TRANSACTIONS

OF THE

TEXAS ACADEMY OF SCIENCE

FOR 1897

VOLUME II.

No. 1.

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1897

CONTENTS.

TITLES OF PAPERS.

COMMITTEE ON PUBLICATION.

W. W. Norman. G. B. Halsted. E. T. Dumble.

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FOR 1897,

WITH PROCEEDINGS FOR 1897.

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(*Presented before the Texas Academy of Science June 15, 1896.*)

AURAL PERCEPTION BY THE BLIND.

A PRELIMINARY REPORT.

BY DRS. S. E. MEZES AND H. L. HILGARTNER.

Owing to the large place occupied by visual perception in our normal experience of outer objects, it is exceedingly difficult to furnish satisfactory descriptions of the rare and overlaid instances of perception by the other senses. It is to those deficient in one or more of the senses that we must turn for our most valuable evidence. In the blind, no doubt, touch takes the place of sight as the intellectual sense *par excellence;* but the limitation of the information it gives them to objects in contact with the body, coupled with the reach of their perceptual horizon far beyond the body, makes it plain that they must depend on the lower senses for a large part of their perceptions. In so far as can be described, the general theory of perception ~~by only sense perception~~ must be the gainer; indeed, to establish the bare existence of, say, aural perception of distant objects, is to assist materially in the solution of the vexed question of the third dimension in vision, for the ear is less sensitive to depth than the eye—it furnishes no sensations auxiliary to sound that vary with depth.

Authorities on the psychology of the blind agree that they have a somewhat detailed sense of their surroundings. They know whether they are on a plain, on a mountain top, or in a valley, whether they are out of doors or indoors, in a large or a small room, whether it is bare or furnished, and, with more individual variations, the kind of furniture therein. Such "perceptions" are, to be sure, decidedly vague, but they are marked unmistakably by the sense of exteriority, insistence and sensational vividness. Naturally, near objects are most clearly perceived—the fences on either side the road, houses and stores along the streets, persons, lamp posts or other obstacles in their way, especially when the obstacle stands more than shoulder-high; then the blind can often perceive the nature of the obstacle. It was with a view to determining which of the lower senses is the informant, and, if more than one, what proportional part they play, that the observations to be here described were undertaken. As the title implies, the conditions were too rough to yield more than very general results, and it was soon decided to use the experiments chiefly for determining the direction in which experimental refinement would be profitable. We trust, however, that our results are not wholly without value and offer them for what they are worth.

The literature of the subject consists of Mr. W. Hank's Levy's account* of his own power, quoted by James in "Principles of Psychology,"† Prof. James' comments and discussion,† and an article by Mr. Dresslar.‡ Galton§ has heard of it, but regrets that those he knows possessing the power were unwilling to undergo experiment.

Levy says: "Whether within a house or in the open air, whether walking or standing still, I can tell, although quite blind, when I am opposite an object, and can perceive whether it be tall or short, slender or bulky. * * * I can * * * often [detect] whether it be a wooden fence, a brick or stone wall, or a quickset hedge." He says further: "None of the five senses have anything to do with the existence of this power," which he calls "facial perception," to indicate that the skin of the face is its organ. James suggests, among other things, that "the tympanic sense noticed on page 140, supra, comes in to help here, and possibly other forms of sensibility not yet understood." Dresslar, by suitable experiments, shows that, *in his subjects*, possessing normal vision, but carefully blindfolded, the tympanum is too insensitive to pressure to account for actual perceptions; that the power is lost with stopped ears and uncovered face, and unimpaired with covered face and open ears. This apparent flat contradiction of Levy by Dresslar's results suggested that the former might be right regarding the blind, or some of them; the latter in the case of those who see.

With one exception, noted below, all our experiments were on absolutely blind subjects, attending the Texas Institute for the Blind at Austin. The apparatus consisted (a) of three wooden boards 2 feet broad and 6 feet 2 inches, 5 feet 8 inches and 5 feet 2 inches high, respectively, so braced that they would stand securely on reasonably level ground; (b) of face-covers long enough to reach from forehead to collar and back to the ears on either side, made of two pieces of cotton cloth sewed together and padded evenly throughout with absorbent cotton; and (c) of fish skin pouches filled with flour, large enough to cover the concha, and flexible enough to penetrate a half-inch or more into the meatus. A watch if *touching* the pouches thus adjusted, could be heard; when the ears were stuffed with putty and covered with cotton, the same watch could be heard from one or two to six inches away. The

* "Blindness and the Blind." London.

† Vol. II, p. 204.

‡ Am. Jour. of Psych.

§ Human Faculty, p. 31.

trials were made on the grounds of the Institute. The original intention was to discover with what accuracy the three boards could be distinguished, but on this point our notes are too incomplete to be of any value. A few times a board was placed on its side, giving a height of two feet, but the records are too few and do not appear in the table; they would have increased the percentage of error. In the trials, a board was placed as noiselessly as possible at a distance of from about 8 to 25 feet from the subject, and the latter was started and left to walk alone toward it. Occasionally no board was set up, when the subject was stopped after walking 30 feet or so, in cases where he had no illusory perception, for that sometimes happened. In a few trials a convenient tree was substituted for the boards. By varying the distance of the boards, by occasionally picking up a board once set down, or another board near it, by using trees after the subject lost his orientation by reason of many turnings, and by other devices, we sought to minimize any error due to the slight noise of setting up the boards. In this we believe our success was complete.

Some of the remarks made by subjects during the course of the experiments will make the table plainer.

C. H. S. says: "I can get around better in clear than in damp weather." "I can't do so well in muddy weather," the latter in answer to a question.

A. G., his ears being closed, passed from the bright sunlight into the shade; on being questioned, he said he felt as if he was running into something, as was besides indicated by the abruptness of his halt. The remark is interesting from him (vide table).

P. D., probably the most intelligent subject, when asked how he could tell of the presence of the board, said: "It seems as if I tell it by my face, but I have heard of that theory [Levy's; P. D. is a University student, taking psychology], and that may have given me the idea." After some remarks about the part played by hearing, but without further questioning, he said: "Often, when I am not sure, I snap my fingers or scrape my foot on the ground; then I can tell." Asked how he came to do this, said: "I don't know; don't remember beginning it."

E. M. says: "A board don't look as dark as a tree," but he mistook boards for trees, and vice versa, several times.

All say that when there are noises their perception is materially interfered with, especially when the noises are of different kinds. "Can't get around so well then." When carts were lumbering by in the street 40 feet away, and when there was piano playing or loud singing, the subjects looked annoyed and confused, and often asked us to wait till the disturbance was over.

	Percentage of obstacles detected.	Average distance at which obstacles were detected.	Age.	How long blind—in years.	Age when became blind.	Sex.
C. S. H.			15	8	7	Male.
Ears open	100	11				
Face covered	100					
Ears stopped	0					
E. P.			19	10	9	Male.
Ears open	100	5				
Face covered	100					
Ears stopped	0					
A. G.			13	5	8	Male.
Ears open	100	6				
*Face covered	—					
Ears stopped	50	2				
L. R.			8	4	4	Male.
Ears open	100	2				
Face covered	—					
Ears closed	$33\frac{1}{3}$	5				
P. D.			22	16	6	Male.
Ears open	100	8				
Face covered	100					
Ears stopped	0					
E. M.			11	6	5	Male.
Ears open	86	2				
Face covered	—					
Ears closed	0					
N. A.			22	12	10	Female.
Ears open	66	5				
Face covered	—					
†Ears stopped	16	1				
D. B.			17	15	2	Female.
Ears open	83	7				
Face covered	—					
Ears stopped	0					
‡W. S.			21			
Ears open	0					

* Out of thirteen trials with his ear stopped he detected the board six times under the following circumstances: One time the board moved audibly; once, wind blew; once, walked into shade of building (and stopped. V. supra); twice, sun strong on board; once board threw a long shadow, the sun being low.

† At different times the sun was shining bright on the side of the board towards the subject, on the opposite side and edgewise; and in each case on some trials she discovered it and on others did not.

‡ Janitor, vision normal, carefully blindfolded. After running over board, always declared he felt it was there. The only seeing subject.

The first column was obtained by dividing the number of times a subject detected a board or other obstacle (by stopping some distance in front of it) plus the number of times he walked 30 feet when there was no board, by his total number of trials. More trials were made with some subjects than with others, the number varying from six to seventeen. The closing of the Institute for the summer prevented further experimentation. The figures of the second column are the average distance of boards, trees, or other obstacles, from subjects when they stopped. The other columns explain themselves.

One conclusion can be safely drawn. In most of the blind the ear plays much the largest part in the perception of objects out of contact. Comparing W. S. with our blind subjects, shows how much less sensitive he is, and suggests that experiments on the seeing are not conclusive.

In looking for evidence of "facial perception" among our subjects, we find hints rather than trustworthy evidence. L. R.'s case we regard as too doubtful to be of any value. He is very young, has been blind four years only, discerned board at two feet with ears open, as contrasted with five feet with ears stopped, and during the latter trials he seemed to be guessing. A. G.'s case is more satisfactory. It indicates that though the ears be stopped the blind may perceive an object that radiates much heat, or intercepts much heat or wind. It may be that this source of information, at the command, apparently, of some of our subjects, is the chief reliance of a few of the blind. It would be interesting to discover how much more sensitive they are in this direction than the seeing, and especially interesting to experiment on subjects at once blind and deaf. While N. A.'s evidence of what "facial perception" is, is not so clear, her frequent failures mean little in view of her low record with open ears.

Among our subjects, the record of the girls is much lower than that of the boys. Our cases are too few to warrant generalization, but it is worth while stating that while the former walk along the paths in groups, composed generally in part of seeing members, the latter walk alone and cross lots.

We had hoped that our figures would show the effect of experience on the keenness of aural perception, but nothing definite appears.

[*Read before the Texas Academy of Science, December 31, 1896.*]

THE ECONOMICS OF CONCENTRATED CAPITAL.

BY MAJOR C. E. DUTTON.

About 200 years ago Gregory King, one of the oldest English statisticians, computed that the cost of transporting a bushel of wheat by land a distance of sixty miles usually exceeded the cost of producing it at the farm. Eighty years later Adam Smith made a similar investigation, and, though the country roads of England had been considerably improved, he found that on the average the cost of transporting wheat about seventy miles was nearly equal to the cost of production. These and many similar facts explain some of the most important differences between the commerce of the past and that of the present.

In those days, the market of each producer was greatly limited in its geographical extent by the cost of transportation. Each town and village, and often a single landed estate, produced within itself, or in its near surroundings, most of the ordinary necessities of life. To a far greater extent than now this applied not only to the first fruits of the soil, but also to the working of them up into more finished products. The wool was shorn, the flax grown and bleached, in the near neighborhood. The yarn was spun in the households; evenings were spent around the firesides with the women knitting. Homespun clothing was the common wear. Families brewed their own ale, made their own bacon and pork, and cured their Michaelmas beef for the winter. If the flour box was getting empty, the head of the family sallied forth to a farmer and dickered for a sack of wheat or rye, which he flung behind his saddle and trotted off to the village grist mill. Then began the usual conflict of wit and thrift about the miller's toll and the quality and quantity of the flour, the miller not always getting the best of it. The memory of these conflicts still survives in the familiar proverb, "Never send a boy to the mill."

INFLUENCES OF EARLY TRANSPORTATION.

Inland commerce, therefore, dealt most largely in commodities of higher finish, containing great value in small bulk; and the same was true to a marked extent in foreign commerce. Thus the great cost of land transportation tended to localization in the markets for the common necessities of life, and at the same time made their production general in all parts of the country. The exceptions were the obvious ones of articles which, in the nature of things, could be produced only in very few localities. Thus, iron, which was then smelted with charcoal, could be produced only in localities which furnished good ore, and at the same time were heavily timbered. Water transportation, on the other hand, was cheap, and, though absolutely dearer than at present, yet in comparison with land carriage was very much cheaper. Marine commerce, therefore, flourished in the nations having a seacoast. But its influences were greater in those areas near the sea and faded out rapidly away from the coasts. It drew its chief exports from a comparatively narrow belt of country, and in this belt were situated all the large commercial cities and manufacturing towns.

Summarizing the foregoing remarks, we see that prior to the advent of cheap transportation by steam power, the great staples and necessities of life were, in greatest part, marketed and consumed in the neighborhoods where they were produced. Even the production itself had a much more domestic character than at present, for many needful things were then made in the household which at the present time are purchased at the stores, and buying at the store was largely barter, pure and simple. Little need to be said to point the contrast with existing conditions in this respect. The mills of St. Paul and Minneapolis grind wheat for the world. The wheat crop of California is sold in England, and its perishable fruits are marketed on the Atlantic seaboard. The Gulf States sell their garden produce in New York, Boston and Chicago. Pittsburg sends coke to the Rocky Mountains, and Northern Minnesota sends iron ore to Pittsburg. Domestic manufacture has almost ceased, and nearly everything is bought for cash or credit from stores, while the market of every manufacturer's goods is now, potentially at least, the world.

TENDENCY TO CENTRALIZE WEALTH.

Thus there has gradually developed a new condition, of which commerce and production have diligently availed themselves. Vast manufacturing establishments are producing goods for markets distant and near. These markets comprise far denser populations than ever before, and the buying capacity of the average individual consumer has greatly increased.

One of the results of these developments has been the marked tendency of some of the most important branches of industry and commerce to concentrate into large aggregates of control. In these branches, we see the gradual disappearance of small concerns, and the growth of a few very large ones into vast proportions, and these supply almost, and sometimes quite, the entire country with their products. Half a dozen Bessemer steel establishments of regular capacity can furnish all the rails required for maintenance of track and for new constructions which the country requires. Four or five sugar refineries could saturate the country with sugar. Half a dozen establishments no larger than some already existing could supply the full demand of the country for steel wire and nails.

The same tendency is also seen to a limited extent in the great department stores in the retail trade of large cities. But the field in which it is most conspicuous of all is in the railroads themselves. When railroads were inaugurated sixty years ago they began as short, detached lines, each under independent management. By degrees they have consolidated into great systems, in which thousands of miles of road are controlled in their general operation by a single directorate.

It would be a great mistake, however, to infer that this tendency to concentration is universal throughout all fields of industrial and commercial activity. The facts are quite to the contrary. Although the number of occupations or branches of industry in which this tendency has developed is now considerable, and is increasing from year to year, yet when it is compared with the number which show no such tendency it is seen to be only a small proportion. It is not exhibited in the greatest of all branches of industry, agriculture, nor in the manufacture of textile goods. In the numberless manufactures of hardware, furnishing goods, tools, machinery, metallic parts, notions, such as diversify so wonderfully the industries of the New England States, we find a few instances of the tendency, though in the great majority of them it has not yet appeared.

The question might arise here, whether this tendency may not develop to such an extent as to reach other lines of industry until nearly the whole field is controlled by similar concentrated capital and management. Prediction is certainly unsafe, but it may be said that, as the indications now stand, we may reasonably anticipate that it will extend to other lines of industry which it has hitherto neglected. But that it will extend to any large proportion of them is impossible. This will appear when we examine more closely the causes and conditions out of which it has developed.

BIRTH OF THE TRUSTS.

I have mentioned cheap transportation and the consequent extension of markets as opening a great field for concentrated capital. But it has done something else, and that is to greatly intensify the competition for the possession of it. Competition has always existed in civilized commerce, but in recent years it has reached a degree of fury of which our ancestors had little conception. It is not many years ago that we began to hear of destructive competition, though precisely where the line between the destructive and any other degree of competition is to be drawn it is impossible to say, for it has always crushed or oppressed the weak and has been the weapon of the strong. Still, in recent times, it has taken on a rigor and remorselessness far exceeding anything known before, and its destructive effects upon capital and vested interests have in countless instances fairly won for it the name of destructive competition. It is a ceaseless war, as old as the human race, in which no truce or armistice is possible, and only the fittest can survive.

Men of affairs have in all times largely snatched every opportunity to escape wholly or in part from the pressure of competition. Formerly it was possible to escape it, sometimes by grants of monopoly or of special privileges by the crown, but these grants became so odious that they were first greatly restricted and then denied altogether. In later days, when the pressure of competition greatly intensified, it was natural that those who were squeezed by it uncommonly hard, who were facing the alternative of destroying or being destroyed, should resort to unusual means of rescue from a desperate situation. Modern ingenuity and enterprise has discovered a way in which it can be done, though only as yet in limited fields and to a partial extent. It consists in the union of the stronger interests into a compact which shall abolish competition among themselves, and unite their resources and strength in one centralized mass against competition by outside parties.

These organizations have received the popular name of "trusts." Beyond the fact that they have been formed for the purpose of escaping in some measure from competition, it would be impracticable to frame any definition of them which would include them all, or even any considerable part of them. The basis of organization differs widely, and no two are alike either in the form or extent of the consideration. In truth, there are frequently features of these modes of combinations which are not fully known to the public, and are matters of inference rather than positive knowledge. But the proximate purpose of the combination is to avoid the full pressure of competition, and is sufficiently plain. The ultimate purpose, of course, is large profits for which the avoidance of competition is the means to an end.

SCOPE AND NATURE OF TRUSTS.

This purpose, however, is here attributed to those concentrations of capital which are engaged in the production and distribution of commodities of widely extended demand throughout the country at large. There have been others which have received the name of trust whose objects or purposes were conspicuously different; being, in short, plunder on a grand scale, and not profit. Fortunately, these have been few. They should be regarded though as special cases, and should be fully distinguished from the organizations to which the name of trust is ordinarily applied. Their discussion will be deferred until we reach another stage of the subject.

The name of a trust is, in most cases, justified, because all, or nearly all, of them involve under different forms and in varying degree the principle of trusteeship. In some it is nothing more than intrusting to a central power the regulation of prices in such manner that each member, individual or corporate, shall receive the benefit as nearly as practicable in proportion to his interest. In others the same or similar power is intrusted with the apportionment of the amount of product to be put out by each member, but each member preserving otherwise his individuality. The total profits are pooled and sub-divided accordingly. In some there is a complete mergence of corporate or individual capital into one common control, each contributor receiving shares or stock as may be agreed upon. Of those which produce commodities for the trade, some intrust to the central management the power of regulating the profits and prices of all intermediaries, and even to create auxiliary corporations to distribute their products, but regulating their profits and prices in conformity with the control policy.

IN THE LIGHT OF POLITICAL ECONOMY.

These organizations have been for some years the source of much public anxiety, which, as they multiply, becomes more and more tense. Nor is this without reason, for their growth involves new economic questions gravely affecting the welfare of the community. In examining them it will be possible here only to do so in the briefest manner, and to indicate only in outline the economic considerations, which are of primary importance.

Political economy may be resolved into two departments. The first is analytic, and concerns itself with the investigation of the natural and universal laws governing the production of wealth, its exchanges and its final distribution and consumption. Here it is essential to note only that in this field it takes no account of moral and ethical questions further than to accept morals and ethics as it finds them, and it proceeds to formulate its laws and conclusions accordingly. The other department is mainly synthetic in which the laws derived from its primary analysis are examined in their relations to the general well-being of society. Here morals and ethics can no longer be ignored, for in the broader applications of the science they constitute great underlying economic forces.

Let us then consider the subject first from the more limited point of view, and inquire how these concentrated masses of capital stand related to the production and distribution of wealth without regard to moral or ethical considerations.

It is generally conceded that the industrial and manufacturing trusts supply the public with goods at extremely low prices, and usually in standard qualities, which may be relied upon, and each standard is well adhered to. It is also probable that under a system of freer competition the goods would be dearer and of much more uncertain standards. Undoubtedly, too, they have lowered the cost of production to a degree which, in very many cases, is lower than could have been expected under full competition. For their practically unlimited capital enables them to utilize to the fullest extent every known labor-saving device, and every economical accessory. They also enjoy a comparative immunity from costs which are very burdensome to competitors hotly contesting for customers. It is said of many commodities that it costs more to sell them than to make them, and there are doubtless instances in which this is literally true. But to the trusts the costs of selling are minimized. There is another advantage which they hold to an unrivaled degree. Markets are always fluctuating greatly in respect to the demand for goods of all kinds. These fluctuations are usually greatest in those things which supply our higher comforts and luxuries, and those which are used in the expansion or increments of fixed capital. They are least in articles of prime necessity. When the demand greatly slackens, competitive producers are often compelled to go on producing at a loss in order to hold their markets, or subject themselves to other losses by closing their establishments. The trusts, on the other hand, are in no danger of losing their markets, and curtail their production to suit the demand with very little shrinkage of profits. It is this sustained character of profits, and, above all, their comparative immunity from losses which make some of these trusts so remunerative.

A MAXIMUM RATE OF PROFIT.

One of the commonest of mistakes is the idea that a manufacturing or mercantile establishment, not subject to the full stress of competition, must always be expected to charge exorbitant rates of profit on its goods. This is far from true. Undoubtedly, we may expect that they will endeavor to secure the largest aggregate profit, but this aggregate can never be secured in that way. The total profit is the number of units of traffic multiplied by the average rate of profit on each unit. In every trade there is some rate of profit which will make the aggregate profit a maximum, or the largest possible. If an attempt be made to increase the total profit by arbitrarily raising the rate of profit beyond this point, it will surely fail, for it will cause a falling off in the volume of sales to a degree more than counterbalancing the increased rate. Or, if the rate be lowered, the increase of traffic will not make up for the diminished rate. Towards this rate the action of the trusts tends. It is, however, an ideal rate, which must be sought and discovered if possible by trial, and not one which is self-evident and visible at a glance. Nor is it fixed and constant in any case, but varies or fluctuates from week to week, and month to month. Whether it is actually reached or not, or even whether it is closely approximated we, of course, have no means of knowing. But there is good reason to infer that it is not only seldom exceeded, but generally is fallen short of. Nor can it in any case be a high or exorbitant one, but on the contrary is a low one. The principle here set forth is well understood by able and sagacious business managers, and, in fact, is seen to be commonplace as soon as stated. It explains why the trusts are under no inducement to overcharge the consuming public for their goods, and yet are able to secure a very large profit.

Hitherto I have spoken of them as being formed for the proximate purpose of escaping from competition. But do they in reality escape from it? Usually they do escape from destructive competition, but by no means from normal competition, though they are more or less shielded from it. Here the question arises whether an escape from competition such as we see in these organizations is a salutary condition of affairs, beneficial to the community.

So far as regards destructive competition, it is not only injurious on moral grounds, but to the economic interests of a community. It is destructive and wasteful to the public as well as to the competitors. As regards normal competition, political economy knows of but one way in which it can be escaped with benefit to the community, and that is to furnish it with goods and services which shall be better in quality or lower in price than anybody else can furnish. In reality, however, this is not escaping from competition, but is keeping ahead of it in the race with competitors who are ever pursuing. But for crushing and throttling competition, neither political economy nor ethics furnish any sanction.

Unfortunately, many of the industrial trusts have been charged with procedures of that character. These charges have been made the subjects of investigation by courts and legislative bodies, and their results are before the public. This, however, is not the time and place, nor am I the one to pronounce judgment upon them. All that I can say here is, that to whatsoever extent these charges are well founded, they involve conduct which is as much opposed to sound economy as it is to sound ethics.

Destructive competition is a trespass upon the industrial liberties which it is the theory and spirit of the common law to defend. On the economic side just competition is one of the cornerstones of the economic fabric. It is a contest as to who shall render to the community the greatest amount of satisfaction in goods or services. His reward may be accordingly. But these rewards must be won, not by putting clogs upon the feet, nor stumbling blocks in the way of competitors, but by fairly outrunning them in the race.

A BETTER DISTRIBUTION OF WEALTH.

Let us now imagine how great concentrations of capital affect the distribution of wealth throughout the community. Here we may extend our thoughts beyond the industrial trusts to all concentrations, whether of fixed or circulating capital, large portions of which are owned by individuals. Here we encounter a strange confusion of ideas in the minds, or at least the language of many people, especially the modern socialistic agitator, who springs at once to the conclusion that the rich are growing richer, and the poor poorer. This is a grave error, wholly unwarranted and misleading. The riches they speak of is really capital which is defined in political economy as that portion of wealth which is applied to the production and distribution of more wealth. It is a means to an end, and the end is the wealth which is destined for final distribution to the community. If, therefore, one man owns the capital, the community gets all the goods it produces, except a small fraction of profit, which goes to the capitalist. Thus, while the ownership of capital may increase in the hands of a few individuals, the products which it multiplies diffuse themselves to all, and are distributed with growing abundance lower and lower down in the scale of living. If, then, some of the rich grow richer in ownership of capital, the whole community grows richer in its usufruct.

The question then is, do these great concentrations of capital tend to a wider and better distribution of its usufruct? The answer must be yes. Whatever diminishes cost of production, whatever prevents waste, whatever tends to the better organization and higher efficiency of labor leads to a greater product, and to a wider and more universal distribution of it. The world gets its living so much the easier, and gets a better living. Thus they are in line with the evolution of the age, and the tendency toward concentration in all fields where it can really accomplish better results is a natural and inevitable one.

This, however, does not imply a concentration of capital in all fields of industry or commerce, but only in those where it yields a larger result both in respect to profit and usufruct. The tendency is for good and on the whole the results are for good, but unhappily it has been attended with some serious evils. Here we reach a point where we must take a broader view of our subject, and where moral and ethical considerations must be taken account of in their economic bearings.

There are many who seem to see in this great concentration of capital an alarming menace to the well-being of communities, and even to civilization itself. They see in them a vast widening of the gulf between poverty and riches.

Wealth brings power to command services, and they see power over the lives and destinies of others growing into despotism on the part of a few, and servility and serfdom on the part of the many. And in general they see an evolution tending ever toward the bad and away from the good.

The economist, on the other hand, takes a different view of it. He is by no means an optimist, indeed, and still less is he a pessimist. He sees no menace to the welfare of the community in the mere fact of vast individual ownerships, unless, perhaps, in the sense in which the fox saw in the increasing size and fatness of the fowls, a growing menace to the future welfare of the population of the hen-coop. These great possessions exist almost wholly in the form and relations of capital, and the function of capital is to increase and multiply the production of goods, and their distribution to the community. It has no other function. He who owns it must employ it in furnishing the goods and services which the community demands, or it will dissolve away from him. Whatever it is instrumental in producing goes to the community, except the small percentage which the owner receives in the shape of profit. Thus the usufruct of capital accrues to the public, and it extends the profit many times over.

In the warm agitation of this and similar subjects now going on, the socialist bends his thoughts almost wholly upon the ownership of wealth in the form of capital, and upon the profits the ownership brings to the owner. This is the measure of inequality of wealth which he holds up as the crowning social evil. Of the usufruct and its distribution to all, he seems strangely unconscious. The economist, on the contrary, is primarily concerned with the usufruct. But he is far from being unconscious of the nature and importance of ownership and its profits, or of their consequences for good or evil. In his sight, the usufruct and its distribution are the main considerations, and his anxiety about the ownership is limited to the desire to see it so placed as to lead to the greatest and most beneficial product, and to the most just and widest distribution of it. So long as this condition is fulfilled he cares little who owns the capital, or how much he owns.

PROFITS GOVERNED BY NATURAL LAW.

Capital (i. e., fixed capital as distinct from the circulating form) is an agency for increasing the efficiency of labor. We may liken labor to the electric current, which does the work, and may liken capital to the electro-motive force or voltage, which multiplies the efficiency of the current. It is the interest of the community that labor shall work at its highest potential or greatest efficiency, and turn out from the hands of each laborer the maximum amount of product. There are many lines of industry in which very large amounts of capital are indispensable to their successful operation, and whose productiveness and profit continue to increase with the enlargements and concentration of capital until a maximum is reached. It is the interest alike of the community and of the capitalist that they should do so. The community receives a larger amount of goods and a more abundant return for its struggle for existence, while the capitalist receives a large aggregate profit.

Nor will the economist worry about the magnitude or rate of the profit so long as it is honest, and attended with the giving of a full equivalent of benefits to the commumnity in conformity with the free and untrammeled action of the law of demand and supply. For it then becomes a gain which the community does not lose, but on the contrary, it is a gainer also, and in much greater degree than the capitalist.

Under these conditions it is safest and best to leave profits to take care of themselves, for they are goverend by a natural law whose action is not only beneficent, but irresistible. In the final division of the product of labor and capital, an increasing share goes to wages, and a decreasing one to profits. New industries may arise, new conditions may develop, and new and improved methods of production or of management may be invented which at first may lead to very large profits. But with the free action of the law of demand and supply, with its attendant condition of fair and just compensation, they also obey the pressure of the law that the rate of profit tends to a minimum.

GREED AND ITS CONSEQUENCES.

But here the trouble and anxiety of the economist begin. I have stated that political economy in its primary analysis takes no account of morals and ethics, but accepts them as it finds them. But there is an implied assumption that men are generally honest and just in their dealings with each other; that they execute their contracts and trusts with fidelity and exactitude. As a general rule, this is true. But it too often has occasion to lament that it is not. During the last forty years there have been many financial transactions which have shocked the moral sense of the community, not only by their intrinsic character, but by their magnitude and far-reaching consequences. These transactions differ indeed in their degrees of immorality. Some few have all the turpitude and ruthlessness of downright robbery. A greater proportion of them are a series of actions which, taken in other relations, might escape censure, but which, in their actual relations, are tantamount to breach of trust. Their object and real result has been the acquirement of large amounts of illicit gain, for which no equivalent has been given, and this result has too often been accomplished with impunity.

And now look at the social and economic consequences. The success of these transactions has stimulated to the uttermost men of easy consciences and lax principles to follow the examples thus set. This, indeed, is nothing new in kind, for successful iniquity unchecked and unpunished has always found a crowd of imitators. But in modern instances the vastness of the prizes or booty which have been won has greatly increased the inducements. It has familiarized wrong to such a degree that thousands are ready first to endure and then to embrace it. It has fostered the idea that great fortunes are to be won by a few bold strokes and that giving a full equivalent for them is in no wise an essential part of the process. It has led to the promotion of great capitalized undertakings under color of vast benefits to the community and corresponding profits to investors, but really for the purpose of securing large and immediate but illegitimate profits to the promoters themselves. It has sunk large amounts of the capital of the country in unproductive enterprises or those which were insufficiently productive to justify their undertaking. And in general its effects have been demoralizing and wasteful.

MORALS HAVE IMPROVED.

But though the economist is grave and anxious over these matters, is there any reason why he should be despondent and pessimistic over them? None whatever. He has delved much in the history of human manners and customs, into industrial and commercial history and into their economic and social development throughout the ages, and he finds in these things nothing that is new so far as their essential nature is concerned. Human society has always abounded in men of low morals in every walk of life. Such men are quick to devise new tricks for acquiring illicit gain. Relatively to the times and opportunities, fraud, injustice, overreaching, malversation, breach of trust were much more common in the past than now. This may not seem so to those who have not fully investigated, but its truth is beyond all question. Business morals have already improved and in the lapse of generations have made considerable progress. This progress is, indeed, not all that we could wish to see, but it has been something, and in truth much. It has been slow, but it has been sure. Much of the aversion and indignation with which immoral business practices are regarded arises from the fact that they are judged by a higher and better moral standard than in former times. Practices which, in former generations or decades, escaped criticism, or barely squeezed through it, can do so no longer. In this progress, the economist finds much comfort and reassurance.

Are these evils any necessary part or accompaniment of concentrated capital and its employment? No more than of any other economic actions of men. In the marvelous progress and swift changes of the nineteenth century, though they have been overwhelmingly for good, it is not surprising that among its numberless inventions some new ways should be found for doing wrong, by methods unknown to the law. If these become formidable, it is then a fair question whether statutes can be devised and enacted which shall prevent them, and this without doing more harm than good.

It appears that most of these wrongs are perpetrated by men who manage the property of others and generally in a corporate capacity. In the eye of the law they are not strictly speaking trustees, but agents acting in a fiduciary relation. And what is their responsibility?

Not many years ago, in some classes of corporations, it was just about what the consciences and personal honor of the corporate officers chose to make it. They gave no bonds, they rendered no full accounts with vouchers to the stockholders, their books were not open to qualified inspection, they could shroud their actions in a secrecy which even the courts found difficult and sometimes impossible to penetrate. Their powers were as indefinite as their responsibilty, and there was no code either statutory or conventional fixing the limits within which these powers might be exercised.

One of the most pernicious and objectionable prerogatives, and one which far more than any other furnished the opportunities for delinquency was that of making contracts in their corporate capacity with themselves as the representative of distinct and often parasite corporations or as natural persons. It is an old proverb that "it takes two to make a bargain." But here it seems that only one is necessary. In truth, the wonder is not that we have scandals in corporate management, but that we have so few of them.

RESPONSIBILITY OF TRUSTS.

During the reigns of the Tudors and Stewarts English law relating to private trusteeship was in a very crude and primitive condition. Whenever property fell into trust or escrow, its chances of finding its rightful owner were discouraging. It was no uncommon thing for the crown itself to appoint trustees or receivers to property, and the understanding was that this was equivalent to giving them the property outright, and generally trusts ended in the absorption of the property by the trustee. By the time of the great revolution (1688) this practice had become intolerable, and Heneage Finch, Earl of Nottingham, after a labor of eight years, succeeded in carrying through Parliament a series of laws which effected a great reform in this matter. They settled the general principles of legal trusteeship, and with the improvements which have since been made, the laws relating to the administration of private trusts are as satisfactory as we could reasonably expect.

Many attempts have been made to bring the responsibility and fidelity of corporate management under similar limitations, supervision and control. Along some lines this has been done. The savings banks and the national banks of our country are instances of it. There is still much to be desired in this respect, but so far the effect has been most salutary. But there are many kinds of corporations concerning whose responsibility and powers the statutes are still very indefinite. It seems as if improvement in this line ought to be earnestly sought, but the practical measures by which it may be made are questions for jurists and the most enlightened and prudent legislators. Into their province it would be presumptious in me to seek to enter. But the general nature of the remedy that is needed seems clear. It is some more effectual guarantees that the trust which is reposed by the State in corporate directors and managers every time it grants a charter, and the trust reposed in them by their stock and bondholders whenever they place their property in their hands, shall be strictly limited to the purposes intended and shall be administered in all honesty and fidelity.

If in dwelling so long upon these matters I have in any way conveyed the idea that there is a low standard of morality among corporate directors as a class, such an inference is wholly wrong, and nothing could be farther from my intention. On the contrary, no higher sense of honor, duty, and responsibility can be found among classes of men than that which exists among corporate directors and managers as a class. If all men were as just, honorable and punctilious as the overwhelming majority of the managers of concentrated capital, it would be an immense advance, equivalent to a moral revolution.

I have dwelt upon the darker phases of the subject for two reasons: first, because of the vast interests involved in the faithful management of concentrated capital, which make moral delinquency, however exceptional it may be, so powerful a factor for evil, both in the economic and purely social relations of men with each other. The second reason is that these unhappy occurrences have been used as an ammunition in the assaults of socialism upon the existing economic system.

Communism will always be the dream of the idealist and perfectionist, and is now. Its most formidable weapons are the misdeeds of mankind, and political economy can not always afford to ignore them, for it is science and not romance. It must treat its facts fairly and justly and let the logical outcome take care of itself. This is always the safest and best course; in fact, is the only proper course. After these facts are duly weighed, they are seen to constitute no impeachment of the existing system, and the use which communism makes of them is but special pleading.

THE SUMMING UP.

And now, let us sum up. The concentrations of capital which we have seen and still see going on in certain fields of capitalized industry are in the main normal evolutions growing out of the wonderful material progress which the world is now making in the arts of production, transportation and distribution. This tendency does not extend to all lines of industry, but only to those in which such concentration is really effective in increasing products and widening their distribution throughout the community. And so far, they are beneficial to the community. They have increased the abundance of needful things for all men, and have lightened the struggle for subsistence, and have raised the scale of living among all classes. But in this development unusual opportunities have been opened up for highly objectionable and pernicious practices with respect to large masses of capital which call for severe condemnation and for remedy. And these opportunities have been seized by reckless men, to the injury alike of the common welfare and of the rights and property of other people of whom they have been the agents. The ease with which these practices have been carried out is due in a great measure to the inadequate definition of the limits of corporate power, and also to the lack of sufficient guarantees of the fidelity of corporate agents to the trusts with which they are charged. This must indicate the general direction which legislative measures may take with the expectation of remedy. But what specific measures should be taken is the province of the jurist and the prudent legislator. If a high order of honesty and justice can be reasonably well secured in the management of concentrated capital, and reasonably well guaranteed by law, and derelictions be made penal, the concentration may be safely left to take care of itself. It will then never concentrate, unless there is great advantage to the community in doing so. But sound morals and sound political economy must ever go hand in hand.

[*Read before the Texas Academy of Science, December 31, 1896.*]

VERTICAL CURVES FOR RAILWAYS.

BY J. C. NAGLE.

Of late years the increasing speed at which passenger trains are run has necessitated such improvements in the surface conditions and alignment of track that the dangers and discomforts to which passengers are subjected shall be reduced to a minimum. Heavy steel rails laid on stone-ballasted tracks, kept always well surfaced, make the disagreeable effects of a speed of fifty miles an hour scarcely more noticable than the jolting of a buggy over a well paved street. Indeed, the year just ending has witnessed an attempt to even filter the air, so to speak, that the passengers are to breathe within the car. Transition curves at the beginning and end of circular curves make the change from tangent to curve almost imperceptible, the centrifugal force being balanced by the proper super-elevation of the outer rail—the elevation increasing inversely with the radius of transition curve. A study of the railway accidents will show that very few casualties result from the wreck of passenger trains, and these mostly from collisions with freights, so that the probability of injury per mile traveled is less than in any other form of locomotion, unless, perhaps, it be ocean travel.

Most of the serious train wrecks occur with freights, and in mountainous regions quite a large per cent of these are due to the train breaking in two and the wild section dashing forward into the front section at the bottom of an incline, or backward into the front of a following train.

The causes of these accidents are many; but some, at least, are due to the absence of suitable vertical curves at the junction of two grade lines having a different rate. Transition curves are of prime importance for passenger service, but less so for freight traffic, while vertical curves are more necessary in the case of freights. The reason for this is seen in the short length and close coupling of passenger trains, particularly vestibuled trains, enabling them to pass readily from one grade line to the next. With freight trains, the case is different. They are generally long and not very closely coupled, so that when the rear cars crowd forward there may be considerable slack present. As the engine pulls out or slows up suddenly, a fearful jerking or jamming is the result, as can be seen in a train leaving or entering the yards or stopping at a station. The effect is very severe upon the drawbars and couplings.

Short, choppy grades are conducive to sudden reversals of stress upon the couplings, especially when the grades are not properly rounded off with suitable vertical curves at the junctions.

The question of the proper form and length of vertical curve to be employed is of first importance, then the best method of setting it out. It should be noticed that the absolute value of the gradients has nothing to do with the problem—it is only their *algebraic difference* that concerns us.

If we consider a train passing from one grade line to another, it is evident that the path of the center of gravity of the train as a whole differs from that followed by each individual car, this difference becoming more marked as the difference in gradients increases. Suppose two grade lines, BA and AC, to unite at A, as shown in Fig. 1, and let the train at

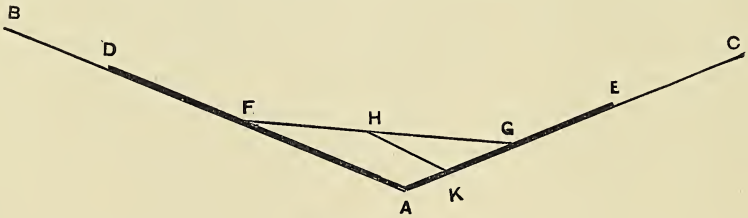

FIGURE 1.

any instant be in the position DAE. For the sake of simplicity, let the mass of train per unit length be the same throughout, and call the length of train a. Let AE $=z$, then DA $=a-z$. The center of gravity of DA will be at F, its mid-point, and of FE at G, distant $\frac{1}{2}z$ from A. Let the center of gravity of the whole train be at H, then taking BA and AC as the axes of y and x respectively, and taking moments at F,

$$GF \times z = HF \times a$$

$$\text{Or} \quad \frac{GF}{HF} = \frac{a}{z} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

From similar triangles,

$$\frac{GF}{HF} = \frac{GA}{AK} = \frac{\frac{1}{2}z}{x} = \frac{a}{z}, \text{ from (1)}$$

$$\text{From which } z = \sqrt{2ax} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Also from the figure

$$\frac{GF}{HF} = \frac{FA}{KH} = \frac{\frac{1}{2}(a-z)}{y} = \frac{a}{z}$$

Whence $az - z^2 = 2ay.$

Substituting value of z from (2) we get

$$\sqrt{2ax} = 2x + 2y.$$

Squaring and arranging terms

$$4x^2 + 8xy + 4y^2 - 2ax = 0 \qquad (3)$$

—the equation to a parabola, which is tangent to the axes at a distance of $\frac{1}{2}a$ from the origin.

If such a curve were substituted for the two intersecting grade lines, the center of gravity of the train would now be found to follow a curve lying somewhat above the parabola given by equation (3). A second approximation might be made by finding the locus of the center of gravity of an arc of the parabola of constant length, which would yield a curve differing slightly from the above parabola, but sufficiently close to the desired curve to answer all purposes in an actual case.

However, it is unnecessary to pursue this line any further, for no matter how many approximations we make, the final length will be a function of the length of train only, and entirely independent of the angle between grade lines, though the actual form of the curve will not. For every different length of train, a different curve would result, and the best that could be done would be to construct the curve for the longest train likely to pass over the road. Evidently the length of curve should bear some relation to the angle between grade lines, increasing with that angle.

It would seem possible, at summits at least, to so adjust the curve that for any given length of train and speed the pressure upon the rails should be constant; but the pressure upon the rails is a matter of no special moment in any practical case.

It would seem, then, that the only other consideration affecting the question in a material way would be the crowding forward of the rear of train in sags, with the consequent jamming of drawheads and sudden tensile stress developed in the couplings as the effect of the engine begins to be felt after passing on to the second grade. At the summits the increase in tensile stress as the engine and forward part of the train pass over and begin to descend might be in danger of rupturing a draw-bar—in either case breaking the train in two.

Wellington, in his book on the "Economic Theory of Railway Location," lays down the proposition that if it be desirable that *all* danger of slack is to be avoided in sags, the difference in the rate of grade of track at the points occupied by the front and rear of train should never exceed the so-called "grade of repose" of last car—a quantity dependent upon the velocity as well as rolling friction.

Taking the dynamometer resistance of last car as six pounds per short ton, we have a grade corresponding to a rate of 0.3 per cent; then calling the train length a, and rate of change per station r,

$$ar = 0.3$$

from which

$$r = \frac{0.3}{a}$$

in which r is in feet and a in stations. If the train be 1200 feet long this gives $r=0.025$. For an algebraic difference of 1.5 feet, this would give 6000 feet for the length of curve, with a correction at the vertex of 11.25 feet.

Recognizing the impracticability of securing such inordinate length of curves, Wellington further states that with the modern close couplers the length of curve and consequent correction may be reduced one-half without danger of breaking the train.

In regions yielding long, easy grades, with relatively small changes in gradients, it may be possible to adhere to this rule; but where heavy grades occur, with frequent changes of considerable amounts, this can not be done. Generally it will be found that where heavy grades occur the local conditions limit the length of curve to such an extent that no theoretical rule can be adhered to; yet it is just such regions as this that require some sort of curve at summits and sags. Local conditions, then, will fix the minimum length of curve—there is no danger of getting them too long, unless it necessitate undue expenditure for construction. The engine man can control his train by a proper use of air to such an extent that even a short curve can be passed without the existence of an undue amount of slack, particularly if he is careful to give the engine steam at the proper point.

Now as to the best curve to use. The parabola offers the advantage of being the kind of curve the center of mass of the train tends to follow, as well as ease in setting out in the field. Two properties of the parabola are utilized: (1) that ordinates from tangent to curve vary as the square of the distance from the point of tangency; and (2) that the curve bisects the vertical intercepted between the vertex and the long chord joining the P. C. with the P. T.

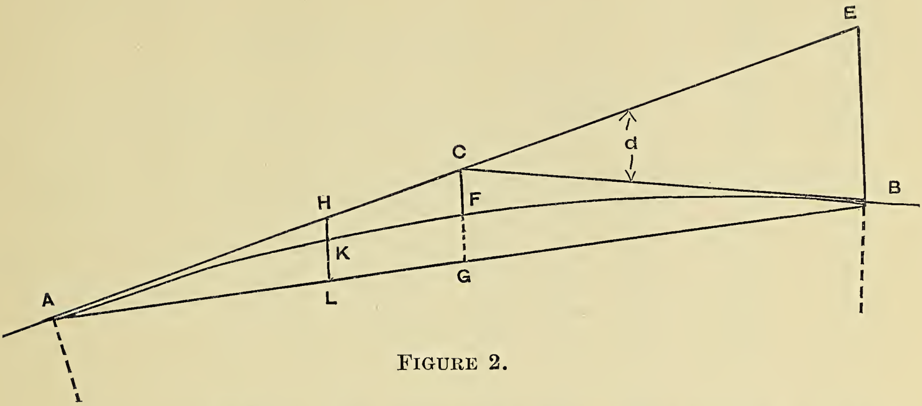

FIGURE 2.

In Fig. 2 let HK=z be the correction at a distance x from A; $m=$CF, the correction at vertex; d the *algebraic difference* of gradients, and $2l$ the length of curve in stations; then from the first property of the parabola, referred to above

$$z = m\frac{x^2}{l^2} \quad \ldots\ldots (4)$$

Prolong AC to E to meet a vertical through the end of curve at B, then EB$=ld$, and, since CF$=\frac{1}{2}$CG by the second property, similar triangles give CF$=\frac{1}{4}$EB, or

$$m = \tfrac{1}{4}ld \quad \ldots\ldots (5)$$

The length of curve, $2l$, may be fixed by local circumstances, or the average rate of change of gradient per station may be similarly fixed. Call this rate of change r, then for l in stations,

$$l = \frac{d}{2r} \quad \ldots\ldots (6)$$

If we substitute the value of d from (6) in (5) and the resulting value for m in (4), we shall have

$$z = \frac{rl^2x^2}{2l^2} = 0.5rx^2 \quad \ldots\ldots (7)$$

When $x=1$ station, $z_1=.5r$, when $x=\frac{1}{2}$, $z_{1/2}=0.125r$, when $x=2$, $z_2=2r$, when $x=3$, $z_3=4.5r$, etc.

In The Engineering News of November 26, Vol. XXXVI, was published a short table of corrections for a few values of d and assumed values of l, which I computed by formula (7). Similar tables may be computed for other values and field computations lessened by their use. The corrections are to be added when d is minus, and subtracted when d is plus. The table is reproduced below:

Algebraic difference of gradients—per cent.	Rate of change per station—feet.	Distances from vertex in feet.								
		0	50	100	150	200	250	300	350	400
0.3	0.075	0.15	0.08	0.04	0.01	0.	......	......	......	......
0.4	.1	.20	.11	.05	.01	0.	......	......	......	......
0.5	.125	.25	.14	.06	.02	0.	......	......	......	......
0.6	.15	.30	.17	.08	.02	0.	......	......	......	......
0.7	.175	.35	.20	.09	.02	0.	......	......	......	......
0.8	.20	.40	.23	.10	.03	0.	......	......	......	......
0.9	.225	.45	.25	.11	.03	0.	......	......	......	......
1.0	.25	.50	.28	.13	.03	0.	......	......	......	......
1.1	0.1833	.83	.57	.37	.21	.09	.02	0.	......	......
1.2	.20	.90	.63	.40	.23	.10	.03	0.	......	......
1.3	.2167	.98	.68	.44	.24	.11	.03	0.	......	......
1.4	.2333	1.05	.73	.47	.26	.12	.03	0.	......	......
1.5	.25	1.13	.78	.50	.28	.13	.03	0.	......	......
1.6	.2667	1.20	.83	.53	.30	.13	.03	0.	......	......
1.7	.2833	1.28	.89	.57	.32	.14	.04	0.	......	......
1.8	.30	1.35	.94	.60	.34	.15	.04	0.	......	......
1.9	0.2375	1.90	1.46	1.07	.74	.48	.27	.12	.03	0.
2.0	.25	2.00	1.53	1.13	.78	.50	.28	.13	.03	0.
2.1	.2625	2.10	1.61	1.18	.82	.53	.30	.13	.03	0.
2.2	.275	2.20	1.68	1.24	.86	.55	.31	.14	.03	0.
2.3	.2875	2.30	1.76	1.29	.90	.58	.32	.14	.04	0.
2.4	.3	2.40	1.84	1.35	.94	.60	.34	.15	.04	0.
2.5	.3125	2.50	1.91	1.41	.97	.63	.35	.16	.04	0.
2.6	.325	2.60	1.99	1.46	1.02	.65	.37	.16	.04	0.

Instead of a parabola, we might employ a flat circular curve to unite the two grade lines, and it may be of some interest to see what the equations to be employed will be like. There would be this advantage, that the rate of change per station would be uniform, and if need be the radius of curvature may be made constant for all differences of gradients, the length of curve varying with the intersection angle. If we let l, r and d have the same significance as before, the length l will be given by (6) as soon as r has been fixed upon.

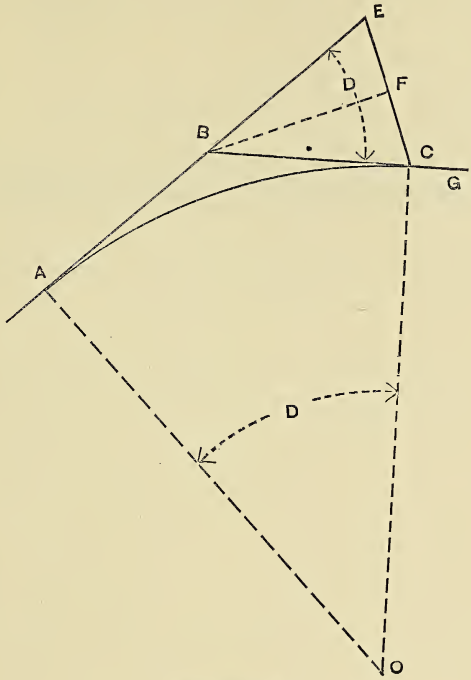

FIGURE 3.

To find the degree of curve in terms of r, let O of Fig. 3 be the center of curvature and AC one station, then will EC$=\frac{1}{2}r$. Draw BF to the mid-point of EC, BE being equal to BC. From the triangle EBC, since angle EBC=D, the degree of curvature,

$$2 \sin \tfrac{1}{2} D = \frac{\frac{1}{2}r}{50} = \frac{r}{100}$$

As D will always be small, we may write the arc for the sine without sensible error, giving

$$D = \frac{r}{100} \quad \dots\dots \quad (8)$$

As (8) gives D in π measure we have, when reduced to degrees,

$$D^0 = \frac{57.3}{100}r = 0.573r \quad \dots\dots \quad (9)$$

The offset for any point will now be, nearly enough,

$$z = R \text{ ex sec. } kD^0 \quad \dots\dots \quad (10)$$

In which R is the radius of curve and kD the angular change of tangent from PC, to the point where z is taken.

If the simple offset formula,

$$z = \tfrac{7}{8}x^2 D^0 \quad \dots\dots \quad (11)$$

be employed under the same limitations as in alignment location, a simpler formula will result. Substitute the value of D from (9) in (11) and we get

$$z = \tfrac{7}{8}x^2 \times .573r = .5014rx^2$$

or nearly enough

$$z = 0.5rx^2 \qquad \text{(12)}$$

a result identically the same as given by (7), thus showing that the circular curve does not materially differ from the parabola previously assumed.

[*Read before the Academy April 2, 1897.*]

EXPERIMENTS WITH X-RAYS UPON THE BLIND.

BY DRS. H. L. HILGARTNER AND E. F. NORTHRUP.

Since the experiments made by Hertz upon electric radiation, verifying the theory of Maxwell that induction is propagated in time, thereby demonstrating the existence of an ether, no scientific discovery has given rise to such widespread popular interest and extensive experimentation as Roentgen's remarkable chance revelation of the existence and the strange properties of the radiation from a Crooke's vacuum tube. Though physicists and physicians all over the world have been actively engaged in striving to add to the facts first set forth by Roentgen in his original paper, very little indeed has been added to our knowledge of the X-rays beyond what was given in this paper, now a little over a year old, which announced their discovery.

Though X-ray myths and theories are rife, physicists do not yet know what these rays are, nor have their proper relations to other well known phenomena as yet been pointed out. Things which are mysterious and not understood are generally assumed to possess hidden potencies which they do not possess. Many have looked to the X-rays hoping to find in them an agency for exciting vision in the totally blind. Reports of some very remarkable results of X-ray experiments upon the blind have, from time to time, appeared in the daily press and occasionally in the scientific journals. A letter from Dr. Louis Bell to the editor of The Electrical World, which was published in this journal December 12, 1896, stimulated the authors, especially in view of the extraordinary claims made in the letter, and the abundant material at our disposal, to carry on some experiments which should either verify or contradict the statements which came under our notice.

Dr. Bell claimed that his subject, a totally blind man, in whom blindness was due to paralysis of the optic nerve, was able to plainly distinguish the flickering of the Crooke's tube. A metal sheet cut off this vision entirely, and the subject was able to see a bunch of keys, the fingers, etc., shadowed upon the illuminated surface of the tube. Dr. Bell says that "the interesting feature of the experiment was this: a sheet of cardboard cut off vision as completely as the metal, and the subject could see forms cut out of cardboard as shadows against the tube." Dr. Bell seems to think that rays other than the X-rays were effective in exciting vision, since cardboard, which is highly transparent to X-rays, should not have stopped the vision if it were the X-rays which excited it. If Dr. Bell's interpretation of his results is correct, they have great scientific interest as indicating the complex nature of the radiation, so little understood, to which a Crooke's tube gives rise. Dr. A. E. Kennelly, in the transactions of the American Institute of Electrical Engineers, December, 1896, says that he has made some experiments upon the perception by the blind of the X-rays. He thinks his "experiments seem to show that when the mechanism of the retina has been destroyed, leaving the optic nerve in a useless or atrophic condition, no X-rays are perceived. When the mechanism of the eye is intact, but the optic nerve is deranged or paralyzed, some visual conception may be obtained by the stimulus of X-rays. When the optic nerve and the retina are both intact, but the cornea is deranged, the fluorescent effect of X-rays upon a calcium tungstate screen held before the eyes excites the visual sensation in the ordinary manner to a large degree that depends upon the corneal opacity. It would seem, however, although it is not certain, that the corneal opacity may itself feebly serve as a fluorescent screen, and the X-rays filtered through wood or pasteboard, falling on some eyes that are corneally blind, produce a faint visual sensation of diffused light."

The outfit employed in our test is of the best. A double focus tube is excited by a Tesla coil, capable of giving an eight-inch discharge. The X-rays produced will show a shadow of the hand upon the fluorescent screen at a distance of twenty-five or thirty feet.

Altogether, eleven subjects were experimented upon. One of these is a student in the University of Texas, and being highly intelligent and scientifically trained, was able to analyze and to accurately record his sensations. Of the subjects treated, seven had no light perception, the blindness being due, principally, to affection of the optic nerve, and four had some light perception. Three of the four having light perception were blind from trouble with the cornea and lens, while the fourth had paralysis of the optic nerve. The four having light perception were able to obtain a sensation of the light from the arc light placed at a distance of three or four feet. It is not necessary to enter into details regarding the test made upon each subject, for the tests were practically identical in each case, and the results the same for all. The manner of experimenting was, first, to allow the subjects to look directly at the tube at a distance from it of about one foot, and to inquire if they thought they had any light perception. In several cases of total blindness the subject seemed to think he or she had a light perception when the X-rays were excited in the tube; but, as further experiments proved, they were in all cases mistaken, and the supposed light perception must have been due to the suggestion arising, possibly, from one or more of three causes: the question put to the subject, the heat sent out from the tube, or the sound produced by the discharge of the coil. A screen of any kind placed between the tube and the subject's face could in all cases be detected. Mr. D., the University student, thought, however, that the presence of the screen was known to him by the sound or heat shadow which it cast upon the face. It is well known that the blind can detect the presence of boards and other objects placed several feet in front of them by the sense of hearing, sounds passing from the subject to the object and back again by reflection probably constituting the means by which the presence of the object is known. The next step was to place an ordinary drafting board, three-fourths of an inch thick, between the subject and the tube. The X-rays passed freely through this board, as was proved by the aid of the fluoroscope. While the X-rays were streaming directly into the eyes, a sheet of lead, impervious to the rays, was repeatedly placed between the tube and the drawing board, and then removed. No sensation was produced upon the eyes of any of the blind or upon the normal eyes by means of which the persons could detect when the lead sheet was screening the rays from their eyes and when it was not. This experiment was tried repeatedly with normal eyes, with those having some light perception, and with those who had none. The authors are, therefore, forced to conclude that the X-rays themselves have no power whatever of exciting vision, or even light perception, in any kind of an eye, diseased or normal. Of course, these results regarding the blind apply only to the eleven subjects experimented upon, and it would be unscientific to say that no subject can ever be found in whom the X-rays will excite light sensations. None of the blind subjects could see anything by looking into the fluoroscope, even those having some light perception getting no sensation, and our experiments gave us no hint that X-rays, or any other kind of rays, proceeding from the Crooke's tube are able to give any light perception to those who are blind from any cause whatever.

Even though others may think they find that the X-rays may, in some subjects, excite light sensation, the X-rays can serve no useful purpose to the blind. The X-rays not being refracted, they never give images of objects, and if the blind persons should be found whose retinas may be excited by them they would only distinguish different degrees of homogeneous brightness. It is not impossible that X-rays falling on a diseased retina might exert, by repeated application, a curative influence, though there is no reason supported by facts to encourage such a belief. To our minds, it is highly absurd to suppose that the X-rays can stimulate a diseased or destroyed eye to light sensation when they have absolutely no effect upon a normal eye. We should not have thought the above negative results worthy of record if the matter had not been taken up by scientists of eminence, and the newspapers filled with trashy and misleading myths.

[*Read before the Texas Academy of Science, June 15, 1897.*]

ON THE BIOGEOGRAPHY OF MEXICO AND THE SOUTHWESTERN UNITED STATES.

II.

BY C. H. TYLER TOWNSEND.

In these *Transactions*, I, pp. 71-96, the writer published a paper on the biogeography of Mexico, Texas, New Mexico, and Arizona, special reference being made to the limits of the life areas. Since the date of completion of that paper, Sept. 23, 1895, the writer has had the opportunity of visiting additional territory and making further observations in this region, particularly in Mexico. The results of this work are presented here as supplementary to the first paper.

MEXICO.

TAMAULIPAS AND NUEVO LEON.—In the latter part of September and first part of October, 1895, the trip was made from Matamoros, in Tamaulipas, to Monterey, in Nuevo Leon, going by rail as far as San Miguel, about 80 miles, and performing the rest of the distance, some 130 miles, by stage. The route traversed was as follows: Matamoros, Ramirez, Reynosa, San Miguel (end of railway), San Francisco, Camargo, Mier, Las Chicharrones, General Treviño, Cerralvo, Papagallos, Doctor Gonzales, Marin, and Monterey. The region passed through is an extremely interesting one, being on the northern dilute confines of the *Neotropical*, distinctly *Lower Sonoran* in the preponderance of its forms, but with a suggestion of the *Neotropical* here and there. An ascent of something less than 2000 feet is reached at Monterey, the ascent being very gradual all the way, except in crossing a foot-hill range beyond Cerralvo. The neighborhood of the Rio Grande is kept all the way from Matamoros to Mier, when the stage road strikes to the south into the interior. From Matamoros to Mier, and south as far as Cerralvo, the vegetation is characteristic of the *Lower Sonoran*—mesquite trees (*Pro-*

sopis juliflora var. *glandulosa*) and prickly pear (*Opuntia* sp.) predominating. The latter is especially abundant throughout the thickets of mesquite and other small trees and bushes, all the way from Matamoros up the river to San Miguel, this lower portion being sub-arid. Before getting to San Miguel, some gravelly ridges are crossed showing the beginning of the transition to the more properly arid district. From here on to Las Chicharrones, the soil and vegetation much resemble those of arid western Texas. The town of General Treviño is situated in a dry and arid-like region. The change in the arid aspect of the country is not marked until we arrive in the immediate vicinity of the town of Cerralvo, from which a fine view of the green mountain range to the west is had. On leaving Cerralvo, the road soon begins to encounter spurs from this range, which is known as the Sierra de Picachos, and the country becomes greener, betokening a greater rainfall. We cross a succession of these spurs and ridges, and soon encounter a region bristling with rather slim but tall and many-branched tree-yuccas, which reach to a height of 25 or 30 feet. In this region also the tree known to the Mexicans as *anacahuita* (*Cordia boissieri* A. DC.) was numerous and in full bloom at this date, Sept. 29. Trees of some size grow in this region, giving a character to the woods that is not exhibited farther down toward the coast. The mountain ridges are now finally left behind, the town of Papagallos is reached, and not long afterward the road emerges from woodlands on to plains of mesquite and brush, the plains cut here and there by arroyos. On crossing these, the town of Doctor Gonzales is reached, just beyond which a river is forded; and still continuing over plains gradually getting more fertile we reach Marin, a town situated only 25 miles from Monterey. From Marin on to Monterey the country is green, with a usually good rainfall and a more varied vegetation. This is the identical route passed over by Dr. Wislizenus, in 1847, from Monterey to Reynosa. He gives a detailed account of his trip, with maps, including a profile of elevations. His observations give Cerralvo an elevation of about 1000 feet, and Marin about 1350 feet. (See Miscellaneous Document No. 26, First Session of 30th U. S. Congress.)

After reaching Monterey, the trip was made by rail to Venadito, Torreon, and El Paso, Texas. In southern Coahuila, between Venadito and Torreon, and nearer to the former, immense patches of a small *Agave* were traversed, very much like *A. heteracantha* of southern New Mexico, if not the same; and it was also noted that *Dasylirion wheeleri* grows extensively in this region. This district must be in the neighborhood of 5000 feet elevation. The change from the rather humid region of Monterey to the dry arid region of the tableland was made gradually between Monterey and Venadito, as the road worked up between the spurs of the table land.

VERA CRUZ AND PUEBLA.—From February to July, 1896, more extensive trips were made in southern Mexico, the newly visited districts being as follows: From Vera Cruz city up the coast by steamer to Nautla; up the Rio Nautla by canoe about 12 miles to San Rafael (or Jicaltepec), where a stay of three months in all was made and large collections of insects secured, throwing much light on the affinities of that fauna; from San Rafael on horseback to Perote, about 95 miles, by way of Martinez, Tlapacoyan, Dos Caminos, and Tezuitlan; and later horseback from San Rafael by a route some 15 miles shorter, by way of Dos Caminos and Jalacingo to Perote, cutting through a dense tropical forest in the mountains between Dos Caminos and Jalacingo. Tezuitlan and Perote are in the State of Puebla, the other places being in Vera Cruz. Perote town is about 9000 feet elevation.

THE LOWER RIO NAUTLA.—*Insects in General.*—The writer has in process of publication an extended paper on the diptera of the lower Rio Nautla region, in the *Annals and Magazine of Natural History* (London). Section I of this paper, in which some general statements are made regarding this fauna, has already appeared. Section II has been sent in, and brings the list of identified species up to 44. Large collections of insects were made at San Rafael, from the first of March up to the 20th of July (not including the seven weeks from the middle of April to the first part of June), as follows: Coleoptera, about 600 species; lepidoptera, over 800 specimens; hemiptera, about 300 species; hymenoptera (except ants, bees, and mutillids), 750 specimens; ants, 25 colonies; bees and mutillids, about 300 specimens (about 50 of which were mutillids); orthoptera, 450 specimens; diptera, over 1100 specimens; attid spiders, about 1500 specimens; myriopods, 125 specimens; phalangiids, about 50 specimens. Outside of hexapods, no collections were made, except a small lot of 27 reptiles; a few terrestrial mollusca; and 35 species of plants, on the flowers of which the bees were taken.

Outside of the bees, diptera, mollusca and plants, the collections have not been worked up yet, but some general points have been noted in a few cases. While collecting the coleoptera and hemiptera, especially the former, a considerable number of familiar forms were recognized which had been previously taken by the writer in the lower Rio Grande region, near Brownsville, Texas. These species, however, were chiefly what represent the semitropical (in part *Neotropical*) element in these orders in the lower Rio Grande fauna, and are to be found in the palmetto hammocks a few miles down the river from Brownsville. Among the smaller heterocerous lepidoptera, many forms were recognized that had been taken at light in Brownsville. Many of the smaller hemiptera, Mr. Uhler writes, are species which occur commonly in Texas, New Mexico, and even in Colorado. The Orthoptera show about a dozen forms new to collections, out of 450 specimens. Regarding the hymenoptera, Mr. Ashmead writes that he was very much surprised to find a great preponderance of West Indian species among the parasites, and several of his own species only recently described from St. Vincent! There were, also, he adds, numerous specimens of a parasitic fig insect described by Mayr from Brazil! One of the ants, *Eciton foreli* Mayr, has been determined by Mr. Pergande, who adds that the spceimens belong to the most northerly form of that species, which is a widely distributed one in the American tropics.

Apidae. — Professor Cockerell has worked over nearly all of the bees collected, one paper being already published by him, and another being in process of completion. His first paper appeared in the *Annals and Magazine of Natural History* (London) for October, 1896. It contains descriptions of thirteen new species. In the genus *Augochlora*—a *Neotropical* group of pretty green bees, some with crimson abdomen—14 Mexican species are now known, including the San Rafael material. The latter contained 5 new species. Prof. Cockerell adds that only one species of *Augochlora* (*A. pura* Say) is known at present from New Mexico; and only 3 from Texas, of which *A. pura* is one. Some of the bees are closely allied to forms which occur in Brazil, but Prof. Cockerell thought, at least in regard to those mentioned in his first paper, that the bees of San Rafael showed more affinities with the Atlantic coast fauna of the United States. He will, however, in a forthcoming paper, give his full views on the subject. The San Rafael bees, so far as determined, are as follows:

1. *Prosopis azteca* Cress. or n. sp.—On flowers of No. 34. July.

2. *Halictus arcuatus* Rob. race or var. *argemonis*, Ckll.—On flowers of *Argemone mexicana*. April. *H. arcuatus* is an Illinois species.

3. *Halictus exiguus* Smith.—On flowers of *Ipomoea* sp. Mch. Peculiar to Mexico.

4. *Halictus politus* Smith.—On flowers of *Solidago* sp. and No. 22. Type locality is Oaxaca.

5. *Halictus pseudopectoralis* Ckll.—On flowers of *Bidens leucantha*(?) Willd. March 8 to 30. Allied to U. S. species.

6. *Halictus pseudotegularis* Ckll.—On flowers of *Argemone mexicana*. March 29. "Very near to the U. S. *H. tegularis* Rob." (Ckll.)

7. *Halictus townsendi* Ckll. — On flowers of *Bidens leucantha*(?) Willd. March 8 to 23. "A very distinct species, allied to *H. ligatus* which frequents compositae in the U. S." (Ckll.)

8. *Halictus* sp.—On flowers of *Cordia* sp., prob. *ferruginea*. June. "Apparently very near to the U. S. *H. obscurus* Rob.; differs from description only in having rufous tarsi." (Ckll.)

9. *Augochlora aurifera* Ckll.

10. *Augochlora townsendi* Ckll.—On flowers of the *Cordia*. June.

11. *Augochlora binghami* Ckll.
12. *Augochlora ignita* Smith.
13. *Augochlora nigrocyanea* Ckll.
14. *Augochlora seminigra* Ckll.
15. *Augochlora* (*Augochloropsis* Ckll.) *splendida* Smith.
16. *Augochlora* (*Augochloropsis*) *subignita* Ckll.

The above seven species of *Augochlora*, and new subgenus *Augochloropsis* Ckll., form a group whose affinities are in the main tropical.

17. *Calliopsis bidentis* Ckll.—On flowers of *Bidens leucantha*(?) Willd. March 14 to 23, and April 8. This species is of *Neotemperate* affinities, being closely allied to those which frequent compositae in the United States." (Ckll.)

18. *Nomada limata* Cress.—On flowers of *Bidens leucantha*(?) Willd. March. "*N. montezumia* Smith, from Orizaba, is a synonym of this species." (Ckll.)

19. *Epeolus lunatus* Say.—On flowers of No. 1. March. "A common U. S. species, widely distributed." (Ckll.)

20. *Coelioxys* sp.—The genus is common in the U. S.

21. *Osmia* sp. indet., probably new. — "Facies of a U. S. species." (Ckll.)

22. *Heriades* sp.—The genus occurs in the U. S.

23. *Megachile bidentis* Ckll.—On flowers of *Bidens leucantha*(?) Willd. March 8. "A singular little species, very near to *M. pilosa* Smith from the Amazons." (Ckll.)

24. *Megachile candida* Smith.—On flowers of *Verbesina* sp.? April 8. Peculiar to Mexico.

25. *Megachile chrysophila* Ckll.—June 20. "Very near to *M. montezuma* Cress." (Ckll.)

26. *Megachile perpunctata* Ckll.—On flowers of *Calopogonium caeruleum* (Benth.) Britt. March 18.

27. *Megachile rhodopus* Ckll.—On flowers of No. 1, March 3 (♀); and *Lippia reptans* H. B. K., June 18 (♂). "Allied to certain of the species found in Brazil." (Ckll.)

28. *Megachile veraecrucis* Ckll.—On flowers of *Lippia reptans* H. B. K., June 18. "Superficially this is much like the male of *M. candida* Smith." (Ckll.)

29. *Ceratina amabilis* Ckll.—On flowers of No. 11, *Ipomoea* sp., and *Canna* sp. March. "Very near to *C. eximia* Smith from Panama." (Ckll.)

30. *Ceratina dupla* Say.—On flowers of *Bidens leucantha*(?) Willd., and *Verbesina* sp.? March. Common U. S. species.

31. *Ceratina nautlana* Ckll.—On flowers of *Bidens leucantha*(?) Willd. March. "Near to *C. strenua* Smith from Texas." (Ckll.)

32. *Melissodes atrata* Smith.— On flowers of *Sphaeralcea* sp.? April 7. Described from Oaxaca.

33. *Melissodes floris* Ckll.—On flowers of *Bidens leucantha*(?) Willd. March 8 to 23. "This is closely allied to the U. S. *M. agilis* Cress." (Ckll.)

34. *Melissodes labiatarum* Ckll.—On flowers of No. 1, March 11; and *Teucrium* sp., April 7 to 8.

35. *Melissodes pernigra* Ckll.—On flowers of *Ipomoea* sp. March 16 and 26. "Closely allied to *M. atrata* and *bimaculata*. In the U. S., Robertson has observed the allied *M. bimaculata* visiting *Ipomoea*." (Ckll.)

36. *Melissodes pinguis* Cress. — On flowers of *Sphaeralcea* sp.(?) March. "A remarkable species peculiar to Mexico. The ♂ is dichroic, one form having hair silvery, the other golden." (Ckll.)

37. *Melissodes raphaelis* Ckll.—On flowers of No. 1, *Vernonia* sp., No. 7, and *Ipomoea batatas* (L.) Lam. March 8 to 15. "Allied to *M. gilensis* Ckll. ined., from New Mexico." (Ckll.) *M. gilensis* was collected by the writer on the headwaters of the Gila.

38. *Entechnia fulvifrons* Smith.—"A *Neotropical* species, which goes north as far as Comal county, Texas. It is represented in the eastern and southern U. S. by the closely allied *E. taurea* Say." (Ckll.)

39. *Xylocopa* sp.—On flowers of No. 18. March. A U. S. and tropical genus.

40. *Bombus carolinus* L.(?)—"A *Neotropioal* species. Smith has described it as *B. excellens* from Venezuela." (Ckll.)

41. *Apis mellifica* L.—Occurs at San Rafael on various flowers.

42. *Euglossa* sp.—"A *Neotropical* genus not found in the U. S." (Ckll.)

43. *Exomalopsis penelope* Ckll.—On flowers of *Cordia* sp., prob. *ferruginea*, and No. 34. July. "Allied to *E. solani* Ckll. from southern New Mexico, and still more to *E. tarsata* Smith from Santarem, Brazil. The genus is *Neotropical*, going only as far north as Albuquerque, N. M. Two species are found in the Mesilla Valley, N. M." (Ckll.)

44. *Temnosoma smaragdinum* Sm. var. ♂ ♀ —On flowers of the *Cordia*. June.

45 and 46. *Melipona*, 2 spp.—On flowers of No. 11. March. "*Neotropical* genus not found in the U. S. Very abundant in the tropics." (Ckll.)

It will be seen from the above list of 44 species of bees, that fully one-half are strictly *Neotropical* species—either known species, or new species which present affinities with such, thereby indicating their relationship with them; while a large part of the remainder are modified forms, apparently descended from *Neotemperate* species, but having become *Neotropical* through long inherited adaptation to their surroundings.

Diptera.—The diptera show very decidedly *Neotropical* affinities. Out of the first lot of 22 species determined by the writer and already published, there are only 4 or 5 that are not strictly *Neotropical,* and these are common to the *Neotemperate* and *Neotropical* regions. In the second lot of 22 species, there are 7 species which are *Neotemperate* as well as *Neotropical,* while all the rest belong to the latter region. The remaining mass of the diptera, still undetermined, promises, so far as a superficial examination goes, to fall not far short of this proportion. Those species so far determined are here given. Unless otherwise noted, they are purely *Neotropical.* The numbers in parentheses are those under which the species were published.

1. *Oecacta furens* Poey.—March 5. Nautla at the mouth of the river. This species is known from Cuba, Jamaica, and the Mexican coast from Tamaulipas to Tabasco. (1)

2. *Psychoda punctatella* Towns. (n. sp.)—March 30. (23)

3. *Olbiogaster taeniatus* Bell.—June 26. The only other locality known is Tuxpango, Vera Cruz (near Orizaba). (24)

4. *Sargus* sp.—June 19. Belongs to a *Neotropical* group. (2)

5. *Chrysops costatus* Fab.—March 16. This is the first record from Mexico. Known from the West Indies, Guatemala, Nicaragua, and Brazil. (3)

6. *Hadrus lepidotus* Wd.—March 5. Known from Cuba and Mexico to Guiana and Brazil. (4)

7. *Tabanus mexicanus* var. *limonus* Towns. (n. var.)—July 17. On flowers of the *Cordia* sp. The varieties of *mexicanus* extend from Florida, the Southern U. S., and Mexico, to Cayenne and Brazil. (25)

8. *Leptogaster pictipes* Lw.—June 21. Belongs to a group of closely allied species occurring from Illinois to Mexico, Cuba, Jamaica, and Porto Rico. (26)

9. *Nausigaster meridionalis* Towns. (n. sp.).—July 16. On flowers of the *Cordia* sp. Belongs to a small group of *Nausigaster* occurring from the lowlands of Texas through tropical Mexico to Brazil. (5)

10. *Baccha phaeoptera* Schin.—March 30. Belongs to a group occurring from South Florida, Cuba, and the lower Rio Grande through tropical Mexico to Brazil. (6)

11. *Ocyptamus fuscipennis* Say.—March 2 to April 7. First record of the species from Mexico. It occurs from the Atlantic States and Florida to Kansas, Mexico, and the West Indies. (7)

12. *Volucella obesa* Fab. — July 18. On flowers of the *Cordia* sp. Florida to New Mexico, and throughout the American tropics, as well as other tropical countries. (8)

13. *Volucella viridana* Towns. (n. sp.).—July 7. On flowers of the *Cordia.* (33)

14. *Volucella chaetophora* Will.—July 7 to 10. On flowers of the *Cordia.* (28)

15. *Volucella opalina* Towns. (n. sp.).—July 6 to 17. On flowers of the *Cordia.* (32)

16. *Volucella nautlana* Towns. (n. sp.). June 28 to July 7. On flowers of the *Cordia.* (31)

17. *Volucella cordiae* Towns. (n. sp.).—June 30 to July 13. On flowers of the *Cordia.* (29)

18. *Volucella rafaelana* Towns. (n. sp.).—July 1. On flowers of the *Cordia.* (30) These last five species, Nos. 14 to 18 inclusive, belong to a *Neotropical* group of *Volucella* so far recorded only from tropical Mexico. No. 13 connects this group with the *obesa* group.

19. *Eristalis ornatus* Towns. (n. sp.).—July 10. On flowers of the *Cordia.* Nearly allied to *E. ochraceus* Will., which occurs from Tabasco to Brazil. (9)

20. *Meromacrus crucigerus* Wd.—July 1 to 18. On flowers of the *Cordia.* Carolina, Florida and Cuba to Texas, and tropical Mexico to Tabasco and Yucatan. (10)

21. *Stylogaster ethiopa* Towns. (n. sp.).—March 29. (12)

22. *Stylogaster stylosa* Towns. (n. sp.).—March 29. (11)

23. *Stylogaster minuta* Towns. (n. sp.).—March 29. (13) The genus *Stylogaster* occurs from the lowlands of the United States to Brazil. This is the first record from Mexico or Central America. These three species were found hovering over and ovipositing in an army of ants, *Eciton foreli* Mayr.

24. *Hyalomyia ecitonis* Towns. (n. sp).—March 29. Belongs to a *Neotropical* section of a group of *Hyalomyia* extending from Western North America to the American tropics. Numerous specimens were found in company with the *Stylogasters,* doubtless also ovipositing in the ants. (34)

25. *Hyalomyia violascens* Towns. (n. sp.).—June 26. Belongs to a group which occurs from the lowlands of the United States to the American tropics. (35)

26. *Trichopoda formosa* var. *radiata* Lw.—July 2 to 4. On flowers of the *Cordia.* (36)

27. *Trichopoda formosa* var. *inconstans* Wd.—July 2 to 6. On flowers of the *Cordia.* (37) These two species belong to the *formosa* group, which occurs from Maryland to Florida, and through tropical Mexico to Brazil.

28. *Trichopoda lanipes* var. *tropicalis* Towns. (n. var.).—June 28. On flowers of the *Cordia.* (38)

29. *Trichopoda tegulata* Towns. (n. sp.).—July 1. On flowers of the

Cordia. (15) These two species belong to the *lanipes* group, occurring also from Maryland to Florida, tropical Mexico, and Brazil.

30. *Trichopoda pennipes* var. *pilipes* Fab.—June 18 to July 10. Mostly on flowers of the *Cordia.* (40)

31. *Trichopoda pennipes* Fab.—March 9 to July 18. Mostly on flowers of the *Cordia.* (39) These two belong to the *pennipes* group, extending from the lowlands of the northern United States to Argentina.

32. *Trichopoda histrio* var. *indivisa* Towns. (n. var.).—June 30. On flowers of the *Cordia.* Belongs to the *histrio* group, extending from Connecticut through the eastern lowlands of the United States and Mexico to Brazil. (41)

33. *Trichopoda phasiana* Towns. (n. sp.).—June 30 to July 13. On flowers of the *Cordia.* Belongs to a *Neotropical* group, not before known outside of South America (Brazil). (42)

34. *Acaulona costata* Wulp.—July 12. On flowers of the *Cordia.* The genus is so far known only from the tropical Gulf coast region of Mexico. (14)

35. *Cistogaster immaculata* Mcq.—March 18. (16)

36. *Cistogaster occidua* Walk.—March 9. (43) The genus is so far known from the lowlands of the northern United States to tropical Mexico and the West Indies.

37. *Penthosia satanica* Big.—July 4 to 6. On flowers of the *Cordia.* Known only from tropical Mexico. (17)

38. *Xanthomelanodes arcuata* Say.—March 28 to July 16. On flowers of the *Cordia* mostly. The genus occurs from Maryland, Indiana and Illinois, to Florida and tropical Mexico. (44)

39. *Saundersia rufopilosa* Wulp.—March 23 and 24. Heretofore recorded only from Guatemala and Costa Rica. (18)

40. *Belvosia bicincta* Desv.—July 16. On flowers of the *Cordia.* (19)

41. *Belvosia bifasciata* Fab.—June 20. (20) These two forms of *Belvosia* occur from the United States generally, to Brazil.

42. *Phasiopteryx bilimeki* B. & B.—March 9. Known only from Mexico, but reaching the lower Rio Grande. The genus extends to Brazil, where it is represented by *P. depleta* Wd. (21)

43. *Euantha dives* Wd.—March 6 to 16. Florida and Kentucky to South America. (22)

44. *Lipoptena depressa* Say, var. *mexicana* Towns. (n. var.).—March 27. On Mexican white-tailed deer, *Cariacus virginianus mexicanus.* The only record of *L. depressa* (typical form) is from Pennsylvania, which is the original locality given by Say, since when the species has never been recorded until now from Mexico. (45)

None of the above species from the Rio Nautla was found by me on the lower Rio Grande, excepting *Phasiopt. bilimeki.* *Baccha phaeoptera* is represented there by *B. tropicalis* Towns. (n. sp.) Not a specimen of *Trichopoda, Cistogaster, Hyalomyia,* or other phasiid, gymnosomatid, ocypterid, or phaniid genus, was met with on the lower Rio Grande, excepting only *Ocyptera euchenor.* But some species of diptera, yet undetermined, from the Rio Nautla and Rio Grande are the same.

Mollusca.—In the September, 1896, *Nautilus,* Mr. H. A. Pilsbry has published a list of terrestrial mollusca, which were all taken on the native vegetation. They are as follows:

1. *Helicina flavida* Menker and varieties.
2. *Glandina* sp. (young).
3. *Volutaxis similaris* Strebel.
4. *Praticolella griseola* Pfr. Also taken by me on lower Rio Grande.
5. *Praticolella ampla* Pfr.
6. *Bulimulus sulphureus* Pfr. and varieties.

It may be added that *P. griseola* was taken, with *Succinea brevis* Dkr., on orange trees in Tampico, by the writer, Oct. 14, 1894 (see Bull. Div. Ent., U. S. Dept. Agric., Techn. Series, No. 4, p. 16).

Flora.—The plants, on the flowers of which the bees were taken, were sent to Dr. J. N. Rose, who has partially determined them. They were later sent to Prof. E. O. Wooton, who worked some of them out more fully. The dates refer to observed time of blooming, and the numbers in parentheses are those of my own collecting. They are as follows:

1. *Argemone mexicana* Linn.—March to April. Det. Rose. (24)
2. *Malvastrum* sp.?—March 13. Det. Towns. (9)
3. *Melia* sp.—March 18. Det. Rose. (16)
4. *Vitis* sp.—April. Det. Rose (also Wooton). (26)
5. *Erythrina* sp.(?)—March 18. Det. Towns. (15)
6. *Calopogonium caeruleum* (Benth.) Britton.—March 8. Det. Miss Vail. (4)
7. *Hamelia* sp.—March 18. Det. Rose. (17)
8. *Vernonia* sp.—March 8. Det. Rose. (5)
9. *Solidago* sp.—March. Det. Towns. (19)
10. *Baccharis* sp.—March 13. Det. Rose. (8)
11. *Melampodium* sp. (possibly two spp.).—March 9, and June. Det. Rose. (6, 30)
12. *Verbesina* sp.(?)—March. Det. Towns. (20)
13. *Bidens leucantha* Willd.—March 8. "Rays are pink, instead of white as given in description" (det. Wooton). (23)
14. *Cnicus* sp.—March and April. Det. Rose (and Wooton). (23)
15. *Cordia* sp. probably *ferruginea* (Auct.?).—June and July. Det. Rose. This species occurs from the lowlands up to about 4000 or 4500 feet. It is known as "barra negra." As well as being a good bee-plant, it is an extremely good fly-plant, a very large number of tropical species

of diptera having been taken on its flowers—in fact the greater part of all the diptera collected at San Rafael. These came almost entirely from two approximated patches of this plant. Its flowers are small and inconspicuous, but they were about the only flowers in the vicinity through June and July. This plant seemed to be rather of occasional occurrence in the lowlands, but was noticed particularly above Tlapacoyan on the road to Perote, as far up as about half way between Tlapacoyan and Jalacingo, about 4000 feet elevation or over, being in height of bloom July 20 and 21. (31)

16. *Ipomoea batatas* (Linn.) Lam.—March 13. Det. Wooton. (10)

17. *Ipomoea* sp.—March 16. Det. Rose. (14)

18. *Lippia reptans* H. B. K.—June 18. Det. Wooton. (29)

19. *Lantana* sp., probably *camara* Linn.—June and July. Det. Towns. (32)

20. *Teucrium* sp.—April. Det. Rose. (27)

21. *Piper* sp.—Food-plant of *Papilio* sp. Det. Rose. (35)

22. *Manihot* sp.—March to July. Called "mala muger." Det. Rose. This is a giant nettle, whose leaves and stems are covered with fine and delicate but most irritating spines, which are exceedingly painful if barely touched to the skin. It grows in luxuriance in the neighborhood of San Rafael, often attaining the proportions of a tree, with a straight and tall woody trunk. It grows likewise in the environs of Orizaba, Jalapa, Cordova, and in the moist mountain region of southern Tamaulipas. The flowers are pure white, borne in an upright cluster. (33)

23. *Canna* sp. probably *indica* Linn. — March and April. Det. Towns. (21)

24. *Commelina pallida* Clark.—April. Det. Rose. (25)

A considerable number of other plants were collected, but have not been determined even generically. These names are but few and the determinations somewhat fragmentary, yet they present a few useful notes which it is well to record here.

General Remarks.—San Rafael is about four or five miles inland from the coast in a straight line, about ten miles by river; and is about 20 or 30 feet above sea level. It is about 75 miles by road north of Jalapa, but much nearer in a straight line; and the town of Nautla at the mouth of the river is about 70 miles by sea from Vera Cruz. The collecting was done there in March, April, June and July.

This is a very good vanilla district, being no doubt of the same nature as the famous Papantla district more to the north. Coffee produces extremely well, and in large yields. Rubber, cocoanuts, and even cacao do well, as do also pineapples, oranges, sapotes, mangoes, papaws, bananas and all other tropical fruits. Mangos sometimes, however, do not seem to ripen well; and cacao seems to have some difficulty in maturing its fruit, which is often attacked by rot while still green. The papaw, *Carica papaya*, grows wild; also *Colocasia*, *Bromelia pinguin*, etc. There are occasional, often frequent, northers through the winter months, continuing through March, and even April. They are usually accompanied by rain. This immediate section is not so liable to untimely drought as some other parts of the coast country of this region. It may be stated that San Rafael is a French colony, on the north side of the Rio Nautla, and about a mile down the river from the town of Jicaltepec, which is situated a little further up, on the south bank of the river.

On the whole the Rio Nautla insect fauna is decidedly tropical in its affinities; but from the fact of its possessing a considerable number of *Neotemperate* types, it must come well within the limits of the *Tamaulipan* fauna, which I have already defined as reaching from the neighborhood of the Nueces river in Texas south along the Mexican Gulf coast, probably as far as the southern limits of the State of Vera Cruz beyond the Coatzocoalcos river.

The mammals, birds, and reptiles of course all bear out, so far as could be noted, the decided tropical affinities of the fauna as indicated by the insects. The "noyaca," large iguana, etc., are found here in this region.

Characteristics of the Region between Jicaltepec (San Rafael) and Perote.—Martinez is about twenty miles by road from San Rafael, on the way to Perote. It is also on the Rio Nautla, elevation probably something like 400 feet. When about half way to Martinez, the Rio Santa Maria de Martinez is crossed, which flows into the Rio Nautla. Its immediate vicinity shows a richer fauna and flora than the surrounding country. About twenty miles beyond Martinez is Tlapacoyan, elevation probably about 1000 feet, situated at the foot of the mountains which rise into the table-land of Mexico. Its vicinity is rich in flora and fauna, as this district receives much more moisture than the much dryer coast region. Tezuitlan and Jalacingo are each about half way between Tlapacoyan and Perote, but on different roads, the road by way of Jalacingo being shorter; by which route it is about forty miles from Tlapacoyan to Perote. The tropical vegetation extends up to about the 4000 feet contour line, Jalacingo being probably about 5500 or 6000 feet, and Tezuitlan about 6500 or 7000 feet. Peaches bear in profusion at Jalacingo, and apples are grown at Tezuitlan. Not far above Tlapacoyan, at an elevation of about 3000 feet, the tree-fern region is encountered, and extensive areas of high tree-ferns are passed on the road. The scenery, as the mountains are gradually ascended, is grand and beautiful in the extreme; and especially between Dos Caminos and Jalacingo, while threading the narrow trail through the damp tropical forest, the views to be obtained from the mountain sides when the trail emerges into an opening are magnificent.

Not far above Tezuitlan, but much farther above Jalacingo, the road enters an entirely different region. Here the vegetation, the grass, the pine trees farther up, even the rocks, the soil and the yellow dust of the road, remind one of the New Mexico mountain regions. The *Tropical* has been left far below, and the *Lower Sonoran* as well; while the higher levels of the *Upper Sonoran* are everywhere evident, giving way to the *Transition* which is next passed into and traversed. The *Upper Sonoran* must begin here at about 6000 feet, and the *Transition* must extend from about 8500 or 9000 feet upward. The road goes for long distances through pine woods, the air is clear and the sky blue, the birds possess the habitus of northern species and remind one of the latter by their song—in fact, one can hardly resist the delusion that he is in the *Transition* of New Mexico, and practically it is the same region. From here the road descends again somewhat, leaving the pines behind but not far above, and emerges upon the Plains of Perote. It is some ten miles across these plains, which must be about 8500 feet elevation, or possibly a little more. Here the maguey (*Agave americana*) grows, apparently at about its best so far as the production of a good quality of pulque is concerned, for the pulque of Perote has the reputation of being the best in Mexico. It seems that the maguey must be considered, in the valleys and plains of the southern table-land region of Mexico, to grow in the *Upper Sonoran* as well as the *Lower Sonoran* zones, thus exceeding here the possibilities of its zonal range in Texas and Northern Mexico. This case is perhaps somewhat paralleled by the peculiarities in the range of *Larrea* in California and New Mexico, as mentioned in paper I. Possibly, in the case of the maguey, sheltering mountain ridges exert some influence in this condition of things; while I believe that the *Larrea*, in California, has adapted itself more to the warmer temperatures natural to the Pacific coast region, but has been unable on the Atlantic slope to invade to any extent the corresponding stretches of *Lower Sonoran* in Mexico. It must be borne in mind that the Atlantic slope stretches of the *Upper* and *Lower Sonoran* are vastly more extensive than those of the Pacific slope; and this fact carries with it a greater element of competition among species, not to mention differences in soil, humidity, seasonal winds, etc., between these two regions of the country.

TABASCO, CAMPECHE, AND YUCATAN.—In April and May, 1896, the trip was made from Vera Cruz by coast steamer to Coatzocoalcos, Frontera, Laguna, and Campeche; by rail from Campeche to Hecelchakán in Yucatan; by volan from Hecelchakán to Maxcanú, thirty-six miles; then by train to Merida, Izamal, and Progreso. From Izamul a horseback trip was made some ten miles southeast to the cenote of Xcolak.

Campeche and the Yucatecan Fauna.—The Gulf coast region presents quite the same coast view from the sea at Tampico, Nautla, Vera Cruz, Coatzocoalcos, Frontera, and Laguna—green the year round, and always tropical in aspect. But when we approach the coast in the vicinity of the city of Campeche, we behold a country of different aspect. Especially strong is the contrast in the dryest season of the year, in April and May. At this time, before the rains begin, the outskirts of Campeche and the coast in that vicinity (leaving out of consideration a few cocoanut palms) present the appearance of a desert mesa in winter in arid Texas and New Mexico. The scrubby growth of native bushes is sere and brown. No shades of green enliven the landscape or rest the eye. The crust of the earth is rocky and gravelly, while the heat is intense. These conditions obtain from Campeche eastward and northeastward over the whole northern half or more of Yucatan. It must be said that there are many stretches of wooded land in this extent of country, or patches here and there; but the trees have such a bizarre form, and wear such a woe-begone expression, in the dry season at least, that these stretches can not lay claim to the dignity of forest regions. The trees are of only moderate height, and the soil is so precarious and incapable of retaining moisture that they are rough, scrubby, and gnarled in growth, and most ungraceful in appearance. No handsome, symmetrical, and well-formed trees are to be seen in a state of nature. There is no green to be seen in the native vegetation except occasional clumps of a thorny bush which seems able to withstand the absence of moisture and still furnish green leaves. Square miles of henequen (*Agave sisalana*) grow everywhere, cultivated for the fibre. This plant may be taken as characteristic of this peculiar half-tropical and half-arid lowland district of Yucatan and Campeche. This country seems like an immense stretch of *Lower Sonoran* set down in the midst of the tropical, but scrupulously preserved intact, notwithstanding its direct contact with the latter over a wide area. Nothing but the peculiar geological conditions could so influence the meteorology, and through it the biogeography of a region; and here is furnished a hint which we may well heed in attempting to explain anomalies in geographic distribution in other localities. Where the henequen will grow to good advantage may doubtless be taken to mark the extent of this flora and fauna, which must be considered as removed entirely from the *Tamaulipan* fauna, but analogous to the northern sub-arid portions of the latter. I have called this fauna the Campechian in my previous paper, but the term *Yucatecan* fauna is far more appropriate and correct, and is adopted in this paper. Whether there is another fauna in this Gulf coast region, between the *Tamaulipan* and the *Yucatecan*, remains to be seen. If so, it must appear at its best in the State of Tabasco, and will take its name therefrom. A contemplated trip to that region, which the writer proposes soon to set out on, for the purpose of making much more extensive collections than heretofore, will, as soon as the collections are worked up, at once decide the point as to the affinities of the fauna and flora of Tabasco.

It may be said in general that the surface of Yucatan consists, for the most part, of limestone rock covered with a very scanty soil. The rock crops out constantly on the surface. The henequen plants thrive in this soil, which, without good rainy seasons, or artificial irrigation, will not produce any other crop. There are no surface streams in Yucatan, but subterranean streams flow beneath all this country, so far as can be judged. The only water to be found on the surface in the dry season is that contained in large holes known as *cenotes* and *aguadas*. A cenote is considered to be an opening to an underground river. A brief description of the first cenote of Xcolak (a Maya word pronounced schkoláck, with a strong gag-like delivery on the first *k*, a holding of the *o*, and a strong accent on the last syllable) will give a correct idea of most of them in the dry season.

What looks like a circular pond of slightly greenish water, about 150 feet in diameter, is seen lying at the bottom of a sudden depression in the surface of the ground, in the midst of the dry and dusty woods. Everything around looks dry and parched, except a little green vegetation on the banks encircling the water. Even the water presents a stale appearance, and does not seem capable of reducing the thirst caused by the intense heat. Its surface is sluggish and motionless, and bears particles of moss or algae floating on it or suspended within it. The water is about ten or twelve feet below the surface of the surrounding country and the banks surrounding it are steep. On the southwest side the water can be waded into for a short distance, but one sinks up to his knees in the soft mud or debris. On the north side the bank comes down more abruptly, and the water goes down sheer at the edge. These cenotes are said to have no bottom, some of them having been sounded with long lines without finding bottom. Dr. George F. Gaumer, of Izamal, told the writer that he had on several occasions tied a long line, with a lead sinker on the end, to a piece of cork used as a float, and placed it in the water at the south end of a cenote, when the cork would invariably slowly float across the surface to the north edge, although the water was absolutely quiet; thus indicating a current deep down, always from south to north, acting on the lead sinker. From these observations Dr. Gaumer concludes, and I think with good reason, that these cenotes are the openings, or overflow valves, as it were, of underground rivers, flowing from south to north. In further evidence of this it should be stated that there are at intervals of a half mile, or a few hundred yards, several other cenotes stretching southward in a line from this first cenote of Xcolak. Crocodiles have been seen in the cenotes, so I was informed, and persons have been drowned while bathing in them, and their bodies never recovered. Dr. Gaumer informs me that two species of fish inhabit all of them—the only fresh water fish known in Yucatan—a pout and a sunfish. The writer caught both of these species with hook and line in Xcolak.

An aguada is a water-hole that has a bottom, and is formed by water collecting during the rainy season in a natural depression of the ground. These are often of large size, holding sufficient water to last throughout the dry season. They are therefore entirely different in character from the cenotes.

Such are the characteristics of the natural surface waters of Yucatan—the water-holes where the wild animals of the country formerly drank, and do yet to this day. Many cattle water at them also, as shown by their tracks at Xcolak; and as witnessed by the countless thousands of ticks, both great and small, that swarm over the dead leaves and branches, and even on the heated surfaces of the bare ledges of rock that lie near the edge of the water, in places where cattle can get down the banks. Despite its appearance this water will quench the thirst, if given time and taken in sufficient quantity, and seems to leave no bad effects. At least the writer took copious draughts of it, warm and greenish as it was, during a whole day. Afterward, about 4 o'clock in the afternoon, impelled by the arid heat of the day, the dust, and the ticks, throwing all precautions to the winds, he stood on a clean bare platform of yellow rock in the shade on the north edge of Xcolak, where the depth was sheer and unknown, and dove many times into the greenish waters, and swam in them; emerging therefrom with a delicious feeling of invigoration, both of body and mind. Such is Yucatan in the dry season.

Since the above was written the peculiar features of Yucatan have been well described by Mr. Frank M. Chapman, of the American Museum of Natural History, in a paper on birds observed at Chichen Itza (Bull. Am. Mus. N. H., vol. VIII, art. XVIII); and by Dr. C. F. Millspaugh, of the Field Columbian Museum, in a work on the flora of Yucatan (Publications Nos. 4 and 15, Field Col. Mus., being Botan. series, Vol. I, Nos. 1 and 3). These, with some important observations given by Dr. Gaumer in a paper by Boucard on the birds of Yucatan (Proc. Zool. Soc. Lond., 1883, pp. 434-462), furnish a very clear idea of the meteorologic and geologic conditions prevailing in Yucatan, and the consequent quite anomalous biogeographic peculiarities which they entail.

A horsefly, taken in numbers on our horses at Xcolak, proves to be an undescribed species, and I have named it *Tabanus yucatanus.* Moreover, it is the first recorded tabanid from Yucatan, so far as I know, which seems strange. A new species of scale-insect, found at Xcolak, has also proved to be of much interest, and has been named by Professor Cockerell *Lecanium* (*Eulecanium*) *perditum.*

Four attid spiders, collected from the scanty green native vegetation at Izamal, in May, have been identified at the United States Department of Agriculture, by Mr. Banks, as follows: *Zygoballus sexpunctatus* Hentz; *Zygoballus* sp.; *Dendryphantes nubilus* Hentz; and *Habrocestum* probably n. sp. The trip from Vera Cruz to Yucatan was made under the auspices of the United States Department of Agriculture, in the interests of the Entomological Division.

The Tabascan Fauna.—Since the foregoing was written, the writer has begun the work of making the Tabasco collections already referred to, and has spent two months in this work at Frontera. It is evident, from observations so far made and material collected, especially as regards mammals, birds, reptiles and insects, that there appears here another well marked fauna cropping out on the coast, between the *Tamaulipan* and the *Yucatecan.* It should be known as the *Tabascan* fauna. Its details can be worked out only with the careful study of the collections when completed, but it will doubtless be found to extend in general from the Coatzocoalcos river to central Campeche, taking in nearly all of Tabasco and the lowlands of northern Chiapas, and extending across northern Guatemala to Belize. Nearly the whole of the State of Tabasco is composed of lowlands, which extend up the Usumacinta river to the Guatemalan frontier. Over this immense stretch of low, rich and well watered country, from the upper waters of the Rio Usumacinta down to the Tabasco coast, the tropical types of Central America have spread northward from eastern Guatemala and Honduras. While some extend on farther north through Vera Cruz, others reach their limit here, and thus a differentiated character is imparted to the fauna. This district is the most decidedly tropical (*Neotropical*), with all the attributes which the word implies, of all Mexico. The lowlands, between the mountains and the coast, are of much wider extent here than elsewhere on the Gulf of Mexico coast within the tropics, while the conditions of soil and climate are the most favorable for tropical life. The extensive lowlands, only very gradually rising, which stretch away into the interior up the Usumacinta to Guatemala, store up and retain the heat, and increase the annual totals of temperature control. At the same time they reduce the possibilities of low winter temperatures. Northers are, as a rule, hardly felt here in the interior. On the coast they are usually light, and occur normally only in January and February.

A coccid secured at Laguna, which comes within this fauna, proves to be extremely closely allied to the notorious *Diaspis amygdali* of the West Indies, Australia, etc.

ISTHMUS OF TEHUANTEPEC (southern Vera Cruz and Oaxaca). During the last two weeks of May, a trip was made by rail from Coatzocoalcos across the Isthmus of Tehuantepec to Tehuantepec City, and Salina Cruz on the Pacific coast; returning horseback later from Salina Cruz to Tehuantepec.

The Atlantic (Gulf of Mexico) slope of the Isthmus of Tehuantepec is *Tropical,* but on the Pacific slope a change is noticeable. The soil and vegetation are more arid in character, and pertain to the *Lower Sonoran.* Around Tehuantepec City, for instance, the aspects of the country and vegetation are those of Sonora, or southern Arizona. On the railroad, long before reaching Tehuantepec City, while going down amongst the hills, the tall cacti and other plants indicate distinctly the *Lower Sonoran.* This shows the *Lower Sonoran* zone to run far on south of the latitude of Oaxaca city, as mentioned in my previous paper, along the Pacific slope of the Isthmus, and doubtess continuing down through Chiapas. Moreover, the *Lower Sonoran* extends down in places over the whole Pacific slope of Mexico to the seacoast itself, judging from the conditions on the Isthmus of Tehuantepec and in southern Sonora, and is not bordered by a continuous tropical coast strip, as on the Gulf of Mexico coast. The *Tropical* exists here along the Pacific slope only in broken patches, in river and mountain valleys and favored spots, like deep barrancas, where the soil and the rainfall are adapted to it. The much greater absence of rainfall on the Pacific slope is the cause of this rather remarkable variance in biogeographic conditions. Sumichrast has remarked (Bull. U. S. Nat. Mus. No. 4) on the differences in the bird faunas of the Atlantic and Pacific slopes of the Isthmus of Tehuantepec.

Of course, it must be remarked that the economic possibilities of the flora here are *Tropical,* provided irrigation and artificial soiling are resorted to where needed, but the natural or meteorologic conditions control the native fauna and flora, and preserve those characteristic of an arid or subarid region, except in the case of the more favored *Tropical* patches and valleys.

Some scale-insects of much interest were secured in the *Lower Sonoran* between Tehuantepec City and the coast. The immense monophloebid, *Llaveia axinus,* was rediscovered. A new species of *Lecaniodiaspis* (*Prosopophora*) was found, being the first finding of the genus in Mexico. *Ceroplastes mexicanus,* originally discovered by the writer at

Guaymas and San Luis Potosi, was found to extend to the Isthmus in range. It is an arid or *Lower Sonoran* species. A large new species of *Lecanium* was found, *L. chilaspidis* Ckll. n. sp., which belongs to a typically *Neotropical* series and has found its way into and adapted itself to the *Lower Sonoran.* A new *Aspidiotus,* of the *rapax* and *ulmi* group; two other new species of *Aspidiotus;* and a *Mytilaspis* near *citricola,* complete the scales found. A complete Locality and Food-plant Catalogue of Mexican Coccidae, including to date 80 species, has been prepared by the writer and will soon be published. In it will appear all the species that have here been mentioned, with distribution in and out of Mexico, and other notes of interest.

NEW MEXICO.

In October, 1895, the trip was made by wagon from Las Cruces to the northern part of the Sacramento Mountains, and on north to the Capitan Mountains. The start was made October 9, and the route was by way of Organ, Parker's Well, Lunas Well (Pelman's), Whitewater, Tularosa, Mescalero, Upper Ruidoso Store, Dowling's Mill (Wingfield's), Gilmore's ranch, Austen's ranch, Fort Stanton, and by way of a dried salt pond known as the Salado, to the Capitan Mountains. In September and October, 1896, the same trip was made by wagon as far as Mescalero, returning from there to Las Cruces, October 7.

SACRAMENTO AND WHITE MOUNTAIN DISTRICT.—A first paper on the Diptera of the Sacramento Mountain region, including White Mountain which lies at the northwestern end of the range, has already been published in the Annals and Magazine of N. H. (London), Feb. 1897, pp. 138-149. A general idea of the topography is given in that paper, but the faunal aspects are not treated. The reader is referred to that paper, however, for many data of interest in connection with what is given here.

Collections were made in Diptera alone on the first trip. On the second trip, Professor Cockerell accompanied me. Diptera, bees, scale-insects, and locusts were collected especially, as well as some other insects. The locusts form a good representation of the acridiid fauna, and with the scales were sent to the United States Department of Agriculture, the trip having been made under the auspices of the Department. A paper on the new scale-insects and bees was published by Professor Cockerell almost immediately on the return from the trip (Journ. N. Y. Ent. Soc. Dec. 1896, pp. 201-207). The locusts will be determined later by the Department.

The Sacramento Mountains are situated in northeastern Doña Ana and western Lincoln counties. White Mountain, the highest point, is 11,092 feet, as given on military maps. Lieutenant V. E. Stottler, U. S. A., who has charge of the Mescalero Apache Indian reservation occupying the northern portion of the Sacramentos, with the agency and headquarters at Mescalero, kindly furnished me with this and several other elevations in the vicinity, together with some valuable topographical data pertaining to the region. Fort Stanton lies just to the north of the Sacramentos, elevation 6151 feet. Tularosa lies at the west base, elevation 4140 feet. The road from Tularosa to Fort Stanton crosses the mountains, the elevation at the top of the divide being about 7000 feet. The Agency, or Mescalero P. O., is eighteen miles up this road from Tularosa, and about seven miles below the top of the divide. It is eighteen miles from the Agency to the Upper Ruidoso store, where the road first strikes the Rio Ruidoso. It is only a couple of miles from here up the Ruidoso to Dowling's Mill (now Wingfield's), the elevation of which is 6455 feet, as given by military map. The road to Fort Stanton, however, leaves Dowling's Mill to the left, and also Gilmore's ranch, which latter is on Eagle creek well up toward base of White Mountain, some twelve or fifteen miles from the Upper Ruidoso store, and at an elevation of about 7000 feet. The main road also leaves Austen's ranch, on the Rio Bonito, to the left. Austen's ranch is on the north fork of the Bonito, twelve miles above Fort Stanton, and at an elevation of about 6400 feet.

The Ruidoso, Eagle Creek, and the two forks of the Bonito all head on the eastern slope of White Mountain. They all run in a general easterly direction. The two forks of the Bonito join immediately above Fort Stanton. Eagle Creek flows into the Ruidoso some eight or ten miles below the Upper Ruidoso store. The town of Lincoln is in the valley of the Rio Bonito, below Fort Stanton; and some distance below Lincoln, the Rio Bonito and Rio Ruidoso join their waters to form the Rio Hondo. It should be stated that Fort Stanton was abandoned in 1895 (about November or December) as a military post.

The Rio Tularosa heads above the Agency, on the opposite side of the divide from the other streams just mentioned, and flows down the Tularosa cañon or valley, and through the town of Tularosa, which it supplies with water. The town is situated at the mouth of the cañon. Up the valley of this stream, the road goes to the Agency.

The plains all around the bases of these mountains are *Upper Sonoran*, and this zone reaches up into the Sacramentos to the elevation of about 6400 feet. Here the piñon (*Pinus edulis*) and juniper (*Juniperus*) begin, and betoken the change to the *Transition*. On White Mountain, the *Boreal* is well-marked above the *Transition*, but at just what altitude can not now be said. The writer has in view a careful investigation of the flora and fauna of White Mountain, from its base to its summit. Full collections will be made, and the slopes thoroughly worked all the way to the summit.

THE INTERRELATIONS OF THE DIPTERA AND THE FLORA. — Some plants that were collected by Professor E. O. Wooton and the writer, at different times, in this region, and on which diptera were taken, have been determined and will be of interest in this connection. Those plants collected by Professor Wooton are so mentioned. The species of Diptera, so far as determined by the writer, are given under the head of each plant, but the mass of them have still to be worked up. Some diptera were taken by Professor Wooton, and are so noted; otherwise they were all collected by the writer. I am indebted to Professor Wooton for the determinations of most of the plants, and also for the elevations, taken by aneroid, of the localities where his own specimens were collected. The names of the plants and diptera follow:

1. *Thelypodium linearifolium* Wats.—Blazer's Mill, about 6200 feet, October 2.

2. *Erysimum asperum* Dc.—Collected on the Ruidoso, 6500 feet, July 3, by Professor Wooton, who took on its flowers:

Oncomyia sp.—Same locality and date.

3. *Rhus glabra* Linn.—This plant was collected by Professor Wooton on the Ruidoso, at 6600 feet, July 10. The locality is well up above Dowling's Mill. The following Diptera were taken by Professor Wooton on the flowers. They are all same locality, elevation, and date:

1. *Pipiza occidentalis* Towns. (n. sp.).
2. *Baccha lemur* OS.
3. *Chrysochlamys croesus* OS.
4. *Milesia bella* Towns. (n. sp.).
5. *Dejeania corpulenta* Wd.
6. *Jurinia lateralis* Mcq.
7. *Echinomyia thomsoni* Will.
8. *Echinomyia neglecta* Towns.

4. *Philadelphus serpyllifolius* Gray. — Collected on the Ruidoso by Professor Wooton, June 30, probably about 6400 feet. He took on its flowers:

Volucella anna Will.—Same locality and date.

5. *Bigelovia graveolens* var. *glabrata*. — This was so determined by Prof. J. K. Small, of Columbia University. Specimens were later sent to Miss Alice Eastwood, who thought at first sight that it might prove to be a different variety, but her conclusion has not yet reached me. This *Bigelovia* grows in profusion all along the stream of the Rio Tula-

rosa from Blazer's Mill (a mile below the Agency), elevation about 6200 feet, down to the crossing of the stream at the half-way place between Tularosa and the Agency, elevation about 5200 feet. It thus occupies here a vertical range of about 1000 feet, in the upper edge of the *Upper Sonoran*, from about 5200 to 6200 feet elevation. The distance that it extends along the road down the stream is 8 miles. It occurs in very large thickly-growing patches, sometimes of several acres in extent. The plants attain a height, some of them, of 8 or 9 feet, and have immense woody stems. This gives an idea of their rank growth here. They are in the height of bloom about October 1st, but last for three or four weeks later than this date, and their flowers are especially visited by large numbers of very interesting diptera, particularly *Tachinidae* and *Syrphidae*. The best collecting of all, in the Diptera, was done on these flowers. Especially prominent were such large-sized genera of *Tachinidae* as *Dejeania, Jurinia, Saundersia, Echinomyia*, etc. All of the details are given in the paper above referred to. Among the *Syrphidae* were many interesting forms also. Such of the Diptera taken on these flowers as have been determined up to the present time, are given; these include but little more than those taken on the first trip, while a mass of material remains that was taken on the second trip. The locality is the Tularosa valley below Blazer's Mill, and the elevation from 5700 to 6200 feet, unless otherwise stated:

1. *Melanostoma stegnum* Say.—October 2, 6200 feet.
2. *Eupeodes volucris* OS.—October 1, 6200 feet. October 5, 5200 feet.
3. *Volucella comstocki* Will.—October 20.
4. *Volucella victoria* Will.—October 20.
5. *Gymnosoma fuliginosa* Desv.—October 2, 6200 feet. See notes on this species, now first recorded from New Mexico, under head of Mesilla Valley.
6. *Dejeania rutilioides* Jaenn.—October 13 and 20.
7. *Dejeania corpulenta* Wd.—October 20.
8. *Dejeania hystricosa* Will.—October 13 and 20.
9. *Saundersia maculata* Will.—October 20.
10. *Jurinia algens* Wd.—October 20.
11. *Jurinia hystrix* Fab.—October 13 and 20.
12. *Jurinia lateralis* Mcq.—October 20.
13. *Echinomyia iterans* Walk.—October 13 and 20.
14. *Echinomyia thomsoni* Will.—October 13 and 20.
15. *Echinomyia victoria* Towns.—October 20.
16. *Echinomyia neglecta* Towns.—October 20.

Also the folowing *Bombyliidae*, and other stray Diptera, taken by Professor Cockerell, and determined by the Department of Agriculture (Coquillett). Locality, Blazer's Mill, elevation 6200 feet. October 2.

17. *Odontomyia nigrirostris* Lw.
18. *Anthrax syrtis* Coq.
19. *Exoprosopa caliptera* Say.
20. *Lordotus diversus* Coq.
21. *Phthiria diversa* Coq.
22. *Sparnopolius fulvus* Wd.
23. *Pegomyia communis* Walk.
24. *Sapromyza vulgaris* Fitch.
25. *Siphonella cinerea* Lw.
26. *Agromyza aeneoventris* Fall.

6. *Aster laevis* Linn. — Specimens collected on the Ruidoso, above Dowling's Mill, October 15, about 6500 feet; where it occurred only scatteringly. Others collected on the Rio Bonito, in the valley bottom at Austen's ranch, October 17, about 6400 feet, where it occurred along the edge of the stream in extensive rankly-growing patches bearing profuse bloom. These flowers were quite as good as the *Bigelovias* for Diptera, but no *Dejeanias* occurred here. The following species were taken on these flowers, the locality, when not noted, being the Rio Bonito, above locality, date and elevation:

1. *Eristalis tricolor* Jaenn. — First record of this species from New Mexico. It is a *Neotropical* species, in the main.
2. *Jurinia apicifera* Walk. — Ruidoso, October 15, 6500 feet. Also Rio Bonito, as above.
3. *Echinomyia iterans* Walk.
4. *Echinomyia thomsoni* Will.

7. *Aster incanopilosus* (Lindl.) Sheld.—Rio Tularosa crossing, October 4, about 5200 feet. Also two miles above Agency, October 3, about 6500 feet. At the former locality there were taken on its flowers:

1. *Melanostoma stegnum* Say.—October 5.
2. *Eupeodes volucris* OS.—October 4.
3. *Volucella haagii* Jaenn.—October 5. A *Neotropical* and *Lower Sonoran* species, which ranges into the *Upper Sonoran.*

Also many other Diptera. It is a good fly-plant.

8. *Helenium hoopesii* Gray. — Collected on White Mountain, 9000 feet, July 3, by Professor Wooton, who took at same time on its flowers:

Echinomyia sp.—A blackish species, with a small but distinct spot on the wing.

9. *Senecio douglasii* DC.—Rio Ruidoso, above Dowling's Mill, 6500 feet. Large patches, in full bloom October 15, with many tachinids on the flowers, belonging to the following species:

1. *Dejeania hystricosa* Will.—October 15.

2. *Jurinia apicifera* Walk.—October 15.
3. *Echinomyia iterans* Walk.—October 15 and 16.
4. *Echinomyia thomsoni* Will.—October 15.
5. *Echinomyia victoria* Towns.—October 15.
6. *Echinomyia neglecta* Towns.—October 15.

10. *Asclepias speciosa* Torr.—Collected on the Ruidoso, 6400 feet, July 8, by Professor Wooton, who took at the same time on its flowers:

Dejeania corpulenta Wd.

11. *Salvia lanceolata* Willd.—Blazer's Mill, about 6200 feet, October 2.

OTHER DIPTERA. — The following Diptera were also taken in the Sacramento Mountain region, not on flowers:

Microchrysa sp.?—Ruidoso, about 6500 feet, July 3 (Wooton).

Echinomyia iterans Walk.—White Mt., 9500 feet, July 6 (Wooton).

Echinomyia victoria Towns.—Ruidoso, 8,500 feet, July 6 (Wooton).

Blepharoptera pectinata Lw.—Agency, 6340 feet, October 3 (Ckll., det. Dept. Agriculture).

Anastoechus nitidulus Fab.—Rio Tularosa crossing, about 5200 feet, October 4 (Ckll., det. Dept. Agriculture).

Cyrtoneura pascuorum Meig. — Tularosa, 4140 feet, September 30 (Ckll., det. Dept. Agriculture).

APIDAE, COCCIDAE, ETC.—Of the bees and scales collected in the Sacramentos, the new ones being already described by Professor Cockerell in the paper before referred to, the following may be mentioned here:

Perdita stottleri Ckll.—A new species, taken on the *Bigelovia* flowers, at the store seven miles below the Agency, elevation about 5500 feet, October 1.

Colletes bigeloviae Ckll.—On the *Bigelovia* flowers, Blazer's Mill, about 6200 feet, October 2. "Allied to the widely distributed *C. armata* Patt." (Ckll.).

Colletes aestivalis Patt.—Ruidoso, 6600 feet, July (Wooton). "A common eastern species, not yet found anywhere else in New Mexico" (Ckll.).

Colletes wootoni Ckll.—Ruidoso, 6400 feet, July (Wooton). A new species.

Icerya townsendi Ckll.—A very interesting new species, found just below Blazer's Mill, 6200 feet, October 2, on stems of *Gutierrezia sarothrae,* at base of plants. It is very likely the same species as a single specimen taken by the writer on the base of a stem of *Gutierrezia,* south of Squaw Spring, Arizona, July 26, 1892; the latter was sent to Dr. Riley, but never described.

Another lot of *Icerya* was found by the writer about a week later, October 8, in the Mesilla Valley, on stems of *Pluchea borealis.* It is so near to *townsendi*, that Professor Cockerell has described it as a variety of that species, var. *plucheae* n. var. It was not confined to the base of the plants, which are rather tall growing, but occurred well up the stalks as well.

Dactylopius gutierreziae Ckll.—On the leaves of *Gutierrezia sarothrae*, Blazer's Mill, 6200 feet, October 2. A new species, with a long white ovisac which takes up the whole width of the narrow leaves of the plant. Also found abundantly all over the mesa to the west of the Organ Mountains, on a variety of the same plant.

Orthezia nigrocincta Ckll. — Found plentifully at Blazer's Mill, on same plants with the preceding. This was originally found by me in the cañon of the Gila, at Gila Hot Springs, N. M., in 1894.

Aleurodes berbericola Ckll.—A new species, found on *Berberis*, Blazer's Mill, 6200 feet, October 2.

CAPITAN MOUNTAINS.—The plains at the base of the Capitan Mountains are probably about 5000 feet elevation, though this is only an estimate. The Capitans rise probably to about 8000 or 9000 feet. They are *Transition*, except the lower portions around the base. There is not more than a touch of the *Boreal* on their highest portions, so far as could be judged at a distance of half way up their sides.

WHITE SANDS.—On the northwestern part of the Tularosa plains, there lies a remarkable piece of country known as the White Sands, far greater in extent than any similar formation known to me in the southwest. These sands are pure gypsum, and are raised up in banks and drifts, often to a height of fifty feet above the level of the surrounding plain. They extend over an area some forty miles long, by perhaps an average of ten miles in width. They lie just to the east of the San Andreas range, and immediately to the west of the wagon road from Las Cruces to Tularosa, which skirts their edge for some ten miles. The gypsum is nearly white—creamy white—in color, the banks appearing from a little distance almost like snowbanks shining in the sun. The texture is not powder-like and dusty, but rather sand-like, though moderately firm, and does not greatly impede walking; nor does it stick to the shoes or clothing, being easily brushed off. It is simply disintegrated and weathered gypsum. From well up in the Sacramento Mountains —as high up on the road from Tularosa to the Agency as one can go before losing sight of this part of the plain—this immense stretch of sand lies spread out before the eye in a panorama of billows, exactly resembling a large area of high surf breaking on a sandy shore. The mountains on the farther side seem like a continuation of the land in a promontory, or rocky coast-line. It is a magnificent sight, and one that will repay the discomforts of traveling far to see. In effect it is veritably a sea of surf turned to gypsum. When one comes to walk over a portion of it, and examine its contours in detail, he finds the waves and billows, the crests and troughs, the heaving swells and profound hollows —all true to the outlines exhibited by a heavy sea. Such an extent of country must have a peculiar fauna and flora, so far as there is a possibility of life existing upon it—and plenty of life exists there. The whole region is scatteringly covered with vegetation—such vegetation as can maintain itself. There are many flowers at certain seasons after rains—in October, for instance—and these flowers are visited by many hymenoptera, diptera, etc. Other insects frequent the vegetation and the sands—mutillids, coleoptera, etc. No collecting has ever been done here, except a half hour of work by the writer, late in the afternoon of October 6, 1896; during which an area of not more than 100 yards diameter was traversed, situated just in the edge of the tract, next the road at the holes known as Whitewater. These holes sometimes have a little saline water in them, but are more often dry. There is often good water, however, just a little further on, over the edge of the sands. It is seven miles from Whitewater to Lunas Well (Pelman's), which is really the nearest water that can be depended on. The elevation of the plain here at the edge of the White Sands is probably about 4000 feet. Whitewater is at the southeastern edge of the White Sands, and about thirty miles from Tularosa. It may be mentioned here that what I have called the Tularosa plains are sometimes called the San Augustine plains; they extend north from the Organ Mountains to White Mountain, and extend down east of the Organs to the Texas boundary.

Remarks on the Fauna.—The writer found on these sands a small lizard of the same whitish color as the gypsum, but unfortunately the few specimens seen escaped capture. Two whitish spiders, one of them an attid, were taken on vegetation on the sands, and have been determined by the Department of Agriculture. They are doubtless peculiar to the sands. The attid is *Habrocestum* n. sp.; it was chalk-white, speckled with black. The other, *Philodromus* sp.?, had the abdomen chalk-white with pale reddish-brown markings, rest of body being greenish-white. These notes were made from the fresh specimens by Professor Cockerell. Several bushy clumps of *Bigelovia graveolens* var. *appendiculata* Eastw. n. var., just beginning to flower, yielded numerous specimens of a new bee of the genus *Perdita*, which Professor Cockerell has named *Perdita townsendi*. "It is nearest to *P. bigeloviae*, but quite distinct, especially in the male." (Ckll.). Another bee, a larger form, belonging to the genus *Colletes*, was taken with the *Perdita* on the same flowers, and was at first supposed to be the same species as occurs on the plains. Professor Cockerell wrote me later concerning it, as follows: "To my surprise, the species you found on the White Sands with the *Perdita townsendi* proves to be quite distinct and new. Probably confined to the White Sands, like the *Perdita*. I have called it *Colletes gypsicolens*. The fauna of the White Sands must be very peculiar. At any rate, both the bees you collected are new, and I feel quite sure do not occur elsewhere. Probably there are a dozen bees peculiar to the sands, not to speak of other things."

FLORA AND DIPTERA.—The following plants were collected at the White Sands, or near that district, and are determined by Professor Wooton unless otherwise noted. Of the diptera taken on their flowers, the few that have already been determined by the writer are included:

1. *Oenothera* 2 spp.—Two species of this genus collected by Professor Cockerell on the edge of the White Sands are pronounced by Miss Eastwood to be new varieties.

2. *Bigelovia graveolens* Gray var. *appendiculata* Eastwood (n. var.).—This has been described by Miss Alice Eastwood as a new variety. On the White Sands, over the edge from Whitewater Holes, October 6. Some interesting diptera, to be determined later, were taken on the flowers of this *Bigelovia*. Also *Perdita townsendi* Ckll. and *Colletes gypsicolens* Ckll., as above mentioned.

3. *Bigelovia pulchella* Gray.—White Sands, over the edge from Whitewater Holes, October 6.

4. *Aster parviflorus* Gray. — Whitewater Holes, at edge of White Sands, October 6. About 4000 feet. On its flowers were:

   1. *Paragus bicolor* var. *testaceus* Meig.
   2. *Paragus tibialis* var. *dimidiatus* Lw.
   3. *Melanostoma stegnum* Say.
   4. *Zodion fulvifrons* var. *abdominale* Say.
   5. *Leucomelina garrula* Gig.-Tos. (coll. Ckll., det. Dept. Agriculture).

   The following bees were also taken on its flowers:

   Perdita townsendi Ckll.
   Perdita fallax Ckll.
   Perdita townsendi Ckll.

5. *Aster canescens* Pursh.—Road near White Sands, September 30.

6. *Sartwellia flaveriae* Gray.—Road near White Sands, September 30.

7. *Statice limonium* Linn. var. *californica* Gray.—First arroyo south of Tularosa, October 5. This is said by Professor Wooton to be probably a very good species, instead of a variety.

As bearing on the San Augustine or Tularosa plains fauna, it should be mentioned that a new form of *Ceroplastes irregularis* Ckll. was found in great abundance along the road between Lunas Well and Whitewater, on branches of *Atriplex canescens*. It has been described by Professor Cockerell as var. *rubidus*. This variety is of a pronounced reddish color, while the normal form is always whitish. The latter was originally described by Cockerell from the State of Chihuahua, not far north of Chihuahua City, but has since been found abundantly in southern New Mexico. It has never been found to vary from its whitish color. While the new variety *rubidus* differs apparently only in color, the many extensive patches of it that were observed showed no departure from its characteristic red color.

MESILLA VALLEY OF THE RIO GRANDE.—This locality has been referred by Professor Cockerell, in his monograph of *Perdita* (Proc. Acad. Nat. Sci., Phil., 1896, p. 31), to what he calls the *Middle Sonoran*, which he defines merely as the "lower part of *Upper Sonoran*." I do not deem it advisable to further split the *Upper Sonoran*, which has already been split off from the *Lower Sonoran*. It will be useful, certainly, to refer to the Mesilla Valley fauna by a distinctive name, at least in time when all its affinities are worked out in detail, but I believe it should be ranked as a fauna, not as a zone or province. As a fauna, considerable other territory in Chihuahua, Texas, and Coahuila will go with it, as well as the Pecos Valley of New Mexico, etc.

DIPTERA.—The following diptera, recently determined by the writer from the Mesilla Valley, are of interest from a biogeographic standpoint.

1. *Paragus tibialis* var. *dimidiatus* Lw. — Las Cruces, August 21. On flowers of *Aphantostephus arizonicus* Gray. Not before recorded from New Mexico. Also taken at the White Sands, as already stated. Recorded from Sonora, Durango, and Guerrero (Biol. C. A. Dipt.).

2. *Nausigaster unimaculata* Towns.—Rincon, July 5 (Ckll.). On *Chilopsis linearis*. This is the first record of this species in New Mexico. The specimen is not typical.

3. *Melanostoma stegnum* Say.—Las Cruces, March 26 (Ckll.). This was taken in the Sacramentos, at the White Sands, and was collected by Cockerell at Santa Fé. It occurs in the Colorado Parks, and seems particularly a *Transition* and *Upper Sonoran* species. Yet it ranges apparently into the lower *Boreal* in Colorado and the Northwest, and into the *Lower Sonoran* and *Neotropical* in Mexico, being recorded from as low down as Orizaba (Biol. C. A. Dipt.).

4. *Eupeodes volucris* OS.—Las Cruces, also Pecos Valley at Roswell. March and April. This distinctly *Upper Sonoran* species is common at Las Cruces, on flowers of *Sisymbrium canescens*.

5. *Gymnosoma fuliginosa* Desv.—Six specimens taken in the Mesilla Valley, at or near Las Cruces, at various times, in March and from August to October. On flowers of *Prunus* (March), *Solidago canadensis* (August), and *Bigelovia wrightii* (September and October). This species has never before been recorded from New Mexico, or in fact from any part of the arid region; nor have the genus, or even the family, *Gymnosomatidae*, to which it belongs. It was taken in the Sacramento Mountains (Rio Tularosa, 6200 feet), as already stated. It is comparatively rare in New Mexico, but is characteristically common in the humid *Upper Austral*—the *Carolinian*, which corresponds in the East to the *Upper Sonoran*. It is very common at Washington, D. C. It also occurs commonly at Constantine, Mich., which is just in the northern edge of the *Carolinian*. I believe that it ranges well into the *Austroriparian*. Its especial abundance at Washington would indicate this, since that locality partakes largely of the *Austroriparian* fauna.

On Trombidium.—It may appropriately be mentioned here, as bearing on the biogeographical position of the Mesilla Valley, that the presence or absence of the irritating larval forms of *Trombidium* will be found to furnish data of much use in connection with the determination of life zones. These mites, as well as causing intense suffering to sensitive persons, are themselves very sensitive to climatic influences. Their comparative abundance when present, coupled with their seasonal duration, indicates much from a biogeographic point of view. They are commonly known to Americans as "redbugs" and "jiggers" (or "chiggers"); to the French as "bête rouge"; and to the Mexicans as "coloradillas."* They are particularly bad in the *Tropical*, in green portions of the *Lower Sonoran*, and in the *Austroriparian*. They are present, but much less numerous and troublesome, and of much shorter seasonal duration, in the *Carolinian* and green spots of the *Upper Sonoran*. In tropical and semitropical latitudes, their seasonal duration lasts throughout the year, in the absence of frost and drouth. Farther north, their season begins from May to July or August, according to climatic conditions and latitude. From my own experience, I can furnish the following data: They are present at Constantine, Michigan, in August, but are not numerous. At Washington, D. C., they are very numerous and, in July and August at least, seemingly quite as bad as I have ever known them in the tropics; their season there lasts from May or June till frost. These facts alone show the strong tinge of the *Austroriparian* in the fauna at Washington (D. C.). They are very bad in southern Texas, southern Louisiana, Florida, Jamaica, the whole Atlantic coast region

*These must not be confused with the *pinolillos* of Mexico, which are the minute newly-hatched ticks (Ixodidae).—C. H. T. T.

of Mexico; and throughout the tropics where there is green vegetation, especially in the lowlands or *tierra caliente.* Their comparative absence during any part of the year in this region is solely dependent on the occurrence of frost or drouth. In the bottom of the Grand Cañon of the Colorado, north of Flagstaff, Arizona, from 4000 or 5000 feet down to 2500 feet (the level of the river), they were quite bad early in July; indicating the locality as bordering on the *Lower Sonoran.* In the Mesilla Valley, they are troublesome sometimes to a certain extent, in June and July, but are less numerous than I found them in the Grand Cañon, and are not a circumstance to what they are at Washington. As regards abundance, allowances must be made for the comparative differences in the extent and rankness of green vegetation in the arid and humid regions.

These larval forms of *Trombidium* have never before been referred to in connection with the subject of biogeography, and I am glad to be able to find some use for them (as I have never had any use for them before!). I can testify that they form an excellent criterion, if taken in June or July, in green and rankly-growing vegetation, grass, or thickets, but not during a time of drouth. These creatures are very sensitive to a high temperature combined with great dryness, but probably only because these conditions destroy the succulency of the vegetation upon which they are vitally dependent. Even in the tropical lowlands of Mexico, I have known them to quite disappear at times from April to June, in consequence of extremely dry and hot weather, this being the usual height of the dry season in the lowlands of the coast. I have also observed them to disappear in southern Texas, on the lower Rio Grande, in August, after a month or two of very hot dry weather. Such weather greatly withers the grass and all the vegetation, upon the juices of which these larval mites feed. They never enter the green and grassy *Transition* of the mountains of New Mexico and Arizona; and hence these regions form a perfect haven of rest to the weary field naturalist, who has done battle for months with the *coloradillas, pinolillos* and *garrapatas* (adult ticks) of the *tierra caliente.* They are present in the *Upper Sonoran* of New Mexico and Arizona only in the low valleys of streams, where there is much green vegetation. I have never noticed them in the valleys of the higher parts of the *Upper Sonoran,* though they may occur there sparingly.

ON THE PARTIAL EXTENSION OF THE LOWER SONORAN FAUNA UP RIVER VALLEYS INTO THE UPPER SONORAN PROVINCE. — It is well known that some *Lower Sonoran* forms extend at times up river valleys for a long distance into the *Upper Sonoran.* The presence of such forms in the Rio Grande Valley guided Dr. Merriam in extending his *Lower*

Sonoran broadly up this valley through New Mexico, as far north as Albuquerque. Such extensions up river bottoms would naturally result to a certain extent from a difference in elevation, but this is so slight in most cases that it can not explain the long range of some species up river valleys out of their natural life areas. We must therefore look for other causes tending to produce this result. Dr. Mark A. Rodgers, in a very valuable and interesting paper, "The Climate of Arizona" (read before the American Climatological Society at Lakewood, N. J., May 13, 1896; and published in the Medical and Surgical Reporter of May 16, 1896), touches upon the differences in climatic conditions between river bottoms and plains in the arid region. As he presents this subject as plainly as possible, I shall quote from his paper at some length. It will be seen that he points out climatic changes that have already occurred, and may take place in future, through putting large areas under irrigation. At the same time his remarks also apply to some extent to river bottoms under ordinary natural conditions, especially where an annual rise takes place and overflows the bottoms, constituting a natural method of irrigation; and where the water permeates the soil up to within a comparatively short distance of the surface, forming what are called subirrigated lands. Dr. Rodgers says:

"It will be noticed by Table III that of all the stations in southern Arizona, Phoenix shows the greatest variation of temperature, being the hottest in summer and the coldest in winter. Phoenix is at an altitude of 1068 feet, just midway between Yuma and Tucson. Under ordinary conditions we would expect to see the temperature there also midway in extremes between these two points. Although we have not at our command records of the relative humidity in the Salt River Valley for more than a period of six months, we feel quite safe in assuming that the difference is due to this cause. Phoenix is situated low down in the valley near the Salt River, and according to the well known principles of gravity as applied to atmospheric drainage, the cold moist air settles in the most dependent localities. This is quite apparent by the sense of appreciation in the differences between the sensible and actual tempera-

TABLE III.—*Showing the Relation between Temperature and Altitude.*

Stations.	Altitude.	Mean Minimum.	Mean Maximum.
Yuma	141	42	106.3
Phœnix	1068	32	107.3
Tucson	2400	35	100.8
*Prescott	5389	20	84.9

*Prescott, in Northern Arizona. But the conditions are the same as for regions in Southern Arizona at corresponding altitudes.

tures, to which any one will vouch who has driven through a river valley or an irrigated bottom in the arid region. The sensible difference between the temperature of Phoenix and other points of southern Arizona is decidedly marked; Phoenix being sultry in the hot season and chilly during the cold. The actual temperature shows greater extremes for reasons which depend on the fundamental principles of natural philosophy. Moist air is heavier than dry air, and is a poorer conductor of heat and cold. Consequently during the intense heat of summer radiation does not take place with sufficient rapidity during the night to lower the temperature to that of other localitiês outside the irrigated district. For the same reason in winter the heat of the sun during the day is not sufficient to raise the temperature to that of the other stations. It is not the presence of the river which causes the increase of the relative humidity, for Yuma, which is situated at the junction of the Gila and Colorado rivers, has the lowest relative humidity of any region of the territory where the records are kept. But at Phoenix, for several miles above and below the city, the country is watered by irrigation and the soil is so thoroughly saturated that the level of the water beneath the surface has been raised from a depth of seventy to from twenty-five to thirty feet. This condition is no more pronounced at Phoenix than at any other point where irrigation is practiced. As for example, in northern Colorado, where prior to the introduction of irrigation an extremely low percentage of moisture existed. Since all that region has been irrigated the relative moisture has been so increased that they now have dews where formerly dews were unknown. The emanations from the growing vegetation also increase the relative humidity, although sufficient areas have not been irrigated to make any perceptible difference in the amount of precipitation by rainfall. What these artificial changes may bring about in time, no one can predict; but it is well known that bodies of water which are surrounded by irrigated regions, such as the Great Salt Lake in Utah, are gradually increasing in volume. The surface of the Great Salt Lake has risen several inches in the last few years.

"The report of the United States Weather Observer at Phoenix, makes the relative humidity at that point, for the six months October to March, 1895-6, inclusive, 52.82 per cent. Records for Tucson during the same period are not obtainable. But compared with other years, when the precipitation was about the same as for this season, we find the relative humidity in the irrigated districts about twelve or fifteen per cent higher than at the other points in southern Arizona."

These same conditions mentioned by Dr. Rodgers for the Salt River Valley in Arizona, obtain in the Rio Grande Valley in New Mexico. It is both warmer in winter, and cooler in summer, on the San Augustine plains, twenty to twenty-five miles east of Las Cruces, on the other (east) side of the Organ Mountains, and several hundred feet (200 to 400 feet) higher up, than it is in the Rio Grande Valley at Las Cruces. This is due to the same causes pointed out by Dr. Rodgers.

The greater summer heat of these river bottoms, over what exists on the surrounding plains and mesas, naturally paves the way for the northward extension of the fauna and flora from the somewhat hotter regions of the *Lower Sonoran.* The bottoms and valleys form an outlet, so to speak, for the overflow of the fauna immediately to the south, which is thus enticed to spread northward as far as possible. Here it finds somewhat different conditions; under these influences, those forms which are able to adapt themselves remain, and in time become more or less modified. Their northward limit is marked by the point beyond which they can no longer adapt themselves to the low winter temperatures. We can thus see that an annual faunal overflow, continued through long periods of time, would finally result in certain forms becoming permanent in these valleys, for a greater or less distance up. In this way, certain *Lower Sonoran* forms have extended up the Rio Grande Valley from the mouth of the Pecos to Albuquerque. Others have found their limit farther south, while a large number extend up half or two-thirds of the way to El Paso. The *Lower Sonoran* forms need a high summer temperature, which is here supplied. At the same time they become gradually adapted to the low winter temperatures, so far as their capability in that direction goes. Such river bottoms offer more or less shelter and protection in winter, which can be taken advantage of by certain animals, insects, etc. The same forms, however, could not thrive on the surrounding *Upper Sonoran* plains and mesas, from the lack of a sufficient total of summer heat for their needs; notwithstanding the fact that the winter temperatures would be higher than those of the bottoms, while as a complement, shelter would be much less. The element of increased humidity in river bottoms threading the *Upper Sonoran* is, therefore, the factor which has caused the *Lower Sonoran* extensions up these valleys.

FURTHER ON SENSIBLE TEMPERATURES.—I wish also to quote here the following on actual and sensible temperatures, from an article by Prof. Edw. M. Boggs, on the climate of Arizona (Bull. No. 20 of the Arizona Agric. Exper. Station), as substantiating the stand taken by me on sensible temperatures in my first paper:

"The simple thermometer, no matter how accurate it may be, does not measure temperature as felt by animal life. Its records must be considered in connection with certain other data in order to afford a mode of comparison with the climates of other portions of the earth. We may term the reading of an accurate thermometer the *actual*, and the sensation of heat or cold as felt by the higher orders of animal life the *sensible* temperature. Neither of these is a measure of the other. The fact is well known to meteorologists, that the thermometer alone can not indicate the *sensible* temperature, but that the humidity of the air must be considered in connection with the actual temperature. This fact is also known to dwellers in the arid region, but it is not known to the majority of otherwise intelligent people throughout the world.

"Where the percentage of atmospheric moisture is high, both extremes of temperature are felt to be greater than the thermometer indicates. Everybody knows something about that condition of the weather which is variously termed 'sultry,' 'close,' or 'muggy.' These terms describe the result of a combination of heat and moist air. This is the condition which exists commonly in the tropical regions of the world where the rainfall is heavy, and in the same way, though in a smaller degree, throughout the United States outside of the arid region. It is especially noticeable in the States bordering on large bodies of water, such as the Gulf of Mexico or the Great Lakes, and is conspicuously absent from the greater portion of Arizona.

"In the dry air of this territory sunstrokes are unknown, while in the Mississippi Valley and in the States lying eastward whole columns of the newspapers are filled with accounts of prostrations from heat; and the fatalities are numerous whenever the thermometer indicates 90 degrees Fahrenheit, or upwards. At many places along the seacoast, where the humidity always remains near the point of saturation, a temperature of 85 degrees brings excessive discomfort, and exertion or exposure to the sun is extremely hazardous. Men and the lower animals perform in safety their customary labor beneath the cloudless skies of Arizona, under the highest temperature ever experienced here. The dry air induces exceedingly rapid evaporation of the abundant perspiration, thus keeping the body at a comparatively low temperature. As a matter of course, the supply of fluid must be maintained, hence the great thirst so often experienced by travelers in desert regions, and the imperative necessity for an adequate supply of drinking water. Of all the lives lost on the desert stretches of Western America—and their number is not small—not one is directly attributable to heat, but to thirst. The experienced traveler provides an ample supply of water and fearlessly invades the worst desert yet discovered.

"An amount ranging from fifteen to perhaps thirty degrees, according to the humidity, should be subtracted from the maximum *actual* temperatures in Arizona, during the hot season, to indicate the *sensible* temperatures. In like manner, the dry air of the arid regions enables extremely low temperatures to be endured without discomfort. The winter cold of the Canadian Northwest Territory is much less disagreeable than that of the United States immediately south of the Great Lakes. The lowest temperatures known on the high plateau of Arizona, bring less discomfort than a chilly day in New Orleans."

GILA HEADWATERS.—The headwaters of the Gila consist of three branches or forks, which unite just above the Gila Hot Springs and thus form the Rio Gila. They are situated in the mountains of southwestern New Mexico, in northern Grant and southern Socorro counties.

DIPTERA.—A first paper has been published in *Psyche* (1897, pp. 38-41) on diptera collected in the Gila cañons during the 1894 trip, the itinerary of which was given in the first paper on biogeography. Some further topographical notes on the district are given in the paper in *Psyche*. The diptera so far determined by the writer are as follows:

1. *Chrysops ceras* Towns. n. sp.—West Fork, July 10 to 17. Forms a group with *C. megaceras* Bell. of Mexico, and *C. tanyceras* OS. of Costa Rica.

2. *Chrysops facialis* Towns. n. sp.—West Fork, July 19.

3. *Tabanus punctifer* OS.—Head of East Fork, DD-Bar ranch, July 22. An *Upper* and *Lower Sonoran* species.

4. *Tabanus gilanus* Towns. n. sp.—West Fork, July 10 to 16. Seems more nearly related to *T. rheinwardtii* Wd. OS., of the eastern United States (*Carolinian* and *Appalachian*), than to other species.

5. *Tabanus intensivus* Towns. n. sp. — West Fork, July 13 to 16. Closely allied to the preceding.

6. *Eristalis latifrons* Lw. and var. *maculipennis* Towns.—East Fork, July 22. A *Transition* and *Upper Sonoran* species, ranging into the *Lower Sonoran* apparently, judging from the localities Sonora and Matamoros recorded for it. It is, however, a higher species, reaching its greatest abundance in the *Transition*.

7. *Chrysochlamys croesus* OS.—West Fork, July 12. A *Transition* species.

8. *Zodion fulvifrons* Say (typical form).—West Fork, July 18. This form seems to range higher than the variety *abdominale* Say, which is *Upper Sonoran* and *Carolinian*, apparently ranging into the *Lower Sonoran* as far south as Guerrero (Biol C. A. Dipt.).

9. *Dejeania corpulenta* Wied.—West Fork, July 16. A *Transition* species, ranging but a short distance down into the *Upper Sonoran*, but considerably into the *Boreal* (Colorado). At the same time it extends southward to the higher mountains of Costa Rica, Panama, and Colombia, at from 4000 to 7000 feet.

10. *Myobia gilensis* Towns. n. sp.—West Fork, July 16. Allied to *M. diadema* Wd. and *flavipennis* Wd., of the *Neotropical* region.

HYMENOPTERA.—The bees and other aculeate hymenoptera have been worked over by Professor Cockerell, and are as follows:

1. *Triscolia* sp.—Gila Hot Springs, elevation about 6000 feet, July 20. The species belongs to a group of *Scolia* found in Lower California and Texas.

2. *Sphex ichneumonea* Linn.—West Fork, July. A common U. S. species, taken commonly at Santa Fé by Cockerell.

3. *Sphex nearcticus* Kohl.—Head of East Fork, July 22. "Common in the Mesilla Valley." (Ckll.)

4. *Priononyx foveolatus* Tasch.—West Fork, July (det. Fox). "Very abundant in the Gila collection. Not known elsewhere in N. M." (Ckll.) This must therefore be a *Transition* species of somewhat restricted range.

5. *Priononyx* sp. apparently *atrata* St. Farg.—West Fork, July. "*P. atrata* is common at Santa Fé." (Ckll.)

6. *Tachytes* sp. apparently *spatulatus* ♀ —.Head of East Fork, July 22. "Can not be sure of determination without a ♂. *T. spatulatus* occurs at Santa Fé." (Ckll.)

7. *Philanthus albifrons* Cress. ♂.—Head of East Fork, July 22. This is the first record of this species from New Mexico. It is a Colorado species, doubtless *Transition*.

8. *Philanthus frontalis* Cress. ♂.—West Fork, July. "Occurs in the Mesilla Valley." (Ckll.)

9. *Philanthus* sp. aff. *flavifrons* Cress.—West Fork, July. *P. flavifrons* is a Colorado species.

10. *Odynerus annulatus* Say.—West Fork, July. "Common in Mesilla Valley. Taken years ago by Lewis in northern N. M." (Ckll.)

11. *Odynerus* sp. aff. *leucomelas* Sauss.—West Fork, July. "Agrees with *leucomelas*, but the markings are yellow, not white. *O. leucomelas* occurs in the Mesilla Valley." (Ckll.) Three other species of *Odynerus* were taken, but are not yet identified.

12. *Polistes* sp.—Head of East Fork, July 22. This is a different species from *P. aurifer*, which is the common New Mexico and southwestern species.

13. *Vespa occidentalis* Cress.—West Fork, July. A Nevada, Colorado, and New Mexico species. "I used to get it at 8000 feet in Custer County, Colorado." (Ckll.)

14. *Colletes gilensis* Ckll. n. sp.—West Fork, July 16. This is larger than any previous species of *Colletes* known from New Mexico. "Allied to northern and eastern types." (Ckll.)

15. *Agapostemon texanus* Cress.—West Fork, July. A Texas species. "Common in Mesilla Valley." (Ckll.)

16. *Stelis costalis* Cress.—West Fork, July. Described from Texas. "Found at Santa Fé." (Ckll.)

17. *Coelioxys* n. sp., near *edita* Cress.—West Fork, July. Mr. Fox does not know this species, which is doubtless new. *C. edita* is from Texas. Another species of *Coelioxys*, not yet identified, was also taken.

18. *Monumetha borealis* Cress.—West Fork, July. This is the first record in New Mexico for this northern species, which occurs in British America and the northern United States.

19. *Anthidium gilense* Ckll. n. sp.—West Fork, July.

20. *Megachile brevis* Say.—West Fork, July. Found in Canada and the United States generally.

21. *Megachile exilis* Cress.—West Fork, July. Found in the United States generally to Lower California.

22. *Megachile fortis* Cress.—West Fork, July. Found in Colorado, Kansas, and Texas.

23. *Megachile fidelis* Cress. — West Fork, July. Found in Colorado, Nevada, Oregon and California. "A striking species not known in the Mesilla Valley." (Ckll.)

24. *Melissodes montana* Cress.—West Fork, July. Occurs in Colorado and New Mexico.

25. *Melissodes pallidicincta* Ckll. n. sp.—West Fork, July. "Also found at Santa Fé; and common at Pinos Altos in Grant County." (Ckll.) Pinos Altos is in the mountains to the south of the Gila Headwaters.

26. *Melissodes gilensis* Ckll. n. sp. — West Fork, July. "Also found at La Tenaja, near Santa Fé." (Ckll.)

27. *Xenoglossa patricia* Ckll.—On the Gila at Lyons' ranch, Grant County (collected by Prof. J. D. Tinsley, August, 1896). "Found in Mesilla Valley, and also in Arizona." (Ckll.) This is the only species in the list not collected by the writer.

It may be added that *Pompilus ferrugineus* Say ♂, and *Glypta variipes* Say ♀, both common United States species, were taken on the West Fork in July, and have been determined at the United States Department of Agriculture by Mr. Ashmead. It should further be said that many other hymenoptera were taken on the Gila Headwaters, but so far have been determined only generically, the genera represented being *Psammophila, Ammophila* (2 spp.), *Isodontia, Bembex* (2 spp.), *Eumenes* (2 spp.), *Halictus* (prob. n. sp.), *Epeolus, Lithurgus* (?), *Anthophora*, and *Bombus*.

OTHER INSECTS.—The following five species complete the list of determinations so far made of the Gila Insects:

Orthezia nigrocincta Ckll.—This scale-insect was collected on a common weed at Gila Hot Springs, 6000 feet, July 20. It is near to *O.*

annae Ckll., with which Professor Cockerell at first supposed it to be identical. It was also found by me plentifully in the Sacramento Mountains, on *Gutierrezia sarothrae,* October 2, 1896, on the Rio Tularosa, 6200 feet, along with *Icerya townsendi* and *Dactylopius gutierreziae.*

Stictocephala inermis Fab.—Gila Hot Springs, July 20. (Det. Goding.)

Papilio rutulus Bdr.—West Fork, July. A common *Transition* species. Dr. Holland received the lepidoptera collected on the Gila, but has not yet worked them over.

Yuccaborus sp.—Mr. Schwarz, who received the Gila coleoptera, tells me that the collection contained a species of *Yuccaborus,* the well known and rather rare large weevil which bores the trunks of *Yuccas.* It may be mentioned here that a species of *Yuccaborus* was found extremely abundant in July, 1895, half way between Brownsville, Texas, and the coast, in trunks of what is probably *Yucca treculeana.* Mr. Wickham and I took several hundred specimens in a couple of hours work at old and decaying trunks. The species will be determined, if possible, and will appear in a separate paper on the coleopterous fauna of the lower Rio Grande.

Trichodectes sp.—Numbers of a very small parasite, with little doubt belonging to this genus, were taken on the hairs of scrotum and adjacent belly parts of a white-tailed deer (*Cariacus virginianus*), shot on the West Fork about a mile below the falls, July 11. The specimens were sent recently to Professor Osborn, who has not yet reported upon them. The species may be *T. parallelus* Osborn n. sp., of Bull. No. 5, new series, Div. Entom. U. S. Dept. Agriculture (1896), pp. 240-241. No locality is given for *T. parallelus,* but the specimens were from the Cornell University collection and probably from the eastern United States.

TEXAS.

Diptera.—A paper by the writer will appear soon in the Journal N. Y. Ent. Soc., on a part of the diptera collected in the lower Rio Grande region, near Brownsville. One or more papers will follow, completing the determinations of the diptera collected there by the writer. The species so far determined are as follows. Those not otherwise noted are Brownsville, and this applies throughout this section both with insects and plants.

1. *Simulium tamaulipense* Towns. n. sp. — Reynosa, Tamaulipas. May 10.

2. *Tabanus atratus* Fab.—April 16 and July 11. A *Carolinian* and *Austroriparian* species.

3. *Nausigaster geminata* Towns. n. sp.—Beeville and Kenedy, Texas. August 30 to September 14. On flowers of *Parthenium hysterophorus* L. This is included, though not from the Rio Grande.

4. *Eupeodes volucris* OS.—May 2. A distinctly *Upper Sonoran* species.

5. *Baccha clavata* Fab.—May 24. A *Neotropical* species, extending into the *Upper Sonoran* of New Mexico along the Rio Grande Valley as far up as Albuquerque.

6. *Baccha tropicalis* Towns. n. sp.—June 21 to 25. On flowers of *Clematis drummondii* T. & G. and *Monardia clinopodioides* Gray. This species belongs to a *Neotropical* group, occurring from Brazil to the lowlands of Mexico.

7. *Volucella esuriens* var. *violacea* Say.—From San Miguel, Tamaulipas, to the coast at Point Isabel, Texas. April 7 to July 14. This species was found to be very abundant in the palmetto hammocks below Brownsville, where it occurred in large companies, hovering in the air high up amongst the tops of the palmettos, the various individuals darting independently here and there, but continually hovering. I have taken this same fly on the bare and rocky summit of San Francisco Mountain, in Arizona, at an elevation above sea level of nearly 13,000 feet. It ranges from the *Boreal* to the *Neotropical.*

8. *Volucella tamaulipana* Towns. n. sp.—June 24 to July 3. On flowers of *Lippia lanceolata* Michx. Belongs to a large *Upper* and *Lower Sonoran* group; more allied to the forms of the group found in the *Lower Sonoran.*

9. *Eristalis furcatus* Wd.—June 24. A *Neotropical* species, ranging from Argentina and Brazil to tropical Mexico.

10. *Eristalis tricolor* Jaenn.—June 16 to 28. On flowers of *Gaillardia pulchella* Foug., and *Lippia lanceolata* Michx. Mainly *Neotropical* and *Lower Sonoran,* but even extending into the *Upper Sonoran* exceptionally. (See case of occurrence in Rio Bonito Valley, belonging to the Pecos river system. This valley is in the edge of the Sacramento Mountains, at an elevation of 6400 feet.)

11. *Eristalis vinetorum* Fab.—June 1 to July 3. On flowers of *Verbesina encelioides* B. & H., and *Gaillardia pulchella* Foug. *Neotropical* but ranging into the *Lower Austral.*

12. *Zodion albonotatum* Towns. n. sp.—June 24 to July 3. On flowers of *Lippia lanceolata* Michx. Nearly allied to *Z. splendens* Jaenn. of the *Upper Sonoran.*

13. *Ocyptera euchenor* Walk.—June 22 to 24. On flowers of *Lippia lanceolata* Michx. This species extends from the *Carolinian* to the *Neotropical.* It enters the *Appalachian* in the north, as I have recorded it from Minnesota, while it is also known from Massachusetts and Quebec.

Walker's record of Nova Scotia, and especially Newfoundland, indicates that it even enters the *Boreal.* I have recently found it in the Rio Grande valley at Las Cruces, N. M.

14. *Jurinia apicifera* Walk.—June 21 to 28. On flowers of *Lippia lanceolata* Michx. Extends from the *Transition* and *Appalachian* to the *Neotropical.*

The following are two species, recently determined, of a small lot of characteristic maritime diptera, belonging to the *Mexican Maritime* fauna (*Antillean*), taken on the south end of Padre Island, opposite Point Isabel, Texas.

15. *Tabanus maritimus* Towns. n. sp. — June 29, 1895. A whitish species found on logs and sand, on the beach. Allied to *T. psammophilus* OS., which belongs to the *Antillean* fauna of the Florida coast, being known from Fort Capron and Lake Worth.

16. *Lipochaeta texensis* Towns. n. sp.—June 8, 1895. Occurs numerously on the moist beach. This very singular fly belongs to the *Ephydridae.* The genus, which is quite an aberrant one, has only recently been described by Coquillett for an allied species, *L. slossonae* Coq., from Punta Gorda on the Florida coast, and which must belong to the *Antillean* fauna of Florida.

Ants.—The species of ants, hymenopetra, and lepidoptera named below are all that have so far been determined of the large material collected in these groups on the lower Rio Grande, and sent to the Department of Agriculture. The ants were examined by Mr. Pergande. They are as follows:

1. *Camponotus vicinus* Mayr.—Feb. 23.

2. *Dorymyrmex flavus* Mayr.—May 2. In foraging parties, climbing trees and plants, and in scattered columns on ground.

3. *Tapinoma anale* André.—March 2. San Tomas, seven miles below Brownsville. In earth around cotton roots.

4. *Pogonomyrmex barbatus* Sm.—February 23. Swarming out of hole in ground. This species is recorded from Texas, New Mexico and Arizona.

5. *Cremastogaster* sp.(?)—February 20. Nest inside dead twigs of fig, bored by longicorn larvae.

6. *Pseudomyrma gracilis* Fab. var.—February 26 to July. Running on vegetation in woods and thickets, especially in the palmetto hammocks. This is a *Neotropical* species, which is found everywhere along the Mexican coast from the lower Rio Grande to Tabasco, running about on vegetation.

7. *Pseudomyrma pallida* Sm.—February 23; a winged specimen. Also

throughout the season. This is also *Neotropical*, being found with the preceding on vegetation all along the Mexican coast. It is recorded from Florida.

The genera of ants, *Prenolepis*, *Aphaenogaster* (♂ Feb. 23), and *Ponera* (♀ Feb. 27), were also determined in the material.

Other Hymenoptera.—The following names conclude the hymenoptera:

1. *Smicra flavopicta* Cress.—April 9. On *Prosopis juliflora*. This species is recorded from Florida and Cuba.

2. *Catolaccus incertus* Ashm.—Bred from *Anthonomus grandis* (cotton weevil). Issued July 18. This is an eastern species, parasitic also on *Anthonomus musculus* in strawberry buds, at Washington City.

3. *Photopsis* sp.—April 19, at light. Not in Natl. Museum.

4. *Pompilus subviolaceus* Cress.—March 26. Found over the United States.

5. *Polistes variegatus* Cress.—April 9, on flowers of *Prosopis juliflora*.

6. *Augochlora humeralis* Patton.—This species was taken at Beeville, Texas, but is included here. Regarding the *Augochlora* group of bees, which is mainly a *Neotropical* group, and of which a number of species were taken on the Rio Nautla in Vera Cruz, there are but three species known from Texas. These are, besides the present species, *A. sumptuosa* Smith, and *A. pura* Say. The last is found in southern New Mexico, western Texas, and northern Chihuahua (Juarez). It is the only species occurring in New Mexico.

Lepidoptera, Etc.—The lepidoptera are as follows:

1. *Philampelus vitis* Linn.—Larvae eating leaves of grape, May 21. A large sphingid found over the United States.

2. *Cisthene subjecta* Walk.—March 23.

3. *Stibadium spumosum* Grote.—Larvae found, April 27 to May 24, eating into buds inside squares of cotton. The larvae eat out the inside of the bud. They were found, June 6 to 17, breeding inside seed-capsules of *Abutilon holosericeum* Scheele, a malvaceous plant, and doubtless the native food-plant in this region.

4. *Erebus odora* Linn.—At light, July 12. A *Neotropical* species, a native of the West Indies and Mexico. It is not known to breed within the United States, but specimens have been found as far north as Canada, and west to Colorado, as well as in California. It is believed that these isolated specimens have flown north from Cuba, or from Mexico. They occur only in late summer and autumn. I believe, however, that it breeds on the lower Rio Grande, as I found a specimen on Padre Island early in June.

5. *Chalcoela* sp.(?)—Larvae found February 13, eating fibre inside of old cotton bolls in fields. The moth was later bred in numbers from these bolls, issuing from March 29 to April 21. It is a very pretty species of *Tortricidae.*

6. *Platynota rostrana* Walk.(?) — Larva found, May 24, eating the bracts of cotton squares on the inside of the square. It makes a slight web to hold the bracts together.

A locust, *Mestrobregma furcifrons* Stal (April 8); and a dragonfly, *Diplax rubicundula* Say (April 9), are all that have been determined in these orders.

HEMIPTERA HETEROPTERA.—A few of the Hemiptera of my own collecting have been determined by the Department of Agriculture. But most of those in the following list were collected either by Mr. H. F. Wickham or by Mr. Frank B. Armstrong, and identified by Mr. Carl F. Baker, who has kindly sent me the names to include here. His determinations will be known from the initial of the collector, W. (Wickham) or A. (Armstrong), occurring after them. Very many of these species were taken by me, and detailed notes made on them, but the Department has not yet determined the material. The Heteroptera are as follows:

1. *Corimelaena atra* A. & S.—A United States species. (W.)

2. *Corimelaena nitiduloides* Wolff.—March 2, in earth in cotton field. A United States species.

3. *Corimelaena lateralis* Fab.—A United States species. (W.)

4. *Pangaeus discrepans* Uhl.—A species of the Western States. (W.)

5. *Stiretrus anchorago* Fab.—June 6, taken on *Solanum eleaginifolium* Cav.; July 5, one taken inside cotton square, doubtless piercing bud. A species of the Southern States.

6. *Perillus claudus* Say.—Brownsville and Point Isabel. A western species. (W.)

7. *Podisus acutissimus* Stal.—Southern States. (W. & A.)

8. *Discocephala marginella* Stal.—A Mexican species. (W.)

9. *Oebalus pugnax* Fab.—A United States species. (A.)

10. *Mormidea pictiventris* Stal.—A West Indian species. (W.)

11. *Euschistus crenator* Fab.—A West Indian species. (W.)

12. *Euschistus tristigmus* Say.—A United States species. (W.) Also identified by the Department from specimens taken by me on wild tobacco, *Nicotiana repanda* Willd.(?), March 24.

13. *Euschistus* n. sp., Uhler.—(W.)

14. *Hymenarcys aequalis* Say.—United States species. (W.)

15. *Holcostethus abbreviatus* Uhler.—Western States. (W.)

16. *Peribalus limbolarius* Stal.—Northern States. (W.)

17. *Thyanta custator* Fab.—United States species. April 9, on mesquite. May 11, at light at Fort Ringgold.

18. *Murgantia histrionica* Hahn.—Southern States. (A.)

19. *Nezara marginata* P. B.—A West Indian species. (W.)

20. *Banasa imbuta* Walk.—A Mexican species. (W.)

21. *Chariesterus antennator* Fab.—United States species. (W. & A.)

22. *Mozena lunata* Burm.—Western States. (W.)

23. *Euthoctha galeator* Fab.—United States species. (W.)

24. *Metapodius femoratus* Fab.—Southern States. (W.)

25. *Chelinidea vittigera* Uhler.—Western States. (W.)

26. *Catorhintha selector* Stal.—Brownsville and Point Isabel. A Mexican species. (W.)

27. *Hyalymenus tarsatus* Fab.—A Mexican species. (W.)

28. *Alydus 5-spinosus* Say.—United States species. (W. & A.)

29. *Catorhinus apicalis* Dall.—March 25. Southern States.

30. *Scolopocerus secundarius* Uhl.—Western States. (W.)

31. *Scolopocerus uhleri* Dist.—A Mexican species. (W.)

32. *Corizus hyalinus* Fab.—May 7, Santa Maria, Texas. Western States.

33. *Jadera haematoloma* H. S.—Western States. (W.)

34. *Jadera* sp. near *haematoloma* H. S.—April 15.

35. *Nysius californicus* Stal.—Brownsville and Santa Maria. March 30 (at light) to May 7. A Mexican species.

36. *Pamera longula* Dall.—Southern States. (A.)

37. *Lygaeus reclivatus* Say.—Flying on beach at Point Isabel, April 25. On *Asclepias longicornu* Benth., April 29, probably its food-plant. At Granjeno, Texas, May 9, on *Verbesina encelioides* B. & H. Western States.

38. *Lygaeus associatus* Uhler MS.—(W.) A new species.

39. *Largus succinctus* Linn.—Refugio, Texas, May 14. Southern States.

40. *Dysdercus obscuratus* Dist.—Not in list of Heteroptera. Probably a Mexican or Central American species. (W.)

41. *Calocoris superbus* Uhl.—Western States. (W.)

42. *Megacoelum catulum* Uhl.—Not in list. (W.)

43. *Poecilocapsus obliquus* Uhler MS.—(W. & A.) A new species.

44. *Teleonemia grossa* Uhler.—Not in list. (W.)

45. *Phymata fasciata* Gray.—Not in list. (W.)

46. *Sinea diadema* Fab.—United States species. (W. & A.)

47. *Sinea undulata* Uhler.—Not in list. (W.)

48. *Sinea incurva* Uhler.—Not in list. (W.)

49. *Sinea integra* Stal.—Western States. (W. & A.)

50. *Heza annulicornis* Stal.—Southern States. (W.)

51. *Atrachelus simplex* Uhler MS.—(W.) A new species.

52. *Diplodus luridus* Stal.—A Mexican species, extending to Michigan. (W. & A.)

53. *Diplodus cervicalis* Stal.—Not in list. (W.)

54. *Apiomerus pictipes* H. S.—Point Isabel. Western States. (W.)

55. *Salda signoretii* Guer.—Point Isabel. Southern States. (W.)

56. *Anisops platycnemis* Fieb.—Found in cistern-water, February 20. Occurs in the Atlantic States.

HEMIPTERA HOMOPTERA.—The following Homoptera conclude the list of Hemiptera:

1. *Proarna signifera* Walk.—Brownsville and Point Isabel. (W.)
2. *Stictocephala rufivitta* Walk.—(A.)
3. *Amastris impressus* Goding MS.—(W.) A new species.
4. *Amastris laeta* Goding.—Brownsville and Point Isabel. (W. & A.)
5. *Stictopelta marmorata* Goding.—(W.)
6. *Euchonopa bifusifera* Walk.—(W.)
7. *Erechtia monstrosa* Germ.—(W.)
8. *Clastoptera xanthocephala* Germ.—(W. & A.)
9. *Agallia constricta* Van D.—(A.)
10. *Homalodisca coagulata* Say.—(W.)
11. *Homalodisca* (*Proconia*) *insoleta* Wlk.—(W. & A.)
12. *Diedrocephala flaviceps* Riley.—(A.)
13. *Diedrocephala mollipes* Say.—(W. & A.)
14. *Athysanus bicolor* Van D.—(W.)
15. *Phlepsius excultus* Uhler.—(W.)
16. *Phlepsius spatulatus* Van D.—(W.)
17. *Chlorotettix viridia* Van D.—(A.)

COCCIDAE.—The following coccidae (scale-insects) were collected in the lower Rio Grande region. They were determined by Professor Cockerell:

1. *Coccus confusus* Ckll.—On leaves of *Opuntia* sp., at Point Isabel, April 25. Also collected at Arroyo Colorado, December 10, 1894.

2. *Coccus confusus* Ckll. var.—On *Opuntia* sp., at La Puerta, Tamaulipas (on the Rio Grande), May 6. The specimens are larger than the normal *confusus*.

3. *Phenacoccus helianthi* Ckll. var.—Found on the road two miles west of Santa Maria, on rattoon cotton. This was at first supposed to be a distinct species, but Prof. J. D. Tinsley, who has taken up this group of Coccidae, writes me as follows: "The scale on cotton is *Phenacoccus helianthi* Ckll. It is probably a variety, but I do not believe that there is difference enough to warrant giving it a varietal name." Judging from

Professor Cockerell's original notes on the material, I think it constitutes a good variety.

4. *Phenacoccus* n. sp.—Found by Mr. E. A. Schwarz on twigs of *Mozinna spatulata* Orteg., June 7. This scale much resembles a monophloebid; it is wax-red, with a brown stripe down each side of the body. The material was largely parasitized, and more is needed for description.

5. *Dactylopius virgatus* Ckll.—On *Cereus princeps* Hort. Würzb., June 1, in large numbers. Eggs, young in all stages, and adult females. June 10, very numerous on guava; and June 6 to 17, on *Abutilon holosericeum* Scheele. The males, apparently this species, were found on guava, May 28.

6. *Dactylopius* sp.—On *Cordia boissieri* A. DC., a tree known as *anacahuita*. Adults on branches, and young on leaves; also on buds and young fruit, June 6. It may be mentioned here that specimens of *Dactylopius* were taken June 1, on *Pithecolobium flexicaule* Coult. (ebony); June 5, on *Mozinna spatulata* Orteg.; June 6, on *Croton capitatus* Michx.; and June 25, on *Clematis drummondii* T. & G. It is not possible to determine them, on account of scanty material in each case.

7. *Orthezia* sp.—Males flying in the palmetto hammock at San Tomas, June 7. Of a beautiful pale azure color, with many long white anal filaments in a wisp-like bunch. Could find no females on any of the plants in the neighborhood.

8. *Pulvinaria simulans* Ckll. var.—In large numbers on underside of leaves and stems of a cultivated bush, probably belonging to the *Caprifoliaceae*, June 1. Also on *Cereus princeps*, in less numbers. The elegant yellow ant, *Pseudomyrma pallida* Sm., was found attending these scales.

9. *Lecanium hesperidum* Linn.—On orange, in Matamoros, June 1. In great numbers on oleander, at Point Isabel, June 8. On orange, at Corpus Christi, December 5, 1894.

10. *Lecanium oleae* Bern.—On fig, February 11. On *Erythrina herbacea*, February 20. On fig and oleander, in Corpus Christi, December 4, 1894.

11. *Lecanium imbricatum* Ckll.—Found a number of specimens on bark at base of live cotton stalks, at San Tomas, April 5. This species was discovered by me at Alta Mira (near Tampico), Tamaulipas, October 15, 1894.

12. *Lecanium* sp.—June 23, on leaf of *Clematis drummondii* T. & G.

13. *Aspidiotus rapax* Comst.—In great numbers on oleander at Point Isabel, June 8.

14. *Aspidiotus nerii* Bouché.—On oleander, February 3. On china tree, *Melia azedarac*, in Matamoros, June 6.

15. *Aspidiotus ficus* Ashm.—Very abundant on orange at San Tomas,

December 9, 1894. Also same date, and through 1895, on orange in Matamoros.

16. *Aspidiotus* sp. incert. (Ckll.).—On ash, probably *Fraxinus viridis* var., in April. Large numbers, but all dead and more or less parasitized. Professor Cockerell could not separate this species from *A. perniciosus*, the San José scale. The scales seemed to have been altered in appearance by the parasites, but the microscopic characters of the females seemed to agree in every way with *perniciosus*. What is probably the same was found on pomegranate, May 31, but the scanty material was also dead.

17. *Parlatoria pergandei* Comst.—On orange, February 17 to May 31. On orange in Matamoros, both ♂ and ♀ scales, June 1.

18. *Mytilaspis gloveri* Pack.—On orange, February 3 to May 31. On orange in Matamoros, December 9, 1894, and June 1, 1895.

19. *Chionaspis furfurus* var. *ulmi* Ckll.—On *Ulmus crassifolia* Nutt., May 1 to 31. In numbers on trees in various parts of town.

Attidae.—The attid or jumping spiders that have been determined, all by Prof. G. W. Peckham, are as follows:

1. *Anoka palmarum* Hentz.—Both sexes. April. Known from New York, the Carolinas, Alabama, and Florida.

2. *Cyrba taeniola* Hentz.—Hidalgo, Texas, May 9. Known from Pennsylvania to Florida and Wisconsin.

3. *Dendryphantes capitatus* Hentz. — Both sexes. April. Known from the United States and Mexico.

4. *Dendryphantes mandibularis* Peckham n. sp.—La Blanca, Texas. May 8.

5. *Dendryphantes militaris* Peck.—Refugio, Texas. May 13.

6. *Epiblemum transversum* Peckham n. sp.—La Blanca, Texas. May 8. Reynosa, Tamaulipas, May 16.

7. *Habrocestum coecatum* Hentz.—April, ♂. New York to Alabama.

8. *Habrocestum townsendi* Peckham n. sp.—April (♀).

9. *Habrocestum* sp. incert. — Refugio, Texas, May 13. Reynosa, Tamaulipas, May 16.

10. *Hasarius paykulli* Peck.—Brownsville, May 20. Refugio, Texas, May 13.

11. *Icius elegans* Hentz.—April (♀). Middle, Eastern, and Southern United States.

12. *Icius* n. sp. (Peck.)—May 20.

13. *Marptusa melanognathus* Lucas. — Agua Negra, Texas, May 8. Hidalgo, Texas, May 9. Fort Ringgold, Texas, May 11. This species is known from South America, Guatemala, and Florida. Also from Japan, Madagascar, Canary Islands, and Mauritius.

14. *Phidippus* n. sp. (Peck.).—Reynosa, Tamaulipas, May 16.

15. *Zygoballus* prob. *bettini* Peck.—April (immature). *Z. bettini* is known from Wisconsin, Missouri, Georgia, and Florida.

IXODIDAE.—The following are ticks determined by the Department of Agriculture:

1. *Argas americana* Pack.—Found abundant in the hen houses at San Diego, Texas, December 6, 1894. Said to be nocturnal in habits.

2. *Boophilus bovis* Riley (?).—Very bad on horses in pastures. February.

3. *Dermacentor americanus* Linn.—Taken from a coyote shot near San Tomas, February 28. One which seems to be this species was taken on a horse, March 13.

4. *Ixodes* sp. (?).—Very numerous in the brush, from February on through the season, both the newly-hatched ones (*pinolillos*) and the adults (*garrapatas*). These are among the pests of the tropics, getting in great numbers on the clothing and person of any one who is hardy enough to venture into the woods and fields. Their occurrence here indicates with certainty the presence of a tropical element in the fauna.

OPHIDIA.—Two species of snakes, collected in 1892 by Mr. Frank B. Armstrong, and determined by Mr. Carl F. Baker, are *Lutainia proxima* Say, taken July 20; and *Lutainia vagrans* B. & G., taken July 23.

MOLLUSCA.—Some terrestrial mollusca were collected also, and sent to the Department of Agriculture. They were referred to Prof. Wm. H. Dall, who has determined them as follows:

1. *Bulimulus alternatus* Say var.—On stems and branches of *Prosopis juliflora*. Found plentifully on mesquite from El Sauz, Texas, to the Rio Grande.

2. *Helicina orbiculata* var. *tropica* Jan.—In ground at Santa Rosalia, March 13. Shell only.

3. *Polygyra texasiana* Mor.—In earth at Santa Rosalia, March 13. Shell only.

4. *Praticolella griseola* Pfr.—On ground at Santa Rosalia, March 13. Shell only. Also taken at Tampico, and San Rafael, Vera Cruz.

5. *Succinea luteola* Gould.—Alive on *Prosopis juliflora* and *Mimosa*, March 11. Santa Rosalia and above Brownsville.

Note.—The coleoptera which I collected on the lower Rio Grande form quite an extensive lot of material, which was all sent to the Department of Agriculture. A portion of the species has been determined, and will be published soon as a first installment of a separate paper.

FLORA.—The following plants, collected at Brownsville by the writer, and determined (unless otherwise noted) by Prof. J. M. Coulter, are given here as a contribution to the flora of the lower Rio Grande. The dates refer in each case to the observed time of blooming. The numbers in parentheses at end are those of my collecting. The specimens were sent to the Department of Agriculture, where they were referred to Professor Coulter for naming.

1. *Clematis drummondii* T. & G.—June 6. "Barba de Chibato." Occurs in valleys throughout Texas, and extends into New Mexico. (48, 68)

2. *Castalia elegans* (Hook.) Greene.—June 18. Occurs in Cuba, northern Mexico, and lagoons of the Brazos and Rio Grande. (88)

3. *Argemone mexicana* Linn.—March 24. Flowers white. Det. Coville. Common in the West Indies and tropical America. (13)

4. *Synthlipsis greggii* Gray.—March 24. Peculiar to the lower Rio Grande. (15)

5. *Capparis* sp.?—A tropical capparidaceous shrub or tree, bearing beautiful erect clusters of pink or rose-colored flowers on ends of top branches, June 28. This seems to be native on the lower Rio Grande near Brownsville. It grows at San Rafael, Vera Cruz. (Det. Towns.) (87)

6. *Portulaca oleracea* Linn.—A common plant, naturalized from Europe. (54)

7. *Abutilon holosericeum* Scheele.—June 6. Rather plentiful at San Tomas, and in places elsewhere near Brownsville. Southern and western Texas. (67)

8. *Abutilon* sp.?—June 1. Two miles south of Matamoros, in Tamaulipas. Very similar to preceding, but flowers smaller, orange-yellow. Leaves whitish pubescent below, soft green above; one to two feet. (41)

9. *Abutilon* or *Wissadula* sp.—June. Edge of palmetto thickets at San Tomas. Leaves rounder than *A. holosericeum*, heart-shaped, without notch each side of tip. (69)

10. *Malvaviscus drummondii* T. & G.—June 7. "Abutilon" (Mexican name). In profusion along edge of palmetto thicket at San Tomas. Cultivated in gardens. Grows abundantly and rankly at San Rafael, Vera Cruz. Extends into Texas to the Colorado and northeastward. (49)

11. *Guiacum angustifolium* Engelm.—March 24. Lower Rio Grande to the Colorado, and west to the Pecos. (17)

12. *Oxalis corniculata* Linn.—March 12. Cosmopolitan. (7)

13. *Xanthoxylum pterota* HBK.—June 27, in seed. Lower Rio Grande region to Yucatan (Is. Cozumel). (82)

14. *Castela nicholsoni* Hook.—March 22 to 24. Very thorny shrub, with small bright red flowers growing directly from thorns and branches.

Leaves very small and inconspicuous at time of flowering. Lower Rio Grande. (14)

15. *Koeberlinia spinosa* Zucc.—Noticed in bottoms from Brownsville to Fort Ringgold. Extends from Brownsville to El Paso and the Mesilla Valley of the Rio Grande, through western Texas and into southern New Mexico. (74).

16. *Sesbania cavanillesii* Watson.—June, blooming through the month. "Seney-weed," and "coffee-bean." Identified (without pods) by Coulter with a query as *vesicaria* Ell., but I am quite sure it is this species. Perennial shrub, not an annual. Lower Rio Grande to San Antonio. (77)

17. *Erythrina herbacea* Linn.—June 7, beginning to bloom. Forming thickets in places near San Tomas. Florida to North Carolina and Mississippi. (47)

18. *Rhynchosia menispermoidea* DC.—June 23. Eastern and southern Texas. The present record extends the range of this species southward; it was previously known to extend only as far as Corpus Christi. (81)

19. *Hoffmanseggia caudata* Gray.—March 29. Shrub or small tree, with beautiful bunches of clear deep yellow locust-like flowers. Native and cultivated. From the Nueces to the Rio Grande. (23)

20. *Parkinsonia aculeata* Linn.—May 2, in height of bloom. "Retamal." Native and cultivated. Southern and western Texas. (36)

21. *Mimosa strigillosa* T. & G.—May. A creeping species. Gulf States, through low coast lands of Texas into Tamaulipas and down the Mexican coast. Det. Coville. (37)

22. *Mimosa berlandieri* Gray?—June 28. Lower Rio Grande region, towards the coast. (83)

23. *Mimosa* sp.—March 6 to 24. Flowers deep buff-yellow. (2)

24. *Leucaena pulverulenta* Benth.—June 7. Tree growing in edge of palmetto hammocks at San Tomas. Southern Texas and the Lower Rio Grande Valley. (70)

25. *Pithecolobium flexicaule* (Benth.) Coult.—June 15, in bloom; and again August 12. "Ebony." Rio Grande Valley, and northern Mexico. (50)

26. *Rosa nutkana* Presl.—June 28. In immense thorny masses, rankly-growing, with very large main stems. Apparently not before recorded from Texas. (86)

27. *Oenothera speciosa* Nutt.—March 12 to 31. From Indian Territory to the lower Rio Grande and West Texas. (4)

28. *Gaura sinuata* Nutt.—April 29. Throughout Texas. (32)

29. *Mamillaria* sp.?—May 12. Fort Ringgold, Texas. Skin smooth, green with a whitish bloom; whole plant measuring six inches, and conical in form. Green crown, or portion above ground, hardly one inch high, two and one-fourth inches in diameter. Tubercles with tuft of

soft silk, not spines. Flower small, white with faint rosy tinge. Green flesh very acrid and bitter; said to cause hair to grow. Det. Towns. (40)

30. *Cereus princeps* Hort. Würzb. (= *C. variabilis* Engelm.).—June. "Jacobo." Mr. Coville writes that this is the first record of this species on the Texas side of the Rio Grande. (44)

31. *Erigeron tenuis* T. & G.—March 12. Southwest Texas. (9)

32. *Parthenium hysterophorus* Linn.—June 22. Florida, Louisiana, Texas, and the West Indies to northern Patagonia. (79)

33. *Lepachys columnaris* var. *pulcherrima* T. & G.—April 29. Southwest Texas. (31)

34. *Viguiera* sp.?—March 22 to 24. About two feet, stems slender, flower-stems eight to ten inches without leaves; flowers deep yellow, petals not long. (18)

35. *Verbesina encelioides* B. & H.—April 29. South Texas to New Mexico, and Mexico. Also Bahamas, and Florida (introduced from Mexico, according to Chapman). (25)

36. *Verbesina* sp.?—April 29. Fowers whitish, resembling boneset. (34)

37. *Gaillardia pulchella* Foug.—April 29. Southwest Texas. Flowers purplish-orange, with deep yellow border. (27)

38. *Cnicus virginianus* Pursh.—June. Common in swampy places in palmetto hammocks at San Tomas. Occurs in pine-barren swamps of Florida northward. (71)

39. *Sonchus oleraceus* Linn.—June 3. Southern States to Yucatan (introduced). (62)

40. *Asclepias longicornu* Benth.— April 29. Habit spreading, flowers whitish. Southwest Texas. (26)

41. *Eustoma silenifolium* Salisb.—June 23. Occurs from Arkansas, Texas and Mexico, to Venezuela. Also in Cuba and Haiti, in the West Indies. (80)

42. *Cordia boissieri* A. DC.—June 17. "Anacahuita." Native and cultivated. In bloom, in east-central Nuevo Leon, September 29. Lower Rio Grande to Nuevo Leon, and through Tamaulipas to Tampico. (75)

43. *Heliotropium parviflorum* Linn.—June 3. West Indies and Mexico to Brazil. (61)

44. *Lithospermum* sp.?—March 12. (5)

45. *Ipomoea sinuata* Ortega. — April 29. Southern United States, West Indies, Mexico, and tropical America. (24)

46. *Solanum triquetrum* Cav.—March 13 to 24. Often in brush fences, somewhat climbing or trailing. South and west Texas. (10)

47. *Solanum eleaginifolium* Cav.—Common. South and west Texas, southern New Mexico, and northern Mexico. (38)

48. *Chamaesaracha coronopus* Gray. — March 12 to 24. Southwest Texas. (6)

49. *Physalis mollis* Nutt.—March 24. Southwest Texas to Yucatan (var. *cinerascens*). (16)

50. *Lycium berlandieri* Dunal.—March 9. Southwest Texas. (3)

51. *Nicotiana repanda* Willd.?—March 24. A native tobacco; eighteen to twenty inches. Flowers creamy-whitish, with five pinkish-blue streaks on ribs of corolla; tube of corolla two inches long; leaves broad, not long. Det. Coville. Lower Rio Grande to San Antonio and Devil's River. (19)

52. *Tecoma stans* Juss.—July 9. South Florida, south Texas, Mexico to Yucatan, and all the West Indies. (52)

53. *Chilopsis linearis* Cav.—This species extends from the Rio Grande region east of and below the Pecos, through western Texas, New Mexico, Arizona, Utah, and Nevada, into southern California. It also extends from west Texas and New Mexico down into northern Mexico (Coahuila and Chihuahua). Specimens without flower or fruit, and supposed to be *Salix*, collected from a tree of some size at Brownsville, were pronounced to be this species by Dr. Coulter. This would extend the range of the species to the lower Rio Grande, which is a considerable extension, as it has not been recorded from nearer than Ixion county. The tree was fifteen to twenty feet high, and bore cone-shaped cecidomyiid galls like those of *Salix*. (84)

54. *Elytraria bromoides* Oerst.—April 29. Lower Rio Grande to west Texas and northern Mexico. (35)

55. *Ruellia tuberosa* Linn. var. *occidentalis* Gray.—April 29. Southwest Texas to Yucatan (typical form). (28)

56. *Verbena ciliata* Benth.—March 12 to 24. Southwest Texas. (8)

57. *Lippia lanceolata* Michx.—June 22. A good fly-plant, the flowers being attractive to diptera. South Texas, and extending down the coast into Mexico. (78)

58. *Lippia lantanoides* (Auct.?)—June 28. South Texas. (85)

59. *Lantana camara* Linn.—April to June. "Yerba de Cristo." Georgia, Florida, West Indies, south Texas, and Mexico to Buenos Ayres. (30, 57)

60. *Salvia coccinea* Linn.—May 24. West Indies, Florida, and south Texas to Brazil. (39)

61. *Monarda clinopodioides* Gray.—April 29 and June 25. Southwest Texas. (33, 76)

62. *Boerhavia hirsuta* Willd.—April 29. South Texas to Yucatan. (29)

63. *Amaranthus chlorostachys* Willd. — Common. "Careless-weed." Texas, from Laredo north and east. (55)

64. *Rivina laevis* Linn.—June 3, in bloom and fruit. Florida, Texas, the West Indies, and Mexico to Brazil and Ecuador. (60)

65. *Ulmus crassifolia* Nutt.—Southwest Texas. (45)

66. *Celtis mississippiensis* Bosc.—May. Southern States to central and south Texas. (42)

67. *Tillandsia recurvata* Linn. — March 24. South Texas and the lower Rio Grande to Yucatan. (11)

68. *Nothoscordum striatum* Kunth.—March 24. Throughout the more humid portions of Texas. (12)

69. *Yucca treculeana* Carr.—Blooms from middle of February to first part of March. Seen in flower in Matamoros, February 15, but usually blooms about March 1. Det. Trelease from flowers, leaves and photographs as probably this species. Extensive areas, consisting of many specimens of this *Yucca*, occur on the gravelly ridges which are to be found half way between Brownsville and the coast (Point Isabel). Southern and southwestern Texas, to northern Mexico (Coahuila). (1)

70. *Sabal palmetto* R. & S. var. *mexicana* (Auct.?).—June 16, in bloom. Covers extensive areas near the river a few miles below Brownsville, forming hammocks or thickets of semi-tropical jungle some miles in extent in the bottoms. Extends from the lower Rio Grande south through Mexico, in suitable places on the Gulf coast slope. (Det. Towns.) (73)

71. *Arundinaria* sp.—Forming dense cane-brakes a few miles below Brownsville and Matamoros, on both sides of the river, especially in places in edges of palmetto thickets. It is probably *A. macrosperma* Michx., which occurs from "central Texas to Virginia" (Coulter). Det. Towns. (89)

It may be noted that the papaw, *Carica papaya*, is cultivated in gardens at Matamoros and Browsville, but freezes to the ground in winter when frosts occur. Bananas and pineapples are cultivated at Brownsville to some extent. Date palms grow well; also oranges, guavas, figs, etc. But purely tropical plants will not succeed in the long run, from liability to killing frosts in winter. It would not be safe to venture their production on more than a very limited scale, and facilities should then be provided for protecting the plants or trees in winter. Sugar is raised on a rather large scale, and succeeds well. The maguey, *Agave americana,* is grown in yards; it flowers and flourishes well. The castor-oil bean, *Ricinus communis,* grows wild.

There seems to be not a little similarity between the southwest Texas region and the northern half of Yucatan. The conditions are very similar in the two regions in many points, and it is a rather striking fact that not a few plants, hitherto supposed to be more or less closely restricted to the lower Rio Grande region, have recently been recorded from the Yucatan Plains (see Millspaugh's two contributions to the Flora of Yucatan).

THE CHARACTER OF THE AUSTRORIPARIAN IN THE TEXAS AND MEXICAN COAST REGION.—There are some peculiarities in the biogeography of the Texas coast region that merit consideration. The *Austroriparian* would, no doubt, were the conditions of humidity and soil alike throughout, extend from Louisiana and eastern Texas in one broad belt covering the whole coast region and lowlands of Texas and northern Tamaulipas; finally losing itself far to the south in Mexico, running along the mountain sides just above the *Tropical.* But the conditions of humidity and soil in the Texas-Tamaulipas coast region are quite different from those of Louisiana; and thus we find a different state of things—the only state that could exist under the prevailing conditions. The *Lower Sonoran* extends east to the vicinity of San Antonio, and stretches from there southeasterly toward the coast, following the broad strip of coast country south into Tamaulipas. But in the river valleys and bottoms, where greater humidity and a different soil obtain, as particularly in the lower valleys of the Nueces and Rio Grande, the *Austroriparian* reappears, mixed more or less with the surrounding *Lower Sonoran,* and also with the *Tropical* forms to the south which come up to meet it. It thus obtains in places, like spots on the face of the *Lower Sonoran.* It doubtless becomes more continuously established farther to the south, in the moist regions of the mountain slopes of eastern Mexico, above the *Tropical;* though somewhat changed in character, from accessions of Mexican forms and losses of others which it possessed farther north. There is a certain analogy between the conditions of the *Austroriparian* in Texas and Tamaulipas, and those of the *Tropical* on the Pacific coast of Mexico, as set forth in the remarks under the head of Isthmus of Tehuantepec.

ERRATA IN PAPER I.

Page 74, line 16 from top, read: *parvifolius.*

Page 74, line 20 from bottom, read: *angustifolia* (now known as *Y. elata*).

Page 74, line 18 from bottom, read: *Fouquiera.*

Page 78, line 10 from bottom, read: Cook's Peak.

Page 80, line 2 from top, read: which lies at the northwest end of the Sacramentos.

Page 81, line 14 from bottom, read: 9000 feet.

Page 85, line 17 from bottom, read: slopes of the termination of the high plateau region.

Page 87, line 15 from top, read: *Tatusia.*
Page 87, line 16 from top, read: *yaguarundi.*
Page 88, line 12 from top, read: Salado.
Page 91, line 10 from bottom, read: *Tamaulipan.*
Page 93, line 15 from bottom, read: Osten Sacken.
Page 96, line 7 from top, read: Tamaulipan.
Page 96, line 8 from top, read: Yucatecan (in place of Campechian).

[*Read before the Texas Academy of Science, June 15, 1897.*]

SOME TEXAS OIL HORIZONS.

BY E. T. DUMBLE.

While the production of oil in Texas has not yet attained a very great importance, it is, nevertheless, a fact that there are a number of productive oil horizons, several of which will sooner or later form the bases of profitable industries.

These horizons are not confined to any particular geologic era or to the beds of any one formation, but extend over almost the entire geologic scale from Lower Carboniferous to Recent.

The lowest productive horizon with which we are acquainted is that of the Bend division of the Carboniferous, which, by one or two paleontologists, has been assigned to the Sub-Carboniferous. The outcrop of the beds of this division in Texas has not a very great areal extent, and its best and most characteristic exposure is found along the San Saba river, from near the postoffice of Bend in San Saba county (whence it takes its name) to Brady in McCulloch county. The top of the deposit consists of highly bituminous shales, and some indications of oil are found in it. It dips to the north and northwest, and is covered in that direction by later beds of Carboniferous and Cretaceous sediments. Some of these beds are porous limestones, which form excellent receptacles for the oil and gas which are distilled from these shales, and wells at various places have tapped such reservoirs and secured oil in different quantities.

In the Reports of the Geological Survey a number of localities have been given where oil and gas have thus been found. The principal localities are Waldrip, Trickham, and Brownwood. At this latter place two wells are sunk, 1643 and 1838 feet deep respectively, and small sipes of oil and flows of gas were obtained. In both wells oil was obtained in the beds of the Bend division* as well as in the more porous materials overlying them.

Beds of the same age were recognized in the Indian Territory by the

* Fourth Annual Report Geological Survey of Texas, pp. 436, 437.

writer, from the fossils common to both localities, as being the horizon of the great asphaltum deposits north of Ardmore, and this determination was afterwards confirmed by the investigations of Dr. Stevenson.

So far, however, the oil in these beds in Texas seems to be entirely confined to the western slope of the Carboniferous geanticlinal, since the well at Fort Worth, on its eastern slope, penetrated the beds for more than a thousand feet without finding a trace of either oil or gas.

The beds of the Cretaceous, which cover so large an area in Texas, show several distinct oil horizons. The lowest of these is in the Trinity Sands in Jack and Montague counties. Here is found a very heavy oil, locally called asphaltum, which impregnates the sand beds, and has been used to a limited extent for paving purposes.

In the vicinity of Burnet, the Pleuroceras (*Vicarya branneri*, Hill) limestone carries a heavy oil or asphaltum in such quantities as to give promise of becoming commercially valuable as a paving material.

The Washita division also yields some asphaltum in Western Texas and in Northern Mexico, but I can not say at present whether the deposits in the vicinity of Cline, Uvalde county, are of this age or later, as such fossils as I have seen are not sufficient to determine the age of the horizon positively.

The Eagle Ford (Benton) shale also furnishes a small supply of oil. In the cut on the International and Great Northern Railway south of Austin these beds are quite oily—so much so that they will burn. A number of years ago a well was sunk at Fiskville, northeast of Austin, and a small amount of oil was found, which is supposed to come from this horizon.

The horizon succeeding these—that of the Ponderosa marls—bids fair to be one of the most productive of the State. This great clay deposit, which is the substructure of our famous black waxy prairies, and whose economic value has always been considered as confined to these soils, now proves to contain great mineral deposits as well. In Presidio county it contains beds of bituminous coal; in Bexar, Navarro, and Hardin(?) counties it furnishes flows of oil and gas; in Van Zandt, Smith, and Anderson counties large beds of rock salt occur in it; and in it, in Calcasieu parish, Louisiana, are the great sulphur and gypsum deposits.

While the production of the oil wells south of San Antonio is limited, the wells have been flowing for several years, and are still productive.

At Corsicana oil was first found by Major Alex. Beaton in boring for water on his place "Gem Hill," southeast of the city. In 1894 the city drilled an artesian well near the "Cotton Belt" track, and at 1040 feet struck a vein of oil. This was shut off and the boring continued to the water sands (Dakota) at 2470 feet. The oil, however, forced itself to the surface of the ground outside the pipe put down to case it off from the water, and has flowed continuously since. While the amount is small, on account of the extremely narrow aperture through which it can rise, the flow is several gallons per day.

Having this evidence of the existence of oil, certain enterprising citizens took the matter up, and the Corsicana Oil Development Company was formed. Another well was put down in the neighborhood of the city well mentioned above, and again the oil was found. The bore of the well was small and the flow was not very strong. Taking the line of strike of the formation, which is here nearly northeast-southwest, the company drilled other wells and found oil in all of them. There are, at the time of this writing, six wells producing oil steadily, and two or three others are being drilled.

The depth is approximately the same in all of the wells—1040 to 1050 feet; but the oil sand is thicker toward the northeast, being 15 feet thick in well No. 7 of the Development Company. Other wells will be sunk east of the line which has proved so productive, with the expectation of extending the field in that direction.

As has been stated, the geological horizon is that of the Ponderosa marls. These beds have a thickness at this point of 1650 feet, as has been proved by several wells that have penetrated them. They are of their usual blue marl or clay character, and the sand bed in which the oil is found is somewhat of an anomaly in this region, although further west such beds are more common.

The wells flow by spurts, and are connected by a pipe line. A pumping station is being erected at the northeast well, which is at the lowest level of the series.

I was unable to make any estimate of the flow of the wells in the short time of my stay, but I was informed that several hundred barrels had been shipped, in addition to the amount used by different industries in the town. At present the oil is principally used for fuel purposes, for which it is excellently adapted, as is shown by the good results at the flour mill at Corsicana and other places where it has had trial. It is also used by several gas companies in the State for the manufacture of gas.

I consider it entirely probable that this field, now very circumscribed in area, will be found to be a broad stretch of territory, or a series of belts paralleling the strike of this formation eastward of the present line of wells.

Geologically these oil deposits are connected with the gas, sulphur, salt, etc., already mentioned, and the connection was, in part, indicated by the writer in his description of the Saline of Anderson county in the Second Annual Report of the Geological Survey, where it is stated:

"The conditions surrounding these salines are very nearly the same in all instances. There is generally a depression surrounded by wooded hills in which are found limestones of white or gray color. The depression is sometimes marshy, or during the winter months holds a body of water of greater or less extent, which evaporates as the summer approaches and leaves an incrustation of salt on the ground.

"The limestones are white to grey in color, and are sometimes quite siliceous, and sometimes they are glauconitic. They are characterized especially by the seams of calcite they contain, and are proved by their fossil contents to be the equivalents of the Ripley group (Cretaceous) of Mississippi. The underlying clays belong to the Ponderosa Marls, numbers of this oyster being found at different places in them.

"Surrounding these salines on every side we find strata of Tertiary age, and the salines themselves are therefore in the nature of Cretaceous inliers in that formation. They represent islands in the Tertiary sea formed by projecting eminences of the underlying strata of Cretaceous age.

"These salines occur also in Louisiana, where they have been studied by E. W. Hilgard and F. V. Hopkins.* 'The only known exposures of the limestones are at Winfield and near Chicot, in St. Landry's parish. The same strata, however, came very near the surface at all the various salt wells in Bienville and Winn parishes, and is the formation to which the sulphur of Calcasieu and the rock salt of Petit Anse belong.'

"Hilgard regards the series of Cretaceous inliers 'which traverse Louisiana from the head of Lake Bistenau in a south-southeast direction, terminating probably in the great rock salt mass of Petit Anse' as representing 'summits of an (more or less interrupted) ancient ridge, a kind of backbone to the State of Louisiana, whose resistance to denudation has measurably influenced the nature and conformation of subsequent deposits.' † The connection between these salines and the strata containing them and the deposits of oil, sulphur, and gypsum existing in southwestern Louisiana is well worthy of notice.

"At the sulphur mine in Calcasieu parish the boring of a well twelve hundred and thirty feet deep showed oil for the first three hundred and eighty-three feet.

" 'The evidence of oil consists of a number of black banks of hardened bitumen on the northern border of the marsh prairie and on its surface; also quite a number of bubbling springs, emitting an inflammable gas; and crude petroleum may be found by walking over the marsh. So abundant is this natural discharge of crude oil that the log haulers for

* First Annual Report Geological Survey of Louisiana, F. V. Hopkins, M. D., p. 206.

† Geol. Hist. of the Gulf of Mexico, A. J. S., vol. 2, Dec., 1871, pp. 209, 210.

miles around obtain their only supply of lubricating material from these springs. And yet the boring made in one of the most promising spots, to obtain a more abundant flow of oil, was almost entirely unsuccessful. The oil was at one stage of the boring obtained in considerable quantity, but was soon exhausted. The well was continued still further down into the bowels of the earth, and instead of more oil the marvelous deposit of sulphur now so well known throughout the State was discovered.'* The sulphur is of unequaled thickness and purity, and the gypsum, which is over five hundred feet thick, is also pure.

"The existence of similar areas and conditions in East Texas, and the discovery of rock salt underlying Grand Saline, in a deposit nearly a mile in length and over two hundred feet thick, are ample encouragement for the expenditure of the money necessary to sink trial wells in every such locality known in the State."

And I hope yet to see such trial wells sunk in many places, believing that the results will be the finding of deposits of salt, oil, and sulphur which will richly repay the prospectors and owners.

The next horizon which claims our attention is the Eocene Tertiary, in which are found the heavy deposits of brown coal, now just beginning to be utilized.

As has been pointed out by Harris, during the period of the deposition of these beds there was direct communication between the Texan waters and those of California, as proved by the occurence of marine fossil forms in both localities which are not found in the waters of the Atlantic coast deposits of the same age. And it is now proved that in these beds in both areas are productive oil horizons. Whether the dedeposits of Texas, like those of California, are "primary deposits," is yet to be determined, but the probabilities are in favor of such being the case, with a part of them, at least, since it is found at practically the same geological level in two or three widely separated localities.

The first prospecting of which we have record was in Nacogdoches county nearly thirty years ago, when the oil was proved to exist at Oil Springs, some 15 miles south of Nacogdoches. Later, wells were dug and a good supply of oil was secured. Seventy-five or more wells were sunk in this region, and oil found at an average depth of 100 feet. Very few of these were flowing wells. The first well yielded, according to report, 250 to 300 barrels of oil the first day, but did not flow afterwards. The wells were bailed and pumped, and the oil barreled and shipped to Nacogdoches. A pipe line 14 miles in length was built to connect the oil wells with the railroad, and a storage tank with a capa-

*Second Annual Report Louisiana State Geological Survey, F. V. Hopkins, M. D., p. 39.

city of 2000 barrels of oil was erected. These were not made use of, as far as I can learn, and were finally moved.

This oil was examined under the direction of Prof. Everhart, of the University of Texas, who pronounced it a useful lubricating oil, not adapted to the production of illuminating oil.

A full description of these wells is given in the Second Annual Report of the Geological Survey.

Similar oil is known in Shelby, Rusk, Anderson, and other counties, but has not been prospected for to any extent. In Anderson county the oil, by evaporation of its lighter portions, has left a heavy residue, locally known as asphaltum, which can be used for paving, as is done with some of the California materials. Other similar localities will doubtless be found when proper examinations are made.

While a number of occurrences of oil are reported from later horizons than those described, I have not yet been able to examine them, and on that account can not, at this time, give any definite information regarding them.

[*Read before the Texas Academy of Science, June 15, 1897.*]

TEXAS PERMIAN.

BY W. F. CUMMINS.

Since writing my paper for the Fourth Annual Report of the Texas State Geological Survey, I have had an opportunity of continuing my examination in the Permian area in Texas, and to do quite an amount of stratigraphic work which had not heretofore been attempted, and which was absolutely necessary to be done before a proper knowledge could be had of the relationship of the different divisions and beds to each other. In this paper I will attempt to give only a brief resume of my recent work done on the Wichita division of the series. A more complete report has been prepared for publication in the Fifth Annual Report of the State Geological Survey.

In previous discussions of the Permian formation in Texas,* I have separated the strata into three divisions, naming them Wichita, Clear Fork and Double Mountain, the Wichita being the lowest in the series. In my description of the Coal Measures in Texas, I separated the strata into five divisions, giving to the upper division the name of Albany and the one immediately below that the name of Cisco. These divisions, in both the Permian and Coal Measures, were made more or less arbitrarily, and were so divided for facility in giving particular descriptions of the different beds. It was understood at the time these divisions were made that they were provisional, and subject to revision when their true relationship to each other might be determined.

The Wichita division was described as extending southward as far as the Salt Fork of the Brazos river. It is represented as resting on the top of the Cisco division of the Coal Measures, along its entire eastern border, and as being overlaid by the Clear Fork division along its entire western border.

The Albany division of the Coal Measures was described as beginning on the north at the Salt Fork of the Brazos river and extending southward to the southern limits of the Coal Measures in the State, resting

* See Annual Reports Geological Survey of Texas, 1889 to 1892.

directly upon the Cisco division and overlaid on the west by the Clear Fork division of the Permian. It will therefore be seen that the Wichita and Albany divisions were made to occupy the same stratigraphic position.

At the time these divisions were first described the relationship between them could not be determined from the facts then in my possession. The area of the Wichita division was known to be Permian, and had been somewhat described prior to my giving it the present designation. It was embraced in the area known as the "Red Beds" of Texas. In it the invertebrate fossils were partly those known to occur in the Upper Coal Measures, and partly those that were characteristic of the Permian in Europe. The vertebrate fossils, which had been found quite abundantly in the area, were forms peculiar to the Permian. The area was therefore assigned to the Permian without any hesitancy.

The fossils that had been taken from the area assigned to the Albany division were only such invertebrate fossils as had been found in the Upper Coal Measures, and no vertebrate fossils had been found.

Instead of the strata being composed of red clay beds and sandstones, as was the case in the Wichita division, they were principally limestones and yellowish and blueish clays. In view of these dissimilarities it was thought best to describe the two areas under different names, although it was thought at the time that it was more than probable that the Wichita and Albany divisions were but different facies of the same beds.

Soon after the publication of my description of the divisions of the Coal Measures and Permian in Texas, Prof. Jules Marcou suggested to me in a private letter that the Albany division was Permian, and in a paper published in the American Geologist, December, 1892, set out his reasons for so believing.

During my recent examinations the true stratigraphic relation between the two divisions has been brought out, and I can now say with absolute certainty that they are the same in time and belong to the Permian.

The Wichita division is now admitted by every one to be Permian. This conclusion is based chiefly on the fossils that have been taken from the area and which have been described and determined by different specialists.

Prof. E. D. Cope described the vertebrate fossils collected from this division, a list of which was published in the Second Annual Report of the Geological Survey of Texas. These fossils show the Permian age of the beds as plainly as any one kind of life can show the age of any formation.

The invertebrate fossils were partly described by Dr. C. A. White, and a list of his determinations was published in the Second Annual Report of the Texas Geological Survey. The evidence from this source strongly corroborates the conclusion reached by a study of the vertebrates, showing the Permian age of the division.

Part of the flora collected from the division was described by Dr. I. C. White, and the evidence thus obtained also corroborated the conclusion of the Permian age of the strata.

The Permian age of this division being admitted, it follows that if the Albany division is but a different facies of the same beds it also must be Permian.

This fact has been abundantly shown by the stratigraphic work done during the past season by myself and party.

In previous years I made and published complete sections, by instrumental measurement, across the area of the Albany and Wichita divisions at right angles with the strike, and gave descriptions of the different beds composing the divisions, with a partial list of the fossils collected from them. The lines of these sections were about seventy miles apart. The section across the Albany division began at Albany and run thence in a northwestern direction, crossing the Clear Fork of the Brazos river at the mouth of Fish creek. The section across the Wichita division began at a point eight miles north of the town of Seymour, and run thence to Wichita Falls.

During the past year (1894) I have traced prominent beds found in each of these divisions across the country between these two sections, and have found them to be continuous from one to the other. By this means I was enabled to see the gradual change in the beds, and to understand that they were the same in time of deposition.

A map has been prepared to accompany the Fifth Annual Report that will show the lines of the sections previously made, and also the escarpments of the beds traced during the last year's work, between these two lines of sections.

The map will also show the type localities from which the specimens were taken as described by Dr. C. A. White. (Bull. No. 77, U. S. Geo. Sur.) It will also show the localities of the fossil flora described by White and Fontaine.

The plan adopted for my work was to select some prominent bed in the Albany division and then trace it to the northeastward toward the section run across the Wichita division. By walking along the outcrop every foot of the way we were enabled to note the gradual change in the lithological character of the bed. We were also enabled to note the gradual extinction and change in the fossils as the beds changed in composition.

We found that a limestone in the Albany division with an abundant and characteristic Coal Measures fauna, gradually changed in composition to a calcareous sandy clay entirely destitute of fossils of any kind. Other limestone beds in the Albany division when traced to the northeastward would gradually pass into sandstone, while still others would entirely disappear.

By this manner of work we were enabled to observe also the gradual change in the fauna of the different beds. As the beds would change in lithological character, indicating a change in the conditions of the waters in which they were deposited, difference in the fauna to correspond with this change of condition was readily observable.

At most places in the Albany division there are only Coal Measures fossils, but going northeastward these would gradually become extinct as the habitat changed, and newer forms would come in and take their places.

I began tracing these different beds at the mouth of Fish creek, on the Clear Fork of the Brazos river in Shackelford county, where the line of the general section from Albany to the foot of the Staked Plains, as published in a previous report, crosses the line between the Albany division and Clear Fork divisions, as then described.

The hills at this place are capped by a bed of limestone two feet thick, with beds of shale and other limestones below. The following fossils were collected at this place: Myalina subquadrata, Bellerophon, Allorisma subcuneata, Pinna peracuta, Fenestella sp?, Productus semireticulatus, Aviculopecten sp?, Hemipronitis crassus, Orthoceras sp?, Naticopsis sp?, Phacoceras dumblei, Hyatt, Nautilus sp?, Euomphalus sp?, Schisodus wheeleri, Murchisonia sp., Synocladia sp., Meekella striatacostata, Pleurophorus sp.

From this point we traced the beds to the northeast as far as the hills on the north side of the Big Wichita river, and noted the gradual changes in the lithological character in the several beds. There was no trouble in tracing the beds across the supposed northern boundary of the Albany division, although they had greatly changed in appearance from what they were at the place of beginning.

North of the Brazos river, in the area heretofore designated as the Wichita division in previous reports, the strata of the escarpment became more and more composed of red clay and the limestone beds less conspicuous. The limestone gradually loses its limy nature. Only a few of the limestones of this escarpment continue as far north as the Big Wichita river, and they are very much modified, some of them passing into a white or gray indurated clay which breaks into hard, rough nodular fragments.

The line of levels run across the Wichita division, and published in the Second Annual Report, crossed this escarpment just south of the Big

Wichita river and near where sections Nos. 28 and 29 were made as published in that report on pages 403, 404.

The locality given by Dr. C. A. White as Military Crossing in his description of Permian fossils (Amer. Nat., Feb., 1889) is on the north side of the Big Wichita river two miles, and about one mile east of this escarpment. No fossils were found in this escarpment on the Big Wichita river except the *Phacoceras dumblei*, Hyatt.

By thus tracing this escarpment between the two points, the Clear Fork of the Brazos river and the Big Wichita river, and finding it continuous, we demonstrated very clearly that the beds called the Upper part of the Albany division in previous reports, are the same as those called the Upper part of the Wichita division in the same reports.

We next selected an escarpment capped by a bed of hard limestone, about five miles east of the one previously mentioned, and traced it southeastward to the Clear Fork of the Brazos river, crossing the supposed line of contact between the Albany and Wichita divisions. Here we again observed the gradual change in the lithological character of the beds that we had seen in the previously traced escarpment.

We made four separate lines of tracing across the area of the two divisions, and found the fact well established that the Wichita and Albany divisions were the same in time of deposition, and therefore the Albany must be abandoned both as to its name and the age to which I had previously referred it, and the beds composing the division must be referred to the Wichita division of the Permian.

Since the Wichita division is now made to include the area heretofore referred to as the Albany division, it becomes at once the most important and interesting part of the Permian in North America.

Prof. F. W. Cragin suggests in a recent paper, that the Permian area south of the Wichita Mountain range ought to be considered as a different basin from that on the north of the range, and that it is "profitless to attempt divisional correlation between them."

It is more than probable that when the areas are better known it will be perfectly plain that they were not two separate basins, but were connected on all sides of this mountain range, and that it will be possible to correlate the divisions of the Permian as accurately as it has been possible to do with the Lower Cretaceous divisions which are similarly situated with regard to this mountain range. Especially will this now become possible since it has been determined that the Albany division, with its numerous fossils, is but another facies of the Wichita division which is beyond question Permian.

The *Phacoceras dumblei*, Hyatt, has been found only along a very narrow horizon in the Texas Permian. That horizon was traced and the fossils found for a distance of seventy-five miles. The fossil was found quite numerous at places, so that it might be said the bed was characterized by that fossil. This fact will assist materially in correlating the Texas and Kansas beds, as that fossil has been reported only from one locality in the Kansas area, where it is associated with the same fossils as in Texas. It is quite certain that the Fort Riley horizon is the same as the Wichita division of Texas, and is at the very top of the division. With one horizon definitely established, it will be easy enough to correlate the other parts of the formation in the two areas.

[*Read before the Texas Academy of Science, October 1, 1897.*]

SCIENCE ON THE CONDUCT OF LIFE.

Address to the Texas Academy of Science by the President, Dr. George Bruce Halsted.

Julian Hawthorne says that eight million human beings have just starved to death in India for lack of a few opportune rains.

Some have answered that he overestimates the numbers, as not all of the eight million are yet dead.

So it may be best to give the unused words of three bicyclers in a brief glimpse at the reality. They say: "Not a hundred yards from this noisy mirth were several hundred poor, fleshless, bone-protruding, cringing wretches who had crawled in from the famine districts seeking a handful of rice from Government relief commissioners or from the missionaries. They were huddled in a compound, listlessly submitting to 'Kismet,' and while uncomplaining about their distress, exhibiting small thankfulness for the aid extended them. There was not an agitator amongst them, not a single denouncer of the Government. They simply squatted in corners, their narrow shoulders perched high, their chocolate skins tightly casing their thin, prominent ribs, a look of blank submission on their faces—a spectacle of inert, heedless starvation."

"There were thousands of trudging pilgrims along the way, worn, ill-fed gangs of men and women who had walked hundreds of miles to make their future state secure by bathing from one of the sacred ghats by the side of the sacred city."

"Down this way is a Hindu dragging a goat to be sacrificed to a goddess who, it is hoped, will cure his sickness; a woman is taking flowers as an offering to the god of creation; down by the river thousands of folks are in mute posture, training the mind to forget the world." "All comers bring flowers and fruit and money, and stretch themselves out before the black stone. And when they have splashed enough water, and tossed enough flowers, and lain long enough on the hard slabs, they go away ever so much better."

This straightforward description of three cycling tourists gives a graphic picture of the pre-scientific solutions offered to the problems of life, and the accompanying states of mind; on the one hand physical and moral torpor, apathy, despondency, resignation; on the other hand a deliberate forcing of a state of abstraction from external reality, and a production of subjective effects by intense introversion of self-consciousness.

This latter is illustrated amongst us by what with rich irony is called Christian Science. A lady Christian Scientist doctor was recently called in by a fond mother to treat a child for boils on the head. Turning upward her rapt face, she began by saying "I see no boils." How perfectly evolutional and archaic this method is was emphasized for me by a recent spontaneous exhibition of it on the part of my youngest child, who had just refused his mother's command to carry a box of matches to his father.

The command being sharply reiterated with threat of dire punishment and the box extended to him, he screamed out, "But I can't see any box of matches! I can't see any box of matches!"

Neither could he; for he was holding his eyes tight shut!

But for those whose eyes actually open on the real horrors of our world, the impulse to the other archaic solution, the resignation, the Kismet, the Calvinism has been so far almost irresistible.

In our free-silver sister republic this summer I was witness to a scene whose piercing pathos no words of mine can adequately reproduce.

At Guanajuato a funeral entered the Panteon. The hired hearse was a man who carried the hired coffin on his head. The funeral procession consisted of three persons; two graceful if barefooted, bareheaded, ragged little girls, sisters of the corpse, and then the poor mother, heartbroken, dazed, who paid the hearse her last poor little silver coin. The shallow grave was just being finished, and so thick is this ground with human remains that a horrid, loathsome, rotting skull, with patches of stinking flesh and hair, was thrown up at our feet. The very earth was putrid, and into this pit the hired hearse, opening the hired coffin, dumped the half-naked body of a beautiful girl.

Not a single word was spoken. The grave-digger began shoveling in the fetid dirt.

Looking from the face of the agonized mother to the bare dead feet still protruding from the earth. I felt an appreciation of Tolstoi's solution for the problem of this life—*renunciation*. What these our fellows can never have any hope of, that will we also reject, to share their lot with perfect unselfishness, brotherhood. Says Tolstoi: "The vocation of every man and woman is to serve other people."

He dwells with stress on the renunciation of our individual happiness. Wonderful is the clearness, simplicity, sweetness of his ideal. Must we accept also its hopelessness?

Here is a truly marvelous personage. He is an erudite scholar of the classics. He writes English, German, French, and has such a mastery of Russian as no man ever had. He is a profound student of the Scriptures in the original tongues. Himself a count, his father was a noble of most ancient lineage, his mother a princess.

His Anna Karénina is the greatest novel since the world began.

His penetration into the deepest sources, the profoundest springs of human action seems supernatural, uncanny. Yet as outcome of intensest wrestling with the problem of this life, the man of whose works Howells says, "To my thinking they transcend in truth, which is the highest beauty, all other works of fiction which have been written"; this man, winner of the world's adoring admiration, puts off the garb of civilization, dons the inside-out sheepskin coat of the moozhik, renounces wealth, denounces courts, ecclesiasticism, militarism, renounces even meat, preaches universal non-resistance, goes to plowing.

Do not imagine that this great man lacks weighty arguments.

Perhaps no one has attempted to compute the daily cost of ecclesiasticism in mere money. No one seems to notice the extraordinary oddness of paying to maintain an army of missionaries to Mexico to convert people already Christians.

But some one has reckoned that the standing armies are costing the world eight million dollars per day, a figure easily remembered by association with Hawthorne's eight million starved-to-death subjects of Victoria, whose jubilee was simply a shockingly expensive military pageant.

Only a short time ago Russia passed through the horrors of a gigantic famine.

When I sailed down "mother Volga" toward Samara, the center of the stricken district, despair seemed still brooding over the land.

Even in favored years it is only by heroic toil of men and women, moozhík and baba together, throughout the brief season, that grim necessity can be held at bay.

All appliances are still of the most primitive. I saw new wind-mills building of precisely the pattern charged on by Don Quixote.

I saw a moozhík and a baba threshing their wheat on the ground with flails.

I saw prisoners for Siberia marching each between two soldiers with fixed bayonets.

Through the streets of the cities I saw drawn at a gallop, as with fire horses, holy images to visit sick patients instead of physicians. On the sides of the cathedrals I saw frescoed the immortal souls roasting in blazing hell forever.

The whole atmosphere seemed murky with two associated ideas—*obedience* and *punishment*. These two strictly human ideas, obedience, punishment, are very familiar to us also, unfortunately. If they are to be permanently valid in the real universe, Tolstoi's solution of the problem of life can never be gainsaid.

But there is a something which was given no effect among the data which led to that solution, a something called *Science*, now grown to be a mighty, an all-pervading spirit, which must, which will be reckoned with.

In our own time, through Darwin, it has answered the riddle of the ages, whence come we? You now accept that we came from lower animals by evolution working through millions of years.

To one enquiring where are we? it is science that presents the telescope, the spectroscope, the microscope.

Science cuts us into infinitesimal slips with its microtomes, gets inside our eyes with opthalmoscopes, looks through us with X-rays.

Applied science is beginning to feed the world almost apart from human labor.

A moozhík, on an American wheat farm, watching the same machine reap the wheat, thresh the wheat, make bags, pack the wheat in bags, tie them up and deposit them ready for shipment, would be prepared to believe the actual fact, that last year we deliberately burned more than a hundred thousand tons of molasses.

The reign of brute strength, of the body is doomed even in the barbarous arts of war. The modern Greeks are a remarkably strong, athletic race. Witness the fact that a Greek peasant lately won the long-distance race against the whole world. But when these athletes, backed by their knowledge of Greek and by the prayers of the combined Protestant church, Catholic church, Greek church, faced the villainous race who have been horrifying the world by their wholesale murder of Christian Armenians, and inconceivable atrocities to Armenian women and children, behold the noble Greeks exercising all their great running powers to get away from these butchers of Christian women. Oh for a tiny division of those tiny, polite, intellectual little dwarfs called Japanese!

Oh the consequent howls of those villain Turks!

You know the Japanese appreciate the non-Euclidean Geometry.

When I was in Hungary everywhere swords and sabres obtruded themselves.

The Hungarian women are beauties gifted with eternal youth. The Hungarian men are big whole-souled athletes. Their lavish hospitality prevented my saying to them that in real scientific warfare now days the sword is of about as much account as a Bologna sausage.

Note in the newspapers that what saves the British armies is the Maxim gun; what is breaking the fetters of Cuba is dynamite.

Why are the dervishes just now at a discount? Answer: the portable steamboats made in sections and to draw not over three feet of water.

Science will be the great missionary to abolish the slavery of compulsory military service, because the time is coming when a few assistants from the chemical and physical laboratories of the universities will be able to annihilate an army of prize-drilled companies.

Good bye to the soldier, and good riddance!

But even more surely has Science undermined the reign of obedience and punishment in the theory of this world and the world to come.

Some think that a law is an enactment, of some legislative body wise or otherwise, and that if you do not obey it you deserve the decreed punishment. But the laws of science can neither be obeyed nor disobeyed. Take as typical the law of gravity, which is that every particle of matter attracts every other particle directly as the mass and inversely as the square of the distance. You can not obey this law. You can not disobey it. It is simply a statement of how your material particles act, and nothing can help them or hinder them for a single moment from so acting.

As the man of science sees once for all that no one can disobey the laws of nature, he questions the grounds on which he has been exhorted to obey the fallible laws of man and the warranty for the terrible punishments here and hereafter which he has been declared to deserve.

If man is the result of evolution in accordance with natural laws, there was no fall of man, and he scarcely deserved eternal conscious punishment for not hurrying his ascent.

Laws that can be disobeyed can be only advice on the conduct of life.

Each must be the judge when this advice is inapplicable or should be rejected. The commandment to keep the seventh day, the sabbath, Saturday, the early church thought best to modify by substituting for a breaking of this command a keeping of a new command to keep the first day, Sunday.

Most primitive, most obvious is that absolute commandment: Thou shalt not kill.

It has already been brought to your attention that the governments are paying eight million dollars a day to keep in readiness for wholesale killing of men.

A startling instance of a single man taking this commandment as advice to be weighed, accepted, or rejected, was the surgeon hurrying through the mass of shattered, wounded humanity on a great war ship in the late Chinese war. Armed with a powerful atomizer charged with Prussic acid—instant death, his adverse decision on the advisability of attempting treatment was one quick jet in the face, and the shattered masses of agony, that had been men, strained toward him, stretching their distorted faces toward the instant death. Was the surgeon right?

If so, there is no command which may not need breaking.

There are only two grounds, then, on which a man may be punished—for the good of himself or for the good of others. But science teaches unselfish love for others, so to harm another is to harm us all. If the advice in any law is good advice, the one who for any reason does not take that advice is to be sincerely pitied, perhaps more deeply pitied than the unmistakable lunatic.

In the high-school building of a thriving Texas city the Superintendent showed me a large table and told with evident pride how he had forty boys leaning over that table at the same time while he hurried around it with his trusty rod administering to each a resounding thwack.

The local bank-president, whose son was a pupil, extolled the perfection of the training by saying that the instant a boy was commanded he obeyed, quick as flash. I answered that nothing could induce me to subject a boy of mine to such volitional ruin. I preferred that my boy should balk automatically at anything that even sounded like a command.

A careful and judicious expert says: Man's temptation to lie is the most expensive item in all commercial transactions.

The essence of the scientist is an ineradicable passion for verifiable truth.

What example of applied science more obvious than the bicycle? The principle that holds it erect was familiar through the mathematics of the gyroscope. The ball bearings are elementary geometry, not to mention the tangential spokes, the pneumatic tire, the air-pump, and all the rest.

How substitute a machine for the human type-setter?

At the world's fair was a machine which imitated the man by actually setting the type, but the solution as seen in machines in use in this city is vastly different.

Instead of type, they set moulds for letters, and cast each line from the molten metal.

Beautiful as a fairy tale it is to see them distribute back all these matrices by an application of pure geometry.

The thousands and thousands of perceptive acts, of volitional acts in every small piece of type distribution are saved for higher thinking.

And finally, all this gives but slightest hint of the many ways science now is storing her vast potential of physical and mental energy for application in service of truth and unselfishness.

Surely her truth will make you free!

TITLES OF PAPERS READ BEFORE THE ACADEMY.

Austin, February 5.

Address, The Improvement of the Galveston Harbor; Lieut. W. V. Judson, U. S. A.

Austin, March 5.

1. Ether; Dr. E. F. Northrup.

2. A New Suggestion Concerning the Transmutation of Matter (postponed from the December meeting); Dr. H. W. Harper.

Austin, April 2.

1. Report of Some Experiments with the X-rays Upon the Blind; Drs. H. L. Hilgartner and E. F. Northrup.

2. Hydrazine Derivatives of Propionic Acid (postponed from the December meeting); J. R. Bailey.

3. On the Roots of Bessel's Functions; M. B. Porter, of Harvard.

Austin, May 7.

1. The Properties of the Living Substance; Dr. Edmund Montgomery.

2. An Account of Some Applications of the Bessel Functions to Astronomy; H. Y. Benedict.

3. A Note on a Generalization of the Numbers of Couchy; H. Y. Benedict.

4. Triazines and Triazoles; J. R. Bailey and S. F. Acree.

5. On the Constitution of a By-Product Obtained in the Preparation of Hydrazopropionic Acid; J. R. Bailey and H. B. Decherd.

Austin, June 15.

1. Notes on the Physiology of the Nervous System of Centipedes; W. W. Norman.

2. The Personality of a Great Genius—Sylvester; George Bruce Halsted.

3. Epsom Salts (Magnesium Sulphate) from Brown County, Texas; H. W. Harper.

4. Some Texas Oil Horizons; E. T. Dumble.
5. Pedagogical Note on Mensuration; Arthur Lefevre.
6. The Texas Permian; W. F. Cummins.
7. On the Bio-Geography of Mexico and the Southwestern United States; C. H. Tyler Townsend.

Austin, October 1.

Annual Address by the President of the Academy, Dr. George Bruce Halsted.

Subject of the President's Address: Science on the Conduct of Life.

Austin, November 5.

Some Experiments on Induction with Currents of High Frequency at Long Distances; Dr. Northrup and Messrs. Pierce and Reichmann.

NEW MEMBERS.

Dr. Adolph Bernhard, Ph. D., Demonstrator in Chemistry, Medical Department, University of Texas, Galveston.

William L. Bray, A. M., Instructor in Botany, University of Texas, Austin.

Morgan Callaway, Jr., Ph. D., Associate Professor of English, University of Texas, Austin.

W. S. Carter, M. D., Professor of Physiology, Medical Department, University of Texas, Galveston.

Charles L. Crow, Ph. D., Weatherford College, Weatherford.

A. Caswell Ellis, Ph. D., Adjunct Professor of Pedagogy, University of Texas, Austin.

Alfred Freshney, High School, Austin.

William E. Luter, M. D., San Antonio.

Samuel D. Magers, B. Sc., High School, Houston.

Ralph Steiner, M. D., Austin.

James Duryee Stevenson, Attorney-at-Law, San Antonio.

NEW FELLOWS.

James R. Bailey, Ph. D., Instructor in Chemistry, University of Texas, Austin.

Charles Corner, C. E., Austin.

L. E. Dickson, Ph. D., Instructor in Mathematics, University of California.

H. L. Hilgartner, M. D., Austin.

Arthur Lefevre, C. E., Instructor in Mathematics, University of Texas.

E. F. Northrup, Ph. D., Philadelphia.

M. B. Porter, Ph. D., Intsructor in Mathematics, University of Texas.

E. P. Schoch, A. M., Instructor in Chemistry, University of Texas.

R. A. Thompson, A. M., Instructor in Applied Mathematics, University of Texas.

Joe S. Wooten, M. D., Austin.

The statement given below was printed in the announcement of the April meeting by the Secretary on the recommendation of the Council:

It has been the custom to mail to each member of the Academy the Transactions in the form of *separates* as soon as issued. This plan will not be followed in the future; instead, a copy of the completed Transactions for the year will be sent to each member. This secures the advantage of having all the papers together in book form. However, that any paper may be furnished at any time to any member who desires it, a number of separates of each paper published will be kept on hand by the Secretary, and a copy will be sent to any member requesting it.

The new publications made from time to time will be announced in the monthly programmes.

November 1, 1897. W. W. NORMAN, Secretary.

TRANSACTIONS

OF THE

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FOR 1898

WITH THE PROCEEDINGS FOR 1898

VOLUME II.

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WILLIAM L. BRAY.
THOMAS U. TAYLOR.
WESLEY W. NORMAN.

[*Extract from a paper presented to the Texas Academy of Science, December 22, 1897.*]

THE INTRODUCTION TO LOBACHÉVSKI'S NEW ELEMENTS OF GEOMETRY.

TRANSLATED FROM THE RUSSIAN BY GEORGE BRUCE HALSTED.

TRANSLATOR'S PREFACE.

No part of Lobachévski's largest work, "New Elements," has ever before been published in any language but the original Russian.

I gave an account of it in 1893 at the Mathematical Congress of the World's Columbian Exposition, and promised then the publication of my translation. (See Mathematical Papers of Chicago Congress, pp. 92–95.)

This promise was delayed for a personal visit to Kazan, the home of Lobachévski, and Maros-Vásárhely, the home of Bolyai.

The volume of *Ucheniya zapiski* in which the publication of *Noviya nachala* was begun is dated 1835, but Lobachévski himself gives as the dates 1836, 1837, 1838, in his "Geometrical Researches on the Theory of Parallels" (1840), the little book by which alone his ideas have heretofore been accessible to the world in general.

But it is preëminently in his "New Elements" that the great Russian allows free expression to his profound philosophic insight, which on the one hand shatters forever Kant's doctrine of our absolute *a priori* knowledge of all fundamental spatial properties, while on the other hand emphasizing the essential relativity of space.

Lobachévski's position is still after sixty years the final philosophy.

No one has gone beyond it.

Many still exhibit, like Professor Newcomb in his beautiful address on the Philosophy of Hyper Space (SCIENCE, January 7, 1898), a marked naïveté. He says: "Certain fundamental axioms are derived from experience, not alone individual experience, perhaps, but the experience of the race." On the contrary, the hereditary geometry, the Euclidean, is underivable from real experience alone, and can not be even proved by experience. Its adequacy as a subjective form for experience has not yet been disproved, but might in future be disproved. It can never be proved.

The realities which with the aid of our subjective space form we understand under motion and position, may, with the coming of more accurate experience, refuse to fit in that form. Our mathematical reason may decide that they would be fitted better by a non-Euclidean space form. But we are, and will be, helpless to get such a space form from any experience whatever.

Space is presupposed in all human notions of motion or position. We may drop out such specifications from our space form as render it specifically Euclidean, but we can not replace them by non-Euclidean. Euclidean space is a creation of that part of mind which has worked and works yet unconsciously.

It is not the shape of the straight lines which makes the angle-sum of a rectilineal triangle a straight angle. With straight lines of precisely such shape but in a non-Euclidean space, this sum may be greater or less. In non-Euclidean spaces, if one edge of a flat ruler is a straight line the other edge is a curve, if the ruler be everywhere equally broad. In any sense in which it can be properly said that we live in space, it is probable that we really live in such a space. What becomes of the dogma that fundamental axioms are derived from experience alone?

GEORGE BRUCE HALSTED.

INTRODUCTION.

Every one knows, that in Geometry the theory of parallels has remained, even to the present day, incomplete.

The futility of the efforts which have been made since Euclid's time during the lapse of two thousand years to perfect it awoke in me the suspicion that the ideas employed might not contain the truth sought to be demonstrated, and whose verification, as with other natural laws, could be helped only by experiments, as for example astronomic observations.

When finally I had convinced myself of the correctness of my supposition, and believed myself to have completely solved the difficult question, I wrote a paper on it in the year 1826.*

* Exposition succincte des principes de la Géométrie, avec une démonstration rigoureuse du théorème des parallèles, read February 12, 1826, in the séance of the physico-mathematic Faculty of the University of Kazan, but not printed

Application of the new theory to analysis is to be found in memoires which I printed in the Kazan Courier of the years 1829 and 1830 under the title *On the Foundations of Geometry.*

The principal result at which I have arrived under the assumption that lines are dependent upon angles, is the possibility of the existence of Geometry in a wider sense than that in which Euclid first expounded it to us.

In this broadened form I gave to the science the name *Imaginary Geometry*, in which as a special case the *Customary Geometry* is contained under limitations in the general hypotheses recommended by practical measuring.

That the new foundations are sufficient, I have undertaken to show in a paper recently published in the Scientific Memoirs of the University of Kazan.*

In the endeavor to attain this aim, not so much directly as rather by the shortest inverse way, I chose then, going over from certain assumed foundations, to arrive at equations for all relations and at expressions for all magnitudes of geometry.

Even should my discovery have produced no other advantage than the filling of the gap in the elements, yet at least the interest which this subject has always aroused obliges me now to treat it with detail. I will begin with an examination of the earlier theories.

It is easy to show that two straights making equal angles with a third never meet, since they are then perpendicular to a certain straight.

Euclid assumed inversely, that two straights unequally inclined to a third always meet.

To demonstrate this latter assumption, recourse has been had to many different procedures; such as trying first to find the sum of the angles of a triangle, or comparing infinite areas comprised between the sides of an angle and between perpendiculars to a straight, or supposing that the angles depend only on the ratio of the sides, or finally attributing to the straight new properties, in order to complete its definition.

All these demonstrations, some ingenious, are without exception false, defective in their foundations and without the necessary rigor of deduction.

There is not even one of them sufficiently simple and sufficiently specious to present usefully to beginners.

In 1800 Legendre, in the third edition of his geometry, set up

*In Book I of the Scientific Memoirs, for the year 1835, under the title *Imaginary Geometry.*

the proposition that the sum of the angles of a triangle can not be greater than π, than two right angles.

There also he wished to prove that this sum could not be $< \pi$. But here he has not noticed that just then when the value of the sum deduced in another way shows some contradiction, the lines possibly no longer make a triangle.

I do not think it necessary to insist here in more detail on this error, which Legendre himself conceded later, when he declared, although the principle used as foundation was subject to no doubt, yet he found difficulties which he could not overcome.*

In the Mémoires of the Academy of Science of Paris for 1833, he has also published the theorem, that the sum of the angles in every rectilineal triangle must equal π, if in any one it has this value.

I had to prove the same proposition in the theory I wrote in 1826. I even find that Legendre often came upon the way which I have chosen with such success. But probably his prejudice in favor of the proposition assumed by all caused him, at each attempt, either to be hasty in the deduction or to fill it out with things which under the new theory are no longer admissible.

Let us analyse all he has printed on this subject in the Mémoires of the French Académie for the year 1833.

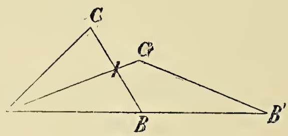

Fig. 1.

In the triangle ABC (Fig. 1) draw from A through the midpoint I of the side BC the straight [sect] $AC' = AB$. Prolong AB to make $AB' = 2AI$. Thus we get a triangle $AB'C'$ in which $B'C' = AC$, and the sum of the angles S is the same as in the first triangle ABC, of which the angle CAB passes into the $\triangle AB'C'$, dividing into the two at the points A and B'.

Suppose now AB the largest side of the triangle ABC or anyhow not less than the others, and also $BC \leqq AC$. Then is $AC' \geqq C'B'$, and the angle opposite the side $B'C'$ in $\triangle AB'C'$ is at most half as great as the angle CAB. Continuing thus, we will arrive at a triangle where two of the angles will be as small as we choose, while the sum of all three has the same value as in the first triangle ABC.

Legendre would from this conclude that in diminishing the two angles the approach of the opposite sides toward the third side would finally convert the remaining angle into two right angles,

*Legendre's own words are: "Nous devons avouer que cette seconde proposition, quoique le principe de la démonstration fût bien connu, nous a présenté des difficultés que nous n' avons pu entièrement resoudre." (Mémoires de l'Acad. des Sc. de l'Inst. de France, Tome XII. 1833, p. 371.)

and that therefore in the original and consequently in every triangle $S = \pi$. (Réflexions sur la théorie des parallèles. Mémoires de l'Acad. des Sc. Tome XII. 1833, p. 390.)

However, this reasoning is not correct, because the sides of the triangle here increase without limit and therefore also we can assume the limit of approach so that the angle $AC'B' = S < \pi$.

Let A, B, C be the angles of △ ABC at the points marked by these letters; let A'B'C' be the angles of △ AB'C' at the points A, B', C'; finally let h be the perpendicular let fall from C' on AB'.

With help of the Imaginary Geometry, supposing $S < \pi$ and designating by e the base of Naperian logarithms, we find

$$\cot A' = \cot A + \frac{\sin C}{\sin A \sin B}$$

$$\cot B' = \cot A + \frac{\sin B}{\sin A \sin C}$$

$$e^h - e^{-h} = 4\sqrt{\frac{\cos \frac{1}{2} S \cos(\frac{1}{2} S - A) \cos(\frac{1}{2} S - B) \cos \frac{1}{2}(S - C)}{\sin^2 B + \sin^2 C + 2 \sin B \sin C \cos A}}.$$

The first two equations show that A' and B' are always real, and with the transformation of the triangle decrease toward limit zero. The last equation gives always the height h and determines the limit of approach

$$h = \log \cot \tfrac{1}{4} S,$$

where the logarithm is Naperian.

Although Legendre designates his demonstration as completely rigorous, he without doubt thought otherwise, for he adds the proviso, that a difficulty which one would perhaps still find can always be removed. For this, he has recourse to calculations founded on the first formulas of plane trigonometry, which it would be necessary first to establish, and which just in this case are useless and lead to no result.

To omit no argument in favor of his theorem, Legendre remarks, that congruent triangles placed together with, throughout, different angles by threes at a point, make a ribbon which can be prolonged indefinitely and which then is bounded by two broken lines concave toward one another for $S < \pi$, for $S > \pi$ convex one toward the other. The proved impossibility of the latter case induces also to reject the first, where the lines, turned toward each other like two circle-arcs, would seem necessarily to meet.

It seems superfluous to analyse and judge such an argument, where there is not even the shadow of a rigorous demonstration. I will only add, that lines concave toward each other only approach each other because of the notion assumed in the ordinary geometry, while on the assumption $S < \pi$ nothing prevents supposing their prolongation while remaining equidistant.

Bertrand [of Geneva] and, after his example, Legendre, have wished to compare infinite surfaces in angles and between perpendiculars.

Demonstrations of this kind should be preceded by a determination of the magnitude idea, which in geometry one can only understand in connection with measurement, if besides it is convened beforehand by what characteristic to discriminate greater from lesser.

For example, a piece of a plane enclosed by a curve is considered greater than a polygon comprised entirely within it; on the contrary, smaller, if inversely the curve is entirely within the polygon; and this is so, even if no means be known of measuring these surfaces.

But as to infinite surfaces, it is necessary here, as everywhere else in mathematics, to understand as the ratio of two infinites its limit when its two terms increase indefinitely.

Besides, it is necessary to understand here by geometric magnitude at least such a one as we can approximately determine, estimating by the characteristics of inequality.

In this regard, the demonstration of Bertrand, and all the analogous proofs are far from satisfactory since in them we see no procedure for measuring the surfaces; not to mention, that the surfaces must first be bounded, to increase into the infinite through widening of their boundaries.

Suppose we wish to compare the surface X (Fig. 2), in the opening of the angle DCE, with the surface Y, between the two perpendiculars AB, CD to AC, for $AC = a$.

The ratio of the two surfaces X and Y, even when they increase to the infinite, will turn out different according to the way we convene in the start to limit them.

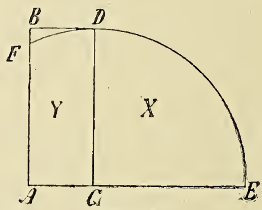

Fig. 2.

Suppose for example that in every triangle the angle-sum $S = \pi$. Make $AB = CD = na$, where n is a whole number.

Then draw the straight DB. On the other hand, limit the surface in the opening of the angle DCE by a circle-arc described from C as center with radius $CD = na$.

We find

$$Y = na^2, \qquad X = \tfrac{1}{4}\pi n^2 a^2;$$

Whence $\dfrac{Y}{X} = \dfrac{4}{\pi n}$

a ratio which with increase of the surfaces Y and X, for $n=\infty$ becomes nul, as Bertrand also has assumed.

If, however, instead of assuming $AB=na$, we make $AB=n^2a$, but CD is left as before, then this time we find the ratio

$$\frac{Y}{X}=\frac{4}{\pi},$$

which is constant for every n and consequently also for $n=\infty$, where both surfaces become infinite.

Thus the ratio Y/X turns out each time different, according as we limit the surfaces in the beginning, and according as they subsequently increase into the infinite.

Now limit both surfaces X and Y by an arc FDE described from C as center with radius $CD=na$.

Under the assumption, that in every triangle the angle-sum $S>\pi$ or $S=\pi$, it is easy to see that the ratio Y : X becomes nul for $n=\infty$.

This means that in both cases Y becomes an infinite of the first order, but X an infinite of the second order, as also Bertrand thought.

On the other hand, with the assumption $S<\pi$, we find the ratio*

$$\frac{Y}{X}=\frac{2\,(e^{na}+e^{-na})\operatorname{arc}\sin\left(\frac{e^{2a}-1}{e^{2a}+1}\cdot\frac{e^{2na}+1}{e^{2na}-1}\right)-4\operatorname{arc}\sin\left(\frac{e^{a}-e^{-a}}{e^{na}-e^{-na}}\right)}{\pi\,(e^{na}+e^{-na}-2)},$$

where the number $e>1$ is independent of n; and consequently for $n=\infty$

$$\frac{Y}{X}=\frac{2}{\pi}\operatorname{arc}\sin\left(\frac{e^{2a}-1}{e^{2a}+1}\right),$$

which is not null so long as $a>0$, and which can be neglected only when a is infinitesimal.

From another point of view it is easy to see that we can not presume the ratio Y:X for $X=\infty$ to become null in case $S<\pi$.

*Designate by e the base of the Naperian logarithms, and leaving indeterminate the unit for length, put

$$\sin r'=\frac{2}{e^{r}+e^{-r}},\quad \sin\psi=\tan r'\cot x',$$

$$\tan r'=\frac{2}{e^{r}-e^{-r}},\quad \tan x'=\frac{2}{e^{x}-e^{-x}}.$$

Then we find as the expression for the piece of the circle comprised between two perpendiculars to the radius r, of which one passes through the center and the other is at distance x from it (Imaginary Geometry)

$$\frac{1}{\sin r'}\operatorname{arc}\cot(\sin r'\cot\psi)-\psi.$$

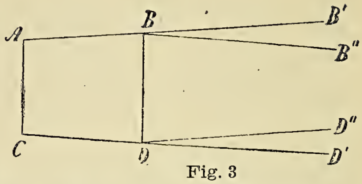

Fig. 3

Let AB, CD, be perpendiculars on AC (Fig. 3); take arbitrarily AB = CD. Assuming S < π, the angles ABD, CDB, are acute; the perpendiculars BB'', DD'', on BD are situated in the interior of the figure B'BDD', without ever meeting, and make with BB' and DD' the angles B'BB'', D'DD'', whose infinite surfaces are smaller than the surface B'ACD', contrary to what Bertrand wished to maintain of all angles without exception.

Bertrand gives another form of his demonstration considering infinite surfaces in angles only.

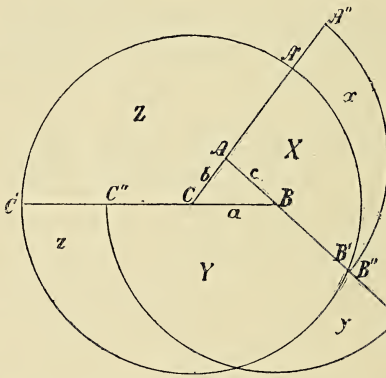

Fig. 4.

In the triangle ABC (Fig 4), call A, B, C the angles opposite the sides a, b, c, which prolong: AC through A to A'', AB through B to B''', BC through C to C'. The surfaces X+x, Y+y, Z, in the openings of the exterior angles $\pi-$A, $\pi-$B, π − C, extended indefinitely, form about the point C toward all sides an unlimited surface, where is omitted the surface ABC, which because of its smallness may be neglected. This signifies that $\pi-A+\pi-B+\pi-C=2\pi$, whence $A+B+C=\pi$.

Verify now this reasoning, after limiting the surfaces by arcs of circles described from the points A, B, C as centers with radii equal to CC' = r.

The circle about center C, meeting the sides of the angle $\pi-$A at A' and B' divides the surface in the opening of $\pi-$A into two parts; the one X within, the other x without the entire circle with center C.

The same circle, meeting at B', C' the sides of the angle $\pi-$B, divides the surface in the opening of $\pi-$B into two parts: Y within, y without the circle; but besides, the piece z of the entire circle does not appertain to the angle $\pi-$B.

That gives all possible cases which our figure can present, presupposing $r>a$, $r>b$, $r>c$, $a>c$.

Designating now by $\triangle$ the area of the triangle ABC, by R the area of the circle of radius r we find

$$\frac{R}{2\pi}(\pi - A) = X + x.$$

$$\frac{R}{2\pi}(\pi - B) = Y + y.$$

$$\frac{R}{2\pi}(\pi - C) = Z.$$

$$R = X + Y + Z + z + \triangle.$$

Hence we get

$$A + B + C = \pi + \frac{2\pi}{R}(\triangle - x - y + z) \ldots\ldots\ldots\ldots\ldots (1).$$

It would still remain now to demonstrate, in the hypothesis that the sum of the angles of a triangle $S < \pi$, that $\triangle = x + y - z$ for every r or at least for $r = \infty$; but to undertake this labor would be in vain. On the contrary, for the condition $S < \pi$, we find always $\triangle < x + y - z$, as we will immediately see.

When $CC' = r$ increases, the points B', B'', B''' withdraw from the point B in the direction AB, while the lines CB', CB'', CB''' approach to a certain limit CD (Fig. 5), which in the new theory I have designated as a *parallel* to AB, and which makes with CA, CB angles $ACD = \pi - A - \alpha$, $BCD = B - \beta$, such that α and β are any positive quantities.

Moreover, by making $CB' = r$ sufficiently great, the angles $B'CD$, $B''CD$, $B'''CD$ become as small as we choose. Calling, then, P the surface of the triangle ACB', we will have for r very great (Fig. 4) without appreciable error

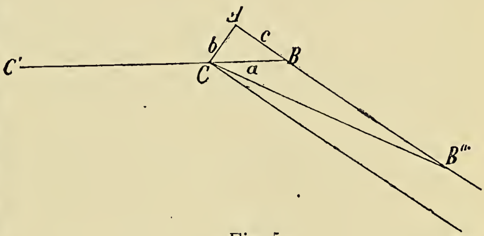

Fig. 5.

$$\frac{1}{2\pi}(\pi - A - \alpha)R = \frac{1}{2\pi}(\pi - A)R + P - x.$$

Hence

$$x = P + \frac{1}{2\pi}\alpha R \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2).$$

Putting for the moment the angle $C'CD = M$ (Fig. 5) the already given equation $(\pi - B)R = 2\pi(Y + y)$ may be written

$$\frac{1}{2\pi}(\pi - B)R = \frac{1}{2\pi}MR + P - \triangle + y - z \ldots\ldots\ldots\ldots\ldots (3)$$

In this substituting the value

$$M = A + C + \alpha$$

we have an equation which combined with equation (2) conducts anew to equation (1) and so verifies it.

If we make

$$M=\pi-B-\beta,$$

we deduce from equation (3)

$$\beta=\frac{2\pi}{R}(\triangle-P-y+z),$$

which combined with equations (1) and (2) gives

$$A+B+C=\pi-\alpha-\beta.$$

So in Bertrand's demonstration is already assumed $\alpha=0$, $\beta=0$, the very thing which was to be proved.

Just as Bertrand was satisfied with the comparison of infinite surfacee in the angles of the triangle, so Legendre wished to use the infinite surfaces between pairs of perpendiculars, which he called *biangles*.

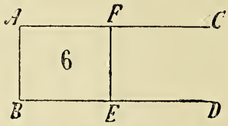

Fig. 6.

Really he only demonstrated that the infinite surface CABD (Fig. 6), between the perpendiculars AC, BD, to AB is equal to the infinite surface DEFC obtained from the preceding in cutting off the quadrilateral ABEF by the perpendicular EF to BD. This is sufficiently evident; but Legendre has not noticed here, that EF may possibly not meet AC.

To overcome this little difficulty, you have only to suppose that EF is the perpendicular from F on BD; but then how can we conclude therefrom that FE=AB and the angle EFC$=\frac{1}{2}\pi$? It is not possible to mend the false deduction, wherein Legendre's inadvertence was so gross that without remarking this grave error, he considered his demonstration as very simple and perfectly rigorous.

Again the plan has been thought of in the theory of parallels to use as foundation, that in triangles the angles must depend on the ratios of the sides.

At first such an assumption seems as simple as necessary; but if we seek to probe what idea we have thereof, whence it takes its source, we are forced to designate it as just as arbitrary as all others to which recourse has been had.

We cognize directly in nature only motion, without which sense-impressions are not possible. Consequently all other ideas, for example geometric, are artificial products of our mind, since they are taken from the properties of motion; and consequently space in itself, for itself alone, for us does not exist. Accordingly it can have nothing contradictory for our mind, if we admit that some forces in nature follow the one, others another special geometry.

To illustrate this thought, assume, as many believe, that attractive forces diminish because their action spreads on a sphere. In the ordinary geometry we find $4\pi r^2$ as magnitude of a sphere of radius r, whence the force must diminish in the squared ratio of the distance.

In the imaginary geometry I have found the surface of the sphere equal to

$$\pi\,(e^{r} - e^{-r})^2,$$

and possibly the molecular forces may follow such a geometry, whose whole diversity would depend, consequently, on the number, always very great, e.

Moreover, suppose this only a mere hypothesis, for whose confirmation other more convincing proofs are to seek; yet nevertheless it can not be doubted that forces alone produce all: motion, velocity, time, mass, even distances and angles.

With forces all are in a close connection, which we do not understand in its essence, wherefore also we can not affirm, that in the relation of different kinds of magnitudes to one another only their ratios can enter.

If we admit the dependence on the ratio, why should we not also assume a direct dependence?

Certain circumstances already favor this opinion. For example, the magnitude of attractive force has as expression the mass divided by the square of the distance. For the distance null this expression really represents nothing.

We must begin with some, large or small, but always really present distance, and then first the force manifests itself. Now we may ask how distance produces this force? How a bond between things so essentially different can exist in nature?

That we will probably never understand. But if it is true that forces depend upon distances, just so also may lines be dependent on angles. At least the diversity is alike in the two cases, for the difference lies properly not in the idea, but only in this, that we know the one dependence from experience, but the other, for want of researches, we must mentally assume, either beyond the limits of the visible world, or in the narrow sphere of molecular attractions.

However that may be, yet will the assumption, that merely the ratio of the distances can determine the angles, be a special case, at which we always arrive, if we assume the lines infinitesimal.

The procedure of ordinary geometry therefore always leads to results true but not in so wide a sense as those given by the general geometric system which I have called imaginary geometry.

The difference between the equations of the one and the other comes from the introduction of a new constant, which observations must determine, but which so obtained, is found such, without noteworthy error, that the geometry assumed by all for practical measurements more than suffices, even if in itself it be not rigorously true. This means either that this system is found in Nature by chance, or else that in it all distances accessible to us are still infinitesimal.

In general must every proposition that the imaginary geometry, if it is applied to lines of great extent, gives about the elements of a magnitude, necessarily lead to the rules of the ordinary geometry, because in this case only the first powers are retained of the numbers which represent the lines, and consequently every where only their ratios enter into the equations. Such for example are, that the distances between two perpendiculars to a straight are everywhere equal; that the perpendicular with its extremity describes a straight line; that the circle with increasing diameter passes over into a straight line.

Of all known theorems of this sort one must give first rank to that which carries with it the dependence of the ratio of lines upon the angles; at least here the simplicity in the idea corresponds to our first impressions; but also that is all that can be said in its defence; every other judgment is either false or superficial.

Again it is not possible to find objectionable, that with the immediate dependence of lines upon angles a magnitude enters which is just as arbitrary as the choice of the unit. To this we may answer, that nothing prevents taking in the equations not the ratios of the lines to one of those therein considered, but the ratios to a magnitude determined in any way in Nature. That I have shown in the Imaginary Geometry by giving equations where all lines appear in relation to a single one to be determined from observations, if these should suffice.

I consider it not necessary to analyze in detail other assumptions, too artificial or too arbitrary.

Only one of them yet merits some attention; the passing over of the circle into a straight line. However, the fault is here visible beforehand in the violation of continuity, when a curve which does not cease to be closed however great it may be transforms itself directly into the most infinite straight, losing in this way an essential property. In this regard the imaginary geometry fills in the interval much better. In it if we increase a circle all of whose diameters come together at a point, we finally attain to a line such that its normals approach each other indefinitely, even though they can no longer cut one another.

This property, however, does not appertain to the straight, but to the curve which in my paper *On the Foundations of Geometry* I have designated as *circle-limit.*

Finally if the difficult problem of parallelism is to be resolved by experiment, Legendre's proposal, to put a radius six times in a circle, must be declared much too insufficient.

In my *Foundations of Geometry* I have shown, using astronomical observations, that in a triangle whose sides are approximately equal to the distance of the earth from the sun, the angle-sum can not differ from two right angles by more than 0.0003 of a second.

This difference increases in geometric ratio with the sides of the triangle, and consequently up to the present, as I remarked before, is the ordinary geometry more than sufficient for the measurements in practice.

We can arrive at this result by the aid of propositions sufficiently simple and conformable to the first notions of the science, though of course the complete theory requires a wholly changed order of exposition and besides the addition of trigonometry.

To the imperfections of the theory of parallels must also be reckoned the definition of parallelism itself. However this imperfection depends nowise, as Legendre supposes, upon a faulty definition of the straight line, nor even on certain faults in primary notions, faults which I propose to indicate here, attempting to correct them so far as I can.

Ordinarily one begins geometry with attributing to bodies three dimensions, to surfaces two, to lines one, while to the point is allowed none.

In calling the three dimensions length, breadth, height, and under these designations actually understanding the three coördinates, we hasten in this way to impart immature ideas by words to which ordinary speech gives already a certain, but indeed for rigorous science still indefinite sense.

In fact, how is it possible to represent clearly to one's self the measurement of length, if we as yet do not know what a straight line is?

How can one speak of breadth and height without previously having said something of perpendiculars, of the plane, and besides how are related perpendiculars in one and in different planes?

Finally, if the point has no extent, what remains over to it then, that it may be the object of a conclusion?

Suppose even that every one represents clearly to himself the straight line, though indeed unable to give an account of his idea; but the question is, how now with help of the straight line to determine one dimension for a curved line, and two for a curved surface?

True, one need not require that length, breadth and height be perpendicular to one another; it suffices, if one has taken for them lines in different directions. Yet we meet also in this case peculiar difficulties.

If we take as principle not to anticipate ideas to be developed later, the question is how then to express the condition that the three dimensions of a solid shall appertain to three straights in different planes?

Further, one must not confuse the different direction of the two parts which go out from a break in the line, with the twofold extension of a surface; finally one must set forth completely what is to be understood precisely by a direction and by an angle.

In short, space, dimension, locus, solid, surface, line, point, direction, angle, are words with which one begins geometry, with which one however never connects a clear idea.

However, we may consider all these things from still another side. It is necessary to observe that here the obscurity in the idea is produced by the abstractness, which is superfluous in the application to actual measurement, and consequently is introduced uselessly into the theory.

Surfaces, lines, points, as geometry defines them, exist only in our imagination; when we treat the measurement of surfaces and lines, we apply thereto solids.

For this reason we need only to speak of surfaces, lines, points, as we must think them in an actual measurement, and then we will hold ourselves only to just the ideas which are immediately connected in our understanding with the representation of bodies, to which our imagination is accustomed and which we can in nature immediately verify, without entering upon others, artificial and strange.

But with these new ideas the science takes even at the beginning another direction, which it follows until it goes over into analysis, where then the procedure in exposition now again takes the ordinary aspect. I will endeavor to explain wherein consists this change.

In mathematics one follows two methods, Analysis and Synthesis.

Equations make the distinctive characteristic of analysis. They serve as first basis for every judgment and in general lead to all conclusions.

Synthesis, or the method of building up, requires exactly the same representation which in our mind is connected immediately with the primary ideas.

The principal advantage of analysis consists in this, that from the equations one goes always straight to the end proposed.

Synthesis is in general subject to no universal rule, but one must necessarily make the beginning with it, in order finally, after one has found the equations, therewith likewise to reach the limit beyond which now all goes over into the science of numbers.

For example, one demonstrates in geometry that two straights perpendicular to a third never meet; that the equality of triangles follows from that of certain of their parts. In vain would one seek to treat analytically propositions of this species, even as all the theory of parallels. One would never succeed, just as one would not be able to do without synthesis for measuring plane rectilineal figures, or solids terminated by plane surfaces.

It is well understood that in synthesis we should use the helps offered by analysis; but it is incontestible that in the beginnings of geometry or mechanics, analysis can not serve as sole method. One may compress the circle of synthesis; but it is impossible to suppress it completely.

It is not even necessary too much to hasten the substitution of analysis for synthesis, and the introduction of functions each time some dependence can be perceived between quantities, without yet knowing in what this dependence consists and how it expresses itself.

With this restriction, analysis is the sole method which, introduced in the science to begin with notions where reasoning alone is thenceforth sufficient, extends the bounds of our knowledge indefinitely in all directions.

Notions acquired in nature by the aid of our senses are without any doubt the primitive data.

The mind can and should as much as possible reduce their number, to make them afterwards the solid bases of the science.

No one, however, uses synthesis from this point of view, observing the rules we have just indicated.

It has generally been chosen to introduce prematurely analysis, and to develop the notions formed naturally in our mind, and to which remains only to give a name, without entering profoundly enough into the explanation, and without considering the exactitude of the definitions.

If facility and simplicity did not require to choose a method of instruction like that I recommend, its superiority in rigor would still make us sometimes employ it to great advantage.

I have made a first trial of it in algebra; I am now to undertake it for geometry.

Pure analysis, without any intermixture of synthesis, ought to be introduced in geometry only after having established equations for every sort of dependence, and given expressions for all geometric magnitudes.

We can not comprehend a geometric magnitude without measuring it, an operation which we can not effect, rigorously speaking, either for curves or for curved surfaces. In fact, however little may be the parts of a curve, they do not cease to be curves, and consequently they can not be compared with a straight; just as parts of a curved surface are not comparable with portions of a plane.

From another side, lines straight or curved, planes and curved surfaces do not exist in nature; we encounter only bodies, so that all the rest, created by our imagination, exist only in theory.

Lagrange admits in principle the proposition of Archimedes, that on a curve one can always take two points so near that the arc between these points may be considered as being greater than its chord, and smaller than the broken line formed by the two tangents touching at its extremities. (Théorie des fonctions analytiques, par Lagrange.)

Such a proposition is, in fact, necessary, but it destroys by itself the primitive idea of measuring curves with straights. The same thing happens when one proposes to measure curved surfaces with planes.

Thus the evaluation of the length of a curve represents not at all the rectification of the curvature; but it has for aim the finding of a limit to which the magnitude that would be obtained by a real measuring would approach the more as this measure became more exact. Now measuring is made more exactly as the chain employed has smaller links; it is done altogether exactly when in place of a chain a perfectly flexible thread is used. This is why in geometry one is obliged to prove that as the subdivisions are increased the sum of tangents decreases and that of chords increases, until these two sums differ indefinitely little from the common limit toward which they tend, and which is considered as the length of the curve.

It is then clear that exhaustion by such rules accords so much the more with direct measuring as this is the more exact. From this is also seen on what is founded the proposition of Archimedes.

As we have reasoned on lines, we should reason on curved surfaces, not pretending at all that very small parts of these latter can be planified.

Rigorously speaking, plane curvilinear areas, as also solids bounded by curved surfaces, can not be measured so long as they are compared those to a square, these to a cube. However, if one only proposes to find a limit toward which tend the results of a direct operation, it will suffice, for the attainment of this end, to demonstrate that such a limit exists necessarily in each particular case, and then to explain in what way we ought to understand the operation of measuring, and how to attain the amount of exactitude desired.

To satisfy these conditions recourse must be had to certain auxiliary propositions, admitted under the name of axioms; namely:

1. Two plane figures are equal when they are decomposable into parts identical, though differently arranged.

2. Of two plane figures, that is the smaller which is entirely contained in the interior of the contour of the other, without, however, filling this completely.

3. The magnitude of a triangle decreases indefinitely when one of its sides diminishes indefinitely.

This latter proposition is necessary for the evaluation of plane areas themselves.

It is necessary also to have recourse to analogous axioms when one wishes to measure solids.

[*Read before the Texas Academy of Science, December 22, 1897.*]

AN ADDRESS TO THE TEXAS ACADEMY OF SCIENCE.

By Governor L. S. Ross,
PRESIDENT OF THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS.

Mr. President and Gentlemen:

The people of Texas have always been noted for a boundless hospitality, where the guest is made to feel that he is at home, and to admire the easy freedom and graceful dignity of a host who banishes all formality in the nobleness of his welcome and the simplicity and generosity of his entertainment.

We trust that there shall be no exception to the general rule, and in making welcome so may representatives of an organization which has to do with the arts and sciences and other allied interests of our State, it will be a source of no small pride to me personally if I shall be able to contribute in an humble way to the success of your meeting. I am keenly alive to the importance of your work, because upon its action depends, in a large measure, not only the extent and degree to which scientific knowledge and research shall be fostered and disseminated among the people, but also the degree of progress which shall be made in all the arts of life—the future development of our untold natural resources, the productiveness of our domain, and the position and power of our State. Only questions pertaining to the existence, integrity, and honor of our commonwealth take higher rank. I believe with Franklin, that the world owes more to great inventors than to all its warriors and statesmen, and that the prizes of the future will be found upon the highway of scientific education. It derogates nothing from the value of your aims, but rather heightens their claim to popular regard to admit that inventions evolved from the brains of unlettered men laid the foundations of our material prosperity, and have been among the most potent factors of the nation's wonderful growth.

The statesmen of the revolutionary period who formulated the self-evident truths upon which is based and framed the Constitution, intended to lay down and define the powers and duties of a mighty government in all its details, had been educated in the colleges and universities of that time. But those of whom I speak had not been favored with corresponding educational advantages, and I believe that if in the early days of the Republic the opportunities for scientific and practical education had been equal to those afforded for training men for the learned professions, the advent of the steamboat and rail car would have occurred at an earlier date. It was the recognition of the importance of such opportunities that led in after years to the establishment of scientific schools, and the earth has been made to give forth her treasures, and the forest has yielded its choicest woods to show what art and science can do in their victory over inanimate nature.

Hereafter intelligence more than ever is to be counted as a factor of success. Thoughtful men are beginning to appreciate its importance to the pressing problems of the future where the possibilities of our State defy prophecy. It needs such work as yours to make these possibilities a living reality. It is practical and material, and will help our State to realize her greatness, and to impress her individuality upon the history of the times.

It is like threshing over old straw to say that among the important subjects that engrossed the attention of the inventors of early days was steam—its properties, adaptations, and possibilities as an agency for moving machinery; and it has been said that the birth of the Republic and that of the steam engine were contemporaneous events. We are informed that the first condensing engine built in this country was constructed by John Fitch, a native of Connecticut, in 1787, with the assistance of a common blacksmith. This successful experiment by Mr. Fitch, who had been favored with only the slightest opportunities for an education, made him the world's pioneer in steam navigation. After perfecting his engine and using it to propel a boat on the Delaware river, he was forced by adverse fortune to abandon his plans for bringing his invention into practical use—not, however, before predicting that some better equipped and more fortunate man, inspired by the success already attained, would acquire fame and fortune from his invention, and that the time would come when large rivers would be navigated by steam, and that ships would be propelled across the Atlantic by the same agency. This man, as you know, soon appeared in the person of Robert Fulton, who transferred steam navigation from the stage of experiment to that of a successful agency to promote the convenience and welfare of the growing Republic. It was not until he had acquired reputation as an inventor that he sought in Paris the scientific training which has given him immortality of fame.

Early in the present century Oliver Evans, a native of Delaware, having previously invented an engine on the high pressure principle, demonstrated that it could be used for the propulsion of land carriages, and claimed that the time would come when transportation would be carried on over land on railways of wood and iron by the agency of steam, and though his opportunity for early education had been of limited character, he may be justly regarded as the pioneer of our present system of railroad transportation, which has filled our solitary and waste places with people, and furnished them an agency for distribution and consumption not easily overestimated.

When a child, it fell to my lot to sit at night before the log fire of our frontier cabin, and with deft but tired fingers pick from the cotton seed the lint which was to be carded, spun, and woven into clothing for the family, and I have lived to see it taken from the farmer's wagon, and while manipulated almost entirely by machinery, pass into a compact and perfect commercial package or bale. The invention of the cotton gin not only more than doubled the value of every acre of cotton-producing land in the South, but it brought into more conspicuous prominence that ancient plant which sprang from the centuries numbering back to the deluge, but not until the Seventeenth century, when first introduced into the South, did it find a soil and climate best adapted to it, and a people with both the skill and intelligence necessary to give it the most successful cultivation, until its yield has become an element of the largest manufacturing interest in the world, a currency within itself, and the greatest boon to human industry.

A hundred years ago agriculture was in little better condition all over the world than it was a thousand years before. It is almost within the limit of my memory that the use of iron for manufacture of farm implements was unknown. They were made of wood, and our present superb equipment of farm machinery existed nowhere. The advance made in all its branches has been prodigious, due largely to the creation of mechanical appliances by American inventive genius. In recounting a few of the indicative trophies which scientists have brought from their explorations of every province of knowledge, it may be added that as unimportant as it may have appeared at the time, nevertheless, the discovery of the uses of ether in surgery disarmed sickness of half its pain, and death of half its terrors. And scientific research for the mitigation of sorrow and misfortune of those afficted with physical infirmities gave eyes to the fingers of the blind, and taught the deaf and dumb articulate speech.

It occurs to me that surely it must defy the power of human measurement to graduate the depth and intensity of the pulse-stirring anticipations which thrill every nerve and mount to the brain of the happy scientist when, as if by magic alchemy, he succeeds in transmuting the visions of the enthusiast into some living reality.

I congratulate you that your time and talents are devoted to the study of those things which will shed light upon the every day problems of life, and better the condition of your fellows.

We hope this occasion may prove to be one pleasant in the remembrance, and that when you separate it may be with renewed and a united determination to put forth increased effort in extending the scope and usefulness of the Academy of Science.

[*Read before the Texas Academy of Science, May 6, 1898.*]

THE ESSENTIAL DIFFERENCES BETWEEN MAN AND OTHER ANIMALS.

By S. E. Mezes.

Although the problem to be considered in this paper has been repeatedly discussed since it was first faced by Aristotle, it is not necessary to undertake a review of opinions, most of which, important and useful as they were in their day, have become quite inadequate since modern science came into possession of precise methods and instruments of observation. Darwin's great discovery as set forth in his *Origin of Species*, and later in his *Descent of Man*, has rendered earlier speculations obsolete. Accordingly the reader's attention is to be directed only to investigations and discussions made and incited by Darwin.

In the full discussion of the subject in his *Descent of Man*, Darwin well says that man manifestly owes his immense superority "to his intellectual faculties, to his social habits, which lead him to aid and defend his fellows, and to his corporeal structure." Passing over man's social habits, the discussion of which, though admittedly of the highest importance, since they are the basis of his moral nature, would lead too far, the plan of this paper contemplates a few words on his corporeal structure, preliminary to the main discussion of his intellectual faculties, a suggestion being made in conclusion as to the interrelation of the two.

Darwin not only mentions man's chief differences in bodily structure from other animals, but also suggests the probable order in which the change of the latter into the former took place. In his account, there are two points of departure, the hand and the brain. First, as he suggests, the forefeet of the hominine apes were somehow transformed into the wonderful human hand; the most skillful and adaptable single instrument that Nature has ever devised, for without the hand man never could have become the tool-making animal. As the hand, deviating from the forefoot, grew in utility and came to be more used, its effective employment being largely dependent on the firmly erect posture, changes in the feet, legs, pelvis, and spinal column followed, in the way of spontaneous variation, of inherited acquired characters, or of both combined. Again, the hand superceding the powerful canine teeth in the matter of offense, of defense, and in other ways, the massive jaw of man's ape-like progenitors was necessarily modified and reduced.

The other line of departure, which Darwin does not coördinate with that beginning in hand-development, though it must have been closely related to it, began in a great increase in the weight, size, and consequently, owing to the confining skull, in the convolutions of the brain. And finally the increased weight of the brain, together with the erect posture, contributed to the modifications in the shape of the skull and spinal column.

Darwin's order has not been universally accepted, and several conjectures, more or less plausible, both as to the order of development and as to the factors conditioning it, have been made. Nevertheless, in view of the evidence he cites, and of further confirmatory evidence that will appear in this discussion, I believe that Darwin's account can be shown to be essentially sound. In this connection it may not seem unimportant that the process of humanization was largely conditioned by changes in the hand, the jaw, and the spinal column. Of that, something more later.

Coming to the second group of distinctions, the broad fact that there is some mental difference between animals and men is too patent for denial, and has long been recognized and commonly asserted in the form of the statement that men alone possess reason. But when it comes to be more clearly seen that animals have some sort of mind and conscious life, the precise definition of what is meant by "reason" is found to be no easy matter.

For a long time, and by many authors, the attempt was made to show that men have general ideas and that animals are without them. But recent investigations, consisting chiefly in a careful study of the higher animals, made by Romanes and others, have shown beyond peradventure that animals also have general ideas. From a large body of evidence given by many authors I reproduce two descriptions, quoted by Romanes, the former from Darwin, the latter from Leroy: "When I say to my terrior, in an eager voice (and I have made the trial many times), 'Hi, Hi, where is it?' she at once takes it as a sign that something is to be hunted, and generally first looks all around, and then rushes into the nearest thicket, to scout for any game, but finding nothing, she looks up into any neighboring tree for a squirrel. Now, do not these actions clearly show that she had in her mind a general idea, or concept, that some animal was to be discovered and hunted?" "A dog which had lost its master runs towards a group of men, by virtue of a general abstract idea, which represents the qualities possessed in common with these men by his master. He then experiences in succession several less general, but still abstract ideas of sensation, until he meets the particular sensatin which he seeks." *

Since general ideas have been abandoned, the most fruitful results in this difficult field have followed the investigation of the language, and in general of the significant signs, used by men and animals. The minutely painstaking observations of Romanes on this subject clearly establish two facts; in the first place, animals use significant signs of various kinds, but, in the second, their use of them is notably different from man's employment of them. This latter fact Romanes expresses by saying that language is common to men and animals, while speech is confined to men. From this point of departure it will be possible, I think, to make very close conjectures as to the precise difference between the mental equipment of animals and man. For of course significant signs are the outward expressions of mind, and the distinction made only opens up a convenient mode of approach to the fundamental question of the mental difference.

Specifying further the distinction of the last paragraph, language involves no more than the use of single words and signs in entire mutual isolation, *and* in obedience to their suggestion through *mere association* by the situations in which animals find themselves, and by the feelings these situations arouse; speech, on the other hand, involves the predication of the word, or other sign, as such, or at least, as Romanes more moderately suggests, the denomination, or calling by name, as such denomination, of the situation, or of some element in it. In terms that the latest logical discussions will make at once clear and highly significant, language is a sign that its possessor has ideas, speech a sign that he makes judgments. The following, quoted from Romanes,† will give some idea of the evidence available for showing that animals use significant signs. "Further, I give an observation of my own on one terrier making a gesture sign to another. Terrier A being asleep in my house, and terrier B lying on a wall outside, a strange dog, C, ran along below the wall on the public road following a dogcart. Immediately on seeing C, B jumped off the wall, ran upstairs to where A was asleep, woke him up by poking him with his nose in a determined and suggestive manner, which A at once understood as a sign; he jumped over the wall and pursued the dog C, although C was

* Romanes, Mental Evolution in Man, pp. 52 and 54.

† Loc. cit., p. 100.

by that time far out of sight, around a bend in the road." This case (and others substantially similar are numerous in the literature of the subject) is so striking that the danger is rather of reading into the minds of the two dogs quite human ideas and processes than of underrating their intelligence; it will certainly serve to show that animals communicate by means of signs.

On the other hand, as to the possession of the power of judgment, the precondition of speech by man and its absence in animals, it is not necessary to give detailed evidence. All authorities, including such persistent opponents on the closely allied question of the derivation of speech from language as Romanes and Professor St. George Mivart, are here agreed, the former cordially accepting the latter's suggestion of the power to "think is," i. e. to assert or judge, as the distinctive characteristic separating man off from other animals.

And now, is it not possible to specify somewhat more narrowly the distinctive characteristics of this admittedly human power of judgment? Is it not possible to describe with some precision, and in relatively familiar terms, the essential properties of judgment? Here again, fortunately, there is no difference among experts. Romanes, Professors Mivart and Lloyd Morgan, and recently Professor Mark Baldwin, all agree that self-consciousness is essential to assertion or judgment. As the first writer says, "The power to 'think is'—or, as I should prefer to state it, the power to think at all—*is the power which is given by introspective reflection in the light of self-consciousness.* It is because the human mind is able, so to speak, to stand outside of itself, and thus to constitute its own ideas the subject of its own thought, that it is capable of judgment. We have no evidence that any animal is capable of objectifying its own ideas; and, therefore, we have no evidence that any animal is capable of judgment." Now in spite of the difficult-sounding technical terms, I am anxious to have it appreciated that this does not mean anything impenetrably obscure and far away from popular thought; it simply means that man knows what he is about, that he knows that he is *doing something*, and, at least in general, what he is doing.*

It will be of interest to the students of philosophy, and it is worth while because of the strong confirmation it brings, to point out that the same result is reached from an entirely different point of view, and

* The slang phrases being, 'onto himself', and knowing what one 'is up to', suggest what is possible to man and impossible to animals. Another way of suggesting the difference leads to the distinction between ordinary wideawake conversation and the all but unconscious—more accurately, unself-conscious—assents and polite remarks one makes when much bored, with one's wits wandering on more attractive subjects.

by a man with a very different turn of mind, by no less an authority than Kant. As a result of many years of thought, probably unparalelled in patience, he declares that the very heart and essence of human reason is unity of apperception, by which he means self-consciousness, the "I think," the "think is," or, in other words, reflective assurance, or knowing what one is saying.

So far then there will be little difficulty and no dispute. Roughly, speech differentiates man from other animals; but for speech judgment is indispensable, while in turn self-consciousness is essential to judgment, and accordingly turns out to be the differencing feature reduced to its lowest terms. The essentially human power is not the ability to use signs that others understand, but the ability to use them knowing what one is about, i. e., knowing *that one is using signs,* and signifying to others that things are so and so.

So far analysis has advanced. But I believe it is now prepared to take another step forward, and I venture to make the suggestion in view of the unification it will give, if well founded, to our conception of the totality of differences between man and other animals.

The further advance is made when an answer is found to the question, Of what are we conscious when conscious of self? Recent analyses of self-consciousness have thrown much light on this problem, and its importance will justify a few words of consideration.

There is no concern here with any conception of a "trancendent" self; whether or not any such unexperienced entity exists, its conception, like any other, must ultimately rest on, and spring from, some group of experiences. And our present business consists in suggesting and describing those experiences. Anticipating what will appear presently, those experiences can be indicated in a word: When conscious of self one is always conscious of voluntary actions. The evidence for this statement may be grouped under two heads, pathology and moral responsibility.

Ordinarily the best way of indicating the objects designated by any name is to point them out. When that resource is not available, as happens in this case, the next best means is to discover the objects whose changes are spontaneously regarded as changes in the class of objects to be defined, for the former will be among the constituent elements sought. When the heart stops, death supervenes, and consequently life consists, among other things, and in some animals, in the beating of the heart. When the piston-rod is broken, the engine is "killed," and consequently the piston-rod is argued to be an essential part of an engine. And a similar line of considerations will suggest the constituents of the self; moreover the records of pathology furnish many instances of the diseases of personality.

Taking up these instances in general, it may be said that when any of the powers, whether physical, mental, or moral, are damaged or changed, the *self* is said to be damaged or changed. Normally there are certain acts of physical strength and skill that each man can perform; and any failure in these abilities will cause remark on the change that is coming over the man, and any sense of the inability to do them will disturb him more or less profoundly depending on the importance he attaches to the power impaired. At the extreme would probably stand the skilled worker's command of his tools, e. g., the painter's loss of dexterity with his brush. Again, in each intellectual direction, every man has certain normal capacities, things he can count on himself to do. Depending on his mental caliber, he grasps situations with characteristic ease, quickness and adequacy, or their opposites; his memory has so much free play, scope and tenacity for faces, places, names, etc., and so with the powers of judgment, reasoning and the rest. A skilled accountant who lost his power of figuring, or an historian who lost his grasp of the dramatic interplay of persons and other forces on the human stage, would certainly be, and feel him*self* to be, deranged. In a pretty familiar round of situations one has put forth an average of so much power for each, with such and such effects, and naturally, depending on the situation, one counts on oneself, and others count on one, for that much; more or less, if striking, means derangement. And just so it is as to what a man can resist in the way of temptation, dare in the way of courage, forego in the way of generosity, and in general as to what he can do that has moral value. The voluntary actions that through inheritance or practice have become habits, those constitute a man's character, and are the essence of his selfhood.*

Again, all ethical authorities are agreed that a man is responsible only for his voluntary actions and their consequences. Indeed, they push the view so far as to maintain that, where an impulse is so strong as to force its way into action in spite of strenuous effort to restrain it,

* Over and above the agent, or active self, psychologists distinguish the bodily self, the self of memory and expectation, and the social self. But important as these undoubtedly are in the finished product, I believe they can be shown to be comparatively accidental elements caught up in the eddy of voluntary action. As will be indicated below, the social self is, as to its mind-stuff, made out of voluntary actions, while the other two selves are present as mind-stuff before volition, but have to await its appearance to get organized into selfhood. But aside from that question, allowing the other selves to be as essential as any one chooses, it can not be disputed that the voluntary actions constituting the agent are indispensable. On this whole question, cf. Psych. Rev. V. II, No. 6., article by Royce, and also Baldwin's discussion of the genesis of the self in his "Interpretations".

the man is not responsible for the action. Actions that are not performed by effort of will, or at least consented to, are as little the man's actions as is the blowing of the wind or the rise of the tide.

It goes without saying that voluntary actions are controlled performances, those subject to the influence of effort. An action is voluntary when I can perform it or not, depending only on whether or not I try, or put forth effort. The point is simple and familiar, but important to bear in mind, for, if the theory to be here advanced is sound, the appearance of effort, and its acquisition of effective functional relations, determines the transition from animal to man.

The conclusion accordingly is that self-consciousness is consciousness of actions subject to control, and of such other psychic phenomena as have, during the performance of those actions, been organized into a functional unity including them. And the hypothesis advanced is that the mental difference between man and other animals does not ultimately consist in the exclusive self-consciousness of the former, but is to be at once adequately and more precisely stated as consisting in man's capacity for voluntary action, which is the fact, and not both the fact and the consciousness of self. If this hypothesis is sound, all the labored writing to show how animals come to "objectify their ideas," how in place of "seeing two things united," or otherwise related, they come "to see them *as united*," becomes at once unnecessary. All of this "seeing" grows up; but it grows up, as will appear presently, in ways quite familiar, as a result of voluntary action and the use of language. The rise to the human level does not depend on the turning inwards to ideas of the attention, which has before been exclusively engaged with outer objects—a change of direction exceedingly difficult to account for except by means of some momentous new experience—but it depends on the appearance of an entirely novel inner experience, the experience of the feeling of efficient effort, that has far-reaching consequences, and that plays beyond question the leading role in human life to-day; it is not new knowledge of old facts, but, in the first instance, new experiences and power that determines the transition. No animal can perform difficult action. With animals impulses and habits have full and uncontrolled sway, and when they conflict the issue is with the stronger; with animals, the recalcitrant matter of muscles and members is not constrained to the more skillful performances counselled by the ideas that look before and after. But volition means control and constraint of the lower nature in the interest of the ideal plans. Man, by trying, can rule his desires and his muscles. If the theory proposed is tenable, for man the doing of the difficult, self-mastery, is possible, and therein lies the essence of his superiority.

But here a warning is in place. Practically all who have studied the question explicitly state that animals are capable of voluntary action, and that children act voluntarily long before they are self-conscious; and they adduce evidence in support of their contention that it is not altogether easy to explain away. Romanes declares that no one disputes that, except for superior complexity, refinement, and foresight, human and animal will are identical in kind,* and attributes intentional use of language to animals as well as to man; and Preyer† finds will in the child long before self-consciousness. Suggesting the nature of the evidence, Professor Lloyd Morgan maintains that his terrier, who will not bite him during the exceedingly painful process of having a wound sewn up, exhibits will; another instance of will, given strangely enough by Professor Baldwin (Mental Dev., p. 386), is that of a dog who, after the word is given, snaps "with a will" at the much coveted savory morsel on his nose; Romanes, in his "Mental Intelligence," also cites the case of an intelligent cebus, who unscrewed, and after many 'experiments' and 'trials' again screwed in the wooden handle of a hearth-broom. And there is plenty of evidence of the same kind, though none, I think, that essentially strengthens the contention that animals will.

As against this evidence it may be remarked, in the first place, that in this field mistakes are easy to make, and in fact have been made. All instinctive actions actually serve a purpose, and it is easier than not to look on them as intended to do so. Add that until recently it has been exceedingly difficult to say what volition is with any precision; on that point suggestions will be made presently explaining the efficacy of effort as similar to, though vastly more momentous than, the efficacy of other feelings. And finally, neither the writers quoted, nor, as far as I know, any others, have seriously raised the question as to whether volition might not be the distinguishing characteristic.

Further, as Baldwin points out in the case Preyer cites as one of volition in the child's fifth or sixth month, viz., holding the head erect, and in many cases of volition attributed to animals, the facts can be easily explained on simpler hypotheses. In Preyer's child, the holding up of the head is due to a reflex that ripens gradually after birth. Instead of saying that will power restrains Morgan's terrier from biting him, the presence of his master and the dog's affection for him is sufficient. Instead of anthropomorphising Baldwin's dog, and maintaining that when allowed he snaps "with a will," or, a more plausible contention, that up to that time he exercises effortful self-control, it is only necessary to point out that the trick is either one already habitual with

* Loc. cit., pp. 8 and 88; cf. Lloyd Morgan, loc. cit., pp. 416 sq. and 459. sq.

† Mind of the Child, Eng. tr. p. 264 sq.

the dog, or at all events that obedience to his master is a habit, especially when the latter is present. And, as to the cebus, imitation, play instinct, and, possibly, curiosity, would seem to offer sufficient explanation. And other explanations, on general analogy with these, would, I venture to think, explain other instances of alleged volition in animals and young children.

But additional positive evidence is not lacking, and is obtained when we inquire into the effects that flow from the appearance and consciousness of effortful action. It will be convenient to consider these effects first in the child, where they are better known, in order to focus the results thus obtained on the problem of immediate concern of the results wrought in the race by the appearance of effort.

The view to be presented on this subject is the theory of the rise of self-consciousness, reached independently and almost simultaneously by Professors Royce and Baldwin, and since worked out by the latter-named author into detail with a large measure of success. It is the only theory on this difficult subject resting on a substantial and systematic observation of facts, and both for this reason, and because of its intrinsic merits, it is for the present the best to accept as a working hypothesis.

At birth the child has no consciousness of self and none of other selves; and, moreover, effort of the kind present in all voluntary actions—to be distinguished carefully from muscular effort—is wholly absent. From the first, however, the child is specially interested in the bodily presence and movements of other persons, who are at once his earthly providence and the most unreliable facts in his experience. On the one hand the ministrations of others give the child nearly all his pleasures and are the only agencies succoring him from pain; and, on the other, owing to the spontaneity, originality, and independence, so characteristic of human actions as contrasted with other movements about him, persons, chiefly his mother, nurse, and a few others, are his standing puzzles. On both accounts they challenge his attention, and hold it more and more.

Further, only persons furnish him with examples and ideas of human actions that he, a human child, can perform. Add to these considerations the further fact that imitation is undoubtedly one of his most powerful instincts, and it is only natural that the youngster should fall into the way of doing after them, as far as he can, the things he sees his elders and other children do. Many of these actions, of course, he can not perform at all, and all others he follows only very imperfectly. However that may be, the observations so far recorded indicate that it is on occasions when the performances of others, such as uttering words and drawing pictures, are repeatedly and persistently imitated that volitional effort first appears. Of course, to discover that it then appears is not to discover how it comes then and thus to appear. But that question is not important here, where the concern is not with the mode of the rise of effort, but rather with its effects after it has arisen. And the point is that the child is fundamentally transformed by the acquisition of this new power. On the one hand, he becomes self-conscious, and on the other he begins to exhibit purpose with all that that implies.

At first volitional effort is called forth but seldom; but soon, as the efficacy of effort to realize the ideas there is desire to realize is more fully experienced, the habit arises of trying for satisfactions there is difficulty in obtaining. The child no longer understands your words, or fails to do so, with equal passivity; he now can and does search for your meaning, question you, work it out, think it out. No longer does he perform actions only when his powers are fully ripe, and when he is strongly incited thereto; but he endeavors and tries, persistently and strenuously, to hold his muscles to the precise performances his ideas depict, much as later the schoolboy learns to write by putting forth the power of his whole body, with tension in the feet, squirming of the trunk, and wonderful facial grimaces. In a word, purposeful action is born, ideas have become ends, aims, goals, that inspire and draw out actions. At this time it is that speech appears, at this time it is that lies are first told, and that rude mechanical devices are first invented; the child has become humanized.

But this is not all. Experiencing agency and the efficacy of effort in himself, and finding it natural that what is striven after with all endeavor should be accomplished, purposeful agency becomes the child's greatest resource for explaining. Did the movements and actions of the bodies of others before puzzle him? Well, they can now be explained on the ground of efficient causation. The movements of his own body have their casual origin in purpose, and effective purpose is the source from which spring those most difficult puzzles, the actions of others. And he applies the explanation to Nature also. Totally ignorant of the laws that science uses for explaining the movements of things, many of these movements appear to him quite as mysterious as the movements of his fellows, and here again he resorts to purposeful agency. When a chair falls on and hurts him, he punishes the "intentional" injury with a kick; when her doll does not sit up, the little girl spanks it; when it thunders and lightens, the child thinks that God is angry; when he comes to know vaguely of the inner parts of the body, he asks if there is not some man in there working them; and so it is with all the mysteries about him. Like his anemistic savage ancestors, the child anthropomorphises all natural phenomena.

Now the same considerations are present, and a safe analogy suggests the same conclusions regarding the effects produced by effort when it first appears and becomes effective in animals, as a glance at the rude activities that even primeval man displays, and that are absent in all animals, even the highest, will make plain. I refer to speech, thought, tool-making and religion.

We already know that man alone uses speech, and that speech consists in the employment of signs with the intent to convey meaning. Indeed, this fact is even popularly known. When asked for the difference between language and speech, the *naive* popular answer, unprejudiced by theory and unclouded by difficult psychological conceptions, gives it in a word—mere language is aimless, as can be seen in the bablings of the child, in the incoherent words of the insane that lead nowhere and mean nothing, and in the vocal gymnastics of a parrot; while speech sticks to the point, and follows up and conveys meaning. This, Romanes asserts, but as former quotations show, without realizing the significance of the assertion, without seeing that to mean something and to intend or will it is the same. "So a man means," he says, "it matters not by what system of signs he expresses his meaning; the distinction between him and the brutes consists in his ability to mean a proposition." *

And of course speech involves much more besides; and especially it involves thinking. For thinking, as contrasted with reverie, consists in control of one's thoughts; it is intellectual activity that at least aims at holding one's thoughts to the subject under consideration, and seeing to it that the topic is developed logically; to lose control of one's thoughts is to sink into a state of aimless dreaming that will shade into slumber if allowed to continue. But for control of thoughts speech is indispensable. As well try to grasp and arrange into system and logical coherency the clouds or the impalpable air itself, as attempt to control the vague and shapeless thoughts that pass through the mind. They are like the snowflakes that disappear in the hand that grasps them. But words are quite different. Through the apparatus for articulation, they can be controlled as one's hand is, by muscles that in turn are controlled by the brain; and, since words have thoughts connected with them, these latter are controlled by means of the former.

Accordingly, in the train of effort and the control it gives, there comes not only speech with the opportunity to converse, discuss, and thus to avail of the ideas of others, but also the power of intelligent or purposeful thinking and reflection, of deliberation, deliberateness, cau-

* Loc. cit. p. 164.

tion, of poise and balance, in a word, of judgment and wisdom, with all that that means for theoretical science and practical knowledge and skill.

And here the mention of skill brings me to the question of tools. It used to be held that a distinctive human capacity was tool-using, much as it was supposed that language was confined to man; but, as Darwin and many after him have shown, animals and especially monkeys use tools; it is the making of tools that only men compass. Animals use tools only if they happen by lucky chance to be at hand, while men look for them, and if they can not find them, make tools. And, as scarcely needs saying, it would not be easy to exaggerate the roll that tool-making, and, in general, implement-making, has played in assuring to man his place of supremacy in the world. For these resources to man's hand, gradually and painfully wrought out, include all weapons of offense and defence, from the first rough club and arrowhead to the modern rifle and the man-of-war with its armor and its 100-ton guns; all domestic devices, from stones, simple pottery and friction fire to the latest inventions of the modern kitchen; all clothes and shelters, from tree-bark and rock shelters to the fashions of Paris and New York and the dwellings of Belgravia and Fifth Avenue; all means of locomotion, from the ass and the ox to railways and steamboats; and all tools, from the first bone needle and stone knife to the delicate, smooth-running and strong steam and electrical machinery of our workshops. And remember that each and every one of these wonderful devices, essential to civilization, had its origin in the power of search, so determined that failure repeated again and again could not discourage it, for means that would accomplish desired ends, and that by adjustments growing in nicety could accomplish them with ever increasing accuracy and ease, till much of the world has been subjected to the dominant will of man.

And finally religion distinguishes man from other animals. Dread and fear animals experience, but the sense of the presence all about of supernatural powers that rule men and the world and mould them to their purposes, the dispensers alike of the most essential benefits and the direst injuries, is an experience peculiar to man alone. Beginning with the vaguely conceived prototypes of Thor and Odin, of Zeus and Apollo, and of the grosser gods of savage tribes, and tracing the advancing evolution to the relatively intellectual and moral supreme deities of Buddhism, Mohammedanism and Christianity, wherever we look, whether backward in time or far abroad in space, we find man believing to his weal or woe in spiritual powers, conceived to explain the mysteries of creation and sustentation, and of reward and retribution. Nor is the reason for this exclusive capacity of man now far to find. No animal has any experience of agency, and therefore no idea of agency that he can use in order to explain what puzzles him. Man has both the experience and the idea, and employs the latter to frame conceptions of the divine agencies whose purposes find fulfilment in the mysteries of the world.

And now a few words to explain the peculiar efficaciousness of effort; for psychology, I venture to think, can make some helpful suggestions on that head. First, it is well to bear in mind that effort is a feeling, belonging in the same class with anger, hate, revenge, and love, interest, enthusiasm. And this will suggest further that effort, too, has a powerful influence over the various bodily movements of strength and skill, as other feelings have. Sometimes a man's interest and enthusiasm slip away from him, and then action is but indifferently performed; while if for any reason it returns, action once more becomes full, free and strong. And so it is with hate and love and anger and all emotions; and, if analogy holds, so should it be with effort.

But before coming to effort, let us see what physiological psychology can do in the way of explaining the motor efficiency of feeling, by tracing backward the reasons for movements to their causes in the brain. Stated in general terms sufficient for our purpose, movements depend on the contraction of the muscles, these on the excitement of the muscles by the stimulations brought to bear on them by the motor nerves, while the active state of the motor nerves is incited by the active state of the portions of the brain with which they are connected. But here a difficulty arises. Not every degree of brain excitement stimulates the motor nerves; and besides, it is often the case that different portions of the brain are active at once, each seeking to effect a movement that the other movement, also sought to be effected, blocks. And this raises the question as the characteristics of a brain excitement that gives it power for effective stimulation of motor nerves that leads to movement of members.

The question can not be discussed at all adequately, but a few specifications may be given. Factors that are known to be important are the intensity of the excitement, and the area over which it exists. Now, both as psychic experiences, and as physical happenings, feelings are at once intense and voluminous. Take the following description, epitomized from Montegazza's account of hatred: "Withdrawal of the head backwards, withdrawal of the trunk; projections forward of the hands; . . . next, threatening movements, as intense frowning, grinding of teeth, etc.; finally, . . . deep inspiration, general trembling, convulsion of lips and facial muscles, of limbs and trunk," etc., etc. These leading traits, with all detail omitted, will serve to suggest that the bodily commotion extends over a wide area and exhibits a high degree of intensity. Moreover, these bodily happenings stimulate the peripheral extremity of the sensory nerves distributed through the body, and pour an intense volume of excitement into the brain, as is witnessed by the fact that on the psychic side feelings partake of the massive and turbulent nature of sensation, rather than of the faintness and vagueness of ideas; for the psychic feeling is either a part or an accompaniment of these imposing bodily happenings. In the case of hate, the process seems to be this: The hated object is seen, recognized, and at once awakens the idea of and the tendency to attack. But simultaneously the whole mass of bodily commotion is under way, creating much brain excitement, and thus powerfully reinforcing the tendency. Corresponding to ideas, there is little brain excitement, but corresponding to emotions the excitement is very great, and, by the association of the two, the idea gains motor force and the feeling intelligent direction.

And now the efficiency of effort can, at least in part, be understood. Just as the sight of the hated object arouses the feeling of hate, just so, situations in which mutually antagonistic desires are battling for supremacy excite bodily happenings that are felt as effort, and that, by associating themselves with one of the desires, tend to give it the victory. The central position of effort thus depends on its office as arbiter of disputes between well matched opponents, and the ideas that can count on its support have gained a most important ally. As to what bodily commotions condition it, the concluding paragraph must offer a conjecture, admittedly only such, but advanced because, if true, it will assist in giving unity to the conception of man's evolution from lower forms.

In describing the process of humanization after Darwin, it will be remembered that it was declared to be conditioned, on the bodily side, "by changes in the structure and use of the hand, the jaw, and the spinal column." And now it is pertinent to range alongside of that fact the fact that to popular conception—and, I believe, to careful observation—effort is largely a feeling of movements and changes resident in and about the hand, the jaw, and the spine. This is suggested by such phrases descriptive of will power or its absence, as "holding firmly in hand," "losing one's grip," "a firm jaw," or "setting one's jaw," "having backbone," and others that will readily occur. A nerveless hand, a weak jaw, and a cartilaginous backbone are synonomous of deficient will. Looking back to man's ape-like ancestors, we conjecture that skillful hand-movements came to be more and more effective, and thus not only were increasingly resorted to, but also came to be resorted to in *all cases of difficulty;* further, that, as the hand came to perform the actions of offense, defense, and skill that had previously fallen to the jaw, the powerful muscles of the shrinking jaw lost their special occupation, and acquired instead the *general* function of assisting the performance of difficult actions; thirdly, it must be borne in mind that skillful use of the hand could not be obtained without a large amount of brain coördination, and that there is much evidence to show that intelligence develops, and still develops, as hand-directing intelligence; and finally it is not impossible that, owing to the spinal changes accompanying hand-changes, the movements and tensions incident to erectness and throwing back of the shoulders should be aroused also by difficult situations.

Now all these facts, properly weighed, point with some probability to the process of humanization as beginning on the physical side in difficultly coördinated hand-movements, and on the mental side in the organization and generalization of effort, the central fact of volition. Stated in bare outlines, the hypothesis is that these hand-movements, bringing into play the muscles of the arm and shoulder as well, and also, owing to the advantage of the erect posture for hand-use, those of the back, and further, for reasons suggested above, the jaw muscles—that these hand-movements, assisted by their associates, proved especially effective in many difficult situations, and thus gradually came to be aroused more and more constantly on such occasions, with increasing effectiveness, the result finally being that, whenever a movement did not correspond to the idea arousing it, this idea aroused, and was supported by, that group of muscular movements, with effort or endeavor, and not infrequently accomplishment, as the outcome. The hypothesis is mentioned merely as a conjecture, though, as it seems to the present writer, not an improbable one. What he regards as all but undoubtedly sound, is the simpler hypothesis that volition, purposeful action, is *the* distinctive characteristic of man. If, however, the broader physio-psychic hypothesis is accepted, it still remains to show the conditions that called forth the difficult and signally effective hand-movements, with all that followed in their train. This may have been accomplished, as Professor Giddings suggests, by association—pre-volitional, however—or, as Dr. Fisk believes, by prolonged childhood, or by some other means so far unknown.

[*Read before the Texas Academy of Science, June 15, 1897.*]

PEDAGOGICAL NOTE ON MENSURATION.

By Arthur Lefevre, C. E.

Although original scientific research must ever be the crowning function of the Texas Academy of Science, aims of humbler service, standing among its express purposes, display the widest human sympathy. In particular, it is part of the benign rôle of Science to consider with cordial interest all matters of true pedagogic import. For, while justly impatient with the shallowness and bombast which so much abound in the literature of pedagogy, the true man of science is quick to appreciate any genuine elucidation or simplification, however minute, whereby the pathway of learners may be smoothed or straightened.

It is my purpose in this brief note to point out what I believe to be a helpful idea in the pedagogic aspect of geometric mensuration.

I have not failed to examine the matter with a view to discovering whether it had import strictly scientific; but it seems clear that the current scientific conventions for the unit-surface and the unit-solid have intrinsic fitness and utilities superior to those which would be afforded by any others.

In a little book called *Questions in Mathematics*, J. C. Smith, Brooklyn, N. Y., 1889, one may find a curiously confused plea for a revolution in our choice of units for the measurement of surfaces and solids. The author seems to know more of the ordinary school or formal logic than of mathematics, but has illogically based his arguments on mystical and inept analogons in what may be called graphical logic. His sanguine questions concerning the advantages to scientific mensuration of changing the essential form of our units for surfaces and solids appear to me to require negative answers.

On the other hand, I have long experienced the efficiency as an aid to instruction of the fundamental ideas which the writer referred to has vaguely misused in an arraignment of the scientific choice in this regard.

It is familiar to all that geometers have adopted the square on the unit-line as the unit-surface, and the cube on the unit-line as the unit-solid. Also, the choice seems from every point of view the best both for computation and theoretical investigation. It would be well to reflect, however, that scientific mensuration has discovered that, although some fraction of the perigon (e. g., the *degree*) is the unit-angle best adapted to calculation, yet a particular angle incommensurable with the perigon (the *radian*) is the unit-angle positively demanded for theoretical analysis. And again, in like manner, the logarithmic base suitable for calculation must be the same as that adopted for numerical notation, while the "natural" logarithmic base, an incommensurable number ($e=1+\frac{1}{1}+\frac{1}{2}+\frac{1}{3!}+\frac{1}{4!}$ . . .), is discovered to be intrinsically the base proper to analysis.

The particular base, or radix, for the systematic expression of numbers is to be chosen purely for convenience; nevertheless—and here one may see precisely the same principle I would apply in teaching mensuration—every teacher who has tried the method will testify to the general tonic effect and distinct elucidation resulting from finally teaching our decimal notation by using the same system for other bases than ten. It is in this particular system of using a basal number that the essence and merit of the beautiful algorithm, so familiar to children but so imperfectly understood by the majority of their teachers, consists, and by no means in the choice of the base ten. Our decimal notation commands admiration not because it is decimal, but because the orderly positions of the figures to the left or right of a point express ascending or descending powers of one basal number. A thoughtful consideration of the notation would enable anyone to adapt its system to any base; and so long as one feels hesitation in doing this, he may be sure he does not understand what he has deemed so familiar. Indeed, a really adequate understanding of the matter requires, still further, examination of the system and existence-theorems of scalar notations, with the recognition of a radix notation as the special case where the scale merely repeats the same number. It is true that other bases (e. g., twelve) would afford greater facilities than the base ten; but no one thinks of attempting to change the confirmed habits of language. It is not as revolutionists that any teachers employ and advocate such comparisons, but upon the profound principle that comparison is essential to satisfactory knowledge.

Without going too deeply into the matter, it is not out of place to point out how exceedingly profound this principle is. The common barrenness of many otherwise widely differing philosophies may be attributed to their divorcement of immediate apprehension and discursive thought. At the root of any nominalist logic lies the opinion that knowledge of anything is an isolated, mechanical fact. But knowledge is not to be explained in any such mechanical fashion; but rather consists in relating a thing to its intellectual conditions, and so assigning its place in the intelligible world. To quote a brief dictum, "difference is no less essential to a judgment than identity."

Out of the perennial and many sided controversy to which fundamental views on this question have reference, there seems to have come at least one clear upshot, namely, that the extremes of Realism and Nominalism are equally wrong, with the conclusion that between the concept and the particular object exists some intimate relation of thought, and that it is necessary for all reasoning that the general and the particular go hand in hand. There is an essential correlation of the particular facts and the general grounds, and knowledge is realized only in the union of the universal and the particular. The one element is not apart from the other, and every way in which knowledge is formed in us presents this twofold aspect.*

Recognition of these fundamental principles in the theory of knowledge underlies all clearly thought-out teaching. It illuminates every step. It would pacify, for example, the inane logomacies so prevalent concerning induction and deduction, analysis and synthesis, by displaying them as the complemental, inseparable rhythm of thought. In fine, in every form and degree of knowledge there is a double aspect, one turning upon essential connections, the other looking to the detached facts in which those connections are manifested.

Such considerations ought to establish the inherent propriety, and therefore the pedagogic utility of comparison and generalization. Any other way leads to the husks, not to the kernel of knowledge. The chief desiderata of enlightened and skillful teachers are concerned with the difficulty of providing at various points grounds for illuminating comparisons. For example, it is wasteful seriously to study grammar, the logical analysis of language, until the student has some acquaintance with more than his mother tongue. A single language may, of course, be studied advantageously from aesthetic standpoints, because in this case other media for the expression of the true, the beautiful, and the good afford the requisite grounds of artistic comparison; yet even here there is perhaps no way for the acquisition of a pure style so safe and ready as translation. The commonplace essay, as a discipline in the vernacular, is too often a stultifying copy in expression as well as in matter. Translation into the mother tongue frankly takes the matter as given, while for the composition it throws the student in a most stimulating manner upon his own resources, with no more than a de-

*Cf. *Logic*, Adamson, Ency. Brit.

sirable degree of suggestion in all questions of style. Or, to take an example more germane to our subject, it was no mean pedagogical achievement to conceive the idea of a comparative presentation of plane and spherical geometry. I wish to testify to the paradox that it is easier to learn plane geometry and pure spherics together than to comprehend either separately. I would welcome a text-book offering a thorough-going parallel development. Both plane and sphere are surfaces of simple laws of being, and the advantages of a parallel development of the geometries of these two surfaces are too manifold to be set forth in this connection. It is enough to say that no other way could so emphatically display the absolute and determining function of definitions and postulates in any mathematical discipline, and, indeed, in all organized constructs of pure reason.

But it is time now to show how, in my opinion, the teaching of mensuration can profit by generalizing comparisons.

Waiving all questions of psychology as to the genesis of ideas of measurement, the measurement of any magnitude is the process of finding its ratio to another magnitude of the same kind arbitrarily chosen as a unit. The measure of a magnitude is this ratio—a number. Under the conventions of English speech the measure of any magnitude is expressed by a phrase made up of this number and the name of the chosen unit. Thus, we say 'the length of this line is three yards,' meaning that the ratio of said line to the arbitrary line named "yard" is three. The physical fact, the spacial phenomenon, is the line, the surface, the solid; and the length, the area, the volume, are numbers, viz., the ratios of the line, surface, and solid respectively to other magnitudes of like kind chosen arbitrarily as units.

In regard to the terms *length*, *area*, and *volume*, writers of every rank might be cited as fostering by careless expression many pernicious errors. The average college graduate labors under the impression that his fashion of calculating areas and volumes is essential to the matter and arises from the very nature of things. He commonly regards the dangerously abbreviated statement, "the area of a rectangle is the product of its base and altitude," as a proposition in the same category, and as completely expressed, as that "the square on the hypothenuse equals the sum of the squares on the other sides." It is true that, if you pressed him, he would see that the former requires the tacit understanding (always expressed, indeed, in his previous special definition of *area*) that the unit-surface be the square on the unit-line; but the idea that the area could possibly be anything else would be new to him. And he would be an extraordinary member of his class if he could explain the warrant for his method of calculation by pointing to the fundamental and truly general form of the theorem, viz., the ratio of the rectangle of two sects to the square on any third sect* is the product of the ratios of the two given sects to the third sect. That is to say, taking the "third sect" for the unit-line:—the *area* of the rectangle, if the unit-surface be the square on the unit-line, is the product of the *lengths* of two adjacent sides.

Similar remarks apply to volumes and cubes.

Now, it seems plain that confusions about the essential meaning of *area* and *volume*, and about the warrants for chosen methods of calculation, would be obviated by a little systematic comparison of surfaces with some other unit besides the square on the unit-line, and of solids with some other unit besides the cube on the same line.

I would suggest the regular triangle whose side is a unit-line, and the regular tetrahedron whose edge is the same line. One reason for choosing these rather than some others is the fact that they are respectively the minimum regular surface and the minimum regular solid determinable by a unit-line.

The suggested comparisons, besides clearing up the confusions already mentioned, would aid in elucidating the whole doctrine of geometric similarity. Every thoughtful student of geometry knows better; but I find the notion prevalent that the essence of the matter is expressed in the statement that, similar surfaces have the ratio of the squares on corresponding lines determined by the surfaces; and that similar solids have the ratio of cubes on such lines. Of course the truth is, similar surfaces have the ratio of the regular triangles, or any other similar surfaces constructed on the said lines; and similar solids, the ratio of the regular tetrahedra, or any other similar solids constructed on the said lines. The plan suggested would compel a more fundamental and generalized concept and definition of *similarity*† than that in vogue, and would clearly display the truth that the essence of the relations just considered is *numerical.* The fundamental statement of the theorems would plainly appear to be, that similar surfaces have a ratio which is the second power of their ratio of similitude; and that similar solids have a ratio which is the third power of their ratio of similitude. All along the line of elementary mathematical instruction I find much retardation due to confusions between the numerical and geometric mean-

*Definite piece of straight line.

†Similarity should be discerned as a special case of projection. The essential definition, from which all properties of similarity flow in a true organic sequence, is: 'Two figures (two-dimentional or three-dimentional) are *similar*, if they can so be made perspective that the ratio of corresponding perspective sects is constant?' This constant ratio of corresponding perspective sects is called the ratio of similitude of the figures.

ings of the words *square* and *cube.* While the numerical meanings of these words took rise in true and proper geometrical applications of number, their double use has had, I believe, a distinct share in postponing general recognition of number's real nature.

In conclusion, and as I have said already, I can find no practical advantages and do find disadvantages in any alternative units, as compared with the square and cube; but the elucidation of our mensuration as one of various possible practices would result from a pedagogic use of other units, and incidentally attention would be called to many interesting and some elegant theorems. It is not necessary in such a paper to go into details, nor have I anything to offer which one would not find for himself were he to adopt the suggestion I have submitted.

[*Annual Address by the President, October 7, 1898.*]

SCIENCE AND THE STATE.

Prof. T. U. Taylor, University of Texas.

In an age so fruitful in development, both in empire and material wealth and prosperity, the attention that the State should pay to science is a question of gravest import, and should in a large degree be measured by the benefits derived from science, both in culture and material advancement. Upon the proper decision of this question the rank of the commonwealth or nation among the sister sovereignties of the earth will depend. To the thoughtful observers of the trend of events in the last century, no statement of facts or arguments in favor of generous State support is necessary. Such conclusion follows as the night the day, and for him who doubts, a glance at the map of the nations of the earth and the order they occupy in importance and influence will convince the most skeptical that permanent national prosperity, whether as to civic or material affairs, is absolutely impossible without a broad and underlying interest in and support of scientific training and research.

The man who adheres and subscribes to the political faith of the Sage of Monticello as to our government, its structure, and the great duty a free people owe themselves, may learn a wholesome lesson and have cause for a higher admiration when he learns the advanced stand Mr. Jefferson took upon this question over one hundred years ago. He will learn that it is no new question and no new theory that is being ventilated. The duty of the people of a republican form of government to themselves has been a subject of the highest importance, and it will continue to be as long as free institutions exist. It was a subject that occupied the best part of Mr. Jefferson's life, and for the exact half century of his pronounced political activity, from the 4th of July, 1776, to the 4th of July, 1826, he devoted himself with a philosophic fidelity to the upbuilding of his country. After having spent years in the councils of his nation as ambassador to France, President for eight years—after adding to our public domain an area larger than the present Spain, France, Belgium, and Germany combined—after having spent over thirty years in the study of the needs and possibilities of the people, he, in urging upon the legislature the necessity of providing for higher education, defined the objects of a higher institution of learning as follows:

"To form the statesmen, legislators, and judges, on whom public prosperity and individual happiness are so much to depend; to expound the principles of government, the laws which regulate the intercourse of nations, those formed municipally for our own government, and a sound spirit of legislation, which, banishing all arbitrary and unnecessary restraint on individual action, shall leave us free to do whatever does not violate the equal rights of another; to harmonize and promote the interests of agriculture, manufactures, and commerce, and by well informed views of political economy to give a free scope to the public industry; to develop the reasoning faculties of our youth, enlarge their minds, cultivate their morals and instill into them precepts of virtue and order; to enlighten them with mathematical and physical science, which advance the arts and administer to the health, the subsistence, and the comforts of human life; and, finally, to form them to habits of reflection and correct action, rendering them examples of virtue to others and of happiness within themselves. These are the objects of that higher grade of education, the benefits and blessings of which the legislature now propose to provide for the good and ornament of their country, the gratification and happiness of their fellow citizens." And further on in the same report, as if he was contemplating the closing instead of the beginning of the Nineteenth century, he said:

"Some good men, and even men of respectable information, consider the learned sciences as useless acquirements; some think they do not better the condition of men; others that education, like private and individual concerns, should be left to private individual effort, not reflecting that an establishment embracing all sciences which may be useful and even necessary, in the various avocations of life with the buildings and apparatus belonging to each, is far beyond the individual means and must either derive existence from public patronage or not at all." I have made rather full extracts from the reports and letters of Jefferson for two reasons. First, to emphasize, if necessary, the fact that the duty of the State to scientific education in this government of ours was clearly and distinctly stated by not only one of the few leading thinkers of our early history, but by the very man who taught so ably the doctrine of States' rights and the duties of a State as a unit to itself; and second, to impress this fact upon those who boast that their political creed is taken pure and unmixed from the Sage of Monticello. It can be added by way of parenthesis that to Jefferson we owe two of our strongest and most efficient scientific organizations—the coast and geodetic survey and the public land system. So fully has every statement been verified, and so fully has every prediction come true, that it seems as if he spoke with prophetic ken. He recognized the young Hercules, Science, that was to change the map of the world and to play havoc with political creeds, and if any proof was ever wanting it was given within forty years of the death of this statesman, diplomat, educator, architect, and philoscpher, when some of the men with whom he lived were engaged in martial strife, and one of the reasons of their inequality in the contest was their neglect of this one fundamental duty of a State to provide scientific training for its people. Notwithstanding the fact that Jefferson so ably presented the claims of science in connection with the claims of other branches, its admission to the schools of the South was slow indeed; for three tyrants held sway and guarded the enchanted land of education in the South—tradition, the blind devotion to the classics, and the peculiar civilization of our own. Science had to fight its way to an uncertain footing in our early schools, and it did not receive the scant courtesy generally accorded the poor relation. It was admitted as an experiment, and its pushing its way to a seat at the first table is one of the loudest advocates in its behalf. Its holding its place in our schools and its gradual advance is a tribute to its own merit, for its welcome was not always the warmest. But it patiently worked with the forces of nature, often with ridiculous toys for apparatus. It dealt with the flesh and blood of the life around us, and not with the bones of past ages. But it takes time for great changes, even with the greatest nations on earth. Notwithstanding the fact that science has held the world spellbound by its phenomenal strides, we have not yet fully realized its power and utility. We are still partially stupefied, and the educational world is not absolutely certain as to the place the new guest should occupy at the banquet. But even without the testimony of such a high authority as Mr. Jefferson, the trend of modern events and developments would convince anyone that the nation that fosters not science will surely die. It has proven the greatest diplomat in all history, and has expanded the State in the same degree that it has been sustained. It is necsesary on account of the tremendous advantage the man of to-day has over the man of one hundred years ago. His efficiency and effectiveness have been increased in some instances one hundred-fold. The advance in the one science of medicine has been sufficient to overbalance all of the money that has been expended upon all kinds of science. Every soul in the civilized world has received benefits from it. You may call it the march of civilization, the Anglo-Saxon, or our manifest destiny, but I call it the march of science. Our manifest destiny or any nation's manifest destiny will be found to be in almost direct proportion to its attention to science and its allies. To all intents and purposes our nation has just about completed its first century of history and achievement; and yet, man to man, we bear no more resemblance to our boyhood—with the bare exception of the forum and, perhaps, letters—than the eagle bears to the snowbird. Horace Greely once remarked that he believed that the history of the progress of the human race could be traced with more accuracy at the patent office than at the national library—and yet not a model exists that is not a type of the brainwork of some patient plodder who toiled often without reward, either in aplause or cash. We were at the beginning of the century widely separated, a few States, with a few counties loosely and lightly bound together in fact, and partially in theory. It is not surprising that the doctrine of State's rights was advocated, for it was the only working theory. But State's rights always implied State's duties, and no one knew this and emphasized it more than Mr. Jefferson. We are to-day, as a nation, more compact in effectiveness than one State was at the beginning of the century. We can travel from the most easterly to the most westerly part of our country in less time than one State could have been traversed in the twenties. The whole pulse of the country can be touched in the one-hundredth part of the time that it would have taken at the beginning of the century. Call it a process of evolution, progress, destiny, course of human events, or what you will, but take out the problem of this development, the factors that science has contributed, and my opinion is that we would not be considered as a nation except in the light of a curious failure to appreciate one of the greatest agencies of nation-making. It is said that Napoleon once remarked in regard to China: "There lies a sleeping giant. Let him sleep." In comparison with our present position among the nations of the earth, had it not been for the contributions that science has made, we, too, would have been a sleeping giant, and it might have been a very young giant at that. State's rights would undoubtedly be a doctrine to-day. The change is not the verification of any statesman's theory, but it was wrought by agencies of which the early statesmen never dreamed. It was often the silent and poorly paid scientist in his laboratory that largely wrought this change in our political system. The railway and telegraph have done more for nationalization than the statesman or legist. You may call it organization, but organization was the direct result and was preceded by the two great discoveries alluded to, namely the railway and telegraph systems. Eliminate the controversy in regard to slavery, and the same result as to nationalization would have occurred, if not in '61, then later. No theory triumphed because it was right, and none went down because it was wrong. It was all the result of agencies that were without the conception of the statesmen of either school. When Jefferson, as early as 1789, attempted to have passed his bill for the general diffusion of knowledge, he little knew when he suggested that provision be made for the mathematical and physical sciences that he was acting as sponsor for an agency that would contribute to the wrecking of his own theory of the federal compact.

The transition from hand laborers to machine-using laborers was a process of organization that was carried on more effectively by larger agencies of the same kind. And although several periods of depression in our material affairs have occurred in our national history by the machine-using tendency, the fact remains that the machine age is here and has been with us for years and it is becoming more prominent. And even yet (quoting from Sir Lyon Playfair) the world has not accommodated itself to the wonderful changes which science has produced in the modes of production and in the exchange of commerce. Whether this adjustment will ever come, I can not say. We must take conditions as they are and have been. The pursuit of happiness, the third inalienable right of mankind as stated in the Declaration of Independence, I do not consider, because it is not a theory, but a condition that has confronted us. Mankind might be happier in some simple arcadia, but science and simple arcadias do not exist in the same country at the same time. It is certain that the changes introduced by science come too quickly upon the heels of each other, but they come, and the State and nation must face the conditions as they may exist. The machine-using tendency is almost universal, and under the circumstances the State that languishes either in their use or further development is lost. For self-defence or self-protection, if not for the love of it, the nation must go on.

The discoveries in science as applied to the wealth producing avocations may be more rapid that the adjusting power of the people. The introduction of a new machine as the result of some abstract discovery in science may throw thousands out of employment, but competition for first place in national affairs keeps every nerve on fire and every muscle taut. National progress is the key note of the national effort. To keep in the field and maintain our position requires the greatest economy in the use of fuel and force. It applies to the State as well as the nation.

Organization in our government is a result that has been brought about in a great measure by the scientist. Science stands for economy of energy and for the maximum efficiency to be obtained from existing conditions, or newly developed conditions.

The ports of Japan were thrown open to the world a few years ago and the Japanese were brought in contact with the nations of the earth, and she measured them with an accuracy that was surprising. The cause of the greatness and importance of each nation was quickly seen, and every advantage was taken of it for self-improvement. Her brightest young men were sent into the universities of the world—to Germany for the study of science, and especially military science; to England for law; to America for engineering, and to nearly every leading country of the world for some special scientific branch of study. Not only this, but the government established a royal university, and called to its important chairs able teachers from the best technical schools of the world. It was my pleasure and profit to work with one of the foremost bridge engineers in America a few years ago, who was one of the original professors called to this university. For a quarter of a century Japan trained her men in the best scientific schools of the world, and not only trained them thus, but maintained the royal university of her own just alluded to, and this very appreciation of the scientific basis of a country's greatness changed Japan from an indefinite and unknown little power of the Eastern barnyard into the game cock of the Orient. Her experience is so recent and emphatic, against odds of eight to one in population, that it points with no uncertainty to the deep meaning of the success of Japan and the failure of China.

Material wealth is the thinking unit for measuring the advancement in all lines of human thought and human activity. National glory, empire, the flag itself, are all typical of that one factor. To advance this the nation can and must for self-preservation, take the producing forces of nature under its own protection and fostering care or assume a position in the rear ranks. The armchair and cigarette philosopher may rail against the ultimate result to which all of this may lead; but I again reply that it is a condition and not a theory that controls our destiny.

As a nation we have been charitably complimented on the attention we have paid to science, its encouragement and development. As before remarked, our coast and geodetic survey and public land system were established early in the century, and since then our geological survey, the national observatory, the army school at West Point, the naval academy, our fish commission, several biological stations, the Hatch provision for experimental work in agriculture, and many smaller bureaus for special investigation have been established. Even a national university seems among the possibilities of the future. All this has been maintained, notwithstanding many discouragements, and the patience and forbearance of our lawmakers can only be explained by the fact that there are always broad-gauged men ready to serve the nation when needed. For we must be frank and acknowledge that funds have been recklessly spent, even squandered; junketing tours in the name of science has been taken; but the sober sense of the American people has generally brought to court-martial the individual and not the scientific department. It was only a few years ago that the superintendent of one of the most important scientific bureaus was dismissed for finding more inspiration in the concrete demijohn than in abstract or applied science. At another time thousands of dollars and months of labor of many specialists were spent in calculating a table of logarithms to a useless extent, whose only reliability was due to its being verified by lower tables. But in each case it was the guilty party that suffered and not the department. And not only has science to carry the load of such derelicts as the shirker, dreamer, and soft-berth scientist,, but also the bombast and advertiser. He is known in the community, because he keeps it thoroughly posted. He offers expert testimony and uses methods of publication that the patent medicine advertisers would eschew. But verily, all such have their reward. 'Tis true that there are some morphological forms of the scientist, but they are known by their fruits. I should like to inject two remarks here, made by two eminent scientists of America who have never played to the galleries. Professor Rowland, of Johns Hopkins University, said: "But for a man to occupy the professor's chair in a prominent college, and by his energy and ability in the commercial applications of his science, stand before the local community in a prominent manner, and become the newspaper exponent of his science, is a disgrace both to him and his college." Dr. T. C. Mendenhall said in an address: "The scientific dilettante, or, worse, the charlatan, is often much nearer the public than the genuine man of science, and the inability to discriminate sometimes results in disaster in which both science and the public suffer."

And now we come to consider the duty the State owes to science. For the material welfare of the State as a State, and of its citizens as subjects of the State, it behooves us to inquire carefully into the question of the aid the State should afford to scientific expansion. And first, we must consider the duty the State owes to pure science as distinguished from applied science. To him who reflects there can be but one decision, for if there was no pure science there would be no applied, and if there were no applied the human race would still be using the ox cart and the clam shell. Pure science is the great underground reservoir that is refreshing the earth here and there by some magnificent spring of pure and sparkling water in the shape of applied science, that invites mankind to come and slake his intellectual thirst. There may be alchemy, astrology, and empirics without pure science, but no order, no organization, and everything haphazard. I know that there is a doubt in the minds of many as to the utility of science. What is the use of spending so much money on this investigation? To the true lover of science such questions excite pity. It is related that Farady was once asked the question, "What is the use of an abstract discovery in science?"

and he replied by saying, "What is the use of a baby?" Similar possibilities are in each. It might have been that some fretful nurse once asked the latter question in regard to Dewey, Hobson, Joe Wheeler, or Fitzhugh Lee. The answer to-day would be swift and sure, but no surer than the scientist or any man of intelligence would reply if you were to ask him of what use were the abstract discoveries of that greatest physicist of modern times, Michael Farady, for he would reply that the very light you read by, the very car you ride on, and every application of induced or direct currents can find a near ancestor in some of his abstract discoveries. I know that it is often asserted that many of our best inventions come from laymen. This is undoubtedly true. The true scientist is not influenced by the money consideration. Agassiz said to the agent of the lecture bureau when he received a flattering offer to lecture to the public, "What care I for your money?" The layman has brought many inventions to the front. But to whom is most credit due? To the man who points out the wonderful richness of an unknown country, or the man that acts upon the suggestion and reaps a golden harvest? Almost all patents, you will find, were preceded by some pathfinder who cared not for money.

I can not urge the care of science upon the State in more fitting language than that used by the prince consort at the Aberdeen meeting of the British Association for the Advancement of Science. In his address as president of the association, he said: "We may be justified in hoping that the legislature and the State will more and more recognize the claims of science to their attention; so that it may no longer require the begging-box, but speak to the State like a favored child to its parent, sure of its paternal solicitude for its welfare; that the State will recognize in science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand." Science should command the respect of the State as a necessary adjunct of power if not as a "favored child." But there are many reforms necessary before science can be considered a "favored child" in some of our States. As long as the practice of medicine is at the mercy of the quack or the second-class medical college, as long as the men who have been thoroughly trained in the best modern schools, and who are familiar with the best practice of the day, are not allowed to control the practice of medicine, there is work to be done by the State. There is work to be done as long as the profession of law has no protection against the shyster. There is again work to be done as long as the profession of engineering is without any legal status whatever. The professions of law and medicine do have a form of requirement before practice can be attempted, but the profession of the engineer has no safeguard whatever. The man who has been graduated at Cornell, Troy, or the Massachusetts Institute of Technology has no more consideration before the law than the man who starts in the field with no training whatever. Can the State afford, for its own protection, not to require some evidence of fitness on the part of those who would assist us in developing its resources. Again, there's work to be done for agriculture as long as Johnson grass flourishes, as long as there are dead spots in cotton-fields, and the boll-worm and sharp-shooter play havoc with our crops; and were all these problems solved, the scientist would still have his hands full of practical problems. Sanitary science is in its infancy. As long as any form of epidemic, be it cholera, yellow fever, or what not, is liable to cross our borders, the scientist stands ready to lay down his life for the protection of his fellows. Our own city has produced such men—men whose names are known to every one in this audience. The physician will yet pierce the armor of that giant evil of cholera and lay his head as a trophy at the feet of the people of the nation. Can a chivalrous people fail to furnish every aid for such work? It is a work for them, pure and simple, and not for personal glory, for the true scientist suffereth long and is kind.

Not only does every duty of the State dictate the fostering of science; not only does common gratitude for the blessings we have received dictate it, but history tells us the fate of those that neglect such plain duty. As I remarked some moments ago, the State or nation that neglects this great factor in civilization will either die or fall to the rear. The great Napoleon founded many universities in France, but consolidated them into one imperial university, but it soon lost its prestige and influence. At the same time the German nation was studding the land with universities, and the German scientist was attracting and holding the attention of the scientific world. In the Franco-German war two armies met on the frontier of France, the one from the leading scientific nation of the world, the other from a nation that at least had not treated science as a favored child; the one composed in part of the spectacled German professors from the universities of Germany; and the result was that France surrendered the largest individual army that was ever surrendered in the history of the world. As soon as peace was declared the German planted a university in the ceded province of Alsace-Loraine. If the people of this province needed a university under the German crown, surrounded by the many universities of the German nation, they certainly needed one while they were part of the French nation that was then poorly equipped with universities. But, as Playfair said, "Both France and Germany are now fully aware that science is the source of wealth and power, and that the only way of advancing it is to encourage universities to make researches and to spread existing knowledge through the community. Switzerland is a remarkable illustration of how a country can compensate itself for its natural advantages by a scientific education of its people. Switzerland contains neither coal nor the ordinary raw material of industry, and is separated from other countries which might supply them by mountain barriers; yet by a singularly good system of graded schools, and by the great technical college at Zurich, she has become a prosperous manufacturing country."

But illustrations are numerous. The law is universal. Economy in the use of materials is the watchword of applied science. So many pounds of coal represent so much work, and science has shown the connection between the heat that has been stored in the lump of coal by the rays of the sun and manual labor. Instead of estimating effectiveness by man, we now estimate by fuel, and the nation that is ruled by empirics can not advance.

It would not be fitting to leave out of the discussion our own breezy experience for the last few months. The result has been ascribed to Anglo-Saxon grit, to American civilization, and a half-dozen other generalities. It is time that a little analysis was applied to this question. I have a general idea as to what American civilization means, and I have a further idea of how much American science constitutes of this civilization. I suppose it would be impossible to separate science from civilization, because the backbone of the structure would be taken. Science did as much or more to make us a nation of expansionists than the dictum or platform of any party. The relative number in the naval contest were not so much out of proportion, but it was the latest science against tradition and valor as the chief factors. Our guns spoke not the language of diplomacy, of manifest destiny, nor any traditional mother tongue, but they spoke, as President Jordan has said, the language of science. Had Spain devoted herself to science with the fidelity that her colonial officers did to gathering the revenue from her colonies, a better record would have been made.

To provide for a scientific training of the people is more incumbent on the South as a section than on the other section, for until the Civil War destroyed it, the old civilization of the South, while perhaps not antagonistic, was with a few exceptions rather indifferent to scientific research, and in no place was it considered a "favored child." The war left us impoverished, our civilization destroyed, and it took us years to get upon our feet. Industrial education was almost unknown, and our lack of training in this respect was and still is an element of weakness. But we are now ready to play our part with grander possibilities. Every need of science should be supplied. It is idle to talk of being a world power without developing and maintaining the very first factor of power; without fostering in every way possible the first essential that makes a nation great and influential.

I would not be understood as intimating that our State has done nothing for science. It has done much, and yet I can not say that the fatted calf has been killed. The State has performed part of its duty to industrial education in partially equipping and maintaining the Agricultural and Mechanical College; it has estalished and partly equipped a medical department of the University at Galveston; and has established the main University at Austin. But one of the foremost and most brilliant factors or subjects, the one that has contributed as much as any other to civilization, to the material wealth and comfort of the people, namely, electricity, is still without home within the borders of Texas. A biological station should be established on our coast. The harvest is ripe, and reapers are needed. Our State and the Legislature must see to it, and that speedily, that no institution of learning fostered by it should ever have to repeat the experience of the Agricultural and Mechanical College a few weeks ago. Instead of having to use the public prints to bring students to the College, President Foster was forced to advertise to keep them away. Texas, one of the most influential States in the Union, should be first in educational facilities. The Agricultural and Mechanical College is full to overflowing, and there are students unprovided for. As long as there is not enough room in any State institution (created for scientific purposes) for the students, science can not be considered a favored child. Here in Austin we need special buildings for science. Texas can not afford to have any other university superior in anything. Until this is the case the State's duty has not been fulfilled to the fathers of Texas, who laid the foundations for a University of the first-class.

[*Read before the Texas Academy of Science, December 28, 1898.*]

SOME NEW MEASUREMENTS OF ELECTRIC WAVES.

By R. S. Hyer, A. M.

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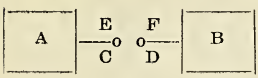
Lord Kelvin's preface to the English edition of Hertz's work on Electric Waves concludes with this sentence: "During the fifty-six years which have passed since Faraday first offended physical mathematicians with his curved lines of force, many workers and many thinkers have helped to build up the nineteenth century school of *plenum*, one ether for light, heat, electricity, magnetism; and the German and English volumes containing Hertz's electrical papers, given to the world in the last decade of the century, will be a permanent monument of the splendid consummation now realized." In similar terms of highest appreciation other noted physicists have spoken of Hertz's work as furnishing complete experimental proof of the Faraday-Maxwell theory that electric discharges may generate electro-magnetic disturbances in the luminiferous ether which are propagated with the velocity of light. His experiments do unquestionably prove that certain electric discharges are sources of electro-magnetic radiations that travel with a finite velocity, pass readily through non-conductors, and are reflected by conductors. The interest naturally to be attached to these results by reason of the fact that Maxwell's theory predicted them was greatly enhanced by the proof which he subsequently offered in favor of the view that these disturbances are propagated with the velocity of light.

Some years since, while attempting to repeat the very beautiful experiments by which he obtained data for the calculation of this velocity, I was surprised to discover that his experiments might lead to results differing greatly from those he had obtained.

To present the subject with some degree of clearness to those not familiar with his work, a brief description of his methods is necessary. The exciting agent, which he called a vibrator or oscillator, consisted of two squares (A and B) of sheet zinc 16 c.m. on the side, each provided with a rod



(C and D), terminating in a ball (E and F). The two plates were set up in the same vertical plane, with the knobs almost in contact. To the rods were attached the terminals of a large Ruhmkorff coil. The instrument used to detect the radiations from the sparks passing between the knobs was called a resonator, and consisted of nothing more than a single wire of about 2.2 meters in length, bent into a circle, and having its free ends terminating in small knobs, whose distance apart was varied by a micrometer screw. When this resonator was held near the vibrator, sparks in the former would produce a corresponding sparking in the latter, though of such diminished intensity as usually to be visible only in a darkened room. By holding the resonator in various planes and bringing the spark gap into different positions, he was enabled to show that this radiation was made up of two components, the one electric, the other magnetic. The experiment by which he clearly proved that this radiation has a finite velocity, and by which also it is generally supposed that he proved this velocity to be the same as that of light, was as follows: The vibrator had been placed in one end of a room about 15 meters in length, and the resonator had responded to its action to the full length of the room. But when a large metal screen was placed at the opposite end of the room certain positions were found where the sparking of the resonator was greatly diminished or entirely extinguished. Beginning near the screen with a well-defined spark, the resonator was carried towards the vibrator. Before the introduction of the screen this approach was always accompanied by increased brilliancy in the resonator spark; but now it had an opposite effect. At a certain distance in front of the screen the spark was almost extinguished. But beyond that point it began to increase, and at a greater distance regained its former brilliancy. Further on it again diminished, to be revived at a still greater distance. These two positions of minimum sparking were at about successively equal distances from the screen. The most natural explanation of this was that these positions of minimum effect were nodal points, produced by the interference of the direct and reflected waves. According to this view the distance between these points was the measure of a half wave length. The period of oscillation was calculated by the well known formula $T = \pi \sqrt{LC}$, and was found by Hertz to be 1.4 hundred-millionth of a second. Multiplying the half wave length by the reciprocal of the time gave 320,000 k.m. for the velocity, approximately that of light; and, therefore, the same ether was the medium of both.

It has already been stated that in attempting to repeat this celebrated experiment I obtained a very different wave length from that found by

Hertz. According to his view, such a difference would be caused by a difference in the size of the oscillator, but in no other way. The one used in my experiment was exactly similar and of the same dimensions as the one employed by him. I soon discovered that this difference was due to the difference in the size of the resonators, and likewise discovered that the differences in the nodal points were proportional to the differences in the size of the resonators. At that time I was not aware of the fact that a similar discovery had already been made by Sarasin and De La Rive at Geneva. It is now well known that they found the nodal distances in both air and wires to depend solely upon the length of wire in the resonator, and stated that this distance was always four times the radius of the circle employed, or 20 per cent greater than the length of wire in the resonator. In view of this discovery, Prof. J. J. Thomson has well said that if we are to retain Hertz's explanation of the formation of these nodal points, we shall have to suppose that the oscillations of the vibrator are very complex, constituting, as it were, a continuous electrical spectrum. If we adopt such a view, how can we determine the period of any particular set of vibrations? Without such a determination, the Hertzian method of calculating the velocity of propagation fails entirely.

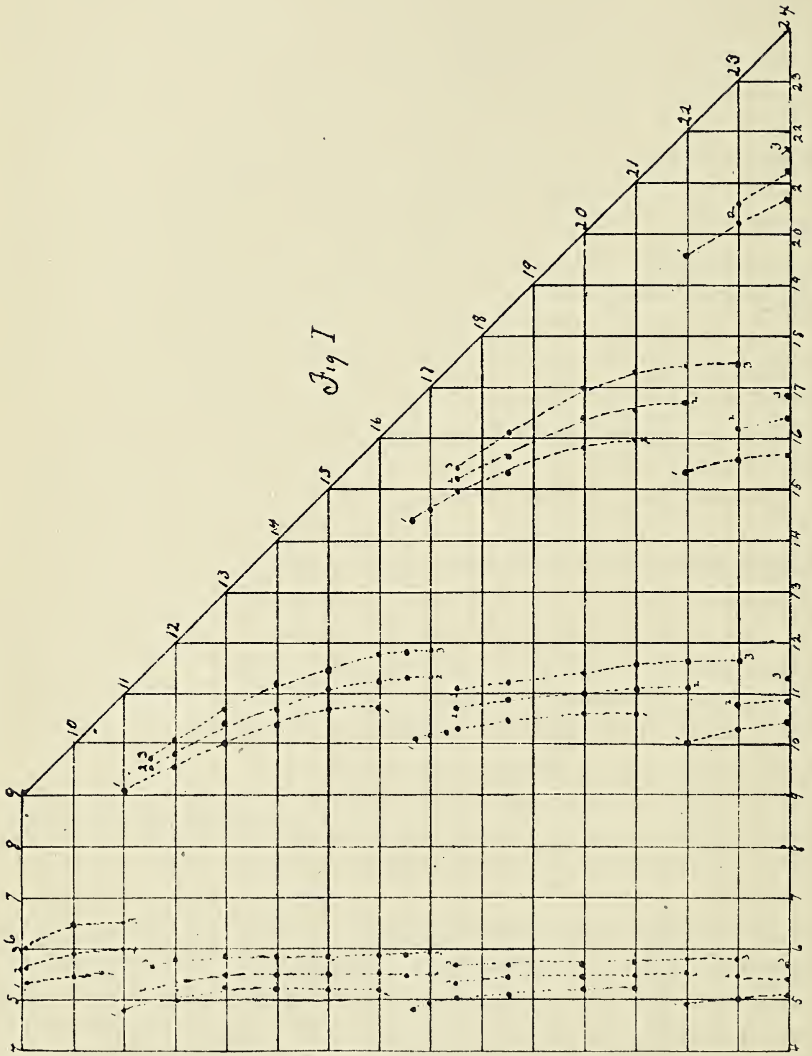
A much simpler view than that of a continuous spectrum is offered by Thomson. He regards the oscillations of the vibrator as being practically dead-beat; and therefore, incapable of making any standing waves by reflection. The so-called nodal points are explained as being interference phenomena in the resonator itself, and not in the air. The dead-beat disturbance originating in the oscillator, moving with a finite velocity, falls upon the resonator and produces in it a disturbance that is quite protracted. The exciting wave travels on to the reflector and is thrown back upon the resonator. This second impact will interfere with the excitement produced by the first, intensifying or diminishing it according to their difference in phase. If we assume, as was shown by the fact that these nodal distances in wires and in air are the same, that the exciting agent travels in the air with the same velocity as that of the disturbance in the wire, we may expect to find at certain definite distances from the reflecting screen points where the first disturbance is intensified by the reflected impact, and, equidistant between these, other points where there is a neutralization. The theory of electric oscillations, as worked out by Thomson, would lead us to anticipate a practically dead-beat oscillation in such an apparatus as was employed by Hertz, and an assumption that such is their real nature very satisfactorily explains all the phenomena observed by him, and also the subsequent observations reported by Sarasin and De La Rive. To this statement one important exception must be made. This was clearly recognized by Thomson, and is best stated in his own language: "There is one result of Sarasin's and De La Rive's experiments which it is difficult to reconcile with theory. They found that the wave length of the vibration was equal to eight times the diameter of the resonator; theory would leave us to expect that the circumference of the resonator should be a half wave length, since, until the sparks pass, the current will vanish at each end of the resonator, as we may neglect the capacity of the knobs, and we should expect the wave length to be 2 π times the diameter, instead of eight times, as found by Sarasin and De La Rive."

The object of the present paper is to call attention to certain observations which I have made that remove the difficulty thus pointed out. But at the same time certain new difficulties will be presented, which I find it difficult to reconcile with any accepted theory. My observations confirm the statement made by Sarasin and De La Rive that the nodal distances are entirely independent of the size of the vibrator, and are proportional to the size of the resonator. But I find this distance so little in excess of the length of the resonator circle that it may fairly be stated that the difficulty which Thomson recognized is removed; for, instead of being four times the diameter of the resonator it is practically π times that diameter. The resonators employed by Sarasin and De La Rive were all small, and I suspect that they were provided with knobs. Thomson, in the passage just quoted, says we may neglect the capacity of such knobs. But such is not the case. To show how results may be affected by them, attention is called to the following:

Upon one occasion, after I had located the nodes in a certain wire, an assistant, provided with a second resonator of the same length as the one I had used, was requested to confirm my observations. To our surprise he found four nodes, where I had found only three. Exchanging resonators, each confirmed the observations already made by the other. Thinking that possibly a mistake had been made in measuring the length of one or the other, the wires were removed from the frame by which they were carried, and stretched out side by side. They were of the same length, and from the same spool of wire, the only difference being that one terminated in knobs while the other did not. Upon removing the knobs, they were found to act alike. With the knobs on, the nodal distances were about four times the diameter of the circle, or 20 per cent more than the circumference; while without the knobs they were reduced to the length of the circumference. It was then decided to make a number of observations on wires of different lengths, with resonators of different sizes, both with and without knobs, to ascertain if any general law could be laid down containing the relative values of nodal distances and the circumferences of the resonators. Many unexpected difficulties were encountered. In the first place, it was discovered that, with the same resonators, there were variations in nodal distances too great to be accounted for by errors of observation. The node nearest the free end was always found at the same distance — practically the length of the resonator, but further along the wire they were always some longer, but quite variable in this excess. More perplexing still was the fact that the nodes were sometimes sharp and easily located, while at other times they were indistinct, and occasionally could not be located at all. One who has not repeated these experiments of Hertz can scarcely realize the difficulties encountered in this character of work. They are well described by a writer in *Nature*, who says: "It is heartrending work at first. A bright spark now and then arouses hope, and long periods of darkness crush it again. The knobs of the generator require repolishing; the spark gap of the detector gets closed up; dust destroys all working; and not without much patience can the art be attained of making sure of getting sparks when the conditions are favorable, though it is easy enough not to get sparks when the conditions are unfavorable. Before making any measurements, all this practice must be gone through. It is hard enough, with the success of others before us to encourage us, with their advice to lead us, with a clear knowledge of what is expected to guide us. How much credit, then, is due Hertz, who groped his way to these wonderful experiments from step to step, without the success of others to encourage him, without the advice of others to lead him, without any certainty as to what was to be expected to guide him. Patiently, carefully, through many by-paths, with constant watchfulness, and checking every advance by repeated and varied experiments Hertz worked up to the grand simplicity of the fundamental experiment in electricity that is engaging our attention."

After many attempts, Hertz failed to obtain anything very satisfactory concerning the velocity of waves in wires. I had discovered enough to know that Sarasin and De La Rive had fallen into serious error. I therefore determined to take up the subject of waves in wires. My results during the first three months given to the work were so discrepant that for a whole year I gave up all attempts to find any method in the mad affair. But from time to time I have returned to the subject. While very little has been accomplished, yet I have discovered certain facts, which, so far as I am aware, have not been pointed out by any other observer.

Attention is first directed to diagram No. 1, in which the numbered horizontal lines represent different lengths of wire in which nodes have been located by means of three different resonators of 500 c.m. each. The first, or No. 1, was made of 24 wire, No. 2 of heavy wire, and No. 3



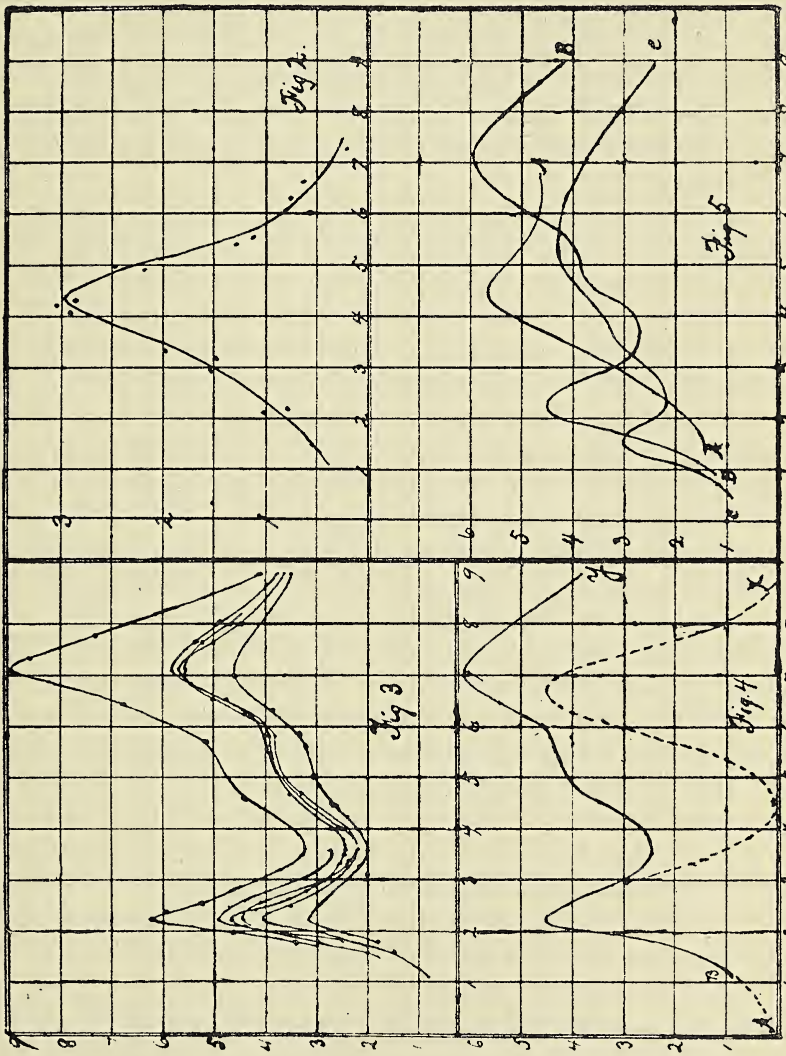


Fig 2.
Fig 3
Fig 4
Fig 5

of heavy wire, terminating in knobs. Lines marked 1, 2, 3, are drawn through the nodal points as respectively found by these three resonators. It will be observed that the nodal distances found by No. 3 are most distant, and those found by No. 1 least distant. With smaller resonators these differences are proportionately greater, and this use of knobs is quite sufficient to explain the error into which Sarasin and De La Rive fell when they concluded that these distances are always four times the diameter of the circle. If their law had held true in this particular case, these distances would have been 633 c.m. The greatest distance given by No. 3 was 590, with an average of 540, while with No. 1 it varied from 480 to 533.*

In these experiments the resonator was held vertically, its plane including the wire. This position was chosen in preference to the one at right angles by reason of the fact that it removed the resonator from the direct influence of the oscillator and was the one deemed least liable to the effects of reflections. One end of the wire under examination was secured to a plate 16 c.m. square, suspended opposite and quite near one of the plates of the vibrator, and the other end was held in place by a silk cord. Beginning near the free end of the wire, the spark gap of the resonator was drawn out to near the maximum sparking length, and the resonator was then carried forward along the wire. Sometimes it was soon extinguished; again could be carried the whole length without any appreciable change. In the former event the gap was made smaller, and in the latter greater. After a few trials a particular spark could be obtained that would continue up to within a short distance of a certain point as it was approached from either side. The point of disappearance was recorded by a chalk mark upon the floor, the room being so dark that the record could not be seen. After quite a number of such observations had been made they were examined, and if found well grouped together the average distance to the end of the wire was measured; otherwise, they were rubbed out and the observations repeated. Sometimes the extreme records would be only an inch or two apart; again they would be scattered over a yard or more, and despite the greatest pains and repeated efforts would remain so. For the sake of explaining the diagram, we will suppose that the experiments begin with the wire 24 meters in length, the oscillator being at the end terminating on the line marked AB. With resonator No. 1, made of 24 wire, and having free ends, four nodes are

*It should have been stated that the data for these resonance curves were obtained in several different rooms, of different sizes, and on different floors; most of the work having been done in a third-floor room 90x130 feet. In all cases the results were the same. It is therefore believed that reflections have not played any important part in the result.

easily located, having an average length of 5.2 meters. With No. 2 the work is somewhat more difficult, and the recorded marks are somewhat scattered. There is a slight, but decided, increase in the nodal distances. With No. 3, having knobs, the work is quite difficult, and the record is least satisfactory of all. Yet it is sufficiently distinct to prove that the nodes are further apart than with No. 2. We shorten the wire to 23.5 meters and find that No. 1 does not work so satisfactorily as before, yet sufficiently distinct to show that the average distances are about 5.10. No. 2 now works unsatisfactorily, and No. 3 does not show any nodes at all, the spark going out first at one place and then at another, or not going out at all. When the wire is shortened to 23, Nos. 1 and 2 are more difficult, the former giving an average of 5.02. No. 3 has improved somewhat, but now gives only three nodes, with an average of 5.77. When the wire is 22 meters, No. 2 likewise drops a node, and after much work we decide that No. 1 gives an average length of 4.90. Shortening the wire to 21 meters causes No. 1 to drop a node also, their distances apart now averaging 5.33. When the wire is further reduced to 20 meters, the nodes are all clear and sharp, and so continue till the length is reduced to 18 meters. Beyond that, Nos. 2 and 3 become difficult; at 17.5 they are both very unsatisfactory, and at 17.2 we can locate no nodes with either; while No. 1, though not so satisfactory, is still doing measurable work at distances of about 500. With 17 meters, after much labor, we can pick out two nodes with Nos. 2 and 3, the latter placing them 5.90 meters apart, while No. 1 continues to find three at an average of 483. With 16.5 meters they are further reduced to 4.73, while with 16 they are still ill-defined, but now clearly only two in number, with an average length of 5.40. With 15, 14, and 13 meters all work beautifully; but between 12 and 10 they successively pass through the throes of dropping a node.

So far as I am aware, no other observer has pointed out this dependence of nodal distances upon the length of the wire. Hertz, it is true, recognized the fact that there are certain lengths which best display these nodal points, but he erroneously ascribed it to a lack of proper syntony with the vibrator. The rule that he lays down for obtaining this syntony will not hold good. By this diagram it could be shown that it would in a particular case call for one of these critical lengths in which no nodes can be found. According to Hertz's view of the duration of the oscillation of the vibrator, we could compare this variation in nodal distances and this existence of certain critical lengths without any nodes, to the forced vibrations of strings; but it would likewise demand that their existence should be detected by only a particular resonator likewise in syntony with the vibrator. While the matter has not been fully investigated, I have found these forced vibrations and critical lengths with various sized resonators. Thomson's view, so far as I can see, would demand that these nodes should always have the same position and intensity in all wires. With my present knowledge of the subject, I find no view of the action of the oscillator so satisfactory in accounting for all the phenomena as that which regards it as emitting a somewhat persistent and complex, though constant, rate of wave motions. Hertz apparently regarded its action as being made up chiefly of one single definite oscillation, whose time depended upon the formula $T = \pi \sqrt{PC} / A$; though he states that this is accompanied by certain irregular disturbances. Thomson appears to agree with him in every respect, save that of the persistence of the vibration. Both recognize the fact that it is rapidly damped, yet from Hertz's standpoint they have sufficient duration to produce appreciable standing waves, while Thomson denies their existence. Thinking that possibly some further light might be obtained by a careful study of the resonance effects of this oscillation, I have been at considerable pains to carefully construct a few resonance curves for various types of vibrators. The resonance curve which Hertz gives in his work indicates a simple and rather continuous oscillation, unaccompanied by any very serious irregularities. This curve is reproduced in Fig. 2. The abscissae represent the lengths of wire in the various resonators examined, and the ordinates the corresponding maximum spark lengths. Unfortunately, he did not give us a curve of the resonance of the type of vibrator used in his most celebrated experiments. He only states that a resonator of 220 c.m. was found to be in tune with it. Assuming this to be a correct maximum, we would expect a minimum for a length of 440, and a second maximum at 660. Line AX in Fig. 4 is designed to show what was to be expected if the observations should agree both with Hertz's curve in a former case and his statements concerning this particular vibrator. According to Thomson's view, we could scarcely expect any appreciable curve at all. To determine the relative merits of these two hypotheses a number of careful experiments have been made, Fig. 3 being a copy of the original record sheet. Hertz's method for determining resonance effects was to place the resonator at a fixed distance from the vibrator, and to measure the maximum spark that was produced by different lengths of wire. My experience in measuring maximum spark lengths is that they are so variable that no very satisfactory results can be obtained. A much more constant method is to fix the gap at a convenient length and then to determine the maximum distance to which the resonator can be carried before the spark is extinguished. Even this method will sometimes give very discrepant results unless it is known how the vibrator has varied in its action during the period of observation. Uniformity of conditions was insured by having an assistant, whose duty it was to determine whether the spark in a certain standard resonator would always be extinguished at the same distance from the vibrator. Unless this test showed regularity of action, no record was made of the distance at which the spark was extinguished in the resonator whose length was varied. Fig. 3 represents the results of five different sets of observations; the abscissae representing the circumference of the resonator, and ordinates the corresponding maximum distances to which a fixed spark could be carried before it was extinguished. The lower curve is for a long spark, and the upper one for a shorter one. By making the sparks very minute, they could be detected to a distance of 35 meters, and possibly beyond. These extreme distances, however, were not convenient for the construction of these curves. The great difficulty encountered in this work is the variable action of the vibrator; it may work well till the curve is half completed, and then suddenly fall in the intensity of its action. When the assistant with the standard resonator reports that he can no longer obtain sparks up to the former distance, the work of observation must cease, the blackened knobs of the vibrator must be polished and their distance adjusted so as to bring it back to its former intensity. Sometimes it is found impossible to do this, and then the work of observation must all be gone over again. It will be observed in Fig. 3 that, while there are some differences in the several curves, they all agree in fixing the first maximum at about 220 c.m., the first minimum at 360, with a considerable value; and the second maximum at about 700, and considerably above the first; while a second minimum either lies at a considerable distance beyond 9 meters, or else has a greater value than the first. Reducing the various observations to a single line, the resulting curve is shown in Fig. 4 by line BY, while below it AX represents what was expected from my understanding of Hertz's views. About the only agreement between the two is the position of the first maximum. Why the first maximum lies at 360, and has such a high value, why the second maximum is greater than the first, why the second minimum does not correspond with the first, are all facts that I find it difficult to explain. That this form of curve is not peculiar to the particular vibrator employed in this experiment is shown by the curves in Fig. 5, where the one already described is represented by the line BB, where AA represents that given by an oscillator with larger plates, and CC that obtained when small cylinders were substituted for the plates. In all of these the first minimum occurs sooner, and has a greater value, than we would expect from Hertz's view. The cylinder, as was expected, showed less resonance effects than the plates, but all were decidedly more resonant than is deemed compatible with Thomson's theory. The data for these resonance curves were obtained in several different rooms, of different sizes, and on different floors; most of the work having been done in a third-floor room 90x130 feet. In all cases the results were the same. It is, therefore, believed that reflections have not played any important part in the result. The most satisfactory explanation for the various phenomena now appears to me to be the assumption that the vibrator produces a large number of waves of different lengths, constituting as it were a continuous spectrum of at least two different maxima, and, though they are all rapidly damped, they have sufficient duration to produce standing waves in both air and wires.

It is my purpose to investigate the matter more fully, particularly to compare the nodes given by a resonator of 360 c.m. circumference with those given by one of 220 c.m..

Great as is my admiration of Hertz's work, I am not fully persuaded that he verified Maxwell's brilliant theory of one ether for light, heat, electricity, and magnetism.

[*Read before the Texas Academy of Science, December 28, 1898.*]

NOTE ON THE DESCENT OF ERYTHRONIUM BULBS INTO THE SOIL.

O. C. CHARLTON, Baylor University.

It is a familiar fact that tubers, rhizomes and bulbs are generally deeper in the soil in age than at the time of beginning their growth. It has been determined that these downward movements are caused (1) by a downward growth of the stem, or (2) by a shortening of the roots with a consequent pulling down of the stem, or by the action of both these causes in the same plant.*

Some of the conclusions which for some time have been established regarding the descent of various forms of subterranean stems may be briefly described as follows:

1. Plants gradually penetrate downwards by means of root contraction, but this contraction diminishes and at length ceases.

2. Plants may have strongly, weakly, or not at all contractile roots, either when mature or immature.

3. The same plant forms strongly contractile roots when at a shallow depth, but weakly contractile roots at a great depth.

4. In normal cases, roots are strongly contractile in youth, less so or not at all in age.

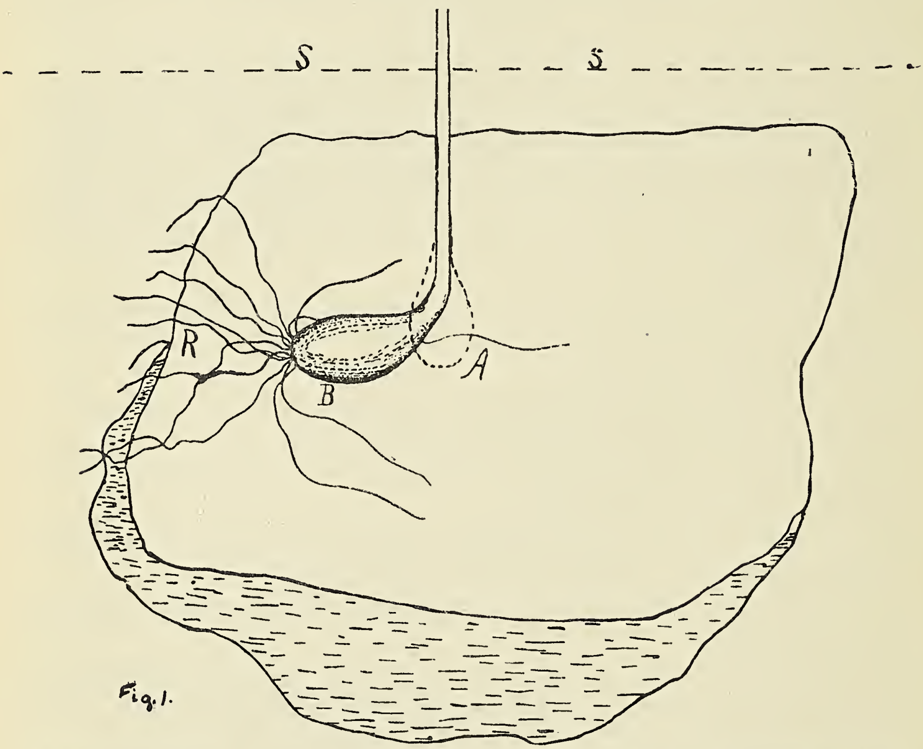
5. The plant tries to adapt itself by ceasing root contractility if put down deep prematurely, but by renewed contractility if its depth in the soil is rendered too shallow by removal of surface layers of soil.

6. Each species has its own maximum depth.

The phenomena which I here report are only a confirmation of some of these conclusions as seen in the Erythronium albidum, or White Dog-Tooth Violet. This well-known bulbous plant grows abundantly in cer-

*In the case of some bulbs the development of new bulbs beneath the old ones has been regarded as accounting in part for the deep position of the bulbs.

tain parts of the cedar brakes just north of Waco. Portions of this area are elevated perhaps 200 feet or more above the Brazos and Bosque rivers, next to which the ridge ends in bold cliffs, with almost vertical faces. All the little valleys draining this area have steep slopes. On one of these slopes, where erosion of the soft limestone and the overlying stony soil is going on quite rapidly, I found last spring (March, 1898) that most of the Erythroniums gave ample evidence that they had been sinking somewhat rapidly into the soil. On carefully digging the soil away from a bulb, I would find that many of its roots curved sharply upwards near the bulb and then continued obliquely upward and outward or horizontally outward from the bulb.



Erythronium albidum. Bulb resting on flat top of rock. The bulb has been drawn by the roots R from the position A to the position B. S S, surface of soil.

The bulb shown in Fig. 1 was found resting on an irregular flat-topped rock, about five by six inches by a greatest thickness of three and one-half inches. But, instead of resting upright on the rock, the bulb was bent into an almost horizontal position, its lower side being flattened against the rock. Nearly all the roots extended to and over the

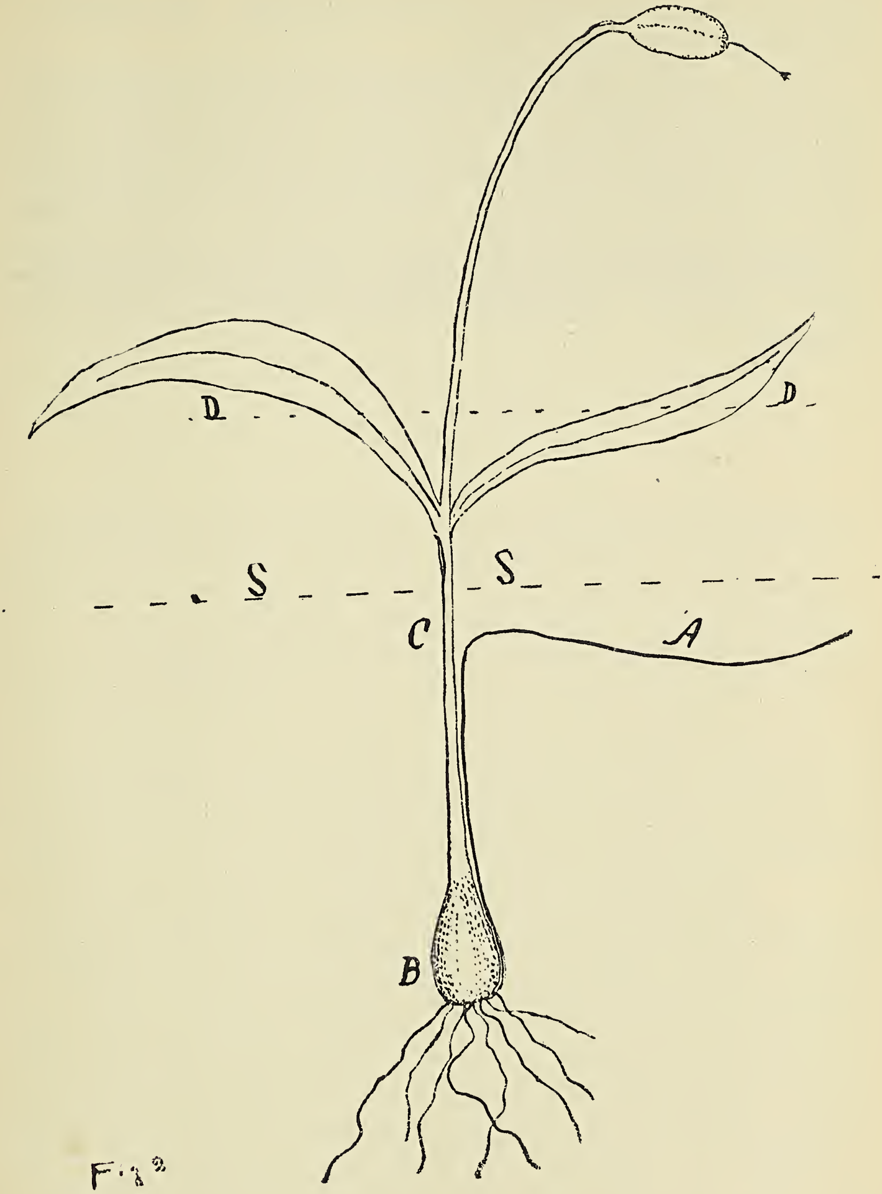


Fig 2

nearer edge of the rock, while several were bent backward, as though the bulb had been dragged past them. Evidently the greater number of roots had reached the edge of the rock and dragged the bulb after them, from the position A to the position B. The soil over the rock was more shallow than that normally over Erythronium bulbs, and plainly the plant had been trying to reach more congenial depths. SS is surface of soil constantly lowered by erosion.

In Fig. 2 is shown a plant in which the descent of the bulb is evidenced in a remarkable manner. When I carefully removed the soil from the lower side of the bulb I was surprised to find a root running upward along the bulb and stem over three inches (9 c.m.) and within less than one-half inch (1.5 c.m.) of the surface, extending outward over three inches (9 c.m.) to the point where I had broken it off in removing the soil. When the root A began its growth, the bulb B must have been at C, and the surface of the soil at DD, instead of SS, as it was when the plant was examined.

[*Read before the Texas Academy of Science, December 28, 1898.*]

VARIATION IN INDIAN CORN WHEN BROUGHT FROM NEW YORK TO TEXAS.

By H. Ness, M. A.

Though I have been unable to find any literature from our experiment stations directly treating upon the changes produced in Indian corn, when brought from one climate or latitude to another, it is a subject that is sure to give both interesting and practical results to the experimenter. There is, perhaps, no plant more sensitive to the change of climate and locality than Indian corn, nor one that sooner adapts itself to new conditions.

At the suggestion of Prof. Bailey, of Cornell University, I planted in the spring of 1896 two varieties of sweet corn sent me by him, which were labeled "Cl. N. Y. La. '93" and "Cl. N. Y. '93," respectively. The same varieties were also to be planted on the grounds of Cornell University, and notes on the varieties at both places were to be taken by me.

The two varieties were planted at College Station, Texas, on March 11, in rather stiff, but moderately well fertilized, clayey soil. On the 11th of June the ears were in proper condition for roasting ears, and the average height of the stalks was 52 inches. The number of ears to the stalk varied from two to three, the lowest of which was inserted 8 to 10 inches above the ground. The length and breadth of the leaf subtending the largest ear were, on an average stalk, 27 and 3¾ inches, respectively. The number of suckers to the stalk varied from three to six. No difference between the varieties was detected on the first of July, when I left for New York, the corn then lacking only a few days of having reached maturity.

On the 13th of August, I examined on the horticultural grounds of Cornell University one of the same varieties, then in full bloom; the other had not been planted. The height of the stalk in this varied from 72 to 84 inches, with one to two ears to the stalk, inserted 25 to 26 inches above the ground. The length of the leaf subtending the largest ear was 38 inches and its width $3\frac{1}{2}$ inches.

Since only one variety was planted on the Cornell grounds, no more notes were taken; but it was decided that the experiment should be renewed the next year with twelve new varieties to be planted, both at College Station and at Cornell.

Upon my return to College Station in August, I found my two varieties of corn fully matured, and that the kernels differed from the seed; only about one-half of them on each ear had the appearance of true sweet corn, the others being either perfectly smooth, or only partially wrinkled. Samples of each of these varieties were then sent to New York to be tried on the experiment grounds of Cornell University for the purpose of observing their behavior there, after having spent a year in Texas.

On the 3d of April, 1897, I planted the kernels from one-half ear of each of the varieties given in the table below, the other half having been retained by Prof. Bailey for planting at Cornell. Seed from the two varieties of the previous year had already been planted on March 11th, which is nearer the proper time for corn planting in this part of Texas. A comparison of the results from both places is given in Table I, while the meteorological observations for the corresponding months are given in Table II.

TABLE II.

		Maximum temperature.	Minimum temperature.	Mean temperature.	Rainfall in inches.	Number cloudy days.	Number partly cloudy days.	Number clear days.
A. & M. College........	April	89	43	66.8	1.57	9	8	13
Cornell..................	June	85	39	60.9	3.54	7	13	10
A. & M. College........	May	93	53	74.6	2.70	8	8	15
Cornell..................	July	94	56	72.4	3.25	9	12	10
A. & M. College........	June	98	62	79.9	2.82	8	12	10
Cornell..................	Aug.	83	46	65.8	2.47	4	15	12
A. & M. College........	July	101	......	85.4	1.45	......	......	......
Cornell..................	Sept.	93	36	61.7	4.72	3	11	16

It will be seen from Table I. that there was a great difference between the corn grown in Texas and the corn grown in New York, especially in the height of the stalks, number of suckers, and number of ears to the stalk. In New York the corn was planted on the 31st day of May and reached its full height during the latter part of July and early part of August. In Texas the same varieties, planted on the 3d day of April, reached their full height, or commenced flowering, during the latter part

	ear.	Length of largest ear in inches.		Thickness of largest ear in inches.		Number of ears first quality per stalk.		Number of ears second quality per stalk.		Number of abortive ears per stalk.	
	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.
1. C. l., N.	4	6	5	1¾	1½	....	....	1	....	2	4.00
2. C. l., La	5	5	6	1½	1¾	....	1.21	1	1.5	3	0.45
3. Amber C	5	8	8	2	1⅞	1	0.69	1	1.7	2	0.19
4. Black M	5	7	6	2	1½	1	1.17	1	0.87	2	0.22
5. Country	6	8	7½	2	1¾	1	.96	1	1.35	2	0.09
6. Cary Re	3	6	6½	1¼	1¾	...	.36	1	0.83	3	0.13
7. Crosby .	5	7½	7½	2	1½	1	.73	1	.68	4	0.13
8. Early A	8	7½	7	2	2	1	1.14	1	.96	0–1	0.19
9. Hickox	6	9½	8	2½.	2	1	.64	1–2	1.26	....	0.07
10. Large E	5	8½	8	2	2	1	.75	2	.76	...	0.28
11. Marbleh	4	....	8	....	1¾	....	.78	...	.86	4	0.19
12. Minneso	5	6½	6½	1¾	1⅗	...	.88	1	1.03	2	0.07
13. P. and	6	7	7	2	1¾–2	1	1.06	2	1.05	....	0.06
4. Stowell's	5	10	8½	2	2¼	2	0.4	1	.85	....	0.3

TABLE I.

	First stamens.		Date of maturity.		Number of days from planting to maturity.		Height of stalk in inches.		Number of suckers per stalk.		Length of leaf in inches.		Width of leaf in inches.		Node of lowest ear.		Length of largest ear in inches.		Thickness of largest ear in inches.		Number of ears first quality per stalk.		Number of ears second quality per stalk.		Number of abortive ears per stalk.	
	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.	A. & M. C.	Cornell.
1. C. l., N. Y., '93......	May 18	Aug. 23	June 29	....	109	....	51	72	2	3	31	30	3¾	4	4	4	6	5	1¾	1½	....	....	1	....	2	4.00
2. C. l., La., '93........	May 20	Aug. 10	June 29	Sept. 15	109	107	54	72	2	0.4	21	30	3	4	4	5	5	6	1½	1¾	....	1.21	1	1.5	3	0.45
3. Amber Cream.......	June 5	Aug. 7	July 15	Sept. 14	105	106	62	88	3	0.1	29	33	3	4	2–3	5	8	8	2	1⅞	1	0.69	1	1.7	2	0.19
4. Black Mexican......	June 8	Aug. 6	July 8	Sept. 8	98	100	57	78	3	0.8	27	30	3	3½	1–5	5	7	6	2	1½	1	1.17	1	0.87	2	0.22
5. Country Gentlemen..	June 18	Aug. 17	July 20	Sept. 16	108	108	60	84	3	0.8	30	36	3⅛	3½	3	6	8	7½	2	1¾	1	.96	1	1.35	2	0.09
6. Cary Red...........	May 20	July 24	June 29	Aug. 18	87	79	53	54	2	1	14	24	2	2¾	1	3	6	6½	1¼	1¾	...	.36	1	0.83	3	0.13
7. Crosby	May 24	July 30	July 8	Sept. 1	96	93	58	80	3	1	28	23	3¼	4	1	5	7½	7½	2	1½	1	.73	1	.68	4	0.13
8. Early Adams	June 8	Aug. 12	July 20	Sept. 15	108	107	68	84	....	....	28	36	3⅜	4½	4–5	8	7½	7	2	2	1	1.14	1	.96	0–1	0.19
9. Hickox Hybrid	May 29	Aug. 6	July 15	Sept. 14	103	106	62	90	1	1	26	33	3	3½	3	6	9½	8	2½.	2	1	.64	1–2	1.26	....	0.07
10. Large Excelsior.....	June 4	Aug. 6	July 20	Sept. 8	108	100	61	78	....	1	29	30	3	3½	2	5	8½	8	2	2	1	.75	2	.76	...	0.28
11. Marblehead.........	May 20	July 26	July 3	Aug. 25	91	86	38	60	2	0.4	18	24	2¾	3	1	4	....	8	....	1¾	....	.78	...	.86	4	0.19
12. Minnesota	May 22	Aug. 3	July 5	Aug. 6	93	92	40	72	2	0.4	21	30	2¾	3½	2	5	6½	6½	1¾	1⅜	...	.88	1	1.03	2	0.07
13. P. and K...........	May 22	Aug. 3	July 3	Sept. 6	91	98	60	78	2	0.1	26	30	3⅜	4	3	6	7	7	2	1¾–2	1	1.06	2	1.05	....	0.06
4. Stowell's Evergreen..	June 1	Aug. 10	July 28	Sept. 27	116	119	68	90	....	0.6	31	36	3⅜	4	4	5	10	8½	2	2¼	2	0.4	1	.85	....	0.3

of May and early part of June. In Table II., it is shown that the temperature of April at College Station corresponds somewhat to that of June at Ithaca, the mean being about 6° higher at College Station, while the rainfall was 1.97 inches higher at Ithaca. For May and July, the months during which the corn made the most growth both at College Station and at Ithaca, the mean temperature will be found to be only 2.20° F. higher at College Station than at Ithaca. From this time on, we find that the months corresponding in the growth of the corn become more and more different in the temperature, the mean temperature becoming constantly higher at College Station and lower at Ithaca.

The following are the differences of the mean temperature between the corresponding months:

April–June, 5.5° F.
May–July, 2.2° F.
June–August, 14.1° F.
July–September, 19.6° F.

Bearing these figures in mind, it seems somewhat paradoxical that the time from planting to maturity, as shown in Table I., is, for most varieties, a little longer at College Station than at Ithaca. This time would have been much more prolonged at College Station if the temperature of July had been lower, but it rose to such a degree, even in the latter part of June, that no normal ripening could take place; and after the 10th of July the corn was literally killed by the heat.

Another striking difference between the corn here and in New York was that the stalks of many varieties (Minnesota, Large Excelsior, Crosby, etc.,) produced short branches which ended in a cluster of three or four ears, all except the terminal one of which were abortive. These branches were generally larger when they arose from the lowest joint and occurred often as suckers from the stool, or collar, of the root. A stalk would sometimes have several of these branches arising either as suckers or from the lower joints.

Before leaving for New York on June 30th, thirty stalks of each row, or variety, were marked for harvesting and additional notes to be taken during my absence; but as our gardener became too busy with his own duties, he was able to render account of only one average stalk from each thirty. As many stalks had been blown over, and the ears scattered on the ground, when I returned, I can give only an approximate average of the yield per stalk.

From Table I. it will also be noticed that in spite of the fact that both the stalks and the leaves were smaller at College Station, the ears were, on an average, larger. Uniformly wrinkled kernels, as in the seed, did not occur in any variety at College Station, since in every variety ears could be found, and especially ears of poor quality, with many smooth kernels, and the rest often imperfectly wrinkled. In ears of first quality, that is, large ears well filled out, this was not so perceptible.

Variation in the height of the stalk and in the time necessary to reach maturity has long ago been observed in Indian corn, when brought from one latitude to another. Thus the seed corn, which in 1882 was imported into northern Illinois from southern Kansas, produced stalks and leaves nearly twice as large as native seed, but not a single ear reached maturity. Last year much seed corn was imported into southern Texas from Missouri that produced stalks 5 to 6 feet high on land which usually produces stalks 8 feet high from native seed; but the yield was not reduced and the corn matured much earlier. Prof. Schübeler, director of the botanical gardens in Christiania, Norway, says (Pflanzenwelt Norwegens, pp. 106, 107,) that he had experimented with maize at that place for twenty years, and that the White Dent corn had reached a height of 15 feet, but did not mature its ears. A large variety, the Golden Sioux, the seed of which he received from New York, reached the first year a height of 10 to 12 feet; after two or three years it grew only 7 to 8 feet high, and became each year earlier.

Prof. Broungart makes the following interesting statements concerning American Dent corn, when brought to Germany (Der Futter-masbau, p. 9): "If seeds are taken in a good season from plants which are, for example, 4 m. high, and they are sown the coming year, then we obtain plants which under favorable climatic conditions are somewhat less in height, but richer in seed, which at the same time may already show a change, a transition from American Dent corn to European round corn. If again seed is sown the next year, then plants arise which are still shorter and still more round-kerneled; so that, after six or eight years, the true imported, tall-growing Virginian Dent corn undergoes a complete metamorphosis, from which a so-called European maize arises, a plant climatically less fastidious, reaching only a medium height, even under favorable conditions, and which produces more rounded kernels and is more suitable for cultivation.

The question now arises as to the causes of these variations, especially as to the size of the plants, when maize is brought from one latitude to another. As already shown in Table II., the cause can not be attributed to difference in the temperature during the time of growth, nor to insufficient amount of moisture during the same period; for, besides the rainfall recorded in Table II., the ground had received heavy showers during the winter and spring at College Station. The soil, it is true, is somewhat poorer at College Station than at Cornell, yet it is very similar, being mostly made up of a grayish stiff clay. The last crop grown upon the ground before the planting of my corn was cow-peas, which were turned under after the vines were dead.

There is, then, only one difference in the conditions under which the two lots of corn were grown that I consider sufficient to produce the variation. This difference is the light, which is so much more intense in Texas than in New York that no one going from the one State to the other can fail to notice it. During the midsummer noonday the glare of the light is so intense here that every object seems to assume a glaring bright color, and can only be looked at by carefully shading the eyes. The black dust of the roads and the ploughed ground look white, and the green fields and forests assume something of a silvery, or steel-gray, tinge. It must also be borne in mind that since College Station is about 10° farther south, not only the quantity, but also the quality, of the light is different from what it is at Ithaca, N. Y. The light, passing almost perpendicularly through the atmosphere here in summer, retains nearly all its rays, while in New York, where it passes much more obliquely, some of the highly refrangible rays must be obstructed by the atmosphere. The difference in season of planting and harvesting between the two places would cause that the plants in New York received the most perpendicular rays during the very early part of their growth, while in Texas this occurred in the latter period of the growth of the plants. Whether this would make a difference I am not at present able to say.

We learn from plant physiology that light, and especially the highly refrangable rays of it, have a retarding or stunting effect upon a growing plant; that this effect increases with its intensity, and that growth will be entirely suspended, if this intensity passes beyond a certain maximum. (Vines, Lectures on Plant Physiology, p. 380 and p. 396.)

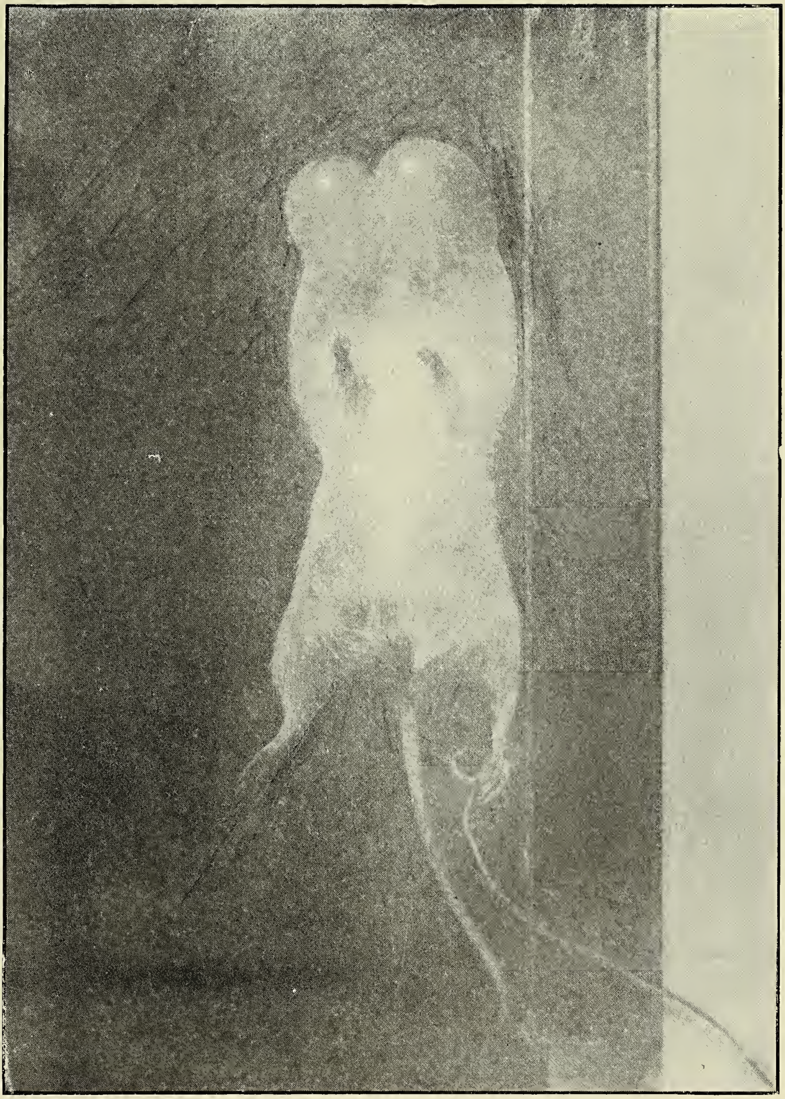
A plant grown under light of high intensity is therefore lower, more short-jointed, more branched, and has smaller leaves than a plant grown under less intense light. (Vines, p. 441.)

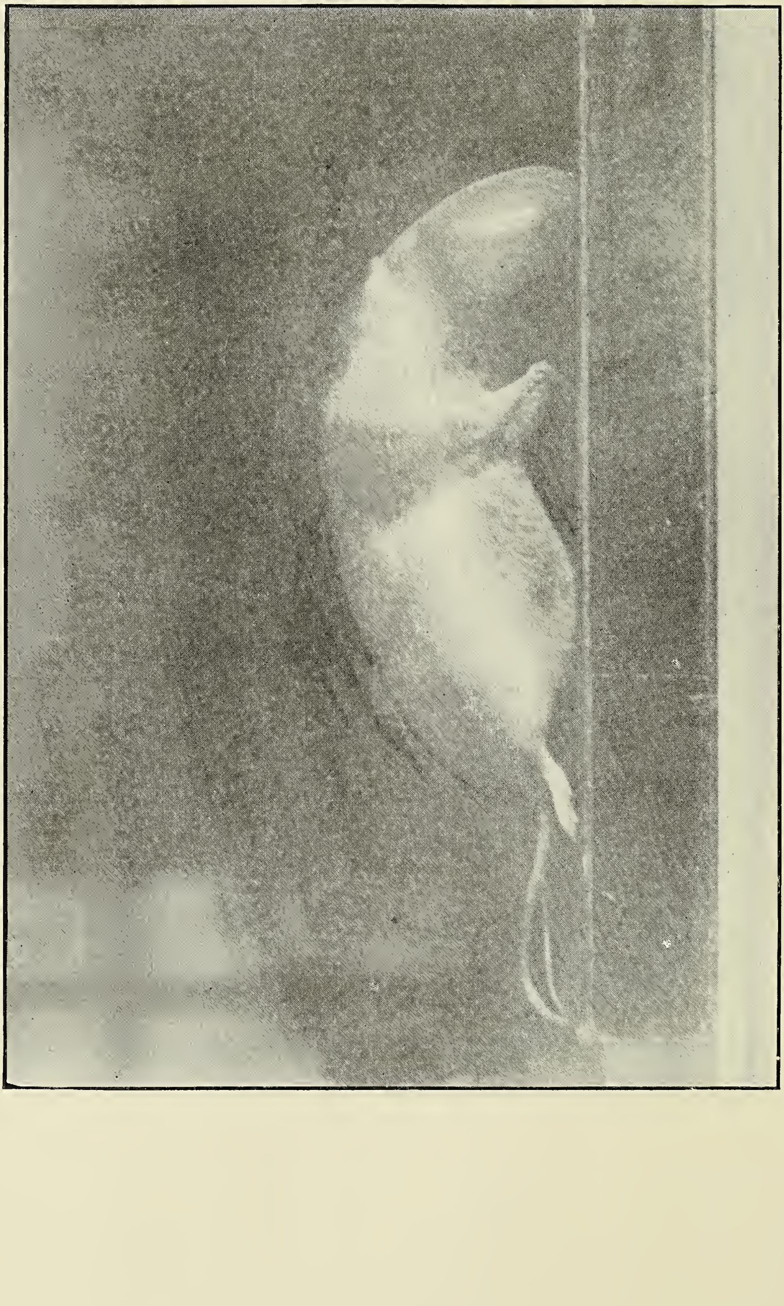
This being the true diagnostics of my corn grown in Texas, I can conclude that the main cause of the decrease in the size of stalks and leaves, and increase in the number of ears in Indian corn when brought from a Northern to a Southern latitude, is the increased intensity of the light; and perhaps also to the relative greater increase of the more highly refrangible rays of that light.

I regret that this experiment had to be carried on in so crude a way. Experiments of this kind carried on here with self-registering apparatus for measuring the growth by day and by night, as well as for measuring the transpiration for the same periods, would be of the highest value to plant physiology, since all such measurements have been made only in countries with a very weak light in comparison with that which lights up Texas during the summer months.

A curious deviation from the normal was observed at College Station in the Red Cary and Marblehead. The ears, which in these varieties were poorly filled out, ended in a little tassel, 2 to 3 inches long, producing good staminate flowers.

Of the two varieties numbered 1 and 2 in Table I., only No. 2 reached maturity at Cornell, and Mr. Gould, who kindly furnished me with the necessary notes on the varieties at Cornell, writes me, that every kernel was perfectly wrinkled, though no more than half of the seed consisted of wrinkled kernels. At College Station, both of these varieties produced ears of only second quality, that is, nubbins, and the kernels were either smooth, or only partially wrinkled.





[*Read before the Texas Academy of Science, June 16, 1897.*]

AN UNUSUAL CASE OF EMPHYSEMA.

By H. W. Harper and W. W. Norman.

I.

During the month of March, 1897, Mr. Felix, of St. Elmo, near Austin, Texas, brought to the Biological Laboratory of the University a rodent (field rat), the peculiar appearance of which led a number of observers to suspect the discovery of a new species.

The specimen was alive when discovered by the son of Mr. Felix, but its life was soon terminated by a dog which accompanied the boy. The scene was in a field near St. Elmo.

The accompanying photographs were taken at the University of Texas, and accurately represent the appearance of the animal (exterior views) when it came into the hands of the authors. The son of Mr. Felix stated that the puffed appearance of the rodent was present prior to the attack of the dog, and in that respect no change had occurred.

So unusual a case of Emphysema was of sufficient interest to justify a very thorough examination into its cause. This was at once begun.

II.

A careful inspection failed to elicit evidence of external injury to the integument. Its continuity was normal; but its relation to subcutaneous tissues presented a marked departure from usual conditions. The skin was bilaterally raised from its moorings by an infiltration of gases, the condition extending over the entire body, with the following exceptions:

(*a*) The ventral median line,

(*b*) On the back involving the superficial area of the trapezius muscle, and extending forward to and including the nose,

(*c*) The proximal flexures of the four limbs,

(*d*) The feet and tail, where it was closely adherent.

Opening the abdominal cavity by a median incision, an ecchymotic spot about 1.5 cm. square situated on the abdominal wall external to the right lobe of the liver was brought to view; but the peritoneum was in tact, the viscera normal, and no accumulation of gas in the cavity.

The thorax was then explored. No accumulation of gas was found there. In the right thoracic wall two broken ribs were encountered—fractures of recent origin—no doubt the result of the encounter with the dog. All the tissues were pale—anæmic. Bubbles of gas were observed beneath the investing membrane of the trachea, and by manipulation they could be pushed forward into the neck, there communicating with the subcutaneous channels, which characterized this peculiar case of emphysema. Following up this clew a patient research was rewarded by the discovery of a small foreign body lodged in the right bronchus.

Contiguous to the foreign body, the bronchus had undergone disintegration. Through this lesion gas escaped, loosening the investment of the trachea, and thereby gaining access to the subcutaneous space aforesaid. The ulcerative process had so cut the bronchus that a portion of its wall projected like a hinged trap-door into the lumen of the tube, permitting air to enter the lung at each inspiratory effort, but preventing its egress through its natural channel from the right lung; it found a line of least resistance along the exterior of the bronchus and trachea from the point of the lesion to its subcutaneous channels. While the gas accumulated in these channels was not chemically examined it was odorless, and supposed to be expired air.

The enormous distension of the labial membrane into bilateral pouches presented a very curious appearance, and the power of so thin a membrane to retain a gaseous body is of special interest.

III.

SUMMARY.

1. The unusual condition and appearance as illustrated by the photographs.

2. That the lodgment of the foreign body in the right bronchus was the cause of such serious trouble.

3. The well preserved but anæmic condition of the tissues.

4. The absence of putrefactive changes.

ABSTRACTS.

A Coahuilan Hacienda. By J. C. Nagle, A. and M. College. Read before the Texas Academy of Science, December 22, 1898.

In this paper was given a description of some of the things observed by the writer during the summer of 1897, particularly such as relate to irrigation matters.

The region considered lies at the bottom of an old lake basin in the so-called Laguna District, towards the southern part of the area formerly known as the Desert of the Bolson de Mapimi, and is entirely without outlet. Into it run the rivers having their sources in the surrounding mountains, of which the two largest are the Nazas and the Aguanaval. The former is about 300 miles long, while the latter is perhaps a little shorter. Water flows in the rivers only during the rainy season, and it is then diverted on to the low, flat lands of the Laguna for irrigation purposes. In the May, 1897, number of the Engineering Magazine, C. P. MacKie gives a detailed description of the methods of utilizing the waters of the Nazas on the Tlahualila Hacienda, thirty miles from the river, but this is the only case in the district in which the irrigation system was laid out according to a well-arranged engineering plan. As the writer saw it done on the Aguanaval near Matamoros and Viesca, the system was much more primitive.

Intakes, which were nothing more than canals cut to the river's bank, and called *tomos,* led the water into the *tajos* or main canals, that conducted it to the point of distribution, where it was diverted into service canals by temporary dams of brush and mud. From these service ditches it was admitted to the *tablas* upon which the crops were growing, and as the duration of flow was short, workmen labored night and day inundating (rather than irrigating) the *tablas* in turn. If a sufficient supply was available, a second inundation was given where most needed. A large amount of suspended matter deposited annually upon the land makes the apparently barren soil of unknown depth and richness, producing magnificent crops. Corn, wheat, barley, beans, cotton, etc., seem to be the crops most generally grown.

Native cotton is replanted about once in five years as the stand grows thin, though isolated stalks fourteen years old and upwards were seen.

American cotton must be planted annually. One irrigation per year—or even one in two years—will insure a good crop of cotton. Corn and other crops must be irrigated annually. Cotton plants are spaced about two meters each way, being planted in checks; corn is sown in the furrows as the soil is turned in breaking it up. No importance seems to be paid to cultivation after planting, save to cut down the grass and weeds once with hoes; yet, notwithstanding this, splendid crops are raised when even a single irrigation can be had. The planting season is much longer than with us, it being no uncommon sight to see corn ready to be gathered standing alongside of that just peeping through the ground.

No evidence of the boll weevil that has invaded Southern Texas was seen, but a peculiar fungus-like disease attacked the cotton leaves in spots, especially after much water had been applied, and to this disease the natives give the name of *viruela*, or smallpox.

The geologic formation is limestone that has been classed as cretaceous, but so much transformation has taken place that characteristic fossil evidences are hard to find. Immense faults run from northeast to southwest, and the dip is to the southeast. From these faults issue, in places, fine streams of limpid water that are used for irrigation—being taken in some cases many miles across the plains, and in one instance across the Aguanaval in a steel-tubed aqueduct before being utilized.

On account of salt and other mineral matter contained in this water, it is not so good for irrigation as the river water, but the supply is surer, and in the long run land so irrigated yields as much, perhaps, as the other. The land must be changed every few years, as the salt kills the soil. Cotton, corn, wheat, barley, beans, chile peppers, etc., are grown, of which chile seems to pay best, but requires much care in curing.

All farm and ranch products bring good returns, and agriculture is favored by the laws. Labor is cheap, an ordinary field-hand receiving only 37 cents, silver, per day—and that in supplies from the store of the hacienda. Separate farms, or *ranchos*, are controlled by local managers, who receive $1.50 per day in silver—the whole being under the direction of one superintendent.

Some of these haciendas are of enormous size, the one referred to here containing nearly 900,000 of our acres, much of it mountainous and fit only for raising sheep and goats, of which they keep hardy mountain varieties. The sheep yield but little wool, but are sheared twice a year, and with the goats supply meats for the neighboring towns of Torreon, Villa Lerdo, etc.

Labor is scarce and unskilled. The workmen, however, soon learn when shown how to do a thing, but it is very difficult to make them do correctly something they have been accustomed to do otherwise. In some leveling done upon the irrigation canals by the writer an Indian assistant soon learned to read the rod and keep a peg-book, but insisted nevertheless that the water was running up hill, since the curvature of the earth made it so appear to him. His explanation was that the force of the spring kept pushing the water along.

Need of engineering skill of all kinds is very evident. In a distance of 14 kilometers the canal above referred to has a fall of only three-fourths of a meter, and the superintendent estimated that 60 per cent of the water was lost—probably too low an estimate. Farming methods are very primitive, but the American plow is gradually replacing the old forked stick drawn by oxen having the yoke lashed to their horns, and a steam plow has recently been imported. In mechanics, however, the lack of skill is more evident. Ponderous carts are still to be seen that have no particle of metal in their construction—not even a nail. The wagons, too, are heavy, and require from ten to fourteen little mules to draw them. A photograph was taken of one that had served to convey Maximillian's body from Queretaro to Mexico City, but which was then loaded with soap, the old guardsman of the Emperor's remains serving as chief of the wagon train.

In masonry work lasting structures are still made after the plan of the old missions around San Antonio, the workmen making excellent mortar from the stones of adjacent mountains. Indeed they seem, in their own peculiar manner, to make the most of what nature has supplied them with, utilizing—for example—one species of the maguey for making alcohol, while from another they derive an excellent rope fibre.

The mountains of Jimulco and Sierra de Lome are rich in minerals such as asbestos, silver, copper, ochre, salt, etc. In the mines all work is done by manual labor, and the ore is transported many leagues in wagons or on the backs of burros, which they facetiously style "The Mexican Express."

The coming of railroads and improved machinery is working a pacific revolution, not only in things material, but even in the social customs of a conservative people. Capital is encouraged, and the laws, while arbitrary and vesting absolute authority in the government officials and wealthy land owners, are especially suited to the needs of an ignorant populace. Education is fostered, and in proportion as intelligence takes the place of ignorance and superstition will the character of the laws be modified. In some things this absolute power of the law is a decided advantage, as for instance in the substitution of the metric system for the clumsy systems of weights and measures formerly employed, and of which Texas has inherited the wretched system of land measurement we yet employ, but which Mexico has entirely abandoned.

According as is felt the march of progress under the influence of modern machinery and methods, will the intelligence of the masses advance, and perhaps closer relations will lead us to learn more of this remarkable republic, wonderfully rich in natural resources and full of objects of intense interest to him who penetrates even a little way into its confines.

A New Suggestion Concerning the Transmutation of Matter. By H. W. Harper. Read before the Texas Academy of Science, March 5, 1897; postponed from the December meeting.

[NOTE.—Except where specified, the following is copied *verbatim* from the author's paper.]

Passing from the absolute to the relative is virtually passing from the unknown to the known and knowable; or, if you please, from the *simple* to the *complex.*

Arrived at concrete matter, i. e., matter as we know it, and motion, as made known to us, are at once interdependent, inseparable, and complex; and all that is vouchsafed to us is the study of relations, phases, changes; and in this work the science of chemistry has done and is doing her part.

Among her various contributions to the world's store of knowledge will be found numerous attempts to solve the insolvable riddle concerning the two constants in which the phenomena of the universe probably have their fundamental mechanism; and out of these efforts has developed a belief in the transmutability of matter.

It is not my purpose to-day to discuss the history of the growth of this belief, nor to outline the many standpoints from which the problem has been attacked; but rather is it my design to point out a new line of research, which, whether it leads to the ultimate goal or not, will at least bring to us additional knowledge, of the most startling nature, concerning the properties of matter.

In brief, my opinion concerning the properties of matter is conveyed by a modified expression of the "Periodic Law." This law states: "That the properties of the elements are periodic functions of their atomic weights." I would modify the statement to read as follows:

The properties of matter are periodic functions of the atomic and molecular masses which constitute it and the rates of motion of these masses.

Any change in the atomic and molecular masses gives rise to a change of properties—likewise, any change in the rate of motion of and within these masses gives rise to a change of properties. The control of these two factors (atomic and molecular masses and rate of motion thereof and therein) will enable us to control the properties of matter. Unfortunately, such control, in the present state of our ignorance, is handicapped by numerous limitations. However, it is the province of science to undertake the removal of these limitations.

Nearly all of the important researches directed toward the solution of the problem of the transmutation of matter have traveled along the line of dissociation at high temperatures; which, to my mind, means *an accelerated motion within the masses.* The *new suggestion* is, that we reverse the order, and study the properties of matter in the neighborhood of what has been called the absolute zero—which means *a lower rate of motion.*

The difficulties in the way are great, indeed—so great that centuries of time may elapse before progress of a high order may be made. But it is incumbent upon us to "blaze the way," and bequeath to others the greater results.

Here the author entered into a mathematical discussion of the well known gas laws. Projecting them over liquids and solids, he showed how it would be necessary to change the constant in one case to a variable in the other, and presented the general formula: $V = \frac{xMT}{P}$, where x is a variable at present determinable, or constant, only in specific cases. He stated that this formula had a wider range of applicability and more nearly expressed the truth concerning the absolute zero; that it reached beyond the conclusions of Clément and Désormes.

Continuing, he said:

If the absolute zero were at — 273° C., this generation would have the glorious privilege of witnessing the most wonderful phenomena, produced at will by the art of man; and within the period of another century transmutation would become a demonstrable fact. Within the past two years the element hydrogen has been liquefied by Professor Olszewski, of Cracow, and observation places its boiling point at — 243.5° C. From calculations made by the same observer, Helium would not be liquefied above — 264° C. So the approach of the absolute zero of Clément and Désormes is near at hand, and we are at the threshold of some extremely important discoveries.

But evidence has accumulated tending to prove that — 273° C. as the real absolute zero (in the sense of perfect atomic rest) is no longer tenable, and many calculations seem to show the true zero to be lower. The ultimate transmutation, then, will not occur at — 273° C.; but, when the lower temperatures are obtainable, we may look for the solution of the problem that engaged the attention of the alchemists "since time whereof the memory of man runneth not to the contrary."

It would lead me too far, and consume too much time, to bring before you a detailed description of the observations thus far made upon the properties of various substances as influenced by recession of temperature; but proof is abundant that chemical action not only grows less, but entirely ceases, at very low temperatures.

The influence of pressure (which means that the masses are brought nearer each other) upon the properties of matter is equally well marked. Combined influence of pressure and temperature would give us the desired conditions at higher temperatures than when either were used alone.

In conclusion, then, let me suggest the possible existence of a "critical temperature," at which one elementary substance will be transmuted into another elementary substance, that this "critical" point will be constant for each substance, growing lower and lower as transmutation proceeds nearer and nearer to the ultimate variety, and that when the *real absolute zero* is reached the atomic masses will lose their motion and be at rest.

The University of Texas, Austin, Texas, December 30, 1896.

Recent Publications Relating to the Geology of Texas. By Frederic W. Simonds, Ph. D. Read before the Texas Academy of Science, February 3, 1899.

I.

The Lower Cretaceous Gryphæas of the Texas Region. By Robert Thomas Hill and Thomas Wayland Vaughan. Bulletin of the United States Geological Survey, No. 151, Washington, Government Printing Office, 1898. Pp. 66. Pl. xxxv.

The chief object of this paper is to set aright the confusion that has long existed regarding the stratigraphical position of a series of fossil oysters commonly assigned to a single species—*Gryphæa pitcheri*, Morton. They occur in especial abundance in the Lower Cretaceous strata of Texas, and when properly classified are of great value in determining the position of strata.

From forms heretofore known as *G. pitcheri* at least eight species are here recognized (table, pp. 45-46), viz.: *G. vesicularis*, Lam., 1806; *G. newberryi*, Stanton, 1893; *G. mucronata*, Gabb, 1869; *G. washitaensis*, Hill 1889; *G. navia*, Hall, 1856; *G. corrugata*, Say, 1823; *G. marcoui*, Hill and Vaughan, 1898; *G. wardi*, Hill and Vaughan, 1898. It is found that even Morton's species (so long considered the type) must be abandoned in favor of Say's *G. corrugata*.

The introduction deals historically with the controversy of many years' standing concerning *G. pitcheri* and the formations in which it occurs.

An account of the fossil oysters of the Texas region and a classification of the Ostreidæ follows.

Contrary to the prevailing opinion that fossil oysters, on account of their great variation, are of little value in the recognition of strata, our authors are led by their observations to conclude "that certain forms of the Ostreidæ possess very distinct characters, have definite geologic horizons, and are of the greatest value in stratigraphic work."

Sixty-one accepted species and varieties of fossil oysters are listed as occurring in Texas Cretaceous, and twenty-three indefinite or abandoned species. Of the former, forty-seven are tabulated as occupying a definite range, "so that they become valuable landmarks in determining the exact geologic position of the beds in which they occur." The following topics are also discussed: "Historical Statement of the Discovery in the Texas Region of the Forms Referred to *Gryphæa pitcheri*, Morton." "Differentiation;" "Geographic and Stratigraphic Distribution of the Lower Cretaceous Gryphæas;" "Specific Classification and Evolution of the Lower Cretaceous Gryphæas;" and the bulletin closes with careful descriptions of six species, characteristic of the Lower Cretaceous, which the authors believe to merit recognition, supplemented by a brief statement of their relationships.

The plates deserve especially commendation. Thirty are devoted to Gryphæas; of the remainder, one is a view of a recent oyster bed, showing the profusion of molluscan growth, the other sections showing the stratigraphic occurrence of the Texas Cretaceous Ostreidæ.

II.

Geology of the Edwards Plateau and Rio Grande Plain Adjacent to Austin and San Antonio, Texas, with Reference to the Occurrence of Underground Waters. By Robert T. Hill and T. Wayland Vaughan. Extract from the Eighteenth Annual Report of the United States Geological Survey, 1896-97, part II, Papers Chiefly of a Theoretical Nature. Pp. 193-321. Pl. xxi - lxiv. Washington, Government Printing Office, 1898.

This is, undoubtedly, one of the most important contributions to Texas Geology that has been made in recent years. While the underlying purpose of the authors has been to deal with the artesian water problem, they have really done much more. Not only has the stratigraphy of the region been carefully studied, but in many instances, as for example about Austin, the work has been done in great detail. An investigation of the source of the artesian water supply at San Antonio shows that the water is derived from the same series of beds that supply the wells at Waco, Fort Worth, and Dallas. There is, however, this important difference: At San Antonio the water is largely supplied by the Edwards limestone, heretofore supposed to be impervious and non-water bearing, while in the region of the above named cities the source of the water is pervious beds of sand. "It became apparent that this hitherto unappreciated water-bearing formation had great possibilities for supplying with either flowing or non-flowing wells a large area of country lying between Austin and San Antonio, extending west of the San Antonio River along the northern margin of the Rio Grande Plain towards the Pecos River, and even comprising the extensive summit region of the Edwards Plateau."

The geographical features of the region are (1) the Rio Grande Plain; (2) the Edwards Plateau; (3) the Balcones Scarp. "Broadly considered, they are a lowland plain inclining gently southeastward to the Gulf of Mexico, an upland plain rising gradually towards the northwest, and a rugged zone of separation which includes a quick ascent from plain to plain."

The Rio Grande Plain is characterized by a low relief, yet there are founds hills of considerable magnitude: buttes, old volcanic necks, and masses of basalt. "The Anacacho Hills, extending east and west in southern Kinney County, and constituting the most rugose part of the plain, are of still another type, consisting of a monoclinal plateau, or cuesta, sloping southward and presenting a steep scarp to the north."

Climatically, the plain is divided into an eastern or humid and sub-humid region, and a western or arid region.

The Balcones Scarp, the position of which "is determined by a complex dislocation of the rocks, the Balcones fault," is the dissected edge of the Edwards Plateau.

The elevated Edwards Plateau merges into the Llano Estacada. There is no definite line of separation between them. The main drainage of the Edwards Plateau is to the east and southeast, and as the water-shed lies well to the westward, the erosion of the streams flowing into the Pecos is but moderate. The Plateau presents three simple topographic elements, viz.: "the flat-topped summits," "the breaks or slopes of its crenulated borders and canyoned valleys," and "the stream ways." The cap-rock is of the Edwards (caprina) limestone.

As the streams of this region have an important bearing upon the underground flow of water, the Rio Frio has been selected as a type and described in detail.

A brief discussion of the flora of plateau brings to light some very interesting facts, one of which concerns the distribution of the cypress: "This tree, which ordinarily grows only in the swamps and bayous of the low sub-coastal regions, attains an enormous size at the edge of the deeper holes near the heads of permanent water of the Pedernales, Blanco, San Marcos, Guadalupe, Cypress, Onion Creek, and other streams. These localities are at altitudes from 1000 to 1750 feet above the sea and hundreds of miles west of the great cypress swamps of the eastern tier of Texan counties, with which they have no possible connection."

Under the caption "Capacity of Rocks for Absorbing Moisture," the following succinct statement is given concerning the water-bearing strata in Texas: "The artesian water-bearing strata of the State east of the Pecos River are composed mostly of extensive sheets of sands, clays, and limestones, succeeding one another in orderly arrangement, except along the Balcones zone of faulting, and in general having a gentle inclination towards the sea, so that in traveling northwestward, although constantly ascending in altitude, one encounters the outcropping edges of rock sheets of lower and lower stratigraphic position. This produces the simple arrangement of a tilted plain built up of a series of alternately impervious and pervious layers. The rain falling upon the outcropping edges of the latter, sinks into the embed, and by gravity is conducted seaward down the plane of its inclination to lower levels beneath the surface. Each different stratum, including any particular water-bearing stratum, becomes embedded deeper and deeper to the southeastward of the point where it outcrops at the surface."

The rocks appearing in the region under discussion are tabulated by the authors as follows:

RECENT.

Wash deposits of the hillsides, stream-bed material, etc.

PLEISTOCENE.

Onion Creek marl, Leona formation, and other terrace deposits.

PLIOCENE.

Uvalde formation.

EOCENE.

CRETACEOUS.

Gulf series:

Webberville and Eagle Pass formations. Taylor and Anacacho formations.....	Montana division.
Austin chalk .... Eagle Ford shales	Colorado division.

Comanche series:

Shoal Creek limestone .... Del Rio clay .... Fort Worth limestone	Washita division.
Edwards limestone .... Comanche Peak limestone .... Walnut formation	Fredericksburg division.
Glen Rose formation .... Travis Peak and allied formations......	Trinity division.

Each of the above formations is described, and those of the Cretaceous with considerable detail — measured sections often-times accompanying the descriptions. The carefully executed work about Austin can not fail to be of great value to students of the Texas Cretaceous which affords in that locality a most inviting field for study.

The igneous rocks of the Rio Grande Plain occur "along the interior margin." They are basic.

The Balcones fault zone forms the "abrupt southern terminus of the Edwards Plateau." "The strata on the seaward side of the faults have been dropped down, so that any particular stratum—the top of the Edwards limestone, for instance—lies 500 to 1000 feet lower on the coastward or downthrow side of the fracture than on the interior or upthrow side." It should be borne in mind that "the fault zone really consists of many faults having subparallel directions, all concentrated within a narrow belt of country." The displacement at Mt. Bonnel, on the Colorado above Austin, is such as to bring the Eagle Ford shales of the Gulf series in contact with the Glen Rose beds of the Comanche series.

The proof of the water-bearing property of the Edwards limestones is supplied by the "great springs * * * bursting out of them at the headwaters of the Llano, Guadalupe, Frio, and Nueces rivers;" the artesian well records at Manor, San Marcos, and San Antonio; and the ordinary wells on the Edwards Plateau.

In discussing underground waters, non-flowing wells, springs, and artesian wells often receive detailed treatment. Of the latter, logs are frequently given, as in the case of the Austin wells at the State capitol; the lunatic asylum, the Natatorium, etc.; the Manor well, the San Marcos well, and the wells at San Antonio. Some of the records, as must be expected, are meager, owing to the want of scientific supervision of the drilling, yet, taken together, they add something to our knowledge of the subject, and could not well have been omitted from the report.

Under the "Chemical Qualities of Water," attention is called to the excellent analyses of water from Austin and vicinity furnished by Dr. Henry Winston Harper, professor of chemistry in the University of Texas.

On page 311 is given a table of the discharge of several spring rivers, that of the San Marcos reaching 57,522,200 gallons in twenty-four hours, and that of the Comal 211,981,932 gallons. From their studies the authors conclude that these and similar "waters come from the deep-seated rocks, and are forced to the surface by hydrostatic pressure. Hence they are artesian in nature and constitute natural artesian wells," and, moreover, that their flow is either from the "sweet-water" horizon of the Edwards formation, or from the Travis Peak sands.

As to the origin of the underground waters: the fact that the valley of the Pecos breaks the continuity of the strata renders it impossible, as the authors have pointed out, to consider the Rocky Mountain region in this connection. "The real source of the water is the rainfall of the Plateau of the Plains and its adjacent borders." By the Balcones faulting, however, the continuity of the water-bearing strata is broken on the southeast and south, hence the water must escape to the surface through fissures or be forced into the porous beds beneath the Rio Grande Plain.

The illustrations accompanying the report are many, and of a high order.

Epsom Salts, Magnesium Sulphate, from Brown County, Texas. By H. W. Harper. Read before the Texas Academy of Science, June 15, 1897.

The occurrence of Epsomite in large quantities in Brown County, and of a purity sufficient to make it the source of an exceedingly cheap commercial product, was here announced for the first time. Dr. Harper's analyses gave the following results:

Water	40.07	40.00
Silica	21.075	21.43
Alumina and Iron Oxides	2.20	2.21
Magnesium Oxide	12.381	12.38
Calcium Oxide	trace	——
Sulphur Trioxide	24.014	24.01
	99.74	100.03

Calculated to contain 76.13 per cent $MgSO_4$, $7H_2O$.

A series of experiments demonstrated that the crude material yields crystallized $MgSO_4$ within one or two per cent of the analytical results.

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The Physical Geography, Geology, and Natural Resources of Texas. By E. T. Dumble. Being Chapter iv of Part iv, Volume II, of "A Comprehensive History of Texas, 1685 to 1897," edited by Dudley G. Wooten. Dallas: William G. Scarff, 1898. Pp. 471-516; 10 plates.

The scope of this work is well shown by the following statement of the topics therein considered, which may be regarded as a table of contents:

Boundaries and Area of the State.

Physical Aspect.

Geology.

Physical Geography:
  The Coast Prairies; the Lignitic Timber Belt; the Black-Waxy Prairies; the Grand Prairie; the Basin Region; the Seymore Plateau; the Llano Estacado; the Granite Highlands; the Wichita Mountains; the Trans-Pecos Mountains.
  Rivers; Islands; Lakes.

Climate:
  Rainfall; Temperature.

Flora; Fauna.

Agriculture:
  Soils; Irrigation.
Artesian Water.

Mineral Resources:
  Gold, Silver, Copper, Lead, and Zinc; Iron; Manganese; Tin; Coal; Asphaltum; Oils.

  Fertilizers:
    Bat-guano; Gypsum; Green-sand Marl; Calcareous Marls.

  Clays; Bricks; Refractory Materials.
  Sulphur; Strontia; Salt.
  Building Material.

Water Analyses—From Springs and Artesian Wells in and near Austin, Texas. By Henry W. Harper, M. D., University of Texas.

P. 301, note; p. 303; p. 304, in Extract from the Eighteenth Annual Report of the U. S. Geol. Surv., 1896-97, Part II. Geology of the Edwards Plateau and Rio Grande Plain Adjacent to Austin and San Antonio, Texas, With Reference to the Occurrence of Underground Waters, by Robert T. Hill and Thomas Wayland Vaughan.

Hydrazine Derivatives of Propionic Acid. By James R. Bailey, Ph. D. Read by title at San Antonio meeting, December 31, 1896.

Consult:

Thiele & Bailey, "Ueber Hydrazin Derivate der Propionsäure." Liebig's Annalen der Chemie, Vol. 303, pages 75-93; Chemisches Centralblatt, No. 26, Vol. 2, pages 1260-1262.

Also Inaugural Dissertation presented at the University of Munich by J. R. Bailey for the doctor's degree, "Ueber Hydrazin-Hydrazo-und Semicarbazidderivate der Propionsäure," 1897.

TITLES OF PAPERS READ BEFORE THE ACADEMY.

Austin, December 10, 1897.

1. Some Permanent Results of Child Study; Prof. A. Caswell Ellis.

College Station, December 22, 23, 1897.

EVENING SESSION.

2. An Address by William L. Bray. Subject: Getting On in the World from a Plant's Point of View.
3. An Address by J. C. Nagle. Subject: A Coahuilan Hacienda.

FORENOON SESSION.

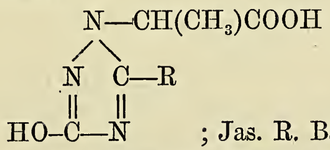
4. A Survey of Velasco Harbor; D. W. Spence.
5. The Development of the Floral Organs of the Compositæ; H. Ness.
6. Applications of non-Euclidian Geometry; George Bruce Halsted.
7. The Biology of the Cattle Ticks; M. Francis.

Austin, February 4, 1898.

8. Degeneration: A Study of Social Pathology; Joe Wooten, M. D.
9. A Mathematical Note; Dr. M. B. Porter.

Austin, March 4, 1898.

10. Discovery of 1—Propionic Acid—3—oxy—5—R—Triazoles of the general formula



; Jas. R. Bailey and S. F. Acree.

11. Some Peculiarities of the Tissues of Plants Inhabiting Salt Bearing Soil; William L. Bray.

Austin, April 1, 1898.

12. The Religious Attitude of Science; John Avery Lomax.

13. The Commercial Spirit and Some of Its Influences; Q. C. Smith, M. D.

Austin, May 6, 1898.

14. Flow of Water Over Rounded Crests; Prof. T. U. Taylor.

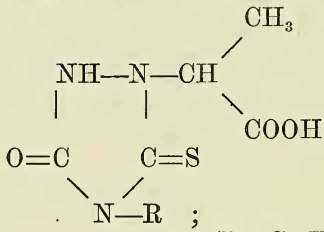
15. The Essential Differences Between Man and Other Animals; Dr. Sidney E. Mezes.

Austin, June 14, 1898.

16. Some Psychic Phenomena Illustrated Upon a Hypnotized Subject; Dr. Matthew M. Smith, Austin.

17. An Unusual Case of Emphysema; Dr. H. W. Harper and Prof. W. W. Norman.

18. Discovery of Triazoles of the General Formula;

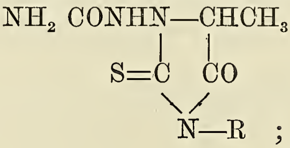


($R=C_6H_5$, CH_3, etc.)

Dr. Jas. R. Bailey and Mr. E. P. Schoch.

19. A New and Improved Method for the Preparation of 1, 6—Dihydro—3, 5—Dioxy—6—Methyl Triazin; Dr. Jas. R. Bailey.

20[1]. Some New Derivatives of Thiohydantoin of the General Formula;



($R=CH_3$, C_6H_5, etc.)

Dr. Jas. R. Bailey and Mr. S. F. Acree.

21. Notes on Earth Work; Prof. T. U. Taylor.

[1] Original work presented by Mr. S. F. Acree to the University of Chicago, for the fellowship awarded him in Chemistry, March, 1898. Date and place of publication will be announced in TRANSACTIONS for 1899.

22. Résumé of the Year's Proceedings of the Academy; Dr. George Bruce Halsted.

Austin, October 7, 1898.

23. Science and the State. Annual Address of the President of the Academy; Prof. T. U. Taylor.

Austin, November 4, 1898.

24. Field Methods in Railway Location; R. A. Thompson.
25. The Geology of the Great Bend of the Colorado;
26. The Age of the Rocks at Shinbone Gap, Burnet County;
27. The Fairland Formation—a Preliminary Announcement;
Dr. Frederic W. Simonds.
28. Interpolation Formulæ; Dr. M. B. Porter.
29. Notes on Perspective; Prof. T. U. Taylor.

Austin, December 26, 27, 1898.

30. Do the Reactions of the Lower Animals Due to Injury Indicate Pain Sensations? Prof. W. W. Norman, University of Texas.

31. Some Recent Archæological Gifts to the University of Texas; Dr. William James Battle, University of Texas.

32. Some New Measurements of Electric Waves; Regent R. S. Hyer, Southwestern University.

33. Variations in Indian Corn When Brought from New York to Texas; Prof. H. Ness, A. and M. College.

34. A Discussion of the Factors Determining the Geographical Distribution of Plants in Texas; Dr. William L. Bray, University of Texas.

35. Note on the Descent of Erythronium Bulbs into the Soil; Prof. O. C. Charlton, Baylor University.

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Clarence Warfield, M. D., Galveston.

Lawrence S. Williams, M. A., Associate Professor of Chemistry, Armour Institute, Chicago.

R. Lee Wilson, M. D., St. Mary's Infirmary, Galveston.

George T. Winston, A. M., LL. D., President of the University of Texas, Austin.

Benjamin Wyche, Librarian, University of Texas, Austin.

B. M. Worsham, M. D., Medical Director, State Asylum for Insane, Austin.

G. B. M. Zerr, Ph. D., Stanton, Va.

LIST OF INSTITUTIONS WITH WHICH THE TEXAS ACADEMY OF SCIENCE EXCHANGES PUBLICATIONS.

AUSTRALIA.

Brisbane.—The Royal Society of Queensland.
Melbourne.—The Royal Society of Victoria.

AUSTRIA.

Wien.—Kaiserliche Academie der Wissenchaften.
Reichs Geologische Anstalt.

BELGIUM.

Bruxelles.—L'Académie Royale des Sciences, des Letters et des Beaux-Arts de Beligique.
Liege.—La Société Royale des Sciences de Liége.

BOHEMIA.

Prag.—Die Koenigl-boemische Gesellschaft der Wissenschaften.

BRAZIL.

Rio de Janeiro.—Museu Nacional de Rio de Janeiro.

CANADA.

Halifax.—The Nova Scotia Institute of Science.
Montreal.—The Natural History Society.
St. Johns.—The Natural History Society of New Brunswick.
Toronto.—The Canadian Institute.
University of Toronto.

ENGLAND.

Cambridge.—Cambridge Philosophical Society.

London.—The Royal Geographical Society.
The Royal Society.
South London Entomological and Natural History Society.
Manchester.—The Manchester Literary and Philosophical Society.

FRANCE.

Marseille.—La Faculte des Sciences de Marseille.
Toulouse.—L'Académie des Sciences, Inscriptions et Belles-lettres de Toulouse.

GERMANY.

Berlin.—Die Berliner Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte.
Giessen.—Oberhessische Gesellschaft für Natur-und Heilkunde.
Halle.—Naturforschende Gesellschaft zu Halle.
Kiel.—Der Naturwissenschaftliche Verein für Schleswig-Holstein.
Rostock.—Der Verein der Freunde der Naturgeschichte.

HOLLAND.

Harlem.—La Société Hollandaise des Sciences à Harlem.

HUNGARY.

Budapest.—Magyar Tudomànyos Akadémia.
L'Akadémie Hongroise des Sciences.
Die Akademie der Wissenschaften.

IRELAND.

Belfast.—Natural History and Philosophical Society.
Dublin.—The Royal Dublin Society.

ITALY.

Livorno.—L'Associazione "Mathesis."
Pelermo.—Circolo Matematico.
Pisa.—Societa Toscana di Scienze Naturali.
Torino.—Revue de Mathematiques.
Academia Reale delle Scienze.

MEXICO.

Mexico.—La Sociedad Mexicana de Geografia y Estadistica.
Instituto Geologico de Mexico.
Observatorio Astronomico Nacional de Tacubaya.
Sociedad Cientifica "Antonio Alzate."

PORTUGAL.

Lisboa.—Real Observatorio de Lisboa.

JAPAN.

Tokyo.—Mathematical-Physical Society, Imperial University of Tokyo.

RUSSIA.

Helsingfors.—Finska Vetenscaps-Societeten.
Kazan.—Société Physico-Mathématique de Kazan.
St. Petersburg.—L'Académie Impériale des Sciences.

SCOTLAND.

Edinburgh.—The Royal Society of Edinburgh.
Glasgow.—The Philosophical Society of Glasgow.

SOUTH AFRICA.

Cape Town.—The Philosophical Society of South Africa.

SWEDEN.

Gothenbourg.—Göteborgs Koengl-Vetenscaps och Vitterhets-Samhälles.
Stockholm.—Koengl-Vetenscaps Akademiens.
Upsala.—The Geological Institution of Upsala.

SWITZERLAND.

Berne.—Die Naturforschende Gesellschaft.
Zurich.—Die Naturforschende Gesellschaft.

UNITED STATES.

Austin.—The Texas State Historical Association.
Baltimore.—Johns Hopkins University.
Johns Hopkins University Hospital.
Berkeley.—The University of California.
Boston.—The American Academy of Arts and Sciences.
The Boston Society of Natural History.
Chicago.—The Field Columbia Museum.
The Chicago Academy of Sciences.
Charlottsville.—The University of Virginia.
Colorado Springs.—The Colorado College Scientific Society.
Davenport.—The Davenport Academy of Science.
Denver.—The Colorado Scientific Society.
Des Moines.—The Iowa Academy of Science.
Denison Scientific Association, Granville, Ohio.
Indianapolis.—The Indiana Academy of Science.
Jefferson City.—The Missouri State Geological Survey.
Knoxville.—The University of Tennessee.
Lawrence.—The Kansas University.
Lincoln.—The Nebraska Academy of Sciences.
Madison.—The University of Wisconsin.
The Wisconsin Academy of Sciences, Arts, and Letters.
Minneapolis.—The Geological and Natural History Survey of Minnesota.
The Minnesota Academy of Natural Sciences.
New York.—American Museum of Natural History.
New York Academy of Science.
Oberlin.—Oberlin University.
The Wilson Ornithological Chapter of the Agassiz Association.
Philadelphia.—The American Philosophical Society.
The Franklin Institute.
The Philadelphia Museums.
The University of Pennsylvania.
Portland.—The Portland Society of Natural History.
Rochester.—The Journal of Applied Microscopy.
The Rochester Academy of Science.
San Francisco.—The California Academy of Science.
St. Louis.—The St. Louis Academy of Science.
The Missouri Botanical Garden.
Topeka.—The Kansas Academy of Science.
Urbana.—Illinois State Laboratory.

Washington.—Department of Agriculture.
Biological Society.
Bureau of Education.
Geological Survey.
The Smithsonian Institute.
The Southern History Association.
The Weather Bureau.
The Geological Society of Washington.

URUGUAY.

Montevideo.—Museo Nacional de Montevideo.

ACTING TREASURER'S REPORT.

STATEMENT OF JUNE 16, 1898.

Annual Dues	$103.00		
Fellowship Fees	27.00		
Membership Fees	22.00		
		$152.00	
Transferred by Treasurer Dumble to Acting Treasurer Bray, December 29, 1897		583.82	
			$735.82
Expenses, January 3 to June 13, 1897	$270.50		
Certificate of Deposit on Austin National Bank	400.00		
			670.50
Amount on hand, June 16, 1898, exclusive of Certificate of Deposit on Austin National Bank			$65.32

[This Account, from January to June, 1898, was audited by Dr. Henry Winston Harper, a member of the Council, on June 20, 1898, and pronounced correct.]

FREDERIC W. SIMONDS, *Acting Treasurer.*

TREASURER'S REPORT.

STATEMENT, MARCH 1, 1899.

[This does not cover the fiscal year.]

Annual Dues	$69.10		
Fellowship Fees	3.00		
Membership Fees	10.00		
		$82.10	
Amount transferred June 16, 1898		65.32	
			$147.42
Expenses, June 17, 1898, to March 1, 1899			118.48
Amount on hand, March 1, 1899, exclusive of Certificate of Deposit on Austin National Bank			$28.94

FREDERIC W. SIMONDS, *Treasurer.*