actual rural densities in the 37 states east of Colorado with a probable error of only 12 per cent.

TABLE 2

Relation of Rural Density to Potential

State	"Potential" V	Rural Density	
		Actual	Computed
N. J.	0.52	94	117
Conn.	.48	99	98
R. I.	.45	49	85
Pa.	.44	70	81
Del.	.42	59	74
Md.	.41	66	71
Mass.	.40	52	68
N. Y.	.38	43	62
Ohio	.38	53	62
W. Va.	.35	52	51
Ill.	.34	36	49
Ind.	.34	40	49
Va.	.33	47	47
Ky.	.32	45	45
Vt.	.31	36	41
N. H.	.30	21	39
Mich.	.30	20	39
N. C.	.29	49	35
Tenn.	.28	41	34
Wis.	.25	25	27
Mo.	.25	25	27
S. C.	.25	41	27
Ga.	.24	34	25
Iowa	.24	27	25
Ala.	.23	37	22
Ark.	.23	28	22
Miss.	.22	36	20
Me.	.20	16	17
Kan.	.19	14	15
La.	.19	24	15
Minn.	.19	16	15
Okla.	.19	23	15
Neb.	.17	12	12
Tex.	.17	13	12
S. D.	.15	7	10
Fla.	.15	13	10
N. D.	.14	8	9
Colo.	.14	5	
N. M.	.13	3	
Calif.	.12	10	
Wy.	.12	2	
Nev.	.11	0.5	
Ariz.	.11	3	
Utah	.11	3	
Mont.	.10	3	
Idaho	.10	4	
Ore.	.10	5	
Wash.	.08	10	

Note: The "potential" V is for the total U. S. population, Census of 1930, in units of millions per mile. The rural density is in persons per square mile. Computed densities are from the formula 425 V^2.

The regularity (2) definitely breaks down in the 11 Rocky Mountain and Pacific Coast states. This failure may be ascribed in part to their large areas of mountain and desert. The actual rural densities for states in the deep South average about $1\frac{1}{2}$ times the computed densities. This systematic deviation is due to the concentration there of the Negro population.

The term "potential" of course is taken over by analogy from the identical inverse-distance law in gravitation and electricity. The density of a population is already a standard term, and is analogous to a surface density of mass or electric charge. Additional applications of the new theory merit investigation, but limitations of space prevent their discussion here.

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