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R. Ellsworth Call

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recollections of my boyhood days are too indefinite to be certain.

These general notes were followed by a register of the species observed in which were given notes on size, abundance, distribution, variations and other facts of observation. The total number of species on which data were obtained were about eighty, the oaks being the most important economically. The botanical relations of the area need a thorough sifting and promise a rich field to whoever shall undertake the study.

ON THE GEOLOGY OF EASTERN ARKANSAS.

BY PROF. R. ELLSWORTH CALL.

(*Abstract.*)

This paper was a continuation and extension of the one presented at the meeting of 1888, and like it was based on the field work done under the auspices of the Arkansas Geological survey. The area studied was much more extensive than that reported on in the preceding year.

The general region examined is all that portion of the State which lies east of the St. Louis, Iron Mountain and Southern Railroad and north of the Arkansas River. The region particularly examined extends from Helena north to the Missouri State line, included a particular study of the geological formations seen in Crowley's Ridge and sought to connect these terranes with those of similar age in other portions of the State. The more obvious facts gleaned during the field investigations are the following:

The eastern half of the State of Arkansas is included within an area which, until comparatively recent geological time, was entirely submerged under a northward extension of the Gulf of Mexico. Reaching away southwestward from near the mouth of the Ohio River, in a nearly direct line, this old

gulf found a western limit at the palæozoic escarpment which is approximately, if not exactly, indicated in the state of Arkansas by the railway line above named. From Newport southwards to near Little Rock, the strata composing the oldest series of tertiary rocks—to which series the subjacent strata throughout this area belong—lie unconformably upon carboniferous shales and sandstones. At and about Little Rock these same strata lie in direct relation to slates of possibly similar geologic age and also to crystalline rocks of uncertain age. Southwestward from the capital of the State to near Arkadelphia and onwards to the State line near Texarkana the strata lie conformably upon rocks of cretaceous age. So gradual is the change in the macroscopic and lithologic characters of the rocks along the Ouachita at Arkadelphia that the line of demarkation between the cretaceous and tertiary cannot possibly be drawn. Here, if anywhere in the State, is to be seen absolute conformity both in stratigraphic and chronologic sequence.

No effort has been made herein to correlate the various subdivisions of the tertiary in this State with the divisions recognized by other observers. Such correlation would be premature, and would be authentic only after very extended and careful observations on the whole tertiary area of the State, while as above noted our observations have been somewhat limited in respect to area. It must suffice to say that the study made shows that the tertiary series included within the scope of this report belong to the eo-lignitic of recent writers and that possibly the Jacksonian group, now considered to attain its most northern extension at Helena, in Phillips County, outcrops in the southwestern portion of Clay County, that is, must be extended northward more than one hundred and forty miles.

One other general conclusion is here deserving of mention, viz: Whatever distinctions or divisions are, in the future,

to be recognized within this area must be based upon stratigraphic and petrographic rather than upon paleontologic data. The paucity of fossil remains in all fossiliferous divisions, except in that which is tentatively, herein, denominated the *Ostrea* bed, and the absolute dearth of such remains in most of the strata lithologically recognized as Eocene tertiary precludes a classification based upon their faunal contents. As has been above indicated the facies of the fauna which has been collected and studied appears to necessitate the correlation of the lowest beds with the Claibornian.

To sum up the stratigraphic or geologic history of Crowley's Ridge and with it that of the region of which it forms a considerable topographic feature it may be said that the ridge is the remains of a former extensive plateau, the western limit of which was the palæozoic scarp of middle Arkansas, as noted above. That erosion occurred from the west, by the waters which are now represented by the White River and other streams, to which, nearly at the northern boundary of the State, the Mississippi added enormous volumes of water, either continuously or periodically. These did their work so completely that the whole of the country between Crowley's Ridge and the palæozoic rocks on the west has been lowered and carried away except where a few unimportant secondary ridges, such as that at Augusta, in Woodruff County, remain to bear witness to the past former height of the whole country. To the eastward the Mississippi was engaged likewise in the work of destruction and denudation, ploughing out an immense trough to which the present Mississippi bed is but the merest pigmy. But while it dug its valley wider it also dug it deeper. Nor has the refilling which for centuries has been occurring yet brought the eastern level up to that west of Crowley's Ridge. During the progress of denudation, the whole southern basin of the Mississippi was slowly sinking, the gulf traveled northwards, until Crowley's Ridge became

entirely submerged while the silt laden waters which came slowly flowing from the north deposited their burdens as the great blanket of loess the remains of which caps it throughout nearly its entire length. Then came the time of continental resurrection since which periods the rivers and their tributary creeks and brooks aided by frost, wind and rain, have recommenced the work of destruction, the task of the removal of Crowley's Ridge.

The surface soils of the region are roughly divisible into two groups, each one of which maintains well its chief features in all sections. To the east of the ridge and in the valley of the L'Anguille the surface soil is a rich black loam, such as is usually found on lands subject to overflow and which may stand as the type of the first group. The cultivable soils in the St. Francis-Mississippi bottoms are deeper and richer than any other locality, but they are limited to, comparatively speaking, small areas and these are ridge-like in their distribution. In the L'Anguille bottom the area of black loamy soil is not only a minimum but is also less in depth, rarely exceeding two or three feet at most. This group of soils on both sides of the ridge is remarkably productive, but, since they are in both sections underlaid—generally on the west but only locally so on the east of the ridge—with a limonitic clay or "buckshot" hardpan which in many places comes quite to the surface they have a defective drainage. While these lands produce abundantly certain cereals, such as oats and less abundantly corn, they give but light yields of the staple of the region which in common with all the south is cotton. The yield of this product is usually about one-half bale to the acre.

The ridge soils are the type of group two and are the least adapted for cultivation profitably. They are usually light colored, reddish or yellow predominating, and always more or less sandy, though in many localities they are stiff with

abundant clay. Wherever the native dense grasses or other vegetation is removed the soils wash badly and since the slopes of the ridge are precipitous soon very large gullies are formed, which in time grow into extensive ravines or even deep canon-like embayments. Nevertheless these soils yield a far return to careful husbandry, but are liable to speedy exhaustion, a condition due to the generally prevalent method of farming, a method which does not contemplate rotation of crops as one of its leading principles. These soils will prove permanently valuable only through the greatest care and a complete change in the methods of culture now in vogue.

To the second group of soils belong, also, all those lands which lie along the slopes of the ridge, on both sides, the western of which are, however, by far the most extensive. These soils are the products of erosion and are largely composed of the lœssian clays which cap the ridge. They are generally mingled with much sand and occasional pebbles from the generally distributed orange sands. They are generally deficient in lime, though this deficiency could be easily remedied by the use of the extensive beds of calcareous marls which are found in some portions of the eastern part of the State, notably in St. Francis County.

With a view to the determination of the value of certain of these soils for agricultural purposes the chemist of the survey, Dr. R. N. Brackett, has made such analyses as are usual in determining the actual value as far as this can be decided by the chemical study of the soil. A chemical analysis in itself, however, does not represent a verdict definitive of the value of a soil for farming purposes. Soils are very complex, the major portions of the elements entering into their constitution are very small in quantities, and their fertility is dependent somewhat on the rate and completeness of the decomposition to which the mineral elements are subject. The analysis then decides nothing as to its agricultural value save

within rather narrow limits. But it may decide (a) the absence of some important element or (b) the presence of some element deleterious to plant growth. Analysis of the soils of the region, it may be said generally, show that its cultivable area is composed of a soil containing plant food in fair abundance and in a tolerably soluble condition; that its chief deficiency is lime and available phosphoric acid; that the ridge soils are easily tilled and thrifty when new but possess little durability; that, for the future as now, the best farming lands will be those that lie along the gentle slopes of the ridge. In this brief estimate, of course, the rich alluvium of the overflowed regions is not considered, for from the presence of abundant decomposing and decomposed organic matter, as well as because of constant additions of fine soil from other regions, this quality of land is always fertile and easily tillable.

There are no economic products of a distinctively geologic character to be found in northeastern Arkansas. There are no ores nor are there any deposits of coal. Its abundant lignite is unavailable for fuel, first, because it is a rather poor variety of brown lignite, with much hygroscopic moisture and comparatively little volatile matter and a minimum of fixed carbon, and second, because its stratigraphic relations to overlying and underlying soft clays are such as to render its mining difficult and expensive.

BEGGIATOA ALBA AND THE DYING OF FISH IN IOWA.

BY PROF. L. H. PANMEL.

(Abstract.)

The secretary of the State Board of Health found fish dying in great numbers at Tama City, Marshalltown and Des Moines. The odor after the removal of ice was very disgusting, partly due to the decomposition of dead fish and other