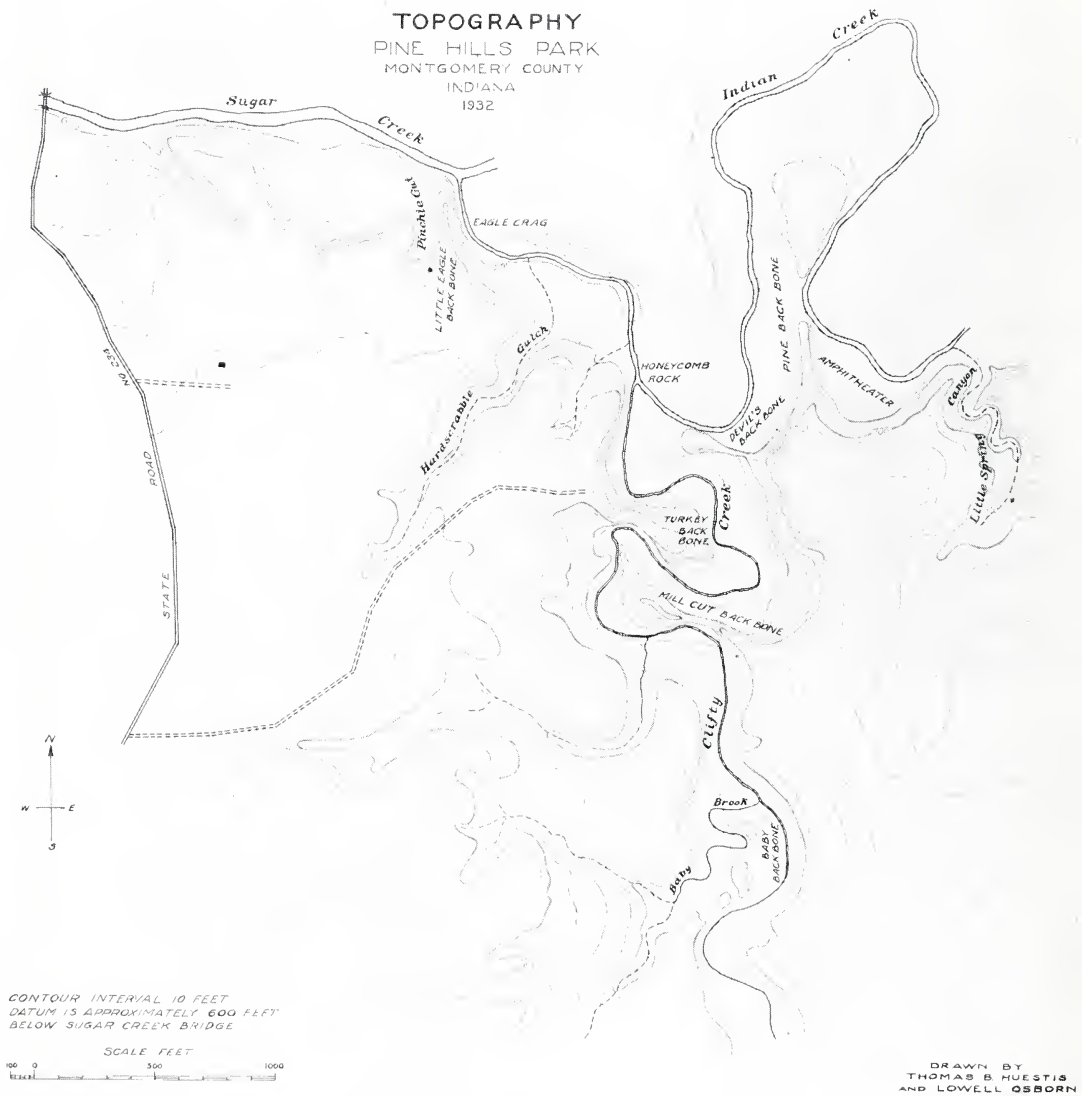
TOPOGRAPHY
PINE HILLS PARK
MONTGOMERY COUNTY
INDIANA
1932
Sugar Creek
Indian Creek
Pinhole Cut
EAGLE CRAG
LITTLE EAGLE BACK BONE
HONEYCOMB ROCK
PINE BACK BONE
AMPHITHEATER
Canyon
Little Spruce
DEVIL'S BACK BONE
Horseradish Gulch
TURKEY BACK BONE
Turkey Creek
MILL CUT BACK BONE
Cliffy Brook
BABY BACK BONE
Baby
STATE ROAD 234
N
W
E
S
CONTOUR INTERVAL 10 FEET
DATUM IS APPROXIMATELY 600 FEET
BELOW SUGAR CREEK BRIDGE
SCALE FEET
500
1000
DRAWN BY
THOMAS B. HUESTIS
AND LOWELL OSBORN

Fig. 1

THE PHYSIOGRAPHIC FEATURES OF PINE HILLS NATURE STUDY PARK, MONTGOMERY COUNTY, INDIANA

Ernest Rice Smith, DePauw University

The incised meanders and other features of natural interest in Pine Hills Park, Montgomery County, Indiana, have aroused such interest among, not only physiographers, but also lovers of nature, that a careful map and study of the park have seemed thoroughly worthwhile. A task of this sort could not have been completed without the hearty cooperation of many individuals. A list of those who have helped is appended to this paper and appreciation for their interest and effort is sincerely expressed.

Location. Pine Hills Nature Study Park, at times called Devil's Backbone, after one of its interesting features, is located in sections 1, 2, 11 and 12, Brown Township, Montgomery County, Indiana. It is about fifteen miles from Crawfordsville, the county seat, and five miles from Waveland, the nearest railroad town and post-office. Pine Hills Park, as a whole, lies on both sides of Sugar Creek and of Indiana State Road 234, where that road crosses Sugar Creek on a fine two-span covered bridge. Although all parts of the park contain points of interest—the great deposits of calcareous tufa with their weird shapes at the base of the Mansfield sandstone, the etched cliffs opposite Bluff Mills, waterfalls, glens, etc.—the immediate subject of this paper is the region of backbones and incised meanders east of road 234 and south of Sugar Creek. Wherever Pine Hills Park is mentioned it may be inferred that this section of the park is indicated.

Drainage. The park is entirely within the drainage basin of Sugar Creek, sometimes called Rock River, an important tributary of the Wabash River. The park drainage is: (a) by steep, short gullies which tumble down into Sugar Creek, e. g., the gullies behind Hemlock Lodge; (b) by Indian Creek (one of the seventeen Indian Creeks in Indiana) and its gullies such as Pinchie Gut and Hardscrabble Gulch; and (c) by a tributary of Indian Creek called Clifty Creek, with its own tributaries such as Camp Brook and Baby Brook. (Fig. 1.)

Topography. Physiographically, Pine Hills Park lies in that part of Indiana above the glacial boundary, called by Fenneman the Till Plains Section of the Central Lowland Province. In the nomenclature in current use in the state, it is in the Tipton Till Plain, but due to the marked entrenchment through the till mantle down into the bed-rock, as at the Shades and Turkey Run, the immediate relief takes on the characteristics of the Crawford or Norman Uplands of southern Indiana. (Fig. 2.) In

"Proc. Ind. Acad. Sci., vol. 42, 1932 (1933)."

Turkey Run State Park, there outcrops the Mansfield sandstone, the basal member of the Pennsylvanian System in Indiana, which formation gives character to the Crawford Upland farther south in Indiana. In the Shades, the steeper cliffs are due to the Mansfield and, in the lower portions, the more gradual slopes are due to the Borden, the underlying rock in the Norman Upland. At Pine Hills only the Borden is found.

The main structural feature of the bedrocks in Indiana, which determines the distribution of formations, is the western limb of the Cincinnati Arch which trends off in the general direction of Chicago. South of the glacial boundary this gives the rocks a general W-S-W dip of from 20 to 40 ft. per mile. This regional dip determines the trend of the physiographic provinces in a N-N-W direction.

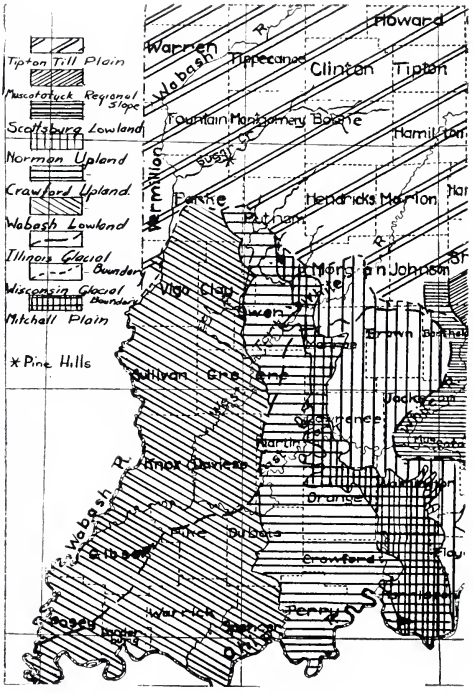

Fig. 2.

From Putnam County south, between the Norman Upland on the east and the Crawford Upland on the west, is the Mitchell Plain, with a more or less typical karst topography due to the development of three limestones: the Harrodsburg, Salem and Mitchell. Because of the thinning down of the limestones toward the north, the Mitchell Plain gradually narrows and finally disappears altogether. The two uplands would fuse into one with the characteristics of the Norman on the east and the Crawford on the west were it not for the work of the great ice sheet. Chiefly because of deposition by the Wisconsin glacier, the region north of Greencastle is not a highly dissected upland, but a slightly rolling till

plain. There are sags and swells characteristic of the general monotony and only where recessional moraines exert their influence do we have a more hummocky topography with knobs, kames and kettles. Where Sugar Creek has cut across the Borden-Mansfield belt, it makes another exception to the montonous surface, incising a relief comparable to that of any place in the Norman or Crawford Upland. This erosion gives the remarkably fine look-out points of Turkey Run, the Shades and Pine Hills Park. In Pine Hills Park, an automobile may be driven to the very edge of an almost sheer cliff, 120 feet high looking out over Clifty and Indian creeks.

Stratigraphy. In the portion of Pine Hills under discussion, the only bedrocks exposed belong to the Borden formation. Stockdale has recently expressed the opinion that they lie in the upper part of the Carwood subdivision of the Borden. The section exposed is about as follows:

3. Heavy-bedded shaly sandstone or siltstone..... 8–10 ft.+
2. Interbedded crinoidal, crystalline biostromes and shaly sandstone ..... 5– 6 ft.
1. Shaly sandstone showing limonite concretions, irregularly cemented; almost no fossils; heavier-bedded, less argillaceous above..... 70 ft.+

Zone 1. The lowest portion of the section as shown throughout the park is somewhat over 70 feet thick. In large part, it is a shaly sandstone. It contains so much argillaceous material that weathering takes place due to frost action, parallel to the surface, the rock spalling off in great flakes up to several square feet in area and two or more inches in thickness. (Fig. 3.)

Another characteristic of Zone 1 in the Carwood is closely connected with the argillaceous content of the lower portion as contrasted with the more arenaceous, heavier-bedded upper part. Wherever talus is removed

Fig. 3.

as rapidly as it accumulates, markedly undercut cliffs are found. Figures 3 and 4 show this characteristic on the south side of Turkey Backbone and the north side of Devil's Backbone. Frequently these excavated areas are coated in spots with Epsomite.

A third outstandingly interesting characteristic of Zone 1 is the irregular cementation which in places results in marked differential weathering: the Honeycomb Rocks at the junction of Clifty and Indian

Fig. 4.

Fig. 5.

Creeks (Figs. 5 and 6), the undercut on the south side of Devil's Backbone and the etched surface on the upper part of Eagle Crag.

The more siliceous upper layers in Zone 1, in addition to supporting the overhanging cliffs, also form the Devil's Backbone (Fig. 7) and are present in the upper portion of Turkey, Mill-Cut and Pine Backbones.

Fig. 6.

Zone 2. The most interesting strata in Zone 2 are the highly fossiliferous, usually crystalline coquinas interbedded in the sandstones (biostromes of Cumings[1]). They are widespread throughout the park and are the springmakers in the park. Such springs are found where the path crosses Hardscrabble Gulch, on Camp Brook, on Spring Cliff and

Fig. 7.

[1] Cumings: Bull. G. S. A., Vol. 43, p. 331, 1932.

up Little Spring Canyon. All the water is highly charged with calcium bicarbonate so that in the neighborhood of seeps and springs there are deposits of calcareous tufa, nowhere on as great a scale as at the base of the Mansfield. Where the water seeps out through deposits of glacial gravel, as on the east end of Devil's Backbone and on the east side of Clifty Creek above Baby Backbone, the gravel is cemented into a fairly resistant conglomerate or pudding-stone.

The fauna of Zone 2 does not seem large. The best fossils have been found on Mill-Cut Backbone. The biostromes consist largely of crinoid fragments, but some very nice heads, a few Spirifers and fairly common Platyceras have been found there. Up Baby Brook at this horizon was found a slab covered with good-sized productids. In the weathered rock in the knoll on the west end of Devil's Backbone, in addition to the crinoid fragments, are many fenestellids. Where the path crosses Hardscrabble Gulch, the biostromes are made up largely of brachiopods.

Zone 3 outcrops in only a few places in the park and is not markedly different from Zone 1. It outcrops in the Shades in Hemlock and Bridal-Veil Falls. It seems to be non-fossiliferous.

The Backbones. These, the major points of interest in the park, may be located on the contour map of the park (Fig. 1). Without exaggeration, they may be considered as the most remarkable examples of incised meanders in the eastern United States. In fact, although they are exceeded in magnitude by such features in the Rockies, none exceeds them in perfection and in interest. In order of length, they are Pine, Turkey, Mill-Cut, Devil's, Baby and Little Eagle. All except Little Eagle are meander spurs either of one stream on itself or of two streams meandering together. A brief description of the backbones, beginning with the longest, will emphasize their salient points.

Pine Backbone is made by Indian Creek returning on itself after a path of some 3,000 feet. The main backbone is about 200 feet long, narrow at the crest, standing 25 to 70 feet above the flat on either side and with a minimum width of 90 feet at the base. It expands to a considerable width at the far end and rises to a knoll called Bald Mountain, over 80 feet above Indian Creek. The far end of Bald Mountain has a typical slip-slope with two flats which probably indicate temporary halts in the down-cutting process. At the present time, the stream does not swing together nearer than 220 feet. The present meander belt at that point, then, is much narrower than at the time in the past when it would seem to have been a matter of but a few years before Pine Backbone would have been cut through. It was at this time that the amphitheater east of the foot of the backbone was developed. It covers more than five acres and nowhere has a relief of even five feet.

There is one other interesting feature of the Pine Backbone. At the north end of the sag, the crest is bifid, with a trough through the center. Indian Creek seems to have maintained a consistent channel close to the backbone on the east side, so that marked under-cutting took place. At some time in the past, a considerable undercut block slumped off carrying down the higher part of the backbone at that point. This leaves a double crest of nearly equal height. The undercutting continues for some dis-

tance around the side of the amphitheater and at one point the growth of evergreens is so heavy, the depth of the undercut is so great, and the exposure in such a direction, that rain never reaches the back of the undercut. In fact, the whole backbone and the far sweep of the meander are so clothed with evergreens, hemlock and white pine, as to make it impossible to take a picture at any time of the year.

Turkey Backbone, the first one usually seen by tourist and physiographer alike, is made by Clifty Creek meandering on itself. The main crest is merely a very narrow footpath about 230 feet long and about 110 feet above the stream. At the base, it is about 140 feet through from stream to stream, Clifty Creek working actively on both sides. On the south side (Fig. 3) there is a remarkable undercut while the north side is a very steep slope. The head end of Turkey Backbone is a broad meander curve with a typical slip-slope and, like Pine Backbone, with two evergreen-clad flats perched above the present stream level.

Fig. 8.

Mill-Cut Backbone (Fig. 8) is of interest, not only for its scenic and physiographic features, but also for the work of man, the Mill-Cut. In the late fifties a trough about 36 feet deep and some 10 feet wide was excavated at the narrowest part of the backbone. Clifty Creek above the backbone and just below this cut was dammed up and the water led through to operate a small woolen mill on the 32-foot drop thus gained. This interesting utilization of the topography will be at once compared to that at Tunnel Mills near North Vernon, Indiana. Although there was year-round water from the spring-fed creek and the head was good, the volume of water was insufficient and the mill was soon moved to the site of Bluff Mills where road 234 crosses Sugar Creek.

The backbone varies between 70 and 40 feet in height, is 5 or 6 feet wide at the crest, about 200 feet long and 160 feet through at the

base. The south side is nearly vertical, the north side steep with a narrow flat at the bottom. There are the same two flats above the present stream level around the end of the meander spur.

Devil's Backbone, for which the park was originally named, was made by Clifty and Indian Creeks when they were meandering much closer than now. In fact, at one time, they were within two feet of piercing the meander spur. Had this taken place, Clifty would have flowed into Indian Creek through a fine natural bridge and the lower course of the present Clifty Creek would have been abandoned. This abandoned course would have included the north side of Turkey Backbone and the cliff down to Honeycomb Rock. As shown in Fig. 1, there is no immediate prospect of this occurrence as both streams are now flowing well away from the Devil's Backbone.

The backbone is about 125 feet long, 70 feet above Indian Creek and 65 feet above Clifty Creek. It has a minimum width at the top of 7 feet. Overlying dirt and weathered rock have probably been cleared off, but this must have been done before the year 1870, as that date is carved on the backbone. Figure 7 shows the backbone with Indian Creek on the right.

Baby Backbone was formed by Baby Brook and Clifty Creek meandering toward each other after Baby Brook had taken an abnormally long route into Clifty Creek. Were it not for the presence of the other backbones, this neat little backbone some 10 to 25 feet high and 150 feet long would arouse much more interest.

Little-Eagle Backbone is a markedly narrow divide just west of Eagle Crag, between Pinchie Gut and Indian Creek. Through the passage of time Indian Creek has cut farther and farther west narrowing this divide. Otherwise, it would have been a perfectly normal divide between a narrow gully and a small creek. Indian Creek formerly flowed into Sugar Creek just below Hemlock Lodge. Probably with the aid of Sugar Creek it later made a cut-off about 400 feet above its former outlet, forcing Pinchie Gut into a slightly abnormal path into the present Indian Creek.

The Origin of the Backbones. The problem of the origin of the backbones resolves itself into two parts—the marked incision or entrenchment in a region with no other evidences of regional uplift and the development of a meandering course in such a youthful topography.

The cause of the entrenchment of the tributaries of Sugar Creek can be ascribed unquestionably to the great rapidity of the downward cutting processes by the main stream, thus continually, or almost continually, keeping the tributaries youthful. Where this down-cutting was temporarily halted, a shelf would be developed, not only in the main stream valley, but also in the tributaries. Such terraces have been noted in Clifty and Indian Creeks and may be seen in the main Sugar Creek valley from the Lookout Point in the Shades.

The Meanders. Normally streams develop meanders such as these only in a relatively mature topography. Yet this region, far from

being mature, bears all the evidences of youth, the but little eroded Tipton Till Plain. After discarding two other theories the following theory is considered to link up all known evidence as to the cause of the remarkable meander pattern. The following factors must be taken into account: The limitation of incised meanders to the Borden formation whether in the main Sugar Creek Valley as at the Shades, or in its tributaries as at Pine Hills Park; the tendency of the Borden to undercut due to spalling off in freezing weather thus furnishing an abundance of tools, not only for the downward cutting process, but also for swinging wider and wider on curves. This would provide the extensive undercut cliffs rather than the more normal meander scars and the well-developed slip-slopes. A meander pattern would not develop in Turkey

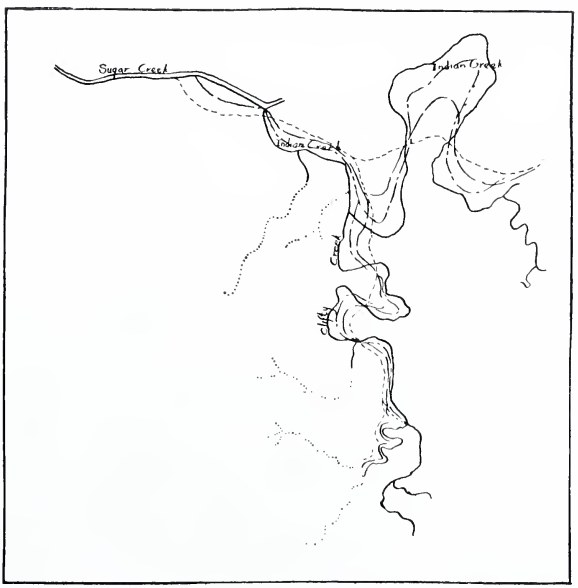

Fig. 9.

Run because the Mansfield sandstone is not sufficiently argillaceous to undercut generally in this manner on the outside of curves, although some undercutting is noted. Figure 9 illustrates this theory of the increasing development of a meander pattern from an originally normally winding course in a glacial topography. The incision process is considered to have started at about the 700-foot contour line, as shown by the present topographic map. Intermediate steps in this process are shown by the dashed lines.

The following men helped wholeheartedly in the forwarding of this project:

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