19 and were soaked in seawater. They were then carefully forwarded to Ithaca where they were stored in a freight shed until November when the writer arrived in Ithaca. On opening, they were found to have dried out, but all metal objects were crusted with rust, books were black with mould and the photographs were reduced to mouldy cards, on which the emulsion surface was changed to a chalky deposit that showed no traces of the former image; *except* a few *platinotypes,* which survived the whole exposure. These were soaked off of their card backs and, except for some slight moulding, were as perfect as when they were first made. It was a revelation as to what kind of a photograph was really permanent.

The platinotype is a gray or black and white print that was much in vogue thirty years ago. A metallic film is deposited directly on the paper of the print so there is nothing organic to change except the paper itself. The print is as permanent as the paper. It is more difficult to print and is more expensive than the present emulsion prints, but for a collection of portraits such as Professor Peirce and Dr. Howard describe, it makes prints every bit as permanent as engravings and etchings.

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SCIENTIFIC BOOKS

Investigations on the Red River made in connection with the Oklahoma-Texas Boundary Suit. By E. H. SELLARDS, B. C. THARP and R. T. HILL. 8vo., 174 pp., 9 plates, 7 maps in color. University of Texas Bulletin No. 2327. 1923.

THE state of Texas has signalized its victory in the famous Red River boundary dispute by issuing a bulletin of the scientific investigations on which the decision was won. In 1890 the Supreme Court of the United States interpreted the treaty of 1819 between the United States and Spain in such a manner as to fix the south bank of the river as the boundary line. The discovery of oil at Burkburnett in 1918 and in the river valley in 1919 rendered it necessary to determine what constituted the south bank, where the definite boundary should be drawn and whether this line had been affected by changes in the course of the river during the lapse of a century. Suit was accordingly brought by the state of Oklahoma, with the United States as intervener, against the state of Texas for the purpose of locating the exact boundary and settling the title to the valuable oil lands in the "Big Bend" of the river. The main contention of the plaintiff was to the effect that at the time of the treaty with Spain the river in this region flowed at or near the foot of the Texas bluff. On the other hand, the defendant maintained that neither the channel nor the bordering sand stretch lay adjacent to this bluff in the Big Bend area during the past hundred years. As a corollary, Oklahoma contended that the valley had been developed by a process described as "island building" and that all trees more than a hundred years old had originated on such islands, while Texas maintained that the development had followed the normal process of erosion and accretion and that the trees had begun growth on the proper floor of the valley.

The main body of the bulletin is divided into three sections, as follows: (1) geologic and soil studies on the alluvial lands of the Red River Valley, by E. H. Sellards; (2) ecologic investigations, by B. C. Tharp; (3) physiographic investigations, by R. T. Hill. In the first section, the most interesting and important studies had to do with the age of the river valley as indicated by the series of dunes and by the growth of trees. While the latter gave the most dramatic evidence, the former constituted a distinct contribution to the physiography and soils of a river system. With regard to the sand-dunes, it was found that their formation is determined by the source of the sand rather than by the direction of the controlling winds, and that they are built on the land as a rule and not on the sand-bed of the river. Dune development in the Big Bend area has not been a haphazard matter, but the dunes fall into four definite series, representing four different periods, probably corresponding to as many successive dry phases of the climatic cycle. The first or oldest series lies close to the Texas bluff, and the last or newest one parallels the sand-plain of the stream. The relative age of the several series is indicated by their position, vegetation and soil, all of which were found to be in entire agreement. The most novel evidence was obtained from the mechanical analysis of the top soil of the successive series, which gave 1 per cent. of finest material for the new dunes of series four, 5 per cent. for series three, 16 per cent. for two and 20 per cent. for series one, the oldest. This increased fineness of the top soil with age is explained by the progressive disintegration of soil particles, the addition of organic matter, and the accumulation of dust particles, and is in complete accord with the successional advance of the plant communities.

The age of the valley was further indicated by the thickness of the soils in relation to the age of trees growing in them and especially by the ring-counts of trees found on the alluvial fans. By determining the depth of soil above the river sand and the amount of fill above the main roots of the trees, it was possible to use the ring-count to approximate a period of four or five hundred years since the tributary began to accumulate a fan on the valley land. The study of the

habits of the river in building its valley led to the conclusion that this was regularly in accordance with the process of accretion by which each new area more or less completely enclosed the older, and that the life-cycle of each individual valley could not be completed in the brief span of a single century.

The ecologic investigation of the Big Bend area was carried out principally by means of transects to determine the successional relations of the various communities from the Texas to the Oklahoma bluff, and by means of ring-counts of the trees scattered over the floor of the valley. The species were listed along each transect in accordance with their importance and then grouped in tables to facilitate comparison between the various localities. This not only rendered possible a complete outline of the development of the climax association in the region, but also afforded a definite comparative basis for the age of different portions of the valley in terms of the climax on the bluffs at either side. Of striking value is the analysis of the cottonwood stage in the succession and its indications for the age of the area occupied. The results of the serial study are in entire accord with those obtained by the reviewer for the dune areas of the river valleys of Oklahoma and of other rivers in the semi-arid and arid regions.

Ring-counts were made of 31 trees of various species which grew scattered over the valley floor. These were chiefly elm and cottonwood, with occasional pecan, ash, hackberry, etc. A third of the individuals gave ages ranging from 100 to 175 years and thus established beyond question the minimum age of the greater portion of the valley as considerably beyond one hundred years.

The results of the ecologic investigation are summarized as follows: The climax stage of the vegetation for the Big Bend region is the short-grass plains modification of the mixed prairie association.

The treeless portions of the valley have virtually reached the climax stage, as is indicated by comparing their vegetation with that of the bluffs on both sides of the river.

While the length of time required for a given area to pass from the initial stage to the climax can not be definitely stated in years, there is much evidence to support the view that it must take at least several hundred years, for example:

(1) Upon a tract on the Oklahoma side above Granfield Bridge, which in its oldest portion must have exceeded 100 years, only ten climax dominants had become established.

(2) At the southernmost limit of the cottonwood savannah, estimated to be more than 150 years of age, only five of a total of 18 climax dominants noted for the valley in this area had appeared.

(3) Using the cottonwood savannah as a basis for judgment, it seems entirely conservative to estimate 150 years as the minimum time required for the cottonwood stage to pass from initiation to extinction.

(4) There is no evidence of closer correlation between the age of the oldest trees in the valley and the maximum age of the soils that support them than there is between the ages of the trees and soils of the uplands along the river.

The conclusion from the studies of the life-history of the Red River is that the alleged islands, as the windrow-like fringing dunes were considered, are not islands at all but land-made features built on the valley-floor at times when a wide strip of flood-plain existed between channel and bench. Therefore, they have never been islands, and there is no ground for the assumption that the valley has been formed by a process of island building.

The maps that accompany the report are of a uniform excellence, and leave nothing to be desired in the matter of scale, execution or detail. From the standpoint of the ecologist they may be regarded as model base-maps for accurate quantitative work in succession.

The ability of the court to weigh scientific evidence accurately and to discriminate between presumption and proof is clearly shown by the following excerpts from the text of the decision:

> The valley land has always been dealt with as upland. . . . Through the long period covered by this course of action there never was any suggestion that this valley land was part of the river bed, nor that the shifting elevations of sand within the sand bed were the river's banks, nor that the land on the south side belonged to the United States. Not until some land on the south side and part of the river bed were discovered to be valuable for oil was this unbroken course of action and opinion drawn in question. However much the oil discovery may affect values, it has no bearing on the questions of boundary and title.
>
> The boundary as it was in 1821, when the treaty became effective, is the boundary of to-day, subject to the right application of the doctrines of erosion and accretion and of avulsion to any intervening changes.
>
> There are no surveys or records depicting the situation in 1821; nor are there any human witnesses who knew this part of the river then. But there are inanimate witnesses, such as old trees, which tell a good deal. At that place the river makes a pronounced but gradual bend to the north and back to the south. The area in question is on the inner side of the bend. It is larger now than 60 years ago, but how much is uncertain. The enlargement is the result of intervening accretions. The habit of the river is to erode the outer bank of a bend and to accrete to the opposite bank. . . . On the outer part are physical evidences of the formation being comparatively recent. On the inner part are like evidences of the formation being old, among them being the presence of living trees more than a century old. One of the trees,

a pecan, attained an age of 170 years. . . . To overcome the inference arising from the presence of the old trees, which were well scattered, testimony was presented to show that in 1821 these trees were all on islands, which afterwards were consolidated amongst themselves and with the lands on the south side. We think this testimony is essentially speculative and not a proper basis for judgment. In this area, as elsewhere in the valley, a succession of depressions is found at the foot of the bluffs and some testimony was produced to show that in 1821 the river, or a part of it, flowed there. It may be that the river was there long ago, but the testimony that it was there in 1821 is far from convincing. Our conclusion is that the claim that the river, or any part of it, ran south of this area in 1821 is not sustained. So the boundary follows the cut bank around the northerly limit of the area.

The perusal of the thousands of pages of testimony leads to the conviction that scientific experts should be appointed by the court and not employed by the litigants. This fact has already been emphasized by one of the scientists concerned (*Geog. Rev.*, 13: 188), who points out that the present practice fosters bias and discounts the spirit of scientific research (*cf.* also SCIENCE, 45: 147, 292). Indeed, it would seem that such cases as the present should not be matters of court procedure at all, but should be left to the decision of a disinterested scientific commission.

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SPECIAL ARTICLES

THE CHROMOSOME COMPLEXES IN THE SOMATIC CELLS OF MALE AND FEMALE OF THE DOMESTIC CHICKEN

IN publishing the rough notes and drawings of the late Miss Stevens on the spermatogenesis of the domestic fowl, Miss Alice Boring points to the insufficiency of our knowledge of the chromosome complex of birds. This state of affairs, together with the intensive work on the genetics of fowl which has been going at the Anikovo Genetical Station of the Moscow Institute of Experimental Biology, induced Professor N. K. Koltzoff to offer this theme to me for further investigation. This work began in the summer of 1922 and was conducted on embryological material, as well as on the testicles of young and adult cocks. Last summer I also investigated some other birds of the family *Passeres*.

Some fundamental results of my investigation had already been reported at the conference of the Anikovo station last June and published as a footnote in the Russian translation of T. H. Morgan's "Physical Basis of Heredity," and the drawings of the chromosome complex of the fowl were amongst the other exhibits of the Anikovo station at the Russian Agricultural Exhibition (inaugurated on August 15), when Number 1491 of SCIENCE (of July 27, 1923) with the stimulating article of Miss Boring came to my hands. The following discoveries confirm some results of Miss Stevens and contain also some quite new facts.

The fundamental results of my investigation can be briefly summed up in the following points:

(1) The somatic complex of chromosomes in fowl of the same sex is characterized by a complete uniformity in all tissues of the embryo.

(2) The chromosome complex consists of chromosomes of very different lengths, whereas the thickness of all chromosomes when properly fixed and colored is quite the same and is nearly equal to 0.5 μ. The shortest are from one fifth to one sixth the length of the longest, which may attain nearly 3 μ (see the chromosomes X, x, B and b in the given drawings). The ordinary form of the chromosomes in the somatic cells is rod-shaped. One may see that any windings, which are to be observed in the longest chromosomes in the equatorial plates, should disappear in the metakinesis stage, when all chromosomes become straight.

(3) In the equatorial plate, at first, when the chromosomes are lying very near one another, they have a very regular and constant position. Their disposition is very characteristic, the longer ones lying outside and the smaller ones inside, as has been shown also by Miss Stevens in her drawings (Figs. 1 and 2). The elements of the outer circle lie in a more or less radial arrangement. Moreover, a very essential circumstance appears here, namely, that the long chromosomes have a tendency to a symmetrical disposition, every long chromosome on the right having its homologue on the left; this is to be particularly noticed in the early equatorial plates and likewise in the daughter plates in the males. This makes the pairs easier to find, especially in the case of the long chromosomes of the outer circle. In figures 1 and 2 the paired chromosomes of the right are designated by letters, A, B, C, and those of the left by small ones, a, b, c. A detailed study of the chromosome complexes of the male and the female lead me to designate these pairs with signs different from those given in Miss Boring's drawings.

(4) The constancy and symmetry of position of the chromosomes may also be observed in some degree in the pachytene spireme, which after the dissolution of the nuclear membrane spreads very regularly like a parachute, whose meridional ribs are lying like the long chromosomes of the outer circle.

(5) In consequence of the small size and comparatively large number of chromosomes in the fowl it is difficult to count them precisely. I have tried, however, to count the chromosomes in many mother and