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TABLE OF CONTENTS.

| | PAGE. |
|---|-------|
| INTRODUCTORY. By W. S. Blatchley..... | 9 |
| THE NATURAL RESOURCES OF THE STATE OF INDIANA. By W. S. Blatchley..... | 13 |
| ON THE PEAT DEPOSITS OF NORTHERN INDIANA. By A. E. Taylor..... | 73 |
| THE IRON ORE DEPOSITS OF INDIANA. By Chas. W. Shannon .. | 299 |
| THE PETROLEUM INDUSTRY IN INDIANA IN 1906. By W. S. Blatchley..... | 429 |
| THE PRINCETON PETROLEUM FIELD OF INDIANA. By Raymond S. Blatchley..... | 559 |
| REPORT OF THE STATE SUPERVISOR OF NATURAL GAS FOR THE YEAR 1906. By B. A. Kinney..... | 597 |
| REPORT OF THE STATE MINE INSPECTOR FOR THE YEAR 1906. By James Epperson..... | 609 |
| A PRELIMINARY LIST OF THE ARACHNIDA OF INDIANA, WITH KEYS TO FAMILIES AND GENERA OF SPIDERS. By Nathan Banks..... | 715 |
| NOTES ON THE CRAYFISH OF WELLS COUNTY, INDIANA, WITH DESCRIPTION OF A NEW SPECIES. By E. B. Williamson... | 749 |

DEPARTMENT OF GEOLOGY AND NATURAL RESOURCES,
INDIANAPOLIS, IND.

W. S. BLATCHLEY, State Geologist.

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NOTES ON THE CRAYFISH OF WELLS COUNTY, INDIANA, WITH DESCRIPTION OF A NEW SPECIES.

BY E. B. WILLIAMSON.

The purpose of this brief paper is to make a permanent record of the species of crays at present to be found in this county and to note some facts in their life histories under local conditions. Some habits hitherto unmentioned or at variance with published statements have been observed and it is believed that these are to be explained by the present environment. The desirability of making record of the present members of the fauna is evident, when the certain ultimate effect of draining and clearing, of stream pollution and diminution is considered.

Some streams in this locality where crays formerly abounded have been so changed that they no longer afford a home for these crustaceans. Undrained fields where burrows formerly existed by hundreds have been drained and pastured, and the burrows have disappeared. Crays formerly occurred commonly in the town of Bluffton in localities where cement walks, asphalt pavements and storm and sanitary sewers now cheer the cultured and refined. The certain decline of the fauna in the future, if it has not already been marked in the past, is too evident to call for remark, however. This is a very level county, practically every square foot of which is tillable. The few permanent streams have had the constituents of their waters vastly altered by drainage of swamps, clearing of forests, and by direct pollution.

The six species occurring in the county fall into three of the five subgenera proposed by Ortmann (Proc. Amer. Phil. Soc., vol. XLIV, 1905, and Annals of the Carnegie Museum, vol. III, No. 3, 1905.)

These three subgenera, with their Wells County species, are: *Cambarus acutus* Girard, *Faxonius rusticus* (Girard), *Faxonius immunis* (Hagen), *Bartoniuss ortmanni* n. sp., *Bartoniuss diogenes* (Girard), and *Bartoniuss argillicola* (Faxon).

Cambarus acutus Girard. In Wells County this species finds its most congenial environment in woodland swamps, though it has been taken frequently from ditches and creeks and one female was

taken in the Wabash River on September 26, 1905. Its habits early in the spring make it a ready victim of raccoons. At a swamp on the farm of Hiram Vanemon, south of Bluffton, the feces of raccoons, found in large quantities about two or three stumps, were composed almost entirely of hard bits of this cray. On March 26, 1906, the species was taken in swamps near Craigville and abundantly in the Vanemon swamp, mentioned above, where specimens of all sizes were associated. On this date and on March 28 females were carrying recently hatched young. In Blackford County is a large swamp near the nitro-glycerine factory just north of Hartford City. This old swamp, formerly surrounded by forests, lies now in a wilderness of sedges, bidens, and button-bushes. Here *acutus* is abundant. On June 11, 1905, they fled in numbers before the intruder who waded the swamp. On June 25, two weeks later, but few were seen and most of these were recently moulted. On September 9 not an individual was to be found in open water, but about 60 specimens were collected from burrows. About this swamp the burrows of this species are short and of large diameter, usually closed with a small flattened mound of homogeneous earth. Their direction is usually oblique or nearly horizontal for a short distance, then descending vertically. The terminal pocket is scarcely evident. They average about two feet in length, though some are half this length and others reach a length of three or four feet, the increase above the ordinary length being usually in the horizontal portion of the burrow. The burrows are placed usually near the water's edge and always in land which is overflowed earlier in the season. Water fills the burrow to within a few inches of the opening. This water contains many dragonfly larvae and other food suitable for the occupants, and the earth at the mouths of the burrows indicates that they are opened rarely if at all. Most of the burrows contained a pair; two of the same sex were never found together. One female on this date (September 9) was carrying eggs, and the largest female taken measured 98. The largest specimens seen were females.

Though *Bartonijs diogenes* also occurs about this swamp there is no doubt that the burrows are the work of *acutus*. In their great diameter they are distinct from the burrows of the true burrowing crays of the subgenus *Bartonijs*. I have also taken this species from burrows along Six-Mile Creek, May 20 and May 27, 1906, two females, 81 and 82 in length, and from a burrow in a creek bank in Robinson Park, Ft. Wayne, June 17, 1906, a female 96 in length. These burrows were in clay, were deep and

vertical, and may have been the work of *diogenes*. In any case it is not the disappearance of water which drives *acutus* to burrows, for the swamp near Hartford City and Six-Mile Creek contains water the year round. It seems a provision entirely for mating and spawning. The burrows mentioned above along creeks contained only females. These were wandering individuals, which, true to their instincts, sought burrows unaccompanied by mates. About the swamp, under more congenial environment, each burrow usually sheltered a pair.

In pools along the C. B. and C. R. R. near the Muncie Inter-urban crossing this species was very common on April 11, 1906. In wading about the edges of these pools in search of toads, *Chlorophilus*, which were calling by hundreds, I frightened these crays from cover and they then swam almost as rapidly as though they were fish to some distance, resting only when they had reached other concealment.

In addition to localities and dates mentioned above, the following may be recorded:

Six-Mile Creek, from one mile above Bethel Church to Six-Mile Church, May 16, 1906, 1 male (I), length 79.5, 7 males (II) 72 to 89, 9 females, 80-104.

Ditch on Alex Fisher farm south of Craigsville, April 12, 1906, one or two taken in open ditch, others at end of tile ditch discussed under *Faxonius immunis*.

Craven ditch, L. R. Vanemon farm, April 13 and 18, 1906.

Pools along C. B. and C. R. R., mentioned above, April 27, 1906, moulting, recently moulted males are of both I and II forms.

Nitro-glycerine swamp, near Hartford City, April 29, 1906, casts very abundant, many individuals recently moulted; fragments of many dead ones lying about; great number of burrows already dug around the edge of the swamp.

Faxonius immunis (Hagen). This species occurs commonly in Wells County, especially in early spring, when they may be expected in almost every ditch and pool, especially the small pools usually formed by the discharge of tile ditches. On April 12, 1906, in a ditch on the Alex Fisher farm, one and one-half miles south of Craigville, a few were taken, and along the same ditch many were found where a tile drain emptied into the ditch. The tile opened about three feet above the water in the ditch and back in the bank about two feet from the ditch. The water fell from the tile in a miniature cataract into a pocket or basin in the clay soil. This clay was almost as resistant to the water as solid rock. The

overflow from this basin into the ditch was blocked by a mass of grass stems and similar rubbish through which the water permeated. In this rubbish were about a dozen dead crays, all females of *argillicola*, excepting a single male of *acutus*. Nearly all of the *argillicola* had eggs or egg cases clinging to the swimmerets, and all but two or three of them had the rostrum broken squarely off, no other injury being apparent. The small basin into which the water from the tile fell was nearly circular, about a foot in diameter and six or eight inches deep. In the sides of this basin were a few short burrows or pockets an inch or two in depth. Just at the edge of the basin was a burrow upward into the bank. This burrow was about two inches in diameter and six inches long. The basin, the short burrows in its sides and the burrow upward from its edge were literally packed with *immunis* in the densest crayfish society I have ever seen. Most of the specimens were females and fully one-half of them carried small black eggs. Altogether at the end of this tile ditch more than 100 individuals were taken; a few were *argillicola*, a still smaller number were *acutus* and the remainder were *immunis*. Dr. Ortmann suggests that the breaking of the rostrum of the dead female *argillicola* may have occurred during fights among themselves.

The eggs of this species are small and black, very different from the large pale eggs of *argillicola*, with which species it is often associated in wet-weather pools or ditches. Females carrying eggs have been taken from March 29 to April 12. On April 29 females were observed with young.

This species, occurring as it does, with one or two exceptions, in wet-weather pools and streams, of necessity becomes a burrower. With the disappearance of water I have no doubt that the crayfish passes into a state of aestivation in most cases. In the case of some this begins comparatively early in the season, while others, because of the greater permanency of the pools or streams which they frequent, have this quiescent period greatly reduced. On October 1, 1905, I took 3 small females and a small second form male from burrows in a swamp four miles north of Bluffton. These burrows were under logs, the opening of the burrow being just at the side of the log. The burrows were of small diameter, simple, nearly vertical, about 18 inches deep, contained several inches of water, and had but little or no earth heaped up about the mouth. But such burrows I believe are not usual and the great abundance of this species and the fact that I have never found burrows of larger individuals lead me to think that the dry season must be spent in a quiescent state.

During the collecting of 1905, males and females were taken in about equal numbers. On March 26, 1905, individuals taken varied from 25 to 65 in length, the smallest female carrying eggs measuring 55.

The species has been taken as early as March 26th and has been found in ditches generally in Lancaster Township from this date to April 2. The following dates and localities may be recorded:

Craven ditch on L. R. Vanemon farm April 8, 1906, females with eggs; a small male had a large leech attached to it; April 13, 1906, males I and II, females with eggs; April 18, 1906.

Six-Mile Creek, May 16, 1906, taken in seine near Bethel Church, two females, 63 and 65.5.

Wet-weather ditch just west of A. R. Vanemon's house, May 18, 1906, abundant, very active, 2 males (II) 62 and 62.5. and one female, 62.

Small wet-weather ditch on James Glasgow farm, May 18, 1906, three males (I) 57, 59 and 61, and one male (II) 47.

Ditch one and one-half miles east of Vera Cruz on the south side of the Wabash, June 10, 1906, 2 males (I) 58 and 66.5.

Eight-Mile Creek, west of Ossian, June 7, 1906, one male (I) 59.

St. Mary's River, Fort Wayne, at Broadway bridge, May 13, 1906, one female, taken in seine.

Faxonius rusticus (Girard). This is the only species in Wells County which occurs at all seasons in streams or permanent pools and nowhere else. Though both *immunis* and *acutus* have also been taken in permanent streams there are reasons to think their presence there is accidental. Because of its habitat this is therefore the best known and to many the only known crayfish. Specimens collected in June, 1905, in Six-Mile Creek were all in the second form. At this time many large individuals were taken, some measuring as much as 90 in length, and specimens 85 in length were common. On September 20, 1905, the species was in first form and collections were made in Six-Mile Creek in the identical spots where seining had been done in June. But on this date the largest male taken measured 70 in length and the largest female 68, and these were exceptional, the other large males in the collection measuring between 55 and 65 in length. The only conclusion possible is that the larger individuals perish during the summer. The largest specimens seen of this species have been males.

The following dates and localities may be recorded:

Gravel pit along Croven ditch, east of L. R. Vanemon's house, April 8, 1906, males in first form, females with eggs.

Six-Mile Creek, from one mile above Bethel Church to Six-Mile Church, May 16, 1906, males all second form, 59 to 86.

Eight-Mile Creek, five miles north and one mile west of Uniondale, May 22, 1906, very abundant, males (II), 54 to 84.5 and one specimen 99, females 50 to 72, females in short burrows in creek bed, young about ready to leave females, in color pale, carapace light green, antennæ, apical half of large chelæ and elbows bright cherry red.

Eight-Mile Creek, west of Ossian, June 7, 1906, males all second form, 64 to 102, only one specimen maximum size; females 50-80.5; June 23, 1906, 13 males (I), 62 to 88, all with old shells, 4 males (II), 52 to 84, 6 females, 67 to 81.

In ditch $1\frac{1}{2}$ miles east of Vera Cruz on south side of the Wabash, June 10, 1906, males all second form.

St. Mary's, St. Joseph and Maumee rivers at Fort Wayne, May 13, 1906, generally abundant, rarest in the St. Joseph, largest males not moulted and sluggish, most individuals recently moulted, only a few females with eggs.

In Pine Creek and Kickapoo Creek, tributaries of the Wabash, in Warren County, on July 1, 1906, males (II) and females of *propinquus* were taken. The occurrence of *rusticus* in Eight-Mile Creek, in the drainage of the Ft. Wayne outlet of glacial Lake Maumee, indicates that the boundary between these two species in the Wabash River must be looked for between Huntington and Delphi, since Hay has recorded *propinquus* for the latter locality. Both species are recorded by Hay from Waterloo, De Kalb County, but exact localities are not given. The distribution of these two species, and in fact of all the species of the State, is a matter that could readily be determined with the co-operation of the high school science teachers of the State. The crayfish in the dissecting pan is common to all high schools. I submit the proposition that the species of crays of a locality, the characters by which they may be recognized, their habits, life-histories, and distribution in the State, are facts more easily learned, of more general interest, and more immediately attractive to the high school student than the rather exhaustive discussion of the anatomy of a crustacean, commonly called crawdad, genus?, species?, related to the lobster, but otherwise uninteresting.

Cambarus ortmanni n. sp.—Named for Dr. A. E. Ortmann, on whose time and energy and broad fund of information it has been the privilege of the author to draw freely during the course of this study of local crays.

Belonging to Faxon's Third Group, subgenus *Bartoni* and section *diogenes* as defined by Ortmann, Proc. Am. Phil. Soc., XLIV, 1905, pp. 117 and 119.

Carapace compressed, with sides and dorsum strikingly flattened, punctate, slightly roughened on the sides and without trace of spines throughout; its greatest width greater than one-half its length. Areola for a part of its length reduced to a line; in length of carapace about 2.3 times. Rostrum concave above, short, triangular, margins convergent; acumen short, triangular. Post-orbital ridges short and low; suborbital angle low. Antennæ not reaching beyond the second abdominal segment.

Chela ovate, coarsely granulate without definite pattern; carpopodite with a large inner, subapical, knob-like spine, and a smaller more acute, sub-basal one; lower side of meropodite generally with reduced and obtuse spines on the inner side only.

Abdomen robust, shorter than the carapace. First appendages of the male suggesting those of *bartonii* but sufficiently distinct; seen in profile from the outside the lower tooth almost reaches the upper tooth (as in *argillicola*, which has the lower tooth proportionately smaller), the two not widely separated as in *bartonii*; the lower edge of the lower tooth passes behind the shoulder of the upper tooth at an angle of about 45° to the long axis of the appendage, and not at right angles as in *bartonii*; so viewed from the side the lower tooth is not a symmetrical tubercle as is the case in *monongalensis*, for example; with the two first appendages side by side the apices of the lower teeth are divergent, more so than in *bartonii*, and not nearly parallel as in *monongalensis*, *diogenes*, *argillicola* and *uhleri*, for example. Annulus ventralis much as in *bartonii* and *monongalensis*, but with the posterior angle more developed and more angulate.

Largest male, 94; largest female, 92. The type male is 90; length of carapace, 48, width 26; areola 21; length of large chela 40, width 20. The type female is 92; length of carapace 48; areola, 21. The largest male has the large chela 46 long and 21.5 wide.

Color in life olive brown without decided markings. Chelæ have plumbeous shades, the ends of the fingers are pinkish and the tubercles whitish; rostrum with very narrow, pale yellowish margin; on the rostrum and just back of it the olive color is clearest; abdominal segments russet-brown basally; tail-fin fringe of hairs black; beneath paler, swimmerets black. The above description was made from the type female during life. A female 63 in length, taken April 18, 1906, was light olive brown, abdomen paler, beneath

almost white, dorsum of abdomen with two rows of brown spots on each side; legs thickly spotted with russet-brown; apices of chela pale yellow. A male (II), 43 in length, taken on the same date, was paler and greener; the dorsum of abdomen, between the two most dorsal rows of spots, pale green.

Wells County, Indiana, March 26 to May 22, from drainage of Six-Mile Creek and Bills Creek, tributaries of the Wabash from the south, and Eight-Mile Creek and Johns Creek, tributaries of the Wabash from the north, very rare, 23 specimens altogether; the type of each sex is in the Carnegie Museum.

A summary of localities and dates of captures follows:

1. Ditch near Craigville (Johns Creek drainage), one female, length 47, April 2, 1905.

2. Eight-Mile Creek, five miles north and one mile west of Uniondale, burrow in spring in creek bank, one male, May 22, 1906.

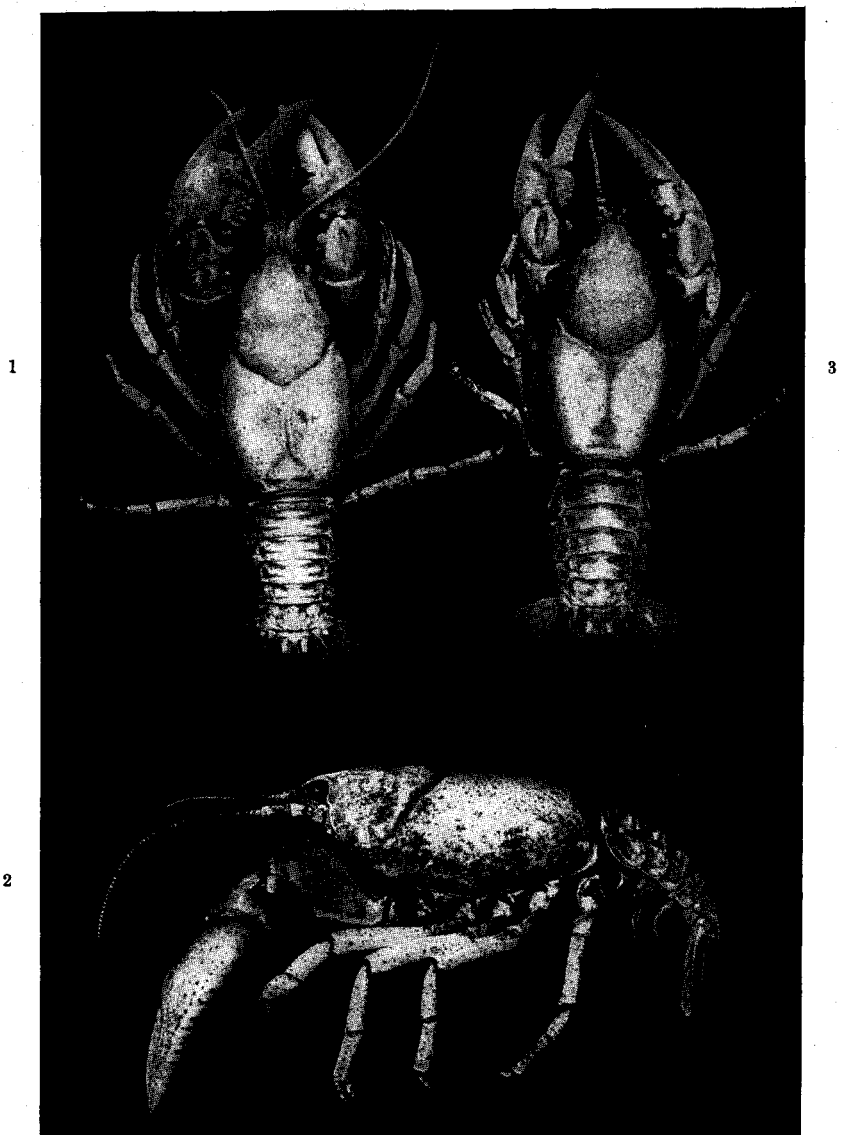
3. Craven ditch, on L. R. Vanemon farm (Bills Creek drainage), one male (I), length 83, March 26, 1905; type female, length 92, April 8, 1906; one female, length 48, and fragments of a male, carapace 42, April 13, 1906; three males (II), length 43, 53 and 69, and one female, length 63, April 18, 1906.

4. Six-Mile Creek from Bethel Church to Six-Mile Church, one male (I), length 94, three females, length 35, 60 and 70, May 20, 1906; three females, length 31, 42 and 84, May 27, 1906; type male (I), length 90 and one male (II), length 50, May 29, 1906.

On April 1, 1906, a male (II), 47.5 length, was taken from a spring near the house on the W. Cover farm northwest of Bluffton, and three small specimens, one male (II), 24 in length, and two females, 26 and 45 in length, were taken from a spring near the house on the Walter Snyder farm north of Bluffton. Both localities are north of the Wabash.

Eight-Mile Creek is a tributary of a stream now occupying the valley of the Ft. Wayne outlet of old Lake Maumee of glacial times. Johns Creek, Bills Creek and Six-Mile Creek are all small tributaries of the Wabash above Bluffton, within a distance of three miles from town. The exact localities for these captures are given because of the apparent rarity of the species in Wells County, the fact that it will probably become rarer here, and that nothing is known of its occurrence elsewhere.

Like all burrowing species in Wells County, this one may be expected in wet-weather ditches from the last of March till at least late in April. The earliest date of capture in ditches is March 26 and the latest April 18. In early April between periods of



CAMBARUS ORTMANNI.

Figs. 1 and 2, type male; fig. 3, type female; from photographs by Prof. W P. Hay.

high water Craven's ditch through L. R. Vanemon's farm is a clear stream two or three feet wide and four or five inches deep. In this ditch I have taken on one date five of the six species of crays occurring in the county; and the sixth species, *rusticus*, is found in Bills Creek, into which the waters from Cravens Ditch pass. Later in the summer this ditch carries no water and the few shallow pools are completely dried up. The actions of *ortmanni* and other burrowers (*diogenes* and *argillicola*) are distinctly different from those of other species. The burrowers move heavily and slowly, rarely swimming when threatened with capture, make little effort at hiding, and are as often found in the middle of the current at a distance from all means of concealment as elsewhere. Of course the young of the burrowers are more active, but they do not approach *acutus* and *immunis* in agility. Of the burrowers *argillicola* is most alert and active. On April 18, 1906, three small males and one female of *ortmanni* were taken under rubbish which had accumulated at the water's edge, beneath the bridge over Cravens Ditch. The single male taken along Eight-Mile Creek was in a short burrow, situated a foot or two from the water's edge, where a little spring oozed from the creek bank. Six-Mile Creek has probably more springs along its course and in its bed than any stream of its size in Wells County, though springs are not abundant even here. Many tile ditches open into the creek's banks. About the end of one of these ditches, carrying a slight amount of cool water, three females were taken on May 20, 1906. The burrows were back under the first tile, were short and but little dirt was piled up. On the same date at another ditch, flowing cool spring water, a slight amount of dirt was observed thrown out about the end of the tile. The tile was pulled from its place in the bank, revealing a large burrow. At a depth of about 18 inches in this burrow the largest male, 94 in length, was taken. All specimens taken along Six-Mile Creek were under tiles from which flowed more or less cool water. On May 16, 1906, Six-Mile Creek was carefully seined from one mile above Bethel Church to Six-Mile Church, but no *ortmanni* were found in the stream. The female, .84 in length, taken May 27, 1906, was in a very intricate winding burrow, with many pockets, in one of which the cray was found. This burrow was horizontal or nearly so in much of its course, with a small quantity of homogeneous earth heaped up at its mouth. None of the females taken have carried eggs or young and in no case has more than one specimen been taken from a single burrow. The burrows themselves may be the work of other species, but I

believe not. I have taken *acutus* in burrows which I opened hoping to get *ortmanni*, but this has happened only a few times. The burrows where I took the largest male on May 20, 1906, was subsequently cleaned up and extended and occupied by a large male *diogenes*, which I captured on May 29, 1906.

The four specimens captured April 18, 1906, in Cravens Ditch were taken home alive and placed in a basin of water. The two largest, a male, 69, and a female, 63, fought viciously whenever they met. One of them killed the male, measuring 53, tore off a leg, and mutilated the abdomen. The smallest one, a male, 43, escaped their attacks by its activity.

The relationship of the species is not altogether certain. In a letter of January 23, 1906, Dr. Ortman writes: "Your specimens are markedly different from the typical *bartonii* (which I had labeled them) not only in the very narrow and longer areola, but also in other characters, chief of which is the carapace, which is depressed in *bartonii*, while here it is rather compressed. The relation of height at gastrical region (G) to width at hepatic (H) and branchial (B) is as follows for species mentioned: *bartonii*, G—H—B=1—1.4—1.6; your specimens, G—H—B=1—1.06—1.3; *carolinus*, *monongalensis*, *diogenes*, G—H—B=1—1—1.1. Thus your specimens are nearer the burrowing forms and I believe that they actually belong to the *diogenes* group, being closer to *carolinus* and *monongalensis* than to *diogenes*." The type male and females were sent to Prof. Hay, who very kindly made the photographs for the plate accompanying this description. At the U. S. Natl. Mus. he compared these types with the extensive series of *bartonii* there. Under date of November 18, 1906, he writes: "Your specimens represent a form with the areola obliterated, with the carapace compressed or cylindrical, the fingers not very strongly ribbed, and the rostrum more decurved and slightly differing in form from any of the specimens which I have identified as *C. bartonii*. At the same time it resembles *C. bartonii* much more closely than it does anything else. We have here one female specimen collected by me at Irvington which has a very narrow areola and which may be regarded as truly intermediate between your specimens and those of southern Indiana. These grade in turn into the Kentucky and eastern Indiana forms." In the reduction of the areola *ortmanni* most nearly approaches the burrowing species of the subgenus, though in robustness and form of carapace it is unique, none of them having the carapace dorsally flattened and with the width greater than one-half the length. In color

and size it suggests *bartonii*, the maximum size known for *monongalensis* and *carolinus* being respectively 76 and 80, while the maximum for *ortmanni* is 94, and specimens of the southern Indiana form of *bartonii*, collected for me by Mr. Newton Miller, exceed 100. Also in the reduction of spines in adults *ortmanni* is unique, the two inner spines on the carpopodite especially losing the character of spines and becoming knob-like structures. In younger individuals these are spine-like, as they are in the largest adults I have seen of *bartonii*, *monongalensis* and *carolinus*. In the spines of the meropodite there is great variation, largely dependent, though not altogether, on age. There may be low spines on both the inner and outer lower edges or both may be practically smooth. In the general form of the carapace *ortmanni* suggests *C. latimanus striatus* Hay of which I collected the type and of which I have specimens from the type locality. These specimens were all collected in a wet-weather ditch and I believe that burrows are certainly dug as the water disappears. In *striatus* the areola is proportionately shorter, the rostrum has the sides more convergent, and the acumen is less abrupt than in *ortmanni*. *Striatus* also differs in sculpturing of hands and spines on the carpopodite, and decidedly in the form of the first abdominal appendages of the male. In *striatus* the upper tooth is long, slender and recurved, longer than the lower tooth, the two teeth widely separated; in *ortmanni* the teeth are shorter, heavier, closely approximated and about equal in length.

Bartonius diogenes (Girard). This, the largest of our crays, is freely distributed over the county. In early spring the largest and oldest males come from their burrows to wander about in ditches, over fields and across highways. I have found them as early as March 26 and as late as the latter part of April. Along some swift flowing ditch, fed by the clear water discharged from tile ditches one can certainly expect to find a large male or two in early April. There he walks heavily and slowly on the bottom. He seeks no concealment. A little eddy catches him and turns him over and over. He slowly rights himself and goes blindly on over a little waterfall. The great pincers are still strong, but they are a burden now. The death instinct is on him. His life of burrowing and concealment has preserved him for this and he now fares forth to become food for raccoon or pig or crow or to be crushed under the hoofs of farm animals. The burrows of this species occur in open fields, usually in low land. Burrows placed in higher and drier locations often lack the chimneys, which are often so conspicuous about some swamp, or have them lower and less perfectly

constructed. In this species the most elaborate chimneys I have seen were those built by smaller individuals over short burrows where the land level was near the water level. Frequently the beginning of the burrow is a horizontal shaft back in some creek bank on a level with the water. Through this shaft the dirt excavated in driving the vertical burrow upward and downward is carried and dumped into the creek. With the completion of the vertical burrow to the surface, much or all of the soil excavated at the bottom of the burrow is carried to the surface. Hence the chimney may be composed entirely of light yellow clay brought from a depth of two feet or more.

This species occurs about two small glacial lakes in Jackson Township. On May 25, 1905, a large female taken from her burrow was carrying nearly hatched eggs. The largest male seen was taken in a ditch near Craigville, April 2, 1905, and measured 124 in length. On April 1, 1906, 22 males and 11 females were taken in a small ditch on the Ed Ware farm north of Liberty Center. All were large, males all first form and the smallest 85 in length. None of the females carried eggs; the largest was 124.5. Dr. Ortmann thinks all of this lot of 33 specimens were at the end of their lives. The male 124 and female 124.5, mentioned above, are the maximum recorded sizes for this species, the largest hitherto being 115 by Hagen.

The following dates and localities may be recorded:

Springs north of Wabash River, northwest of Bluffton, April 1, 1906, three males (I) 80, 82 and 83, one male (II) 25, two females, 21 and 40.

Craven ditch, Vanemon farm, April 8, 1906, and April 18, 1906, all old males; June 9, 1906, one female, 112, with young, 10 in length.

Eight-Mile Creek, five miles north and one mile west of Uniondale, May 22, 1906, from burrows in creek bank, male (I) 110, female, 98, with eggs.

Six-Mile Creek at Six-Mile Church, May 29, 1906, males and females from burrows in creek bank.

Ditch near Craigville, April 29, 1906, two large females without eggs, one dead in the water without sign of any injury.

Along ditch $1\frac{1}{2}$ miles east of Vera Cruz on south side of Wabash, June 10, 1906, three large females, one with exuviae on abdominal feet, two carrying recently hatched young, measuring about 7.5; one female was carrying 215 young, the other 87. These two females were taken at the surface near burrows. Their presence

out of their burrows is to be explained I believe by an attempt on their part to regulate the temperature of water for their young. Following heavy rains the temperature of the water in burrows would be considerably lowered by the intake of subterranean water, while the water of the conveniently adjacent ditch would change but little in temperature, remaining appreciably warmer than the cooled water of the burrows.

Swamp near nitro-glycerine factory, north of Hartford City, April 29, 1906, many fragments of large individuals, one male (I) 83, dug from a burrow.

Bartonius argillicola (Faxon). While *diogenes* is the burrowing species of open fields and swamps, this species prefers thickets or woodland. In the spring I have taken a few specimens in pools in woods, and in tramping through woodland in search of hawks' nests I have found many large pinchers of males. In April, 1905, this species was very numerous in ditches near Craigville. On April 2d, females were carrying eggs which were beginning to hatch and in ditches females were eight or ten times more numerous than males. The average size of females with eggs was about 65 and the smallest female with eggs was about 53. Specimens about 25 in length were taken March 26, 1905.

The following dates and localities may be recorded:

Small ditch on Ed Ware farm north of Liberty Center, April 1, 1906, one male and eleven females, females with eggs.

Ditch northeast of Bluffton, south of Wabash, April 1, 1906, a large female with eggs; a large leach was attached to the cray, which was lying on its back in the water apparently helpless.

Craven ditch, L. R. Vanemon farm, April 8, 1906, large and small individuals, two females with eggs; April 13, 1906; April 18, 1906, female with young.

Ditch $1\frac{1}{2}$ miles south of Craigville, on Alex Fisher farm, see discussion under *immunis*.

Woods east of swamp on H. Vanemon farm, April 13, 1906. In 1905 several unsuccessful attempts were made to determine the species of cray in this colony of burrows. The burrows pass in and out among the interlaced tree roots making their excavation very difficult. April 13, 1906, at a depth of about $3\frac{1}{2}$ feet a male and female of *argillicola* were taken from a burrow. On this date water completely filled the burrows.

Pools along the C. B. and C. R. R. near the Muncie interurban crossing, April 25, 1906, several specimens, one large male without apparent injury found dead; April 11, 1906.

Fred Reppert farm east of Vera Cruz in Adams County, from burrow in yellow clay on hillside, one male, burrow about four feet deep.

To summarize, it may be said that on a favorable day in early April the six species of crays occurring in the county may all be taken without digging in an area covered by a walk of a quarter of a mile. In all western Pennsylvania, including the lake and Mississippi drainage, an area having great range in altitude, Dr. Ortmann has found only five species and one variety, and there is no reason to believe others will be found there. The six species of Wells County occur at the same level and in all parts of the county, their distribution determined entirely by the water supply. *Rusticus* has a continuous habitat determined by the course of streams in which all its life is spent; *immusis* during its period of activity is an inhabitant of mud-bottomed streams and pools from which the water disappears early in the season; *acutus* is an inhabitant of more permanent marshes, especially in woodland; *ortmanni* digs its burrows in the vicinity of cool running water; *diogenes* is an inhabitant of the warm subterranean waters of fields and marshes; and *argillicola* prefers the cooler subterranean water of forests and thickets. Of course the high waters of spring render marsh, ditch, creek and river one continuous, unbroken water-way and greater or less mingling of species at this season, when all waters are practically the same temperature, is inevitable.

In the preparation of this paper I have had the invaluable help of Dr. Ortmann, through whose hands nearly all my specimens have passed, thus securing an accuracy of determination of which I am not capable. To Professor Hay I am indebted for the excellent photographs reproduced in the halftone plate which accompanies this article, and for a careful comparison of the types of *ortmanni* with the large material in his collection and in the U. S. Nat. Mus. To several friends in Wells County I am indebted for specimens.