between the two regions, but the correspondences are certainly extraordinary.

We shall hope soon to hear that the excellent and practical work of the New Jersey Survey has been appreciated by the school-boards of that State, and that copies of this new topographic map and of the appropriate local sheet of the State atlas have been placed in all the high schools and academies. Teachers could then carry on the modern reform in geographic teaching beyond its simple first step, which involves a map of the school-yard and home town, to the more difficult second step, in which correct maps of larger areas are needed. Until this is generally possible and actual, reform in geographic teaching will not go far beyond the merest elements of the subject. If Professor Cook is as successful in putting the State maps into practical use as he has been in surpervising their preparation, we shall owe him a double debt.

W. M. D.

TISSOT'S THEORY OF THE PROJECTION OF MAPS.

THE question as to what projection to select for a certain map is one of great importance to the cartographer. As is well known, the earth's surface cannot be represented on a plane sheet of paper without distorting the lengths of lines, and without altering the size of surface or of angles; and for this reason it becomes the duty of the cartographer to select a projection, or a method of representing the curved surface on a plane, by which the distortions and alterations become as small as possible. Merit is due a French geographer and mathematician, M. A. Tissot, for having first pointed out a method by which this problem can be easily solved. Unfortunately his book, which was published in 1881,[1] is little known, and therefore the necessary process of replacing the old projections, which he has proved to be inadequate, by new and better ones, is making hardly any progress.

The principle which underlies his researches is so clear and simple, that it may be stated here. Tissot assumes an infinitely small circle on a curved surface. If this surface is represented on a plane, the circle assumes the shape of an ellipse, on account of the unavoidable distortion. The great and small diameters of this ellipse are a and b, and their ratio is a measure of the angular distortion, while their product is a measure of the alteration of surface. The ratio between a and the radius of the original small circle, r, is a measure of the alteration of scale. Tissot shows how to compute the length of the axes of this ellipse, which he calls the indicatrix, as indicating the distortion, and how to determine their direction.

This general theory is next applied to the construction of maps. For any law according to which a system of meridians and parallels is constructed, we can compute a and b as functions of latitude and longitude, and thus a means is obtained of studying the distortions all over the surface of the map.

Maps are made to serve various purposes. In many cases it is necessary that a square inch on one part of the map should represent the same area as a square inch on any other part of the map, or, as it is generally expressed, that the areas should be preserved. Projections of this kind are called 'equivalent,' while Tissot introduces the expression 'authallic.' It is evident that every projection in which the indicatrix-ellipse is equal to the small circle, is equivalent. In other cases it is desirable that each small part of a map be similar to the corresponding part of the earth. This is possible only when the indicatrix is a circle; that is, when $a = b$. These projections are called by Tissot 'autogonal,' as the angles are preserved. In still other cases we do not mind an alteration of angle and surface, but wish to preserve the length of lines as much as possible. For this purpose the ratio of a, b, and r must be as near 1 as possible. Tissot calls projections in which angles and surfaces are altered 'aphylactic.'

The problem, according to this, is very simple. According to the purpose for which a map is intended, we choose one of the three classes of projections. It is the task of the cartographer to select the projection for a map so that, if one property is preserved, the others are changed as little as possible. If, for instance, the areas are preserved, the angles must be altered as little as possible. A projection which has this property is called by Tissot 'perigonal,' while an autogonal projection in which the alteration of surface is a minimum is called 'perihallic.' We have seen that the distortion is a function of latitude and longitude. If, then, a country of limited extent is given, we must study this function over the whole area of the map; and, as there are an infinite number of each class of projections, we are able to select the function so that the unavoidable distortion of one of the elements becomes a minimum.

The last case, that of 'aphylactic' projections, has been treated by Airy in his projection by balance of errors; but the theory of these projections and their application to certain areas has first been given by Tissot. His admirable work must form the basis of all future cartographic work.

The importance of his researches may be understood by his discussion of the distortions of the map of France. The great map of the war department of that country is constructed in Bonne's projection; the map being equivalent, and the maximum alteration of angle being 18 minutes, and the greatest distortion of scale $\frac{1}{880}$. These would have been 10′ 30″ and $\frac{1}{650}$ respectively, if a more suitable central meridian had been selected; but they would have been reduced to 25 seconds and $\frac{1}{110}$, if Tissot's principles had been applied.

It is to be hoped that the thorough study of his work will lead to the adoption of better projections than those which are at present in use.

[1] *Mémoire sur la Représentation des Surfaces et les Projections des Cartes Géographiques.* Par M. A. TISSOT. Paris, Gauthier-Villars.

SCHOOL-WORK AND EYESIGHT.

Five Per Cent of Near-sighted Children in an Old, Badly Illuminated and Ventilated School-Building, and only 2.8 in a New, Well-arranged Building. — School Life, according to Dr. Tiffany of Kansas City, has Little or Nothing to do in the Development of Ocular Anomalies.

IN the chapter entitled 'Our School Systems,' which is one of the most interesting and suggestive of all those that will accompany the forthcoming annual report of the United States commissioner of education, the effect of school-work on eyesight will be very fully discussed, chiefly in extracts from the reports of city school superintendents.

Mr. George Howland, superintendent of Chicago schools, says: —

"In the old school-rooms, and we need not go far back for them, the light was often so insufficient, that much harm undoubtedly resulted to the eyes of the children. But in our newer buildings so much thoughtful attention has been given to this subject, that the evil no longer exists there. Pupils, too, have been allowed to study with too little regard to position, and with the object too near the eye; perhaps with the result of myopia in some cases, but by no means, in my judgment, to the extent often charged.

"The oculist is too definite, and too certain in his knowledge. Why should the book or paper always be 'fifteen inches from the eye'? Five feet seven may be the average height of a man, and eight the right number for his boot; but is he to be considered deformed, or a monstrosity, who is five feet six, or who wears a number seven or nine?

"Of over eighty thousand children in our schools, I have never seen one voluntarily take that distance, and have eminent professional opinion that such an enforced rule would work more harm than ever our neglect has done. Nothing will lie so unblushingly as figures."

The following, from the report of the board of education, describes the results of a recent examination of the eyes of the pupils of two of the leading public schools of Memphis, Tenn: —

"The eyes of 681 pupils have been examined. Of these, 588 had perfect sight, 60 had imperfect sight from general causes, and 30 had impaired vision from eye-strain. It is interesting to trace the gradual increase of this form of impaired sight (near-sightedness) from the primary classes, where it is hardly noticeable, to the highest grade, where it reaches fifteen per cent. In this particular my results are similar to those obtained by examiners in this and other countries. But a point which should not be overlooked is this, — that my examinations were confined to pupils in two different school-buildings, each of which may be taken as a sample of its class. The Market Street building has been recently constructed,

and is well arranged, both as to illumination and ventilation; whereas the antiquated structure on Linden Street is sadly deficient in both of these particulars. Now compare the percentage of near-sighted children in corresponding classes (fourth, fifth, and sixth) in the two buildings, and you will find that while the Market Street school has 2.8 per cent, the Linden Street school has 5 per cent. These figures commend the new building as strongly as they condemn the old, and no stronger plea can be advanced for new buildings, so constructed as to furnish proper illumination and a plentiful supply of fresh air, than is furnished by these figures, which show that nearly double the number of the pupils with impaired sight come from a badly constructed building with poor light and bad air."

In November, 1886, Dr. H. P. Allen of Columbus, O., was appointed by the board of education of that city to examine the eyes of the pupils of the public schools. In his report he says: —

"I examined between Dec. 12, 1886, and June 6, 1887, the eyes of 4,700 pupils of the public schools, as follows: All of the high-school classes, 12 in number; all of the grammar schools, 72 in number; all of the primary schools, 24 in number; and 12 of the B, C, and D primary schools; making a total of 120 schools out of the 200 of the city. This included all of the children above 10 years of age, with the exception of about 250, who were scattered through the various lower schools. I visited all of the school-buildings, and saw most of the school-rooms.

"The examinations were made chiefly to determine the condition of vision of the children, and find, in cases where vision was defective, the correcting glasses. The work was done in the school-room during school-hours. Each child was examined separately, its name, age, sex, nationality, complexion, color of eyes, condition of sight, and required glass noted at the time. My records indicate the kind of trouble and the condition of sight with sufficient accuracy for all practical purposes, and enable us to draw certain well-defined deductions. The points to which I wish especially to call your attention are as follows: —

"First, The large number and percentage of pupils among the 4,700 with one or two defective eyes, — 1,175 cases, or 25 per cent of all the children examined.

"Second, Those with two defective eyes, — 936, or 20 per cent of all the children examined.

"Third, The increase in prevalence of near-sightedness as we go up the scale from 0 per cent in the D primary schools to 13 per cent in the senior class of the high school, and 17 per cent among the females of the senior class from 0 per cent at the age of 6 years to 11.3 per cent at the age of 17 years, showing the relation of this trouble to increasing age and increasing demands upon the eyes.

"Fourth, The about equal percentage of each of the other defects in the low, intermediate, and high grades, showing their independence of increasing years and increasing demands upon the eyes.

"Fifth, the diminution in the percentage of good eyes as we ascend the scale, from 80 per cent in the D primary to 66.6 per cent in the senior class of the high school."

A similar examination was made during the year, of the eyes of pupils in the public schools of Kansas City and Nevada, Mo., and of the students of the State normal schools at Warrensburg and Kirksville, Mo., and the State universities of Missouri and Kansas, by Flavel B. Tiffany, M.D., of Kansas City, Mo. The results of this examination differ in at least one material respect from those reported from Memphis and Columbus. The most important facts developed, with other matters of interest mentioned by the examiner, are here shown: —

"That perfect vision, perfect eyesight, be enjoyed by our progeny, depends largely upon the recognition of any defect, slight though it may be, in early life, timely correction of the same if possible, and care and proper use of the organ while in the school-room. That many a boy or girl with some anomaly of refraction or accommodation has been allowed to suffer day after day in order to keep pace with his class, and eventually develop more serious conditions or even blindness, is too evident; whereas if the trouble had been recognized in time, and proper steps taken, much suffering as well as serious consequences could have been averted. The object of these investigations is to ascertain the condition of the eyes of the youth, the effect of use of the organ for near and small objects, and the final consequences; and finally, if possible, to correct the evils arising before irremediable damage has been done.

"In our investigations not only myopia but hypermetropia, astigmatism, spasm of accommodation, and strabismus were looked for. Every eye that was not up to the standard of vision (that of twenty-twentieths) was not dubbed myopic. A careful examination was made with the trial glasses, or optometer, and a more accurate diagnosis made. Our results show a much larger per cent of hypermetropia and astigmatism, and spasm of accommodation, than myopia, there being nearly four times as many hypermetropic pupils as myopic. Of the whole number examined, 2,040, in the different grades and schools, 99, or 4.8 per cent, had spasm of accommodation. Now, spasm of accommodation, or simple hypermetropia even, if not corrected by glasses or relieved by rest from near and small objects, is likely to develop into myopia, or possibly intra-ocular disease: hence the importance of these examinations.

"In our examinations the increase of anomaly of refraction as we ascend in the grades is not marked, — in fact, in some schools it seems to diminish, — but this would not be a definite proof one way or the other, since from one examination, as a different set of pupils are examined in each grade and in each school, there is no means of knowing but that those of the higher grades started with the same degree of anomaly in the primary departments as is found in the seventh year of the grammar school or the high school. In fact, it seems to be true that pupils with anomalies of refraction, both myopes and hypermetropes, are closer students and fonder of books and study than the emmetropes or those of perfect vision; and hence these students remain in school, while many of those with perfect vision drop out before they reach the higher departments. In our examinations we find a greater percentage of anomaly among the normal schools of Kirksville and Warrensburg than any other; but it does not necessarily follow that this is the result of a longer course of study and closer application with the eyes, although it is conjecturally true. The only way to prove that study is the cause, or otherwise, is to watch the same set of pupils from the primary department up through the different grades, and see if John, Mary, and James, starting at six or seven years of age in the primary department with perfect emmetropic eyes, finally later on develop myopia. In our examinations this can be done, as we have the name in full, color of each eye, present amount of vision, whether there is any hereditary defect or not; and now, should the examinations be continued and the same pupils called for as they enter the higher grades year after year, a very definite and satisfactory idea can be gained.

"As to the lighting and ventilation of our school-rooms, very little need be said, as so much attention has been given to this subject by our efficient board, that the Kansas City school-room is almost perfection in those particulars. In the Washington School, where we find the largest per cent of defective eyes in the lower grades, I noticed first and second year pupils, for want of room, were crowded into a room calculated for older pupils, and hence the distance between the desk and the seat was too great, as well as that from the seat to the floor, compelling the little pupil to hang, as it were, upon the desk, his feet not touching the floor. This position, of necessity, brought his face too near his book or slate, and hence taxed the power of accommodation of the eyes to a great degree; and besides, this school, from its location on the north side of the hill, is not so well lighted and ventilated as others. In the Nevada School I found a less degree of anomaly among the same grade of students than in the Kansas City schools. This I attributed to the fact that the school is in a small country town, where the children have more freedom of the field, where they are not crowded so much as our city children are, and perhaps have better ventilated school-rooms.

"There were 2,040 pupils examined, embracing seven different nationalities, besides several of mixed nationality.

"Of the 1,422 Americans, 300, or 21.1 per cent, have some anomaly of refraction.

"Of the 129 Germans, 32, or 24.8 per cent, are affected; of the 26 French, 5, or 19.2 per cent; of the 15 Scotch, 3, or 20 per cent; of the 67 Irish, 20, or 27.8 per cent; of the 47 English, 8, or 17 per cent; of the 11 Swedish, 3, or 27.2 per cent; of the 93 mixed, 22, or 23.6 per cent.

"The Irish, Swedish, and Germans have the highest percentage of affections; the English, French, Scotch, and Americans, the lowest percentage. Out of the whole number examined, 1,162 were girls and 878 boys; 458 had some ametropia (some anomaly of refraction). Of the 1,162 girls, 290, or 24.9 per cent, were ametropic; of the 878 boys, 168, or 19.1 per cent, were ametropic; being a larger per cent of affection among the girls than among the boys.

"Out of the 2,040 pupils, 13, or 0.6 per cent, had strabismus; 94, or 4.6 per cent, were myopic; 202, or 9.9 per cent, were hypermetropic; 42, or 2.06 per cent, were astigmatic; 99, or 4.8 per cent, had spasm of accommodation; and 63, or 3.1 per cent, had latent hypermetropia.

"We find that hypermetropia predominates. If we add latent hypermetropia and spasm of accommodation, saying nothing of astigmatism, of which the majority was hypermetropic, we have 364 hypermetropes to 94 myopes, or nearly four times as many hypermetropes as myopes, or over twice as many as all the other affections taken together. In the table, as seen, all the grades, from the primary through the grammar school, high school, normal school, and university, are represented; but in no instance, excepting the Kansas State University, is there any thing like a gradual increase of myopia or any of the anomalies simply or collectively. In nearly all of the schools there seems to be a higher per cent of affection in the first years; then, a little later in the course, a marked diminution; and then again an increase. Probably many of those having some trouble after remaining in school for a short time drop out, which would account for the diminution; and then spasm of accommodation and latent hypermetropia becoming manifest later on, or perhaps developing into myopia, would account for the increase in this affection.

"School-life, however, as stated above, so far as I can gather by these examinations, has little or nothing to do in the development of these anomalies. That they exist, however, in a much greater degree than is generally supposed, is very evident; and that continuous use of the eyes having these errors of refraction, whether in the school-room or out of it, if not corrected, is sure to have its evil consequences. The importance of a recognition of the existence of these anomalies, of their extreme frequency, and of detecting and correcting them, is obvious enough. We should take into consideration that spasm of accommodation and latent hypermetropia frequently exist, and that these affections often develop into myopia; and if recognized early, and timely treated by rest and glasses, much suffering and irremediable troubles are averted. Cohn and others may have been able, twenty years ago, to trace the development of myopia to badly appointed school-rooms; but here in America our school-rooms are so carefully arranged as to light, seats, desks, ventilation, etc., that we can scarcely attribute to the work in the school-room the cause of anomalies. In a very great degree these errors of refraction are congenital, frequently they are latent, and, if the eyes were not overtaxed by near work, they would never become manifest. The evil arising from work in the school-room is that these errors of refraction are not perceived, and hence not corrected. If the teacher could be made to understand that the little pupils complaining of headache, pain through the temples, and weakness of the eyes, or dimness of vision, arose neither from stupidity nor desire to avoid study, but that these complaints were symptoms of some defect of the organ of vision, or, what would be better still, let a competent oculist carefully examine each child as he enters upon each year of study in the school-work, and his anomaly, if he have any, corrected, anomalies would gradually diminish."

COMMERCIAL GEOGRAPHY.

The Neglect of Native Fruit-Plants in California.

SINCE the settlement of California, its fruit-growing interests have rapidly gained great importance. It is remarkable, that, notwithstanding the economic value of this industry, hardly any attempts have been made to utilize the native fruit-plants; and Mr. H. Semler, who is so well conversant with the flora of California, has done good service in calling attention to the numerous plants that appear well worth being cultivated, and promise to become a source of considerable revenue. He states, that except the seeds of the nut-pine, which are sometimes used as a dessert, only one or two species of blueberry (*Vaccinium*) are sold, although they are not cultivated. Hardly any attempts have been made to cultivate the numerous native berries. In a recent number of *Petermann's Mitteilungen* he draws attention to a number of these plants.

There is a good Californian raspberry (*Rubus leucodermis*). The European raspberry is cultivated with limited success only in the valley of the Hudson and in New Jersey, although its culture is made difficult by the extreme cold of winter. For this reason attempts were made to cultivate *Rubus strigosus* and *Rubus Occidentalis* (the red raspberry and the thimble-berry). By breeding and crossing these species, the raspberries now in use were obtained. These have been introduced into California, while the native raspberry of that State is neglected, although, even in its wild state, it has a better taste than the wild eastern berries.

In the same way the eastern blackberries and dewberries have been introduced, although two excellent species are native to the Pacific coast. Since the discovery of the 'Lawton' or 'New Rochelle,' numerous varieties of *Rubus villosus* have been cultivated, and plantations of great extent and value are found in California. No attempts, however, have been made at developing *Rubus ursinus*, a native of the Californian coast, which is used by farmers for making jams and jellies; nor has *Rubus pedatus* of the Sierra Nevada, which has small and sweet jet-black berries, attracted any attention.

Gooseberry-culture has so far been a failure in North America. The European varieties degenerate and perish after a few years. A few years since, *Ribes aureum*, a native of Missouri, was cultivated and used as a stock for the European great-fruited varieties. The Californian *Ribes divaricatum* seems still better adapted to this purpose, and with proper culture it will undoubtedly produce fruits that will equal the European varieties in every respect.

The salmon-berry (*Rubus spectabilis*) and the Pacific thimble-berry (*Rubus Nutkanus*) are admirably adapted for making jams. Both have a peculiarly sweet and aromatic taste and very small seeds. They do not keep any length of time, and cannot be transported on account of their softness, but may be preserved, as is now extensively done by settlers in the woods of Oregon and British Columbia. The young sprouts of the salmon-berry are boiled, and are said to be better than spinach.

Besides these, we mention the large currant, *Ribes bracteosum*, which would probably prove a valuable shrub; the *Leña amarilla*, one of the four Californian barberries, which is frequently used in Mexico, but has not attracted the attention of horticulturists; and the Californian vine, *Vitis Californica*, which might be developed just as well as the eastern species of *Vitis æstivalis* and *V. riparia*, which have become the stock of renowned eastern vines.

It would be well if Californian horticulturists would not only direct their attention to foreign products and to endeavors to introduce them into California, but also attempt to cultivate the native plants of their State, many of which might become sources of important industries.

ELECTRICAL SCIENCE.

Improvements in Methods of Manufacturing Storage-Batteries.

MR. MADDEN, in the *Electrical World*, describes some recent improvements in the methods of manufacturing secondary batteries of the grid type. The plates of which these batteries are composed have been made heretofore by pasting by hand a mixture of red lead and sulphuric acid into hourglass-shaped holes in a cast-lead frame. Hand-labor in such work has two objections: it is expensive, and it does not give uniform results. The life of the cell, and its freedom from expensive depreciation, depend to a great extent on a perfect uniformity of condition all over the plate. To attain this, Mr. Madden has devised a machine that pastes the plate automatically, giving a uniform density to the red lead in each hole.

The red lead, mixed with the proper amount of dilute sulphuric acid, is fed to a mixing-screw of varying pitch, working in a cylindrical casing. The pitch of the screw is such that the mass is compressed as it nears an opening which has a length equal to