the increase of resistance which is observed when the tissue is transferred from NaCl + $CaCl_2$ to pure $CaCl_2$ of the same conductivity. On one hypothesis the plasma membrane would retain its normal properties after the transfer but would show increased resistance because it is normally less permeable to the ions of $CaCl_2$ than to the ions of NaCl.

On the other hypothesis the plasma membrane would suffer a change in its properties as the result of the transfer. The facts strongly favor this hypothesis. I will mention only a few. Visible changes in the outer layer of the protoplasm are produced by $CaCl_2$ (and many other substances) and this makes it probable that the plasma membrane suffers change. Alum, which is known to alter the properties of many colloids (*e. g.*, in tanning), when added in solid form to the sea water greatly increases the resistance of the protoplasm although it greatly decreases the resistance of the sea water. In this case the only explanation is that the permeability of the plasma membrane is altered. On the other hand it is clear that the large number of substances which produce irreversible decrease of resistance must also alter the plasma membrane.

It seems probable therefore that a great variety of substances alter the plasma membrane so as to increase or decrease its permeability.

It may be pointed out that these results are precisely what should be expected if the antagonistic action of salts is due, as Loeb has suggested, to the fact that they hinder each other from penetrating the protoplasm. It is quite clear from the experiments that $CaCl_2$, $SrCl_2$ and $BaCl_2$ in small amounts are able to hinder very greatly the entrance of the ions of NaCl. The mechanism of this action is not fully understood, but I may state that $CaCl_2$, $BaCl_2$ and $SrCl_2$ bring about visible changes in the plasma membrane which are entirely different from those produced by such salts as NaCl. It is hoped that a further study of these visible changes may throw light on this question.

Previous experiments on plasmolysis have shown essentially similar phenomena and the complete confirmation of the results of one method by those of the other form the most striking proof possible of the facts outlined above.

It may be asked how merely delaying the entrance of a salt can protect the protoplasm against its toxic action. In this connection it may be pertinent to recall the familiar phenomenon of colloid chemistry that a salt which produces marked effects when added suddenly may produce little or no effect when added slowly. It should be noted that there is good evidence to show that the NaCl does not enter the cell alone but is accompanied by $CaCl_2$. It is possible that these salts may wholly prevent each other from penetrating internal membranes (*e. g.*, the nuclear membrane) which are of importance in this connection.

The chief conclusions are as follows:

1. Quantitative studies of permeability may be made by a simple and accurate method.
2. Slight changes in the rate of penetration may be observed and accurately measured at very brief intervals.
3. A great variety of anions and kations readily penetrate living protoplasm.
4. Inasmuch as these ions are insoluble in lipoid it would appear that Overton's theory of permeability can not be correct.
5. The plasma membrane is readily altered by a variety of substances in a fashion which is easily understood on the hypothesis of a colloid (probably proteid) plasma membrane but which can not be explained on the hypothesis that the plasma membrane is a lipoid.
6. The antagonistic action of salts is largely or entirely due to the fact that they hinder or prevent one another from entering the protoplasm.

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NOTES ON THE DISTRIBUTION OF THE SOUTHEASTERN SALAMANDERS (GEOMYS TUZA AND ALLIES)

A CHARACTERISTIC feature of many parts of the pine forests of the coastal plain of Georgia, Alabama and Florida is the common occurrence of small mounds of sand a foot or more in diameter and a few inches high, scattered irregularly over the surface or in more or less evident lines, and usually several feet apart. A traveler from farther northeast, seeing these mounds for the first time, might easily imagine that some one had been driving along with a wagon-load of sand and dumping it out in large shovelfuls. They are seen best in winter and spring, partly because the surrounding vegetation is less conspicuous then, and partly for other reasons.

These diminutive mounds cover the outlets of the burrows of a subterranean rodent, *Geomys Tuza*, which is known throughout its range as the "salamander."[1] (Zoologists have divided the original *G. Tuza* into some half-dozen species and subspecies, but there are no wider gaps between the ranges of the different forms than there are between some colonies of the same species, and they all have essentially the same habits and habitat, so that for the purposes of this discussion it will be most convenient to treat the group as a unit.) The animal feeds on roots, travels entirely underground, as far as known, and very rarely shows itself, in the daytime at least.

While working for the Florida State Geological Survey in 1908–1910 I had occasion to visit every county and to travel on nearly every railroad in that state; and on railroad journeys I usually had nothing better to do than look out of the car-window and make notes on the topography, vegetation and other geographical features. The salamander hills, which certainly constitute one of the topographic features, even if a very insignificant one, thus received their share of attention, and in that way I have accumulated records of hundreds of precise localities for this elusive animal. On plotting these on a map recently some interesting correlations between them and certain other geographical features became evident. In previous years I had visited every county in Georgia and Alabama in which *Geomys* is known, but my notes on its distribution in these two states are much less complete than they are for Florida.

In both Georgia and Alabama the salamander ranges all the way across the coastal plain up to the fall-line, in about latitude 33° 15′, but one can travel many miles without seeing any evidences of it, and it is much less abundant in those states and in west Florida than it is in peninsular Florida. The Biological Survey of the U. S. Department of Agriculture has a record[2] of just one station for it outside of the coastal plain, namely, near Chipley, Georgia.[3] In Alabama the only known stations for it north of the latitude of Montgomery seem to be around Kingston, in Autauga County; in the northeastern corner of Hale County; on high pine hills near Lock 14 on the Warrior River, and between Brookwood and Searles. At both of the last-named stations, which are in the upper (northeastern) part of Tuscaloosa County, the salamander hills are found over Carboniferous rocks, but always where there is a thin layer of some unconsolidated coastal plain deposit, presumably the Lafayette, on the surface.

In Florida salamander hills can be seen in abundance at frequent intervals all the way down to a point between Nocatee and Fort Ogden in DeSoto County, about latitude 27° 10′, which is about fifty miles farther south than the southernmost station for *Geomys* mentioned by Outram Bangs in his interesting paper on the land mammals of

[1] Dr. C. Hart Merriam in his elaborate monograph of *Geomys* and related genera ("N. Am. Fauna No. 8," p. 112, 1895) characterized this common name as "singularly inappropriate and misleading." But contrary opinions as to its appropriateness have been expressed by Goode (Powell's Report on Colorado River, p. 281, 1875) and Bangs (*Proc. Bost. Soc. Nat. Hist.*, 28, p. 175, 1898); and it is no more misleading than the names cypress, cedar, sycamore and poplar, applied to very different trees in this country from what they are in the old world.

[2] Unpublished, but communicated to me by Mr. A. H. Howell.

[3] There happens to be also a Chipley in Florida, a more important place than the one in Georgia, and it is barely possible that the specimen in question came from Florida and was ascribed to Georgia by a slip of the pen.

peninsular Florida.[4] I have seen them in every county in that state except Franklin, Manatee, Lee, Osceola, Brevard, St. Lucie, Palm Beach, Dade and Monroe, all of which were included by Dr. Eugene A. Smith, in his classical paper on the geography of Florida,[5] in what he called the "pitch-pine, treeless and alluvial region." These counties are all in south Florida with the exception of Franklin, which is in middle and west Florida, over 200 miles from the rest. Dr. Smith admitted that this was not a very homogeneous area, but he grouped these counties together for convenience because they produced almost no cotton (only two bales being reported from that whole area in 1880). The distribution of *Geomys* now furnishes an additional character for distinguishing these counties from the remainder of the state; for I have seen salamander hills in every county included by Dr. Smith in his other two regions, namely, the "long-leaf pine region," and the "oak, hickory and pine upland region." (The counties in Florida are of course more numerous now than they were at the time of the Tenth Census, but it so happens that that does not affect the truth of this statement.)

About a year ago, in a report on the peat deposits of Florida,[6] the writer divided the state provisionally into fourteen geographical divisions. Of these the lime-sink region and the lake region, near the axis of the peninsula, seem to be the headquarters of the salamander. The animal is not known at all in the East Coast strip or the coast region of West Florida, both of which consist chiefly of modern (active) dunes next to the ocean and ancient (fixed) dunes a little farther back. It occurs in varying degrees of abundance in the remaining divisions, except those south of the latitude of Lake Okeechobee.

[4] *Proc. Bost. Soc. Nat. Hist.*, 28, p. 176, 1898.

[5] Tenth Census U. S., 6, pp. 175–257, 1884. This monograph, like those on other southeastern states in the same volume, bears the entirely too modest designation of a report on cotton production.

[6] Ann. Rep. Fla. Geol. Surv., 3, pp. 201–375, pls. 16–28, January, 1911.

The range of the southeastern salamander[7] seems to terminate abruptly on the east at the Savannah River, and on the west at the Warrior and the streams which under two or three other names connect that river with the Gulf of Mexico. From all accounts it appears that the various subspecies (or species as some regard them) of this group, which are the only representatives of the genus east of the Wabash River and its continuations, nowhere occupy the same territory, but are separated by rivers, which must be almost impassable barriers to an animal which spends its life underground and has no use for water. Indeed it is difficult to imagine how such an animal could ever have crossed any of the large rivers which extend all the way across the coastal plain; but at some time in the past the ancestors of the present salamanders must have crossed at least three such rivers, namely, the Altamaha, Apalachicola and Alabama. (The crossing of the Mississippi and Ohio rivers by members of the genus must have taken place at a much more remote period, judging from the much greater geographical and phylogenetic gap between the species on opposite sides of these rivers.) Mr. Bangs, in his paper already cited, expressed the opinion that *G. Floridanus* is separated from the other forms by the St. Mary's and Suwannee rivers, with Okefinokee Swamp connecting their headwaters. If this is true then the salamanders of middle Florida (*i. e.*, that part of the state between the Suwannee and Apalachicola rivers) must be typical *G. Tuza*, the same as in Georgia. However that may be, salamander hills of exactly identical appearance can be found within a mile or two of each other on opposite sides of the Suwannee, which has almost no swamps where it passes through the lime-sink region.

So much for the areal distribution of our salamander. Some interesting correlations

[7] According to Dr. Merriam's monograph previously cited, *Geomys Tuza* and its near relatives are confined to the three states already named, but the same common name is also applied to another species which inhabits Arkansas and Louisiana.

between it and certain soils and other environmental factors can now be made. Its hills are almost always in dry sandy loam,[8] presumably of Pliocene or Pleistocene age. It avoids on the one hand the fertile limestone and clay soils which characterize some parts of the coastal plain, and on the other the hopelessly sterile sands of the shifting dunes along the coast and the "scrub" of the Florida peninsula. It is most abundant in regions where according to the statistical maps in the fifth and sixth volumes of the Tenth Census less than one acre to the square mile was cultivated in cotton in 1880; but in soils which at the present stage of the economic development of the southeastern United States are being appropriated by farmers most rapidly. Being confined to dry soil, it is absent from land which is too damp for cultivation by ordinary methods (as well as that which is too sterile or too rocky). But I have never heard any complaints about its interfering with agricultural operations.

The southeastern salamander seems to be invariably associated with the long-leaf pine (*Pinus palustris*), and it may derive part of its food from the roots of that useful tree. The only known station in the Piedmont region of Georgia, mentioned above, is probably not right in the city of Chipley, but very likely on the Pine Mountains near by, where the rocks and soil are pretty sandy, and long-leaf pine abounds.[9] The range of our animal is by no means coextensive with that of the long-leaf pine, though, for the tree ranges from Virginia to Texas, as well as considerably farther inland in Georgia and Alabama and a little farther south in Florida than the salamander does. Two other trees usually found in the vicinity of salamander hills, and having more nearly the same range, are two scrubby oaks, *Quercus Catesbaei* and *Q. cinerea*. Mr. Bangs (*op. cit.*, p. 180) states that Cumberland Island, Georgia, is the only one of the sea-islands (which fringe the coast from about Charleston to Jacksonville) on which a *Geomys* occurs. It is also, to the best of my knowledge and belief, the only one which has *Pinus palustris* and *Quercus Catesbœi* on it; and its geological history must have been somewhat different from that of the others.

Lastly there are some interesting relations between the salamander and forest fires, as was noticed briefly long ago in the papers cited in the first footnote.[10] Every long-leaf pine forest, without exception, is periodically swept by fire, which burns off the dead herbage and keeps down the underbrush, but does no harm to sound pine trees after they get beyond a certain age. (In prehistoric times these fires, presumably set by lightning, probably did not visit any one spot oftener than once in four or five years, on the average; but now so many fires are set accidentally or purposely by man that few of these forests escape fire longer than a year or two at a time.)[11] The dunes and scrub of Florida, mentioned above, as well as the other extreme, the rich hammocks, have so little herbage that fires are very rare, and in such places there are neither long-leaf pines nor salamanders.

Fires in the southern pine woods are most frequent in late winter and early spring, and the salamanders seem to be most active just about that time. The locality near Lock 14 on the Warrior River, when first discovered on April 15, 1911, had evidently been burned over a few days or weeks previously, and the salamander hills there looked pretty fresh. What is still more interesting, none could be found in precisely similar areas near by

[8] At the northernmost Alabama stations there is a considerable admixture of gravel in the soil, and it is possible that if specimens could be obtained from these somewhat isolated localities they might be found to differ perceptibly in some characters from the only form at present known in that state, *G. Tuza Mobilensis*.

[9] See *Bull. Torrey Bot. Club*, 36, pp. 585–586, 1909.

[10] The same relation was noticed still earlier by Sir Charles Lyell, the English geologist, in Screven County, Georgia, in the winter of 1841–42. ("Travels in North America," Vol. I., p. 161, 1845.)

[11] In this connection, see *Bull. Torrey Bot. Club*, 38, p. 522, 1911.

which had not been burned recently. The locality was revisited in May and June, during which time there were no more fires, and the salamander hills were gradually settling down and disappearing, no new ones having been made in the interval, apparently.[12] It would be very interesting to know if the related species of the middle northwest, *G. bursarius*,[13] shows a similar reaction to prairie fires.

ROLAND M. HARPER

THE AMERICAN MATHEMATICAL SOCIETY

THE eighteenth winter meeting of the society was held at Columbia University on Wednesday and Thursday, December 27–28, 1911, the program occupying two sessions on each day. The total attendance was about seventy-five, including sixty-three members. President H. B. Fine occupied the chair, being relieved by ex-President H. S. White. The following new members were admitted: Professor Ida Barney, Rollins College; Professor Louis Brand, University of Cincinnati; Professor C. W. Cobb, Amherst College; Professor J. C. Fitterer, University of Wyoming; Mr. G. H. Graves, Columbia University; Dr. Solomon Lefschetz, University of Nebraska; Mr. G. H. Light, Purdue University; Mr. E. S. Palmer, Rutgers College; Professor E. R. Smith, Pennsylvania State College. Eight applications for membership were received. The total membership of the society is now 669, an increase of 27 during the past year.

On Wednesday evening forty-two of the members gathered at the annual dinner at the Murray Hill Hotel. These informal dinners have long been recognized as one of the most attractive features of the meetings.

The treasurer's report shows a balance of $8,-723.89, or deducting outstanding bills, about $8,200, a slight increase for the year. The income from sales of publications was $1,513.66. The life membership fund now amounts to $4,137.17. The number of papers read at all meetings of the year was 180; the total attendance of members was 350. At the annual election 197 votes were cast.

[12] In June Mr. A. H. Howell set traps in several of these hills, but without catching anything, which seems to indicate that the animals were not working near the surface at that time.

[13] Since Dr. Merriam's monograph some additional notes on the habits of this species have been published by Mr. C. L. Webster in the *American Naturalist*, 31, pp. 114–120, 1897.

The society's library has increased to 3,840 volumes, beside some 500 unbound dissertations.

At the annual election, which closed on Thursday morning, the following officers and other members of the council were chosen: *Vice-presidents*, H. F. Blichfeldt and Henry Taber; *Secretary*, F. N. Cole; *Treasurer*, J. H. Tanner; *Librarian*, D. E. Smith; *Committee of Publication*, F. N. Cole, E. W. Brown and Virgil Snyder; *Members of the Council* (to serve until December, 1914), A. B. Coble, E. W. Davis, Oswald Veblen and E. B. Wilson.

The following papers were read at this meeting:

W. M. Smith: "A characterization of isogonal and equitangential trajectories."

C. L. E. Moore: "Surfaces in hyperspace which have a tangent line with three-point contact passing through each point."

J. E. Rowe: "How to find a set of invariants for any rational curve of odd order."

J. E. Rowe: "A covariant point of the R^4, and a special canonical form."

R. L. Moore: "On the sufficient conditions that an integral equation of the second kind shall have a continuous solution."

E. B. Wilson: "Some mathematical aspects of relativity."

Edward Kasner: "Families of surfaces related to an arbitrary deformation of space."

H. B. Phillips and C. L. E. Moore: "Algebra of plane projective geometry."

Anna L. Van Benschoten: "Products of quadric inversions and linear transformations in space" (preliminary report).

Arthur Ranum: "N-dimensional spreads generated by ∞^1 flats."

O. E. Glenn: "Generalizations of a theorem on reducible quantics, due to Eisenstein."

F. R. Sharpe: "Finite groups of birational transformations in the plane."

John Eiesland: "On a flat spread-sphere geometry in an odd dimensional space."

C. N. Moore: "The summability of the double Fourier series, with applications."

S. E. Slocum: "A general formula for torsional deflection."

G. A. Miller: "Groups which contain a given number of operators whose orders are powers of the same prime."

R. G. D. Richardson: "Theorems of oscillation for three self-adjoint linear differential equations of the second order with three parameters."

L. A. Howland: "Points of undulation of algebraic curves."