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JANUARY 1918

Vol. XXXI, No. 10.

THE OTTAWA NATURALIST

Published by The Ottawa Field-Naturalists' Club

Editor:

ARTHUR GIBSON,

Entomological Branch, Department of Agriculture,
OTTAWA.

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THE OTTAWA NATURALIST

Vol. XXXI.

JANUARY, 1918.

No. 10.

THE CANADA PORCUPINE.

BY CHARLES MACNAMARA, ARNPRIOR, ONTARIO.

The abrading and compacting which all language undergoes in the course of time have changed the "porcus spinatus" or spiny pig, of the Latins into the "porcupine" of modern English. Zoological classification among the ancients was based on very superficial resemblances, and so it is not surprising to find that they regarded this short-legged, thickset rodent as a kind of pig. Numerous species of porcupines inhabit the four quarters of the globe. In the Old World, where the family originated, they are all terrestrial in their habits, and some kinds are armed with quills so enormous that they are often used to make fancy penhandles. The porcupines of the New World are mostly tree-dwellers, and one or two of them have prehensile tails. They seem to have come across from Africa to tropical America by some very early land connection far older even than the fabled Atlantis. Most of them stayed in the tropics, only one genus of two species having extended north of Mexico. These are the yellow-haired porcupine (*Erethizon epixanthus*) of the west, and the Canada porcupine (*E. dorsatus*) of the east.

Although popularly called the "Canada" porcupine, we in this country cannot claim the animal as our exclusive compatriot, for it is a familiar resident of the wooded regions of all northeastern America as far south and west as Pennsylvania and Ohio. In eastern Ontario it is abundant, and in the course of a day's drive in the spring before the leaves are out, it is not unusual to see three or four of them in the treetops.

Judging the appearance and expression of animals by our human standards, we are often amazed to find some species, like the elephant or the pig, far more intelligent than it looks. The porcupine, however, looks stupid, and is even more stupid than it looks. A large Canada porcupine, Mr. C. W. Nash tells me, sometimes attains to a body length of three feet; but usually an adult is about two feet long exclusive of the tail, and weighs 25 lbs. to 30 lbs. Its body is thick and heavy, and its movements are slow. Its head is small and pointed, with but scant room for the brain, and the little sleepy eyes are almost lost in the long hair; the nostrils are open, and the lips fail to close

over the large orange-colored, chisel-like teeth. The short thick legs terminate in small horny-soled feet armed with long black claws well adapted for climbing. The limbs and the stout body, with the exception of the middle of the back, are clothed with long fine, almost woolly hair. Intermixed with this along the sides and over the nape is a wide band of stiff, coarse, grey-tipped hair about six inches long, and the forehead bears a short tuft of grey bristles. Along the middle of the back and out to the end of the short tail grows a dense mass of erectile quills, mixed with a few long black hairs. The quills are of all lengths from less than an inch to three and a half or four inches long. In addition to this principal mass, there is a scattered growth of short but stout quills concealed in the hair all along the sides and over the head, extending low down on the forehead and above the eyes. Only the underparts of the animal are entirely free from the spines.

I have never come across the young of the porcupine myself, but I am informed by Mr. C. W. Nash that they are born in May, two to four in a litter, and are at birth extremely large in proportion to the size of the adults. They are covered with long black hair interspersed with quills about half an inch in length.

The quills of the adult are white at the base, shading towards the top into yellow and dark brown to black. The largest of them are $3\frac{1}{2}$ inches to 4 inches long (approximately, 90 mm. to 100 mm.) and about $1/16$ inch (approximately 2 mm.) in diameter at the thickest part. They are clearly only modified hairs, and various types may be found on the same animal, ranging from plain stiff bristles through slender smooth-pointed spines up to stout needle-sharp barbed quills. The quills are loosely held in the soft fat skin by a conical root with a rounded shoulder, and they appear to come out at the slightest touch. Indeed, before trying some experiments I could not understand why they did not all fall out in the ordinary stress of daily life; and I formulated a theory, that when the quills were in their normal depressed position, they were held in the skin more firmly than when they were erected to stand off an enemy. Herbert Spencer's friends said that the philosopher's sole idea of a tragedy was a beautiful theory killed by a devilish little fact. In my case the little fact was that the quills were *not* held more firmly in one position than in another. Admittedly, the porcupine, I experimented with was a dead one, but I cannot see that there would be any difference in the result in life. The truth is that it requires a pull of a quarter of a pound or so to free the quills from their sockets, and no ordinary friction to which they are subjected is sufficient to remove them. But when once the point of the quill is caught in the flesh of an enemy, the barbs hold it so firmly that it readily pulls out of the porcupine's skin.

The barbing, which is so minute that its structure can only be seen under considerable magnification, is formed simply of tiny overlapping scales, like shingles on a roof. To the touch it is only a slight roughness at the point of the quill, but the hold it takes is astonishing. Once the quill makes an entrance, it never draws back, and every movement of the victim only serves to drive the dart in deeper. Its policy, like that of the high-handed Strafford is "Thorough." A hapless dog with his nose, jaws and tongue stuck full of these inexorable little arrows is a most painful sight; and a strong forceps is needed to pull them out.

Obviously, without the protection afforded by its quills, the slow-moving, dull-witted porcupine would fall an easy victim to its many predaceous enemies; but usually wild creatures seem to leave him alone, and those that do attack him are generally sorry for it. Hornaday says that pumas and lynxes have been found in starving condition with their mouths and throats stuck so full of porcupine quills that eating was impossible; and I have heard of horned owls taken with numerous spines piercing their claws.

The only animal known to prey on the Canada porcupine habitually is the fisher (*Mustela pennanti*). This active tree-climber hunts the porcupine assiduously for food, and when it has exterminated them in one district moves on to the next. Its method of attack seems to be to turn the porcupine over on its back and eat it out from the belly. I have seen foxes feeding in this way on a porcupine shot by a wanton hunter. But like the Scotch thistle, the porcupine cannot be assailed with impunity, and a fisher with a taste for porcupine meat always has numerous quills implanted in his head and breast, but which, strange to say, do not seem to incommode him very much. An ancient error, still in existence in connection with the porcupine family, is that they can shoot their quills to a distance, and some old writers went so far as to affirm that in this way the porcupine could kill very large animals. Considering that more than 150 years ago the majestic M. Buffon himself went to the trouble of disproving the myth by practical experiments, and that since his time no writer of any standing has attempted to support the fiction, it is very remarkable that it should still be current. It is true that in "Hiawatha" Longfellow commits the double zoological crime of referring to the porcupine as a "hedgehog" and of asserting that the animal "shot its shining quills like arrows," but the fallacy is commonly repeated by people who never heard of "Hiawatha" or Longfellow either. Apparently, like the story firmly believed by most small boys that if you soak a horse hair in water it will turn into a snake, the fable is handed down by oral tradition among the illiterate.

So far from ever shooting its shining arrows, the fact is that beyond erecting its quills and sometimes striking at the aggressor with

its spiny tail, the porcupine always stands strictly on the defensive. He is the original passive resister. One winter morning while breaking my way on snowshoes through a thick growth of alders along the edge of a swamp, I came on a porcupine trying to hide in the hollow butt of an ash tree. Protected by my heavy deerskin mitts, I seized him by the hind legs in order to carry him out into the open with the intention of photographing him. Naturally, he objected to this impertinence, and in his struggles his formidable yellow teeth came alarmingly close to my hand. But the poor creature never made the slightest attempt to bite. His faith was all in his quills: they had failed him, and he knew no other defence. But to carry 25 lbs. of contorting porcupine at arms length with one hand, and my camera and tripod with the other, and to force a way through the brush, all at one and the same time was too much for me, and I had to drop the porcupine. He promptly hitched himself up to the top of a tall young red maple, climbing the smooth bark as easily as a person goes upstairs. This was about noon, and as I left him, it was beginning to snow heavily. I passed the place again on my way home about five o'clock in the evening. It was still snowing, and there was the porcupine clinging to the slender maple top in exactly the same position in which I had left him five hours before, with about four inches of snow piled on his back! I have often wondered how long he stayed there.

Our porcupines occasionally make their dens in a hollow log or under an upturned stump, but their favorite dwelling is in a crevice between the stones of a rocky hillside. They be but a feeble folk yet make they their houses in the rocks. They are confirmed vegetarians, living in a state of nature exclusively on bark and twigs; and being poor travellers they always lodge close to their food supply. This is often a poplar tree, on which they feed continuously night after night—they are mostly nocturnal in their habits—until it is completely stripped of its bark out to the very end of the branches. They also browse on cedars, hemlocks and spruces, but in the case of these conifers, it is the tender twigs that they eat. In the winter, their resorts are readily discovered by the trench-like path they make in the snow from their den to the tree they are feeding on. And their table manners being sadly wanting in refinement, they let many succulent pieces fall to the ground, which are so attractive to the hares, that the snow beneath the porcupine tree is generally trampled hard by the concourse of *Lepus americanus* gathered to feast on these crumbs from the rich man's table.

While the porcupine is a vegetarian, he is not a bigoted one. He feeds on all kinds of scraps around a camp and sometimes he indulges in peculiar hors d'œuvres. Fire rangers often complain that the porcupines eat their cotton posters off the trees; and lately a farmer on

the Bonnechere who left a set of harness in a shed in the woods over summer, found it chewed to pieces in the fall. Like all herbivores, porcupines are extremely fond of salt, and will greedily gnaw anything with a salty taste. I have been told of a camp on the Gatineau where they completely ate away a veranda post that had some brine spilt on it; and a similar example is afforded by the experience of a friend of mine on a canoe trip through Algonquin Park. One night he was awakened by a deep reverberating noise repeated again and again, coming from some little distance down stream. My friend said it sounded like a horse galloping over a wooden bridge, but there was no road within many miles and there was no bridge. At last he got up to investigate, and discovered that the disturbance was caused by a porcupine gnawing the inside of an empty bacon case left on the shore by a drive gang. Under the vigorous rasping of the porcupine's powerful teeth, the boards of the case thundered like a brass drum. But the appetite for salt does not explain why a porcupine last summer gnawed many square feet of the dry weather beaten boards of an old shed at an abandoned mine near Calabogie. Both inside the building and outside, from the ground level up to a height of six or eight feet, he chewed away large patches of the wood, in some places eating completely through the boards. What sapidity he discovered here is a mystery.

It is said that when quarrelling with one of its own kind, the porcupine gives vent to a variety of noises, but the only sound I have ever heard them make is a kind of whining grunt, best described as just about the kind of sound you would expect from a porcupine. But it seldom expresses its emotions vocally, and when assailed it keeps its back to the foe, and maintains a dogged silence. All one winter, my friend Mr. Armon Burwash and I paid weekly visits to a large old porcupine who lived in a hole in the rocks on a bare hillside. We knew he was old, for it must have taken him years to accumulate the dirt that matted his quills together, and which exhaled a strong, but truth to tell, inoffensive enough, odor of cedar. The den was simply a low tunnel open at either end, and roofed over with a couple of large blocks of limestone. We always found him in, though his lodging was in a most exposed situation, open to all the winds of heaven, and on a cold winter's night it certainly could not have been described as cosy. But be it ever so humble there's no place like home, and our friend seemed well satisfied with his quarters. We called him our friend, but it is doubtful if he reciprocated the sentiment. Mr. Burwash suggested that he used to say to himself when he heard us coming: "Confound it, there are those two hanged nuisances again!" For every week we tried some new scheme to drive him out of his den; but all in vain. We reached in through a hole in the roof and slapped him on the back, the only result being a dozen long

quills stuck firmly in our buckskin mitts. By poking a stick in one end of the tunnel, we tried to force him out of the other end; but he would have evidently suffered death rather than move an inch. An attempt to smoke him out with a smudge choked and blinded us, but had no effect whatever on the steadfast porcupine. So, not wishing him any real hurt, we at last gave up, and left him to the cold comfort of his wind swept hillside.

An ambition of mine has long been to get a good photograph of a porcupine in his native wilds. They are plentiful enough, but one generally sees them high up in the tree tops or finds them wedged inaccessibly into a crevice in the rocks. One day last summer, however, I came on a fine young specimen wandering along the edge of a beaver meadow, and alas! my camera was at home. Next day I had occasion to visit the same place again, but as I thought there was no chance of seeing the porcupine the second time, and the day was very hot, I decided not to burden myself with a camera. And when I came to the beaver meadow, there were *two* porcupines ambling side by side in the grass. The third day I loaded myself with all my apparatus, and set out for the meadow with high hopes. "The third time is the charm." There was no porcupine there, and I have not seen one since.

NOTES ON THE BIRDS IN AN OKANAGAN ORCHARD.

By J. A. MUNRO.

The following notes apply to a ten acre orchard of mixed fruits on Okanagan Lake, B.C. The fruit trees are planted on a narrow strip of land, at the base of an abrupt rise. Behind this small hill are a series of benches, originally covered with bunch-grass (*Agropyron spicatum*) and now partly sown to alfalfa. Behind these benches is a steep rocky mountain, five hundred feet in height, covered with a fairly heavy growth of Douglas fir (*Pseudotsuga taxifolia*) and Yellow pine (*Pinus ponderosa*) with several patches of Quaking aspen (*Populus tremuloides*) and Mountain birch (*Betula fontinalis*). A waggon-road has been built close to the shore of the lake, and on the lake side of this road there is a continuous row of various species of wild fruit; chiefly Black haw (*Crataegus douglasi*) Bitter cherry (*Prunus emarginata*) and Service berry (*Amelanchier alnifolia*).

The summer of 1916 was remarkable for the number of birds that visited the orchard, in excess of the normal population of breeding birds. In spite of the abundance of natural food afforded by the wild fruits, many species showed a marked preference for the orchard crop. Italian prunes, sweet cherries, and several varieties of plums

were eaten extensively by Bullock's Oriole (*Icterus bullocki*), Western Tanager (*Piranga ludoviciana*), Cassin's Purple Finch (*Carpodacus cassinii*), Catbird (*Dumetella carolinensis*) and Western Robin (*Merula migratorius propinquus*). The largest and ripest fruits were attacked first; generally, only a small portion of each fruit was eaten and in some cases they were only slightly punctured but rendered unfit for marketing. About seventy-five per cent. of the cherries and forty per cent. of the prunes and plums were destroyed.

Of the wild fruits, the Service berry (*Amelanchier alnifolia*) was the most freely eaten; even such species as Tree Swallow (*Iridoprocne bicolor*), Rocky Mountain Hairy Woodpecker (*Dryobates villosus monticola*), Red-naped Sapsucker (*Sphyrapicus varius nuchalis*), and Red-shafted Flicker (*Colaptes cafer collaris*) were seen eating them. Kingbird (*Tyrannus tyrannus*), Northern Pileated Woodpecker (*Phloeotomus pileatus abieticola*), and Red-eyed Vireo (*Vireosylva olivacea*) were partial to the white berries of the Red dogwood (*Cornus stolonifera*).

Mountain breeding birds such as Western Tanager, Townsend's Solitaire (*Myadestes townsendi*), Willow Thrush (*Hylocichla fuscescens salicicola*) and Cassin's Purple Finch came down from the hills as soon as the young were able to fly, and remained in the orchard and the brushy thickets in the vicinity, for the remainder of the summer, or until such as were migratory, departed for the south. During the latter part of July and early August the hills were almost destitute of bird life.

The following species bred commonly in the orchard and in the trees and brush along the lake shore.

Red-shafted Flicker; Western Meadowlark, (*Sturnella magna neglecta*); Western Chipping Sparrow, (*Spizella socialis arizonae*); Western Vesper Sparrow, (*Pooecetes gramineus confinis*); Spurred Towhee, (*Pipilo megalonyx montanus*); Kingbird; Arkansas Kingbird, (*Tyrannus verticalis*); Alaska Yellow Warbler, (*Dendroica aestiva rubiginosa*); Cedar Waxwing, (*Bombycilla cedrorum*); Western Wood Pewee, (*Myiochanes richardsoni richardsoni*); Bullock's Oriole; Tree Swallow; Mountain Bluebird.

During the past seven years, there has been a noticeable increase in the number of birds breeding in the orchard and vicinity. During that time much of the sheltering brush has been cut down and a number of houses have been built. The increase is no doubt largely due to the merciless warfare that has been waged against such enemies as crows, magpies, squirrels and chipmunks. These are the chief enemies of orchard breeding birds, but the white-footed mouse (*Peromyscus*) is suspected of being an egg thief. Nests containing eggs, that had been under close observation for several days, were found rifled of their contents, and with the lining of the nest pulled

out and hanging over the rim; as if the horsehair or other fine material, had been caught on the claws of some small mammal. These depredations, apparently occurred at night and were done at a time when squirrels and chipmunks had been cleaned out of the orchard.

The following notes show the gradual increase of mountain-breeding birds and the first movement of the fall migration.

July 12, 1916—A slight increase in the numbers of birds in the orchard. Broods of Audubon Warblers (*Dendroica auduboni auduboni*), Western Vesper Sparrow, Shufeldt's Junco (*Junco hyemalis connectens*), and Calaveras Warbler (*Vermivora rubricapella gutturalis*) appear.

July 15, 1916—The hedge full of birds, feeding on service berries; Catbirds unusually plentiful.

July 26 to July 28, 1916—Hundreds of swallows of all species, passing through.

July 16 to August 8, 1916—A steady increase during this time. Broods of Red-naped Sapsucker, Townsends Solitaire, Wright's Flycatcher (*Empidonax wrighti*) and Olive-backed Thrush (*Hylocichla ustulata swainsoni*) appear.

August 10, 1916—Large flocks of Cassin's Purple Finch, juvenals and adults arrive.

August 11, 1916—Spurred Towhee, adults and juvenals very plentiful. Several juvenal Western Evening Grosbeak (*Hesperiphona vespertina montana*) and Lazuli Bunting (*Passerina amoena*) seen.

August 12, 1916—Large increase in the number of Bullock's Oriole and further increase of Cassin's Purple Finch.

August 14, 1916—Bullock's Oriole, Cassin's Purple Finch, and Western Tanager very destructive in the orchard. The locally bred robins have left.

August 15 and 16, 1916—The orchard nearly empty of birds.

August 17, 1916—Large flocks of Shufeldt's Junco, Pine Siskin (*Spinus pinus*), Western Robin and Western Chipping Sparrow arrive. Arkansas Kingbirds and Bullock's Orioles have all left.

August 20, 1916—Nearly all the catbirds have migrated.

August 21, 1916—The common kingbird left to-day.

August 24, 1916—Cedar Waxwing and Cassin's Purple Finch are still numerous. The former prefer the wild fruit to the domesticated.

THE RICHMOND FAUNAS OF LITTLE BAY DE
NOQUETTE, IN NORTHERN MICHIGAN.

BY A. F. FOERSTE.

(Continued from page 103).

Pterinea (Caritodens) demissa (Conrad) is represented by specimens 50 millimeters in height, both in the cherty Richmond and in the upper part of the underlying argillaceous Richmond. At both horizons it is associated with a *Byssonychia* which is similar to the form occurring more or less abundantly in the Waynesville member of the Richmond on Manitoulin Island, in Ontario, but good specimens for figuring are rare.

The *Opisthoptera* occurring in the cherty Richmond bears a general resemblance to *Opisthoptera casei* (Meek and Worthen) but probably is a distinct species. Anteriorly, along the umbonal ridge, the shell is convex and elevated above the more posterior parts of the shell very much as in *Byssonychia*, and this appearance is strengthened here by a tendency of the radiating plications here to remain simple. Moreover, the anterior outline of the shell is concavely curved near the beak and convexly curved below, more as in *Byssonychia* than in typical *Opisthoptera casei*. Along the posterior part of the middle third of the shell, posterior to the umbonal part, the plications are arranged in fasciculate groups, while along the posterior third and also along the anterior margin the plications tend to be narrow, numerous, and subequal. This probably is a new species, but no specimens suitable for figuring have been found so far.

CLIONYCHIA ANGUSTA sp. nov., Fig. 20. This species has been figured so as to suggest a form similar to *Clionychia excavata* Ulrich (Geol. Surv. Ohio, vol. 7, 1893, pl. 51, figs. 4, 5), from the White-water member of the Richmond in Indiana. As a matter of fact, however, the specimens at hand do not show any indication of a ligamental area along the upper part of the shell when thus oriented. Compared with the Indiana species, when thus oriented, the shell is narrower and the basal part is more abruptly rounded. It occurs in the cherty Richmond, associated with specimens of *Cynatonota* resembling *Cynatonota typicalis* Ulrich but not sufficiently preserved to make their identity certain. Small modiolopoid specimens resembling *Colpomya faba* (Emmons) also occur.

Ten feet below the base of the cherty Richmond there is an argillaceous band, 12 to 18 inches in thickness, forming a single layer, usually spalling off in larger masses than the immediately overlying or underlying strata; in this layer fossils, with the exception of certain lamellibranchiata, are few. This is the chief horizon for

Pholadomorpha pholadiformis (Hall), originally described and figured from this locality (Rept. on Geol. of Lake Superior Land District, 1851, page 213, pl. 30, figs. 1 a-c; pl. 31, fig. 1). Here it is associated with a species of *Modiolopsis* curved as in *Modiolopsis concentrica* Hall and Whitfield, but erroneously regarded by Hall as identical with *Modiolopsis modiolaris* (Conrad), from the Lorraine of New York, a form having a relatively straight hinge-line. This form from the Richmond of Little Bay de Noquette is much larger than typical *Modiolopsis concentrica* and probably represents a distinct species. It is more or less abundant in the Lorraine-like strata which form the lower part of the Richmond section in various parts of Manitoulin Island, on the southern shores of Georgian Bay, and north of the western half of Lake Ontario. Among other specimens of *Modiolopsis* found associated with *Pholadomorpha pholadiformis* occurred a specimen, apparently shortened by pressure (Fig. 21), whose affinities for the present must remain in doubt.

The species of *Archinacella* occurring in the cherty Richmond (Figs. 16, A, B), is more circular in outline and more distinctly elevated toward the beak than in *Archinacella richmondensis* Ulrich, from the Whitewater member of the Richmond in Indiana; moreover the concentric striations are rather fine and not distinctly delimited at equidistant intervals. The general appearance of the shell is smooth. Similar specimens occur in the cherty Richmond two miles southwest of Kagawong, on the road to Gore Bay, on Manitoulin Island, Ontario. The shell is regarded as a new species, *ARCHINACELLA KAGAWONGENSIS*, the specimens from Manitoulin Island forming the types.

In the same cherty Richmond, on the eastern shore of Little Bay de Noquette, occurs *Cyrtolites ornatus*, Conrad, a form of *Hormotoma gracilis* (Hall), *Lophospira bicincta* (Hall), *Helicotoma brocki*, Foerste, and a species of *Conularia*. The *Hormotoma*, Fig. 17, is a thick-shelled form; and is notable chiefly for its size. The *Lophospira*, Fig. 18, has a more angular peripheral and upper carina than the enlarged figure suggests, but there is no evidence of a trilineate peripheral band and the lower volution is distinctly convex for some distance below the lower carina. No fourth carina is present.

Helicotoma brocki, Foerste (Bull. Sci. Lab. Denison Univ., vol. 17, 1912) is common and attains a width of 18 millimeters. The only fragment of *Conularia* found evidently belongs to some fairly large species, and may be identical with *Conularia formosa*, Miller and Dyer, from the Richmond and Maysville groups of Indiana and Ohio.

A single specimen of a species of *Orthoceras* (Fig. 19) resembling *Orthoceras amplicameratum* Hall, from the Trenton of New York, in its rate of expansion and in the ratio of the distance between the septa

to the diameter of the shell, was found loose, about a mile north of the light house at the southern end of the peninsula. Its horizon appears to have been the cherty Richmond. It differs from the Trenton species named in having the septa relatively even more distant, the ratio mentioned above varying from 5 to 8 in 10. The siphuncle apparently was narrow and cylindrical, probably not exceeding a millimeter and a half in diameter where the width of the shell is 15 millimeters.

A species of *Amphilichas* and one of *Chasmops* occur in the cherty Richmond. The fragment of the first (Figs. 27, A, B), as far as preserved, cannot be distinguished from the type of *Amphilichas cucullus* (Meek and Worthen), described from the Kimmswick limestone, in Alexander county, Illinois, (Geo. Surv. Illinois, vol. III, 1868, pl. 1, figs. 6 a, b, c). This type is numbered 12021 in the Worthen collection in the University of Illinois, and was examined through the courtesy of Prof. T. E. Savage. The axial and lateral lobes of the glabella, the occipital segment, and as much of the fixed cheeks as remains, present the same appearance in the Richmond specimen and in the Kimmswick type from all points of view. Although at first sight the Richmond specimen appears to be much more abundantly tuberculated, a close examination of the Kimmswick type indicates the presence of similar tubercles or granules, but those of the Richmond specimen are much more prominent, at least in their present state of preservation. Two figures of the Kimmswick type (Figs. 26 A, B) are here presented. The first presents the left side of the type of the cephalon, and the second illustrates the anterior, so placed as to have the top of the axial lobe parallel with the line of vision.

The associated specimen of *Chasmops*, mentioned above, consists of a fragment presenting the middle and lateral lobes of the glabella and the occipital segment. This is sufficient to indicate the generic reference. In the illustration here presented (Fig. 32), a faint outline of the probable course of the movable cheeks and genal spines is presented, but this part is not preserved in the specimen at hand. For purposes of comparison, several illustrations of *Chasmops breviceps* (Hall) Figs. 31 A, B, C, from the upper part of the Richmond, at Richmond, Indiana, are here presented. The original specimens were collected hereby Mr. John Misener. The only specimens collected by myself were obtained near the top of the Liberty member of the Richmond, along Cowen creek, in Clinton county, Ohio. Here they were associated with *Xenocrinus baeri* (Meek), *Gyroceras baeri* (Meek and Worthen), *Gomphoceras eos* Hall and Whitfield, *Ceraurus miseneri* Foerste, typical pygidia of *Amphilichas harrisi* (Miller), accompanied by a fragment of a glabella (Figs. 28 A, B) bearing the same kind of pustulose ornamentation as the aforesaid pygidia. In this fragment, the strong downward curvature of the anterior part of the

cephalon suggests a form more or less similar to that of *Amphilichas*. However, this fragment of a glabella was not actually found attached to any specimen which could be identified confidently as *Amphilichas harrisi*.

The species originally described by S. A. Miller (Jour. Cincinnati Soc. Nat. Hist., vol. I, 1878, p. 106, pl. 3, fig. 9) as *Lichas harrisi* is a typical *Amphilichas*, a genus characterized by a pygidium in which the axial lobe anteriorly is marked by two transverse rings, while posteriorly it terminates in a point; there are three pairs of pleural segments with free ends. The lateral lobes of the glabella not only reach the neck furrow but are extended along the latter for some distance. *Lichas halli*, Foerste, and the pygidium recently figured by the writer from the Richmond formation at Richmond, Indiana (Jour. Cincinnati Soc. Nat. Hist., vol. 22, No. 2, 1917, page 43, pl. 1, fig. 2) evidently belongs to another genus, possibly *Arctinurus*.

The specimens of *Calymene* occurring in the cherty Richmond are not sufficiently well preserved to be referred to any definite species, although fragments are not uncommon.

Two figures of cephalons of trilobites are here presented in the hope that they may prove of interest, although not belonging to the fauna here under discussion. They serve at least to fill spaces which otherwise would have been left vacant on the plate. *Synhomalonotus christyi* (Hall), Fig. 29, from the upper part of the Waynesville member of the Richmond, is represented by a slightly crushed cephalon. *Pterygometopus carleyi* (Meek), Fig. 30, is represented by an entire enrolled specimen, lacking only the genal spines; but only the cephalon and the outline of the axial part of the first segment of the thorax is here presented. It was obtained in the Fairmount member of the Maysville group, at Cincinnati, Ohio.

BOLLIA PERMARGINATA, sp. nov., Figs. 33 A, B, C. Carapace only three-fourths of a millimeter in length, closely resembling the specimen from the Arnheim member of the Richmond identified by Ulrich and Bassler (New American Paleozoic Ostracoda, Proc. U.S. Nat. Mus., 1908, p. 288, fig. 13) as *Bollia regularis* (Emmons). It differs chiefly in the prominence and continuity of the ventral part of the marginal ridge. The two middle ridges are slightly more elevated than the anterior and posterior branches of the marginal ridge, and are connected at the base so as to produce a more or less U-shaped aspect. They vary from vertical to slightly divergent, with the basal part inclining slightly toward the rear, especially in case of the anterior one of this pair. The anterior branch of the marginal ridge tends to be vertical, and as far separated from the anterior one of the middle pair as the latter are separated from each other. It is located at a distinct interval from the anterior margin of the carapace. The posterior branch of the marginal ridge, however, is marginal, and tends

to be narrower than the other vertical ridges. A very narrow border, Fig. 33 C, extends around the entire carapace, excepting, of course, along the dorsal line. All four vertical ridges are abruptly elevated to a height varying from one-tenth to one-eighth of a millimeter. Very abundant in thin limestone layers, about half a centimeter in thickness, interbedded in the shales, and in much smaller numbers in the shales themselves, about a mile and a half north of the store of J. B. Stratton, along the lake shore.

FAUNAL CORRELATIONS.

Lithologically, the cherty, light-brown or light-blue Richmond limestone, forming the upper part of the section along the eastern shore of Little Bay de Noquette, resembles the cherty Richmond exposed one and a half miles southwest of Kagawong, on the road to Gore Bay, on Manitoulin island. *Archinacella kagawongensis* is common to both localities, but no conclusions can be based upon this species alone. Among the more significant fossils found in the cherty Richmond of the Michigan locality are *Lichenocrinus tuberculatus* and *Dinorthis subquadrata*; the first is known only from the Whitewater member of the Richmond in the typical Cincinnati areas, while *Dinorthis subquadrata* occurs both in the Liberty and Whitewater members. *Chasmops breviceps* is known by me only from the Liberty member, although listed by Bassler also from the Waynesville. If *Clionychia angusta* is closely related to *Clionychia excavata*, then the occurrence of the latter in the Whitewater member should be noted. Apparently this cherty Richmond limestone may be correlated provisionally with the post-Waynesville portion of the typical Richmond section. *Helicotoma brocki* has been known hitherto only from the lower, or Waynesville member of the Richmond section on Manitoulin island. *Strophomena neglecta* is known chiefly from the upper third of the Waynesville member, although characteristic specimens occur occasionally in the Whitewater member, especially in the vicinity of Richmond, Indiana. The presence of *Amphilichas cucullus* is merely another instance of the occurrence in the Richmond, with very little change, of a characteristic Trenton species. It is very evident that, while the Cynthiana, Eden, and Maysville invasions were taking place in the states bordering on the Ohio river, a large part of the Trenton fauna was able to maintain itself in some other area, as yet unrecognized, and from this area it was able to make a second incursion into the area surrounding Cincinnati. Something similar appears to have taken place in case of the Kimmswick limestone and the upper Richmond in northern Michigan.

The more significant fossils in the argillaceous Richmond limestones on the eastern shore of Little Bay de Noquette include *Hebertella alveata* and *Platystrophia acutilirata*, from the Liberty and

Whitewater members of the typical Richmond, and *Strophomena neglecta*, *Strophomena sulcata*, and *Strophomena vetusta*, which range from the upper third of the Waynesville member into the Liberty and Whitewater members. In Ohio, *Dalmanella jugosa* is most abundant in the Waynesville member. *Platystrophia clarksvillensis* occurs both in the Waynesville and Liberty members. These fossils may represent a late stage of the Waynesville fauna or an early stage of the post-Waynesville portion of the typical Richmond.

The underlying *Pholadomorpha pholadiformis* horizon is regarded as a part of the Richmond section.

The shale section along the shore of the bay, a mile and a half north of the J. B. Stratton store, lithologically resembles the Sheguindah clay shales of Manitoulin island, but not a single fossil has been found which would warrant such a correlation. The nearest relative of *Bollia permarginata* appears to be *Bollia regularis*, from the basal or Arnheim member of the Richmond. Considering the inadequacy of the small fauna collected it is not worth while to discuss the possibility of this Michigan shale corresponding to the Maquoketa shale of more western states. It may not belong to the Richmond at all. For the present, at least, its correlation must remain in doubt.

PLATE IV.

- Fig. 1. *Streptelasma rusticum*.
 Fig. 2. *Streptelasma* cf. *divaricans*.
 Fig. 3. *Lichenocrinus tuberculatus*, magnified.
 Fig. 4. *Dalmanella jugosa subplicata*. A, B, brachial valves; C, pedicel valve.
 Fig. 5. *Hebertella alveata*. A, brachial valve; B, C, pedicel valves.
 Fig. 6. *Rafinesquina brevisculus*. A, B, pedicel valves, on the same slab with 10A; C, D, interiors of brachial valves; b, c, outlines of the corresponding valves.
 Fig. 7. *Leptaena unicostata*. Type. A, pedicel valve; B, interior of brachial valve; a, b, outlines of the corresponding valves. Maquoketa strata, Savannah, Illinois.
 Fig. 8. *Rafinesquina pergibbosa*. A, B, pedicel valve and lateral view of the latter; C, D, interiors of brachial valves.
 Fig. 9. *Rafinesquina alternata*. Interior of brachial valve.
 Fig. 10. *Strophomena parvula*. A, brachial valve.

PLATE V.

- Fig. 10. *Strophomena parvula*. B, C, D, brachial valves; E, interior of pedicel valve; F, interior of brachial valve.
 Fig. 11. *Strophomena neglecta*. Interior of pedicel valve.
 Fig. 12. *Strophomena vetusta*. A, pedicel valve; B, interior of pedicel valve.
 Fig. 13. *Platystrophia clarksvillensis*. Pedicel valve.
 Fig. 14. *Platystrophia acutilirata*. Brachial valve.
 Fig. 15. *Zygospira recurvirostris turgida*. A, pedicel valve; B, brachial valve; both enlarged; C, lateral view, with brachial valve on left side.
 Fig. 16. *Archinacella kagawongensis*; not the type. A, viewed from above; B, lateral view.
 Fig. 17. *Hormotoma gracilis*, var.
 Fig. 18. *Lophospira bicincta*.
 Fig. 19. *Orthoceras* sp. Curvature of septa limiting chamber A shown separately.

PLATE VI.

- Fig. 20. *Clionychia angusta*.
 Fig. 21. *Modiolopsis* sp. Shortened by pressure.
 Fig. 22. *Cyrtodonta* cf. *affinis*.
 Fig. 23. *Cyrtodonta* cf. *persimilis*.
 Fig. 24. *Clidophorus neglectus*.
 Fig. 25. *Clidophorus noquettensis*, enlarged.
 Fig. 26. *Amphilichas cucullus*. Type: A, left side of cephalon; B, anterior view; from Kimmswick limestone, in Alexander County, Illinois.
 Fig. 27. *Amphilichas cucullus*. A, left side of cephalon; B, viewed from above; from Richmond section on east side of Little Bay de Noquette.
 Fig. 28. *Amphilichas* sp. A, left side of glabella; B, viewed from above, magnified; from near top of Liberty member of Richmond, Clinton county, Ohio.
 Fig. 29. *Synhomalonotus christyi*, magnified; Waynesville member of Richmond, at Oxford, Ohio.
 Fig. 30. *Pterygometopus carleyi*, magnified; Fairmount member of Maysville, at Cincinnati, Ohio.
 Fig. 31. *Chasmops breviceps*, magnified. A, cephalon of enrolled specimen; B, imperfect cephalon; C, pygidium of enrolled specimen. From Liberty member of Richmond, at Richmond, Indiana.
 Fig. 32. *Chasmops* sp. middle part of cephalon, with indications of missing parts. From Richmond strata on east side of Little Bay de Noquette.
 Fig. 33. *Bollia permarginata*, magnified. A, left valve; B, right valve; C, posterior view of left valve.

BOOK NOTICE.

OUTLINES OF COMPARATIVE ANATOMY OF VERTEBRATES. By J. S. Kingsley, Professor of Zoology in the University of Illinois, Philadelphia, P. Blakiston's Sons & Co. Second Edition, Revised, 1917; pp. 449; price \$2.50.

Students of comparative anatomy will welcome the second edition of Professor Kingsley's text-book which has already proved itself a valuable acquisition to the English-speaking zoological and medical schools. As compared to the first edition, the number of pages of reading matter, as well as text-figures, has been considerably augmented, and a very thorough revision made of the whole work. A knowledge of the derivations of the terms used in anatomy and embryology is undoubtedly of great assistance to the student's memory, and a useful reference list of the most frequently occurring Latin and Greek roots and their meanings has been appended.

It has been the author's endeavour not to treat of anatomical facts only in so far as they affect isolated representatives of several classes, but to correlate and compare these facts with each other and with the conditions in other animals. Thus a more intelligent representation of the subject is made, answering the needs and satisfying the conceptions of modern science. To the zoologist who must necessarily found his knowledge on the dissection of types, Professor Kingsley's book will supply a deeper comprehension of the "analogies and homologies" of vertebrate structure.

Taking as his thesis the axiom that the "life-history of the individual is a recapitulation of the history of the race," the author builds up his ideas of comparative anatomy around the important basis of embryology. His comparative conception is not always apparent in the text but in a study that is at once detailed and general the difficulty of a broad discrimination is duly recognized. Thus the work might be criticised as not catering to the tastes of the undergraduate in general, but its usefulness in the zoological laboratory and class-room will be greatly appreciated.

In his treatment of the subject, the author demonstrates his exceptional familiarity with animal structure as well as a very extensive acquaintance with the literature of comparative anatomy and embryology, and for these very reasons, one would expect to find a cautious as well as scholarly exposition of the whole subject.

The illustrations, mostly original, constitute a notable feature of the book and the author must be complimented for his great skill as an artist, especially for the admirable stereograms. Unfortunately, the same cannot be said for the outline drawings which are at times too crowded and suffer from lack of contrast. In this respect they fall short of the work of Balfour, Marshall, Flower and Wiedersheim. A few errors still persist in the second edition, both statements of fact as well as typographical. For instance, the statement (p. 132) that "the somatic wall of the mytome does not participate in muscle formation" needs qualification, since it is not true of all vertebrates. Again in Fig. 378, the two oviducts are shown as uniting in a "urinary bladder." On the whole, however, the work will be more than acceptable to morphologists who will feel justly proud both of the author and the publisher who has accomplished his typographic responsibilities in such careful fashion.—A. E. C.

NOTE.

Mr. Alfred T. Davies has written under the title "Student Captives" a short account of the British prisoners of war book scheme, whose object is to provide British prisoners of war interned in enemy or neutral countries with educational books. Much trouble has been taken to provide the prisoners with mental interests, and to make suitable provision for their education so as to enable them to redeem the time of their captivity. Letters of enquiry as to what to send should be addressed to A. T. Davies, Esq., C.B., Board of Education, Whitehall, London, S.W.L., England, and the word "Prisoners of War" written in the left-hand top corner.

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