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The Indiana of Nature: Its Evolution.

By W. S. Blatchley.

Afar out in the limitless realms of space a planet moves—propelled onward by an unseen, uncontrollable force around its parent orb, a sun. For millions, perhaps billions, of years, as man counts time, that planet has moved in the same pathway, meanwhile undergoing most wonderful changes in bulk and form. At first a vast, irregular mass of burning, gaseous matter, thrown off from that sun about which it still revolves, the planet gradually cooled, condensed, and assumed a spheroidal form. Its gaseous elements rearranged themselves to form new compounds, at first liquid, then solid, until in time it came to be a solid globe, or at least one with a solid but uneven crust. The processes of cooling and contraction still continued. The ocean of vapor which formed a large portion of the atmosphere about the planet condensed and fell and formed an ocean of water which filled the depressions in its crust. Above the rim of this ocean there showed in places large areas of land—bare igneous rock, absolutely devoid of life—as, for millions of years, the temperature of both rock and ocean remained too high for living things.

When the mean temperature of its oceanic waters by continued and oft repeated evaporation, cooling and condensation, was reduced to about 150° (degrees) F., there occurred the grandest event in the history of that planet. *In some unknown, unknowable manner, Life came to be.* Within the waters of its ocean there was brought about a combination of matter—a living thing—which could take from the water and from the air above certain elements, and by their aid increase in size and reproduce its kind. The first lowly parasites upon the face or surface of the planet were thus aquatic plants—algæ, fungi and kindred forms. In the course of ages there evolved from them other and higher plants which could live on land; for the decay and erosion of the igneous rocks, added to the remains of the aquatic plants thrown upon the beaches of the ocean, produced a soil from which the higher land plants could derive a part of their nourishment. As the centuries and the æons rolled by, the plants—true parasites that they were—found their way to every part of the planet's

surface. Onto the tops of the loftiest mountains, into the abysses of the deepest oceans, they made their way; their province being the conversion of inorganic matter—earth, air, water—into a form of food suitable to the needs of a higher type of parasite which meanwhile was coming into existence upon the planet's surface. For, as the temperature of the ocean gradually decreased, the Era of Animal Life was ushered in.

The first animals on the planet were also lowly aquatic forms—scarcely differing from the first plants, but possessing a freedom of motion which enabled them to procure a better supply of air and water. Then, evolving into higher and more varied forms as they became adapted to new environments, they spread far and wide through ocean's depths and over plain and mountain, until the whole surface of the planet was peopled, too, by them. But, ever and always, from the time the first animal came to be upon that planet, until the last one finally disappears into the darkness of everlasting night, the *growth* of animal life will depend upon *living food* prepared by the plant—the *motion* of animal life upon *energy* stored within the cells of the plant.

That sun, which in the beginning first cast off the matter of which the planet is formed, still controls it—still rules over it and its destinies with an iron will. Both plant and animal parasite must forever bow before its power. Of the vast floods of energy which stream forth from that sun's disk, in the form of heat and light, an insignificant fraction falls upon the surface of its satellite. Of the minute portion that the planet thus arrests, an equally insignificant part is caught up by its plants and used directly in their growth. Yet the entire productive force of the living portion of that planet turns on this insignificant fraction of an insignificant fraction.

The vegetable cell is thus a storer of power—a reservoir of force. It mediates between the sun—the sole fountain of energy—and the animal life on the planet. The animal can not use an iota of power that some time, either directly or indirectly, has not been stored in the plant cell. Thus, of the two great groups of parasites upon the surface of the planet, the plant must, perforce, have preceded the animal.

For thousands of centuries each type of animal and plant parasite upon that planet was content if it could secure food enough to reach maturity and then a mate to reproduce its kind. All the energies put forth —all the variations in organ and form—all the adaptations to modified environment—were but means toward the better accomplishment of these

two ends. Sometimes a type would reach a culmination or highest point, beyond which it could not advance. Then a degeneration would occur along side lines, or, in many instances, even total extinction of the race or group. Finally, after the planet was hoary with age, a race of animal parasites evolved from the lower forms, whose variations were ever concentrated toward the head or cephalic region. During untold ages their brains slowly but surely increased in size until, in time, they became possessed of the power of reason and of abstract thought. In that age the "prince of parasites" was born. From then on he began to rule not only the other animal and plant parasites about him, but to discover and control the powerful forces of nature, heretofore wholly latent. As he grew in brain power, he grew in greed, in egoism. He came to think that the planet, on which he was but a parasite, was created for him alone; that all other plants and animals were put there for his especial benefit, though many of them out-dated him by millions of years. He began to modify the surface of the planet in all ways possible—to change, as it were, its every aspect to conform to his ideas. He imagined, vain creature that he was, that he could improve upon the works of Nature. In time he divided up the entire land surface of the planet by using sometimes imaginary lines and again natural boundaries. Acres and sections, townships and counties, states and republics, kingdoms and empires were the terms he used to denote his subdivisions, and over all lands, and even seas, he proclaimed himself chief ruler. For that planet is the earth. That "prince of parasites" is Man.

To 36,350 square miles of the earth's surface, lying between the imaginary lines 37° 41′ and 41° 46′ north latitude, and between 84° 44′ and 88° 6′ west longitude, man, in time, gave the name "Indiana." How came this area to be where it is? Of what kind of matter is its surface composed? What was its condition at the time of the advent of the white race? These are questions which should be of interest to every resident of the Hoosier State.

The oldest known rocks on the American continent are those of Archæan Time laid down during the Azoic or lifeless æon of the earth. They are known as the Laurentian System of Rocks and consist mainly of coarse granites, thick-bedded gneisses and syenites, serpentines, schists and beds of modified sandstones, limestones and clays. They were formed from the debris of other rocks still older than themselves; these in their turn having been derived ages ago from those original igneous or

primary rocks whose molten sands rose first above the boiling floods and cooled and crusted into a chaotic continent. For Archæan time comprised those millions of years which elapsed while the crust of the earth was cooling down to a point where life was possible.

The Laurentian rocks are thus devoid of fossils or contain only the remains of the simplest aquatic forms. In North America they comprise the surface of a vast, V-shaped area of 2,000,000 or more square miles which lies, filled with wild lakes, pine clad, rugged, almost impassable, spread in savage sleep from Labrador to the Arctic Ocean. This area embodies the general form of the North American continent and was the nucleus of all the land which was afterward added to it. From these old Laurentian rocks came the debris and sediment which was laid down in the bed of a shallow ocean to form the first rocks comprising the surface of what is now "Indiana."

At the close of the Azoic or Lifeless æon, during which the Laurentian rocks were formed, the Paleozoic or "Æon of Ancient Life" was ushered in. At its beginning the entire area of what is now known as Indiana was covered by a broad ocean which stretched far away to the southwest, while to the north and northeast it extended beyond the present sites of the Great Lakes. This ocean is known to geologists as the "Interior Paleozoic Sea." Into it was carried the sediment derived from the erosion and destruction of the old Laurentian rocks by water and air, which agencies then, as now, were ever at work. The Potsdam sandstone of the Cambrian era, which probably underlies the Trenton limestone of the Lower Silurian beneath the greater portion, if not all, of Indiana, was one of the first strata to be laid down in this sea. But as none of the surface of Indiana is represented by the Potsdam stone, it will be passed with this mere mention.

Following the Cambrian came the second grand sub-division of Paleozoic Time, the so-called Lower Silurian or Ordovician Age. At its beginning the sea covering Indiana and the area to the north and east was of course more shallow, as 1,000 feet or more of Potsdam sandstone had been deposited on its floor. The first great stratum of Ordovician rock to be laid down in this sea which is of interest to us was the Trenton limestone, which, during the past two decades, has become so noted in Indiana as the source of natural gas and crude petroleum.

It is a well known geological fact that most, if not all, limestones owe their origin to the presence of minute organisms in the water in which

the limestone was formed. The animals from whose remains the Trenton limestone was, for the most part, derived, were probably very low forms —the polyps and bryozoans of the ancient Silurian seas. In untold numbers they existed, and the carbonate of lime, which makes up 80 per cent. of the unmodified Trenton rock, is largely the remains of their secretions and incrustations. Associated with these lower forms were myriads of higher ones—crinoids, brachiopods, trilobites, gastropods and even fishes. The presence of such swarms of animal life made necessary the existence of an abundance of plants; since the plant must ever precede the animal and gather for the latter the energy, and form for it the food—the living protoplasm—necessary to its existence. These plants were mostly marine algae or seaweeds and fucoids, though doubtless many other forms existed of which no remains have been preserved in the rocks of that age.

The Trenton limestones were evidently formed in rather clear waters, at moderate depths. Near the bottoms of these shallow seas great beds of calcareous sediment were gradually collected, and were swept to and fro by the tides and currents. Rivers from the older Cambrian rocks brought down their eroded particles and added to the thickness of the ocean floor. Within these beds of sediment both plants and animals found a grave—their bodies in vast numbers being buried beneath the slowly accumulating deposits of centuries. Once buried in such deposits, they did not decay, as do animals on land, because by the waters above and the calcareous ooze around them, they were shut off from free oxygen, which is the chief agent in decay. Gradually this ooze or fine sediment was, by the agency of the sea water, cemented and consolidated into limestone. In this manner that great layer of Trenton rock which underlies at variable depths the whole of Indiana, was formed. From it has been derived, directly or indirectly, more wealth than from any other one formation, either underlying or forming a portion of the surface of the State.

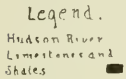
In time the waters of the ocean containing this vast stratum of Trenton limestone, with its enclosed accumulations of undecayed plants and animals, became turbid, and instead of calcareous sediment, deposited mud and clayey sediment in thick beds on top of the limestone strata. These deposits of mud and silt were afterward, by later deposits, compressed into the fine-grained, impervious Utica shale, 100 to 300 feet in thickness, which thus effectually sealed the Trenton limestones and so

retained within them the oil and gas derived from their enclosed organic remains. This oil, and its more volatile portion, the natural gas, was not formed in a short time, but is the result of a slow decomposition or destructive distillation, carried on through thousands of centuries. Accumulating in vast reservoirs—the more porous portions of the Trenton limestone or mother rock—it there remained until man came with his iron drill and furnished a vent through which it could rise. Then by combustion he caused it to yield up the stored energy, conserved since the sun's rays fell on the plants of the old Silurian seas.

After the Utica shale had been laid down as a thick, impervious cover above the Trenton limestone, there followed the Hudson River epoch during which 200 to 600 feet of alternating beds of shale and limestone were deposited in the old sea bottom where now is Indiana. These form the uppermost division of the Lower Silurian age. During the myriads of years necessary to their deposition marine forms were excessively abundant and the advancement in the scale of animal life was correspondingly great. All the principal groups of marine invertebrates which came into existence during the Trenton epoch were represented, but the species were widely different. In addition to life in the sea, there came also to be life on land. Acrogenous plants—forerunners of the ferns and mosses—harbingers of the vast forests of future centuries—came into being along the moist waterways of the growing continent, while insects, the first winged creatures, began to traverse the air.

As yet no part of Indiana was above old ocean's level, but at the close of the Ordovician, after the Hudson River limestones and shales had been laid down, a great upheaval, caused by some subterranean force, brought above the sea a large island of Ordovician rock which ever since has been dry land. This upheaval was greatest over the point where Cincinnati, Ohio, is now located, and the "Cincinnati Uplift" is the name given by geologists to the island and the broad belt of shallowly submerged land which extended from its northern shore in a northwesterly direction, diagonally across the area of the future Indiana. The main portion of that island comprised the southwestern corner of what is now Ohio and a part of northeastern Kentucky. It also included a small part of what is now Indiana and formed the first and oldest portion of the surface of our State. The area whose surface rocks belong to this Hudson River formation comprises part or all of Wayne, Union, Fayette, Franklin, Dearborn, Ripley, Ohio, Switzerland and Jefferson counties.

Over this area the exposed rocks are composed of a series of bluish, thin-bedded limestones intercalated with bluish-green limey shales, while at the top are massive sandy limestone beds of a brownish color The shales are soft, easily weathered and very fossiliferous, while the bluish lime-



stones are in places largely composed of fossils. As a part of an island, therefore, upheaved from the Ordovician seas, was the first born land of Indiana; and to that little corner all other portions of our noble State were added in their turn by the workings of nature's forces during after ages.

At the end of the Ordovician or beginning of the Upper Silurian age, the Interior Paleozoic Sea had greatly diminished in area. A broad belt of land had been added to the southern border of the old Laurentian crest, especially over what is now Wisconsin and a portion of northern Illinois; while, extending from what is now Labrador down to Georgia, was another broad belt, following the general trend of the present Alleghany mountains. By the raising of several large islands above its surface at the time of the Cincinnati Uplift, aided by the broad belt of shallowly submerged land already noted, the area of the Interior Sea was still further diminished and to that portion covering what is now the northeastern part of Indiana and the greater part of Ohio, West Virginia, New York and Pennsylvania, the name of "Eastern Interior Sea" is given. This was simply a great bay or eastward extension of a greater "Central Interior Sea" which, at that period, covered most of Indiana, southern Michigan, Illinois and a large portion of the present United States west of the Mississippi River. The most northeastern limits of the Eastern Interior Sea were the present sites of Albany and Troy, New York. The rock-making material which was deposited on the floor of both it and the Central Interior Sea was derived in part from the land along their borders, but mainly from the limey secretions of the life within their waters. The dry land draining into them was small in area and hence there were only small streams for the supply of sediments. Yet, in the course of countless years, sufficient material was deposited to form the thick layer of Niagara limestone which now forms the surface rock over much of northern and eastern Indiana.

The epochs of the Upper Silurian age, as represented in Indiana, are three in number, viz., the Clinton, the Niagara and the Water Lime, or Lower Helderberg. Each is represented by its characteristic rocks, bearing the peculiar fossils of its time. The Clinton epoch is represented in the State by a close-grained, salmon-colored limestone, varying in thickness from a few inches only to about seven feet. It outcrops in a very narrow strip along the western edge of the area of the Hudson River limestone, already mentioned as the oldest rock in Indiana, and overlies that formation beneath the surface of at least the eastern third of the State. It has no economic importance and serves only as a line of demarcation separating the older Silurian rocks from those great beds of Niagara limestone which were afterward laid down in the Upper Silurian seas.

At the beginning of the Niagara epoch the waters of the Central and Eastern Interior Seas were laden with sediment and beds of bluish-green shales, known as the Niagara shales, and varying in thickness from two to forty feet, were first laid down. Owing to gradual changes in the level of the sea bottom, and a consequent shifting of its tides and currents a clearer, deeper water then resulted, within whose depths there existed life of great variety. Corals and bryozoans were especially represented, and from their remains and those of other marine forms were gradually constructed those beds of gray and buff Niagara limestone, varying in thickness from 100 feet along the Ohio River to 440 feet in the northern and northwestern portions of the State.

Near the close of the Niagara epoch a gradual uprising of a portion of the Eastern and Central Interior Seas took place. From their bottoms there emerged a long peninsula-like strip of land, whose general trend was northwest and southeast. In the former direction it was imperfectly attached to those portions of Wisconsin and Illinois which had come into existence during the Ordovician era. At its lower extremity it merged with that old island of the Cincinnati Uplift which had formed the first land of our present State. The surface rocks of the northwestern corner of Indiana, a narrow and probably interrupted strip extending diagonally across the State, a wide area in the central third and a narrower southern prolongation along the western border of the pre-existing Hudson River group, were thus, for the first time, brought above the level of the sea.

It appears that the force which caused this upraising of the Niagara sea floor was more pronounced at certain points than at others, and so caused a number of dome-like ridges or crests resembling true upheavals in the Niagara beds. These domes are present in an area extending from the Illinois line in Newton County, through the Upper Wabash Valley nearly to the Ohio line, being especially prominent near Wabash, Delphi, Monon, Kentland and other points in the region mentioned. In them the Niagara strata, elsewhere nearly horizontal, are strongly tilted and show other evidence of a true upheaval. These domes were at first probably small islands whose crests remained permanently above the surrounding sea. They thus formed, for a long period, a more or less broken or interrupted connection between the larger area of the Niagara to the southeast and that area in northwestern Indiana which was from now on a part of the continent proper.

The Water Lime and Lower Helderberg are two closely related limestones of the Upper Silurian age which, in Indiana, so merge as to be difficult to distinguish. They represent an epoch between that of the Niagara limestone and the lowest or oldest rocks of the Devonian era.

Their texture and composition shows them to have been laid down in very shallow seas close into the shores of the recently upraised Niagara limestone. The Water Lime is an impure magnesian hydraulic rock, ranging in thickness in Indiana from 20 to 90 feet. It outcrops near Kokomo

where have been found numerous fine examples of its most characteristic fossils—gigantic crustaceans, two feet or more in length, closely related to the king crabs of the present seas. Over the extensive mud flats of the closing period of Upper Silurian time they were the undoubted rulers, while in the nearby waters sported descendents of those mail-clad fishes which first appeared in the Trenton period of the Lower Silurian era.

The Lower Helderberg represents the final epoch of Upper Silurian time. In Indiana its rocks form a buff to gray cherty limestone, 25 to 250 feet in thickness and often irregular and uneven in its bedding. It directly overlies the Niagara limestone where the Water Lime is absent. Outcrops occur at Logansport and other points to the northwest, and drill holes sunk for oil and gas show that it probably forms a portion of the surface rock beneath the deep drift-covered area of the northern third of the State.

The advance in life during the Upper Silurian era was not proportionally as great as that of the preceding age. The earliest of Arachnids, the scorpions, came to be, their first remains being in the Water Lime, showing that they were neighbors of the giant Eurypterid crustaceans. Cockroaches and progenitors of dragonflies were also present, but remains of other terrestrial forms are few or lacking. Among marine invertebrates, Cephalopods reached the acme of their development, the gigantic Orthoceratites of this group, whose remains are so common in the Niagara limestones of Wabash and adjoining counties, being worthy of especial mention.

We have seen that by the beginning of the Devonian Age or Era, which succeeded that of the Upper Silurian, the waters of that great bay known as the Eastern Interior Sea, had become farther separated from those of the Central Interior Sea by the uprising of the Niagara limestone area of eastern Indiana and western Ohio, and also by the deposition along the margin of this formation of the sediment comprising the Water Lime and Lower Helderberg limestones. A probable connection still existed between the waters of these two basins across the broken or interrupted strip connecting the main body of Niagara limestone in eastern Indiana with the main land area of the same formation in northwestern Indiana and northern Illinois.

The Devonian rocks of Indiana may be roughly classed as representing two great epochs, the Corniferous and the Genesee, the former being represented by beds of more or less pure limestone, ranging up to 55

feet in thickness; the latter by beds of black or brownish bituminous shales, which reach a known maximum thickness of 195 feet. The waters in which the materials of the Corniferous limestone were deposited were clear and comparatively pure, and in them sponges, corals, crinoids, trilobites and lower animal forms existed in great profusion. From the lime secreted by these marine forms the upper and purer beds of the Corniferous rock are mainly composed. The great abundance of coral life during the period is grandly shown at the Falls of the Ohio, opposite Louisville, Kentucky, where the Corniferous beds have a notable outcrop. Here "the corals are crowded together in great numbers, some standing as they grew, others lying in fragments, as they were broken and heaped up by the waves; branching forms of large and small size being mingled with massive kinds of hemispherical and other shapes. Some of the cup corals are six or seven inches across at the top, indicating a coral animal seven or eight inches in diameter. Hemispherical compound corals occur, five or six feet in diameter. The various coral-polyps of the era had, beyond doubt, bright and varied coloring like those of the existing tropics; and the reefs formed therefore a brilliant and almost interminable flower garden."

Near the close of the Corniferous epoch deposits of silt, mud and sand began to becloud the clear waters and put an end to the life of many marine forms. The upper beds of rock then laid down, known as the Hamilton, contain in places quite a percentage of magnesia and clay, and embody those vast deposits of hydraulic limestone which, in southern Indiana, have been so extensively used in making natural rock cement.

The Corniferous rock, when raised above the surface and added to the pre-existing land of the State, formed along the western margin of the latter an irregular strip 5 to 40 miles in width, extending from the present bed of the Ohio River at Jeffersonville northward to the present sites of Logansport and Monticello. North of the Wabash it has been found to be the surface rock in a number of the deep bores sunk for oil, but on account of the thick mantle of overlying drift, its exact limits are unknown. It is probable, however, that at the close of the Corniferous epoch a strip 20 miles or more in average width and extending nearly across the State was, in this region, raised above the floor of the old Devonian sea, to become a part of the permanent land of the future State.

During the latter part of the Devonian Era those lowly acrogenous plants known as Rhizocarps flourished in vast numbers in the fresh waters and brackish marshes of the time, and their spores by countless millions of tons were carried out as sediment into the surrounding seas. Mingling with the mud and silt and sand, brought down by erosion from the rapidly increasing land surface, they formed those vast mud flats which have since, by age and pressure, been consolidated into the thick beds of brown and black, finely-laminated shales which form the rocks of the Genesee epoch in Indiana. At New Albany the outcrops of this shale are 104 feet in thickness and especially prominent, so that the local name, "New Albany black shale," has been given it by geologists of the State. Along the western edge of the Corniferous limestone this shale forms a continuous strip, 3 to 35 miles in width, reaching from the present site of New Albany north and northwesterly to Delphi and Rensselaer. Over much of this strip it is covered by a thick mantle of drift, but everywhere within the area wells or the eroding streams have proven it to be the surface rock. The black shale has also, by deep bores, been found to be the rock immediately underlying the drift over much of the area embraced within the two northern tiers of counties in the State.

The Genesee shale is rich in bitumens, derived from the spores of the ancient Rhizocarps, which also gave it color. When kindled, it will burn until they are consumed, and it is therefore, by the uninitiated, often mistaken for coal. These bitumens are, by natural processes, sometimes separated from the shale and in the form of gas or petroleum are collected in reservoirs in it or in the underlying Corniferous limestone.

During the thousands of centuries of the Devonian Period, a great advancement took place in the flora and fauna of the times, especially in the vegetation of the land and the development of the higher aquatic vertebrates. Among the acrogens growing on land, ground pines, tree ferns and equiseta or horse-tails came into existence and flourished in vast numbers. Their remains are often found in the Corniferous limestone, into the sediment of which they were drifted and preserved. The first Phanerogams, conifers of the yew and cycad families, were also evolved, their leaves and branches being found in the upper or Hamilton beds of the Corniferous epoch. As the land plants increased in number and variety, insect life became more varied and numerous.

Mayflies abounded and the first musicians of the earth appeared in the form of Orthopterans which, by means of their shrilling organs, enlivened the solitudes of the strange old Devonian forests with their love calls and wooing notes. Among fishes, the Ganoids and Selachians,

of which our gar-pikes, sturgeons and sharks are degenerate descendants, reached the acme of their development; while gigantic species of Dipnoans or lung-fishes, now only represented by the dog-fish or "John A. Grindle," abounded in the bays and bayous about the ancient Genesee flats.

At the beginning of the Lower or Sub-Carboniferous Era, which followed the Devonian in regular sequence, we find more than half of Indiana above the level of the sea. By the deposition and subsequent raising of the rocks of the Corniferous and Genesee epochs, the gap between the large area of Niagara limestone in the eastern part of the State and the mainland to the northwestward had been filled and that portion of the future Indiana became for the first time a part of the slowly growing North American continent. The rocks which were afterward added on its western side were deposited on the sloping floor of the Central Interior sea which stretched far away to the southwest, and they consequently have a notable dip in that direction.

The lowermost stratum of the Sub-Carboniferous rocks in Indiana is a thin but very persistent bed of greenish limestone, known as the Rockford Goniatite limestone. It is but about two feet in thickness at its most notable outcrops, and hence forms but a very narrow area of the surface rocks of the State. It serves well, however, as a line of demarcation separating the Upper Devonian shales from the thick beds of Knobstone which represent one of the early and important epochs of Lower Carboniferous time.

These Knobstone rocks consist at the base of a series of soft, bluish shales, which gradually become more arenaceous or sandy, until toward their western horizon they merge into massive beds of impure grayish sandstone. The formation ranges in known thickness from 440 to 650 feet. The name "Knobstone" was first given it by that eminent geologist, David Dale Owen, because its siliceous strata weather into those peculiar conical "knobs" or hills which are so prominent a feature of the topography in the southern unglaciated portion of its area. By the deposition and upraising of the Knobstone a strip of territory, 3 to 38 miles in width, extending from the Ohio River southwest of New Albany north and northwesterly to a point a few miles south of the present site of Rensselaer, Jasper County, was added to the existing land of the future State. Deep bores have also shown the Knobstone to immediately underlie the drift in a strip of varying width along the extreme northern border of the State. By its deposition and subsequent upraising over this area, all of the northeastern portion of the State became for the first time dry land, and the waters of the Eastern Interior Sea were forever banished from the future Indiana.

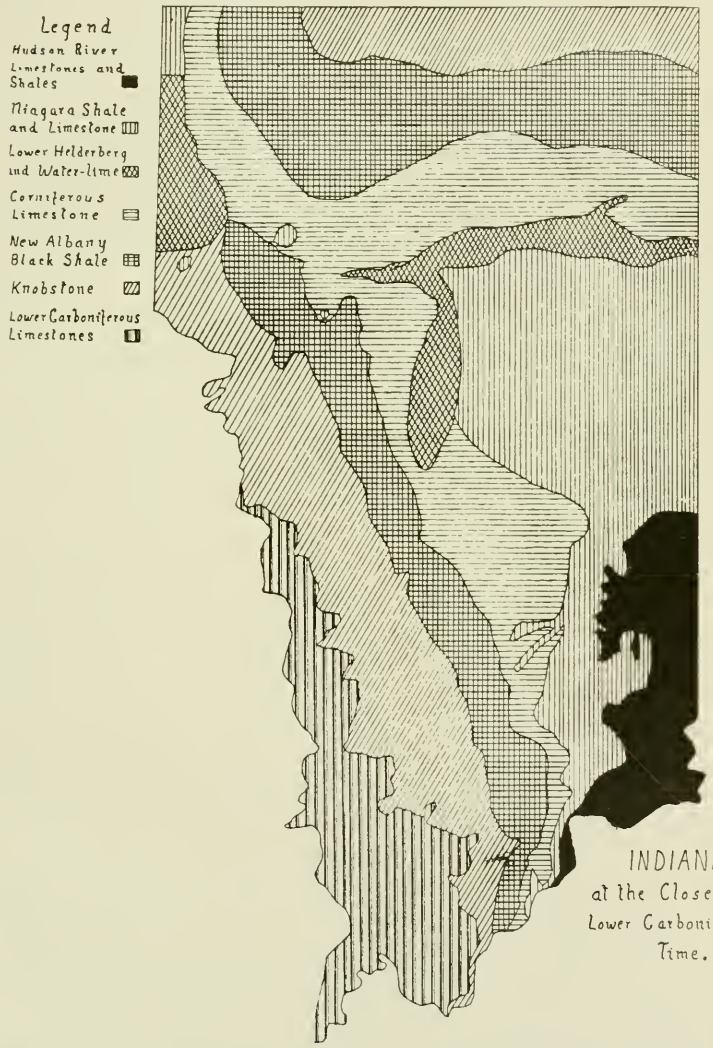
Over much of the northern part of its main area in Indiana, the Knobstone is at present more or less covered by glacial debris, its strata being exposed only in the stream valleys. The shales of the basal or eastern third of its unglaciated portion are excellently adapted to the making of vitrified wares, as paving brick, sewer pipe, etc., as well as for the clay ingredient of Portland cement; though as yet their possibilities of service for these products have been largely ignored.

Following the Knobstone epoch came that of the Lower Carboniferous limestones. Four distinct horizons of these limestones are recognized in Indiana, viz., the Harrodsburgh, Bedford, Mitchell and Huron, in the order named; each representing a distinct period of deposition in the slowly retreating Central Interior Sea. Their total thickness is nearly 600 feet, and together they form the surface rocks over an area 40 miles wide on the Ohio River, but which gradually narrows northward until it disappears beneath the drift in the vicinity of Crawfordsville, Montgomery County.

Of the four horizons that of the Bedford is by far the most noted, since from it is obtained that famous Bedford or Indiana oölitic limestone which is now widely recognized as the finest building stone on the continent of America. It is mainly composed of the globular shells of microscopic foraminifera or Rhizopods—minute one-celled animal organisms—which must have swarmed in untold myriads in the sea waters of the time. The shells or cell walls of these animals were composed of a very pure carbonate of lime, and when they died and sank on the old sea bottom these shells were cemented together by the same material. Under the lens they resemble a mass of fish eggs soldered together, hence the name "oölitic," meaning "like an egg." The Bedford stone is noted among architects for its strength and durability, and for the ease with which it may be sawed or carved into any desired form. For many years it has ranked as one of the principal natural resources of the State.

The "Mitchell limestone" overlying the oölitic is composed of a series of close-grained limestones, shales and cherts. Its outcrop—5 to 30 miles in width—is a fairly level plateau which is pitted with a great number of sink holes, many of which form the openings into underground caverns and the beds of subterranean streams. The thick beds of Mitchell limestone, taken in connection with the underlying Bedford and Harrodsburgh limestones, afford a series of rocks which are more

or less jointed, and therefore easily eroded by underground waters. As a result, large caves, some of them possessing great vaulted rooms,



deep pits, high waterfalls and streams of water large enough to allow the ready passage of a boat, are found throughout this area. All of these caves are due to the action of water—that greatest of nature's

solvents and abraders—its work of a day, a year, a century, upon the solid limestone not appreciable to the eye—yet by slow unceasing action through the ages which have elapsed since that limestone was raised above the sea, it has carved every room and passage, constructed every pillar and stalagmite existing beneath the surface of southern Indiana.

The Huron limestone or Huron group of rocks represents in Indiana the latest epoch of the Lower Carboniferous Era. It is composed of three beds of limestone with two intervening beds of sandstone, their combined thickness being about 150 feet. The sandstones carry in places concretions of iron ore and thin beds of coal, the latter being the forerunners or harbingers of those vast veins of stored energy which, in southern Indiana, represent the Carboniferous and final era of Paleozoic time.

The Carboniferous Era is noted as one of gentle oscillations in the surface of those shallow seas bordering the land, these "causing successive more or less wide emergencies and submergencies, the former favoring the growth of boundless forests and jungles, the latter burying the vegetable debris and other terrestrial accumulations beneath fresh water or marine deposits."

During the era, that cryptogamous land vegetation which had sprung into existence in the Devonian Era, advanced with wonderful strides. The temperature was mild; the atmosphere moist and heavy laden with carbon dioxide. As a result the vast lowland marshes were overgrown with great trees of Sigillaria, Lepidodendron and Calamites; while at their base grew dense thickets of fern underbrush, inhabited only by insects and amphibians. For the first examples of the latter evolved during this period from some mud-loving, fish-like creature. No flowering plant had as yet unfolded its petals. No bird had, as yet, winged its way through the buoyant air. No mammal was, as yet, a denizen of earth or sea. Those dim watery woodlands were flowerless, fruitless, songless, voiceless, unless the occasional shrill of a cricket or grasshopper could be called a song. Yet in the cells of the semi-aquatic plants and trees of those old forests there was stored that heat which was destined in after ages to be freed by man and used in doing the work of the world.

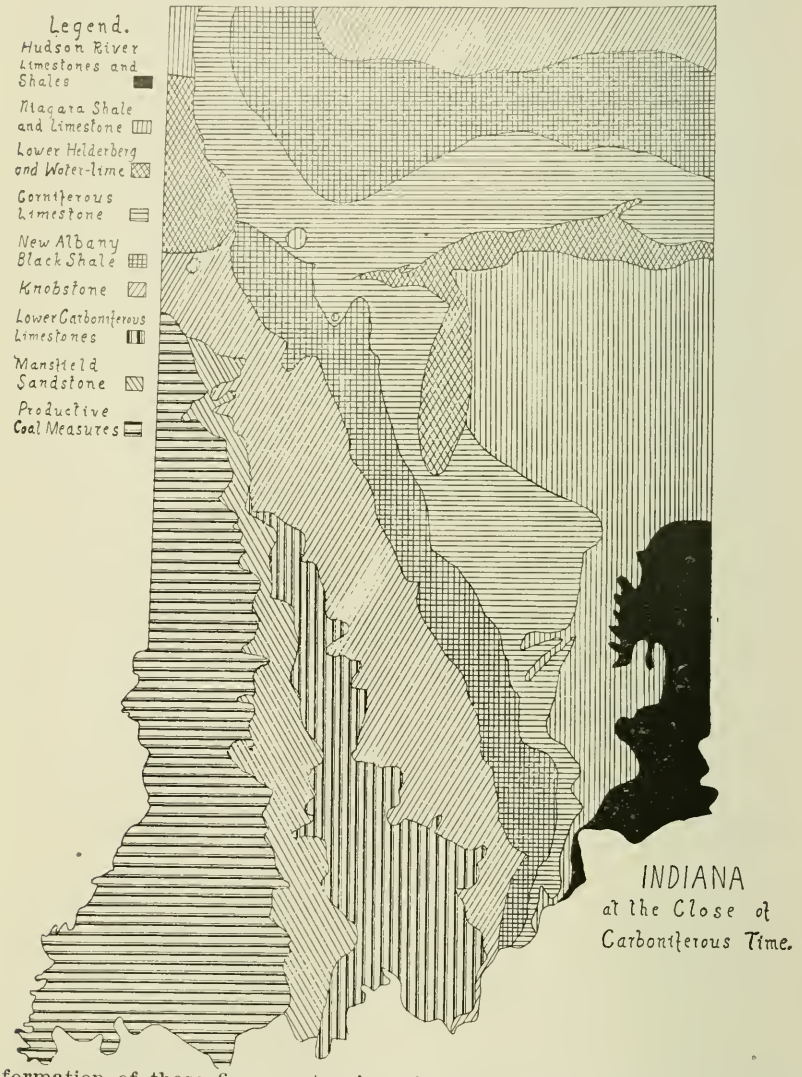
The rocks laid down during this era were alternating beds of sandstone, shale, clay and limestone with occasional beds of compressed vegetation which, during after centuries, has been changed into coal.

The basal formation of the Carboniferous Era in Indiana, as generally elsewhere, is a bed of coarse-grained sandstone, known as the Mansfield sandstone or "Millstone Grit." It has a total thickness of 150 feet and forms the surface rock over a strip 2 to 22 miles in width, extending from the northern part of Warren County in an east of south direction to the Ohio River, a distance of 175 miles. In Martin and Orange counties it occurs with an even, sharp grit, furnishing a most excellent material for whetstones and grindstones.

Above this sandstone are the Productive and Barren Coal Measures, which comprise 7,500 square miles of the land surface of the State. At the time of their deposition or formation the area which they cover, as well as a large part of Illinois, was a great basin or depression, but little above the level of the sea, and surrounded on every side except the southwestern by the higher lands of the older formations. By successive alternations of upheaval and subsidence—carried on through thousands of years—this depression was at times an area of the southwestern sea, again a fresh water lake, and then, for a period, a vast swamp or marsh. When raised high enough to form a marsh, the luxuriant vegetation, above mentioned, sprang up from the ooze and mud at its bottom, flourished for centuries, the newer growths springing from between the fallen masses of the older, as in the peat bogs of today, and so formed a mighty mass of carbonaceous material. By subsidence, the level of the marsh was, in time, lowered until it became a lake into which rivers from the surrounding highlands flowed, bearing with them millions of tons of clayey sediment and disintegrated quartz, the remains of the older decayed rocks. This sediment was spread out over the mass of submerged vegetation, compressing it into the hard, mineral coal; the clayey sediment itself being in time compressed into vast beds of shale, and the particles of quartz into sandstone. In some places a more prolonged subsidence took place, sinking the floor of the lake below the level of the sea, and allowing the waters of the latter with their accompanying forms of marine life to flow in. In time beds of limestone were then formed over those of the shale or sandstone, but none of these cover an extensive area or are of great thickness.

After each subsidence, with its resulting beds of coal, shale and sandstone or limestone, had taken place, an upheaval followed. The floor of sea or lake was again raised so near the surface that the semi-aquatic

vegetation for a new coal seam could spring up and, in time, the processes above detailed were again undergone. Such, in brief, was the origin and



formation of those five great veins of coal which form today the chief mineral wealth of our State, and of those vast beds of overlying shale which, in recent years, have come to be used for so many varied products.

We have now traced the growth of the area comprising Indiana through Paleozoic time. We have seen how that area gradually appeared above old ocean's rim. But it was not yet the "Indiana of Nature"—the finished product of the ages ready for the advent of man. Centuries untold had yet to come and go before it was complete—centuries during which changes of momentous importance were to come to pass. For, as yet, no palm, no angiosperm or flowering plant with seeds, no osseous or common fish, no reptile, no bird, no mammal had come to be upon the surface of the earth. All these were evolved from pre-existing forms during the age or era immediately succeeding the Carboniferous or final period of Paleozoic time. This age is known as that of the Mesozoic or Middle Time, represented by the Triassic, Jurassic and Cretaceous eras. For our purpose there may be combined with these eras the Tertiary of Cenozoic or recent time. During the myriads of years ascribed to these eras, while vast changes were taking place in other parts of the American Continent, the surface of Indiana probably remained above sea level. On it there grew the plants and over it there doubtless roamed, in their turn, the animals of each successive era, but as its surface was above the sea, they left no fossil bone or footprint to tell us of their presence.

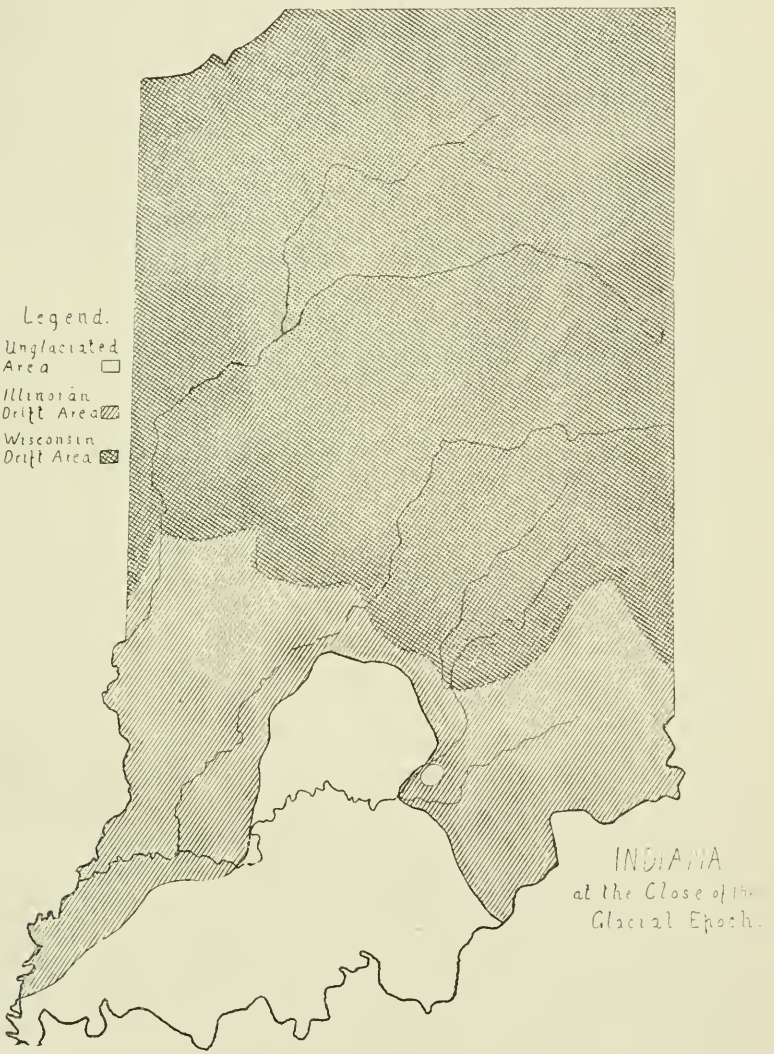
All this time, however, the silent processes of nature were unceasing in their labor, and wrought great changes in the surface of the future State. Decay and erosion were in action then as they are today. Sunshine and rain, wind and frost, trickling rills and strong streams were ever at work, softening and sculpturing and wearing down the exposed rocks, forming clays and sand and gravel and bearing them away to lower levels. At the close of the Tertiary Era, the entire surface of what is now Indiana resembled that of today in the driftless area of its southern part, being cut up by erosion into a complex network of valleys, ridges and isolated hills. In certain portions of the northern half great streams, of which there are now no surface indications, had worn their channels a half mile in width, 200 feet or more down into the solid Niagara limestone. The Ohio River valley, a trench from one to six miles wide and 400 feet deep, was mainly eroded during this period, as was also the greater portion of the Wabash Valley, from Huntington to its mouth. Everywhere over the surface was a thin soil, formed from decaying rocks and vegetation, poorer, perhaps, than much of that which at present covers the surface of the driftless area, where the underlying limestones and shales have been the parent rock. In this soil grew the cedar and the

sassafras, the willow and the maple, the oak and the beech, while over its surface spread many of the coarser grasses, sedges and mosses of the present day.

During these long periods of erosion and decay, mild climatic conditions had prevailed. But near the close of the Tertiary a change in these conditions came gradually to pass—a change which was most sweeping and far-reaching in its final results. For some, as yet unknown, reason, the mean annual temperature of the northern hemisphere became much lower. The climate of the regions to the east and south of Hudson's Bay became similar to that of Greenland of today, or even colder. The snow, ever falling, never melting, accumulated during hundreds of centuries in one vast field of enormous thickness. Near the bottom of this mass a plastic, porous sort of ice was gradually formed from the snow by the pressure from above. This ice mass or glacier took upon itself a slow, almost imperceptible motion to the south or southwestward, until it covered three-fourths or more of what is now Indiana. As it moved slowly southward great masses of partly-decayed rock and clay from hillsides and jutting cliffs rolled down upon it and were carried on and on until, by the melting of their icy steed, they were dropped hundreds of miles from the parent ledge. Large irregular masses of rock from the region in which the glacier was formed were either frozen into its nether portion or rolled along beneath it, and as the ice sheet moved they served as great stone drags, grinding down and smoothing off the hills and ridges and filling up the valleys, until the irregular, uneven surface of the old preglacial rocks was planed and polished.

From the striæ formed by these imprisoned boulders and from other evidence which it is difficult to otherwise explain, it is now believed that there were several distinct epochs in the glacial period. The great ice sheet, which was at first formed, several times advanced and as often—by an increase of the temperature of the region which it entered—melted and receded; its retreat or recession being each time as gradual as its advance had been. Like a great army which has attempted the invasion of a country and has been compelled to withdraw, it would again assemble its forces and start in a slightly different direction. But, perchance, before it had reached the limit of its former invasion a force of circumstances would render a retreat necessary. Its advancing margin was thus not in a straight line, but in lobes, or long, gradual curves.

When the first ice sheet reached its greatest advance into the region now comprising Indiana, the ice "was at least 500 or 600 feet deep over



the present site of Terre Haute and nearly as deep over that of Indianapolis, and it thickened gradually northward. If an observer could have stood on one of the hills in Brown county at that time, he would have

seen to the east of him the great wall of the ice front extending south toward Kentucky, while toward the west it would have been seen in the distance stretching away toward the southwest. For hundreds of miles to the east and west, and for 2,000 miles or more to the north, the glaring, white desert of snow-covered ice, like that seen in the interior of Greenland by Nansen and Peary, would have appeared, stretching away out of sight, with not a thing under the sun to relieve its cold monotony."

By the incursions of the various ice sheets all the so-called "drift soils" of northern and central Indiana were accumulated where they lie. Derived, as they were, in part, from the various primary and igneous rocks in the far north, ground fine and thoroughly mixed as they were by the onward moving force of a mighty glacier, they are unusually rich in all the necessary constituents of plant food. Principally to them does Indiana owe her present high rank as an agricultural state. All the level and more fertile counties lie within this drift covered area, and its southern limit marks, practically, the boundary of the great corn and wheat producing portion of the State. But few of the present inhabitants of Indiana realize how much they owe to this glacial invasion of our domain in the misty past. It not only determined the character of the soil, the contour of the country and the minor lines of drainage, but in manifold other ways had to do with the pleasure, the health and the prosperity of the present population.

When the final ice sheet gradually receded from the area now comprising Indiana, the surface of the glaciated portion was left covered with a sheet of drift or till composed mainly of clay, gravel and boulders, and varying in thickness from one to 400 feet or more. Over the greater portion of this area the surface of the drift was comparatively level, but in the northern fourth of the State it was in numerous places heaped up in extensive ridges and hills, due to irregular dumping along the margins and between the lobes of the melting ice sheets. In the hollows or low places between those ridges and hills the waters of the melting ice accumulated and formed those hundreds of fresh water lakes which are today the most beautiful and expressive features of the landscape in the region wherein they abound. At first all of those yet in existence were much larger than now, while for every one remaining a score have become extinct.

A new vegetation soon sprang up over the land left desolate and barren by the retreating ice. The climate gradually became much

warmer than it is today. The great expanse of water in lakes and rivers, aided by the increase in temperature, gave rise to excessive moisture. Fostered by the rich soil and the mild, moist atmosphere, a vast forest of deciduous trees spread over the larger portion of our State. Through this forest and about the margins of the lakes and marshes there wandered for centuries the mammoth and the mastodon, the giant bison and the elk, the tapir and the peccary, the mighty sloth and that king of rodents, *Castoroides ohioensis*. Preying upon these and smaller mammals were the great American lion, and tigers and wolves of mammoth size. The bones and teeth of all of these species of extinct animals have been found buried beneath the surfaces of former bogs and marshes in various portions of the State. It is not improbable that with them was also that higher mammal—man—in all the nakedness of his primitive existence.

But over this phase in the evolution of the future Indiana there came again a change, for nature knows no such thing as rest. The great rivers which had borne south and southwestwardly the floods and debris of the melting glaciers gradually diminished in size and filled but a small portion of their former valleys. Extensive shallow lakes in the northwestern part of our present area gave way to marshes and these, in time, to wet prairies, possessing a rich black soil derived largely from the decay of aquatic vegetation. The climate gradually grew less moist, more cool. The mammoth, the mastodon and contemporaneous mammals disappeared, and in their stead came countless thousands of buffalo and deer. With them came, too, that son of Nature—that descendant of the naked barbarians of centuries before—the noble Red Man. From out of that dark night which hangs forever over all we know or shall know of early America he came—a waif flung by the surge of time to these later ages of our own.

With the advent of the Red Man the "Indiana of Nature" was complete, was perfect. It possessed that primeval savage beauty of a world unmarred by man. Lakes, streams, forests, prairies, stored fuel, noble game—all were here. For centuries the Indian lived in peace within its bounds. The forest yielded him bear and deer—the prairies, buffalo and wild fowl. On the higher ridges, overlooking the larger streams and lakes, he had his principal village sites. Over their placid waters he paddled his birch bark canoe. From their depths he secured with spear and hook fishes sufficient to supply his needs; while the skins of muskrat, otter and beaver which he trapped about their marshy margins

furnished him protection against the cold. Through the forest glades, when returning from the chase, his cries of triumph were echoed. Here, in a land of plenty, his wants were few and easily satisfied; his ambitions lowly, his hopes eternal.

But to this, as to all things peaceful, there was an end. From across the seas came that "prince of parasites," the white man—self-styled heir to all the ages—so-called conqueror and civilizer—but in reality the greatest devastator that Nature has ever known. First as a discoverer came he. Then as a trapper and trader among the Indians; last as a settler of the future State. His first permanent hamlets or settlements were, like those of the Indians, located on the larger streams. From these he penetrated farther and farther the forest, building his cabins wherever a spring purled forth from a hillside to furnish water. In less than two centuries—a mere second as compared with those measureless eternities before he came—the white man has changed beyond recognition the "Indiana of Nature." Only its outlines remain as they were.

From its bounds he has driven forever the buffalo, bear, panther, elk, deer, wild turkey, ivory-billed woodpecker, paroquet and wild pigeon, together with the noble Red Man, the one-time contemporary and lord of them all. From its surface he has cleared that dense forest of tall trees—of which no domain could boast a better—leaving in its stead a mere remnant of what would have been termed underbrush a century ago. Following the felling of the forests came, as a direct result, the drying up of springs and the dwindling to mere rivulets of former creeks and streams. To gain control over a few more acres of mother earth, he has dredged deep ditches and so lessened greatly the size or brought about the total extinction of 90 per cent. of those crystal lakes which once gave variety and beauty to the northern fourth of the State.

He has caused the picturesque trails and woodland paths of the Indian to disappear, and in their stead we find, at intervals of a mile or two, those broad unshaded roadways, many of which are floods of dust in summer and seas of mud in winter. As a complement to these he has, in nearly every county, leveled hills, filled up valleys, bridged streams, and stretched long bands of steel spiked to wooden ties. Drawn by the harnessed forces of Nature, he rushes over these at almost lightning speed; while along them he sends, with many a roar and rumble, those necessities and luxuries of his artificial life.

Not content with his destruction of the natural beauty of the surface of the State, he has delved deep into its depths, in search of those riches of stored power, there hidden since the sun gave up its heat and light to the plant cells of the old Silurian seas and Carboniferous marshes. With his iron drill he sunk, in eighteen years, ten thousand vents to the Trenton rock. Through these there poured natural gas valued, even at the extremely low price at which it was sold, at $77,618,189. So greedy was he, so ignorant of the real value of this gaseous fuel and the manner of its formation, so reckless in its consumption, that at the end of less than a score of years there remains only the dregs of the plenty that has been.

As with natural gas, so with its mother liquid, crude petroleum. Since 1891, 16,975 bores have been sunk within the limits of the State, for it alone. Through these 55,172,755 barrels of oil, valued at $42,757,-834, have reached the surface. But few years will elapse before the stored supply of it, too, will have vanished. A priceless gift of nature—hundreds of millions of years in forming—it will be sacrificed to the greed of the white man in less than the life of a generation of his kind.

More valuable than either gas or oil, closer to the surface and, therefore, more easily secured, are those vast veins of coal which underlie the southwestern area of our State. For sixty years man has sunk his shafts and pitholes to their levels, and tunneled miles along their courses, until the output has risen above nine million tons per annum. Less than two centuries will see the end of this stored fuel, and Indiana will then have been raped of all those riches which, in the ages past, were formed beneath her surface.

But why continue? Examples manifold could yet be given of the changes wrought by man since first he gave the name Indiana to the area in which we dwell—changes which one and all have but marred the face of nature and left everywhere the signs of his greed, his egoism. Only the great blue ethereal dome—the sun which shines and rules over all—the moon, cold and lifeless—the stars, gleaming from their heights in the realms of space—the clouds which oftentimes hide even these from view—seem as they were when the Indiana of Nature was first perfected.