SAND DUNE REGION

ON

SOUTH SHORE OF SAGINAW BAY

Mrs. Howard Hill

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A BIOLOGICAL SURVEY OF THE SAND DUNE REGION ON THE SOUTH SHORE OF SAGINAW BAY, MICHIGAN

PREPARED UNDER THE DIRECTION OF
ALEXANDER G. RUTHVEN
Chief Field Naturalist, Michigan Geological and Biological Survey

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1911.

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LETTERS OF TRANSMITTAL.

To the Honorable the Board of Geological and Biological Survey of the State of Michigan:

Governor Chase S. Osborn, President.
Hon. D. M. Ferry, Jr., Vice President.
Hon. L. L. Wright, Secretary.

Gentlemen:—I have the honor to present herewith as a part of the report for 1910 of the Board of Geological and Biological Survey, Publication No. 4, being a contribution to the biological survey of the state authorized by Act No. 250 of the Session of 1905.

Very respectfully,
R. C. ALLEN,
Director.

Ann Arbor, Mich., January 11, 1911.

Sir—I submit herewith a report upon the biological survey of the sand dune region on the south shore of Saginaw Bay, Michigan, carried on under my supervision during the summer of 1908. The report aims to give a comprehensive account of the natural history of the region, and to furnish data for the work of students and those interested in the preservation of our native fauna and flora, or in the introduction of animals and plants into the state.

Respectfully,
ALEXANDER G. RUTHVEN,
Chief Field Naturalist.

R. C. ALLEN, Director,
Geological and Biological Survey,
Lansing, Michigan.

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BY ALEXANDER G. RUTHVEN.

The region investigated by the biological survey in the summer of 1908 lies immediately along the west shore of Huron County. (Map.) This county forms the apex of the "thumb" of Michigan—the broad land area that separates Saginaw Bay and Lake Huron. This region was chosen for two principal reasons: first, there was cause to expect that the slightly peculiar climate that this coast of Michigan is said to have would be attended by a different (more southern) fauna and flora than is found in the interior of the state; and, second, the area is almost wholly uncultivated and in a primitive condition, and would consequently be expected to harbor the primitive fauna and flora.

On June 13, the party, consisting at this time of Mr. A. Franklin Shull, Columbia University, Mr. H. B. Baker, University of Michigan, Mr. A. L. Leathers, Cornell University, Mr. N. A. Wood, University of Michigan Museum, and the writer, started from Ann Arbor for the field. Camp was established on the north shore of Sand Point, in the fishermen's shacks of the W. J. Orr Fish Company. From this camp the entire Point could be worked to advantage, and one man (Mr. Wood) was kept here throughout the season. The party was enlarged as follows: On June 21 by Mr. Frederick Gaige, Ann Arbor, Michigan; on July 8 by Prof. G. H. Coons, Michigan Agricultural College; on July 9 by Mr. C. K. Dodge, Port Huron, Michigan.

The members of the party confined their attention to Sand Point until July 12, except that Dodge and Coons spent a few days on the Charity Islands. On July 12, the writer with Shull, Baker, Gaige and Dodge moved to Stony Island. On July 15, Dodge severed his connection with the expedition, but the Stony Island party remained on the island (also working North Island to some extent) until July 19, returning to Sand Point on the latter date. On July 20, Baker and Leathers were sent to Caseville, where they worked the region about the lower part of the Pigeon River until July 28, when they again joined the Sand Point party. On July 29, Baker, Leathers, Shull and Gaige were sent to Rush Lake, where camp was made at the eastern end of the lake. The writer joined this party on August 1. On August 3, Coons left the party, and on August 8 Leathers was returned to Sand Point. The remainder of the Rush Lake party, consisting of Gaige, Shull, Baker and the writer, remained at Rush Lake until August 27. On August 20, Dodge again joined the Sand Point party and moved to Rush Lake on August 21, leaving the party again on August 25. From the Rush Lake camp the entire region between Oak Point and Port Crescent was examined. On August 28, the parties were again united on Sand Point, and on the following day left the field.

On June 15, 1909, Dodge returned to Caseville and spent two days between that place and Sand Point, one day at Rush Lake, and one day on the Charity Islands, and about five days at Bay Port and on the adjoining islands. Again he went to Sebewaing and spent three days in that vicinity, July 10, to Port Austin for three days, August 7, and to Grindstone City for three days, September 14, 1909.

From this itinerary it will be seen that the expedition worked in detail a strip of coast extending from Sand Point to Port Crescent, with the islands immediately off shore, and the botany of the entire sand region and the Charity Islands. In this work Shull devoted his entire time to insects, laying particular stress upon the Orthoptera and Thysanoptera; Baker confined his attention entirely to the molluscs; Leathers investigated the fish fauna; Wood and Gaige worked on the birds and mammals; Dodge and Coons studied the botany; and the writer had general charge of the expedition, and devoted his time in the field to the investigation of the reptile-amphibian fauna.

That the results of the expedition exceeded what the writer hoped it could accomplish is due in large part to the excellent work done by its members. Both in the field and subsequently in working over the collections, the men have been untiring in their efforts to make the most of the opportunity that the survey provided of obtaining a detailed knowledge of the biota of the region. In work of this kind the actual number of specimens obtained means little as a measure of the results obtained, but the following resumé of the collections will give some idea of the amount of data secured:

Insects—15,000.
Molluscs—15,000.
Crawfish—84.
Fish—1,647.
Amphibians and Reptiles—352.
Birds—641 skins, 68 nests and eggs, 631 stomachs.
Mammals—69.

It has been found impossible to work up all of this material in the present report, which will, therefore, have to be supplemented from time to time as the remaining data is organized.

In carrying on this investigation the Survey became indebted to a number of persons for very material assistance. The camps on Sand Point and Stony Island were secured from Messrs. W. H. Wallace and W. J. Orr of Saginaw, and Mr. George Clark, Bad Axe, Michigan, kindly provided the camp used for a time at Rush Lake. The assistance received in the identification of material is acknowledged in the different papers.

The writer wishes to acknowledge his personal indebtedness to Prof. Jacob Reighard, University of Michigan, and to Mr. Bryant Walker, Detroit, for many helpful suggestions and much material assistance.

DESCRIPTION OF THE ENVIRONMENTAL CONDITIONS AND DISCUSSION OF THE GEOGRAPHIC RELATIONS OF THE BIOTA.

BY ALEXANDER G. RUTHVEN.

LOCATION AND DESCRIPTION OF THE SAND DUNE REGION.

Topography.

The region investigated by this expedition comprises the greater part of the strip of sand ridges that extends along the south shore of Saginaw Bay, from Hardwood Point to Sand Point, "in fact at intervals all along the western shore" (Davis. 1900, p. 40). This sand area varies from about three-fourths to one and one-half miles in width and consists of a succession of sand and gravel ridges (in general parallel to the shore) with intervening swales and swamps. Beginning, according to Davis (1900, p. 56), "at the north extremity of the county around Point Aux Barques," there is a continuous ridge of sand hills, "which continues swinging from point to point, like draped festoons, clear to the southwest edge of the county. Exceptionally high knobs rise more than 40 feet above lake (620 A. T.), but in general the top of the ridge is a little above 30 feet above lake level ...... On the landward side this ridge is backed by extensive swamps, now rapidly being artificially drained, at an altitude of 20 to 24 feet above lake (606 feet A. T.). On the lake side we find series of sand and gravel beach ridges, interspersed with swamps. Their altitudes are quite various, depending somewhat upon how far the ridges pass into dune sand aggregates. There are in places at least four or five strand lines."

Many of the ridges are low and composed largely of gravel, being very evidently old beaches. Others consist of small dunes superimposed upon the old beaches, and two are high ridges of pure sand that are unmistakably fossil dunes. Even in the case of the latter, however, the dunes have been blown up on an old beach and have undergone little subsequent migration. This is well shown where blow-outs cut them to the base, revealing the underlying beach. (Plate III b.)

At the present time the dunes are all stationary, even the newest ones being covered by vegetation. From Sand Point eastward, of the two largest ridges, one—as described by Davis—extends along the landward or southeastern side of the sand area, while the other extends along the northwestern side following the present beach of Saginaw Bay. These two ridges are apparently true sand dunes (with long windward and steep leeward slopes) superimposed upon what was in times past in the case of the southern ridge, or is now in the case of the northern one, the upper beach of Saginaw Bay.

West of Caseville the inner sand ridge curves eastward, swinging back toward the shore at Bayport, while the outer one, following the shore, curves abruptly to the west and is continued to the end of Sand Point. The base of the Point (the area lying between a line drawn across the Point just west of Orr Lake and the eastern dune ridge) is low and swampy, and relieved by only low gravel ridges. These angle off from the outer dune ridge and parallel the eastern one in a general way. On the Point these ridges successively bear more and more to the westward, crossing it in a direction diagonal to its length, and are connected at their southern ends by low ridges that run east and west. From about the middle to the end of the Point the dune ridges are higher, but have about the same arrangement and cross the Point in a more north and south direction. Near the end the high outer dune swings away to the southwest and leaves a wide sand flat (Plate II a), replaced at the very end by a bay opening to the west, between the dune and the present beach. The outer side of this bay is formed by a sand bar submerged at its outer end, and there is a parallel submerged bar a short distance off shore that is continued far out in the bay. Toward the end of the Point the transverse ridges are connected on the south side by a single ridge, but toward its base other ridges now intervene between the present beach and the one joining the ends of the transverse ridges, and still another is being formed as a southeastwardly projecting sand spit. Flats similar to the one at the end of Sand Point are found on the west side of Hat Point, Oak Point (II b) and Little Oak Points (Plate III a).

The topographic conditions briefly outlined above may, I believe, be interpreted as follows:

1. As the level of the water in the post-glacial lakes fell low enough to uncover the sand ridge region, the sand formed by the comminution of the exposed rock was built up into beaches each one of which represents a halt in the fall of the water level.
2. In the longer halts opportunity was given for the sand blown up by the winds from the beach to be piled into dunes on the upper beach.

3. There is now and has been since sometime during the formation of the beaches in the sand region a westward movement of sand along this coast that results in an accumulation behind (west side) the points, and the elongation of Sand Point. That this is taking place at the present time is evidenced by the projecting bars behind (west side) Oak, Little Oak and Hat Points, and at the end of Sand Point. That Sand Point is being elongated is shown by the fact that the present beach has recently (see next) been built and extends well out into the water, and is replaced off shore by another bar that extends far out in the lake. The employes of the W. J. Orr Fish Company assert that within the past five years the fishing boats have been compelled to keep farther and farther out in rounding the Point, and this company has even added flat-bottomed boats to its fleet in order that they may stand in closer to shore. Furthermore, the logs on the fossil beach (Plate IV a), now several hundred yards from the present beach, show by the mill marks that they were cast up since lumbering operations began in the region. The direction of all the ridges composing the Point shows that practically all of its growth has been in this way.
4. The beaches have been formed by the elevation above water (during storms) of the off-shore bars. These beaches are first tied to the land on the eastern side and then extended westward. This is shown in the flats that extend westward from Hat, Little Oak and Oak Points and particularly well at the end of Sand Point where the present beach swings away from the dunes and extends out into the water for a considerable distance, while just off shore is another bar covered by but a few inches of water and extending far out into the lake. That the last abandoned beach was along the dunes is shown by the drift logs strewn along the foot of the ridge, although at present several hundred yards from the water (Plate IV a). These beaches on Sand Point are also joined with the mainland by others formed by a return drift that builds them to the southward as sand spits, enclosing lakes, ponds, marshes or low flats between the main ridges, or, in the case of those just forming, bays that will become enclosed between the low paralled ridges.

The only areas examined outside of the sand region were the islands in Saginaw Bay and the clay country about Rush Lake. The latter region needs little discussion, as it was not worked in detail. It forms a part of the broad flat plain intervening between the high land of the central part of the county and Saginaw Bay. It is mostly cleared and under cultivation, and the only wooded areas examined were the extensive swamps that occur all along the inner dune, and the patches of forest that extend out in places from the south side of the inner dune ridge.

Stony, North and Katechay Islands lie off the coast at Bayport. Stony Island was worked in detail, North Island to some extent, but Katechay, which is almost entirely a swamp, was not examined. Stony Island consists of a rocky elevation (north end) and a series of low parallel sand ridges that, with a swamp along its eastern side, forms the long point on the south. This island is being built southward by the formation of sand bars, and the southern end is very much like the sand region on the mainland, consisting as it does of several ridges with intervening swamps, but the ridges are low. The large marsh on the east side is also being enclosed on the east by a sand spit, much like Turtle Bay on Sand Point. North Island is also characterized by a rocky nucleus and is apparently being built up to the southward, as shown by the sand bar running across to Stony Island. The Charity Islands could not be worked in detail in the time available, only a botanical investigation being made as the basis for future work.

General Soil Conditions.

From the foregoing discussion it will be seen that the sand region is composed of a series of roughly parallel ridges with intervening lakes, ponds or swamps as the case may be. The ridges are of sand, varying from the pure sand of the dunes to the mixture of sand and beach gravel in the lower ridges. The swamps, ponds and lakes are also apparently floored with sand, which occasionally, in the more recent ones, is not covered as yet by mud or peaty deposits (e. g., Long Lake), although in the older ones (Orr Lake and Mud Pond) such deposits are present. The soil of the main parts of Stony and North Islands is a shallow stony loam covering the bed rock; that of the southern end of Stony Island is the same as that of the sand region.

Habitats.

The uniformity in the topography restricts the number of habitats, but there are several major ones plainly indicated by the vegetation. I have distinguished the following groups of environic conditions:

Terrestrial habitats.	*Aquatic habitats.*
Sand ridges.	Transient ponds.
Beach of Saginaw Bay.	Permanent ponds.
Wooded swamps.	Streams and artificial ditches.
Mesophytic woods.	Saginaw Bay.
Sedge and grass swamps.	

The habitat distribution of the flora and fauna has been considered more or less completely by the writers on the different groups, so that all that will be attempted here is a brief outline of the general conditions.

Sand Ridges: This habitat comprises the dry sand ridges and grades down into the swamps and to the shore of Saginaw Bay. Most of the ridges are clothed with an open growth of oaks, jack pine, large-toothed aspen, sand cherry, choke cherry and wild red cherry, with scattering white and Norway pines and a ground cover of such forms as black huckleberry, bearberry, New Jersey tea, hairy puccoon, wintergreen, golden-rod, etc. In other words the society is xerophytic. (Plate IV b)

The fauna of the sand ridges is less characteristic because as a rule less closely associated with the soil. However, certain relations are evident. The numerous forms, such as myriapods, snails, beetle larvae, earthworms and salamanders, usually found in the humus and decaying logs in mesophytic woods are nearly entirely absent from the ridges but are better represented on the borders of the swamps, where some humus has formed under the deciduous shrubs and trees. The absence of these forms from the ridges is due to the lack of humus and the fact that the decaying logs are usually too dry. The few found on the ridges were nearly always in or under the logs. On the other hand, we found on the ridges an abundance of forms not usually found in numbers in mesophytic woods. Among these are to be mentioned the hog-nosed snake, grasshoppers, ant-lions, cicadas, the mollusk, *Polygyra albolabris maritima*, and the field sparrow.

Beach of Saginaw Bay: From the end of Sand Point eastward the beach of Saginaw Bay is practically pure sand. It may be divided into two parts—a lower washed by the summer waves and devoid of vegetation, and an upper part that is washed by the winter waves, strewn with logs and supporting a few annual plants such as *Cakile edulenta, Arabis lyrata,* and *Triglochin palustris.* The outer dune arises directly from the beach proper. The outer face of this dune is covered by a sparse growth of xerophytic grasses and herbs such as *Artemisia caudata,* beach pea, *Cirsium pitcheri,* two prominent xerophytic grasses, *Ammophila arenaria* and *Calamovilfa longifolia,* etc., and the top by the vegetation of the older dunes with a greater proportion of juneberry, choke cherry, *Cornus baileyi,* and sand cherry. The trees that occur both here and on the older ridges are generally more scrubby in this habitat. (Plates I, III b.)

The fauna of this group of habitats is very meager, the resident spotted sandpiper and the numerous migrant sandpipers and plovers are characteristic of the beach proper, and also generally to be found here are a few leopard and green frogs, deer mouse and Baird's field mouse, but as a whole the fauna is very poor owing largely to the drifting sand that soon buries the logs. Where the beach is partially protected from the waves by off-shore bars and is thus narrower, the upper part is damper and more protected from shifting sand. Here a few sedges and certain forms such as various snails (see Baker) are found among the logs. The characteristic forms of the dune face are the grasshoppers (see Shull).

The conditions described above are typical of the beach throughout most of the region, but there are a few local variations that should be mentioned here. These variations are associated with the sand flats that are being formed back of the sand bars at Hat, Oak and Little Oak Points, and at the end of Sand Point. These flats are moist sand and support a sparse vegetation of sedges, *Equisetum*, nodding ladies tresses, etc., and where broader are covered with clumps of willows, balsam-poplar, and occasionally paper birch. (Plates II, III a.) There is apparently no characteristic fauna on these flats, the inhabitants being the beach forms plus a few swamp types (e. g. Jefferson salamander, leopard frog, cockroaches, myriapods, etc.) and in the dryer places with some from the ridges (skink, fox snake and milk snake).

When these flats are formed or when an off-shore bar has become elevated to enclose a lagoon (Plate II b), the older beach is removed from wave action and becomes a fossil beach. The best fossil beach was found at the end of Sand Point, and was so recent that it was still strewn with logs in advanced stages of decay (Plate IV a). The fauna consists of the upper beach forms with a few others from the sand region that seem to find particularly favorable conditions here. The conspicuous forms are: Baird's mouse, deer mouse, skink, fox snake and milk snake, and a number of invertebrates (such as cockroaches, myriapods and snails) that are usually found in decaying logs.

Wooded Swamps: The habitats grouped here vary greatly. In one direction they grade into the grass marshes, in another into the low sand flats that occur between the ridges when the elevation is somewhat higher, and in still another into the mesophytic forest. The flora of the typical swamps of the wetter type in the sand region consists principally of a growth of swamp white oak, black ash, red maple, arbor vitae, yellow birch and a number of ferns and mosses. As these swamps approach those of the grassy type they become mixed with willows, alder (*A. incana*), dogwoods, and cottonwood. While in the higher swales the American aspen, paper birch, balsam-poplar, etc., become predominant.

In the wooded swamps the fauna consists chiefly of the forms usually found in mesophytic forests. To be mentioned are, the greater abundance of the invertebrates that inhabit humus and decaying logs, e. g. many gasteropods (see Baker) and, among vertebrates, the salamanders,. *Ambystoma jeffersonianum* and *Plethodon cinereus.* Other characteristic forms are the wood frog, common tree toad, whippoorwill, ovenbird, redstart, and the American hare.

We found no typical bogs within the sand region proper, doubtless because the porous soil provides too perfect drainage. That the conditions in some of the swamps are somewhat bog-like is shown by the presence of occasional tamaracks and black spruces, but these nowhere dominate the vegetation, as they do in the bogs of the clay country. At Rush Lake several typical bogs occur on the east side of the inner dune ridge and form islands in the lake itself. These support the plants characteristic of such conditions, e. g., tamarack, black spruce, cassandra, Labrador tea, pitcher plant, etc. The fauna was not studied in detail.

Mesophytic Woods: The typical mesophytic forest of this part of the state was found in the sand region proper only on low ridges of considerable age, e. g., at the base of Sand Point and along the south side of the inner dune ridge where it has encroached to some extent upon the ridge from the clay country. On Stony and North Islands the high land is clothed with mesophytic types. The conspicuous plants of this formation are sugar maple, basswood, beech, ironwood, butternut, shag-bark hickory, mountain maple, prickly ash and spikenard with a few hemlocks and balsam firs.

Here is found a good development of the ground fauna found in such conditions. Characteristic forms are: Shield-backed locust, *Plethodon cinereus*, myriapods, cockroaches, and many gasteropods (see Baker). The other forms found here are those mentioned as characteristic of the wooded swamps—ovenbird, redstart, whippoorwill, etc.

Sedge and Grass Swamps: The swamps in which grasses and sedges predominate are usually found in the swales and about the ponds. They are all small, with the exception of a rather large area on the base of Sand Point and the wet marsh on the south end of Stony Island. (Plates V, VI, VII, VIII a, XII a.) The vegetation consists of various grasses and sedges, with clumps of willows, poison sumac and *Rosa carolina.* Characteristic animals are: a number of snails (see Baker), swamp tree-frog, leopard frog, ribbon and garter snakes, green snake, rattlesnake, American bittern, sora rail, Virginia rail, red-winged blackbird, swamp sparrow, long-billed marsh wren and yellow warbler.

Transient Ponds: In the sand region there are a large number of shallow depressions that contain water only for a part of the year.

These temporary ponds may or may not be filled with grasses and sedges. In the former case, upon drying up in the summer, small grassy areas are left, and in the latter expanses of drying mud. These ponds mostly harbor forms (a) that have aquatic larval stages that are passed before the ponds vanish (e. g., frogs, tree frogs and salamanders), or (b) that may aestivate (a number of gasteropods), but some truly aquatic forms annually get into them that either migrate or are killed by the drying-up. For example, turtles and water snakes are occasionally found in these and the bugs Notonectidae and *Belostoma* were found dying in the beds of dried-up ponds in July. The beds of the transient ponds that are not filled with grasses and sedges furnish feeding grounds for several sandpipers and plovers—the greater yellow-legs, least sandpiper, and semipalmated plover were observed.

Permanent Ponds: There are also many bodies of water in the sand region that do not usually dry up in the summer. Those studied in detail are, Orr Lake, Mud Pond. and Long Lake, all on Sand Point. The two former are deep ponds, with a bottom of mud and peat and a rich aquatic vegetation. The animals collected in them were such pond forms as *Planorbis campanulatus, P. exacuous* and *Segmentina crassilabris*, and *Rana clamitans*. Another small one investigated had the following fish: bullhead, tad-pole stone cat and mud minnow.

Long Lake is a long narrow lake back (south) of the first dune at the end and north side of Sand Point. It is very shallow, nowhere attaining a depth of over two or three feet. The bottom is sand, and there is not an abundant flora except at the east end where the bottom is peaty. Much of the bottom is bare, but there is a sparse growth of rushes about the shore, a few large patches of a very short chara, and small patches of water-lilies. At the ends there is a slight deposit of peaty material, and there the aquatic vegetation is much better developed. (Plates XII, XIII a.)

There are no fish in the lake. The reptiles and amphibians are represented by the painted turtle, Blanding turtle, and the red newt, and such marginal forms as the water snake and green frog. Many tadpoles of the latter are found in the lake, and there is an abundance of such invertebrates as Notonectidae, dragon-fly larvae, etc. The shells found here are listed by Baker.

On the south end of Stony Island there are three ponds (Plate VIII b) that have apparently been formed much as the lagoon ponds in the sand region, and the fauna is about the same. The painted turtle, Blanding turtle, red newt, dragon-fly larvae and numerous shells were collected.

Rush Lake, by far the largest body of water in this region, is outside of the sand region proper. It is a part of the series of swamps that occur along the landward side of the inner dune ridge. It is about two and one-half miles long by one mile wide. The bottom consists of deep deposits of peat and marl, and the depth of water is, in summer, but a few inches over most of the lake, although along the north side of the middle there is a channel from three to five feet deep. There is a rich aquatic vegetation, consisting mostly of pond weeds, over most of the bottom. The plants whose stems and leaves mostly float upon, or are often thrust above the water, grow in patches. These patches we found to consist of such forms as potamogetons, pickerel-weed, tape-grass, water-shield, bur-reed (*Sparganium eurycarpum*), pond-lilies, great bulrush, etc. In places the peat has been built up so that it will support bog plants, and bog-islands have been formed with a flora the same as in the tamarack swamps about the margin of the lake. (Plates IX, X a.)

The aquatic invertebrate collections of Rush Lake have not been studied, with the exception of the mollusks. The painted turtle and bull frog were found here, and the following fish: yellow catfish, long-jawed catfish, blunt-nosed minnow, golden shiner, Cayuga minnow, grass pike, sun fish, perch, and spindle darter.

Streams: The Pigeon River was the only stream studied that heads back in the "hill district" of the central part of the county. Flowing across the intervening plain it enters the sand region and empties into Saginaw Bay at Caseville. As it crosses the plain district it is little more than a meandering creek, with a bottom of clay and gravel. After entering the sand region it becomes much more winding, as it is nearly at base level. It also becomes wider and deeper (up to six feet) which with the feeble current permits a rich growth of aquatic plants. (Plates X b, XI b.)

Within the sand region (at Caseville) the river is a sluggish meandering stream with a mud bottom, and considerable aquatic vegetation in places. One of the curves has been cut off as an ox-bow pond. (Plate XI a.) The conditions in this pond apparently differ little from those of the river except that the quiet water permits a greater development of vegetation. Zones of rushes surround it and beds of yellow and white waterlilies and *Sparganium eurycarpum* occur in the open water.

The only animal groups studied in these habitats were the fish and mollusks. The fish found in the river are: dog-fish, yellow catfish, black bullhead, common sucker, mullet, silver fin (one specimen), grass pike, calico bass, rock bass, sun-fish, black bass, large-mouthed black bass, wall-eyed pike, perch, log perch, black-sided darter, Iowa darter, and spindle darter. Those found in the ox-bow pond are: bullhead, golden shiner, red-fin dace, little pickerel, grass pike, rock bass, and large-mouthed black bass.

Mud Creek, located in Caseville Township and emptying into Wild Fowl Bay just west of the base of Sand Point, is the only stream in the region studied that does not head in the "hill district." It is nothing more than a small creek that flows for most of its length through the clay country, and is very sluggish in the sand region. It was only studied near its mouth where the following species of fish were taken: *Lepisosteus osseous, Ameiurus vulgaris, A. melas, Pimephales notatus, Semotilus atromaculatus, Notropis cayuga, Umbra lima, Ambloplites rupestris, Micropterus salmoides, Perca flavescens.*

Saginaw Bay: About Sand Point and all along the coast to the east the bottom of Saginaw Bay is sand, except at Oak and Hat Points. (Plate I a.) This sand is practically devoid of pebbles and forms a clean hard bottom out to considerable depths. Except for the fish, the biota of the margin of the littoral zone only was studied. The shallow water part of this zone is nearly everywhere devoid of vegetation, owing to the shifting nature of the substratum and the action of the surf. The animal life is also very meager for the same reasons. The fish taken in this habitat are: common sucker, spawn-eater, red-fin dace, red-fronted minnow, trout-perch, rock bass, wall-eyed pike, perch, log perch, black-sided darter, spindle darter and miller's thumb (one specimen). No bottom forms were found until the deep littoral zone was reached. For the mollusks of the deeper part of this zone see Baker.

The north shore of Stony Island is rocky (Plate XIV); at Oak Point there are large rocks off shore, and at Hat Point the bed rock forms a cliff and a small high island off shore. The rocks at these points are covered with a coating of algae and in the crevices there may be a scattered growth of the rush, *Scirpus americanus.* Here, as pointed out by Baker, are to be found the univalve mollusks with large feet—*Physa ancillaria magnalacustris, Lymnaea emarginata ontarioensis* and *Goniobasis livescens.* Leeches were also found here.

Where the bars are being elevated above the water, e. g., on the west side of Oak Point, the end of Sand Point and the south side of the base of Sand Point, shallow bays are being formed. Those in the first two places mentioned are shallow and floored with sand both for the reason that the drift is great along this shore and much sand is washed into them before they become separated from the bay and also because a large amount of sand is blown into them after the barrier beach has been raised above the surface of the water. In general it may be said that the substratum of sand here, as on the beach, is an unfavorable factor, and the elimination of the wave action a favorable condition, the two partially offsetting each other. Thus the vegetation is sparse (mostly sedges) but better represented than off the exposed beaches. Even before the barrier beach has been elevated above water its influence in checking the force of the waves is shown by a narrower lower beach and the presence of a littoral zone of sedges, as at the end of Sand Point. That the fauna also responds to these conditions is shown by the abundance of clams (see Baker) on and between the bars and in the lagoons, and a muskrat house on the bar at the end of Sand Point.

The bay (Turtle Bay) on the south shore of Sand Point differs from those just mentioned in being itself at the head of a bay (Wild Fowl Bay) and thus protected from severe wave action. (Plate VII b, XIII b.) The beach of the sand spit that is enclosing this body of water is narrow, and the marginal rushes and sedges are rather well represented. In the bay itself there is a deposit of mud and a rich aquatic flora and fauna. The animals found here are: snapping turtle (abundant), painted turtle, Blanding turtle, dog-fish, gar pike, long-jawed catfish, bullhead, Mississippi catfish, mullet, golden shiner, grass pike, calico bass, rock bass, sun fish, large-mouthed black bass, perch, log perch, Iowa darter, spindle darter, wood duck, black duck, and other more or less aquatic birds.

THE GEOGRAPHIC RELATIONS OF THE TERRESTRIAL FLORA AND VERTEBRATE FAUNA OF THE SAND DUNE REGION.

As previously stated, the main reason for selecting this region for study was to determine, if possible, the effect upon the biota of the slightly more equable climate that this coast is supposed to have. It has become evident upon a study of the material and the literature that this question cannot be definitely answered as yet, owing principally to our lack of knowledge of the biota of other parts of the state. For this reason it has been made the first aim of this report to present the conditions in the region studied so that the data may be available for future comparison when more work has been done in the interior of the state. There are, however, a few conclusions concerning the geographic distribution of some of the forms in the region that seem to be warranted.

Before taking up the discussion of the affinities of the terrestrial fauna of the sand region the general geographic conditions in southern Michigan should be briefly outlined. In the first place, there are no physiographic barriers to migration, as there are no high elevations, large streams, etc., so that as far as this factor is concerned there seems to be no reason why any form cannot range over practically the entire area if favorable habitats can be found. This peninsula, however, extends through four degrees of latitude, and furthermore, as is well known, constitutes an area of transition between a northern biota found mostly north of Lake Superior, and a southern one that is characteristic of Indiana, Ohio and Kentucky. This subject need not be discussed in detail here, but it should be pointed out that there are great differences in the extent to which different northern forms push southward and southern forms northward in southern Michigan, and that the determining factors are the climate and the constitution and habits of the organism.

Climate.

The climate of the sand region may be described briefly as follows:

Precipitation: Jefferson * has shown that the "thumb" of Michigan is characterized by a decidedly light precipitation as compared with the rest of the lower peninsula. The rainfall over the greater part of southern Michigan is between 30 and 35 inches. On the west coast, north and south of the Saginaw-Grand Valley and in a few places in the interior the precipitation is increased to 35-40 inches, and two localities in the northwestern and southwestern parts have a rainfall of over 40 inches, but the greater part of the lower peninsula has a precipitation of 30-35 inches. There are two areas that have a rainfall of less than 30 inches. One of the latter is a small area northwest of Detroit, the other is the "thumb", lying between Saginaw Bay and Lake Huron.

The decrease in the precipitation in this region would itself probably be too slight to affect the facies of the biota, but the effect it may be expected to have is, in the sand region, added to those due to the sandy soil thus increasing the general aridity of the conditions.

Temperature. Winchell † long ago pointed out that the southern peninsula of Michigan has a much more equable temperature than the states to the south and west. Owing to the prevailing westerly winds and the presence of a large body of water on either side, the winters are milder, and while the summers are cooler the possibilities of early and late frosts are much less than in the region to the west of the lakes. This influence is felt throughout southern Michigan but is much more noticeable along the coasts, particularly along the west coast. However, it is not much less along the east than along the west coast of the state, owing to the fact that, although the prevailing winds are westerly,

*Eighth Ann. Rept. Mich. Acad. Sci., 78-97.

†Harpers Monthly, XLIII (1871), pp. 275-285.

Other references on this subject are: Winchell, *Sparks from a Geologist's Hammer*, pp. 200-233; *The Grand Traverse Region; Proc. Amer. Assn. Adv. Sci.*, 1866, pp. 84-89, 1870, pp. 106-117; *Rept. Geol. Surv. Mich.*, 1871; *Walling's Atlas of Michigan*, 1873; *Zeitsch der Osterreich. Ges. fur Meteor.*, VII, p. 351, VIII, 40; *Ann. Rept. State Hort. Soc. (Mich.)*, 1880; *Michigan* (1873). McCracken, *The State of Michigan* (1876). Lyster, *Sixth Ann. Rept. Sec. St. Board of Health of Mich.*, pp. 167-250.

Saginaw Bay and the westward bend of Lake Huron exert some influence upon the western shores of the lake.

Although Winchell states (pp. 282-283) that the mean annual temperature is also slightly higher along the west coast of Michigan than on corresponding latitudes west of Lake Michigan, the annual mean in Huron County (as shown by Davis) is practically the same as obtains at points on corresponding parallels on the great plains so that in this region the lakes operate principally to check oscillations and extreme vaiations. As said above, just what effect the more equable temperature of this coast has upon the fauna and flora cannot be determined until the fauna of the remainder of Huron County and the interior of the state has been worked in much greater detail. That we may expect more southern forms than occur in the interior seems to be shown by the biota of the west coast, where the flora at least is decidedly more southern than in the interior at a given latitude.*

It should be pointed out, also, that within the sand region on this coast peculiar local conditions prevail, for the sparse vegetation and consequent exposure, and the rapidity with which the sand heats up acts to produce higher summer temperatures. That this is true for our region is shown by a comparison of our temperature records for July with the corresponding records for Hayes (in the clay country).

Station.	Highest.	Date.	Lowest.	Date.	Mean.	Average daily range.	Greatest daily range.
[1]Hayes	95a	11	45a	16, 17	70.0	23.1a	33a
[2]Sand Point (Woods)	103a	11	53a	16, 24-5	75.8a	23.3a	34a
[3]Sand Point (Beach)	113c	11, 30	48c	16c	76.9c	33.2c	47

[1]These records are taken from the July report of the Michigan Section of the climatological service of the Weather Bureau, and may be taken as representative of the conditions in the clay country adjacent to the sand region. Letters represent number of days for which records are wanting.

[2]Records secured by this expedition. Thermometer placed in the woods and sheltered from the sun. These records are comparable with those of Hayes.

[3]Records secured by this expedition. Thermometer fully exposed to the sun on the north beach.

Of the temperature conditions the most important from the standpoint of the plants and animals are undoubtedly the checking of extreme oscillations and the higher summer temperature. Considering then the physical conditions discussed we may group them on the basis of their effects as follows:

*Beal, W. J., Michigan Flora. Fifth Ann. Rept. Mich. Acad. Sci. (1903), p. 20.

Dominant conditions.	Favorable to	Unfavorable to	Not strongly effective in the case of	Not effective in the case of	
Relatively small precipitation and sandy soil.	Upland plants and animals adapted to xerophytic conditions.	Upland plants and animals adapted to mesophytic conditions.	Lowland plants and animals.	Animals and plants living in bogs and lowest swamps and on sheltered rock cliffs.	The conditions in these habitats favor northern forms.
Higher summer temperature.	Southern upland and lowland plants and animals.	Northern upland and lowland plants and animals.		Animals and plants living in bogs and lowest swamps and on sheltered rock cliffs.	
Absence of early and late frosts.	Southern plants and probably to some extent southern animals.		Northern plants and animals.		

Local and General Distribution of the Biota.

In examining the above table account should be taken of the intensity of the environic conditions. If this is done the table expresses the actual conditions which are as follows:

(1) The sand ridges support a fauna and flora composed principally of those forms that are adapted to xerophytic conditions in this latitude.

(2) The swales support the mesophytic forms of the region.

(3) The bogs are dominated by distinctly northern forms, which are also present on shaded rock cliffs.

(4) There are very few decidedly southern forms in the biota, and of those that occur here some are found on the ridges and some in the lowland habitats.

This is shown in the following analysis of the fauna and flora. The more distinctly northern and southern forms in each group are in bold-faced type.

1. Forms that range widely over eastern North America both to the north and south of Michigan, e. g., the pied-billed grebe, wood duck, great blue heron, spotted sandpiper, kingfisher, robin, leopard frog, American toad, green frog, and a great many plants that do not need to be enumerated.

2. Southern forms that in Michigan extend considerably north of this latitude, e. g., American beech, white oak, bur oak, swamp white oak,

long-billed marsh wren, rose-breasted grosbeak, catbird, woodchuck, bluebird, chewink, red-headed woodpecker, fox snake, red-bellied snake, common garter-snake, brown snake, red squirrel, and chipmunk.

3. Northern forms that in Michigan extend considerably south of this latitude, e. g., sora rail, Virginia rail, swamp sparrow, swamp fly honeysuckle, tamarack, pitcher plant, cassandra, Labrador tea, Cambridge frog, arbor vitae, yellow birch, chestnut-sided warbler, Wilson thrush, chickadee, porcupine.

4. Southern forms that in Michigan are known to extend little if any north of this latitude, e. g., **Carolina wren,**[2] **Butler's garter-snake,**[2] wood reed grass,[2] butternut,[2] black walnut,[2] shag-bark hickory,[2] *Carya microcarpa,*[2] yellow-barked oak,[2] scarlet oak,[2] spice bush,[2] American crab,[2] **sassafras,**[1] **hog-nosed snake,**[1] **blue-tailed skink**[1], ribbon snake.[1-2]

5. Northern forms that in Michigan are known to breed little if any south of this latitude, e.g., **American hare,**[2-4] blackburnian warbler,[2-4] black-throated green warbler,[1] American yew,[2] **balsam fir,**[2] hemlock,[2] black spruce,[2-4] Norway pine,[1] *Clintonia borealis,*[4] swamp red currant,[4] sessile-leaved twisted stock,[4] false miterwort,[4] **Polypodium vulgare,**[3] **Phegopteris polypodiales,**[3] **Woodsia obtusa,**[3] *Lycopodium complanatum,*[1] jack pine,[1] common hair grass,[1] *Agropyron dasystachum,*[1] *Cyperus houghtoni,*[1] *Ceanothus ovatus, Amelanchier spicata,*[1] *Salix glaucophylla,*[1] *Habenana hookeri,*[1] sweet fern,[1] *Hieracium umbellatum,*[1] *Linaria canadensis.*[1]

I believe that we may safely conclude that the environic conditions along this coast of Michigan while permitting a few southern forms are not favorable to the intrusion of a large number. On the other hand, it seems as if they do permit a more northern extension of range on the part of a few of the forms that find their northern limit in the interior of the state farther to the southward. However, more data on the fauna and flora of the interior of the state must be obtained before the extent of the influence of the variations in climate upon the distribution of the forms can be ascertained.

LITERATURE.

The literature on this region is meager. There are a number of references to the geology (see Lane, 1900, p. 2 *et seq.*), but the only observations that I have been able to find on the natural history,

[1]Inhabiting sand ridges.
[2]Inhabiting drained swamps or low ground.
[3]Inhabiting shaded rock cliffs.
[4]Inhabiting bogs.

including archeology, are those of Schoolcraft, Miles, Lane, Davis, Thomas, and Smith.

In 1820, Schoolcraft (1855) traversed this coast from Pointe aux Barques to Oak Point (Point aux Chenes), crossing the bay at this place. He describes briefly the topography and vegetation of the sand ridges (p. 54).

In 1859, Dr. Manly Miles (1861, pp. 22-23) "who had been designated to take special charge of the department of zoology [Michigan Geological Survey] descended the Saginaw River to its mouth, in company with a young man who was subsequently employed during the season as taxidermist and general assistant." Although the region explored by Miles on this trip is far removed from the area worked by us, it is necessary to call attention to this expedition for many of the records, published in the lists after the work of the following year on the coast farther eastward, are given as "vicinity of Saginaw Bay" or "Saginaw Bay" so there is no way of determining just where the species was observed.

In 1860, A. Winchell, Miles, White, and N. H. Winchell (botanical assistant) explored "the whole coast from the mouth of the Saginaw River to the vicinity of White Rock." (1861, p. 27.) In his catalog of the mammals, birds, reptiles and mollusks of the state, Miles (1861, pp. 219-241) gives a few foot-note references to the occurrence of certain species of animals taken "near Saginaw Bay." As said above, it is impossible in many instances to determine which of these records apply to the sand region, and similarly general locality records are given in the list of plants of lower Michigan compiled by N. H. Winchell in the same report (1861, p. 247, *et seq.*), but a supplementary list of the plants of Stony (Stone) Island is also given (p. 328).

By far the best and, in fact, the only good report on the physical conditions and biology of the region is to be found in Lane's (1900) "Geological Report on Huron County, Michigan." In this report the sand region topography is described in detail, and the climate discussed. There is also a discussion of the flora by C. A. Davis with lists of the plants observed by him in the county. In this list exact localities and habitats are given as a rule, so that the paper has been of particular value to us in our work on the flora of the sand region.

Some of the records secured by this expedition have been published elsewhere (Ruthven, 1909 and 1910).

The archeology of this part of Huron County is referred to by several writers. Thomas (1891, pp. 109-110) states that there is a "large circular work in Caseville Township on a small stream emptying into

Wild Fowl Bay, 5 miles southwest of Caseville;" "mounds along the northern coast, especially between Port Austin and Pointe aux Barques, also between Grindstone City and Huron City;" and several "mounds on Mason [Katechay] Island southwest of Wild Fowl Bay."

Smith (1894, p. 303) describes a cache found by him at Bay Port, and in another paper (1901, pp. 288-291) comments on the mounds listed by Thomas and the Bay Port cache, describes workshops on North Island, and village sites on Stony (Heisterman) Island and at Bay Port. These are described again by Smith (1901, pp. 11-15), and again listed in a recent publication of this survey (1910).

The only other publications on the fauna and flora, known to us, are the references to the fish of Saginaw Bay (see Leathers).

1855. Schoolcraft, Henry R.
Summary of an Exploratory Expedition to the Sources of the Mississippi River, in 1820. Philadelphia.

1861. Miles, M.
A Catalogue of the Mammals, Birds, Reptiles and Mollusks of Michigan. First Biennial Report of the Progress of the Geological Survey of Michigan, pp. 219-241.

1861. Winchell, N. H.
Catalogue of the Phaenogamous and Aerogenous Plants found Wild in the Lower Peninsula of Michigan and the Islands at the Head of Lake Huron. First Biennial Rept. Geol. Surv. Mich., pp. 245-330.

1891. Thomas, Cyrus.
Catalogue of Prehistoric Works East of the Rocky Mountains. Smithsonian Institution, Bureau of Ethnology. Washington.

1894. Smith, Harlan I.
Caches of the Saginaw Valley, Michigan. Proc. Am. Assn. Adv. Sci., 1893, pp. 300-303.

1900. Lane, Alfred C. and Davis, C. A.
Geological Report on Huron County, Michigan. Geol. Surv. of Michigan, Vol. VII, Pt. II.

1901. Smith, Harlan I.
Summary of the Archeology of Saginaw Valley, Michigan. American Anthropologist, III, pp. 286-393.

1901. Smith, Harlan I.
The Saginaw Valley Collection. Supplement to American Museum Journal, I, No. 12.

1909. Ruthven, A. G.
Notes on Michigan Reptiles and Amphibians. Eleventh Annual Rept. Michigan Acad. Sci., pp. 116-117.

1910. Ruthven, A. G.
Notes on Michigan Reptiles and Amphibians, II. Twelfth Annual Rept. Michigan Acad. Sci., p. 59.

1910. Smith, Harlan I.
A Preliminary List of the Sites of Aboriginal Remains in Michigan. Geol. and Biol. Surv. of Michigan, Bull. I, Biol. Ser. 1.

ECOLOGICAL RELATIONS OF THE FLORA.

BY G. H. COONS.

In the summer of 1908, the writer was a member of the field party of the Michigan Geological and Biological Survey which was at that time conducting biological investigations in the sand region of Huron County. As Mr. C. K. Dodge was engaged to make the exhaustive floral lists, the writer restricted himself to the examination of the ecological relations of the plants. The work was practically confined to Sand Point, where the habitats were worked in as much detail as the time (6 weeks in July and August) permitted. On account of the time limitations the work was necessarily very incomplete, but the writer submits the following paper, trusting that the results are correct as far as they go, and that the work will be a contribution to the subject.

The results are presented according to the following outline:

- Physiographic Conditions.
- Ecological Relations.*
  - Hydrophytes.
    - Fresh Water Formations.
      - Chara Association.
      - Nymphaea Association.
  - Helophytes.
    1. Amphibious Formation.
       - Scirpus Association.
       - Juncus Association.
       - Carex Association.
    2. Reed Swamp Formation.
       - Phragmites Association.
    3. Bush Swamp Formation.
       - Alnus Association.
    4. Wooded Swamp Formation.
       - Birch-Willow Association.
  - Mesophytes.
    - Forest Formation.
      - Poplar-Birch-Maple Association.
  - Psammophytes.
    1. Beach Formation.
    2. Dune Formation.
       - Calamovilfa-Ammophila Association
    3. Dune-Heath Formation.
       - Poa Association.
       - Arctostaphylos Association.
    4. Dune Bush Land Formation.

* The ecological nomenclature follows Warming's *Oecology of Plants*.

PHYSIOGRAPHIC CONDITIONS.

Sand Point is situated on the northern shore of Huron County, Michigan. (Map.) As its name implies it is a sandy projection about four miles long and from one-fourth of a mile to a mile wide, and extends almost directly westward into Saginaw Bay. The manner of its formation has been discussed by Ruthven. In general it may be said that it is composed of a series of more or less parallel ridges formed by the elevation of sand beaches through wave and wind action. Between the ridges are ponds, swamps, or low sand-flats, depending on the depth.

The beaches are of two types—the sand beach and the mud-flat. The stretch of beach on the north side of the Point has a broad upper beach and is built up entirely of sand. On the south side the point faces a muddy, sheltered bay, Wild Fowl Bay, in which drift-wood and organic matter are tending to change the sandy shore into a mucky one.

On Sand Point, there are but two ponds of any size, Long Lake and Orr Lake. These are lagoons that have been closed in by ridges formed as barrier beaches or sand spits and elevated by wind action. These lakes will never be reclaimed by the bay, as the water of the latter has subsided since they have been formed and the separating ridges have been well developed, and since the processes of filling will soon elevate the lakes themselves to base level.

In general then it may be said that the Point has been and is being constructed by the successive addition of beaches that enclose ponds or low flats. These beaches are subsequently elevated into dunes, the ponds or lowlands gradually becoming converted into dry land. The succession of habitats is therefore as follows:

Mud-flat.

1. *Lake* with the formation of a series of sand bars becomes
2. *Bay.* A barrier beach or sand spit changes this into
3. *Lagoon or Closed Swale.* Vegetation and inwash (and wind-blown sand if near the bay) changes this into
4. *Undrained Swamp* or *Marsh.* Drainage and humus formation changes this to

5. *Thicket* and *Wooded Swamp* and
6. *Drained Situations.*

Sand Beach.

1. *Open Beach* through drying and wind action becomes
2. *Embrionic Dune* or *Upper Beach* and this through sand binders becomes
3. *Established Dune.* Through heaths, shrubs and trees this becomes
4. *Dry Ridge* and
5. *Jack Pine Barrens.* Humus formation and cessation of fires change this into
6. *Mixed Pine Woods*, which through humus formation become
7. *Mesophytic Woods.*

Sand Point was chosen by Dr. Ruthven as a base largely because of the comparative simplicity of its physiographic features. It is a recent geological formation showing all stages of development even to the very newest. The advantages of such a region to the plant ecologist lie in the fact that the genetics of the plant formations in a region physiographically young are more evident than in an older area. The progression is faster, being necessarily so in a region that is moving toward the forest formation, for trees are longer in growing and in taking possession of a habitat than sedges, and are correspondingly persistent.

ECOLOGICAL RELATIONS.

Hydrophytes—Fresh Water Formations.

Turtle Bay, on the south side of Sand Point, presented quiet water conditions and the resultant hydrophytes (Plate VII b and XIII b). It was a protected arm of Wild Fowl Bay and was very large and shallow, the water varying in depth from six inches to four feet. The muck was about two inches deep; the bottom being frequently exposed in places cleared by the sunfish for their nests. This muck consisted of finely divided silt and water logged vegetal debris. It was seldom compact and in walking on it the foot would sink through this upper layer to the packed sand beneath.

On the bottom, forming a carpet, the *Chara* was very strongly developed. This association, however, was not restricted to any given depth in this bay. In this carpet mass was entangled shells, blackened wood, and a large mass of larval cases of the May-fly. The water-lily (*Nymphaea advena*) and the *Chara* association were the only marked societies represented, except for a few plants of *Potamogeton*—(*heterophyllus, perfoliatus,* and *pectinatus*). The depth of the water seemed to be the factor which was eliminating the *Potamogeton* association and favoring the spread of the lily pads.

Helophytes—Swamp Formations.

This class of formations except for the sand type includes the greater part of the Point, for the amount of land that is upland is much less than that which is low and water-soaked. On account of the recent formation of the Point, and the fact that new lagoons are being formed by the great storms, etc., as explained by Ruthven, almost a complete series of formations can be described. (Plate II b.) Thus we have the amphibious formation (reed-swamp formation) composed of many associations, the bush-swamp and the wooded-swamp formations.

Amphibious Formation—Carex, Juncus and Scirpus Associations: These associations appeared along the lagoons. The lagoon studied, Long Lake (Plate XII a), was surrounded by jack pine ridges and was itself being filled to a considerable extent by wind-blown sand as well as by inwash and vegetable debris near the shore. This physiographic feature was somewhat intermediate between the open water of the bay and the half filled marsh, hence the vegetation consisted of the formations found in each. In the open, shallow water the water-lily association and the *Chara* persisted while extending from the shores the *Scirpus, Juncus* and *Carex* associations pressed out in the order named.

Along the shore of the lake the strip of helophytes was gradually being narrowed by the encroachment of the xerophytes from the bank. (Plate XII b). In places this encroachment was great enough to entirely suppress the shrub zone of willow, dogwood and alder. This was especially true on the side of the lake nearest the open bay.

The *Scirpus* and *Juncus* associations were almost pure and found growing in the water. The *Carex* association was a closed one, growing on the banks where the ground was wet and soggy, yet offered solid foothold (Plate XIII a). Here the greatest variety of plants was found as shown by the lists.

Detail of the Carex Association.

Dominant Species:

Carex filiformis.

Sub-Dominant Species:

Equisetum sylvaticum.
Alisma plantago-aquatica.
Sagittaria latifolia.
Phragmites communis.

Scirpus americanus.
Scirpus validus.
Juncus balticus littoralis.
Carex lupulina.
Salix nigra.
Mimulus ringens.
Lycopus americanus.
Cephalanthus occidentalis.
Eupatorium purpureum.
Eupatorium perfoliatum.

Quadrats* were laid out and a frequency count made with the following results:

Quadrats.

Plant.	1	2	3	4	Av.
Equisetum sylvaticum	1	....	4	1	1
Carex filiformis	40	35	35	20	32
Phragmites communis	....	8	....	10	4
Scirpus validus	1	1	3	4	2
Juncus balticus littoralis	45	35	30	....	28
Salix nigra	1	....	....	....	0
Lycopus americanus	25	....	....	15	10
Cephalanthus occidentalis	1	....	3	4	2
Eupatorium purpureum	2	....	....	1	1
Solidago juncea	1	5	1	....	1
Totals	117	84	76	55	81

Assuming that there were 80 to 100 plants to the square meter in this association, if the individuals were evenly spaced each would have had 100 sq. cm. at its disposal.

Where the xerophytic societies were establishing themselves by advance from the dunes surrounding the lagoon, the following plants commonly found higher on the bank were the vanguard in the invasion. Many of these plants persisted in the helophytic society and became prominent in the meadows—e. g., *Hypericum kalmianum.*

*The meter quadrats were made at typical localities by staking out a four meter rope in the form of a square. The counts were made by pulling up the plants, and in cases of great discrepancy in the size of the individuals, the number was obtained by lumping the small plants and using the average leaf surface as a gauge. This lumping is but a rough method and can give only approximate results, but if a number of quadrats are taken and an average of results made, the error will be largely effaced and the numbers obtained will indicate a fair type. For example, although there is an excessive development of a species at one location this is quite likely to be offset by a weaker showing at some other and the average will indicate the general condition. In selecting quadrats the aim was to seek similar conditions where the species were about of the same age. No attempt was made to have the quadrats include all the species listed for a place. The numbers obtained, therefore, indicate in each case what may be expected at typical locations in such associations.

Transition Species:

Spartina cynosuroides.
Carex muhlenbergii.
Rubus hispidus.
Desmodium paniculatum.
Apios tuberosa.
Hypericum perforatum.
Hypericum kalmianum.
Teucrium canadense.
Solidago graminifolia.
Solidago juncea.

Reed Swamp Formation—Phragmites Association: The type studied was an expanse of grassy meadow probably a mile square situated at the base of the Point. It was principally covered by tall grasses and was studded with clumps of bushes, and the zones* were the same as in the younger stage of the formation, although the dominant species had changed with the conditions. This meadow evidently represented an old bay, cut off from Wild Fowl Bay by a sand spit and subsequently filled by inwash and the accumulation of vegetal debris, the history being revealed quite as plainly by the vegetation as by the physiography.

The *Phragmites* association follows the *Juncus, Scirpus,* and *Carex* associations. At Long Lake we saw the encroachment of the swamp plants in the open water. With the filling of such a lake the *Scirpus* association disappeared, the *Carex* stools gave way to the rhizome propagation of *Phragmites* and the swale resulted. The process was an elimination of the more hydrophytic societies and kept pace with the disappearance of the open water. At the time studied the general elevation was just about at lake level, but the formation of "woody islands" had begun, as was shown by the clumps of trees and shrubs that differentiated the grassy plain. (Plate VI a)

The plants did not grow close together and xerophytic structures were common. Holes sunk at various parts of this swamp showed black amorphous peat to the depth of more than two feet. Roots and stems were also found to this depth, showing that the substratum was built partly by living plants and was not merely a silt deposit.

**Editor's Note.*—This paper having been written before the rulings on nomenclature by the Brussel's congress were made the word *zone* is used throughout in the sense of *girdle* or *belt* as now used in Ecology.

Detail of the *Phragmites* Association.

Dominant Species:

Phragmites communis.

Sub-Dominant Species:

Aspidium thelypteris.
Aspidium spinulosum.
Aspidium spinulosum intermedium.
Equisetum sylvaticum.
Calamagrostis canadensis.
Cladium mariscoides.
Scirpus americanus.
Iris versicolor.
Calopogon pulchellus.
Habenaria blephariglottis.
Habenaria psychodes.
Polygonum amphibium.
Polygonum hydropiper.
Polygonum hydropiperoides.
Polygonum persicaria.
Potentilla canadensis.
Potentilla anserina.
Potentilla palustris.
Amphicarpa monoica.
Hypericum virginicum.
Sium cicutaefolium.
Menyanthes trifoliata.
Asclepias tuberosa.
Asclepias incarnata.
Solanum dulcamara.
Mimulus ringens.
Scutellaria lateriflora.
Veronica scutellata.
Utricularia cornuta.
Lythrum alatum.
Campanula aparinoides.
Eupatorium purpureum.
Eupatorium purpureum maculatum.
Artemisia caudata.

Quadrats.

Plants.	1	2	3	4	5	Av.
Aspidium thelypteris	15	10	6	35	5	14
Phragmites communis	90	105	70	60	102	85
Iris veriscolor	2	4	......	......	......	1
Salix nigra	......	......	......	1	......	......
Polygonum persicaria	1	......	2	2	......	1
Lobelia spicata	......	......	......	4	......	1
	108	129	78	102	107	102

If evenly spaced, each plant would have had about 100 sq. cm. to itself—a sparse vegetation considering the linear-leaf habit of the majority of the species.

Bush Swamp Formation—Alnus Association: Wherever the ground was dryer than in the main portion of the meadow, due to the mounds formed by the vegetation, the bush swamp formation began. The pioneers seemed to be *Rosa carolina* and *Spiraea salicifolia*, but these by no means dominated the resulting thicket (Plate VI b). In these thickets a dense shade prevailed and mosses (*Amblystegium riparium longifolium* and *Polytrichium* sp.) with mushrooms, (*Marasmius rotula, Omphalia, Russula veternosa media*) formed the bottom layer. On the borders of the thicket the vegetation was plainly terraced, the shorter forms being toward the front and the taller ones in the center.

The ground around the thickets was completely built up so that there was no marshy vegetation in the series. Yet it was no doubt the case that in spring and wet seasons these plants were submerged for a time. This feature, together with its origin, classes the bush swamp with the helophytes, although it may pass directly into a mesophytic woods or wooded swamp, depending on the water relation. A peculiarity in the development of this feature was shown by the trunks of *Larix laricina* found in the peat and in some cases still standing. These trees had been destroyed by fire or by lumbering but they indicated a phase of the development of the forest not shown by anything on the Point. The presence of *Andromeda, Menyanthes, Utricularia, Thuja,* etc., also point to an oxylophytic formation or at least oxylophytic conditions. The better drainage and the resulting aeration of the soil in these hammocks were doubtless in large part responsible for the fact that this oxylophytic formation disappeared and was replaced by the plants of the shrubby growth-form.

Detail of the Alnus Association.

Dominant Species:

Myrica gale.
Alnus incana.

Sub-Dominant Species:

Osmunda regalis.
Larix laricina.
Thuja occidentalis.
Salix longifolia.
Populus tremuloides.
Spiraea salicifolia.
Potentilla fructicosa.
Rosa carolina.
Pyrus melanocarpa.
Ilex verticillata.
Rhus vernix.
Cornus stolonifera.
Asclepias incarnata.
Cephalanthus occidentalis.
Verbena hastata.
Lactuca canadensis.

Wooded Swamp Formation—Birch-Willow Association: From the *Alnus* association surrounding the meadow there was an easy gradation to the wooded swamp, the birch-willow association, found at older or innermost and lower parts of the Point. The damp conditions of the thickets persisted, but, while the thicket growth in the formation was frequently so dense that it was hard to penetrate, at other places it was thinned so that there was an approach to the open woods which was the climax of this succession. In the wooded swamps we found that the shrubs and bushes which characterized the younger thickets diminished and there was a gradual increase in the dominance of the elms, maples, and birches over the alders. No detailed lists were made for this formation.

An examination of the lists given above will show that the swamps on Sand Point belong to the "drained" as distinguished from the "undrained" type, of Cowles (1901) and Transeau (1903). A few bog forms such as *Menyanthes trifoliata, Andromeda polifolia, Cassandra,* tamarack and black spruce are occasionally present but only in small numbers. The fact that the bog societies are dominant in no place in the sand region is very probably due to the fact that the sandy substratum affords better drainage conditions than is most favorable for the bog forms. (Gunnar Andersson, 1896, p. 433, et seq.) But the conditions in the swamp association as last described are very similar to those in the mesophytic woods. Probably the chief difference in factors is that of elevation which has kept the ground in the former water soaked, i. e. not aerated, and acid. Probably the chief difference in the makeup of these two associations was the predominance of *Betula alba papyrifera, Salix* sp., *Cornus circinata,* and of *Alnus incana* in the wet soil, whereas the mesophytic formation was more open. The growth-form of the latter impressed one as a growth of trees, penetrable and clean underneath, not as one of saplings with frequently impenetrable under brush.

Mesophytes—Forest Formation.

Poplar-Birch-Maple Association: The thicket which fringed the marsh graded into a dense wood of young trees, the latter exhibiting a well defined stratification. Those members of the *Alnus* association that could endure shade were here, and where the shrubs were dominant before, the sapling was now the prevailing growth-form.

This formation is mesophytic. The great increase in the number of shade plants, the presence of trees such as *Ulmus americana, Betula alba papyrifera, Populus tremuloides,* etc., and the loose rich humus covering the ground, showed that here the various factors of light soil and moisture were in a moderate amount.

Detail of the Poplar-Birch-Maple Association.

Dominant Species:

Populus tremuloides.
Betula alba papyrifera.
Acer rubrum.

Sub-Dominant Species:

Equisetum sylvaticum.
Thuja occidentalis.
Agrostis alba.
Carex tribuloides.
Alnus incana.
Ulmus americana.
Boehmeria cylindrica.
Dicentra cucullaria.
Rubus idaeus var. *aculeatissimus.*
Rubus hispidus.
Rubus allegheniensis.
Viola incognita.
Trientalis americana.
Rhus toxicodendron.
Aralia nudicaulis.

Fraxinus americana
Cornus circinata.
Apocynum cannabinum.
Scutellaria galericulata.
Scutellaria lateriflora.
Lycopus americanus.
Galium trifidum.

Quadrats (Ground Stratum).

Lower layer plants about six inches to one foot tall.

Plants.	1	2	3	4	5	Av.
Percentage of moss, sticks, etc........	25	50	40	20	30	30% 1
Onoclea sensibilis	......	6	......	......	......	6
Aspidium Thelypteris	......	8	3	4	16	
Equisetum sylvaticum	......	......	2	......	......	1
Agrostis alba	10	......	......	......	14	5
Poa pratensis	8	......	5	10	......	5
Maianthemum canadense	......	......	......	......	2	1
Ulmus americana	2	......	......	4	......	1
Ilex verticillata	......	......	1	......	......	0
Acer rubrum	40	90	20	90	10	50
Impatiens biflora	......	1	1	......	......	1
Psedera vitacea	8	3	2	......	1	3
Fraxinus americana	......	......	3	5	2	2
Scutellaria lateriflora	40	2	......	......	......	8
Lycopus americanus	1	1	......	......	......	1
Solidago sp	3	......	......	......	......	1
	112	111	38	111	35	86

A typical quadrat contained about 86 plants on 70 per cent of the area, giving each plant, assuming even spacing, about 80 sq. cm. Since all of the plants were small, the vegetation was very thin.

Psammophytes—Beach Formation.

The lower beach was in general without vegetation. The middle beach was an area of varying width, depending on the age of the Point. At the older portions it was narrow or vertical, the waves having cut into the outer sand dune forming a cliff of sand, while at the west end of the Point the middle beach was about thirty feet wide and about eighteen inches above the summer level of the lake. (Plate I a.) The sand was medium fine, well packed, and was wet two inches below the surface. Vegetation was sparse and there were no definite clumps of plants, the distribution seeming to be due to the chance lodgment of seeds. The following species were noted and are recorded in order of observed frequency.

Cakile edentula.
Arabis lyrata.
Artemisia caudata.
Triglochin maritima.
Salsola kali.
Xanthium echinatum.
Potentilla anserina.
Cirsium pitcheri.
Cenchrus tribuloides.
Physalis heterophylla.
Echinocystis lobata.

Dune Formation-Calamovilfa-Ammophila Association: The upper beach, the upper and lakeward side of the outermost dune, was clothed with easily the most distinct association on the Point. This close organization was holding the sand, was withstanding the sand storms, and was persisting under the competition of the plants of the jack pine ridges. (Plate II a.) In fact the assault was from two sides, for the water currents and winds were lodging the common weed seeds —*Amaranthus, Salsola, Chenopodium,* and the asters and golden rods —on the middle beach, from whence they tended to invade the dune face.

It is not necessary to describe this beach in detail. It belongs to a type that exhibits relatively little variation around the Great Lakes. The edaphic conditions are very severe. The clean lake sand of very fine particles (81 per cent, .25 to .001 mm. in diameter, see Bull. Bureau of Soils, 1901, p. 99), the absence of organic matter and the excess of certain mineral elements are the common characteristics of the substratum. Cowles (1899) has pointed out, furthermore, that the xerophylly shown by the members of these formations is due not so much to the lack of water in the soil as to the xerophyllous air. In such places the light is most intense, the heating effects are greatest and the drying action of the wind most vigorous. King (1900, p. 230) records that the drying effect of the wind 300 feet from a hedge row was 24 per cent greater than near the hedge. In a similar manner the absence of all shrub-like plants or wind-breaks on the outer face of the dune permits excessive dessication here.

To this should be added the effect of great diurnal variations, as only a plant fitted for xerophyllous conditions can adjust itself to high temperatures in the day time and very low ones at night. Maximum and minimum temperatures for the open beach and deep woods were taken for July. (See appendix.) These records are useful in illustrating the fact that the beach was always warmer during day time and colder at night than the deep woods. Also the difference in maximum and minimum as shown by comparison by days shows that the drop in temperature averaged about twice as much for the beach as for the woods. In July the minimum at no time became low enough to affect the plant activity, but in growing months when the temperature approached freezing this excessive difference would become an important factor, for it must be considered that during the night the wind still vigorously exerts its drying action. These records were for air temperatures, but soil temperatures on the beach and in the woods would show the same or greater range in temperature due to the low specific heat of sand (Warming, 1909, p. 52, gives the specific heat of sand as .2).

Detail of the Calamovilfa-Ammophila Association.

Dominant Species:

Calamovilfa longifolia.
Ammophila arenaria.

Sub-Dominant Species:

Equisetum hyemale intermedium.
Elymus canadensis.
Populus tremuloides.
Rumex crispus.
Arabis lyrata.
Potentilla anserina.
Prunus pumila.
Lathyrus maratimus.
Oenothera biennis.
Convolvulus sepium.
Solanum nigrum.
Erigeron canadensis.
Artemisia caudata.
Lactuca canadensis.
Cirsium arvense.
Cirsium pitcheri.

Four quadrats laid out at typical parts of the dune.

Plants.	1	2	3	4	Av.
Calamovilfa longifola and *Ammophila arenaria*	31	16	20	17	21
Cakile edentula	......	2	......	1	1
Lathyrus maritimus	......	......	2	9	3
Solanum nigrum	1	......	......	......	......
Artemisia caudata	......	1	1	......	1
	33	19	23	27	26

The plants averaged about 26 to the sq. m. With even spacing this means one plant to every 400 sq. cm., a very sparse vegetation.

Dune Heath Formation: This formation is typical all along the shores of the Great Lakes. There is shown also great similarity to the corresponding formations on sandy tracts inland (Warming 1909, p. 272). Such areas make up a large part of the northern half of lower Michigan.

Wherever clearings have been made, or where the land has been reclaimed from the lake, the jack pine association is the dominant one in the open area, but it is almost always preceded by a heath formation. (Plate IV a.)

In the heath formation the plants grow on very fine leached sand. The waterline is low—Kedzie (1888) gives it as from 15 to 30 feet below the surface of the soil for the jack pine barrens and at Sand Point it is determined by the height of the ridges above the lake level (average about 10 to 15 feet). Humus is practically absent, the dune sand showing up one inch below the surface. In this sort of location the leaves and stems of previous years are slow to decay, which partly accounts for the barrenness of the soil. The plants are subjected to strong light, and the temperature extremes very nearly approach the rigorous ones of the beach.

The most typical heath conditions were found on the landward side of the outermost dune.

In the dune heath formation two well-defined associations appeared, the *Poa* and the *Arctostaphylos*. The former was a closed one consisting of a firm sod broken only in places by seedlings of jack pine and choke cherry.

The *Arctostaphylos* association was different. It did not conceal the sand but it collected the dead leaves forming a thick dry mat. With it occurred the blueberry—dwarfed and stunted—and a great army of other species. The reindeer moss was plentiful with these two associations.

Detail of the Arctostaphylos Association.

Dominant Species:

Arctostaphylos uva-ursi.
Vaccinium pennsylvanicum.

Sub-Dominant Species:

Pteris aquilina.
Lycopodium complanatum.
Panicum xanthophysum.
Myrica asplenifolia.
Comandra umbellata.
Oxalis stricta.

Gaylussacia baccata.
Helianthus divaricatus.
Solidago juncea.

Quadrats.

Plant.	1	2	3	4	5	Av.
Pteris aquilina	......	......	1	1	1	1
Lycopodium complanatum	......	......	6	......	......	1
Pinus banksiana	......	3	1	......	......	1
Panicum xanthophysum	10	......	1	7	......	4
Poa compressa	16	20	10	45	16	21
Smilacina stellata	......	......	2	......	......	1
Comandra umbellata	......	10	......	......	......	2
Gaylussacia baccata	......	......	1	......	......	......
Arctostaphylos uva-ursi	10	6	13	......	......	5
Vaccinium pennsylvanicum	1	8	20	21	30	16
	38	49	55	74	47	51

Each plant has about 200 sq. cm., assuming even spacing.

Dune Bushland Formation: This formation was not prominent at Sand Point. In many places it was left out of the succession altogether. The trees of the jack pine were able to develop in the *Poa compressa* sod without the nurse agency of this formation.

Where the bushland was developed *Prunus pumila, Cornus stolonifera* and *Populus tremuloides* were the principal species. The bush was best developed on the inner side of the outer dune.

The formation was not prevalent enough to lend itself to a grouping into associations.

Dune Forest Formation: In the typical dune forest formation the predominating tree was *Pinus banksiana.* The formation was open, the trees averaging 15 to 20 feet apart. The floor stratum consisted of persistent heaths and some other xerophytic species. Blueberries were common and made their best growth here. In the open places on Sand Point there was a very prominent sod of *Poa compressa* and this sod association was very important in the succession, being even more so than the heath mat, for in it were found seedlings of *Pinus resinosa* and *Pinus strobus.* (Plate IV b.)

Detail of the Jack Pine Association.

Dominant Species:

Pinus banksiana.

Sub-Dominant Species:

Pteris aquilina.
Pinus strobus.

Pinus resinosa.
Maianthemum canadense.
Myrica asplenifolia.
Rumex acetosella.
Fragaria virginiana.
Prunus virginiana.
Prunus pennsylvanica.
Prunus pumila.
Geranium maculatum.
Ceanothus ovatus.
Ceanothus americanus.
Gaylussacia baccata.
Vaccinium pennsylvanicum nigrum.
Rhus typhina.
Apocynum androsaemifolium.
Melampyrum lineare.
Lobelia spicata.
Solidago juncea.
Rudbeckia hirta.
Aster macrophyllus.
Helianthus divaricatus.
Achillea millefolium.

Farther in these woods, that is towards the older portion of the Point, the woods become much more heavily shaded. Here the jack pines were about equaled in numbers by *Pinus resinosa*. Scattering trees of *Pinus strobus* of all ages were found and scrubby growths of *Quercus rubra* and *Q. coccinea* were common. The heaths and sod disappeared and the group of plants just listed was giving way to plants fitted for shade. In the latter the leaves were larger so that the ground could not be seen because of them, and the species were more mesophytic and showed better than the present upper layer the future of the formation. The following mosses were common: *Dicranium flagellare, D. fuscescens congestum, Polytrichum piliferum, Thuidium virginianum.*

Detail of the Pine-Oak Association:

Dominant Species:

Pinus banksiana.
Pinus resinosa.
Quercus coccinea.
Quercus rubra.

Sub-Dominant Species.

Pteris aquilina.
Equisetum hyemale intermedium.
Pinus strobus.
Uvularia grandiflora.
Maianthemum canadense.
Smilacina racemosa.
Smilacina stellata.
Polygonatum commutatum.
Medeola virginiana.
Dioscorea villosa.
Cypripedium acaule.
Epipactis pubescens.
Quercus velutina.
Quercus alba.
Actaea rubra.
Potentilla monspeliensis.
Osmorhiza claytoni.
Hamamelis virginiana.
Desmodium paniculatum.
Psedera vitacea.
Vitis vulpina.
Rhus toxicodendron.
Chimaphila umbellata.
Gaultheria procumbens.
Pyrola elliptica.
Pyrola americana.
Pyrola secunda.
Aralia nudicaulis.
Apocynum androsaemifolium
Diervilla lonicera.
Lonicera canadensis.
Lonicera glaucescens.
Melampyrum lineare.
Aster macrophyllus.

Quadrats.

Plants.	1	2	3	4	5	Av.
Pteris aquilina	13	20	10	1	16	12
Equisetum hyemale intermedium	......	1	......	......	......	......
Panicum sp.	......	2	......	......	......	......
Maianthemum canadense	8	22	14	......	8	10
Smilacina racemosa	......	......	......	4	3	1
Smilacina stellata	......	......	1	1	4	1
Fragaria virginiana	......	......	5	3	1	2
Hypericum perforatum	1	5	1	......	......	1
Rhus toxicodendron	4	......	4	20	14	8
Aralia nudicaulis	......	......	......	1	4	1
Pyrola elliptica	......	......	......	......	2	......
Gaultheria procumbens	5	15	20	7	......	9
Gay-lussacia baccata	......	3	......	3	5	2
Vaccinium pennsylvanicum nigrum	4	......	......	......	......	1
Diervilla lonicera	7	......	......	......	......	1
Solidago juncea	1	......	......	1	......	......
	42	64	59	42	57	50

Each plant had about 200 sq. cm., assuming even spacing.

From inspection of the flora lists it seems that the jack pine barrens are much alike throughout Michigan and Minnesota. Sand Point has 80 per cent of Smith's list of plants typical of the jack pine plains and 79 per cent of his list of less frequent plants. Considering the sand region as a whole all the plants in both lists appear. (Smith, 1880, quoted in Beal, 1904, p. 16-17.)

The most applicable work on the pine barrens is that of Livingston in Roscommon and Crawford counties where the formation is the same as on Sand Point and the relation of the trees to the substratum is similar. From his studies in these places, Livingston draws the conclusion that the chief factor in determining the distribution of the species of pine is the amount of humus in the soil. (Livingston, 1903, p. 30.) He proves by laboratory experiments that the relation of this constituent to the amount of water in the soil is an important one by demonstrating that humus soil holds nearly twice as much water as sandy soil. He considers the mineral elements in the soil sufficient for plant growth, but the analyses given by Kedzie (1888 and 1893) seem to show that these mineral constituents, especially the salts of Potassium, Phosphorus and Nitrogen, are insufficient.* Furthermore these salts are not made available because of the lack of organic acids in the soil water and the analyses of soil water from West Olive, Michigan, as furnished by the Michigan College of Agriculture, show

* See footnote opposite page.

the same apparent lack of plant food materials.† The soil at West Olive is given as jack pine barren. It would thus seem that in the determination of the factors responsible for the predominance of the jack pine the poor mineral content of the soil must be considered.

If Livingston is correct, the chief force in preventing the betterment of the barrens is the fires which not only destroy all growth but burn the small accumulation of humus as well. Beal (1888, p. 28) has shown that jack pine seeds have great vitality and can last over a great many years, which explains in a way the invasion and ecesis in the burned over sections, for the seeds of many species falling on the newly denuded area are not able to last over until a favorable time.

It was observed at Sand Point that the sand dune could be rapidly clothed by heath and sod and this in turn be replaced by jack pine and scrub oaks. With these trees the humus building is very slow, but the sod formed by *Poa compressa* and the gradual accumulation of humus after a time enables *Pinus resinosa* to replace the jack pine.

†Analyses of Soil Water from W. Olive, Michigan, made July 25, 1904.
(Analyses furnished by Prof. F. S. Kedzie, Michigan Agricultural College.)

Material. (In parts per million.)	Sample.		
	1	2	3
Volatil	24.1	106.4	38.6
Mineral consisting mostly of			
Ca 0	20.866	115.9	24.6
Mg 0	16.666	96	26.9
Fe 0	trace	11.173	trace
Total Solid	88.1	548.	90.9

* Analyses of Soil of Jack Pine Barrens.

Material.	Sample.		
	1	2	3
Sand and Silicates	94.97	94.30	95.02
Alumina	1.03	.61	.49
Oxide of Iron	.86	1.17	.78
Lime	.20	.24	.32
Magnesia	.12	.17	.15
Potash	.20	.33	.30
Soda	.90	.58	.62
Sulphuric Acid	.06	.05	.05
Phosphoric Acid	.05	.04	.01
Organic Matter	(Nitrogen .02) 1.61	(Nitrogen .05) 2.50	(Nitrogen .04) 2.25
Water	.23	.20	.21

Sample 1 is from virgin soil from experimental farm at Grayling (in Jack Pine plains).
Samples 2 and 3 are from fields which have been cultivated and had various green crops (legumes) plowed under for three years.
Adapted from Kedzie, R. C. Mich. Agr. Sta. Bull. 99.

Pinus resinosa, on the other hand, is a greater humus producer and very soon beneath this tree appear mesophytic species which lead to the deciduous forest. It should be stated that *Pinus strobus* appears with the Norway pine only as scattering growths and these are generally replaced by the hard woods.

Summary of Ecological Relations.

The ultimate forest formation will be a mixed deciduous one with a sprinkling of *Pinus strobus*. *Carya microcarpa* has been found at North Island, five miles from Sand Point and *Ulmus americana* and *Tilia americana* are making strong growths in the bottom land of Sand Point.

Judging from the progressions under similar conditions in other regions about the Great Lakes, the beech-maple type is the climax association. There is every indication here that the mesophytic trees — maples, elms, hickories, basswoods, oaks, etc., are taking possession of the humus covered ridges of the pine association, and probably only the *Pinus strobus* can persist in the mesophytic forest. The older helophytic and mesophytic associations will persist in their lowest situations and the pines will hold the ridges. But the valleys and hollows between are so shallow and the agents of filling and denuding so rapid in this loose soil, that it is but a question of decades until the area will be levelled. With this, of course, comes the uniformity of association. However, the nature of the soil will shut out for a long time those trees that are common in calcareous areas.

Scheme of Ecological Succession on Sand Point.

Class.	Hydrophytes.	Helophytes.				Mesophytes.
Formation.	Fresh Water.	Amphibious.	Reed Swamp.	Bush-Swamp.	Wooded Swamp.	Forest.
Association.	Chara Nymphaea.	Scirpus Juncus Carex.	Phragmites.	Alnus.	Birch-Willow.	Poplar-Birch-Maple.
Habitat.	Bay.	Lagoon. Lake.	Marsh.			Drained Situations.

Class.	Hydrophytes.	Psammophytes.				
Formation.	Beach.	Dune.	Dune Heath.	Dune Bush.	Dune Forest.	Forest.
Association.		Calamovilfa-Ammophila.	Arctostaphylos Poa.	Prunus.	Jack Pine Pine-Oak.	Mixed.
Habitat.	Beach.	Upper Beach.	Established Dune.	Dry Ridge—Barren.		Old Ridge.

Tabular View of Meter Quadrats.

Name.	Number of Plants.	Space to Each.	Remarks.
Helophytes:			
Carex Association	81	about 120 cm².	
Phragmites Association	102	100	
Alnus Association	86	80	
Psammophytes:			
Calamovilfa-Ammophila Ass'n.	26	400	Very sparse.
Arctostaphylos Association	51	200	Sparse.
Pine-Oak Association	50	200	Sparse.

FUNGUS FORMATIONS.*

The prevailing xerophytic effect of the conditions upon the green plants likewise shows in the fungous flora on Sand Point. The summer of 1908 was very dry, thus increasing the xerophytic influences and the fleshy fungi were singularly scarce. However, the lists given below show the ecological character of the habitats almost as clearly as do the other plant lists. Such lists of fungi have not often been prepared, although the general habitat relation (whether frequenting woods or fields, sandy soil, etc.), have been recorded. The latter kind of records are, however, comparable to the habitat notes given in the manuals of vascular plants, while the former method is an attempt to list the fungi of definite formations.

*The determinations of fungi are by Dr. C. H. Kauffman of the University of Michigan unless otherwise indicated. Thanks are due also to Prof. T. H. Macbride of the University of Iowa, and to Prof. Moore of Missouri Botanical Garden for assistance in this connection. Where the determinations were made only in the field, the species are marked with the author's initials.

On this expedition, owing to the scarcity of fleshy fungi, practically all individuals that were seen were collected and these collections were labelled as to habitat. It was found that the restriction of species to these formations was singularly close and that the appearance of the same fungus in two formations was rare. These considerations seem to add an importance to these lists which ordinary citations of habitats, in which duplication of species is avoided, would not have. Fungi, not only in the mycelium but especially in the sporophore production, are probably more susceptible to the water relation than any other plants so that the limitation of species to special formations is largely due to this factor.

Bush-Swamp Formation:

Galera vittaeformis Fr. *fide* G. H. C.
Hygrophorus cantharellus Schw.
Marasmius oreades Fr.
Marasmius rotula Fr.
Omphalia campanella Batsch.
Omphalia fibula Bull.
Russula emetica Fr. (swamp form).
Russula roscipes (Secr.) Bres.
Russula veternosa Fr. *media.*

Wooded Swamp Formation:

Agaricus abruptus Pk.
Agaricus sylvaticus Schaeff. *fide* G. H. C.
Amanitopis vaginata Roze.
Boletus felleus Bull.
Cantharellus cibarius Fr.
Clavaria cristata Holwsk.
Fuligo ovata Schaeff. *fide* T. H. Macbride.
Fomes applanatus (Pers.) Wallr. (*leucophaeus.*)
Hemitrichia clavata (Pers.) Rost.
Lactarius piperatus Fr.
Lactarius volemus Fr.
Lenzites betulina Fr.
Paxillus atrotomentosus (Balsch.) Fr.
Pluteus cervinus Schaeff.
Poria vaporia Fr. *fide* Prof. Moore.
Russula chamaeleontina Fr.
Stemonitis Smithii Macb. *fide* Macbride. (*S. ferruginea* Ehren.)
Strobilomyces strobilaceus Berk.
Trametes cinnabarina Fr.

Beach Formation:

Daedalia unicolor Fr. *fide* Prof. Moore.
Lentinus lepideus Fr.

Dune Forest Formation:

Jack Pine Association.

Astraeus stellatus (Scop.) Fischer.
Hypoxylon annulatum (Schw.) Mont. *fide* Prof. Moore.
Hypoxylon atropurpureum Fr. ? *fide* Prof. Moore.
Hypoxylon marginatum (Schw.) Berk. *fide* Prof. Moore.
Nummularia Bullardi Tulasne.
Lenzites saepiaria Fr.
Panus rudis Fr.
Polystictus hirsutus Fr.
Polystictus pergamenus Fr.
Polystictus zonatus Fr.
Polystictus versicolor L.
Schizophyllum commune Fr.
Stereum versicolor Schwartz.

In addition to the above in older bãrrens:

Amanita rubescens Fr. *fide* G. H. C.
Clitocybe pinophila Pk.
Polyporus elegans Fr.
Polyporus picipes Fr.

Pine-Oak Association:

Amanita excelsa Fr. *fide* G. H. C.
Amanita phalloides Fr.
Amanita verna Bull.
Clitocybe ochropurpurea Berk.
Clitocybe laccata Scop.
Favolus europaeus Fr.
Hypocrea Richardsoni Berk. & Mont. *fide* Prof. Moore.
Lycoperdon pyriforme Schaeff. *fide* Prof. Moore.
Polyporus ignarius Fr.
Polystictus perennis Fr.
Polyporus Schweinitzii Fr.
Russula brevipes Pk.
Stereum versicolor Schwartz.

Although the data given above are very meager, the writer offers them as an illustration of the fact that fungi may be grouped in formations.

All fungi are tending to migrate and many are cosmopolitan. Some agents are very efficient in their distribution, for example, self propulsion as in the Ascomycetes and Basidiomycetes, as has been shown by Buller (1909), or biotic as in the Phalloids, etc., whose spores are carried by insects. Fungi also show successions, as, for example, the successive appearance of different species on fallen logs at different stages of decay and the zonation shown about a dung heap.

The ecological relations depend on the life habit. If parasitic, the problem is similar to the problem of the higher parasites, namely: entrance of host, appropriation of the food supply, and reproduction. The problems of immunity and virulence also come here. If saprophytic, the problem is comparable to the problems of the green plants, for saprophytic species are affected by climatic and by edaphic factors, chiefly water and nutrient content. The former allows the fungi to be classed as xerophytic, mesophytic or hydrophytic, while the nutrient content probably accounts for the facts of successions and the occurrence on distinct species of fallen trees, etc., or on distinct kinds of soil, as *Astraeus* on sand and *Hygrophorus miniatus* in the bogs. Climatic factors would be operative through the effect of light and temperature, the former probably being more important. The fact that fungi present spring, summer and fall aspects would probably come from the effect of climatic factors.

These things may be seen working in the general fungus layers but as a group the fungi are much more important as biotic factors, producing diseases and epidemics, and in the important activities of destructive metabolism and nitrification.

Fungi have been listed from special forest associations (La Garde 1909) and a number of ecologists have listed the species along with the higher plants. (Weber 1902) (Jennings 1909) (Ganong 1897).* The group now requires a great amount of physiological work and nutrient relation determination, and the forms present difficulties in the field through their evanescence, size and periodicity (Harshberger 1904, p. 149) and from the fact that the presence of the mycelium is not always betrayed by the production of a pileus, but notwithstanding these difficulties they present attackable problems of distribution and ecology which are worthy of notice. (For criticism of this view see Pound and Clements, 1900, pp. 121-4.)

PHYTOGEOGRAPHICAL RELATIONS.

Sand Point is located in the Transition Zone, as outlined by Merriam (1898), and its flora, disregarding species of continental distribution, is about evenly divided between the so-called Boreal and Austral species.

*Klebahn (1904, pp. 97-103) has attempted to connect the occurrence of certain heteroecious forms of rusts with the formation in which the hosts occur, but the meagerness of observation of both host and fungi in the same formation makes his work largely conjecture. For such analyses there is need for suitable lists.

However, more distinctly northern and southern species are found here than in the interior parts of the state at the same latitude. Adams (1902) has pointed out that the post-glacial migration of plants and animals into Michigan was principally from southeastern United States. That the southern forms tend to push farther northward on the western side of the state is shown by the comparison of the species reported for Roscommon County with those found in Kent County. (Livingston, 1903 and 1901.) Similarly the flora of Sand Point is more southern than that of Roscommon County as also is the flora of Manistee and Sturgis as reported by Daniels (1904) or of Manitou Island as reported by Whitford (1901). This is probably due in part to the more equable climate of the coasts. Whatever the explanation, however, the fact stands that the vegetation has advanced in a V-shaped manner, the central portion of the state lagging behind the border portion. Typical southern species which show this advance are *Benzoin aestivale*, *Sassafras variifolium*, *Asimina triloba*, *Liriodendron tulipifera*, *Celastrus scandens*, *Gleditsia triacanthos*, *Cornus florida*, *Cercis canadensis*, etc.

Similar to this movement northward by southern forms is the movement (or persistence) southward by northern forms for which no explanation is offered. This is also V-shaped following the shores of Lakes Michigan and Huron, such species as *Pinus banksiana*, *Pinus strobus*, *Tsuga canadensis*, *Betula lutea*, *Taxus canadensis*, *Abies balsamea*, *Equisetum hyemale* var. *robustum*, *Clintonia borealis*, *Salix glaucophylla*, being reported from Northern Indiana (Hill, 1896), Chicago (Cowles, 1899), South Haven (Bailey, 1880) on the west and from Port Huron on the east side (Dodge, 1897) but are rarely found south of 43° in the interior of the state (Beal, 1904).

Several classifications of the region have been made, all largely based on the type of forest. Schimper (1903, p. 571) has followed Sargent (1884) in including this in the Northern Coniferous Forest Area.

A comparison of the floral lists given by Cowles for Chicago and vicinity, Jennings (1909) for Lake Erie, Dodge for Port Huron, Daniels for Manistee and Sturgis, Coulter (1904) and Whitford (1901) for Manitou Island, Ruthven for Ontonagon County (see Adams, 1906) and the compiled records from Beal and Gray's Manual (7 ed.) show that, as far as Michigan is concerned, the flora of the Great Lakes region is strikingly a unit, not alone as regards species but also in the composition of the plant societies. Furthermore, the genetics of the plant formations are very similar and the formations are passing from a heterogeneous aggregation into a homogeneous climax if we follow Cowles and Whitford. Now the basis of province delineation is similarity of constituents of formation or climax formation, and the limits of the province that includes the Great Lakes flora seem very well marked by the distribution of *Pinus strobus* as given by Sargent and (in Michigan) by Spalding (1899). The range of this tree is not restricted to the St. Lawrence basin but extends from New Brunswick along the ocean well through the Atlantic states, following the Allegheny Mountains almost to North Carolina. The explanation of this range seems to be found largely in the climatic conditions.

Engler points out that there is a difference in the secondary species found in the Atlantic States and those found in the St. Lawrence Basin, and he denotes the Atlantic States portion of the *Pinus strobus* province as the transition zone between this province and the Mississippi and Allegheny Forest Province. (Engler, 1902.) The forms and species enumerated for this last province he records as having penetrated to Nova Scotia, New Brunswick and Ontario, and we find them in Michigan. A comparison of lists shows that the typical species of each zone are present at Sand Point.

It is interesting to note that the plants of the Mississippi and Allegheny Province are almost altogether confined to the swamps or thicket formations while those of the *Pinus strobus* zone proper are on the sandy ridges. This affords an hypothesis to account for the difference in the secondary species of Sargent's White Pine Forest Area, for apparently the climatic factors account for the wide distribution of the pine but the edaphic conditions determine the exact makeup of the formations. The sandy ridges are taken by the hardier, less mesophytic northern societies and the loamy portions support the flora which we have learned to associate with the deciduous woods. Hence the leached glacial till of the St. Lawrence and Great Lakes is held by pines with the somewhat scanty accompanying flora, and the levelled highlands of the coast states with its richer soil is taken by the mesophytic species from the Allegheny-Mississippi zone.

GENERAL SUMMARY.

The Sand Point successions fall into two types: The swamp series (lagoon-swamp-thicket-forest) and the sand series (beach-heath-jack pine barren). The progression is to a similar mesophytic formation in each case.*

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* The following fungi were noted for the first time in the state :

Clitocybe laccata Scop
Clitocybe pinophila Pk.
Clitocybe ochropurpurea Berk.
Fuligo ovata Schaeff.
Hypocrea Richardsoni Berk. & Mont.
Hypoxylon annulatum (Sch.) Mont.
Hypoxylon atropurpureum Fr.
Hemitrichia clavata (Pers.) Rost.
Nummularia Bullardi Tul.
Panus rudis Fr.
Poria vaporia Fr.
Russula emetica Fr. (Swamp Form.)
Russula veternosa Fr. *media*.
Stemonitis Smithii Macb. (*S. ferruginea* Ehren.)

The fungi lists are given to show that this layer responds to the environmental factors even as the higher plants do. Allowing for differences in life relations, fungi also come under the laws of ecological succession.

The phytogeographic relations of this area show that it is now in a transition zone where pronounced northern and southern species are found. The genetics and climax group in this location as compared with other points on the Great Lakes show that the whole region is becoming a phytogeographic unit, and, while the division into northern and southern forms, and Engler's separation of the White Pine area into Eastern and Western regions, are now justifiable, the Great Lakes drainage system is becoming a stable province, with northern and southern species growing in the same localities, but sorted out into associations by edaphic conditions.

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University of Nebraska, December, 1909.

CATALOG OF PLANTS.

BY C. K. DODGE.

INTRODUCTION AND GENERAL DESCRIPTION OF THE REGION.

So far as known to the writer, no botanist has ever given special attention to the flora of the region here considered, except Prof. C. A Davis, who more than 10 years ago, while engaged in geological work, noted and reported 300 species. [1]

The observations on which this paper is based were mostly made by the writer while attached to the field party of the Michigan Geological and Biological Survey, during the summer of 1908, and on supplementary trips to this region in June, July, August and September, 1909. In the course of the work, Stony Island, North Island, Charity Island, and Little Charity Island were visited, and the whole shore between Sebewaing and White Rock traversed. Special attention was paid to the shore and sand dune plants, but at the same time notice was taken of nearby fields and the adventive plants and weeds in villages, gardens, about country dwellings and near fishery buildings.

Huron County lies at the north end of a peninsula often called "the thumb" and is bounded on the east by Lake Huron and on the west by Saginaw Bay. (See map.) The proximity of so much water affects its climate, making it average about three degrees warmer in winter and three degrees cooler in summer than in the middle of the state, but the principal effect of the lakes is to check oscillations and extreme variations in temperature. [2]

Beginning near Point aux Barques, sand ridges or sand dunes extend almost continuously to Bayport, Sebewaing and southwest into Tuscola County, but not always close to the shore. [3] From Sebewaing to Sand Point much of the shore is of the mud flat type, the dunes being some distance back. These dunes owe their origin exclusively to local conditions and the combined action of waves and wind, the former bringing the material to the shore, the latter heaping it up above the water level. They are formed of fine pure sand blown up mostly into long and often somewhat sinuous ridges, occasionally into heaps, ranging

[1] Geological Survey of Michigan, Vol. VII, p. 234.
[2] Loc. cit. p. 31 *et seq.*
[3] For a report on the geology of Huron County, see Vol. VII, pt. II, Geological Survey of Michigan, by Alfred C. Lane.

from a few to 30 and, in exceptional cases, 40 feet above the level of Lake Huron. The dunes are mostly very old, and at present the older ones are mostly fixed, being sufficiently covered with grasses, sedges, other small herbaceous plants, shrubs and trees to protect them from the action of wind. (Plate IV b.) A very few small ones near the lake are still forming (Plate II a), but the sand area is not extending farther upon the flat and valuable agricultural land, except where occasionally the vegetation is in some way removed from an old and outer dune which is thus exposed to and attacked by the wind. By far the largest dunes in this district are located between Caseville and Port Crescent.

While the dunes at present are of little value for agriculture and useful only for timber growth and a small amount of pasturage, the land south of them is usually flat, very fertile, and valuable for general farming. In 1909 fine crops of wheat, oats, corn, peas, timothy and clover were noticed, and the farmers appeared thrifty and prosperous. At Sebewaing many large fields of sugar beets were observed and at Bayport a large acreage of onions. The climate and land are also apparently suitable for apples, plums, pears and cherries.

Between the dunes are bogs, marshes, wet flats, small tracts known as cranberry marshes, and ponds, some of which are locally called lakes. The largest body of inland water so situated, lying a few miles east of Caseville, is Rush Lake, which is about two miles long by one mile wide, shallow and with a deep muddy bottom. Its surface is about 20 feet above the level of Lake Huron.

The islands consist of rock, generally limestone covered by a rather thin layer of glacial till that has been more or less modified by wave and current action while the waters of the bay were subsiding to their present level. The rock is often very thinly covered, as on parts of Stony Island, and low sand ridges are also noticed. They are well covered with trees, shrubs and herbaceous plants, and the vegetation generally is quite primitive. No evidence of cultivation or much pasturage was noticed, except on Stony Island which contains about 800 acres and supported about 45 cattle and a few hogs. Just back of the fishery buildings are fields, formerly cultivated, and an old apple orchard, many of whose trees still bear good fruit. In one part the staghorn sumach has taken possession of the ground and completely overshadowed the fruit trees. The farm buildings, if there ever were any, have disappeared, except an old log stable. North Island has an area of about 86 acres. Charity Island, owned by the U. S. Government and used for lighthouse purposes, contains over 640 acres; Little Charity Island, a fraction over 4 acres. In 1909 the fishery buildings on the islands were not occupied except on Little Charity Island.

The rivers and creeks running into Saginaw Bay are much impeded by the dunes and drifting sand. During their courses they form many so-called "ox-bows," the streams almost doubling upon themselves and very materially changing their beds from time to time. Pigeon River, reaching the lake at Caseville, seems at present to flow continuously but its winding course near the mouth, and the many coves and old river beds there show that it has often in the past been impeded if not closed up. The Pinnebog River at Port Crescent, the creek at Port Austin, and most of the streams throughout the sand district were, in the summer of 1909, closed up at their mouths with gravel and sand washed up by the waves.

Each of the habitats mentioned above harbors plants adapted to such places and in studying and listing the flora of the district all must be taken into consideration. It will be seen therefore that an exhaustive plant list of this region will very probably include nearly all the species of the northern half of Huron County, although the various species vary greatly in abundance in different associations. The present list may be considered a fairly exhaustive one of the flora of the region and should furnish substantial data for the study of the geographic distribution of the plants in the state.

A better locality than Sand Point for a base from which to examine and study the fauna and flora of the sand dune region could hardly have been chosen. It is a comparatively narrow point running from the mainland westward about three and one-half miles into Saginaw Bay. It is not over a mile wide at the east and gradually narrows to a point on the west end. A large outer dune passes along the north side from southwest to northeast, and from about the middle the west end is covered with dunes mostly running parallel with the shore. The balance, a large tract, is flat sandy land with only low gravel ridges, numerous marshes, swamps, small creeks and ponds, some of which are spoken of as lakes. In 1908 the fishery buildings were not occupied, and scarcely any signs of cultivation appeared throughout. It was practically a primitive wilderness.

Vegetation on the beaches and dunes is comparatively very sparse, but quite primitive, especially on the sandy beach. While fires have many times swept over Huron County, especially over all low and marshy parts that become very dry in mid-summer, the plant covering of dunes and beach has been practically untouched and remains nearly the same as it has been for a long time. Only such plants establish themselves on beaches and dunes as are fitted to endure the hard conditions imposed. The shore is often swept by heavy waves and powerful winds, both of which must be resisted. Under such conditions it is difficult for seeds to lodge and germinate, or for young seedlings to establish themselves and grow. On dunes drouth and sterility must be overcome. Yet when once these beach and sand dune plants are fairly established, they become vigorous and thrifty, sending out strong and wide-spreading roots deep into the ground, searching far and wide for food stuffs and water.

The sand dunes of Huron County are in no way comparable in size and height to those on our west coast along Lake Michigan nor to those at Port Franks in Lambton County, Ontario, where they rise to nearly 100 feet in height. In Huron County, dunes only in exceptional cases rise to 40 feet above the lake surface. Nor are they being formed at present except in a small way near the shore, while those on the west coast are still forming on an immense scale, invading and covering swamps and destroying forests. The older dunes there are often rejuvenated and blown away exposing the remains of forests formerly covered.

In discussing the plant covering and plant associations of the sand region only those of the beaches and dunes will be considered. But the "List of Species" includes those collected in all habitats. (For a detailed discussion of the plant associations see Coons.)

PLANTS OF THE BEACHES.

From Sebewaing around to White Rock on the east side of Huron County, the beach varies greatly. Between Sebewaing and the east end of Sand Point, the water of the bay near shore is shallow, and the beach is partly at least hydrophytic. Out some distance from shore may be found clumps of *Scirpus occidentalis* and Potamogetons. Marshy places and bogs often fringe the immediate shore where are seen in more or less abundance the plants characteristic of such places, *Scirpus validus*, *S. heterochaetus*, *S. americanus*, *Typha latifolia* and *Cicuta bulbifera*. At Caseville the beach is wide, flat and sandy in one place, being often washed by the waves. One plant common there, *Triglochin palustris*, seems to be characteristic of a damp sandy beach, but most species not being able to withstand the attacks of wind and waves seldom come to maturity. At Hat Point, near Port Austin and at Point aux Barques, for short distances, the only beaches are overhanging rocks where the beautiful fern, *Polypodium vulgare*, is common.

From Point aux Barques nearly to White Rock, the beach is mostly narrow and sandy. Back of it is a flat strip of ground varying in width from a few rods to a half mile or more, formerly and mostly now covered with timber—beach, maple, white birch, basswood and ash. A bluff borders this flat strip of wooded ground for nearly the entire distance. From Sand Point to Point aux Barques, except where the rock outcrops, most of the beach is sandy and xerophytic conditions prevail. The one on the north side of Sand Point is fairly representative of such beaches. Here it is lashed by heavy waves and swept by strong winds.

The plants of such beaches, as would be expected, are not numerous nor equally distributed. Very few plants can exist under such severe conditions. One of the most characteristic is the American sea rocket, a succulent crucifer, venturing nearer the water than any other beach plant, and often abundant in places. It has been noticed from Sand Point to Lake St. Clair and from Port Huron to Port Franks in Lambton County, Ontario. In this region it is seldom seen farther up the beach than the dune line. Sea-side spurge was not noticed at Sand Point, but it was frequent and abundant in drifting sand in places from Caseville to Port Austin, following the shore to Port Huron and on the Canadian shore to Port Franks. The beach pea, a vigorous perennial and a good sand binder, is frequent, seldom seen beyond the first dune, and nowhere noticed as abundant except on the south side of Little Charity Island, where it carpeted the sand and very effectually held it in place. It is remarkable that these three plants are common on the Atlantic shore in similar situations. One of the most interesting plants of the region, said to be found only about the Great Lakes, where it probably originated, is the thistle, *Cirsium pitcheri*, which prefers a sandy wave-washed and wind-swept shore and seldom gets farther away than the first shoreward dune. It is common from Sand Point to Port Austin and on Charity Island. So far as known to the writer it does not occur from near Port Austin to Port Huron in Michigan, but it is common on the drifting shore at Port Franks in Lambton County, Ontario, about 30 or 35 miles northeast of Port Huron. It is interesting to know that this thistle was named for Dr. Zina Pitcher, an army physician stationed more than fifty years ago at Fort Gratiot, now a part of the city of Port Huron, and who probably was one of the first botanists to examine the flora of this part of Michigan.

Two grasses of the beach are very prominent as sand binders and are most abundant on the north shore of Sand Point and for a mile or more near Hat Point. One of these, the sea sand-reed, by its matted rootstock system, demonstrates fully at these two places that it can very successfully hold the shore and dune sands against the powerful action of the waves, and equally well against the constant action of strong winds. It is so well fitted for this purpose, as shown here, that its reputation has become world wide. The other, *Calamovilfa longifolia*, a tall and fine looking grass with a large reddish panicle, does not usually here at least, grow so near the water, but holds the sands firmly against the persistent action of the wind. It is frequent at Sand Point, and from there to Port Huron is noticed in drifting sands. It is also abundant in places on the Lake Huron shore in Lambton County, Ontario, where also the sea-side reed is noticed, as far as Port Franks. *Artemisia caudata* and *Oenothera biennis* often occur as beach plants, but these are also found on dunes and flat sandy land. *Salix longifolia, S. glaucophylla* and shrubs of *Populus balsamifera* and cottonwood frequently spring up on the beach, but usually only above the wave line.

PLANTS OF THE DUNES.

As has been intimated, the dunes of this region, even the largest and most massive, have almost without exception a fairly good plant covering on sides and crest. The vegetation consists of trees, shrubs and herbaceous plants, but varies somewhat in density. This plant covering, although not so pronounced at first, generally begins at the upper beach and near the foot of the first shoreward dune, and continues on the sides, crests, and between the ridges, if sandy ground prevails, to the farthest outer dune. In the opinion of the writer the dunes of this region are not large or high enough to make it of value or importance to undertake to distinguish differences in the plant covering on sides and crest. Species and their relative abundance vary from point to point between Bayport and Point aux Barques, and from the beach to the last outer sand ridges.

At Sand Point the dunes are not large or very high. On the north side the first dune is fringed with an abundance of choke cherry, *Amelanchier canadensis, A. rotundifolia*, and *A. spicata*, the last being common on other ridges and flat sandy land, and very noticeable on account of the large, sweet, juicy and palatable berries. The dominant trees at Sand Point are scarlet oak and red oak, with jack pine prevailing in places and scattered throughout the upper end. White pine is frequent, but usually small and formerly much more plentiful. Good specimens of red pine are scattering. On the flat sandy land of the eastern half, the dominant trees are red oak, yellow-barked oak and white oak, consisting mostly of small trees. Small white pines prevail in spots and are scattered throughout the sand district. Near Caseville, west of Port Austin and at Port Crescent, the jack pine is very common, seldom large, usually scraggy, and apparently of little value. It should be noted that along these dunes the jack pine reaches its extreme southern limit on this side of the state. Here also the red pine, found on the sides and crests of dunes and on flat sandy land, altho not abundant anywhere, finds nearly its southern limit for this region, the exception being a small amount on sandy ground near Port Huron and along the sandy shore of Lake Huron, where it is abundant near Port Franks in Lambton County, Ontario. The dominant shrubs are the black huckleberry and low sweet blueberry, the latter often densely covering the ground, and a variety, the black blueberry, is very common on flat sandy land and dunes, producing a great abundance of delicious fruit. *Ceanothus ovatus, C. americanus*, sand cherry, bearberry and *Gaultheria procumbens*, are plentiful in places, and all these are efficient in holding the sand in place. The beautiful *Cyripedium acaule* is plentiful near Caseville in sandy ground on the sides of and between dunes. *Linaria canadensis*, a small blue-flowered plant, is abundant throughout the sand region, and *Deschampsia flexuosa* frequents *Elymus canadensis* and *Agropyron dasystachyum*, good sand binders, are common on the shoreward dunes near Port Austin and occasional, throughout. Many other very efficient sand binders are frequent and abundant in places, like *Asclepias syriaca* in sand near Port Austin, also *Cornus stolonifera* and *C. baileyi*. Sweet fern, *Lithospermum gmelini, Lilium philadelphicum andinum, Andropogon scoperius, Koeleria cristata, Arabis lyrata, Danthonia spicata, Smilacina stellata* and Indian grass are scattered throughout.

GEOGRAPHIC NOTES.

There are no species limited or peculiar to this region, the area being too small. But many other species, like the two pines above mentioned, find their limits along or near this sand dune district, some reaching from the north to this line or just below it, others from the south just reaching it or going very little beyond. The balsam fir and sweet gale are not known farther south. *Linaria canadensis* is occasionally noticed south of this line, and black spruce and hemlock frequently creep down as far south as Port Huron and perhaps somewhat farther. On the other hand, a few species common farther south are scantily represented in this district. Only a few small specimens of sassafras were seen, and on Little Charity Island a dozen trees and many shrubs of *Celtis occidentalis*. The tulip tree and black walnut were not noticed growing wild, although reported as occasionally found near Sebewaing. *Carya microcarpa* was noted near this last place. The hickories and oaks, except red oak, become less and less frequent north of this line.

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In the preparation of the following list, Gray's New Manual of Botany has been followed, except where no common name is given in this work, it has been taken from Britton and Brown's Illustrated Flora and Britton's Manual. In writing all specific names capital letters have been purposely omitted.

LIST OF SPECIES.

1. **Polypodium vulgare** L. Common polypody.—Abundant on edge of overhanging rocks at Hat Point, Port Austin and Point aux Barques.
2. **Phegopteris polypodioides** Fée. Long beech-fern.—"Under overhanging rocks of old shore cliff east of Point aux Barques." Prof. C. A. Davis.
3. **Phegopteris dryopteris** (L.) Fée. Oak fern.—"Under overhanging rocks east of Point aux Barques." Davis.
4. **Adiantum pedatum** L. Maidenhair.—Frequent in rich damp woods.
5. **Pteris aquilina** L. Common brake.—Very common on both damp and dry ground.
6. **Woodwardia virginica** (L.) Sm. Virginia chain-fern.—Abundant at one place, in a swamp northeast of Rush Lake.
7. **Asplenium filix-foemina** (L.) Bernh. Lady fern.—Common in moist places.
8. **Polystichum achrosticoides** (Michx.) Schott. Christmas fern.—Near Port Austin. Not common.
9. **Aspidium thelypteris** (L.) Sw. Marsh shield-fern.—Very common in damp and marshy places.
10. **Aspidium cristatum clintonianum** D. C. Eaton. Clinton's crested shield-fern.—In rich woods near Harbor Beach.
11. **Aspidium marginale** (L.) Sw. Evergreen wood-fern.—East of Port Austin and on rocky cliffs west of Grindstone City.
12. **Aspidium spinulosum** (O. F. Muller) Sw. Spinulose shield-fern.—Rich woods, Caseville, Sebewaing, Port Austin, Sand

Point, Stony Island, Big Charity Island, and near Rush Lake.

13. **Asplenium spinulosum intermedium** (Muhl.) D. C. Eaton. Spinulose shield-fern.—Frequent in damp woods at Caseville, Port Austin, and on North Island.
14. **Cystopteris bulbifera** (L.) Bernh. Bladder fern.—In damp woods at Sand Point and east of Bayport.
15. **Cystopteris fragilis** (L.) Bernh. Brittle fern.—Under overhanging rocks west of Grindstone City.
16. **Woodsia obtusa** (Spreng.) Torr. Blunt-lobed woodsia.—"Growing abundantly in crevices in the overhanging rocks on the lake shore near Port Austin." Davis.
17. **Onoclea sensibilis** L. Sensitive fern.—Common in damp places.
18. **Onoclea struthiopteris** (L.) Hoffm. Ostrich fern.—Low bank of Pigeon River near Caseville.
19. **Osmunda regalis** L. Flowering fern.—Common in low places between sand ridges.
20. **Osmunda cinnamomea** L. Cinnamon fern.—Occasional in damp places.
21. **Botrychium virginicum** (L.) Sw. Rattlesnake fern.—Rich woods at Sand Point, Sebewaing and near Rush Lake.
22. **Equisetum arvense** L. Common horsetail.—Common, especially on damp sand.
23. **Equisetum sylvaticum** L. Wood horsetail.—Frequent on damp shaded ground.
24. **Equisetum fluviatile** L. Pipes.—Common in very wet places and in shallow water.
25. **Equisetum hyemale** L. Scouring rush.—Frequent on sandy and dry shaded ground.
26. **Equisetum hyemale intermedium** A. A. Eaton. Scouring rush. —Common on sandy ground at Sand Point and Caseville.
27. **Equisetum hyemale robustum** (A. Br.) A. A. Eaton. Scouring rush.—Occasional on sandy ground at Sand Point.
28. **Equisetum variegatum** Schleich. Variegated equisetum.—Lake Huron shore east of Caseville, on damp sand.
29. **Lycopodium lucidulum** Michx. Shining club moss.—East end of Sand Point, among hemlocks.
30. **Lycopodium clavatum** L. Common club moss.—In dry woods, east end of Sand Point.
31. **Lycopodium complanatum** L. Trailing Christmas-green.—Frequent on sides of sand dunes but not abundant.
32. **Lycopodium tristachyum** Pursh. Trailing club moss.—"Common on sand dunes east of Port Crescent." Davis.

33. **Selaginella apus** (L.) Creeping selaginella.—Common on damp ground at Bayport and Sebewaing.

34. **Taxus canadensis** Marsh. American yew.—Noticed at Bayport, Sand Point, Point aux Barques, and near Rush Lake.

35. **Pinus strobus** L. White pine.—Small trees are frequent throughout the sand region, and formerly large trees were abundant but have been cut by lumbermen. Occasional on the islands of Saginaw Bay. Seedlings abundant.

36. **Pinus banksiana** Lamb. Jack Pine.—More or less common throughout the sand dune district. Abundant at Sand Point, west of Caseville, and west of Port Austin. Not noticed on the islands of Saginaw Bay, except one small tree on Charity Island. Seedlings abundant. Apparently a tree of little value.

37. **Pinus resinosa** Ait. Red pine; Norway pine.—Frequent throughout the sand dune district and formerly abundant. Fine specimens still exist west of Caseville and on big Charity Island. Seedlings abundant.

38. **Larix laricina** (Du Roi) Koch. Tamarack.—Occasional throughout the sand region and formerly abundant in low wet ground, but now nearly exterminated by cutting, drainage and fires.

39. **Picea mariana** (Mill.) BSP. Black spruce.—Occasional and formerly much more abundant. Noticed at the west end of Sand Point, at Bayport, Caseville, and Point aux Barques. On a small island in Rush Lake the trees are being killed by a parasite, the dwarf mistletoe.

40. **Picea abies** (L.) Karst. Norway spruce.—Planted as an ornamental tree and thriving, but not spreading.

41. **Abies balsamea** (L.) Mill. Balsam fir.—Occasional. Over 50 trees were noticed at the east end of Sand Point and a few near Bayport and Point aux Barques.

42. **Tsuga canadensis** (L.) Carr. Hemlock.—Occasional throughout the sand district.

43. **Thuja occidentalis** L. White cedar; arbor vitae.—Frequent in wet places between sand dunes throughout the sand district. Formerly much more abundant, but has been cut and destroyed by fires.

44. **Juniperus communis** L. Common juniper.—Frequent throughout the sand dune district. Abundant west of Port Austin.

45. **Juniperus communis depressa** Pursh. Low juniper.—Occasional near Caseville.

46. **Typha latifolia** L. Common cat-tail—Common in wet, boggy places.

47. **Typha angustifolia** L. Narrow-leaved cat-tail.—In very wet places along the lake shore near Bayport.
48. **Sparganium eurycarpum** Engelm. Broad-fruited bur-reed.—Abundant in very wet places throughout the sand region.
49. **Potamogeton natans** L. Common floating pondweed.—Noticed in Rush Lake, in coves near Caseville, Port Austin, and Sebewaing.
50. **Potamogeton heterophyllus** Schreb. Various-leaved pondweed.—In Rush Lake and at Sand Point near fishing dock. "East of Port Austin." Davis.
51. **Potamogeton heterophyllus longipedunculatus** (Merat) Morong. Various-leaved pondweed.—"In water nearly four feet deep off the beach of Point of Pines Hotel, Port Austin. The root stocks of the plants grow in the crevices in the rocks, and the plants thrive in spite of the violent surf which frequently breaks on the shore." Davis.
52. **Potamogeton angustifolius** Berchtold & Presl. Ziz's pondweed.—In Rush Lake.
53. **Potamogeton richardsonii** (Benn.) Rydb. Clasping-leaved pondweed.—Near fish dock, Stony Island.
54. **Potamogeton perfoliatus** L. Clasping-leaved pondweed.—Near fish docks at Sand Point and on Stony Island.
55. **Potamogeton foliosus niagarensis** (Tucherm.) Morong. Leafy pondweed.—Noticed in Pigeon River at Caseville. "Pinnebog River." Davis.
56. **Potamogeton filiformis** Pers. Filiform pondweed.—"Shallow water less than one foot deep on beach between Port Austin and Port Crescent. Also at North Charity Island in water six inches deep. Abundant at both localities." Davis.
57. **Potamogeton pectinatus** L. Fennel-leaved pondweed.—In shallow water on margin of the lake and near the fishery dock on Stony Island. "Pigeon River, Caseville." Davis.
58. **Najas flexilis** (Willd.) Rostk. and Schmidt. Slender naiad.—Abundant in Rush Lake.
59. **Triglochin maritima** L. Seaside arrow-grass.—Frequent in bogs and marshes at Sand Point, Bayport, Sebewaing and on North Island.
60. **Triglochin palustris** L. Marsh arrow-grass.—Frequent on damp sand along Lake Huron shore.
61. **Sagittaria latifolia** Willd. Broad-leaved arrow-head.—Common on mud and in shallow water throughout the sand region.
62. **Alisma plantago-aquatica** L. Water plantain.—Very common on mud and in shallow water.

63. **Elodea canadensis** Michx. Water-weed.—In Rush Lake, coves of Pigeon River, and near the fishery dock, Stony Island.

64. **Vallisneria spiralis** L. Wild celery. Tape grass. Eel grass.—Abundant in Rush Lake and the coves of Pigeon River.

65. **Andropogon scoparius** Michx. Broom beard-grass.—Frequent throughout the sand dune region, mostly growing in tufts.

66. **Andropogon furcatus** Muhl. Forked beard-grass.—Frequent on and near sand dunes.

67. **Sorghastrum nutans** (L.) Nash. Indian grass. Wood grass.—Frequent on light sandy ground and on fixed dunes.

68. **Digitaria sanguinalis** (L.) Scop. Crab grass.—A common weed throughout the sand region. "At Port Crescent in drifting sand where it was getting a foothold and may help hold the sand in place." Davis.

69. **Panicum capillare** L. Old-witch grass.—A common weed throughout the sand region, especially in adjacent gardens and fields.

70. **Panicum miliaceum** L. European millet.—Cultivated and occasionally escaping near villages.

71. **Panicum virgatum** L. Switch grass.—Occasional in tufts throughout the sand district. "On Charity Islands in sandy soil." Davis.

72. **Panicum depauperatum** Muhl. Starved panicum.—Occasional on sandy ground and sand dunes.

73. **Panicum lindheimeri** Nash. Lindheimer's panicum.—On open sandy ground at Bayport, Sebewaing, and Port Austin.

74. **Panicum meridionale** Ashe. Panicum.—Along the railroad near Sebewaing.

75. **Panicum tsugetorum** Nash. Hemlock panicum.—On sandy ground at Bayport.

76. **Panicum scribnerianum** Nash. Scribner's panicum.—On sandy ground at Sand Point and near Rush Lake.

77. **Panicum xanthophysum** Gray. Slender panicum.—On light sandy ground at Sand Point and Bayport.

78. **Panicum latifolium** L. Porter's panicum.—On sandy ground and shaded sand dunes at Sand Point, Bayport, and Port Austin.

79. **Echinochloa crus-galli** (L.) Beauv. Barnyard grass.—A common weed on damp ground and in waste places throughout the sand dune region.

80. **Setaria glauca** (L.) Beauv. Foxtail. Pigeon grass.—A weed in gardens, about fish shanties, country dwellings and in fields.

81. **Setaria viridis** (L.) Beauv. Green foxtail. Bottle grass.—A common weed in gardens, fields, and about fish shanties.

82. **Setaria italica** (L.) Beauv. Millet. German millet. Hungarian grass.—Cultivated as a field crop and occasionally escaping.

83. **Cenchrus carolinianus** Walt. Sand bur. Bur grass.—Noticed in the streets of villages, on roadsides, about country dwellings, fish shanties and occasionally in adjacent fields. Also on the islands of Saginaw Bay. Said to be of recent introduction and spreading rapidly.

84. **Zizania aquatica** L. Wild rice. Water rice. Indian rice.—In Rush Lake, where it had been sown by sportsmen to attract wild ducks, but apparently not thriving there. Reported that several barrels of seed had been sown in the lake a number of years ago. Reported by W. H. Wallace as abundant in shallow water near Stony and Katechay Islands. "Marshy places along the lake shore usually small in such localities." Davis.

85. **Leersia virginica** Willd. White grass.—In damp rich woods near Bayport and Sebewaing.

86. **Leersia oryzoides** (L.) Sw. Rice cut-grass. Often called scratch grass.—Frequent in moist places and along low banks of streams.

87. **Phalaris arundinacea** L. Reed canary grass.—Frequent in low wet places throughout the sand dune region and on the islands of Saginaw Bay.

88. **Millium effusum** L. Millet grass.—In rich damp woods near Rush Lake and Port Austin.

89. **Oryzopsis pungens** (Torr.) Hitchc. Slender mountain rice.—Frequent on sandy ground and shaded sand dunes.

90. **Oryzopsis asperifolia** Michx. White-grained mountain rice.—"Sides of older dunes about Port Austin." Davis.

91. **Stipa spartea** Trin. Porcupine grass. — Occasional in sandy ground at Sand Point.

92. **Muhlenbergia sylvatica** Torr. Wood muhlenbergia.—In moist woods east of Port Austin.

93. **Muhlenbergia mexicana** (L.) Trin. Meadow muhlenbergia.—Along a small stream east of Port Austin.

94. **Muhlenbergia racemosa** (Michx.) BSP. Marsh muhlenbergia.—Occasional in low damp ground at Sand Point.

95. **Phleum pratense** L. Timothy.—In good ground throughout the sand region. Fine fields of it noticed under cultivation on adjacent farms.

96. **Sporobolus cryptandrus** (Torr.) Gray. Sand dropseed.—Frequent and often abundant in sand on the lake shore and on sand dunes, acting as a sand binder.
97. **Agrostis alba** L. Red top.—Frequent between sand dunes on damp prairie-like ground.
98. **Agrostis hyemalis** (Walt.) BSP. Hair grass.—In dry ground near Port Austin. Not abundant.
99. **Calamovilfa longifolia** (Hook). Hack. Long-leaved reed-grass.—A very remarkable grass. Often abundant on drifting sand along the lake shore and on the sides of the dune nearest the lake. In Michigan it is probably the best sand binder against the action of strong winds. It usually takes a position on the shore farther away from the water than *Ammophila arenaria.*
100. **Calamagrostis canadensis** (Michx.) Beauv. Blue-joint grass.—Frequent between sand dunes in damp places.
101. **Ammophila arenaria** (L.) Link. Sea sand-reed.—Frequent and often abundant along the sandy shore of Lake Huron. Probably in Michigan the best shore sand binder against the action of waves. Occasionally mingled with *Calamovilfa longifolia*, but where the shore is fairly even it takes its place nearer the water than the other grass. This is noticed particularly on the north shore of Sand Point and west of Hat Point. Its root or rootstock system is remarkable.
102. **Cinna arundinacea** L. Wood reed grass.—Occasional in moist woods and damp shaded places.
103. **Koeleria cristata** (L.) Pers. Koeleria.—Frequent in sandy ground and on sand dunes.
104. **Deschampsia flexuosa** (L.) Trin. Common hair grass.—Frequent on shaded sand dunes. Abundant on Sand Point.
105. **Danthonia spicata** (L.) Beauv. Common wild oat grass.—Frequent throughout on sandy ground and sand dunes.
106. **Spartina michauxiana** Hitchc. Slough grass.—Frequent in wet marshy ground.
107. **Phragmites communis** Trin. Reed.—Occasional in very wet places, but nowhere abundant in the sand region.
108. **Eragrostis hypnoides** (Lam.) BSP. Creeping eragrostis.—Occasional on damp sand and in other damp places.
109. **Eragrostis megastachya** (Koeler) Link. Strong-scented eragrostis—On sandy ground on Stony Island and abundant on sand along the Pinnebog River at Port Crescent.
110. **Melica striata** (Michx.) Hitchc. Purple oat.—In rich open woods at Sebewaing.

111. **Dactylis glomerata** L. Orchard grass.—Frequent in the streets of villages and on roadsides.
112. **Poa annua** L. Low spear grass.—Frequent in the lawns and streets of villages.
113. **Poa compressa** L. Canada blue grass. English blue grass.—Frequent on sandy ground and sand dunes throughout. Often acting as a sand binder on the older dunes.
114. **Poa triflora** Gilib. Fowl meadow grass.—Along the railroad in a damp place south of Port Austin.
115. **Poa pratensis** L. June grass; Kentucky blue grass.—Frequent throughout the sand region in good ground and often on sand.
116. **Glyceria canadensis** (Michx.) Trin. Rattlesnake grass.—In very wet places near Port Austin.
117. **Glyceria nervata** (Willd.) Trin. Fowl meadow grass. Nerved manna-grass.—Common in moist and wet places and damp open woods.
118. **Glyceria grandis** Wats. Reed meadow grass.—Frequent in damp open places on Sand Point and near Caseville.
119. **Glyceria septentrionalis** Hitchc. Floating manna-grass.—In very wet places near Port Austin.
120. **Festuca octoflora** Walt. Slender fescue grass.—Frequent on sandy ground and on sand dunes.
121. **Festuca elatior** L. Meadow fescue.—On roadsides and in streets at Bayport and Sebewaing.
122. **Festuca nutans** Spreng. Nodding fescue grass.—In damp shaded places at Sand Point.
123. **Bromus secalinus** L. Chess.—Occasional as a weed in villages and adjacent fields.
124. **Bromus ciliatus** L. Wood chess.—In damp shaded places at Sand Point and near Rush Lake.
125. **Agropyron repens** (L.) Beauv. Couch-grass.—Occasional in streets of villages and about country dwellings.
126. **Agropyron dasystachyum** (Hook.) Scribn. Northern wheat-grass.—Common on sand along the lake shore and on sand dunes. Abundant at Port Austin. A good sandbinder.
127. **Agropyron caninum** (L.) Beauv. Awned wheat-grass.—Occasional in dry open woods at Sand Point.
128. **Hordeum jubatum** L. Squirrel-tail grass.—Occasional in streets and about the grain elevators in villages.
129. **Elymus virginicus** L. Virginia wild rye.—Occasional in damp open places.

130. **Elymus canadensis** L. Nodding wild rye.—Common on sand on the lake shore and on sand dunes. A fair sand binder against the action of wind.
131. **Elymus striatus** Willd. Slender wild rye.—Occasional in dry shaded places at Sand Point.
132. **Hystrix patula** Moench. Bottle-brush grass.—Frequent in damp woods.
133. **Cyperus rivularis** Kunth. Shining cyperus.—In damp sand on lake shore east of Caseville.
134. **Cyperus strigosus** L. Straw-colored cyperus.—Occasional in damp open places near Rush Lake and Port Austin.
135. **Cyperus houghtonii** Torr. Houghton's cyperus.—Frequent on sandy ground and sand dunes.
136. **Cyperus filiculmis** Vahl. Slender cyperus.—In sandy ground throughout the sand dune district.
137. **Dulichium arundinaceum** (L.) Britton. Dulichium.—Frequent in wet swampy places between sand dunes.
138. **Eleocharis olivacea** Torr. Bright green spike-rush.—"Lake shore." Davis.
139. **Ellocharis obtusa** (Willd.) Schultes. Ovoid spike-rush.—Wet places about Rush Lake. "Common along shore of Lake." Davis.
140. **Eleocharis palustris** (L.) R. and S. Creeping spike-rush.—Common in wet marshy ground and on damp sand.
141. **Eleocharis palustris glaucescens** (Willd.) Gray. Creeping spike-rush.—Frequent in wet shaded places.
142. **Eleocharis acicularis** (L.) R. and S. Needle spike-rush.—Wet ground edge of Rush Lake and near Port Austin. "Very abundant along the lake shore." Davis.
143. **Eleocharis tenuis** (Willd.) Schultes. Slender spike-rush.—In marshy places and on damp sand along the lake shore.
144. **Eleocharis acuminata** (Muhl.) Nees. Flat-stemmed spike-rush.—In wet places, often on wet sand near the lake shore.
145. **Scirpus pauciflorus** Lightf. Few-flowered club-rush.—Shore of Rush Lake and at Bayport. "Forming large masses on the marshy belt left by the retreat of the lake near Port Austin." Davis.
146. **Scirpus subterminalis** Torr. Water club-rush.—Plentiful in edge of ponds enclosed by sand dunes east of Caseville.
147. **Scirpus debilis** Pursh. Weak-stalked club-rush.—Abundant in Rush Lake.
148. **Scirpus americanus** Pers. Three-square.—Found in wet places generally. Very common in wet places along the lake shore.

149. **Scirpus validus** Vahl. Great bulrush.—Common on damp ground and in very wet places.
150. **Scirpus occidentalis** (Wats.) Chase. Western bulrush.—Common on marshy ground and on borders of ponds.
151. **Scirpus heterochaetus** Chase. Unequal-bristled bulrush.—Lake shore at Bayport, growing in six inches of water.
152. **Scirpus atrovirens** Muhl. Dark-green bulrush.—Common in wet open places.
153. **Scirpus lineatus** Michx. Reddish bulrush.—Frequent on low damp open ground between sand dunes.
154. **Scirpus cyperinus pelius** Fernald. Wool grass.—Common in wet and marshy open places.
155. **Eriophorum viridi-carinatum** (Engelm.) Fernald. Tall cotton-grass.—Frequent in very wet open places between sand dunes.
156. **Rynchospora fusca** (L.) Ait. f. Brown beaked-rush.—In a boggy place at Sand Point.
157. **Rynchospora alba** (L.) Vahl. White beaked-rush.—Occasional in very wet open places between sand dunes.
158. **Rynchospora capillacea** Torr. Capillary beaked-rush.—In marshes about Rush Lake and near lake shore at Bayport.
159. **Cladium mariscoides** (Muhl.) Torr. Twig-rush.—Common in very wet marshy places.
160. **Carex scoparia** Schkuhr. Pointed broom sedge.—Frequent on low open ground.
161. **Carex tribuloides** Wahlenb. Blunt broom sedge.—Frequent in edges of damp woods.
162. **Carex siccata** Dewey. Dry spiked sedge.—Frequent on dry, sandy ground, occasional in shade on the fixed sand dunes.
163. **Carex cristata** Schwein. Crested sedge.—Frequent in wet shaded places near Sebewaing.
164. **Carex straminea** Willd. Straw sedge.—Occasional in dry open places at Sand Point and near Rush Lake.
165. **Carex suberecta** (Olney) Britton. Prairie sedge.—On damp ground on Stony Island.
166. **Carex bebbii** Olney. Bebb's sedge.—Stony Island on marshy ground.
167. **Carex stelluata** Good. Little prickly sedge.—On low damp ground west of Caseville.
168. **Carex scirpoides** Schk. Inland sedge.—On wet ground near Caseville.
169. **Carex canescens** L. Silvery sedge.—On damp sand at the upper end of Sand Point.

170. **Carex canescens subloliacea** Laested. Silvery sedge.—On wet ground west of Caseville.
171. **Carex bromoides** Schkuhr. Brome-like sedge.—Frequent in very wet places.
172. **Carex deweyana** Schwein. Dewey's sedge.—Frequent in rich open woods at Sebewaing, Bayport, and near Rush Lake.
173. **Carex tenella** Schkuhr. Soft-leaved sedge.—On very wet shaded ground near Rush Lake.
174. **Carex rosea** Schkuhr. Stellate sedge.—On open dry ground on Big Charity Island.
175. **Carex rosea radiata** Dewey. Stellate sedge.—In shaded dry ground on Stony Island.
176. **Carex muhlenbergii** Schkuhr. Muhlenberg's sedge.—Frequent on sandy ground throughout the sand region.
177. **Carex vulpinoidea** Michx. Fox sedge.—Common on damp ground.
178. **Carex diandra ramosa** (Boott) Fernald. Lesser panicled sedge. —In a wet place near Rush Lake.
179. **Carex stipata** Muhl. Awl-fruited sedge.—Frequent on very wet ground.
180. **Carex sartwellii** Dewey. Sartwell's sedge.—In very wet places at Sand Point and on border of Rush Lake.
181. **Carex crinita** Lam. Fringed sedge.—In very wet places about Rush Lake.
182. **Carex aquatilis** Wahlenb. Water sedge.—Frequent in wet marshy places near and along the lake shore.
183. **Carex stricta** Lam. Tussock sedge.—Frequent in very wet marshy places.
184. **Carex aurea** Nutt.—Golden-fruited sedge.—In damp ground near Rush Lake. Abundant at the end of Sand Point.
185. **Carex leptalea** Wahlenb.—Bristle-stalked sedge.—In boggy places near Caseville and Rush Lake.
186. **Carex polygama** Schkuhr. Brown sedge.—Frequent in very wet and boggy places.
187. **Carex gracillima** Schwein. Graceful sedge.—Frequent in edge of damp woods near Bayport.
188. **Carex communis** Bailey. Fibrous-rooted sedge.—"Near Grindstone City." Davis.
189. **Carex pennsylvanica** Lam. Pennsylvania sedge.—Common on sandy ground and fixed sand dunes.
190. **Carex livida** (Wahlenb.) Willd. Livid sedge.—In a very wet and swampy place west of Caseville.

191. **Carex tetanica** Schk. Wood's sedge.—On very wet ground west of Caseville.
192. **Carex tetanica meadii** (Dewey) Bailey. Mead's sedge.—On rich open ground at Sebewaing.
193. **Carex eburnea** Boott. Bristle-leaved sedge.—Occasional on shaded fixed sand dunes.
194. **Carex laxiflora patulifolia** (Dewey) Carey. Loose-flowered sedge.—In woods near Port Austin.
195. **Carex laxiflora varians** Bailey. Loose-flowered sedge.—In woods at Port Austin, Sebewaing and on Big Charity Island.
196. **Carex laxiflora latifolia** Boott. White bear sedge.—In rich woods at Bayport and near Rush Lake.
197. **Carex granularis haleana** (Olney) Porter. Meadow sedge.—On prairie-like ground near Sebewaing.
198. **Carex crawei** Dewey. Crawe's sedge.—On damp sand on the upper end of Sand Point and on Little Charity Island.
199. **Carex flava** L. Yellow sedge.—Frequent in wet marshy places.
200. **Carex oederi** Retz. Sedge.—On wet ground on Sand Point and near Sebewaing.
201. **Carex oederi pumila** (Cosson and Germain). Fernald. Green sedge.—Frequent on damp sand along the lake shore.
202. **Carex filiformis** L. Slender sedge.—Common in boggy places.
203. **Carex lanuginosa** Michx. Woolly sedge.—On edge of ponds enclosed by sand dunes east of Caseville, and near Rush Lake.
204. **Carex riparia** W. Curtis. River-bank sedge.—Borders of streams near Sebewaing, Port Austin and Rush Lake.
205. **Carex pseudo-cyperus** L. Cyperus-like sedge.—In very wet and boggy ground near Rush Lake.
206. **Carex comosa** Boott. Bristly sedge.—On wet ground at Sand Point and Sebewaing.
207. **Carex hystericina** Muhl. Porcupine sedge.—Common in wet marshy places.
208. **Carex lurida** Wahlenb. Sallow sedge.—In swampy places near Bayport, Rush Lake and Sebewaing.
209. **Carex lurida gracilis** (Boott) Bailey. Bailey's sedge.—In edge of damp woods near Bayport.
210. **Carex retrorsa** Schwein. Retrorse sedge.—In wet places near Port Austin and Rush Lake.
211. **Carex lupulina** Muhl. Hop sedge.—Frequent in swampy places and wet woods.
212. **Carex intumescens** Rudge. Bladder sedge.—In damp woods near Bayport and Sebewaing.

213. **Carex intumescens fernaldii** Bailey. Bladder sedge.—In rich damp woods near Sebewaing.
214. **Carex rostrata** Stokes. Yellowish sedge.—In swampy places near Sebewaing.
215. **Carex rostrata utriculata** (Boott) Bailey. Bottle sedge.—Frequent on edge of streams and very wet places.
216. **Carex tuckermani** Dewey. Tuckerman's sedge.—On open rich ground near Rush Lake.
217. **Arisaema triphyllum** L. Schott. Indian turnip. Jack-in-the-pulpit.—Common in damp rich woods and shaded places.
218. **Symplocarpus foetidus** (L.) Nutt. Skunk cabbage.—On moist ground near Port Austin. Infrequent.
219. **Acorus calamus** L. Sweet flag.—In shallow water and wet places along streams at Caseville, Port Crescent and Port Austin.
220. **Spirodela polyrhiza** (L.) Schleid. Greater duckweed.—Occasional in ponds and pools.
221. **Lemna minor** L. Lesser duckweed.—On stagnant shallow water at Caseville.
222. **Pontederia cordata** L. Pickerel-weed.—Occasional in quiet parts of streams. Abundant in Rush Lake.
223. **Juncus bufonius** L. Toad rush.—Very common on damp open ground. Abundant on damp sand at Port Crescent and Port Austin.
224. **Juncus tenuis** Willd. Slender rush.—Common along paths and road sides.
225. **Juncus dudleyi** Wiegand. Dudley's rush.—On bank of large ditch at Sebewaing. Apparently infrequent.
226. **Juncus balticus littoralis** Engelm. Baltic rush.—Frequent on damp ground and common on sand along the lake shore. A good sand binder.
227. **Juncus effusus** L. Common rush.—Common on damp ground.
228. **Juncus brachycephalus** (Engelm). Buchenau. Small-headed rush.—In wet places near lake shore, Rush Lake and Port Austin.
229. **Juncus brevicaudatus** (Engelm.) Fernald. Canada rush.—"Port Austin." Davis.
230. **Juncus canadensis** J. Gay. Canada rush.—Frequent in marshy places and on damp sand on lake shore.
231. **Juncus nodosus** L. Knotted rush.—Common in marshy places and on damp sand.
232. **Juncus alpinus insignis** Fries. Richardson's rush.—"Abundant

in the creek valley at Port Austin, also not uncommon along the lake shore." Davis.

232a. **Juncus alpinus fuscescens** Fernald. Richardson's rush.—Charity Island in damp sand along the west shore.

233. **Luzula saltuensis** Fernald. Hairy wood-rush.—Abundant in moist woods.

234. **Luzula campestris multiflora** (Ehrh.) Celak. Common wood-rush.—Occasional in open woods near Bayport, Sebewaing and Port Austin.

235. **Uvularia grandiflora** Sm. Large-flowered bellwort.—Frequent in rich woods.

236. **Oakesia sessilifolia** (L.) Wats. Sessile-leaved bellwort.—Frequent on damp open ground and in open woods.

237. **Allium tricoccum** Ait. Wild leek.—In rich woods west of Caseville. Not noticed elsewhere, but reported as formerly very abundant.

238. **Allium canadense** L. Wild garlic.—In meadow-like ground near Rush Lake and on North Island.

239. **Hemerocallis fulva** L. Common day lily.—Common as an escape in the villages and near country dwellings.

240. **Lilium philadelphicum andinum** (Nutt.) Ker. Western red lily.—Occasional on sandy ground at Sand Point, Sebewaing and on Charity Island.

241. **Lilium superbum** L. Turk's-cap lily.—Occasional on rich low ground.

242. **Erythronium americanum** Ker. Yellow adder's-tongue.—Frequent on shaded rich ground.

243. **Asparagus officinalis** L. Garden asparagus.—A frequent escape to poor and sandy ground.

244. **Clintonia borealis** (Ait.) Raf. Yellow clintonia.—Frequent in moist woods.

245. **Smilacina racemosa** (L.) Desf. False spikenard.—Frequent in moist shaded places, often on sandy ground and shaded sand dunes.

246. **Smilacina stellata** (L.) Desf. Star-flowered Solomon's seal.—Common on moist shaded ground, often abundant on sand near the lake shore.

247. **Maianthemum canadense** Desf. False lily-of-the-valley.—Very common in damp woods and thickets.

248. **Streptopus roseus** Michx. Sessile-leaved twisted-stalk.—In rich damp woods at Sand Point.

249. **Polygonatum biflorum** (Walt.) Ell. Small Solomon's seal.—In

open woods at Sand Point, Port Austin, Sebewaing, Bayport, Stony Island, and North Island.

250. **Polygonatum commutatum** (R. and S.) Dietr. Great Solomon's seal.—In open woods at Sand Point, near Rush Lake, and on Charity Island.

251. **Medeola virginiana** L. Indian cucumber-root.—On shaded rich ground at Sand Point, Caseville, near Rush Lake, on Stony Island and Charity Island.

252. **Trillium rectum** L. Ill-scented wake-robin.—Common on rich shaded ground at Sand Point and near Rush Lake. The white-flowered form is frequent.

253. **Trillium grandiflorum** (Michx.) Salisb. Large-flowered wake-robin.—Common in rich shaded woods.

254. **Smilax herbacea** L. Carrion-flower.—Frequent in moist places throughout the sand region and on the islands.

255. **Smilax ecirrhata** (Engelm.) Wats. Upright smilax.—Frequent in rich woods and thickets.

256. **Smilax hispida** Muhl. Hispid greenbrier.—Frequent on borders of moist woods and in damp thickets.

257. **Dioscorea villosa** L. Wild yam-root.—Common in damp thickets.

258. **Hypoxis hirsuta** (L.) Coville. Star grass.—Common on meadow-like ground near Caseville and on Stony Island.

259. **Iris versicolor** L. Larger blue flag.—Frequent in wet places, but not noticed as abundant anywhere.

260. **Sisyrinchium albidum** Raf. White blue-eyed grass.—Frequent on damp ground. Noticed on the islands.

261. **Cypripedium parviflorum pubescens** (Willd.) Knight. Larger yellow lady's slipper.—A very few specimens observed near Caseville. Apparently rare.

262. **Cypripedium acaule** Ait. Stemless lady's slipper.—Frequent between and on the sides of fixed shaded sand dunes.

263. **Habenaria bracteata** (Willd.) R. Br. Long-bracted orchis.—Occasional in damp woods and thickets.

264. **Habenaria flava** (L.) Gray. Small pale green orchis.—Occasional in wet places.

265. **Habenaria hyperborea** (L.) R. Br. Tall leafy green orchis.—Occasional on wet boggy places.

266. **Habenaria dilatata** (Pursh.) Gray. Tall white bog orchis.—In a very wet and boggy place west of Caseville.

267. **Habenaria hookeri** Torr. Hooker's orchis.—In dry shaded ground at Sand Point.

268. **Habenaria blephariglottis** (Willd.) Torr. White-fringed orchis. —Noticed by Coons in boggy ground on Sand Point.
269. **Habenaria psycodes** (L.) Sw. Smaller purple-fringed orchis.— Frequent in damp grassy places.
270. **Calopogon pulchellus** (Sw.) R. Br. Grass-pink.—In very wet marshy places at Sand Point and near Rush Lake.
271. **Spiranthes gracilis** (Bigel.) Beck. Slender ladies tresses.—A few specimens noticed on open sandy ground at Sand Point.
272. **Spiranthes cernua** (L.) Richard. Nodding ladies tresses.— Occasional at Sand Point on damp ground. Common near the lake shore below Grindstone City. "What seems to be this species was collected by Dr. Lane in the neighborhood of Bayport." Davis.
273. **Epipactis pubescens** (Willd.) A. A. Eaton. Downy rattlesnake plantain.—A few specimens noticed in dry woods near Rush Lake.
274. **Corallorhiza maculata** Raf. Large coral-root.—Frequent in rich woods. "Point aux Barques." Winchell's catalogue.
275. **Saururus cernuus** L. Lizard's-tail.—"Pinnebog river, Hume township." Davis.
276. **Salix nigra** Marsh. Black willow.—Mostly on banks of streams, and seldom more than a shrub.
277. **Salix amygdaloides** Anders. Peach-leaved willow.—Common on damp ground along streams and on borders of moist woods.
278. **Salix lucida** Muhl. Shining willow.—Common on low wet ground.
279. **Salix alba** L. White willow.—Planted more or less in all the villages and often escaping.
280. **Salix babylonica** L. Weeping willow.—Noticed in cultivation at Sebewaing, but not escaping.
281. **Salix longifolia** Muhl. Sand bar willow.—Common along the lake shore, in damp sand and along streams.
282. **Salix glaucophylla** Bebb. Broad-leaved willow.—Common along the lake shore and on sand dunes nearest to the water. A good sand binder.
283. **Salix glaucophylla brevifolia** Bebb. Broad-leaved willow.—On sand dunes near Caseville.
284. **Salix discolor** Muhl. Glaucous willow.—Frequent along streams and on borders of marshes.
285. **Salix petiolaris** Sm. Slender willow.—Common on damp ground.
286. **Salix humilis** Marsh. Prairie willow.—On sandy ground at Sand Point and near Rush Lake. Not abundant.

287. **Salix sericea** Marsh. Silky willow.—On damp ground at Sand Point.

288. **Salix rostrata** Richards. Bebb's willow.—Frequent in open woods and on borders of marshes.

289. **Salix candida** Flügge. Sage willow.—In a very wet and boggy place west of Caseville.

290. **Populus alba** L. White poplar.—Cultivated in the villages and spreading by root.

291. **Populus tremuloides** Michx. American aspen.—Very common in damp ground, frequent on sand dunes and abundant on burnt-over lands throughout Huron County.

292. **Populus grandidentata** Michx. Large-toothed aspen.—Frequent between and on sand dunes.

293. **Populus balsamifera** L. Balsam poplar.—Common on sand along the lake shore and frequent on sand dunes. A sand binder. Trees usually small. Covers large areas in Huron County north of Bad Axe.

294. **Populus deltoides** Marsh. Cotton-wood.—Frequent on damp ground with other trees and along streams throughout the sand region. The large-leaved poplar occasionally planted is for the present referred to this species.

295. **Populus nigra italica** Du Roi. Lombardy poplar.—Cultivated in the villages and spreading by root.

296. **Myrica gale.** Sweet gale.—Abundant in a large marsh at Sand Point. Also noticed near Caseville and on Charity Island.

297. **Myrica asplenifolia** L. Sweet fern.—In small patches on sandy ground at Sand Point and near Caseville.

298. **Juglans cinerea** L. Butternut.—Frequent on rich damp ground with other trees and often between sand dunes.

299. **Juglans nigra** L. Black walnut.—Noticed only in cultivation. Lumbermen report that it is not known to grow wild in the sand district. Noticed in Tuscola County.

300. **Carya ovata** (Mill.) K. Koch. Shag-bark hickory.—Throughout the sand region on rich ground with other trees. Trees now usually small, the larger ones having been cut.

301. **Carya microcarpa** Nutt. Small-fruited hickory.—A few trees noticed in good ground about Sebewaing.

302. **Carya cordiformis** (Wang.) K. Koch. Bitter nut.—Frequent on rich damp ground with other trees, but mostly south of the sand area.

303. **Corylus americana** Walt. Hazel-nut.—Not noticed in or near the sand region, but reported by W. H. Wallace as occasionally growing near Bayport and on Stony Island.

304. **Ostrya virginiana** (Mill.) K. Koch. Ironwood.—Common on rich ground with other trees.
305. **Carpinus caroliniana** Walt. Blue beech.—Common on rich damp ground with other trees.
306. **Betula lutea** Michx. f. Yellow birch.—Frequent on moist ground with other trees. Trees mostly small, the larger ones having been cut.
307. **Betula alba** L. Paper birch; canoe birch; white birch.—Common throughout the sand district, often on sand near the lake shore. Abundant throughout Huron County on burnt-over lands.
308. **Alnus incana** (L.) Moench. Speckled alder.—Very common on damp ground and along streams.
309. **Fagus grandifolia** Ehrh. American beech.—Not abundant, but noticed on small patches of rich ground with other trees throughout the sand region.
310. **Quercus alba** L. White oak.—Frequent on rolling or level sandy ground and on fixed sand dunes.
311. **Quercus macrocarpa** Michx. Bur oak.—Frequent on small patches of good ground between sand dunes. Occasional on sand near the lake shore, where it acts as a sand binder but usually smaller in such places.
312. **Quercus bicolor** Willd. Swamp white oak.—Occasional on rich patches of ground near and between sand dunes.
313. **Quercus rubra** L. Red oak.—Plentiful at Sand Point on level sandy ground and common on all the fixed sand dunes.
314. **Quercus coccinea** Moench. Scarlet oak.—Abundant at Sand Point. Fine large specimens noticed near Port Austin. Common throughout the sand region.
315. **Quercus velutina** Lam. Yellow-barked oak; black oak.—Frequent on sandy ground and sand dunes.
316. **Ulmus americana** L. American elm.—Very common along streams and in damp ground.
317. **Ulmus fulva** Michx. Slippery elm. Red elm.—A few specimens noticed near Sebewaing, but reported by lumbermen as frequent throughout.
318. **Ulmus racemosa** Thomas. Rock elm.—Not noticed, but reported by lumbermen as occasional.
319. **Celtis occidentalis** L. Sugarberry. Hackberry.—Abundant on Little Charity Island. Some of the trees over one foot in diameter two feet from ground. Not noticed elsewhere, but reported by W. H. Wallace as occasional near Bayport.

320. **Cannabis sativa** L. Hemp.—On sandy ground as a weed in the villages.
321. **Humulus lupulus** L. Common hop.—Noticed as an escape near Caseville, Rush Lake, Port Austin, Bayport, and Sebewaing.
322. **Maclura pomifera** (Raf.) Schneider. Osage orange.—Occasionally planted for hedges, but not a success. Not spreading.
323. **Urtica gracilis** Ait. Slender nettle.—Frequent along streams, in open damp woods and low ground.
324. **Laportea canadensis** (L.) Gaud. Wood nettle.—Common in rich woods.
325. **Pilea pumila** (L.) Gray. Richweed.—In damp rich woods near Rush Lake, Port Austin and Sebewaing.
326. **Boehmeria cylindrica** (L.) Sw. False nettle.—Frequent on moist and shaded ground.
327. **Comandra umbellata** (L.) Nutt. Bastard toad-flax.—Abundant on flat or dry rolling ground and frequent on fixed shaded sand dunes.
328. **Arceuthobium pusillum** Peck. Dwarf mistletoe.—A parasite on *Picea mariana* on a little island in Rush Lake, where the trees are being attacked and killed by it.
329. **Asarum canadense** L. Wild ginger.—Common in rich woods.
330. **Rumex britannica** L. Great water dock.—On low marshy open ground near Rush Lake, Port Austin and Sebewaing.
331. **Rumex crispus** L. Yellow dock.—Frequent as a weed in villages and adjacent fields throughout the sand region. A troublesome weed in meadows and hay fields.
332. **Rumex obtusifolius** L. Bitter dock.—Occasional as a weed in villages and around country dwellings.
333. **Rumex acetosella** L. Field sorrel.—Occasional as a weed on poor ground.
334. **Polygonum aviculare** L. Knotgrass. Knotweed.—Common as a weed in villages and about country dwellings.
335. **Polygonum erectum** L. Erect knotweed.—Occasional near Rush Lake and Port Austin.
336. **Polygonum lapathifolium** L. Dock-leaved persicaria.—In a wet place at Port Austin and frequent below Grindstone City.
337. **Polygonum amphibium** L. Water persicaria.—Frequent in very wet and marshy places at Sebewaing, Port Austin, Bayport, and near Rush Lake.
338. **Polygonum amphibium hartwrightii** (Gray) Bissel. Hart Wright's persicaria.—On very wet ground at Port Austin and near Rush Lake.
339. **Polygonum muhlenbergii** (Meisn.) Wats. Swamp persicaria.—

In shallow water and in very wet places along streams and near Rush Lake.

340. **Polygonum pennsylvanicum** L. Pennsylvania persicaria.—Occasional at Port Austin and below Grindstone City.

341. **Polygonum hydropiper** L. Common smartweed.—Frequent in moist open or shaded places.

342. **Polygonum acre** HBK. Water smartweed.—On very wet marshy ground near Rush Lake, Port Austin and Harbor Beach.

343. **Polygonum orientale** L. Prince's feather.—Occasional in the villages as an escape.

344. **Polygonum persicaria** L. Lady's thumb.—Usually on damp ground in and near the villages.

345. **Polygonum hydropiperoides** Michx. Mild water pepper.—Frequent in bottoms of ditches and along and in beds of small streams.

346. **Polygonum virginianum** L. Virginia knotweed.—Common in damp rich open woods and thickets.

347. **Polygonum convolvulus** L. Black bindweed.—A weed in gardens, fields, and waste places.

348. **Polygonum cilinode** Michx. Fringed black bindweed.—Very abundant on Little Charity Island. Occasional in other localities.

349. **Polygonum scandens** L. Climbing false buckwheat.—Occasional in moist thickets at Sand Point.

350. **Fagopyrum esculentum** Moench. Buckwheat.—Occasional in the villages as an escape.

351. **Polygonella articulata** (L.) Meisn. Coast jointweed.—On sand at Sand Point, near Caseville, Rush Lake and on Charity Island. Abundant on the beach at Grindstone City.

352. **Cycloloma atriplicifolium** (Spreng.) Coult. Winged pigweed.—On sandy ground at Port Austin and Grindstone City.

353. **Chenopodium botrys** L. Jerusalem oak.—On sand at Port Austin and Grindstone City.

354. **Chenopodium capitatum** (L.) Asch. Strawberry blite.—On bank of Pigeon river at Caseville. "Occasional in woods." Davis.

355. **Chenopodium hybridum** L. Maple-leaved goosefoot.—Frequent in open woods and a weed in villages and fields.

356. **Chenopodium album** L. Lamb's quarters. Pigweed.—A common weed in villages, gardens, and fields.

357. **Atriplex patula hastata** (L.) Gray. Halberd-leaved orache.—

A frequent weed in waste places, villages, and about country-dwellings.

358. **Salsola kali tenuifolia** G. F. W. Mey. Russian thistle.—Noticed as a weed in sandy ground at Bayport, Sebewaing, and Port Austin. Not abundant.

359. **Amaranthus retroflexus** L. Green amaranth. Pigweed.—A common weed in villages, fields, and about country dwellings.

360. **Amaranthus graecizans** L. Tumble weed.—Frequent as a weed in villages, gardens, fields, and waste places.

361. **Amaranthus blitoides** Wats. Prostrate amaranth.—A frequent weed in the streets and gardens of villages.

362. **Mollugo verticillata** L. Carpet weed.—Frequent on sandy ground throughout the sand district.

363. **Arenaria serpyllifolia** L. Thyme-leaved sandwort.—A frequent weed on sandy ground in villages.

364. **Stellaria longifolia** Muhl. Long-leaved stitchwort.—Frequent in damp grassy places.

365. **Stellaria borealis** Bigel. Northern stitchwort.—"Pointe aux Barques." In Michigan Flora.

366. **Stellaria media** (L.) Cyrill. Common chickweed.—A common weed in the streets and gardens of villages.

367. **Cerastium vulgatum** L. Common mouse-ear chickweed.—A common weed in the gardens of villages and in adjacent fields.

368. **Agrostemma githago** L. Corn cockle.—Occasional in waste places in villages and in adjacent wheat fields.

369. **Lychnis coronaria** (L.) Desr. Mullein pink.—"Waste places, Port Austin." Davis.

370. **Silene antirrhina** L. Sleepy catchfly.—Frequent on dry and sandy ground throughout the sand region.

371. **Silene noctiflora** L. Night-flowering catchfly.—Frequent as a weed in villages and adjacent fields.

372. **Saponaria officinalis** L. Bouncing bet.—Common in villages and along the lake shore, often covering large areas of sandy ground.

373. **Claytonia virginica** L. Spring beauty.—Common in rich woods.

374. **Portulaca oleracea** L. Common purslane.—Frequent on sandy ground in the gardens and streets of villages.

375. **Nymphaea advena** Ait. Yellow pond lily.—Common in stagnant water.

376. **Nymphaea tuberosa** (Paine) Greene. Tuberous white water lily.—Frequent in coves, ponds, and slow streams. Abundant in Rush Lake.

377. **Brasenia shreberi** Gmel. Water shield.—In quiet water in Pigeon River. Abundant in Rush Lake.
378. **Ranunculus delphinifolius** Torr. Water crowfoot.—Common in still water and slow-flowing streams.
379. **Ranunculus sceleratus** L. Cursed crowfoot.—Common in wet and boggy places.
380. **Ranunculus abortivus** L. Small-flowered crowfoot.—Very common on damp shaded ground.
381. **Ranunculus recurvatus** Poir. Hooked crowfoot.—Common in damp places, rich open woods and thickets.
382. **Ranunculus septentrionalis** Poir. Swamp buttercup.—Frequent in moist and shaded places.
383. **Ranunculus pennsylvanicus** L. f. Bristly crowfoot.—Frequent on damp open grassy ground.
384. **Ranunculus acris** L. Tall crowfoot.—In waste places at Bayport and Caseville. Not frequent.
385. **Thalictrum dioicum** L. Early meadow rue.—Frequent in rich open woods and thickets.
386. **Thalictrum dasycarpum** Fisch. and Lall. Purplish meadow rue. —On damp rich ground at Caseville, Bayport, Port Austin, Sebewaing, and near Rush Lake.
387. **Hepatica triloba** Chaix. Round-lobed liverleaf.—Frequent in rich open woods and thickets near Rush Lake, Port Austin, Bayport and on Charity Island.
388. **Hepatica acutiloba** DC. Sharp-lobed liverleaf.—In rich damp woods at Bayport, Port Austin and Sebewaing. Also on the islands.
389. **Anemone cylindrica** Gray. Long-fruited anemone.—Throughout the sand dune region, but nowhere abundant.
390. **Anemone virginiana** L. Tall anemone.—Occasional on borders of woods, thickets and banks of streams.
391. **Anemone canadensis** L. Canada anemone.—Plentiful on damp ground in small patches.
392. **Anemone quinquefolia** L. Wood anemone.—In open woods near Port Austin and on Stony Island.
393. **Clematis virginiana** L. Virgin's bower.—Occasional in damp thickets and on banks of streams.
394. **Caltha palustris** L. Marsh marigold.—Frequent in swampy places.
395. **Coptis trifolia** (L.) Salisb. Goldthread.—On damp ground near Port Austin and Rush Lake.
396. **Aquilegia canadensis** L. Wild columbine.—Frequent on sandy ground.

397. **Delphinium consolida** L. Field larkspur.—Occasionally escaping to streets in villages.
398. **Actaea rubra** (Ait.) Willd. Red baneberry.—Frequent in rich woods and thickets.
399. **Actaea alba** (L.) Mill. White baneberry.—Occasional in rich woods and thickets.
400. **Liriodendron tulipfera** L. Tulip tree. Whitewood.—Not noticed but reported as formerly existing near Sebewaing. "Not uncommon in southern Tuscola Co." Davis.
401. **Menispermum canadense** L. Moonseed.—Occasional on banks of streams and in damp shaded places. Also on the islands.
402. **Podophyllum peltatum** L. May apple; wild mandrake.—Frequent on rich shaded ground throughout the sand district and on the islands.
403. **Caulophyllum thalictroides** (L.) Michx. Blue cohosh.—Frequent in rich woods and thickets.
404. **Sassafras variifolium** (Salisb.) Ktze. Sassafras.—A very few small shrubs noticed in sandy ground north of Rush Lake. Reported as existing in many other places.
405. **Benzoin aestivale** (L.) Nees. Spice bush.—Frequent in rich woods and thickets.
406. **Sanguinaria canadensis** L. Bloodroot.—Noticed in open rich woods near Rush Lake. Abundant on Charity Island.
407. **Adlumia fungosa** (Ait.) Greene. Climbing fumitory.—Abundant among broken rocks near cliff west of Grindstone City. "At the quarries, Grindstone City, on refuse piles." Davis.
408. **Dicentra cucullaria** (L.) Bernh. Dutchman's breeches.—Not noticed but reported as existing at Port Austin, Bayport and Sebewaing.
409. **Dicentra canadensis** (Goldie) Walp. Squirrel corn.—In rich woods near Rush Lake and on the flats between the bluff and the lake shore above Harbor Beach.
410. **Corydalis sempervirens** (L.) Pers. Pale corydalis.—Occasional on sandy ground at Caseville and Port Austin.
411. **Corydalis aurea** Willd. Golden corydalis.—Occasional on shaded sides of sand dunes near Port Austin and Caseville.
412. **Alyssum alyssoides** L. Yellow alyssum.—Along the railroad south of Caseville and Port Austin. Apparently rare.
413. **Thlaspi arvense** L. Field penny cress.—A weed on sandy ground at Port Austin but apparently rare.
414. **Lepidium virginicum** (L.) Willd. Peppergrass.—A common weed about villages and country dwellings.

415. **Lepidium apetalum** Willd. Apetalous peppergrass.—A frequent weed about villages.

416. **Lepidium campestre** (L.) R. Br. Field cress.—Along the railroad south of Caseville.

417. **Capsella bursa-pastoris** (L.) Medic. Shepherd's purse.—A common weed in villages and adjacent fields.

418. **Camelina sativa** (L.) Crantz. Gold-of-pleasure.—Along the railroad south of Caseville.

419. **Cakile edentula** (Bigel) Hook. American sea rocket.—Common in sand along the lake shore. "Not observed back of the outer row of dunes and usually on the side facing the lake." Davis.

420. **Brassica arvensis** (L.) Ktze. Common mustard. Charlock.—A frequent weed in villages and adjacent fields.

421. **Brassica campestris** L. Ruta-baga.—An occasional weed along railroads and in villages; an escape from cultivation.

422. **Conringia orientalis** (L.) Dumort. Hare's-ear mustard.—Along the railroad south of Caseville. Apparently rare.

423. **Sisymbrium officinale** (L.) Scop. Hedge mustard.—A common weed about villages.

424. **Sisymbrium altissimum** L. Tumble mustard.—Near the grain elevator at Caseville.

425. **Sisymbrium cheiranthoides** L. Wormseed mustard.—A weed in villages, about fishery buildings and in adjacent fields.

426. **Radicula nasturtium aquaticum** (L.) Britten and Rendle. True water cress.—Abundant in a creek near Port Austin.

427. **Radicula palustris** (L.) Moench. Marsh cress.—Frequent in wet open places.

428. **Radicula armoracia** (L.) Robinson. Horseradish.—Frequent on damp ground as an escape.

429. **Dentaria diphylla** Michx. Two-leaved toothwort; crinkle-root.—Not noticed but found in the herbarium of Miss Elma Kelley at Harbor Beach and collected near there. No doubt common on rich shaded ground throughout the sand region.

430. **Dentaria laciniata** Muhl. Cut-leaved toothwort.—Abundant on east side of Charity Island. Not noticed elsewhere.

431. **Cardamine bulbosa** (Schreb.) BSP. Spring cress.—Occasional on wet springy ground.

432. **Cardamine douglasii** (Torr.) Britton. Purple cress.—Common in rich damp woods.

433. **Cardamine pratensis** L. Cuckoo flower.—On border of a creek east of Port Austin.

434. **Cardamine pennsylvanica** Muhl. Pennsylvania bitter cress.—Occasional on damp shaded ground.
435. **Arabis lyrata** L. Lyre-leaved rock cress.—Common on flat sandy ground and on sand dunes.
436. **Arabis drummondi** Gray. Drummond's rock cress.—Frequent near the lake shores of the islands.
437. **Arabis laevigata** (Muhl.) Poir. Smooth rock cress.—Frequent on sand on lake shore and sand dunes.
438. **Drosera rotundifolia** L. Round-leaved sundew.—Abundant on a small island in Rush Lake. Not noticed elsewhere.
439. **Sarracenia purpurea** L. Pitcher plant.—Abundant in boggy places about Rush Lake and west of Caseville.
440. **Penthorum sedoides** L. Ditch stonecrop.—Frequent in wet places.
441. **Sedum acre** L. Mossy stonecrop.—A harmless weed in villages, often covering large patches of sandy ground.
442. **Sedum purpureum** Tausch. Live-for-ever.—Frequent on sandy ground as an escape.
443. **Tiarella cardifolia** L. False miterwort.—Common in rich damp woods.
444. **Mitella diphylla** L. Two-leaved bishop's cap.—Common in rich damp woods and thickets.
445. **Mitella nuda** L. Naked bishop's cap.—Frequent in rich damp woods and thickets.
446. **Chrysosplenium americanum** Schwein. Golden saxifrage.—In very wet shaded places near Rush Lake and Port Austin.
447. **Ribes cynosbati** L. Prickly gooseberry.—Common in open damp woods and thickets.
448. **Ribes huronense** Rydb. Lake Huron gooseberry.—In rich woods near Sebewaing.
449. **Ribes oxyacanthoides** L. Smooth gooseberry.—Frequent on damp ground and along streams.
450. **Ribes floridum** L'Her. Wild black currant.—Common in damp thickets and on banks of streams.
451. **Ribes triste** Pall. Swamp red currant.—In rich damp woods near Rush Lake and Bayport.
452. **Ribes aureum** Pursh. Buffalo currant.—Inclined to escape in the villages to sandy ground.
453. **Hamamelis virginiana** L. Witch-hazel.—Common. Usually in damp ground, often on sides of and between sand dunes.
454. **Platanus occidentalis** L. Sycamore. Buttonwood.—Frequent in rich ground with other trees. Occasional in sand along lake shore. Trees not large.

455. **Physocarpus opulifolius** (L.) Maxim. Nine-bark.—Frequent along streams and borders of woods. Also on the islands.

456. **Spiraea salicifolia** L. Meadow-sweet.—Common on low ground, on borders of marshes, ponds, and often on damp sand between sand dunes.

457. **Sorbaria sorbifolia** (L.) A. Br. Mountain ash spiraea.—Inclined to escape to sandy ground in villages.

458. **Pyrus baccata** L. Siberian crab.—On Stony Island, apparently part of an old abandoned orchard.

459. **Pyrus coronaria** L. American crab.—In thickets and open woods but usually not common. Rare on the islands.

460. **Pyrus malus** L. Apple.—Frequent throughout the sand region.

461. **Pyrus arbutifolia atropurpurea** (Britton) Robinson. Chokeberry.—Noticed in very wet places between sand dunes near Caseville and Rush Lake, and often over ten feet high.

462. **Pyrus melanocarpa** (Michx.) Willd. Black chokeberry.—Frequent on damp ground, occasional on damp sand.

463. **Amelanchier canadensis** (L.) Medic. Juneberry; May-cherry.—Frequent along banks of streams and on sandy ground throughout the sand district. Abundant at Sand Point and on Stony Island.

464. **Amelanchier oblongifolia** (T. and G.) Roem. Shad-bush.—Abundant at Sand Point. Frequent on sand dunes.

465. **Amelanchier spicata** (Lam.) Koch. Round-leaved Juneberry.—Abundant at Sand Point and on Stony Island. Common on sand dunes throughout. Fruit comparatively large and very palatable.

466. **Crataegus crus-galli** L. Cockspur thorn.—Frequent in dry ground throughout. *Crataegus attenuata* Ashe and *C. arduennae* Sarg.

467. **Crataegus punctata** Jacq. Large-fruited thorn.—Frequent throughout the sand district and on the islands.

Throughout the sand dune district and on the islands of Saginaw Bay many species of Crataegus were noticed that are not yet identified. These were formerly included under *C. coccinea.*

468. **Fragaria virginiana** Duchesne. Common strawberry.—Common throughout.

469. **Fragaria vesca americana** Porter. American wood strawberry. Frequent in damp open woods and thickets.

470. **Potentilla monspeliensis** L. Rough cinquefoil.—A common weed in villages, adjacent fields, and about fishery buildings.

471. **Potentilla argentea** L. Silvery cinquefoil.—Frequent on dry and sandy ground.

472. **Potentilla palustris** (L.) Scop. Marsh five-finger.—Frequent in wet marshy open places.

473. **Potentilla fruticosa** L. Shrubby cinquefoil.—Occasional on wet or dry open ground.

474. **Potentilla anserina** L. Silver weed.—Common in many places and often abundant not far from the lake shore. Usually not extending far inland.

475. **Potentilla canadensis** L. Five-finger.—Frequent throughout the sand region.

476. **Geum canadense** Jacq. White avens.—Frequent in damp open woods and thickets.

477. **Geum virginianum** L. Rough avens.—Occasional on low ground and on borders of woods at Bayport, Sebewaing and near Rush Lake.

478. **Geum strictum** Ait. Yellow avens.—Frequent in moist meadow-like places at Sebewaing, Bayport and Port Austin.

479. **Geum rivale** L. Water avens.—Occasional in wet boggy places at Sebewaing and near Rush Lake.

480. **Rubus idaeus aculeatissimus** (C. A. Mey). Regel and Tiling. Wild red raspberry.—Common on dry and sandy ground throughout the sand region.

481. **Rubus occidentalis** L. Black caps. Black raspberry.—Frequent in damp open woods and thickets.

482. **Rubus triflorus** Richards. Dwarf raspberry.—Common in damp woods and thickets.

483. **Rubus allegheniensis** Porter. High bush blackberry.—Common on flat sandy ground and on fixed sand dunes.

484. **Rubus hispidus** L. Hispid blackberry.—Common on low dry ground and between sand dunes.

485. **Rubus villosus** Ait. Dewberry.—Common on flat or rolling ground and on shaded sides of fixed sand dunes.

486. **Agrimonia gryposepala** Wallr. Tall hairy agrimony.—Frequent on dry ground in open woods.

487. **Rosa blanda** Ait. Meadow rose.—Frequent on borders of marshes and on sandy ground not far from the lake shore, where it often acts as a sand binder. "Growing in sand and nearly buried by it at Hat Point." Davis.

488. **Rosa rubiginosa** L. Sweetbrier.—Frequent on sandy ground throughout the sand district.

489. **Rosa carolina** L. Swamp rose.—Common on borders of swamps in marshes and along streams.

490. **Prunus serotina** Ehrh. Wild black cherry.—Frequent on rich ground with other trees.

491. **Prunus virginiana** L. Choke cherry.—Common on flat sandy ground and on sand dunes. Fringing the lake shore in abundance on the north side of Sand Point.

492. **Prunus pennsylvanica** L. f. Wild red cherry.—Frequent in open dry woods throughout the sand region and on the islands.

493. **Prunus pumila** L. Sand cherry.—Frequent throughout the sand region on dunes and flat sandy ground. "Abundant on the dunes west of Port Crescent." Davis.

494. **Prunus cerasus** L. Common sour cherry.—Noticed as a frequent escape in the villages.

495. **Prunus americana** Marsh. Wild plum.—Apparently rare in the immediate vicinity of sand dunes. Two specimens noticed on the west side of Stony Island. Rare on the islands. More frequent east of Port Austin to and below Grindstone City as far as White Rock. "Hume township along streams." Davis.

496. **Lupinus perennis** L. Wild lupine.—Abundant on south side of Sand Point, on flat sandy ground. Apparently rare in other places.

497. **Trifolium pratense** L. Red clover.—Occasional throughout the sand region. Abundant in cultivation in adjacent fields.

498. **Trifolium repens** L. White clover.—Common in streets and waste places of villages, abundant in adjacent pastures and fields.

499. **Trifolium hybridum** L. Alsike clover.—Frequent in streets and waste places of villages, abundant under cultivation in adjacent fields.

500. **Melilotus officinalis** (L.) Lam. Yellow sweet clover.—Occasional in villages, around country dwellings and fishery buildings.

501. **Melilotus alba** Desr. White sweet clover.—Frequent in streets and waste places of villages. Abundant along the road below Grindstone City.

502. **Medicago sativa** L. Alfalfa. Lucerne.—Occasional near Rush Lake, Port Austin and Sebewaing.

503. **Medicago lupulina** L. Black medic.—Common in villages and adjacent fields.

504. **Robinia pseudo-acacia** L. Common locust.—Cultivated as an ornamental tree and escaping in the villages.

505. **Astragalus canadensis** L. Carolina milk vetch.—Along the bank of a creek near Harbor Beach.

506. **Desmodium nudiflorum** (L.) DC. Naked-flowered tick trefoil. —On rich shaded ground at Sand Point.

507. **Desmodium grandiflorum** (Walt.) DC. Pointed-leaved tick trefoil.—Frequent in rich woods.

508. **Desmodium dillenii** Darl. Dillen's tick trefoil.—On poor shaded ground near Rush Lake.

509. **Desmodium paniculatum** (L.) DC. Panicled tick trefoil.—On flat sandy and shaded ground at Sand Point.

510. **Desmodium canadense** (L.) DC. Showy tick trefoil.—In open dry woods and on open ground at Sand Point and Port Austin.

511. **Lespedeza frutescens** (L.) Britton. Wand-like bush clover.— On poor sandy ground on Stony Island. Apparently rare.

512. **Lespedeza hirta** (L.) Hornem. Hairy bush clover.—On sandy ground near Rush Lake. Apparently rare.

513. **Lespedeza capitata** Michx. Round-headed bush clover.—On poor sandy ground at Sand Point, Port Austin and Sebewaing. Not common.

514. **Vicia sativa** L. Spring vetch.—Occasional as a weed in villages and adjacent fields.

515. **Vicia augustifolia** (L.) Reichard. Common vetch.—Frequent along railroad near Caseville and Port Austin.

516. **Lathyrus maritimus** (L.) Bigel.—A conspicuous beach and sand dune plant and sand binder. Common on sand along the lake shore, often growing near the wave line, and on the dunes nearest to the water. Very abundant at Port Austin and on south side of Little Charity Island, where it almost completely covers the ground.

517. **Lathyrus palustris** L. Marsh vetchling.—Frequent in damp and marshy places.

518. **Lathyrus palustris myrtifolius** (Muhl.) Gray. Myrtle-leaved marsh pea.—On borders of marshes and along streams. Frequent.

519. **Apios tuberosa** Moench. Groundnut. Wild bean.—Frequent on borders of woods and thickets.

520. **Amphicarpa monoica** (L.) Ell. Hog peanut.—Frequent on dry open or shaded ground.

521. **Amphicarpa pitcheri** T. and G.—Common in rich damp woods and thickets.

522. **Linum usitatissimum** L. Common flax.—Occasional as a weed in villages and along railroads. A common weed in fields near Ruth.

523. **Oxalis stricta** L. Yellow wood-sorrel.—Common on damp or dry ground.

524. **Geranium maculatum** L. Wild cranesbill.—Common in rich open woods and in open places.

525. **Geranium robertianum** L. Herb robert.—Abundant in shade on North Island and near Harbor Beach. "Along the beach near Grindstone City, also in rocky soil inland." Davis.

526. **Geranium carolinianum** L. Carolina cranesbill.—Occasional on dry ground in the villages.

527. **Geranium bicknellii** Britton. Bicknell's cranesbill.—On the edge of overhanging rocks at Pointe aux Barques.

528. **Geranium pusillum** Burm. f. Small-flowered cranesbill.—Noticed as an occasional lawn weed in the villages.

529. **Zanthoxylum americanum** Mill. Northern prickly ash.—Common on rich damp ground throughout the sand region. Specimens over three inches in diameter and 15 feet high were observed.

530. **Polygala paucifolia** Willd. Fringed polygala.—On poor and sandy ground east of Bayport, near Rush Lake, and on Charity Island.

531. **Polygala polygama** Walt. Racemed milkwort.—On sandy ground on Sand Point.

532. **Polygala senega** L. Seneca snakeroot.—On poor ground west of Caseville. Apparently rare.

533. **Euphorbia polygonifolia** L. Seaside spurge.—Observed only in drifting sand on the lake shore where it is often abundant.

534. **Euphorbia preslii** Guss. Upright spotted spurge.—On dry open ground near Sebewaing.

535. **Euphorbia maculata** Engelm. Milk purslane.—Frequent in villages, about country dwellings and fishery buildings.

536. **Euphorbia hirsuta** (Torr.) Wiegand. Hairy spurge.—Frequent along railroad near Caseville and Port Austin.

537. **Euphorbia corollata** L. Flowering spurge.—On poor dry ground at Port Austin and Bayport. Not common.

538. **Euphorbia cyparissias** L. Cypress spurge.—Common, especially on sandy ground, in and near villages, about country dwellings and in cemeteries.

539. **Callitriche palustris** L. Water fennel.—"Dry bed of branch of Pinnebog River, Hume Township." Davis.

540. **Rhus typhina** L. Staghorn sumach.—Very abundant on damp ground and on sand dunes.

541. **Rhus copallina** L. Dwarf sumach.—"Sand dunes." Davis.

542. **Rhus vernix** L. Poison sumach; poison dogwood.—Frequent in swampy places.
543. **Rhus toxicodendron** L. Poison ivy; poison oak.—Abundant on sand dunes and generally in dry sandy or rich damp ground.
544. **Ilex verticillata** (L.) Gray. Black alder; winterberry.—Common in low damp ground.
545. **Nemopanthus mucronata** (L.) Trel. Mountain holly.—In swampy places near Caseville and Rush Lake. Apparently infrequent.
546. **Evonymus obovatus** Nutt. Running strawberry bush.—In damp shaded places at Caseville, Port Austin, and Stony Island.
547. **Colastrus scandens** L. Bittersweet.—Common along streams, in open woods and thickets.
548. **Acer spicatum** Lam. Mountain maple.—Frequent in damp woods. Also on the islands.
549. **Acer saccharum** Marsh. Sugar maple.—Frequent on rich ground with other trees. Charity Island.
550. **Acer saccharinum** L. Silver maple.—Frequent on rich ground along streams with other trees.
551. **Acer rubrum** L. Red maple.—Common on rich damp ground with other trees.
552. **Acer negundo** L. Box elder.—Cultivated as an ornamental tree and spreading.
553. **Aesculus hippocastanum** L. Common horsechestnut.—An ornamental street tree but apparently not spreading.
554. **Impatiens biflora** Walt. Spotted touch-me-not.—Common on damp shaded ground.
555. **Ceanothus americanus** L. New Jersey tea.—Frequent on sand dunes and flat sandy ground.
556. **Ceanothus ovatus** Desf. Smaller red-root.—Common on sand dunes and flat sandy ground.
557. **Psedera vitacea** (Kneer.) Greene. Virginia creeper. American ivy.—Common in woods and thickets and along streams.
558. **Vitis bicolor** Le Conte. Summer grape.—On dry ground near Rush Lake and Bayport. Apparently rare.
559. **Vitis vulpina** L. River-bank grape; frost grape.—Common along streams and on sides of sand dunes, often acting as a sand binder.
560. **Tilia americana** L. Basswood.—Common on rich ground with other trees.

561. **Abutilon theophrasti** Medic. Indian mallow.—Occasional as a weed in the streets and gardens of villages.
562. **Malva rotundifolia** L. Common mallow; cheeses.—A common weed in the streets, gardens, and waste places of villages.
563. **Malva sylvestris** L. High mallow.—"Port Austin." Davis.
564. **Malva moschata** L. Musk mallow.—"Roadsides. Frequent." Davis.
565. **Hypericum perforatum** L. Common St. John's-wort.—Frequent in dry sandy ground on roadsides and about country dwellings.
566. **Hypericum punctatum** Lam. Spotted St. John's-wort.—Noticed on damp and usually shaded ground near Caseville and Port Austin.
567. **Hypericum kalmianum** L. Kalm's St. John's-wort.—Frequent on sandy ground, usually along the lake shore. Often abundant. "Prairies near Bayport." Davis.
568. **Hypericum mutilum** L. Dwarf St. John's-wort.—In damp open ground at Port Austin.
569. **Hypericum majus** (Gray) Britton. Larger Canadian St. John's-wort.—"Crevices in the rocks on the lake shore near Port Austin." Davis.
570. **Hypericum canadense** L. Canadian St. John's-wort.—On damp open ground among grasses and sedges near Rush Lake.
571. **Hypericum virginicum** L. Marsh St. John's-wort.—Common in marshes and swamps.
572. **Helianthemum canadense** (L.?) Michx. Frost-wort.—Common on sand dunes and poor sandy ground.
573. **Viola cucullata** Ait. Marsh blue violet.—On marshy ground near Sebewaing.
574. **Viola nephrophylla** Greene. Small mottled blue violet.—Along the railroad near Sebewaing.
575. **Viola sororia** Willd. Woolly blue violet.—In open woods near Sebewaing, Bayport, and Rush Lake.
575a **Viola sagitata** Ait. Arrow-leaved violet.—Along the railroad near Sebewaing.
576. **Viola pallens** (Banks) Brainard. Small sweet white violet.—In very wet and springy places.
577. **Viola incognita** Brainard. Sweet white violet.—Common in rich woods and thickets.
578. **Viola pubescens** Ait. Downy yellow violet.—Occasional on dry shaded sandy ground.
579. **Viola scabriuscula** Schwein. Smooth yellow violet.—Common in rich damp woods.

580. **Viola conspersa** Reichenb. American dog violet.—Common on rich, damp and shaded ground.
581. **Viola arenaria** DC. Sand violet.—Occasional on sand dunes north of Rush Lake.
582. **Viola rostrata** Pursh. Long-spurred violet.—Below Grindstone City on the bluff facing the lake and from that point south to Harbor Beach.
583. **Dirca palustris** L. Moosewood.—On rich shaded ground near Caseville.
584. **Shepherdia canadensis** (L.) Nutt. Canadian buffalo-berry.—At Pointe aux Barques near the edge of the overhanging rocky shore. "Also on sand dunes west of Port Crescent." Davis.
585. **Decodon verticillatus** (L.) Ell. Water willow.—On swampy ground about Rush Lake.
586. **Lythrum alatum** Pursh. Wing-angled loosestrife.—In a small "cranberry marsh" near Caseville; wet places near Bayport and Port Austin.
587. **Ludvigia polycarpa** Short and Peter. Many-fruited ludvigia.—"Common in marshy places near lake shore in Tuscola Co." Davis.
588. **Ludvigia palustris** (L.) Ell.—In ditches and muddy places near Caseville and Port Austin.
589. **Epilobium densum** Raf. Linear-leaved willow-herb.—On wet marshy ground among grasses and sedges near Rush Lake and Port Austin.
590. **Epilobium coloratum** Muhl. Purple-leaved willow-herb.—"Port Austin." Davis.
591. **Epilobium adenocaulon** Haussk. Northern willow-herb.—Common on rich damp ground.
592. **Oenothera biennis** L. Common evening primrose.—Common on sand on or near the lake shore and on sand dunes.
593. **Circaea lutetiana** L. Enchanter's nightshade.—Common in damp open woods.
594. **Circaea alpina** L. Smaller enchanter's nightshade.—Common in damp woods and thickets.
595. **Myriophyllum spicatum** L. Spiked water milfoil.—In quiet places in Pigeon River at Caseville.
596. **Myriophyllum heterophyllum** Michx. Various-leaved water milfoil.—"Pinnebog River, Port Crescent." Davis.
597. **Proserpinaca palustris** L. Mermaid-weed.—Frequent in wet, marshy places.
598. **Aralia racemosa** L. Spikenard.—Very frequent in rich woods.

599. **Aralia hispida** Vent. Bristly sarsaparilla.—On poor sandy ground at Sand Point and near Rush Lake. Not common.

600. **Aralia nudicaulis** L. Wild sarsaparilla.—Abundant throughout, in rich woods and thickets, often spreading to poor and sandy ground.

601. **Panax quinquefolium** L. Ginseng. Rich woods.—Not noticed, but reported as having been collected in the vicinity of all the villages.

602. **Panax trifolium** L. Dwarf ginseng; groundnut.—"Hard wood lands west of Bad Axe and probably in beach and maple woods near sand dune region." Davis.

603. **Sanicula marilandica** L. Black snakeroot.—Common in rich open woods and thickets.

604. **Hydrocotyle americana** L. American marsh pennywort.—"Moist woods, Port Austin." Davis.

605. **Osmorhiza claytoni** (Michx.) Clarke. Woolly sweet cicely.—In rich open woods at Caseville, Bayport, Sebewaing, Stony Island and near Rush Lake.

606. **Osmorhiza longistylis** (Torr.) DC. Smoother sweet cicely.—In rich open woods at Port Austin, Stony Island, Charity Island and near Rush Lake.

607. **Cicuta maculata** L. Water hemlock.—Common on damp open ground.

608. **Cicuta bulbifera** L. Bulb-bearing water hemlock.—Common on marshy and swampy ground.

609. **Carum carui** L. Caraway.—Along railroad south of Caseville and near Rush Lake. Infrequent.

610. **Sium cicutaefolium** Schrank. Water parsnip.—Common in very wet and muddy places.

611. **Cryptotaenia canadensis** (L.) DC. Honewort.—Very common on rich, damp and usually shaded ground.

612. **Zizia aurea** (L.) Koch. Golden alexanders.—Along the bank of Pigeon River at Caseville. Apparently infrequent.

613. **Taenidia integerrima** (L.) Drude. Yellow pimpernel.—Frequent and often abundant on dry flat or rolling sandy ground and on sand dunes.

614. **Pastinaca sativa** L. Parsnip.—Noticed as a weed about Port Austin.

615. **Heracleum lanatum** Michx. Cow parsnip.—Abundant in rich open woods at Bayport, on North Island and Charity Island.

616. **Angelica atropurpurea** L. Great angelica.—Plentiful at one place near Rush Lake. Not noticed elsewhere.

617. **Daucus carota** L. Wild carrot.—Occasional at Caseville, Sebewaing and Port Austin. Not noticed as a troublesome weed in adjacent fields. Abundant on roadsides and in cultivated fields below Grindstone City.

618. **Cornus canadensis** L. Dwarf cornel; pigeon-berry.—Frequent in damp woods.

619. **Cornus circinata** L'Her. Round-leaved cornel.—Common on damp ground and on sand dunes.

620. **Cornus amomum** Mill. Silky cornel; kinnikinnik.—Frequent along streams on damp ground and occasional on sand along the lake shore.

621. **Cornus baileyi** Coult and Evans. Bailey's cornel.—Observed on sandy ground near Port Austin. "Very common along the lake on sand dunes. Also at Bayport." Davis.

622. **Cornus stolonifera** Michx. Red-osier dogwood.—Common on damp ground and sand dunes.

623. **Cornus paniculata** L'Her. Panicled cornel.—Common on banks of streams, borders of woods, and in damp thickets.

624. **Cornus alternifolia** L. f. Alternate-leaved cornel.—Frequent in open, rich woods.

625. **Chimaphila umbellata** (L.) Nutt. Prince's pine; pipsissewa.—Frequent among pines and on shaded sand dunes.

626. **Pyrola secunda** L. One-sided wintergreen.—In rich woods at Sand Point, Caseville, Port Austin and near Rush Lake.

627. **Pyrola elliptica** Nutt. Shin leaf.—In dry woods and thickets, at Sand Point, Caseville, Port Austin, Charity Island and near Rush Lake.

628. **Pyrola americana** Sweet. Round-leaved wintergreen.—In open woods on dry sandy ground at Sand Point, Charity Island and near Rush Lake.

629. **Monotropa uniflora** L. Indian pipe.—In dry ground at Port Austin and near Rush Lake.

630. **Ledum groenlandicum** Oeder. Labrador tea.—In a swamp near Rush Lake.

631. **Kalmia polifolia** Wang. Pale laurel.—In swamps about Rush Lake.

632. **Andromeda glaucophylla** Link. Bog rosemary.—In swamps about Rush Lake.

633. **Chamaedaphne calyculata** (L.) Moench. Leather leaf.—In swamps about Rush Lake. "Bog in Chandler township." Davis.

634. **Epigaea repens** L. Trailing arbutus. Mayflower.—Frequent

on flat or rolling sandy ground under pines and on shaded sand dunes, but nowhere abundant.

635. **Gaultheria procumpens** L. In Michigan known as wintergreen. —Very common on flat or rolling sandy ground, usually in shade, and on shaded sand dunes.

636. **Arctostaphylos uva-ursi** (L.) Spreng. Bearberry.—Common on sand dunes, and a good sand binder.

637. **Gaylussacia baccata** (Wang.) C. Koch. Black huckleberry.—Very common on flat or rolling sandy ground and on sand dunes. Fruit usually abundant.

638. **Gaylussacia baccata** forma **glaucocarpa** (Robinson) McKenzie. Blue huckleberry.—On drifting sand near Port Austin.

639. **Vaccinium pennsylvanicum** Lam. Low sweet blueberry.—Very common on flat sandy ground and on sand dunes. Fruit usually abundant.

640. **Vaccinium pennsylvanicum nigrum** Wood. Low black blueberry.—On flat sandy ground at Sand Point. Not noticed elsewhere.

641. **Vaccinium vacillans** Kalm. Late low blueberry.—"Sand dunes west of Port Crescent." Davis.

642. **Vaccinium corymbosum** L. High bush huckleberry.—Abundant in the swamps about Rush Lake.

643. **Vaccinium macrocarpon** Ait. American cranberry.—Frequent near Caseville between sand dunes, in what are called "cranberry marshes." Occasional in other localities.

644. **Samolus floribundus** HBK. Water pimpernel.—"Bank of Pinnebog River, Hume Township." Davis.

645. **Lysimachia terrestris** (L.) BSP. Bulb-bearing loosestrife.—Frequent in open low wet places.

646. **Lysimachia nummularia** L. Moneywort.—Abundant at Port Hope, covering large areas of damp clayey ground.

647. **Lysimachia thyrsiflora** L. Tufted loosestrife.—Frequent in wet places, often growing in shallow stagnant water.

648. **Steironema ciliatum** (L.) Raf. Fringed loosestrife.—Common in low damp ground, damp open woods and thickets.

649. **Steironema quadriflorum** (Sims) Hitchc. Prairie moneywort. —Frequent on open marshy ground.

650. **Trientalis americana** (Pers.) Pursh. Star flower.—Common in rich woods and thickets.

651. **Fraxinus americana** L. White ash.—Common on rich moist ground with other trees.

652. **Fraxinus pennsylvanica** Marsh. Red ash.—Frequent on low rich ground with other trees.

653. **Fraxinus pennsylvanica lanceolata** (Borkh.) Sarg. Green ash. —In rich woods at Bayport. Apparently infrequent.

654. **Fraxinus nigra** Marsh. Black ash.—Frequent in swamps and wet places with other trees. Reported as formerly very abundant, but it has been mostly destroyed by drainage and fires.

655. **Syringa vulgaris** L. Common lilac.—Frequent as an escape in villages and near country dwellings.

656. **Ligustrum vulgare** L. Privet.—On Stony Island, apparently persisting in an old garden or yard.

657. **Gentiana crinita** Froel. Fringed gentian.—Frequent on damp ground near the lake shore from Grindstone City to Harbor Beach.

658. **Gentiana andrewsii** Griseb. Closed gentian.—Abundant on flat damp ground near Harbor Beach.

659. **Menyanthes trifoliata** L. Buckbean.—Common in very wet places and often in shallow water.

660. **Apocynum androsaemifolium** L. Spreading dogbane.—Frequent on open dry ground in open woods, and on shaded sand dunes.

661. **Apocynum cannabinum** L. Indian hemp.—On the bank of a stream near Sebewaing. "Stream banks near Port Austin." Davis.

662. **Apocynum cannabinum pubescens** (R. Br.) DC. Velvet dogbane.—"Charity islands." Winchell's catalogue.

663. **Apocynum cannabinum hypericifolium** (Ait.) Gray. Clasping-leaved dogbane.—Common on marshy ground, the prevailing form in the sand region.

664. **Asclepias tuberosa** L. Butterfly-weed.—Frequent on flat sandy ground and sand dunes.

665. **Asclepias purpurascens** L. Purple milkweed.—Reported as found in Tuscola County by Davis.

666. **Asclepias incarnata** L. Swamp milkweed.—Common in wet and swampy places.

667. **Asclepias syriaca** L. Common milkweed.—Common on flat sandy ground and sand dunes. Often growing on drifting sand near the lake shore, and acting as a sand binder. Very abundant on the sandy shore at Port Austin.

668. **Asclepias sullivantii** Engelm. Sullivant's milkweed.—"Common on prairie-like land, Akron Township, Tuscola County." Davis.

669. **Acerates floridana** (Lam.) Hitchc. Florida milkweed.—Common on prairie-like ground between Bayport and Sebewaing.

670. **Convolvulus sepium** L. Hedge bindweed.—Common on open damp ground.

671. **Convolvulus arvensis** L. Field bindweed.—Occasional at Sebewaing and below Grindstone City.

672. **Cuscuta gronovii** Willd. Gronovius' dodder.—Occasional near Rush Lake and below Grindstone City. "Valley of the Pinnebog River." Davis.

673. **Phlox divaricata** L. Blue phlox.—In damp rich woods near Port Austin and Sebewaing.

674. **Cynoglossum officinale** L. Common hound's tongue.—Noticed as a weed in villages and about country dwellings.

675. **Cynoglossum virginianum** L. Wild comfrey.—Frequent in rich open woods near Bayport and Sebewaing.

676. **Lappula virginiana** (L.) Greene. Beggar's lice.—Occasional on borders of woods at Sebewaing, Bayport and Sand Point.

677. **Lappula echinata** Gilibert. European stickseed.—A roadside weed and in the streets and waste places of villages.

678. **Lithospermum arvense** L. Corn gromwell.—A weed noticed in the streets and waste places of Caseville and Port Austin.

679. **Lithospermum gmelini** (Michx.) Hitchc. Hairy puccoon.—Frequent on flat sandy ground and sand dunes. Noticed on Charity Island.

680. **Verbena urticaefolia** L. White vervain.—"Port Austin." Davis.

681. **Verbena hastata** L. Blue vervain.—Common on damp open ground.

682. **Verbena bracteosa** Michx. Large-bracted vervain.—Noticed as a weed in the streets of Caseville.

683. **Teucrium canadense** L. Wood sage.—Frequent on rich low open ground.

684. **Teucrium occidentale** Gray. Hairy germander.—On marshy ground at Sand Point.

685. **Scutellaria lateriflora** L. Mad-dog skullcap.—Frequent in damp shaded places.

686. **Scutellaria galericulata** L. Marsh skullcap.—Frequent in marshy places.

687. **Marrubium vulgare** L. Common horehound.—Frequent on sandy ground in the streets and waste places of villages and about country dwellings.

688. **Agastache nepetoides** (L.) Ktze. Catnip; giant-hyssop.—In damp open woods, Sebewaing, North Island.

689. **Nepeta cataria** L. Catnip.—Common in villages and about country dwellings.

690. **Nepeta hederacea** (L.) Trevisan. Ground ivy.—Frequent in villages and near country dwellings.

691. **Prunella vulgaris** L. Heal-all.—Very common everywhere except on sand dunes.

692. **Leonurus cardiaca** L. Common motherwort.—Frequent in villages and about country dwellings.

693. **Stachys palustris** L. Woundwort; hedge nettle.—Occasional on marshy ground.

694. **Monarda fistulosa** L. Wild bergamot.—Occasional on damp shaded ground.

695. **Monarda mollis** L. Pale wild bergamot.—Frequent on flat sandy ground and shaded sand dunes.

696. **Blephilia hirsuta** (Pursh) Benth. Wood mint.—In rich woods near Harbor Beach.

697. **Satureja vulgaris** (L.) Fritsch. Basil.—Occasional on poor open ground.

698. **Hyssopus officinalis** L. Hyssop.—Abundant on sandy ground at one place in Caseville.

699. **Pycnanthemum virginianum** (L.) Durand & Jackson. Mountain-mint.—On damp open ground at Sebewaing and Stony Island.

699a. **Pycnanthemun pilosum** Nutt. Hairy mountain-mint.—In damp prairie-like ground near Caseville. Not noticed elsewhere. Dr. Edward L. Greene has lately named this *P. huronense* Greene.

700. **Lycopus virginicus** L. Bugle weed.—On rich moist ground near Rush Lake and at Harbor Beach.

701. **Lycopus uniflorus** Michx. Thin-leaved bugle weed.—On damp ground at Sand Point.

702. **Lycopus rubellus** Moench. Stalked water hoarhound.—In rich woods near Rush Lake. This may be doubtful.

703. **Lycopus americanus** Muhl. Cut-leaved water hoarhound.—Very common on damp open ground.

704. **Mentha spicata** L. Spearmint.—Occasional in villages and about country dwellings.

705. **Mentha piperita** L. Peppermint.—Frequent on damp ground near country dwellings and about fisheries.

706. **Mentha arvensis canadensis** (L.) Briquet. American wild mint. —Common in damp places and on shaded rich ground.

707. **Collinsonia canadensis** L. Horsebalm.—In rich woods near Rush Lake. Apparently infrequent.

708. **Solanum dulcamara** L. Known as "nightshade" in Michigan, the common name "bittersweet" being applied only to *Celas-*

trus scandens. — Frequent, usually appearing like a native plant, being found even in deep woods and swamps.

709. **Solanum nigrum** L. Common nightshade.—Common on rich shaded or open ground, and a common garden weed.

710. **Physalis heterophylla** Nees. Clammy ground-cherry.—Frequent on open sandy ground, but not a sand dune plant.

711. **Physalis pruinosa** L. Strawberry tomato.—Along the roadsides; on sandy ground west of Caseville.

712. **Physalis subglabrata** McKenzie & Bush. Philadelphia ground-cherry.—In a cultivated field near Rush Lake.

713. **Lycium halimifolium** Mill. Common matrimony vine.—Inclined to escape from cultivation to sandy ground, in villages and about country dwellings.

714. **Datura stramonium** L. Stramonium.—Noticed as a weed in the streets of villages and about country dwellings. Also a weed in adjacent bean fields.

715. **Datura tatula** L. Purple thorn apple.—In streets and waste places at Port Austin.

716. **Verbascum thapsus** L. Common mullein.—Occasional as a weed along roads and often abundant in pastures.

717. **Linaria vulgaris** Hill. Butter and eggs.—Common as a weed in poor and sandy ground in the villages. Very abundant at Bayport.

718. **Linaria canadensis** (L.) Dumont. Wild toad-flax.—Common on flat sandy ground and shaded sand dunes throughout the sand region.

719. **Linaria minor** (L.) Desf. Small toad-flax.—Along the railroad at Port Austin.

720. **Chelone glabra** L. Turtle-head.—Frequent in damp places.

721. **Mimulus ringens** L. Square-stemmed monkey-flower.—Common in wet open places.

722. **Veronica americana** Schwein. American brooklime.—"Brooks near Port Austin." Davis.

723. **Veronica scutallata** L. Marsh speedwell.—Frequent in wet open places.

724. **Veronica serpyllifolia** L. Thyme-leaved speedwell.—With grasses on damp ground near Port Austin.

725. **Veronica peregrina** L. Neckweed.—A garden weed at Port Austin.

726. **Veronica arvensis** L. Corn speedwell.—In grassy places about Port Austin.

727. **Gerardia pedicularia** L. Fern-leaved false foxglove.—On shaded sandy ground at Sand Point.

728. **Gerardia virginica** (L.) BSP. Smooth false foxglove.—On sandy ground on Charity Island.

729. **Gerardia paupercula** (Gray) Britton. Small-flowered gerardia.—Common, usually on damp sandy ground, at Sand Point, near Rush Lake, and Harbor Beach.

730. **Castilleja coccinea** (L.) Spreng. Scarlet painted cup.—On prairie-like ground at Sand Point and on Stony Island. Apparently not frequent.

731. **Melampyrum lineare** Lam. Cow wheat.—Frequent in open dry woods.

732. **Pedicularis canadensis** L. Wood betony.—Frequent on dry shaded ground.

733. **Utricularia vulgaris americana** Bray. Greater bladderwort.—In shallow water on Sand Point and North Island.

734. **Utricularia intermedia** Hayne. Flat-leaved bladderwort.—On very wet and boggy ground at Sand Point. "Chandler Township." Davis.

735. **Utricularia cornuta** Michx. Horned bladderwort.—"In shallow pools left by the retreat of the lake on the beach just east of Port Austin. A small flowered stunted form of the species common at Bayport on the flats along the bay shore." Davis.

736. **Epifagus virginiana** (L.) Bart. Beech-drops.—Occasional under beech trees near Port Austin.

737. **Conopholis americana** (L. f.) Wallr.—Occasional at Sand Point, and abundant on north side of Stony Island.

738. **Catalpa bignonioides** Walt. Catalpa.—Occasionally planted in the villages as a street tree, but not thriving or spreading.

739. **Phryma leptostachya** L. Lopseed.—In moist open woods on Sand Point and North Island.

740. **Plantago major** L. Common plantain.—Common in the villages and about country dwellings.

741. **Plantago rugelii** Dcne. Rugel's plantain.—Frequent in villages, open woods, fields, and along roadsides.

742. **Plantago lanceolata** L. English plantain.—Frequent as a weed in villages, fields, along roadsides, and about country dwellings.

743. **Plantago aristata** Michx. Large-bracted plantain.—"Grounds of the Bayport Hotel under trees, sandy soil." Davis.

744. **Galium aparine** L. Cleavers. Goose grass.—Occasional on rich shaded ground. Very abundant on the Saginaw Bay islands.

745. **Galium pilosum** Ait. Hairy bedstraw.—Frequent on flat sandy ground and shady sand dunes.
746. **Galium circaezans** Michx. Wild liquorice.—Frequent in rich woods.
747. **Galium lanceolatum** Torr. Torrey's wild liquorice.—In dry open woods near Port Austin.
748. **Galium boreale** L. Northern bedstraw.—Borders of dry woods near Port Austin and Sebewaing.
749. **Galium trifidum** L. Small bedstraw.—Frequent on very wet and boggy ground.
750. **Galium tinctorium** L. Stiff marsh bedstraw.—Frequent on marshy ground and in damp shaded places.
751. **Galium asprellum** Michx. Rough bedstraw.—Common in damp thickets.
752. **Galium triflorum** Michx. Sweet-scented bedstraw.—Very common in rich dry woods.
753. **Mitchella repens** L. Partridge berry.—Common in dry shaded places.
754. **Cephalanthus occidentalis** L. Buttonbush.—Frequent along streams, about small ponds, and in very wet swampy places.
755. **Diervilla lonicera** Mill. Bush honeysuckle.—Frequent on dry open or shaded ground.
756. **Lonicera canadensis** Marsh. American fly honeysuckle.—Frequent in rich open woods.
757. **Lonicera oblongifolia** (Goldie) Hook. Swamp fly honeysuckle.—In very wet marshy places at Sand Point and west of Caseville.
758. **Lonicera hirsuta** Eat. Hairy honeysuckle.—"Charity Islands." Winchell's catalog.
759. **Lonicera glaucescens** Rydb. Douglas honeysuckle.—Frequent on sandy ground throughout the sand region.
760. **Lonicera dioica** L. Glaucous honeysuckle.—On Stony Island and Charity Island. Apparently infrequent.
761. **Symphoricarpos racemosa** Michx. Snowberry.—In open woods east of Port Austin and not far from the lake shore.
762. **Linnaea borealis americana** (Forbes) Rehder. Twin-flower.—Frequent on dry shaded ground.
763. **Triosteum aurantiacum** Bicknell. Scarlet-fruited horse gentian.—In open damp woods near Port Austin and Sebewaing.
764. **Viburnum opulus americanum** (Mill.) Ait. Cranberry-tree.—Borders of rich woods west of Caseville and near Port Austin.
765. **Viburnum acerifolium** L. Dockmackie. Arrow-wood.—Fre-

quent in open woods, Sand Point, Port Austin, and near Rush Lake.

766. **Viburnum pubescens** (Ait.) Pursh. Downy arrow-wood.—On dry shaded ground at Sand Point and near Rush Lake.

767. **Viburnum lentago** L. Nannyberry; sheepberry.—Frequent in rich woods. Also on the islands.

768. **Sambucus canadensis** L. Common elder.—Common on rich open ground.

769. **Sambucus racemosa** L. Red-berried elder.—Frequent in damp woods and thickets.

770. **Dipsacus sylvestris** Huds. Wild teasel.—Frequent along roadside below Grindstone City. Not noticed elsewhere.

771. **Sicyos angulatus** L. One-seeded bur cucumber.—In waste places at Caseville and Port Austin.

772. **Echinocystis lobata** (Michx.) T. & G. Wild balsam apple.—On damp sand at the extreme west end of Sand Point, appearing as an escape.

773. **Campanula americana** L. Tall bellflower.—On shaded rich ground near Port Austin. Apparently infrequent.

774. **Campanula rotundifolia** L. Harebell; bluebell.—Frequent along and near the lake shore, on flat sandy ground and sand dunes.

775. **Campanula aparinoides** Pursh. Marsh bellflower.—Frequent in wet grassy places.

776. **Lobelia cardinalis** L. Cardinal flower.—Frequent on low open and often shaded ground.

777. **Lobelia siphilitica** L. Great lobelia.—On low damp ground near Port Austin and Rush Lake.

778. **Lobelia spicata** Lam. Pale spiked lobelia.—Frequent on prairie-like ground. Also on islands.

779. **Lobelia kalmii** L. Brook lobelia.—Frequent in wet places along creeks, and around small ponds. Occasional on damp sand.

780. **Lobelia inflata** L. Indian tobacco.—Occasional on dry open ground below Grindstone City.

781. **Eupatorium purpureum** L. Joe-pye weed.—Occasional in damp places on borders of woods.

782. **Eupatorium purpureum maculatum** (L.) Darl. Spotted joe-pye weed.—Frequent in wet marshy places.

783. **Eupatorium perfoliatum** L. Thoroughwort; boneset.—Very common on low marshy ground.

784. **Eupatorium urticaefolium** Reichard. White snakeroot.—Occasional in rich damp woods.

785. **Liatris cylindracea** Michx. Cylindric blazing star.—Occasional on flat sandy ground and shaded sand dunes.

786. **Liatris spicata** (L.) Willd. Dense button-snakeroot.—On wet marshy ground west of Caseville and near Bayport.
787. **Solidago caesia** L. Wreath golden-rod.—Common on rich shaded ground.
788. **Solidago caesia axillaris** (Pursh) Gray. Wreath golden-rod.—Frequent in damp woods.
789. **Solidago latifolia** L. Broad-leaved golden-rod.—Common in rich woods.
790. **Solidago hispida** Muhl. Hairy golden-rod.—Frequent on flat sandy ground and shaded sand dunes.
791. **Solidago uliginosa** Nutt. Bog golden-rod.—On wet marshy ground near Rush Lake. Apparently infrequent.
792. **Solidago juncea** Ait. Early golden-rod.—Common on dry sandy ground. Occasional on shaded sand dunes.
793. **Solidago neglecta** T. & G. Swamp golden-rod.—Occasional in very wet places at Sand Point and near Rush Lake.
794. **Solidago rugosa** Mill. Wrinkle-leaved golden-rod.—Often abundant on flat sandy ground, occasional on shaded sand dunes.
795. **Solidago nemoralis** Ait. Field golden-rod.—Occasional on shaded sand dunes and flat sandy ground.
796. **Solidago canadensis** L. Canada golden-rod.—Common on borders of woods, thickets and fields.
797. **Solidago serotina** Ait. Late golden-rod.—Frequent on rich open ground.
798. **Solidago serotina gigantea** (Ait.) Bray. Late golden-rod.—Occasional on low ground.
799. **Solidago ohioensis** Riddell. Ohio golden-rod.—"Marsh near Bayport." Davis.
800. **Solidago graminifolia** (L.) Salisb. Bushy golden-rod.—Very common in moist open ground.
801. **Aster macrophyllus** L. Large-leaved aster.—Very common in dry open woods and thickets.
802. **Aster novae-angliae** L. New England aster.—Occasional on moist ground, but nowhere abundant, at Caseville, Bayport, Port Austin, Sebewaing, North Island and near Rush Lake.
803. **Aster azureus** Lindl. Sky-blue aster.—Occasional on flat sandy ground near Rush Lake and Bayport.
804. **Aster cordifolius** L. Common blue wood aster.—Frequent in woods and thickets.
805. **Aster laevis** L. Smooth aster.—Common on flat sandy ground and on shaded sand dunes.
806. **Aster polyphyllus** Willd. Faxon's aster.—Occasional at Sand

Point, on damp sand near the lake shore. Apparently infrequent.

807. **Aster multiflorus** Ait. Dense-flowered aster.—On dry open ground east of Port Austin and near Sebewaing.

808. **Aster vimineus** Lam. Small white aster.—Abundant near Huron on roadsides and borders of fields. Not noticed elsewhere.

809. **Aster lateriflorus** (L.) Britton. Calico aster.—Common in fields and along roadsides below Grindstone City.

810. **Aster tradescanti** L. Tradescant's aster.—Common on low wet ground.

811. **Aster junceus** Ait. Rush aster.—On very wet marshy ground near Rush Lake. "Bog on North Charity Island." Davis.

812. **Aster puniceus** L. Red-stalk aster.—Common on wet open ground and in damp open woods.

813. **Aster umbellatus** Mill. Tall flat-top white aster.—Common in damp open woods and thickets.

814. **Aster angustus** (Lindl.) T. & G. Rayless aster.—Plentiful in the streets of Port Hope. An immigrant from the west.

815. **Erigeron pulchellus** Michx. Robin's plantain.—Occasional on open shaded ground at Sand Point, Caseville, and near Rush Lake.

816. **Erigeron philadelphicus** L. Philadelphia fleabane.—Common as a weed in villages and adjacent fields.

817. **Erigeron annuus** (L.) Pers. Sweet scabious.—Common as a weed in villages and adjacent fields.

818. **Erigeron ramosus** (Walt.) BSP. Daisy fleabane.—Usually on poor dry and sandy ground. Common as a weed in villages and adjacent fields.

819. **Erigeron canadensis** L. Horseweed.—A common weed in waste places and fields.

820. **Antennaria dioica** (L.) Gaert. Smaller cat-foot.—Common on dry and sandy ground at Sand Point and near Rush Lake. Usually in shade.

821. **Antennaria canadensis** Greene. Canadian cat's-foot.—Frequent on sandy ground at Sand Point.

822. **Antennaria fallax** Greene. Tall cat's-foot.—Frequent on shaded sandy ground at Sand Point.

823. **Anaphalis margaritacea** (L.) B. & H. Pearly everlasting.—Frequent on dry open or shaded ground.

824. **Gnaphalium polycephalum** Michx. Common everlasting.—Frequent on borders of woods and often abundant in adjacent fields.

825. **Gnaphalium decurrens** Ives. Clammy everlasting.—Occasional on open sandy ground, often with *Gnaphalium polycephalum*.

826. **Gnaphalium uliginosum** L. Low cudweed.—Frequent in dry ditches, low ground, and along roadsides. Often abundant as a weed in cultivated fields.

827. **Inula helenium** L. Elecampane.—Occasional along roadsides and in pastures.

828. **Silphium terebinthinaceum** Jacq. Prairie dock.—Common and in many places abundant on prairie-like ground between Bayport and Sebewaing, often invading cultivated fields and becoming a troublesome weed.

829. **Ambrosia trifida** L. Great ragweed.—As a weed in waste places at Port Austin.

830. **Ambrosia artemisiaefolia** L. Ragweed.—Common as a weed in villages and adjacent fields.

831. **Xanthium canadense** Mill. American cocklebur.—Occasional in moist open or shaded places.

832. **Xanthium echinatum** Murr. Beach clotbur.—Occasional on or near the lake shore; more frequent in the streets of the villages.

833. **Heliopsis helianthoides** (L.) Sweet. Ox-eye; false sunflower. —Occasional on banks of small streams and in damp places below Grindstone City.

834. **Rudbeckia hirta** L. Yellow daisy; black-eyed-susan.—Frequent on light sandy ground and occasional on shaded sand dunes, but nowhere abundant.

835. **Rudbeckia laciniata** L. Tall cone-flower.—The cultivated form known as "golden glow." In low damp ground below Grindstone City.

836. **Helianthus annuus** L. Common sunflower.—Noticed as an occasional escape in the villages.

837. **Helianthus giganteus** L. Tall sunflower.—Occasional in damp open ground. Not abundant.

838. **Helianthus divaricatus** L. Woodland sunflower.—Common in dry open woods, on flat sandy land and on shaded sand dunes.

839. **Helianthus strumosus** L. Pale-leaved wood sunflower.—In open dry woods on Charity Island and near Port Austin. Apparently infrequent.

840. **Helianthus tracheliifolius** Mill. Throatwort sunflower.—In dry ground north of Rush Lake. Apparently rare.

841. **Helianthus tuberosus** L. Jerusalem artichoke.—Observed only in cultivation.

842. **Bidens frondosa** L. Beggar-ticks.—Common on damp ground and as a weed in villages and adjacent fields.

843. **Bidens comosa** (Gray) Wiegand. Leafy-bracted tickseed.—Noticed in damp rich ground below Grindstone City and from there to White Rock. Probably frequent in rich ground throughout the sand region.

844. **Bidens connata** Muhl. Swamp beggar-ticks.—In swampy places, ditches, and on the borders of damp cultivated fields, from Grindstone City to White Rock. Probably common throughout Huron County.

845. **Bidens cernua** L. Stick-tight; small bur-marigold.—Frequent in open wet places.

846. **Bidens laevis** (L.) BSP. Larger bur-marigold.—Occasional in wet and swampy places along the lake shore, from Grindstone City to White Rock. Probably common throughout Huron County.

847. **Bidens trichosperma** (Mich.) Britton. Tickseed sunflower.—In wet swampy places at Sand Point and near Rush Lake.

848. **Bidens trichosperma tenuiloba** (Gray) Britton. Tickseed sunflower.—Occasional on swampy ground about Rush Lake.

849. **Helenium autumnale** L. Sneezeweed.—Occasional on damp ground from Grindstone City to White Rock.

850. **Achillea millefolium** L. Common yarrow.—A common weed along roadsides, in villages and adjacent fields.

851. **Anthemis cotula** L. Mayweed.—Common in villages and about country dwellings.

852. **Chrysanthemum leucanthemum pinnatifidum** Lecoq. & Lamotte. Ox-eye daisy; marguerite.—A few specimens noticed on the north side of Stony Island and near Port Austin. Not noticed as a weed in the cultivated fields adjacent to the sand region.

853. **Tanacetum vulgare** L. Common tansy.—Frequent as an escape in villages and about country dwellings.

854. **Artemisia caudata** Michx. Tall wormwood.—Common on sand along the lake shore and seldom far away from the lake.

855. **Artemisia vulgaris** L. Common mugwort.—On North Island near an old stable.

856. **Artemisia stelleriana** Bess. Beach wormwood; dusty miller; old woman.—Often cultivated. More than ten years ago Davis noted and reported this as an escape from cultivation to sandy ground, saying: "This plant is well established in the sand of a roadside dune between Port Austin and Port Crescent where it covers a large space. It is also abundant

in the barren sand near Huron City, and a large tuft of the plant grows in the sand just back of the storm wave line near the old Carrington Salt Blocks at Port Austin. Prof. Wheeler of the agricultural college informs the writer that it has not been previously reported as growing wild in the state." In 1908 and 1909 it was noticed as a common and permanent escape covering large areas of sandy ground about country dwellings and in all the villages of the sand region. Also found in sand at Port Huron, Michigan, and near Sarnia, Lambton County, Ontario.

857. **Artemisia biennis** Willd. Biennial wormwood.—Occasional about villages and fisheries, and on Stony Island.

858. **Artemisia absinthium** L. Wormwood.—"Roadside near Port Austin." Davis.

859. **Erechtites hieracifolia** (L.) Raf. Fireweed.—Occasional on damp ground and in damp open woods.

860. **Cacalia tuberosa** Nutt. Tuberous Indian plantain.—Frequent on prairie-like ground between Bayport and Sebewaing.

861. **Senecio aureus** L. Golden ragwort.—Occasional in moist places below Grindstone City.

862. **Senecio balsamitae** Muhl. Balsam groundsel.—On poor sandy ground on Stony Island and west of Caseville.

863. **Arctium minus** Bernh. Common burdock.—Common everywhere on dry or damp ground.

864. **Cirsium lanceolatum** (L.) Hill. Common thistle.—Occasional about country dwellings, along roadsides, and in pastures.

865. **Cirsium pitcheri** (Torr.) T. & G. Pitcher's thistle.—Frequent and often plentiful on drifting sand along the lake shore. "Not seen back of the crest of the first dune line." Davis.

866. **Cirsium muticum** Michx. Swamp thistle.—On damp marshy ground near Port Austin, Bayport and Sebewaing.

867. **Cirsium arvense** (L.) Scop. Canada thistle.—Not often on sand dunes, occasional in villages, more frequent on roadsides and in adjacent cultivated fields.

868. **Cichorium intybus** L. Common chicory.—Occasional in the villages and about country dwellings.

869. **Tragopogon porrifolius** L. Oyster-plant.—Noticed as an escape near Port Austin and Sebewaing.

870. **Taraxacum officinale** Weber.—Infrequent on sand dunes, more common about country dwellings, in villages and cultivated fields.

871. **Sonchus arvensis** L. Field sow thistle.—Noticed at Caseville and along the railroad at Port Hope.

872. **Sonchus oleraceus** L. Common sow thistle.—Noticed as a weed in fields, gardens, and waste places.

873. **Sonchus asper** (L.) Hill. Spiny-leaved sow thistle.—Frequent as a weed in cultivated grounds.

874. **Lactuca scariola** L. Prickly lettuce.—Along the railroad between Bayport and Sebewaing. Rare.

875. **Lactuca scariola integrata** Gren. & Godr. Prickly lettuce.—Frequent about country dwellings, along railroads, and in villages. The prevailing form.

876. **Lactuca canadensis** L. Wild lettuce.—Borders of woods, thickets, and on damp ground. Frequent.

877. **Lactuca hirsuta** Muhl. Hairy wood lettuce.—On dry open ground on Sand Point, Stony Island and near Rush Lake.

878. **Lactuca spicata** (Lam.) Hitchc. Tall blue lettuce.—Frequent on damp ground and in damp open woods.

879. **Prenanthes racemosa** Michx. Glaucous white lettuce.—In wet marshy places at Sand Point and near Rush Lake.

880. **Prenanthes alba** L. White lettuce.—In rich open woods at Sand Point.

881. **Prenanthes altissima** L. Tall white lettuce.—In rich open woods at Sand Point, Bayport and Sebewaing.

882. **Hieracium venosum** L. Rattlesnake-weed.—Frequent on poor sandy ground; occasional on shaded sand dunes.

883. **Hieracium scabrum** Michx. Rough hawkweed.—Occasional in sandy ground at Sand Point.

884. **Hieracium gronovii** L. Gronovius' hawkweed.—On sandy ground on Charity Island.

885. **Hieracium canadense** Michx. Canada hawkweed.—On poor sandy ground near Bayport and Sebewaing.

886. **Hieracium umbellatum** L. Narrow-leaved hawkweed.—Frequent on sandy shaded ground throughout the sand region.

MOLLUSCA.

BY H. BURRINGTON BAKER.

INTRODUCTION.

The work that has furnished the basis of this report was done by the writer while attached to the biological expedition sent out by the Michigan Geological and Biological Survey during the summer of 1908. The party made its headquarters on Sand Point, Huron County, but made trips to a number of other places in the vicinity. Thus the writer worked on Sand Point from June 14 to July 12, on Stony and North Islands from July 12 to 20, in the vicinity of Caseville and along the Pigeon River from July 20 to 28, and in the vicinity of Rush Lake (this includes the region between Hat and Oak Points) from July 28 to August 24.

In pursuing this work, the writer has become indebted to a number of persons. He wishes to thank all of the members of the party, but especially Dr. Ruthven, for kind assistance in collecting and in locating favorable places to study. He is also under considerable obligation to Mr. C. K. Dodge for the identification of many of the plants of the various habitats. Some of the identifications of the shells were made

in the field, others from the specimens after the party had returned to Ann Arbor. In this connection it should be said that the majority of the identifications were made or verified by Mr. Bryant Walker, with the exception of the Sphaeridae, which were sent to Dr. V. Sterki for examination.

GENERAL DISCUSSION.

Physiography.

The region studied (see map) lies in about 83° 15′ longitude and 44° latitude, and is about 600 feet above sea-level. Sand Point is four miles long, about one and one-half miles wide at the base, and runs out almost due west into Saginaw bay, tapering towards the point. North Island lies about two miles south and one mile west of the end of Sand Point and is approximately one mile long from east to west and one-fourth of a mile wide; Stony Island is somewhat over a mile still farther south and west, is tadpole-shaped, and measures about one and one-fourth miles from north to south, by one mile wide in the widest portion. Caseville is situated on the shore of the Bay, near the mouth of the Pigeon River, about three miles north and east of the base of Sand Point; the portion of the Pigeon River studied is that running east from Caseville. Rush Lake is about three miles long from the north-east to the south-west corner and one mile wide, and lies about four miles east and one mile north of Caseville. The portion of the Pinnebog River investigated is about three miles due east of Rush Lake.

The shore of the Bay runs almost due north from Caseville for about two miles to Oak Point, where it turns almost straight east so that Rush Lake is but little over a mile from the shore of the Bay and lies immediately behind the innermost sand dune. This strip of sand dunes between Oak Point and Hat Point is about nine miles long by one wide. It is broken along the Bay in three places by outcroppings of rocks, viz., at Hat, Little Oak, and Oak Points.

Sand Dunes.—The sand dunes were most thoroly studied on Sand Point, but the strip along the coast between Oak and Hat Points was also examined. The underlying rock in the latter region is Marshall sandstone, with the exception of the western end; there and at Sand Point the sand is underlaid by rocks of the Michigan or Lower Grand Rapids Series, hydraulic limestones, shales, gypsum, etc. Thruout this entire region the rock is but a short distance below the surface so that it outcrops in several places as mentioned above. (A C. Lane* states that it also should underlie Sand Point.)

The shallow water off Little Oak and Hat Points most likely repre-

*Geol. Surv. of Mich., Vol. VII, part 2, page 106.

sents the primitive beach habitats of this region. At Hat Point, the sandstone outcrops in almost horizontal layers to form a small cliff about twenty feet high. For some distance off the Point the water deepens very gradually and the bottom is strewn with large and small irregular rock fragments broken from the shore by the waves. At Little Oak Point the conditions are similar except there is no cliff and the outcrop is smaller.

In most places the sand has been washed up over the rock outcrops and has covered them entirely, but at Hat Point the overhanging cliff still outcrops some distance in from shore and forms damp caves (habitat 27). In the former case, unprotected, sand beaches (habitat 5) are produced.

Two kinds of currents, the off-shore and the littoral, work on the exposed, sandy shores. The off-shore currents build points or sand hooks, while the littoral currents make barrier beaches parallel with the shore. The former are usually formed in partially protected places, the latter on the side from which the currents come. Behind these points and bars, the water is more nearly calm and the sand is not disturbed so that another habitat, that of the protected, sandy shores (habitat 7), is formed. This kind of a habitat is also found on the protected side of projections not built of sand.

The barrier beaches often become connected at both ends with the shore, forming shallow lagoons or sand pools (habitat 6). New beaches are built up farther out and the sand dunes are blown up around these lagoons, the larger of which become long, shallow lakes (habitat 9), or swamps (habitats 18, 19). In a similar manner the free ends of the sand spits produced by the off-shore currents swing in towards shore and form, at first partially land-locked coves (habitat 8), and finally lakes (habitat 10), which are usually deeper and more nearly circular than those produced by the barrier beaches. Swamps of a similar shape may also be produced in this manner, if the vegetation in the cove forms a deposit of muck fast enough to fill the cove before it becomes a lake.

The sand beaches along any of these places form another habitat (habitat 25), and the wind, blowing back the sand from these beaches, builds up rows of sand dunes (habitats 28, 29), with swamps (habitats 18, 19) or even long, shallow lakes (habitat 9), similar in shape to those formed from the sand pools, between them.

The vegetation in all of these lakes soon starts depositing material which converts them first into perennial (habitat 19), and then into annual swamps (habitat 18), and finally fills them entirely, forming alluvial flats (habitat 26). This filling in takes place mainly around the edge where the water is shallow, so that all except the very youngest lakes and swamps have an alluvial deposit partly or entirely surrounding them. These deposits may be reconverted into swamps artificially by the burning of the peat that composes them, or naturally by the formation of sand dams thru the agency of the wind.

North and Stony Islands.—When the water retired from the Algonquin level, North and Stony Islands appeared as rocky islands covered with a thin layer of clay or sand and the currents attacking them from the north-west soon laid bare these shores. On Stony Island, the Maxville limestone outcropped for some distance above water, but on North Island the outcropping along the north-west shore was mostly under water. The soil from the exposed portions of these islands and more sand from the shallow water off shore was carried about the ends of each of them and deposited in long bars which converged toward a point some distance southwest of each. A large amount of sand was also deposited between the bars around each of the islands, so that North Island came to have a long, submerged triangle of sand stretching southeast from it, while Stony Island acquired on the south two long converging ridges of sand above the water with a large swamp between them. A bar of sand along the south side of North Island makes the water very shallow for a considerable distance off shore; in fact, there is a long sand bar, reaching from the eastern shore of that island to a sand point on the eastern shore of Stony Island, along which the water is so shallow that it is grown up with bulrushes along the entire length. A similar strip lies between Stony and Katechay Islands.

There is a low ridge of alluvial soil all of the way around North Island while the central portion is low and swampy. Only the northern portion of Stony Island corresponds to North Island; the remainder is built up of drifted sand, as described above. This northern alluvial portion may be divided into a northern dry ridge and a southern swampy strip corresponding to the similar divisions on North Island. A sand beach, about two rods wide, along the southern side of the latter island, together with the shallow water off shore, is all that represents the southern two-thirds of Stony Island.

Caseville and Pigeon River.—The region around Caseville is a young coastal plain sloping gently towards the Bay, the soil of which is a calciferous, gravelly clay, with streaks of sand and even boulders in it, forming low ridges in some places, and with high dunes between it and the Bay.

Thru this plain cuts the Pigeon River, a small stream which is very sluggish until it gets within two miles of Saginaw Bay, where it becomes swifter, but becomes sluggish again near the town where it cuts thru the sand dunes to the Bay. On account of the very gentle slope of the land, the river has already cut its valley about as deep as possible and is now widening it by meandering greatly, so that quite extensive creek flats have been and are being formed.

Rush Lake.—Rush Lake occupies a semi-circular depression in the clay plain immediately behind the sand dune area. On the northern and northwestern sides of the lake is the innermost ridge of sand dunes, while on the southern and southwestern sides is a portion of the clay plain, similar to but not so well drained as around Caseville, where the land is somewhat higher and slopes toward the Pigeon River.

Geographic Relations.

Aquatic Forms.—The portion of Huron County under consideration was first uncovered after the Wisconsin stage of glaciation at about the time when Lake Warren combined into one lake what had been Lake Saginaw, a lake of the Saginaw Bay basin, and Lake Whittlesey, a lake of the Huron-Erie basin. At, and previous to, this time, the Great Lakes had been draining into the Mississippi valley, and it was not until considerably later that they began to empty into the Atlantic Ocean. The Saginaw-Grand River drainage led directly past here, and this and others following nearly the same route were the main drainage channels, altho Lake Maumee, one of the progenitors of Lake Whittlesey, early in its life history drained thru the Fort Wayne outlet into the Ohio.*

Thus the aquatic habitats in Huron County are at present in connection with the northern and southeastern portions of the state, and have been connected with the western portion. It is then not surprising to find that the aquatic shells of Huron County are mostly similar to those of all parts of the lower peninsula. The strongest affinities appear to be with the northern and southeastern portions; for example, *Lampsilis multiradiata*, which is found only in the southeastern portion of the state, inhabits the Pigeon River, while *Sphaerium flavum*, more typical of the northern portion, is common in Rush Lake. On the other hand, no shells distinctive of the western portion appear to occur in the region studied.†

Terrestrial Forms.—The land molluscan fauna of this region has rather distinct northern affinities. Altho those collected with the exception of six forms, are those of general distribution at least in the lower peninsula, the smaller shells which are most characteristic of the northern regions were more prevalent here. Of the six exceptions, four (*Vitrea binneyana*, *Zonitoides milium*, *Pyramidula cronkhitei catskillensis*, and *Cochlicopa lubrica morseana*) are northern forms.

*A. C. Lane, Geol. Rept. Huron County, Geol. Surv. Mich., Vol. VII, Pt. II, Chap. IV.
†Walker, Bryant. The Distribution of the Unionidae in Michigan. Detroit, Mich., 1898.

while two (*Strobilops virgo* and *Bifidaria corticaria*) are typical of the northern and middle counties.

This northern element in the fauna may be due to the fact that the peculiar shape and location of this county make it a sort of a pocket which prevented the shells entering it after the retreat of the glaciers from migrating farther northward, but this cannot be positively ascertained until more is known of the interior of the county. Only the region among and near the sand dunes was studied, and these conditions and those of the adjacent swamps are often favorable to northern faunas and thus may have formed a region of preservation of these forms.*

HABITAT STUDY.

Aquatic Habitats.

Habitats of Saginaw Bay.—1. Deep littoral, 16-24 feet. This is just such a habitat as was found by Hankinson at corresponding depths in Walnut Lake,† but in this case the habitat does not extend so far in towards shore, as the instability of the sand in shallower water effectually prevents all higher plant and most animal life. The only data in regard to this habitat was obtained from the evidences of life which were brought up on the line of fish nets off the camp on Sand Point, when these were taken out for the summer. It was found at this time that the sandy bottom at these depths has a scanty vegetation, consisting, in the main, of *Potamogeton.* This belt of vegetation begins in about sixteen feet of water, is most dense in about nineteen feet, and is diminishing at the end of the net in about twenty-four feet of water, one and three-quarters miles off shore. Altho this is the only locality actually studied, it was deduced from dead shells along the shore that this kind of a habitat stretches all the way along the north shore of Sand Point.

In this habitat were obtained a few specimens of *Goniobasis livescens,* one of *Campeloma decisum,* one of *C. integrum,* seven of *C. rufum,* a single light-colored specimen of *Planorbis bicarinatus,* two specimens of a variety of *Physa ancillaria* (one of which was very much distorted), and a specimen of the lake form of *Lampsilis luteola.* Two other species, *Planorbis truncatus* and *Lymnaea catascopium,* which had been washed up on the beach were referred to this habitat, as there was apparently no other habitat in the vicinity from which they could have come.

2. *Shallow littoral, rocky, unprotected.* In places, especially at the ends of points facing the north and on the north sides of islands, the sand is washed away, or perhaps has never been deposited, so that the

*Adams, C. C. Post Glacial Origin and Migration of Life. Jour. Geog., Vol. I, 1902, p. 310.
† State Geol. Surv. of Mich. Ann. Rept. 1907.

bare rock is exposed. The farther north one goes, the larger are the outcroppings, until Port Austin is reached, where the rock predominates. This is probably due to the fact that the main currents come down along the shore from the north. The islands, however, being out some distance from the protection of the shore, have as much rock exposed as points far to the north of them. The rock forming the points to the north is Marshall sandstone; that forming the outcrops on the two islands studied, North and Stony Islands, is Maxville limestone. (Pl. XIV).

This firm substratum of rock gives a secure footing to plants, so that there is often a narrow belt of *Scirpus americanus* growing in the crevices along the edge of the water, even in places where the exposure to the wave action must be very severe. The rocks under water are covered with a thin layer of gelatinous, diatomaceous material and marl, while crevices, etc., support tufts of *Cladophora* and *Chara*. These plants can, of course, obtain no such footing on the unprotected, sandy stretches, as the sand there is constantly shifting.

This habitat was preeminently one of univalve molluscs with large feet, as these found here a firm substratum to which they could cling. *Physa ancillaria magnalacustris*, *Lymnaea emarginata ontarioensis*, and *Goniobasis livescens* were present in very large numbers all along the rocky shores of North and Stony Islands; *Goniobasis livescens* and *Physa ancillaria* occurred on the rocks off Oak and Hat Point. In addition, a few specimens of *Physa heterostrapha* were found off the north shore of North Island, and a thin form of *Physa ancillaria magnalacustris* on an artificial rock breakwater off Sand Point.

3. *Rock pools.* On the northwest shore of Stony Island, the strata of rock are slightly tilted up toward the lake so that the beach is formed of successive terraced outcroppings. When these terraces outcrop near the water's edge, shallow pools are formed behind them; some of which are connected with the Bay all of the time while others are filled only by the waves. The outcropping ledges of rock protect the pools thus formed from the direct action of the waves, and along these ridges there are often dwarfed willows and belts of *Scirpus americanus* which also help to protect them. A rank growth of *Cladophora* is characteristic of these spots, and the rocks are covered with a thin layer of gelatinous material, probably full of diatoms. These pools form a habitat rich in food for molluscs, but with rather adverse physical conditions, despite the protection already referred to.

Goniobasis livescens, *Physa ancillaria magnalacustris*, and *Lymnaea emarginata ontarioensis* were found in these places in considerable abundance; specimens of *Lymnaea humilis* and a light-colored, little-malleated form of *L. palustris*, were also collected, but in lesser numbers.

4. *Shallow littoral, rocky, protected.* East of the unprotected northwest shore of Stony Island, described under habitat two, and between that strip and the sandy coast along the north and east sides of the island, there is a small stretch of rocky shore protected by a rocky point jutting out to the east of it, and by the shallowness of the water for some distance off shore. Here, the water plants, obtaining a strong foothold, have formed a thick layer of peaty muck over a small area. At present, several species of water plants that flourish here form a small swamp, much like those of the small inland lakes on Sand Point. *Scirpus americanus, S. validus, Pontederia cordata* and *Typha latifolia* predominate; *Carex filiformis, Sagittaria latifolia* and *Spartina cynosuroides* are also present, but in lesser numbers.

On driftwood and decaying plant material in this swamp, variations of *Lymnaea reflexa* were quite abundant, together with lesser numbers of *Planorbis trivolvis, P. exacuous* and *P. hirsutus.*

5. *Shallow littoral, sandy, unprotected.* This habitat includes all sandy beaches not protected from the direct action of the waves by islands, sandbars, etc. Of course no distinct boundary line can be drawn between this habitat and the one that includes the protected beaches, as they intergrade around the edges of the barriers. Usually there is no vegetation in the shallow water along the shore in this habitat, but in places where the shoals extend some distance out from shore there is a narrow belt of *Scirpus americanus* along the edge of the water. Being so unprotected, this habitat is one of extremely variable physical conditions; also, the substratum being sand, every storm materially affects the whole shore-line and the depths of the water thruout the area. This drifting makes a secure footing for molluscs impossible, so that most of the forms in this habitat are quite large, burrowing ones. (Pls. I a, II b.)

Under this head were included all of the beaches from Caseville as far west as Twin Bars (near the end of Sand Point), the shoals northwest of them, and the beaches from about one mile west of Little Oak Point to Hat Point, excepting those on the points themselves, where there are rocky headlands.

All of the shells of this habitat are bivalves, with the exception of a few which were found on the rocks in artificial breakwaters, etc., and which have been also included among the shells of the rocky littoral habitats, 2, from which they have probably been brought by the waves and currents. This is probably due to the fact that the univalve molluscs are unable to cling to the drifting sand, which would also be liable to bury them on account of their small size. The univalve shells above mentioned were a thin form of *Physa ancillaria magnalacustris,* which was obtained in considerable numbers from an artificial breakwater on Sand Point, a single specimen of *Goniobasis livescens* which was found on a board that had probably been washed from some other habitat, and specimens of *Goniobasis livescens* and *Physa ancillaria* obtained from the stone piers of a dock near Little Oak Point. The small, lake forms of *Lampsilis luteola* and *L. ventricosa* were very abundant all along the coast, and a similar form of *L. nasuta* were also found, but in lesser numbers; all of these were most abundant in places where the water was shallow for some considerable distance off shore, as at Twin Bars. A few specimens of *Unio gibbosus* were obtained from Sand Point and Stony Island, and single individuals of the small, lake forms of *Anodonta grandis footiana* and *Anodontoides ferussacianus subcylindraceus*, and specimens of *Lampsilis recta sageri* and *Alasmidonta calceola* were also collected, the first three from Sand Point, the last from Little Oak Point.

6. *Sand pools.* As remarked under the description of habitat two, most of the currents in this region come from the north; that is, their general trend is southwest. This causes the sand beaches to be worn away, more or less, to the east of points jutting north, while wide beaches are deposited to the west of them. Also, the beaches to the east of these points are piled up by the action of the littoral currents during storms, etc., so that they are relatively steep, while the sheltered beaches on the western sides are low. On such beaches as the latter, where the water is shallow for some distance off shore, the sand is piled up slightly along the shore, while inside of this low, rounded ridge there is often a more or less temporary lagoon. This relationship is caused, as is shown at Oak Point, by a barrier beach, parallel to the shore, being formed in shallow water by the drifting and pounding up of the sand, especially during the high water produced by heavy storms, which shoal in time landlocks the small lagoon left behind it.

Sand pools are also formed by the currents blocking up the mouths of small, intermittent brooks, which have washed out considerable depressions in the beach during heavy rains. Pools formed in both ways have a similar fauna and apparently constitute but one habitat. The water in these pools is usually strongly impregnated with iron obtained probably from repeated evaporations.

The flora of these pools consisted, in the main, of such sedges as *Juncus balticus*; one pool had in addition several shoots of *Sparganium eurycarpum* in it. The molluscan fauna of these localities consisted mostly of *Lymnaea palustris* and a small form of *L. obrussa*, the former being very abundant. *Succinea retusa* and the form *major* of *S. avara vermeta* occurred in and around several of them.

These pools shift considerably with the drifting of the sand. The larger ones may form the shallow, sand dune lakes and swamps, as will be described under those habitats.

7. *Shallow littoral, sandy, protected.* Along protected portions of sandy shoals, *Scirpus americanus* has formed marshes of considerable extent. These marshes are protected from the direct force of the waves and currents in various ways. Off some, a point or sandbar has been formed as described under habitat six. These marshes, when small, are often the first stage in the production of the sand pools (or when larger, of the sand dune lakes to be described under habitat nine). Also, the whole south shore of Sand Point and of North Island, and the sandy stretch on Stony Island which is protected by the latter, all have a belt of *Scirpus americanus* along the water's edge and form extensive marshes. Those on Sand Point, east of "The Bayou", and those on Stony Island are, however, rather unfavorable habitats for molluscan life as they are not well enough protected, the former being unprotected from the south (Wild Fowl Bay being too wide for the opposite shore to afford such protection) and the latter from the northwest. Those on North Island are, on the other hand, very favorable, as the water deepens slowly off shore and the entire south side forms a shallow bay; here the pickerel weed is intermingled with the common sedge, *Scirpus americanus.* In all of these localities, the molluscs congregate in greatest numbers where the water is from six to twelve inches deep, and where there is a belt of dead and decaying sedges floating along the shore.

Better protected marshes, as those along the east end of Wild Fowl Bay, and the similar one in the marshy cut-off between the lower part of the Pigeon River and Saginaw Bay, have a marly bottom and a sparse growth of *Chara.* These are especially well protected by their sheltered position to the east of large points, by the shallowness of the water and by the outlying barrier beaches characteristic of such positions. In all of these places the molluscs are to be found in large numbers all over the bottom, especially in very shallow places, where the spires of such large shells as *Lymnaea stagnalis appressa* often project above the surface of the water. In these places, the water, being so shallow, is quite warm.

Lymnaea reflexa was the most abundant shell in these localities. It varied considerably; the variety *walkeri* and many other variations were found.* *Lymnaea obrussa, L. stagnalis appressa,* and *L. humilis, Planorbis deflectus, P. trivolvis,* and *P. exacuous, Physa heterostrapha* and *P. gyrina* were also obtained, but in lesser numbers, together with a few juvenile specimens of *Planorbis truncatus,* and the lake forms of *Strophitus edentulus, Lampsilis luteola,* and *L. ventricosa.* In addition,

*Baker, H. Burrington. Variations in Lymnaea reflexa Say, from Huron County. 12th Ann. Rept. Mich. Acad. Sci., 1910, pp. 60-63.

Succinea retusa, *S. avara*, and *Agriolimax campestris* were found out on the decaying sedges.

8. *Cove, almost cut off from Bay.* On the south side of Sand Point and about a mile from its base, there is a large cove that is separated from Wild Fowl Bay, except for about ten rods, by a long sand spit which runs out from the shore in a southeasterly direction. This spit has been formed, apparently, by the sand being washed down along the coast by the off-shore currents, and deposited to form a small point, which has increased with continued deposition, so that a long sand strip has been built up. To all appearances, this process is still going on as there is a shoal for some distance out from the end of the spit, and the end itself is a low sandbar, elevated but slightly above the water. Probably in time there will be formed a lake, like the several that are along this side of Sand Point, which were apparently formed in a similar manner. (Pl. XIII b.)

This cove (known locally as "The Bayou") is oval in shape and is quite large, being about three hundred yards long by one hundred wide; in places the water reaches a depth of six feet. *Scirpus americanus*, *Typha latifolia*, *Potamogeton natans*, the common white and yellow water-lilies (*Castalia odorata* and *Nymphaea advena*), bulrushes (*Scirpus validus*), and other water plants, gaining a footing here, have deposited a layer of soft, peaty muck, reaching, in places, a depth of four or five feet. Along the north and south shores, the bottom is more firm and sandy; here there is a zone of *Scirpus americanus* off shore, with a zone of *Scirpus validus* outside of that. The west and southwest shores are, however, very soft and mucky, the sedges having grown out for some distance from the shore, forming a floating marsh. There is a moderate-sized patch of *Typha latifolia* separating this soft portion from the firmer southern shore. The whole center of the cove is soft-bottomed and over large patches is almost covered with the flat, floating leaves of *Potamogeton natans* and the white and yellow water-lilies.

Planorbis trivolvis, *P. exacuous*, and *P. parvus* occurred thruout this habitat, but the remainder of the shells were more restricted. *Amnicola walkeri*, *A. limosa*, *Ancylus parallelus*, *Lymnaea humilis*, and *Physa heterostropha* were found only on the under side of lily-pads, etc., in places where the bottom was mucky. *Lymnaea reflexa* and an obese variation of that species, *Physa gyrina*, *P. sayii*, *Planorbis hirsutus*, *Lymnaea palustris*, and *L. obrussa*, on the other hand, were found only in localities where the bottom was hard and sandy, while *Musculium securis* was collected both from the latter place, and from among sedges where the bottom was very mucky.

Habitats of the Sand Dune Lakes.—9. *Shallow lakes, north side of Sand Point.* Near the end of Sand Point, just south of the outer dune on the north shore, there is a long, narrow lake, Long Lake, which is about nine hundred yards long by sixty wide, and is very shallow, nowhere reaching a depth of over three feet. This lake has apparently been formed in the same manner as the sand pools and marshes in partially protected places where the water is very shallow for some distance off shore, that is, by a barrier beach having been thrown up parallel to the beach during storms. Then, as the beach moved north, growing out in this same way, a sand dune would be blown up between the lake and the Bay, and the present relations would be established. The long narrow shape of the lake and its shallowness accord with this view; but these relations might also be explained by the presumption that the lake was formed by the drainage water collecting between parallel sand dunes. It seems probable, indeed, that both methods have contributed to the formation of this lake. (Pls. XII, XIII a.)

The lake has a firm, sandy bottom and has the characteristic zone of *Scirpus americanus* along the edge. The main portion of the lake has little vegetation besides this sedge and a few patches of the yellow water-lily (*Nymphaea advena*). The extreme east end, however, has a soft peaty bottom composed of decaying vegetation. (Pl. XII b.) Here the yellow water-lilies and a small sedge, probably *Carex filiformis*, almost hide the water. The water thruout the lake is quite strongly impregnated with iron.

A few specimens of *Planorbis trivolvis*, *P. exacuous*, and of a small form of *Musculium securis* were found on lily-pads and among sedges in the sandy, western portion of the lake. In the mucky-bottomed east end, the first species was found in much greater abundance on the under-side of lily-pads; and among and on sedges, about six inches from the bottom, the small form of *Musculium securis* was also collected in great abundance.

The eastern end of this lake is being filled in by the deposition of plant material, the western end by sand blown in from the dunes on both sides. The ultimate end of either process will be the destruction of the lake. The eastern end will probably become a peaty swamp, while the western end may become dominated by the aquatic vegetation as the lake becomes shallower and better protected by the surrounding growths, or it may be filled in by the sand alone.

10. *Deep lakes, south side of Sand Point.* A few rods in from shore, along the south side of Sand Point, are two lakes and several marshes where similar lakes have been. These two lakes are known locally as Mud and Orr Lakes. They are neither of them long, narrow lakes of small depth, as is that described under habitat nine, but are irregularly oblong in shape, are quite deep and have a soft, mucky bottom. These

lakes were apparently formed in the same manner as one is even now being formed at Turtle Bay (habitat 8).

These habitats are much richer in plant and animal life than the sand dune lakes along the north shore of the Point. Yellow and white water-lilies abound, and *Potamogetons* are also very numerous. The common rush (*Scirpus americanus*) is largely replaced by the bulrush (*Scirpus validus*) and cat-tails (*Typha latifolia*), the first named appearing to prefer sandy regions. The alders have deposited a layer of fallen leaves in the shallow places along the shore; these are the places that were most studied.

The most abundant shell in this habitat was *Planorbis campanulatus;* both the typical shell and a variation of it were obtained. *Planorbis exacuous, P. trivolvis,* and a form of *Segmentina crassilabris* were also found in considerable abundance.

All along this side of the Point are many large swamps and peaty bogs. These are apparently the beds of former lakes, which have been filled in by the encroachment of vegetation and are probably the final stage in the life history of lakes similar to Mud and Orr Lakes.

Habitats of Rush Lake.—Rush Lake is about three miles long by one wide and lies just behind the sand dunes farthest from Saginaw Bay. Its formation was probably due to a combination of the forces acting in the formation of the lakes on Sand Point; also, the lowering of Lake Huron, mentioned in the preliminary discussion, probably played a greater role in the production of this larger and older lake. It can not be included among the sand dune lakes, as it is not entirely surrounded by the sand dunes; its greater size and age also tend to place it in a class by itself, as does its fauna. (Pls. IX, X a.)

The greater portion of the lake has a soft, mucky bottom, but in some places there is a heavy deposit of marl which makes the bottom more firm. In other places, off, and to the west of, points running out from the northwest shore, the sand or gravel outcrops or has only a very thin covering of peat and marl. There are three such places—off Raymond's, Dune and Fourth Points.

In mucky-bottomed places, there are three more or less well-defined zones. Counting out from the shore these are: the sedge-marsh zone, the water-lily zone, and the pond-weed zone. Thruout the other portions of the lake, the sedge-marsh is broken thru, and then the three zones are: the zone of *Scirpus americanus*, the zone of *Scirpus validus* (the bulrush), and the mucky zone with a vegetation consisting of hornworts, *Potamogetons*, etc. Between the two last there is often a zone with no vegetation.

This lake is a good example of the encroachment of vegetation in a filling lake. Besides the sedge marsh, other water plants have built up islands all over the lake, varying in size from a few feet to several hundred yards across. The larger ones are covered with spruce, tamarack and a few white pine, with an undergrowth of sphagnum, pitcher plant, sundew, huckleberries and poison sumach. As the water in most places is not over a foot or two in depth, and nowhere is over four or five feet deep, while the peat deposit is in places over twenty feet deep and the tamarack belt around the lake attains a width of over a mile, Rush Lake is apparently in a late stage of its life history.

11. *Mucky bottom.* The bottom over the greater portion of this lake, as mentioned in the general discussion, is finely divided, peaty muck, so soft that it is almost impossible to distinguish, by feeling, the uppermost layers from the water over them. This layer of muck varies from a few inches to over twenty feet in depth, and is underlaid thruout the northern, western and most of the eastern portions with sand or gravel, and thruout most of the southern side by clay and, in a few places, with Marshall Sandstone. The water over most of the lake is very shallow but along the northern side there is a deeper channel, the bottom of which is also mucky. Beds of bur-weed (*Sparganium eurycarpum*), pickerel weed (*Pontederia cordata*), bulrush (*Scirpus validus*), wild celery (*Valisneria spiralis*), *Potamogeton natans*, *Najas*, and other water plants are forming islands, by the deposition of peat, all over the shallower portions of the lake, while the white and yellow water-lilies (*Castalia odorata* and *Nymphaea advena*) and *Carex filiformis* are filling in along the mucky shores. Also, along the deeper channel, there is an abundance of vegetation, consisting mainly of several species of *Potamogeton*.

On lily-pads, *Lymnaea stagnalis appressa*, *Planorbis trivolvis*, *Physa heterostrapha*, *Ancylus parallelus*, and *Amnicola limosa* were collected in considerable numbers. The first two species were also obtained from the roots of sedges, and on the bottom in shallow places. In lesser numbers, all of these species were present in the pond-weed zone, and, in addition, numerous specimens of *Anodonta marginata* and *A. grandis gigantea*, and a few individuals of *Lampsilis luteola*, were found partially buried in the soft muck, especially in places where there was little vegetation.

12. *Floating sedge-marshes.* Out from the shore of the lake, in almost all places where the bottom is mucky off shore, there runs out a belt of floating marsh, which in many places is twenty yards wide. The marsh is principally built up of *Carex filiformis;* there is, however, a narrow zone of a heavier sedge along the drier portions in-shore. Among the sedges and helping to form the marsh are large numbers of plants of the marsh fern (*Aspidium thelypteris*), the common blue flag (*Iris versicolor*), arrowhead (*Sagittaria latifolia*), *Asclepias incarnata*, alder

(*Alnus incana*), dwarf willows (*Salix* sp.), and, in wetter places, patches of the cat-tail flag (*Typha latifolia*), and the sweet flag (*Acorus calamus*). During the month of August, which was the time of the year the party was at Rush Lake, there is no water in most places along the marsh, but the ground is very wet and is overflowed every season. For this reason, both land and water snails were found in these places; however, in most places, the latter were aestivating. (Pl. VII a.)

In the drier portion of this sedge marsh, a single specimen of *Vertigo ovata* and many specimens of *Succinea retusa* were obtained under planks, etc., and considerable numbers of *Lymnaea palustris*, and two specimens of *Planorbis nautileus* were found aestivating. In the wetter portions, *Planorbis trivolvis*, *Lymnaea palustris* and the form *zebra*, and *Succinea retusa* were found in some abundance.

13. *Marly bottom.* One of the places where the bottom is covered with quite a firm deposit of marl was studied. This deposit is probably due to Chara as there is quite a thick growth of it here, and Davis has shown that this plant is a great producer of marl.* There is also, besides the *Chara*, a wide zone of *Scirpus americanus* along the water's edge and outside of that a scattered belt of *Scirpus validus*. The water deepens very gradually off shore which makes the zone of the first-named sedge especially wide.

In this habitat, out beyond the middle of the sedge zone, *Anodonta grandis gigantea* was very abundant. A few small specimens of *Lampsilis luteola* were also obtained.

14. *Raymond's Point.* This point is one of the few places in the lake where the sand on the bottom is not covered with a deposit of marly muck; here there is practically no peat present but the sand is somewhat intermixed with marl. The water is quite shallow for some distance off shore; the sand begins to become covered over with the peaty muck about forty yards out from the shore. Along the sandy beach and out into about two inches of water, *Dulichium arundinaceum* is the predominant plant. Beyond this for about ten yards is a zone of *Scirpus americanus*, and beyond that a narrow zone of *Scirpus validus*. Thruout the second zone, there is a sod formed of a small *Utricularia* that is almost buried in the sand; so much so that it is hardly noticeable from a boat.

In this habitat, in about six inches of water, *Pleurocera subulare intensum* and *Amnicola limosa* were very abundant. As the water becomes deeper farther out, first *Sphaerium flavum* and then *S. sulcatum* and a form of *Amnicola lustrica* appeared, while the first species soon began to diminish in numbers, until in about a foot and one-half of water, near the middle of the inner sedge zone, the *Sphaeridae* were

*Geol. Surv. Mich., Vol. VIII, Part III, Chap. V.

more numerous than the *Pleurocera*, and *Amnicola lustrica* had almost entirely supplanted *A. limosa*. Thruout these depths, the living and dead shells were present in such large numbers as to almost entirely cover the bottom. In about two feet of water, the *Sphaeridae* reached the climax of their abundance; in deeper water they diminished in numbers even faster than the *Pleurocera*, until in nearly four feet of water, some distance beyond the limits of the vegetation, both the *Sphaeridae* and the *Pleurocera* were rare, but were present in almost equal numbers, while *Amnicola lustrica* had about disappeared. Here, however, the *Pleurocera* apparently dropped out, leaving only the *Sphaeridae* in deeper water. *Planorbis parvus* was quite abundant from the shallow water out into the deep places, while *Anodonta grandis gigantea*, a form of *Lymnaea obrussa*, and *Valvata tricarinata simplex* were present in considerable numbers in water about a foot and a half deep.

15. *Dune Point.* This locality resembles the preceding, but there is a layer of peaty marl, not quite an inch thick, covering the sandy bottom; and in places where there are clumps of *Chara* this layer is much thicker, reaching a depth of over a foot. Along the shore there is a zone of *Scirpus americanus* only about two yards wide; the bottom in this zone is mucky, and is carpeted with decaying leaves from the trees along the shore. East of this habitat the layer of mucky deposit becomes much deeper, until it reaches a depth of two or three feet. (Pl. X a.)

Off this point, *Sphaerium sulcatum*, *Amnicola limosa*, a ventricose form of *Amnicola lustrica*, and *Pisidium medianum* were found in great abundance; *Lymnaea obrussa* and forms connecting it with the variety *decampi*, *Anodonta grandis gigantea*, *A. marginata*, *Planorbis parvus*, *Valvata tricarinata unicarinata*, *V. t. simplex*, and variations connecting the last two forms, were also obtained but in lesser numbers. In addition, a few specimens of *Planorbis hirsutus*, *Pisidium splendidulum*, *P. vesiculare*, *P. strengi*, *P. variabile*, and *Musculium truncatum*, single individuals of *Lymnaea haldemani*, *Pisidium compressum* and the variety *rostratum*, and *Lampsilis luteola*, and a few, indeterminate, juvenile specimens of *Lymnaea* and *Pisidium* were collected. *Amnicola limosa* was only abundant in the mucky strip along the shore, and *A. lustrica* and *Sphaerium sulcatum*, only in the deeper water out beyond this strip; the remainder of the shells occurred in both localities, or their distribution was not satisfactorily determined on account of the small numbers of specimens that were obtained.

16. *Fourth Point.* Off Fourth Point, as in the two preceding habitats, there is little or no peaty marl covering the firmer, and in this case gravelly bottom. There is a narrow border of *Scirpus americanus* along

the shore, but the definite mucky zone of the preceding habitat is not present.

In this locality, there were found considerable numbers of *Sphaerium sulcatum*, and a ventricose form of *Amnicola lustrica;* small numbers of *Valvata tricarinata unicarinata, Planorbis campanulatus minor,* and *P. parvus,* and single specimens of *Pisidium splendidulum, Lymnaea obrussa, Amnicola walkeri,* and of some species of *Musculium* (too young to indentify).

17. *County drain.* This ditch empties into the south-east corner of Rush Lake. It has a clay bottom and is almost choked with *Spirogyra,* except at the mouth, where the bottom is mucky and covered with a growth of *Potamogetons, Ceratophyllum,* etc. There is no current in this drain except after heavy rains; but it does not dry up as the heavy, clayey soil is almost impenetrable. Near the mouth of this ditch, *Lymnaea stagnalis appressa* was quite abundant. In the upper portions, *L. palustris, Planorbis trivolvis,* and *Physa gyrina* were present, the first in much greater abundance than the others.

Habitats of the Swamps. 18.—*Annual swamps.* In every part of the region, where work was carried on, there was one habitat that was always present and which always showed similar conditions and faunas. This was the temporary swamp. The swamp in the sand dunes, altho it may only be a small hollow protected by a few dogwoods, differs from the larger hollows in the alluvial woods mainly in the number rather than in the kinds of shells. In all cases, the substratum is made up of a thick layer of decaying leaves, etc., the water is shallow when present, and there are extreme seasonal variations between dessication and a flooded condition. The similarity of these conditions apparently dominate over the effects of differences in the sub-soils. The formation and surroundings of these swamps vary greatly. In the sand dunes, any hollow capable of holding water in the spring becomes choked with dogwoods (*Cornus stolonifera* and *circinata*), whose leaves and roots prevent too rapid seepage and evaporation, and an ideal habitat of this kind is formed. In the long hollows between the ridges, as in the beds of old lakes and swamps, there is a thicker deposit of leaf mould, alders (*Alnus incana*) and perhaps a few ashes and swamp maples (*Acer rubrum*) helping in its production, and the seepage is slower; here we find the number of shells increasing but the species remaining about the same. There are also the swamps in the low woods on Stony and North Islands, where there is a thin layer of alluvial soil over limestone, and those of similar localities around Rush Lake and Caseville, where the underlying soil is clay. In both of these the trees shading the swamps are about the same; they consist of swamp maples and sugar maples (*Acer rubrum* and *saccharum*) and the elm (*Ulmus americanus*).

Lymnaea palustris, Aplexa hypnorum, Sphaerium occidentale, and *Musculium truncatum* were the typical shells of the annual swamp habitat in this region. All of these were found in large numbers at all of the places where this habitat was studied, with the exception of *Musculium truncatum* which was not found on North and Stony Islands where these conditions were but poorly represented. In addition, there were found in lesser numbers: at Sand Point, *Lymnaea palustris zebra, L. p. michiganensis*, a slender, little-malleated form of *L. palustris, Planorbis parvus, P. umbilicatellus, Physa elliptica*, and a small form of *Musculium partumeium;* on Stony Island, *Segmentina armigera;* near Rush Lake, *Planorbis parvus walkeri, P. umbilicatellus, Physa gyrina, P. g. hildrethiana, Lymnaea palustris michiganensis, Segmentina crassilabris*, a small form of *Musculium partumeium*, and some shells of *Lymnaea* which were too young to be indentified.

19. *Perennial swamps.* On Sand Point, Stony Island, and around Rush Lake there are a few shallow ponds and marshes which do not dry up in the summer, or, at least, have not for some time. Of course this depends upon the dryness of the season, but the ones studied were those that did not dry up during the summer of 1908, which was one of extreme drouth thruout this part of Michigan. (Pl. VIII b.)

These habitats, then, are distinguished from the annual swamps by their greater permanency. They intergrade into the latter, however, and are probably converted into them thru filling-in by vegetation, etc. They often have an aquatic vegetation of *Riccia*, duck-weeds, hornworts, etc., while around the edges are found the semi-aquatic bulrush (*Scirpus validus*), *Scirpus americanus, Equisetum fluviatile*, and other sedges and rushes, the *Equisetum* being especially abundant in the sandy regions.

Planorbis trivolvis and *Musculium securis* appeared to be the typical shells of this habitat: they were found in abundance at Sand Point, on Stony Island and near Rush Lake. There were also collected, but in lesser numbers: at Sand Point, *Aplexa hypnorum, Segmentina armigera*, a form of *S. crassilabris, Planorbis exacuous, Succinea retusa, Amnicola walkeri, Physa elliptica, Musculium truncatum, Sphaerium occidentale*, a small form of *Lymnaea obrussa*, an elongate form of *L. reflexa*, and *L. palustris michiganensis;* on Stony Island, *Musculium ryckhaltii, Planorbis deflectus, P. hirsutus, P. nautileus, Lymnaea reflexa*, and an elongate form of the last shell; near Rush Lake, *Aplexa hypnorum, Segmentina armigera, Sphaerium occidentale, Lymnaea palustris*, a form of *Planorbis parvus*, and *Physa gyrina*.

20. *Swamp in old stone quarry.* About a half of a mile west of Little Oak Point, there is an old stone quarry, Babbitt's Stone Quarry, which is partially filled with water. Cat-tails and alders have grown up in

places where there is an alluvial deposit along the edges of the pond, and the pond itself is choked with *Potamogeton natans* and bladderworts, so that a favorable habitat for aquatic life has been formed. These conditions have, of course, developed after the work on the quarry was stopped, which was not many years ago, so that whatever shells are now present have been planted in the last few years. The quarry is not connected with any other ponds or swamps, and none of these drain into it, so that the shells must have been introduced by accidental means.

The only shells found were *Musculium securis, Pisidium abditum*, and *Planorbis parvus*, but these were present in considerable numbers.

Habitats of the Pigeon River.—21. *River portion.* The Pigeon River is a small, sluggish stream that winds around thru the clay country between Pigeon and Caseville, and down thru the sand dunes to empty into Saginaw Bay near the latter town. Thruout the last mile of its course, the stream assumes the proportions of a small river as here the slope is very gradual, the river being hardly above the level of the Bay. This river portion is from three to six feet deep and in most places has almost no current; in consequence, there is a luxurious growth of algae, mostly *Vaucheria*, along the bottom and sides, and a few of the higher water-plants, especially *Potamogeton natans*, in the more sluggish places. The bottom, in these places, is muddy and soft, but contains some gravel and boulders in the more rapid portions. (Pl. X b.)

Among the algae along the shores, a few specimens of *Planorbis bicarinatus*, and numerous individuals of *Sphaerium striatinum, S. solidulum, Planorbis parvus, P. trivolvis, Physa heterostropha, P. integra, Amnicola limosa, Pisidium abditum*, and *Succinea retusa*, and many small, juvenile specimens of *Goniobasis livescens* were found. From places where the current was swifter, considerable numbers of *Campeloma integra, Anodontoides ferussacianus subcylindraceus, Lampsilis luteola*, and *Quadrula undulata*, and single individuals of *Anodonta grandis, A. g. footiana, Lampsilis multiradiata, L. iris*, and *Quadrula rubiginosa* were discovered partially buried in the clay along the shore and in the gravel in deeper water. In addition, almost every rock was literally covered with specimens of *Goniobasis livescens.*

22. *Bayou off the Pigeon River.* Near its mouth the river made in the past an "oxbow" bend about nine hundred yards long. During the days when the river was used for floating logs, the small neck of land separating the ends of the bend was cut thru in order to obtain more current, leaving a typical oxbow pond, which has filled in at the upper end so that it is only connected with the river at the lower end. This pond is about six feet deep in the deepest place and is choked thruout by a thick growth of vegetation, consisting of *Potamogetons*, etc.; along

the shores beds of yellow and white water-lilies (*Nymphaea advena* and *Castalia odorata*), and marshes of *Sparganium eurycarpum* and *Scirpus validus* are already making inroads on the channel. In addition, the upper end of the pond is covered over with duckweeds and *Riccia;* this, however, is probably largely washed out during the high water in the spring, when the river partially overflows into its old channel. (Pl. XI a.)

On the west side of this pond there is a high bank of sand which by caving in has destroyed most of the plant life for some distance along the shore. In these bare spots, partially hidden by large masses of algae, numerous specimens of *Campeloma integrum, Lampsilis luteola, Anodontoides ferussacianus modestus, A. f. subcylindraceus,* and *Anodonta grandis* were found. From boards floating among the sedges along the edges of the pond, considerable numbers of *Planorbis parvus, P. exacuous, P. trivolvis, Lymnaea humilis, Physa heterostropha,* and *Succinea retusa,* and a single specimen of *Ancylus fuscus* were obtained. There were also collected, but in lesser numbers, *Planorbis campanulatus* and a form of that species in which the aperture was deflected, *Lymnaea reflexa, Physa heterostropha, Goniobasis livescens,* and *Amnicola limosa,* from *Potamogeton,* etc., near the middle of the bayou; and *Planorbis campanulatus, P. parvus, Physa heterostropha, Amnicola limosa,* and *Ancylus parallelus,* from the under-side of lily-pads near the shore.

Vegetation is fast filling in this bayou. There is a filled-in marsh along the inner shore which has in places become a rod wide, and the upper end has already been converted into a flat, about fifteen rods long, which is only under water during flood seasons. This rapid deposition is not to be wondered at, as the bottom growth of higher aquatic plants is remarkably luxuriant even for an ox-bow pond.

23. *Creek portion.* Above the lower portion of the river, described under habitat twenty-one, the stream becomes swifter and smaller and runs thru a clay country. It has a gravelly bed, and presents the general appearance of a typical small creek of the glacial region. People living in Caseville say that the rapids and the most shallow spots become dry in the late summer so that the rapid creek is converted into a series of stagnant pools. In the spring, on the other hand, the stream becomes a torrent so both extremes of conditions are present during the year. This is extremely detrimental to molluscan life as in the spring the forms living in the algae probably tend to be washed out, while in the summer the shells which prefer swifter water die. The older inhabitants state that these conditions have not always prevailed, but that formerly the stream used to flow thruout the year. The change is probably due to the fact that the woods, which fed a more

constant supply of water, have now been cleared off. This probably accounts for the fact that the bottom of this portion of the stream was strewn with the dead shells of *Goniobasis* and a few of the larger uniones, which are not now found alive in this part.

On a plank floating along the marshy shore of this part of the river, there were found a few specimens of *Sphaerium solidulum*, *Segmentina crassilabris*, *Succinea avara*, *Lymnaea palustris michiganensis*, and *L. humilis*. Among algae, in situations similar to those in the river, *Amnicola cincinnatiensis*, *Planorbis trivolvis*, *Physa integra*, *Agriolimax agrestis*, *Succinea retusa*, *Campeloma integrum*, *Sphaerium solidulum*, *S. striatinum*, and a small form of *Lymnaea obrussa* occurred in larger numbers. In addition, along the bottom were obtained specimens of *Planorbis trivolvis*, a form of *Planorbis campanulatus* similar to that found in the bayou, *Sphaerium solidulum*, and *Lymnaea palustris*, and some dead shells of *Goniobasis livescens* and *Quadrula undulata*.

24. *Dead waters.* About five miles up stream from its mouth, the river widens and deepens, so that there is formed a long "pickerel pond" or dead water, a stagnant pool about ten yards wide by one hundred yards long. This pool is bordered by swampy, deciduous woods, and there is a marginal zone of button-ball bushes (*Cephalanthus occidentalis*) growing out over the water. The edges of the pool are covered with pickerel weed (*Pontederia cordata*), while outside of these the yellow water-lilies form quite a definite zone. The water is black and slimy, and rotting logs almost block up the stream. (Pl. XI b.)

In this habitat, on the under-side of lily-pads, a few specimens of *Ancylus parallelus*, *Lymnaea palustris*, *Planorbis parvus*, *Physa gyrina* and *P. integra*, and single individuals of *P. elliptica*, *Planorbis trivolvis*, and *Succinea retusa* were collected.

This dead water is so deep and wide (in comparison with the small stream which flows into and out of it) that there is little current even during flood seasons, and the quiet water causes most of the sediment carried in by the stream to be deposited. In addition, the broad zones of pickerel weeds and water-lilies along the shores must deposit considerable organic material, so that it appears that it will be simply a matter of time before this body of water is reduced to the size of the creek.

Land Habitats.

Habitats of the Sand Dunes.—25. *Sand beach.* Along considerable stretches of the lower and middle beaches of protected shores, the waves have washed up masses of decaying vegetation. These are kept moist by the capillary action of the sand; the masses themselves are often in direct contact with, and even floating on, the water. Among these decaying sedges, and under driftwood washed up with them, there are to be found considerable numbers of land shells, especially the smaller ones; these places comprise one of the most favorable land habitats for shells in the sand dunes.

As these habitats are separated from all humus deposits by considerable stretches of sandy beach, and the humus deposits near these shores are themselves devoid of a large proportion of the shells found along the beaches, it seems probable that a large proportion of these localities are populated from driftwood, etc., washed upon the beaches from other more favorable localities, such as the clay region inland and the alluvial deposits on the rocky islands. In most of the places studied, this would mean a journey by water of not much over a mile, and land shells will stand an immersion of several hours. All of these places must necessarily be repopulated nearly every spring as the ice and the fall storms must usually sweep these beaches clean.

In these places, *Succinea retusa*, *S. avara*, *Pyramidula cronkhitei anthonyi*, *Agriolimax campestris*, *Zonitoides arborea*, *Vitrea hammonis*, and *Carychium exiguum* were found in great abundance. *Vertigo ovata*, *Bifidaria tappaniana*, *Carychium exile*, *Zonitoides minuscula*, *Z. nitida*, *Vitrea binneyana*, *Polygyra albolabris*, *P. a. maratima*, *P. monodon*, and *Cochlicopa lubrica* were also obtained, but in lesser numbers.

These habitats are very short-lived. In addition to the fauna being swept away nearly every winter by the ice and the fall storms, slower changes are constantly affecting all of these shores, as has been discussed under the habitats of Saginaw Bay, so that these conditions are either moving out towards the Bay or in towards land, depending on their position. As they are usually in more or less protected places, the movement is probably outwards, as in such localities there is usually deposition.

26. *Borders of lakes and swamps.* The sand dunes are usually arranged in ridges more or less parallel to the shore. Between these ridges, swamps, marshes, small ponds and even lakes may be formed. Here the deciduous trees, such as the maples (*Acer saccharinum* and *A. rubrum*), the red and white oaks (*Quercus rubra* and *Q. alba*), the ashes, the dogwoods (*Cornus stolonifera* and *C. circinata*), and the alders (*Alnus incana*) predominate, the coniferous trees being in the minority, but represented by the white pine (*Pinus strobus*), the arbor vitae (*Thuja occidentalis*), and the hemlock (*Tsuga canadensis*), with an occasional clump of tamaracks (*Larix laricina*), balsam firs (*Abies balsamea*), or Norway pines (*Pinus resinosa*). This vegetation of course causes the formation of considerable leaf mould and humus, and a rich soil has also been formed where sedges, etc., have partly or entirely filled in a marsh, pond or lake. Among the fallen logs and decaying leaves in these

moist places (many of which are flooded in the spring) the land shells, especially the smaller ones, are quite numerous, surpassing in numbers of species, altho not in individuals, the sedge-heaps along the beach. These localities vary considerably in the numbers and habits of the shells present, as the conditions vary from those in small hollows in the sand dunes, which are flooded in the spring and dessicated in the summer, to the large, moist alluvial flats and cedar thickets along the lakes and marshes. (Pl. XII b.)

In this habitat, *Zonitoides arborea*, *Z. nitida*, *Vertigo ovata*, *Agriolimax campestris*, *Polygyra albolabris*, *P. monodon*, *Succinea retusa*, *S. avara*, *Carychium exile* and *C. exiguum* were collected in considerable numbers. *Bifidaria tappaniana*, *B. contracta*, *B. pentodon*, *Punctum pygmaeum*, *Helicodiscus parallelus*, *Vitrea rhoadsi*, *V. indentata*, *V. hammonis*, *Euconulus fulvus*, *Pyramidula alternata*, *Polygyra thyroides*, *P. multilineata*, *P. albolabris dentata*, *Vertigo gouldii*, *V. ventricosa elatior*, *Succinea ovalis*, and *Philomycus carolinensis* were also obtained, but in lesser numbers, the last nine being represented by only a few specimens.

Along the borders of bodies of water, these habitats are constantly becoming larger, owing to the filling-in of the swamp or lake which they surround, while the xerophytic conditions are, in their turn, encroaching on these more humid ones; thus the latter displace the aquatic habitats, and are themselves finally, but much more slowly, destroyed by the advance of the sand dune conditions.

27. *Under rock ledge, Hat Point.* Hat Point, as mentioned under preceding habitats, is formed by an outcrop of Marshall Sandstone which juts out over the water, forming a small cliff some fifteen or twenty feet high. The waves have worn this away at the base so that it hangs over the water and small caves are formed. Along both sides of this Point, the sand has been washed and blown up around it; on the west side it is flush with and covers the rock, but on the east side the small overhanging cliff is still exposed for about one hundred and fifty yards back from the Point. Against the base of this, the fallen leaves of the nearby birches (*Betula papyrifera*), the red oaks (*Quercus rubra*), and the dogwoods (*Cornus stolonifera* and *C. circinata*) have gathered, and the ground is kept moist and well shaded by the trees themselves and the overhanging rock, thus forming an excellent habitat for the small shells.

In these places, a few specimens of *Vitrea binneyana*, *Helicodiscus parallelus*, *Zonitoides minuscula*, *Z. arborea*, *Pyramidula cronkhitei anthonyi*, *P. c. catskillensis*, *Sphyradium edentulum*, *Euconulus fulvus*, *Strobilops virgo*, *Agriolimax campestris*, *Pallifera dorsalis*, and *Polygyra thyroides* were collected.

28. *Outer sand dunes.* The outer sand dunes form the most un-

favorable land habitat for molluscan life in this region, only excepting the exposed sand beach where no mollusc can live. They are very dry and have little humus, and that little comes mainly from coniferous trees, the principal trees of this region being white, Norway, and jack pines (*Pinus strobus, P. resinosa*, and *P. divaricata*), with lesser numbers of poplars (*Populus tremuloides, P. grandidentata*, and *P. balsamifera*), and a scattering growth of red, white, pin, and scarlet oaks (*Quercus rubra, Q. alba, Q. palustris*, and *Q. coccinea*). The fallen leaves of these deciduous trees might harbor more snails, despite the dominance of the conifers, except that the mycelia of a dry mould attack all of the leaves except those directly exposed; and this, together with the exceeding dryness, effectually prevents all molluscan life except under fallen logs. Here a few dwarfed shells are to be found, which are more numerous, contrary to what might be expected, in the pine woods on the outermost dunes, perhaps on account of the fact that the mould does not appear to be able to obtain as strong a footing among the pine needles. The sand roads on these ridges form effectual traps for molluscs, and several specimens were found dead and dried up, which had apparently perished in attempting to cross them. (Pls. I, II a, III b, IV b.)

Polygyra albolabris maratima was by far the most abundant shell on these dunes, both on Sand Point and north of Rush Lake. *Polygyra fraterna* was also present, but in lesser numbers, in the latter locality, while a single specimen of typical *P. albolabris* was obtained from under a log in the humus near a cabin on Sand Point.

29. *Inner sand dunes.* The inner and more permanent sand dunes have a thicker deposit of humus than the outer shifting ones, so that they are not as dry and barren as the latter. The deciduous trees predominate here, especially the oaks, the same species being present as were found on the outer dunes. Also there is a thicker undergrowth of brake (*Pteris aquilina*) and a considerable layer of leaf-mould. The ground, however, is dry enough so that most of the snails and slugs are congregated under the decaying logs during the summer, altho they may wander out among the leaves at night and in wetter seasons. They are, nevertheless, much more numerous both in species and individuals than on the sand dunes nearer the Bay.

This habitat was best represented just north of Rush Lake. Here were found a number of specimens of *Polygyra albolabris maratima, P. fraterna, Pyramidula alternata, Pallifera dorsalis*, and *Zonitoides arborea.* A few albino specimens of the last species were also obtained.

Habitats of North and Stony Islands.—North and Stony Islands, as has been mentioned under the rocky, littoral habitats, are formed of limestone and covered with a relatively thin deposit of alluvial soil, except along the north shores where the rock outcrops or is covered with sand. Almost all of North Island and the northern portion of Stony Island are quite heavily wooded, mostly with deciduous trees, so that there is a good carpeting of humus. In fact, the whole appearance of the islands suggests the deciduous woods of the southern part of Michigan.

There is a wide strip all the way around North Island and along the northern and western shores of Stony Island that is high and dry, but a large part of the center of the former and the whole southern two-thirds of the latter is lower, and is covered with pools during the rainy season. The northern portion of this damp area on Stony Island is wooded and is relatively dry during the summer, as is the whole of North Island, but the southern part of the former forms a large swamp which is never dry and is without trees. This part is apparently devoid of molluscan life except in open pools which have been included in the treatment of perennial swamps. Probably this lack of life is due partly to the stagnancy and the oily character of the water, and partly to the fact that the marsh grasses and sedges grow so thickly as to exclude the light.

30. *Swampy woods.* As mentioned under the general treatment of these islands, there are considerable areas near the center of both North and Stony Islands which are damp and quite heavily wooded. These woods are mostly made up of deciduous trees, which in these swampy places are mostly small, such as ash, sugar maple and American elm saplings, with a few larger trees among them. There are also a few arbor vitae (*Thuja occidentalis*) scattered thru them.

These damp, well-shaded localities, as might be expected, formed excellent habitats for the larger shells, but, on the other hand, few of the more minute species were found. I cannot explain this, but do not think that I could have so entirely overlooked them if they had been present, as considerable time was spent in searching for them. Their absence seems all the more strange because they were found in considerable numbers among the drift on the sandy beaches of North Island.

In this habitat, *Polygyra albolabris* was the most abundant shell, both on Stony and North Islands. On both islands, *P. thyroides*, *P. multilineata*, *Pyramidula alternata* and *Agriolimax agrestis* were also obtained quite abundantly. In addition, on Stony Island, a few specimens of *Polygyra monodon*, and on North Island, a few individuals of *Pyramidula alternata alba*, *P. cronkhitei anthonyi*, *Zonitoides arborea*, and *Succinea avara major* were found.

31. *High woods.* The wide strip of high woods around North Island, and that along the north and west shores of Stony Island differ mainly from the preceding habitat in being much higher and drier, and in containing, on the average, larger and fewer trees. Here, in addition

to the trees found in the damper woods, basswoods and oaks are quite abundant, and, in one limited area, there are considerable numbers of white pine.

This habitat was only studied on Stony Island. There, *Polygyra albolabris, P. thyroides, P. monodon, Pyramidula alternata, Pallifera dorsalis* and *Agriolimax agrestis* were very abundant; and a few specimens of *Zonitoides arborea,* and a single juvenile individual of *Polygyra multilineata* were also obtained. *Polygyra albolabris* was much more abundant here than in the preceding habitat, while *P. multilineata,* on the other hand, was almost entirely wanting.

32. *Dry clearing.* On account of the shallowness of the soil on these islands, all of the clearings are very dry. Grasses are the only plants that appear to be able to hold their own here, with the exception of the sumachs, which are of large size and cover considerable patches of ground. In these places a few shells were found which had taken refuge under boards and in a stone pile, from which they probably come out during rains and heavy dews.

Under a stone-pile in this habitat, a number of specimens of *Pyramidula alternata* and *Polygyra monodon* were obtained. A single individual of *Polygyra albolabris* was also obtained under a plank.

33. *Rocky beach.* A few shells are to be found on the bare rocks of the middle beach, in protected places under driftwood and rocks where a little soil has gathered. The fauna of these places is most probably temporary, as the ice in the winter months sweeps these beaches clean. A few molluscs may be able to winter in the deeper crevices of the rocks, but it appears that the main portion of the fauna must be derived annually from the woods adjacent to the beach; snails may also be washed ashore as mentioned in the discussion of the sand beaches in the sand dune region, but in this case this would not be necessary for their restocking, as woods with considerable molluscan life are in direct connection with these beaches. (Pl. XIV.)

Polygyra albolabris, Pyramidula alternata and *Succinea retusa* were obtained from these localities. The first two were present in quite considerable numbers.

34. *Sand beach.* Land molluscs also occur in considerable numbers on the middle beach along the sandy portions of the shore of these two islands, especially where the beach is partially protected, as along the southern shore of North Island. These sand beaches appear to be more favorable to molluscan life than the rocky ones discussed under the preceding habitat, perhaps because the sand beaches are formed in the protected places—the ones most suitable for the life of the snails. The fauna of these places is probably destroyed during the winter as are those of the preceding habitat and habitat twenty-five; and they are

probably restored both by migration from inland as mentioned under the preceding habitat, and by shells being washed ashore on driftwood as suggested under the discussion of habitat twenty-five.

These conditions were much better represented on North Island than they were on Stony Island. On the former, considerable numbers of *Succinea retusa, S. avara, S. a. vermeta, Pyramidula cronkhitei anthonyi, P. alternata, Polygyra albolabris, P. monodon, P. thyroides, Zonitoides minuscula, Z. arborea, Vertigo ovata, Bifidaria contracta, B. tappaniana* and *Agriolimax agrestis* were obtained, while on the latter, lesser numbers of *Polygyra albolabris, P. monodon, Pyramidula alternata,* all of them large shells, were all that were collected.

Habitats of the Creek Flats.—The flats of the Pigeon River form a series of closely allied habitats unlike any others in this region. They are formed, primarily, by the meandering of the stream, which deposits soil and debris on the side where there is little current, but there may also be included under this head the other low ground on which the stream is depositing soil during floods, as of course the soil will be practically the same. This is necessarily deposited below the level of floods, so that these habitats are flooded nearly every spring. In the district studied, these flats may be divided into three groups: swampy meadows, dry meadows and wooded flats.

35. *Swampy meadows.* Under this habitat are included all of those treeless flats which have pools of water on them even in the summer. They are grassy, except around the pools, where the vegetation consists mainly of the common blue flag with scattered sedges and marsh ferns (*Aspidium thelypteris*). Most of the shells obtained were found under drift logs, etc., but also in lesser numbers in the wet grass.

In such localities, *Cochlicopa lubrica, Carychium exile, Zonitoides nitida, Z. arborea, Succinea retusa, S. avara, Vitrea hammonis* and *Helicodiscus parallelus* were present in considerable numbers, and *Zonitoides minuscula, Punctum pygmaeum, Pyramidula cronkhitei anthonyi, Bifidaria tappaniana, Vertigo ovata, Vallonia pulchella,* and *Agriolimax agrestis,* were also obtained, but in lesser numbers. In addition, a few specimens of *Vertigo,* too young to be identified, were collected.

36. *Dry meadows.* Most of the meadow flats along the Pigeon are high enough above the level of the river so that they are well-drained and relatively dry during most of the year. They are covered with grass which is quite green, even in August, and which, in the places studied, had been kept short by grazing. Under driftwood, etc., in these places, as in the preceding habitat, many species and individuals of shells are to be found.

Here were found considerable numbers of *Bifidaria contracta, B. tappaniana, Zonitoides arborea, Z. nitida, Vitrea hammonis, Cochlicopa* *lubrica*, *C. l. morseana*, *Pyramidula cronkhitei anthonyi*, *P. alternata*, *Succinea avara* and *Polygyra thyroides*.

37. *Wooded flats*. On the wooded flats, most of which are considerably above the level of low water, the trees keep the ground quite moist. A habitat is thus formed which is more moist than the dry meadows, less so than the swampy ones, and more stable than either. Also, in addition to the river deposit, there is considerable leaf mould; the ground in the higher places is carpeted with fallen leaves, and in the lower and damper places has a thick undergrowth of nettles.

The trees of these woods are mostly deciduous, consisting of swamp maples, black ashes, poplars, cottonwoods, and elms, the first two being the most abundant. It is under fallen logs and driftwood that the majority of the shells are to be found.

Wooded flats were studied both along the Pigeon and Pinnebog Rivers, but the former was a much more favorable collecting ground. Along the Pigeon River, *Helicodiscus parallelus*, *Zonitoides arborea*, *Pyramidula alternata*, *P. cronkhitei anthonyi*, *Cochlicopa lubrica*, *C. l. morseana*, *Agriolimax agrestis*, *Succinea avara*, and juvenile specimens of some *Polygyra* were collected in considerable numbers, while *Zonitoides minuscula*, *Z. nitida*, *Carychium exile*, *C. exiguum*, *Euconulus chersinus polygyratus*, *Bifidaria tappaniana*, *Vitrea hammonis*, *V. indentata*, *V. binneyana*, *Polygyra albolabris*, *P. thyroides*, *P. fraterna*, and *Succinea ovalis optima* were also obtained, but in lesser numbers. Along the Pinnebog River, *Pyramidula alternata*, *Succinea avara*, *S. ovalis*, *Polygyra albolabris maratima*, *P. fraterna*, *Cochlicopa lubrica*, *Helicodiscus parallelus*, and *Zonitoides arborea* were found in small numbers.

Habitats of the Clay Soil.—Behind the narrow sand region along the shores of the Bay lies a flat region of clay soil, the old lake bottom. In Huron County, the latter region is much larger than the former, but most of the work of the party was done in the sand dune region, so that the only portions of the clay region that were studied are those along the inner border of the sandy region. These records, then, cannot be taken as characteristic of the region farther in towards the center of the county.

38. *Swampy woods*. The land around Rush Lake is so low and flat that the majority of the woods near the lake are low and swampy. These woods are made up in large part of deciduous trees, consisting mostly of ashes, swamp maples and elms, with a sprinkling of sugar maples, common and blue beeches and poplars; the arbor vitae, however, is quite abundant and the hemlocks and balsam firs are also present in small numbers. (Pl. XV.)

In damp swamps, under logs and among leaves, a large number of shells were collected. The species were: *Euconulus fulvus*, *Succinea* *avara, S. ovalis optima, Vertigo ovata, Strobilops virgo, Carychium exiguum, C. exile, Pyramidula alternata, Pyramidula cronkhitei anthonyi, P. c. catskillensis, Agriolimax campestris, Vitrea ferrea, V. hammonis, Punctum pygmaeum, Bifidaria tappaniana, B. corticaria, Zonitoides nitida, Z. arborea, Polygyra monodon and P. fraterna.* In very wet swamps, among leaves and underbrush and fallen bark in quite dry, raised portions around the roots and bases of trees, a large number of shells were also obtained. Here were found *Euconulus fulvus, Succinea avara, S. retusa, S. ovalis, Carychium exiguum, C. exile, Pyramidula alternata, P. cronkhitei anthonyi, Agriolimax campestris, Vitrea hammonis, V. binneyana, V. rhoadsi, Helicodiscus parallelus, Vertigo gouldii, Bifidaria tappaniana, B. pentodon, B. contracta, B. corticaria, Zonitoides arborea, Polygyra monodon,* and specimens of *Vertigo* and *Bifidaria* which were too young to indentify.

39. *Dry woods.* On the higher and drier ground around Rush Lake, the woods consist mainly of poplars, birches, beeches, elms, and maples, with a few balsam firs and hemlocks scattered thru, and of rich cedar thickets. They are often adjacent to the sand dunes, but they are usually quite easily distinguished as the latter are much more sandy and are covered with great numbers of small oaks.

Under fallen logs and beneath their bark, the small land shells were especially plentiful, this and the preceding habitat being the most favorable localities for such shells in this region. *Pallifera dorsalis, Pyramidula alternata, P. cronkhitei anthonyi, Polygyra thyroides, P. fraterna, Philomycus carolinensis, Vitrea hammonis, Zonitoides arborea, Bifidaria contracta, B. pentodon, Agriolimax campestris,* and *Helicodiscus parallelus* were present in great abundance in such places. *Zonitoides minuscula, Z. milium, Punctum pygmaeum, Succinea avara, Vitrea rhoadsi, V. ferrea, V. indentata, Bifidaria corticaria, Strobilops virgo, Polygyra albolabris, P. a. maratima, Carychium exiguum, C. exile, Vertigo gouldii, Euconulus fulvus, E. chersinus polygyratus, Pyramidula cronkhitei catskillensis,* and indeterminate specimens of *Vertigo* were also obtained, but in lesser numbers.

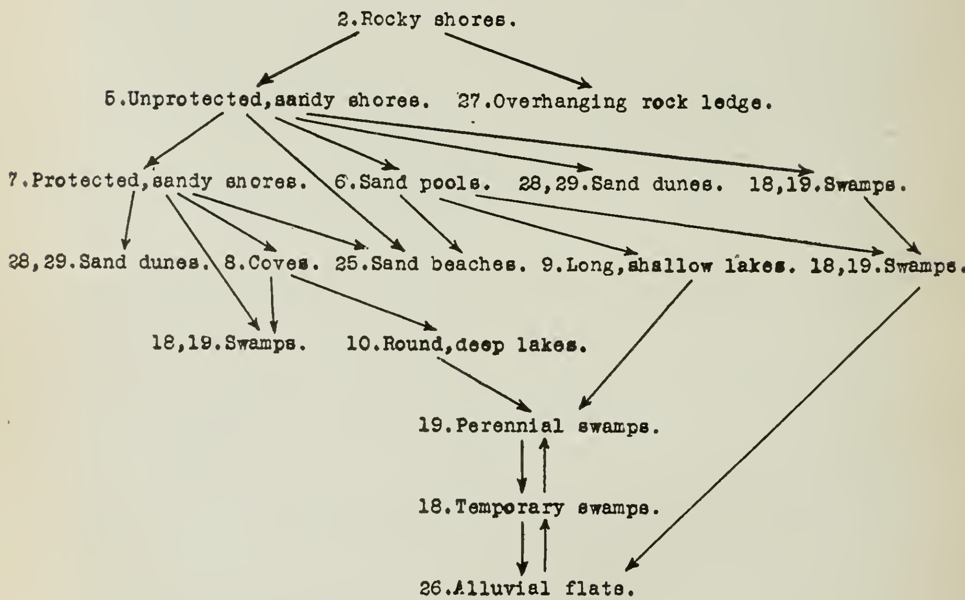
40. *Meadow along the edge of woods.* Under fallen logs in a moist, grassy meadow along woods such as were described in the preceding habitat were found *Bifidaria contracta, B. tappaniana, Carychium exile, C. exiguum, Succinea avara, Zonitoides arborea, Polygyra albolabris, P. monodon, P. thyroides, Pyramidula alternata, P. cronkhitei anthonyi, Vitrea hammonis, Helicodiscus parallelus, Agriolimax campestris,* and some juvenile specimens of *Polygyra,* which were too young to identify.

41. *Dry yard.* Under stones in the yard of a deserted farmhouse near Rush Lake, numerous specimens of *Vallonia pulchella* were col-

lected, altho the place seemed almost too dry to support molluscan life.

42. *Tamarack swamps.* Around the most of Rush Lake, there are large tamarack swamps with the characteristic vegetation of tamaracks, sphagnum, black spruces, pitcher plants, sun-dews, poison sumach and huckleberries. Most of these places are without any molluscan life, but in the sphagnum in a very wet portion, a few specimens of *Vitrea hammonis, Agriolimax campestris, Pisidium roperi, Lymnaea palustris, Musculium truncatum,* and *M. securis* were collected.

Derivation of the Sand Dune Habitats.



LIST OF THE HABITATS.

Aquatic Habitats.

I. Habitats of Saginaw Bay.
  1. Deep littoral, 16-24 feet.
  2. Shallow littoral, rocky, unprotected.
  3. Rock pools.
  4. Shallow littoral, rocky, protected.
  5. Shallow littoral, sandy, unprotected.
  6. Sand pools.
  7. Shallow littoral, sandy, protected.
  8. Cove, almost cut off from Bay.

II. Habitats of the Sand Dune Lakes.
  9. Shallow lakes, north side of Sand Point.
  10. Deep lakes, south side of Sand Point.

III. Habitats of Rush Lake.
  11. Mucky bottom.
  12. Floating sedge-marshes.
  13. Marly bottom.
  14. Raymond's Point.
  15. Dune Point.
  16. Fourth Point.
  17. County drain.

IV. Habitats of the Swamps.
  18. Annual swamps.
  19. Perennial swamps.
  20. Swamp in old stone quarry.

V. Habitats of the Pigeon River.
  21. River portion.
  22. Bayou off of the Pigeon River.
  23. Creek portion.
  24. Dead waters.

Land Habitats.

I. Habitats of the Sand Dunes.
  25. Sand beach.
  26. Borders of lakes and swamp.
  27. Under rock ledge, Hat Point.
  28. Outer sand dunes.
  29. Inner sand dunes.

II. Habitats of North and Stony Islands.
  30. Swampy woods.
  31. High woods.

32. Dry clearing.
33. Rock beach.
34. Sand beach.

III. Habitats of the Creek Flats.

35. Swampy meadows.
36. Dry meadows.
37. Wooded flats.

IV. Habitats of the Clay Soil.

38. Swampy woods.
39. Dry woods.
40. Meadow along the edge of woods.
41. Dry yard.
42. Tamarack swamps.

LIST OF SPECIES.

PULMONATA.

Helicidae.

1. **Polygyra albolabris** (Say).—This species appeared to be one of the most abundant and widely distributed of the larger shells in this region. It was found in the following localities and habitats: on Sand Point, under fallen logs among sand dunes, even on the outermost ones (26)*, among driftwood and decaying sedges along the sand beach (25) and among fallen leaves, etc., around the borders of swamps and lakes (26); on Stony and North Islands, under fallen logs and among decaying leaves, etc., in both swampy and dry woods (30, 31), under boards in a dry clearing (32), under slabs of rock on the open rock beaches (33), among driftwood and sedges along the sand beaches (34); at Caseville, on wooded flats (37); at Rush Lake under fallen logs in dry woods (39), in similar places in meadows along the edges of woods (40) and among the sand dunes along the borders of swamps (26); and under fallen logs, etc., on the wooded flats (36) along the Pinnebog River. Altho sometimes found in damp places, this shell appeared to prefer the drier habitats.

The shells varied considerably in size; the largest shells were found on North and Stony Islands, where the thin, rich soil, over limestone rock, seemed to furnish excellent conditions for all of the larger land shells. The smallest were obtained from the sand dunes, where the shells graduated into the variety *maratima*. A single albino specimen was obtained under a log in high woods, 31, on Stony Island.

2. **Polygyra albolabris, var. dentata** (Tryon).—A single specimen of the dentate form was collected near a swamp (26) on Sand Point.

3. **Polygyra albolabris, var. maratima** (Pilsbry).—This shell was the most abundant one among the sand dunes. It was obtained from Sand Point, among sedges and driftwood along the sand beach (25) and under fallen logs on the sand dunes (28); from near Rush Lake, on both the inner and outer sand dunes (29, 28) and in high woods grading into the sand dunes (39), under fallen logs; and from wooded flats (37) near the sand dunes along the Pinnebog River.

4. **Polygyra multilineata** (Say).—A few specimens of this shell were obtained from under logs in damp places along the borders of

*The numbers thruout the list refer to the type of habitat described above under the same number.

swamps (26) at Sand Point. It was also collected, in considerable numbers, in swampy woods (30) on North and Stony Islands. In the latter locality, a single specimen was found on higher ground (31), but, in the region studied, the species appeared to prefer a wet habitat.

5. **Polygyra thyroides** (Say).—Single specimens of this species were found at Sand Point, along the border of a swamp (26) and at Hat Point, among leaves under a rock ledge (27). It was collected in larger numbers on North and Stony Islands, from under logs both in the swampy and the higher woods (30, 31) and on the sand beach (34); at Caseville, in dry meadows and under driftwood, etc., on wooded flats (36, 37); and near Rush Lake, from under fallen logs in dry woods and along the edges of meadows (39, 40).

6. **Polygyra fraterna** (Say).—This species was generally found on rich and quite dry ground. It was obtained in considerable numbers on wooded flats (37) along the Pigeon and Pinnebog Rivers, and in swampy and dry woods (38, 39) and on the outer and inner sand dunes (28, 29) near Rush Lake.

7. **Polygyra monodon** (Rackett).—This shell was found quite abundantly as follows: at Sand Point, among driftwood along the sand beach (25), and among fallen leaves near the borders of swamps and lakes (26); on Stony and North Islands, under fallen logs in swampy and high woods (30, 31), in a stone-pile in a dry clearing (32) and under driftwood along the sand beach (34); and near Rush Lake, under logs in swampy woods (38) and in a clearing near a cedar woods (40).

Polygyra sp? A considerable number of juvenile shells, too young to identify, were obtained from a stump on a wooded flat near Caseville (37) and from a log in a meadow near Rush Lake (40).

Zonitidae.

8. **Vitrea hammonis** (Strom).—This shell was found in abundance: under driftwood and sedges along the sand beach (25) and under logs and leaves around swamps and lakes (26) on Sand Point; under logs and driftwood on the wooded flats (37) and the low and high meadow-flats (35, 36) along the Pigeon River; under logs and among leaves in the swampy and dry woods (38, 39), in the damp meadows (40) and in *Spaghnum* in a tamarack swamp (42) near Rush Lake.

9. **Vitrea binneyana** (Morse).—This species was collected in small numbers among sedges and driftwood along the sand beach (25) at Sand Point, under logs and driftwood on the wooded flats (37) along the Pigeon River, under logs and among leaves in wet woods (38) near Rush Lake, and among leaves under a rock ledge (27) at Hat Point.

10. **Vitrea ferrea** (Morse).—A few specimens of this species were obtained under logs and leaves in both swampy and dry woods (38, 39) near Rush Lake.

11. **Vitrea indentata** (Say).—Small numbers of this shell were collected: at Sand Point, among decaying leaves along the border of a swamp (26); along the Pigeon River, under logs and driftwood on wooded flats (37), and near Rush Lake, from dry woods (39).

12. **Vitrea rhoadsi** Pilsbry.—This species was found in small numbers at Sand Point, among decaying leaves along the border of Long Lake (26), and at Rush Lake, among leaves and under logs in both swampy and dry woods (38, 39).

13. **Euconulus fulvus** (Müller).—A few specimens of this shell were obtained among fallen leaves in wet places along the border of a large marsh and in an alder thicket along the south side of Mud Lake (26), on Sand Point. It was also found in small numbers among fallen leaves and under logs in both swampy and dry woods (38, 39) around Rush Lake, and among leaves gathered under an overhanging rock ledge at Hat Point (27).

14. **Euconulus chersinus**, var. **polygyratus** (Pilsbry).—Two specimens of this form were collected under fallen logs on a wooded flat (37) along the Pigeon River, and a single juvenile specimen was obtained under a log in a cedar thicket near Rush Lake (39).

15. **Zonitoides nitida** (Müller).—This species was very abundant in wet places thruout the region studied. It was found as follows: at Sand Point, among sedges and driftwood along the sand beach (25) and among leaves and under logs along the borders of swamps and lakes (26); along the Pigeon River, on dry and wet meadow-flats (35, 36) and under logs and driftwood on wooded flats (37); and near Rush Lake, among leaves in wet woods (38).

16. **Zonitoides arborea** (Say).—This appeared to be the most abundant of the small land shells in the region studied. It was collected: at Sand Point, under driftwood and among rotting sedges along the sand beach (25) and among leaves and under logs along the borders of lakes and swamps (26); on North and Stony Islands, under logs in dry and swampy woods (30, 31) and under driftwood and among decaying sedges along the sand beach (34); along the Pigeon River, under driftwood, etc., on the wooded flats (37) and on the dry and swampy meadow-flats (36, 35); near Rush Lake, under logs and among leaves in the swampy and dry woods (38, 39) and damp meadows (40); along the Pinnebog River, under logs and on wooded flats (37); and at Hat Point, among leaves under a rock ledge (27). Albino specimens were obtained from the inner sand dunes (29) north of Rush Lake.

17. **Zonitoides minuscula** (Binney).—This species was found in small numbers among decaying sedges and driftwood along the sand beach (25) at Sand Point; in a similar location on North Island (34); under logs and driftwood on a swampy meadow-flat (35) and a wooded flat (37) along the Pigeon River; under logs in dry woods (39) near Rush Lake; and among leaves under a rock ledge (27) at Hat Point.

18. **Zonitoides milium** (Morse).—A few specimens of this species were found under logs in a cedar thicket (39) near Rush Lake.

Limacidae.

19. **Agriolimax agrestis** (Linné).—This slug was found in considerable abundance among sedges and under driftwood on a sand beach (34) on North Island; in swampy and high woods (30, 31) on Stony Island; and under logs and driftwood on swampy and wooded flats (35, 37) along the Pigeon River, and on algae floating in the river itself (23). The species was probably originally carried to the islands by man. There was a farm on Stony Island for a number of years and later a hotel, and both islands are now used by the fishing companies.

20. **Agriolimax campestris** (Say).—The native species was collected in abundance in the following localities: under driftwood and among sedges along the sand beach (25), on driftwood floating in the sedge marshes (7), and under logs along the borders of lakes and swamps (26) at Sand Point; among leaves and under logs in wet and dry woods and meadows along their borders (38, 39, 40) and in a tamarack swamp (42) at Rush Lake; and among leaves under a rock ledge at Hat Point (27).

Endontidae.

21. **Pyramidula alternata** (Say).—This species was found in small numbers at Sand Point, but was collected in abundance thruout the rest of the region. On Sand Point it was obtained only from swamps near the base of the Point (26); on North and Stony Islands, from the wooded habitats (30, 31), under logs, from the sand beaches (34), among sedges and driftwood, on the rock beaches (33), under slabs of rock, and in a stone-pile in a dry clearing (32); along the Pigeon River, from the dry meadows and the wooded flats (36, 37); from near Rush Lake, under logs and among fallen leaves in swampy and dry woods and an open meadow (38, 39, 40); along the Pinnebog River, on a wooded flat (37); and north of Rush Lake, under logs on the inner sand dunes (29).

22. **Pyramidula alternata, var. alba** (Tryon).—A few specimens of the albino form were found in a swampy woods (30) on North Island.

23. **Pyramidula cronkhitei, var. anthonyi** Pilsbry.—This variety was found in considerable abundance at Sand Point, under driftwood and among decaying sedges on the sand beach (25); on Stony and North Islands, in swampy woods (30) and along the sand beach (34); along the Pigeon River, on swampy and dry meadow-flats (35, 36) and wooded flats (37); near Rush Lake, under logs and among fallen leaves in swampy and dry woods (38, 39) and meadows (40); and at Hat Point, under leaves along a rock ledge (27).

24. **Pyramidula cronkhitei, var. catskillensis** (Pilsbry).—The carinate form was also collected, altho in much smaller numbers than the preceding. It was found near Rush Lake, in swampy and dry woods (38, 39), under logs and among fallen leaves, and at Hat Point, under leaves along a rock ledge (27).

25. **Helicodiscus parallelus** (Say).—A few specimens of this species were obtained among fallen leaves along the border of a swamp (26) on Sand Point, and many individuals from under leaves along a rock ledge among the sand dunes at Hat Point (27). It was also collected, but in smaller numbers, along the Pigeon and Pinnebog Rivers, both on wet, open flats and on wooded ones (35, 37), under driftwood, etc., and, in larger numbers, around Rush Lake, under logs in both swampy and dry woods and in a moist meadow (38, 39, 40).

26. **Punctum pygmaeum** (Draparnaud).—This minute species was found in small numbers under logs along the border of a swamp (26) on Sand Point, in a swampy meadow-flat along the Pigeon River (35), and in swampy and dry woods (38, 39) near Rush Lake.

27. **Sphyradium edentulum** (Draparnaud).—A single specimen of this species was found among leaves gathered under a rock ledge (27) at Hat Point.

Philomycidae.

28. **Philomycus carolinensis** (Bosc).—This slug was found in a woodpile near a swamp (26) on Sand Point, and in a high woods near Rush Lake (39). All of the specimens obtained are variation *d* of Binney*, that is, they are heavily blotched with large markings which are arranged in the form of three distinct longitudinal bands. The specimen from Sand Point is quite large, measuring about 60mm. in alcohol. Those from Rush Lake are far below the normal, the largest alcoholic specimens measuring 40mm.

29. **Pallifera dorsalis** (Binney).—This slug was obtained in small numbers from the south side of Sand Point (29), feeding on fleshy fungi; from under logs in high woods (31) on Stony Island; and in

* W. G. Binney and T. Bland: Land and Fresh Water Shells of N. A. Smith. Misc. Coll. 194, Part I, page 299.

large numbers in dry woods (39) and on the inner sand dunes (29) near Rush Lake, and among leaves under a rock ledge at Hat Point (27).

Succineidae.

30. **Succinea retusa** Lea.—This shell was found in great abundance in wet places thruout the region studied. It was collected as follows: on Sand Point, among driftwood and rotting sedges along the sand beach (25), on leaves and on trees growing in the water in swamps (26), and on floating driftwood along the protected shores of Saginaw Bay (7) and in Turtle Bay (8), and in a perennial swamp (19); on Stony and North Islands, among sedges and driftwood along the sandy and rocky beaches (34, 33) and on driftwood out in the water in these localities (7, 4); along the Pigeon River, in swampy meadows (35) and on algae and driftwood in the upper and lower portions, the ox bow pond and the "dead waters" (23, 21, 22, 24) of the river itself; at Rush Lake, in the sedge marsh along the border of the lake (12) and in very wet places in woods nearby (38); and near Little Oak Point, in a sand pool (6).

31. **Succinea ovalis** Say.—This species was obtained at Sand Point, among leaves, etc., in a large swamp (26), and near Rush Lake, in swampy woods (38). Living specimens were found at Rush Lake but not at Sand Point. An example measures: length 16.5mm., diam. 10mm., aperture length 12.5mm., aperture width 7mm.

32. **Succinea ovalis**, var. **optima** Pilsbry.—A few shells of this variety were collected along the wooded flats (37) of the Pigeon and Pinnebog Rivers, and in a poplar swamp (38) about two miles east of the first river. An example measures: length 21mm., width 12.5mm., aperture length 14.5mm., aperture width 9.5mm.

33. **Succinea avara** Say.—Specimens of this shell were found in considerable numbers at Sand Point, among sedges along the sand beach (25), under logs and fallen leaves along the shores of lakes and swamps (26) and on floating driftwood out from the shore in the sedge marshes (7); on North Island, among decaying sedges along the sand beach (34); along the Pigeon River, under driftwood and logs in the swampy and dry meadow and wooded flats (35. 36, 37) and on planks floating along the marshy shore of the upper portion of the river (23); near Rush Lake, under logs, etc., in swampy and dry woods and meadows (38, 39, 40); and along the Pinnebog River, under logs and driftwood on the wooded flats (37).

34. **Succinea avara**, var. **major** W. G. Binney.—Single specimens of this form were collected in swampy woods (30) on North Island and in a sand pool (6) near Little Oak Point. The latter specimen

has the sutures enough impressed to be referable to the form *vermeta;* it measures: length 9.5mm., width 5.25mm., aperture length 5.75mm., aperture width 3.25mm.

35. **Succinea avara**, var. **vermeta** (Say).—Specimens of this form were obtained from the sand beach (34) on North Island and, as mentioned above, from a sand pool (6) near Little Oak Point.

Pupillidae.

36. **Strobilops virgo** (Pilsbry).—This species was found in small numbers among leaves and under logs in swampy and dry woods (38, 39) near Rush Lake, and among leaves gathered under a rock ledge at Hat Point (27).

37. **Bifidaria contracta** (Say).—This shell was, next to *Bifidaria tappaniana,* the most abundant and the most widely distributed species of the genus in the region studied. Specimens were found not uncommonly in damp places on Sand Point (26), on the sand beach along the south shore of North Island (34), in dry meadow-flats along the Pigeon River (36), in wet and in high woods (38, 39) and in a damp meadow along a cedar thicket (40) near Rush Lake. It was found most abundantly around Rush Lake, under fallen logs in quite dry woods on clayey soil.

38. **Bifidaria corticaria** (Say).—This species was quite rare in the region studied. A few specimens were found near Rush Lake, under decaying logs and among fallen leaves in wet woods (38) and under the bark of a fallen log in a quite dry patch of woods (39) just inside of the sand dunes. It seemed to prefer a wet, rich habitat.

39. **Bifidaria pentodon** (Say).—This shell was not rare in wet places on Sand Point (26), under fallen logs and among decaying leaves, and in similar places in both swampy and high woods (38, 39) in the clay region around Rush Lake.

Bifidaria sp?—A few juvenile pupiform shells, probably *Bifidaria pentodon,* were found among leaves around the bases of trees in a wet woods (38) near Rush Lake.

40. **Bifidaria tappaniana** (C. B. Adams).—This species was the most widely distributed and abundant species of the genus in this region. It was quite abundant under driftwood and decaying sedges along the sandy, middle beach (25) and among fallen leaves on the border of a swamp (26) at Sand Point, on the sand beach on North Island (34), under driftwood on both swampy and dry creek flats (35, 36) and in woods (37) along the Pigeon River, and under fallen logs in swampy woods (38) and in a moist meadow along a cedar thicket (40) near Rush Lake.

41. **Vertigo ovata** Say.—This species was collected in numbers

among sedges and driftwood on the sand beach (25) and among leaves and under logs along the shores of lakes and swamps (26) on Sand Point, under driftwood along the sand beach (34) on North Island, under logs and driftwood in the swampy meadows (35) along the Pigeon River, and among leaves and under logs in swampy woods (38) and under driftwood in the sedge marsh (12) at Rush Lake.

42. **Vertigo ventricosa,** var. **elatior** Sterki.—A single individual of this form was obtained among leaves along the shore of Mud Lake (26) on Sand Point.

43. **Vertigo gouldii** (Binney).—This shell was found in small numbers under logs near a small swamp (26) on Sand Point and under logs and among leaves in both swampy and dry woods (38, 39) at Rush Lake.

Vertigo sp?—Specimens of this genus, too young to identify, were collected under driftwood on the swampy flats (35) along the Pigeon River and under logs and fallen leaves in swampy and dry woods (38, 39) at Rush Lake.

Cochlicopidae.

44. **Cochlicopa lubrica** (Müller).—A single specimen of this species was obtained from the middle sand beach at Sand Point (25), and a juvenile specimen from a wooded flat on the Pinnebog River (37). Around Caseville, it was found in considerable numbers under driftwood and in the grass on the dry, wet and wooded flats along the Pigeon River (35, 36, 37).

45. **Cochlicopa lubrica,** var. **morseana** (Doherty).—This elongate form was found on the dry and the wooded creek flats (36, 37) along the Pigeon River, in the same localities as the typical individuals, but in larger numbers; intermediate examples were also present.

Vallonidae.

46. **Vallonia pulchella** (Müller).—This species was found in small numbers on a low flat along the Pigeon River (35) and in larger numbers under rocks in a dry pasture (41) near Rush Lake.

Auriculidae.

47. **Carychium exiguum** (Say).—This species was quite abundant in wet places on the mainland thruout the region. It was found to be very abundant under driftwood and among decaying sedges along the middle beach (25) and was taken in considerable numbers in wet places on the borders of swamps, etc., on Sand Point. In the latter locality, however, it was not nearly so abundant as its companion

species, *Carychium exile.* It was also found, but in lesser numbers, on a wooded flat along the Pigeon River, under driftwood in wet places (37), and under fallen logs, etc., in quite dry woods (39) and in an open meadow near a cedar thicket (40) at Rush Lake. It was obtained in greater abundance from similar places in a wet woods (38) near Rush Lake.

48. **Carychium exile** H. C. Lea.—This species occurred in about the same localities as the preceding species. Specimens were found, in larger numbers than those of *Carychium exiguum,* around the borders of swamps, etc. (26), but in lesser numbers on the sand beach (25) at Sand Point. It was found in the wet meadows along the Pigeon River (35) where *Carychium exiguum* was not found, and on the wooded flats farther up the river (37), and in about the same places (38, 39, 40) and in the same abundance as the preceding species at Rush Lake.

Lymnaeidae.

49. **Lymnaea stagnalis,** var. **appressa** (Say).—This species was quite abundant in the sedge marshes (7) along the shores of Sand Point and near Caseville, on the mucky bottom in Rush Lake (11) and near the mouth of a county drain (17) which emptied into the lake. The shells vary considerably, as is characteristic of this species. Those from Rush Lake are, as a general rule, smaller and more slender than those from the Bay. An extreme from Rush Lake measures: altitude 29.5mm., width 10.25mm., aperture length 15mm., aperture width 7mm.; one from the Bay: altitude 53.5mm., width 23.5mm., aperture length 28.5mm., width 16mm.

50. **Lymnaea haldemani** "Dkr." W. G. Binney. — A dead shell of this species was collected in about six inches of water in a place where the marl layer over the sand was quite thick, off Dune Point (15). This specimen could not have been long dead, as it was in excellent condition. Several other dead specimens were found that were so fragile that they could not be saved. The shell measures: length 20.5mm., width 4.5mm., aperture length 9mm., aperture width 3mm.

51. **Lymnaea obrussa** Say.—A very few specimens of this shell were found at Sand Point, in a shallow, marly-bottomed marsh at the east end of Wild Fowl Bay (7) and on the under side of lily-pads in Turtle Bay (8), and at Rush Lake juvenile specimens were obtained off Dune and Fourth Points (15, 16). A representative example from Sand Point measures: altitude 8.5mm., width 4.5mm., aperture length 5mm., aperture width 3mm.

Lymnaea obrussa Say, small form.—Shells thus labeled by Mr.

Walker were obtained on leaves on the bottom of a large swamp (19) on Sand Point, on driftwood along a marshy shore in the upper portion of Pigeon River (23) and in a sand pool on the beach at Little Oak Point (6). They are small and narrow. An example from Sand Point measures: altitude 6.5mm., width 3mm., aperture length 3mm., aperture width 1.5mm.

Lymnaea obrussa, var. approaching **decampi** (Streng).—A juvenile, very fragile shell found at Raymond's Point (14) and heavier, adult specimens obtained from off Dune Point (15) are intermediate between the typical species and the variety.

52. **Lymnaea obrussa,** var. **decampi** (Streng).—Typical specimens of this form were obtained from the shallow water off Dune Point (15). An example measures: altitude 9.25mm., width 4.75mm., aperture length 4.5mm., aperture width 2.75mm.

53. **Lymnaea humilis** Say.—A single specimen of this shell was found on floating driftwood in the mucky part of Turtle Bay (8). A few specimens were also obtained from driftwood in the ox-bow pond near the mouth of Pigeon River (22) and along a marshy bank of the river itself (23). A considerable number of shells were collected in rocky pools along the north shore of Stony Island (3).

54. **Lymnaea catascopium** Say.—A single dead shell of this species was found on the north shore of Sand Point. It had probably been washed up from deep water (1) as that is the only habitat in the neighborhood that it could have come from. The shell is quite large, measuring: altitude 21mm., width 12mm., aperture length 12.5mm., aperture width 7.5mm.

55. **Lymnaea emarginata,** var. **ontarioensis** (Mühlfeldt).—This form was very abundant on limestone rock off the north shore of Stony Island, on the docks in the same locality (2) and in the rock pools along the shore (3). The shells are quite heavy, and are almost pure white outside and pinkish inside. There is considerable variation in size among them. Some are malleate, others not; some are long and narrow with the aperture only about one-half as long as the entire shell, others are wide with the aperture almost two-thirds the length of the shell. Extremes measure: altitude 18.5mm., width 9.75mm., aperture length 10mm., aperture width 9.75mm.; and altitude 15.5mm., width 11mm., aperture length 10.25mm., aperture width 7.5mm. Some of the shells are perforate but the majority are not.

56. **Lymnaea palustris** (Müller).—In this region, *Lymnaea palustris* was the characteristic shell of the temporary swamp (18). Owing to the work being done in the summer, a large part of the shells were found buried in the leaves, aestivating, where ponds had been

in the spring. This species was found in abundance wherever the temporary swamps (18) were studied, on Sand Point, North and Stony Islands, and around Rush Lake. It was also found, but in lesser numbers, in protected marshes (7) and in Turtle Bay (8), on Sand Point, in rock pools along the north shore of Stony Island (3), in the creek portion and in the "dead waters" of the Pigeon River (23, 24), in a sedge marsh (12), in perennial swamps (19) and in a county drain (17) at Rush Lake; and in sand pools (6) along the beach at Hat Point.

Lymnaea palustris, var.—The majority of the specimens obtained from a certain temporary swamp (18) on Sand Point are elongate, small, little malleated, and have a very heavy internal callus on the lip. A representative example measures: altitude 18mm., width 7.75mm., aperture length 9mm., aperture width 4mm. An example of the short, light-colored, little malleated specimens that were collected from the rock pools (4) on Stony Island measures: altitude 18.25mm., width 9.5mm., aperture length 10.5mm., aperture width 6.5mm. Of some large, slender, and heavily malleated specimens that were found in a temporary swamp (18) on Stony Island, an extreme measures: altitude 31mm., width 11mm., aperture length 12.5 mm., aperture width 6mm.

57. **Lymnaea palustris**, var. **michiganensis** Walker.—A considerable number of juvenile shells of this form were collected from a temporary swamp (18) on Sand Point. A few young specimens were also obtained from the upper portion of the Pigeon River (23) and from a large, perennial swamp on Sand Point (19). A number of adult shells were found in an annual swamp near Rush Lake (18).

58. **Lymnaea palustris**, var. **zebra** Taylor.—The striped form of *Lymnaea palustris* was found abundantly in two of the temporary swamps on Sand Point (18) and in shallow water in a sedge marsh along the shore of Rush Lake (12). Most of the shells are striped longitudinally, often with serrated or wavy stripes, and one specimen from Rush Lake is spirally striped.

59. **Lymnaea reflexa** Say.—This species was characteristic of the protected sedge marshes of the Bay (7) just as *Lymnaea palustris* was of the temporary swamps in this region (18). It was found in great abundance in this habitat at Sand Point, Stony Island, and Caseville. It was also collected in small numbers at Sand Point, in Turtle Bay (8) and in a large perennial swamp (19); at Stony Island, in a protected marsh on the rocky north shore (4); and at Caseville, in the ox-bow pond of Pigeon River (22).

60. **Lymnaea reflexa**, var.*—Some specimens obtained from the

* Baker, H. Burrington. Variations in Lymnaea reflexa Say, from Huron County. 12th Ann. Rept. Mich. Acad. Sci., pp. 60-63.

sedge marshes and Turtle Bay (7, 8) at Sand Point are striped transversely, much as *Lymnaea palustris zebra* except that the stripes run at right angles to the usual direction of the bands on that form. Other specimens collected in Turtle Bay are considerably broader than normal. An example measures: altitude 28mm., width 11mm., aperture length 14.25mm., aperture width 7mm. Those from the perennial swamps on Sand Point and Stony Island (19) are, on the other hand, large, elongate and very often strongly but irregularly malleate. One of these measures: altitude 29.25mm., width 10.5mm., aperture length 12.5mm., aperture width 7mm. Some of the shells from these swamps on Stony Island are, in addition, somewhat scaliform, with the suture quite deeply impressed.

61. **Lymnaea reflexa,** var. **walkeri** Baker.—The scaliform variety was found in small numbers with the typical shells in two of the sedge marsh habitats (7) and in Turtle Bay (8) at Sand Point.

Lymnaea sp?—Juvenile specimens, too young to identify, were obtained in a temporary swamp (18) and off Dune Point (15) at Rush Lake.

Planorbidae.

62. **Planorbis bicarinatus** Say.—This species appeared to be very rare in the region studied as only four specimens were obtained. One of these was brought up on the nets of the fishermen from deep water off Sand Point (1), the other three were found among algae, principally *Vaucheria*, along the shores of the Pigeon River (21). The specimen from Sand Point is pure white and very sharply carinated; the specimens from the river are considerably roughened by the growth lines. The largest of the latter measures: greater diameter 13.25mm., aperture length 7mm., aperture width 6.25mm.

63. **Planorbis trivolvis** Say.—This shell was widely distributed and quite abundant in the region studied. It was found as follows: at Sand Point, on decaying sedges and driftwood in the sedge marshes (7) and in Turtle Bay (8), on lily-pads in the lakes (9, 10) and on leaves on the bottoms of the perennial inland swamps (19); on North and Stony Islands, on driftwood, etc., in the protected swamps along both the rocky and sandy shores (4, 7) and in the perennial swamps (19); at Caseville, in a sedge marsh (7) on the Bay near the mouth of the Pigeon River, among algae thruout the river itself (21, 23) and on lily-pads and driftwood in the ox-bow pond (22), and in the "dead waters" (24) off from it; and at Rush Lake, in the perennial swamps (19), on lily-pads in the lake where the bottom was mucky (11), in the wet places in the sedge marshes (12) and in a county drain (17).

The shells from the Bay were, as a rule, larger and heavier than those from inland waters.

64. **Planorbis truncatus** Miles.—Only two living specimens of this species were obtained, but dead shells were quite common in places along the exposed north shore of Sand Point. The two living specimens, which were juvenile, were collected from floating driftwood and dead sedges in a protected sedge marsh on the south shore of Sand Point (7) near Turtle Bay. The dead shells had probably been washed up from deep water (1), as continued search did not reveal any adult specimens anywhere. It seems probable that in this region the species lives during the summer in deep water, and comes into shallow water at certain seasons of the year to breed, etc., as has already been noted in the case of *Lymnaea megasoma*.

65. **Planorbis campanulatus** Say.—Typical specimens of this shell were obtained from the ox-bow pond of the Pigeon River (22), on *Potamogeton*, lily-pads, etc.

Planorbis campanulatus, var.—Many of the specimens of this shell are far from typical, the size being smaller and the whorls narrower, the lips not so strongly campanulate, and the reflection more abrupt, the end of the last whorl turning upward very much after the manner of variety *minor*, which shell they somewhat resemble. A shell from Sand Point measures: height 5mm., greater diameter 11.5mm., aperture length 4.5mm., aperture width 3mm.

This type of shell was obtained from the lakes on the south side of Sand Point (10), and from the upper portion of the Pigeon River (23) and the ox-bow pond off from it (22). A specimen was also found washed up on the rocky east shore of Stony Island (2). Shells nearer the average for *campanulatus* were collected from Stony Island and Caseville, in the same localities as the more aberrant ones. In the latter locality typical shells were found, as mentioned above.

66. **Planorbis campanulatus,** var. **minor** Currier.—Dead shells of this variety were found in large numbers in Rush Lake. These appeared to be fresh shells, but no living specimens were found. An individual measures: height 4.5mm., width 9.75mm., aperture length 4mm., aperture width 4.25mm.

67. **Planorbis exacuous** Say.—This shell was obtained on driftwood in the sedge marshes (7), on driftwood and lily-pads in Turtle Bay (8), on lily-pads and decaying leaves in the lakes (9, 10) and on leaves in the perennial swamps (19), at Sand Point; on driftwood in protected places along the shores, both rocky and sandy (4, 7), on Stony Island; and on driftwood in the ox-bow pond of the Pigeon River (22). The amount of carination varies considerably in these shells.

68. **Planorbis hirsutus** Gould.—Specimens of this shell were obtained in small numbers at Sand Point, from the under-side of lily-pads in Turtle Bay (8); on Stony Island, from lily-pads in the large swamps (19) and from driftwood in a marsh along the protected rocky shore (4); and in Rush Lake, off Dune Point (15). Some of the specimens are quite strongly carinated, others show very little carination.

69. **Planorbis deflectus** Say.—This species was not found so widely distributed as the two preceding ones, but it was more abundant in the localities where it was found. It was collected at Sand Point, from decaying driftwood in the sedge marshes (7), and on Stony Island, from lily-pads in the perennial swamps (19).

70. **Planorbis parvus** Say.—This shell appeared to be the most abundant and widely distributed of the small planorbices in this region, just as *Planorbis trivolvis* was among the larger ones. It was found at Sand Point, on the under-side of lily-pads and driftwood in Turtle Bay (8) and on decaying leaves in an annual swamp (18); in the Pigeon River, among algae (21), on lily-pads in the ox-bow pond (22) and in the dead water, (24); at Rush Lake, on the bottom off Raymond's, Dune, and Fourth Points (14, 15, 16) and in a perennial swamp (19); and near Little Oak Point, in an old stone quarry (20).

Planorbis parvus, var.—A variation that was slightly carinate and concave, above and below, was collected in a perennial swamp (19) near Rush Lake.

71. **Planorbis parvus,** var. **walkeri** Vanatta.—A single individual of this form was found in a temporary swamp (18) near Rush Lake.

72. **Planorbis umbilicatellus** Cockerell.—Single specimens of this species were collected from temporary swamps (18) on Sand Point and at Rush Lake.

73. **Planorbis crista** (Linné).—A shell of this species was found on the under-side of a lily-pad in a perennial swamp (19) on Stony Island, and two others in the sedge marsh (12) at Rush Lake.

Planorbis sp?—Some specimens, too young to identify, were found in temporary swamps (18) on Sand Point and near Caseville.

74. **Segmentina armigera** (Say).—This species was obtained in considerable abundance on Sand Point, from a perennial swamp (19); on Stony Island, from a temporary swamp (18); and from Rush Lake from both kinds of swamps (18, 19). An example measures: greater diameter 7.5mm., height 2.75mm., aperture height 2.5mm., aperture width 2.25mm.

75. **Segmentina crassilabris** Walker.—This species was collected in small numbers from driftwood in the upper portion of Pigeon River (23) and from temporary swamps (18) near Rush Lake. A

shell measures: greater diameter 6.5mm., height 2.75mm., aperture height 2mm., aperture width 1.75mm.

Segmentina crassilabris, var.—A variation of the species was found on Sand Point, on leaves on the bottom of the larger lakes (10), and in a perennial swamp (19). This form has not so strong a callus on the lip as has the typical form, nor is the lower lip so strongly carinate; it is even higher in proportion to its diameter. A representative example measures: greater diameter 6.75mm., width 3mm., aperture height 2.5mm., aperture width 2.25mm.

Ancylidae.

76. **Ancylus fuscus** C. B. Adams.—Only one specimen of this species was found. It was obtained from a board which was floating on the water in the ox-bow pond off the Pigeon River (22). This shell is quite narrow and high, measuring: length 6mm., width 4mm., altitude 1.75mm.; the left slope is quite convex, while the right is straight.

77. **Ancylus parallelus** Haldeman.—This shell was found in small numbers in a cove on the south shore of Sand Point (8), in considerable abundance in the ox-bow pond off the Pigeon River (22) and in the dead waters several miles up the same river (24), and from mucky-bottomed portions of Rush Lake (11). In all of these places the specimens were found on the under-side of lily-pads. The specimens from Sand Point are narrow, and the sides are quite parallel; those from Caseville and Rush Lake are more typical, are broader and wider anteriorly. All of the shells are small; one of the larger examples from Sand Point measures: length 4.25mm., width 1.25mm., altitude 1.25mm.; one from Rush Lake: length 4mm., width 2.25 mm., altitude 1.50mm.

Physidae.

78. **Physa ancillaria** Say.—A few specimens of this species were found on rocks in an old wharf near Little Oak Point. A representative example measures: altitude 11.5mm., width 7.25mm., aperture length 9mm., aperture width 4mm.

Physa ancillaria, var.—Two specimens of this species that are not typical were brought up on the nets of the fishermen from about twenty feet of water, a mile off the north shore of Sand Point (1). One is a deformed shell, but apparently is the same form as the other, which is a fragile shell, with the last whorl enlarged at the top so that it swells considerably out of the line of the conical first whorls. In shape it somewhat resembles the variety *magnalacustris*, but the last whorl enlarges more abruptly at its upper end. It measures: altitude 9.5mm., width 6.5mm., aperture length 6.75mm., aperture width 3mm. The deformity of the other specimen has apparently been caused by an injury near the beginning of the last whorl, which is greatly enlarged. The shell measures: altitude 12.25mm., width 9.25mm., aperture length 9.5mm., aperture width 5mm.

79. **Physa ancillaria**, var. **magnalacustris** Walker.—This variety was collected in considerable numbers on the limestone rock bottom off the north shores of North and Stony Islands (2), and from rock pools along the shore of the former (3). A thin form was also found on the rocks of a wharf off the north shore of Sand Point. An example of the former measures: altitude 14.25mm., width 10mm., aperture length 11mm., aperture width 6.25mm.; of the latter: altitude 15mm., width 11mm., length of aperture 12.25mm., aperture width 7mm.

80. **Physa sayii** Tappan.—A single specimen of this species was obtained from Turtle Bay (8), from the under-side of a piece of driftwood. It measures: altitude 17mm., width 9.75mm., aperture length 13mm., aperture width 6.25mm.

81. **Physa heterostropha** (Say).—This species was fairly abundant and quite widely distributed in the region studied. It was found as follows: in the sedge marshes (7) and on lily-pads in Turtle Bay (8), at Sand Point; on rocks off the north shore of North Island (2); among algae along the shores of the Pigeon River (21) and on the under-side of lily-pads and driftwood and among *Potamogeton* in the ox-bow pond off the river (22); and on the under-side of lily-pads in the mucky-bottomed portions of Rush Lake (11). The specimens obtained from North Island are very light-colored, some of them being pure white. All of the specimens are quite small: one of the largest measures: altitude 10.25mm., width 6.25mm., aperture length 7.75 mm., aperture width 3.25mm.

82. **Physa gyrina** Say.—This shell was more abundant locally than the preceding and was almost as widely distributed. It was found on driftwood in the sedge marshes (7) and on driftwood and among grass in Turtle Bay (8), at Sand Point; on the under-side of lily-pads in the dead waters several miles up the Pigeon River (24); and in temporary and perennial swamps (18, 19) and in a county drain (17) at Rush Lake. The shells are mostly small; the largest one measures: altitude 16.5mm., width 10.75mm., aperture length 12.5mm., aperture width 6.5mm.

83. **Physa gyrina**, var. **hildrethiana** (Lea).—A few specimens of this variety were obtained from a temporary swamp (18) near Rush Lake. The largest one measures: altitude 14mm., width 7.5mm., aperture length 10.5mm., aperture width 4.75mm.; it is considerably malleated.

84. **Physa elliptica** Lea.—This shell appeared to be quite rare in the region studied. A few specimens were found in a temporary swamp (18) and in a perennial swamp (19) on Sand Point, and in the dead waters of the Pigeon River (24). An example measures: altitude 7.5mm., width 4.5mm., aperture length 5.5mm., aperture width 2mm.

85. **Physa integra** Haldeman.—A few juvenile shells of this species were collected among algae, principally *Vaucheria*, in the creek and river portions, and on the under-side of lily-pads in the dead water of the Pigeon River (23, 21, 24).

86. **Aplexa hypnorum** (Linné).—This shell was very abundant in the temporary swamps (18) on Sand Point, Stony and North Islands, and around Rush Lake. Juvenile specimens were also obtained from a perennial swamp (19) on Sand Point and from one near Rush Lake. The shells are quite narrow: a representative specimen from Sand Point measures: length 14.25mm., width 6mm.; from Stony Island: length 15mm., width 6.25mm.; from Rush Lake: length 17.5mm., width 7.5mm.

PECTINIBRANCHIA.

Pleuroceridae.

87. **Pleurocera subulare,** var. **intensum** (Reeve). — This species was found in great abundance off Raymond's Point (14) in Rush Lake, living in from about six to forty-eight inches of water. An example measures: altitude 21.5mm., width 8mm., aperture length 7.5mm., aperture width 4.5mm.

88. **Goniobasis livescens** (Menke).—This species was found in great numbers in the unprotected, rocky, littoral habitats off the north shores of both North and Stony Islands, both on the limestone rock that forms the bottom and on piers of wharves, etc., in the same localities (2). It was also collected in rock pools (3) along these shores. In the Pigeon River (21), from about one-half mile from the mouth up as far as the creek portion, these molluscs almost cover the stones on the bottom. A single specimen was found on *Potamogeton* in the ox-bow pond (22) off from this river. A few specimens were also found on the rock bottom off Little Oak Point (2).

The shells obtained off the shores of North and Stony Islands and Little Oak Point are heavy, and often have concretions of marl on them. Those from the Pigeon River are comparatively fragile, strongly malleated, and encrusted with a growth of algae.

Goniobasis livescens, var.—A few shells were obtained off Sand Point in deep water (1) and one from shallow water off Twin Bars (5) that are not typical. They are somewhat narrower, and the whorls are much less convex. They somewhat resemble the specimens of *Pleurocera subulare intensum* obtained from Rush Lake. An example measures: altitude 17mm., width 7mm., aperture length 7mm., aperture width 4.5mm.

Amnicolidae.

89. **Amnicola limosa** (Say).—In this region, this species was the most widely distributed of the genus, altho it was the most abundant one only around Caseville. Specimens of *Amnicola walkeri* were more numerous on Sand Point, and shells of a form of *Amnicola lustrica* in Rush Lake. A single juvenile specimen was found on the under-side of a lily-pad in Turtle Bay (8) on Sand Point. Around Caseville it was very abundant in the masses of algae along the Pigeon River (21) and on lily-pads and *Potamogeton* in the ox-bow pond (22) off from the same. Specimens of this species were quite numerous in Rush Lake, on the under-side of lily-pads in places where the bottom was mucky (11) and on the bottom in sandy and gravelly places (14, 15, 16). In these latter places it was found in the very shallow water along the shore.

90. **Amnicola lustrica** Pilsbry, var?—Shells referred to this species were found in great abundance off Raymond's, Dune, and Fourth Points (14, 15, 16) at Rush Lake. They differ from typical shells in having the basal whorl larger and more ventricose, and the aperture more nearly circular; these make the shell somewhat broader. An example measures: length 3.90mm., width 2.2mm.

91. **Amnicola walkeri** Pilsbry.—This species was the most abundant *Amnicola* on Sand Point, where specimens were quite numerous in a cove on the south side (8) and in one of the more permanent swamps (19). A single juvenile shell was also obtained on the gravelly bottom off Fourth Point (16) in Rush Lake.

92. **Amnicola cincinnatiensis** Anthony.—Only one specimen of this species was obtained. This was found in a small basin along the shore of the creek portion of Pigeon River (23). It is slightly smaller than the average, being 4.5mm. in height.

Valvatidae.

93. **Valvata tricarinata, var. simplex** Gould.—Specimens of this form were obtained in large numbers at Rush Lake, off Raymond's and Dune Points (14, 15). They were much more numerous off the latter. Some of the shells approached closely the following form.

94. **Valvata tricarinata, var. unicarinata** (De Kay).—This shell was collected in large numbers off Dune and Fourth Points (15, 16)

at Rush Lake. They occurred in greater numbers off the former. As mentioned above, shells intergrading between the unicarinate and non-carinate forms were found in abundance.

Viviparidae.

95. **Campeloma decisum** (Say).—A single specimen that has been referred to this species by Mr. Walker was brought up on the nets by the fishermen, from about twenty feet of water, a little over a mile north of Sand Point (1). The shell is heavily eroded and measures: length 12mm., width 9mm., aperture length 7.5mm., aperture width 6mm. The epidermis is green with a tinge of red at the apex.

96. **Campeloma integrum** (De Kay).—A single juvenile or dwarf specimen of this species was brought up with *Campeloma decisum* from about the same situation as that shell (1). Its epidermis is copper-colored and its measurements as follows: length 19.5mm., width 13mm., aperture length 10.5mm., aperture width 8.5mm. Specimens were also found in considerable numbers buried in the sand in shallow water along the shore of the ox-bow pond off the Pigeon River (22), and in less abundance in the river itself, both in the creek and river portions (21, 23). The epidermis of these shells is green, sometimes tinged with reddish. Representative examples measure: male, length 25mm., width 14mm., aperture length 12mm., aperture width 10mm.; female, length 35mm., width 22mm., aperture length 19mm., aperture width 16mm.

97. **Campeloma rufum** (Haldeman).—Seven specimens of this species were obtained in the same manner and in the same locality as *Campeloma decisum* and the first specimen of *C. integrum* (1). Five are apparently females while two are males. They all have a copper-colored epidermis and are quite heavily eroded. The largest of each sex measure: female, length 16.5mm., width 13mm., aperture length 11.25mm., aperture width 8mm.; male, length 12.5mm., width 8.5mm., aperture length 6.5mm., aperture width 5mm.

PELECYPODA.

Unionidae.

98. **Lampsilis ventricosa** (Barnes).—This unione was very abundant all along the unprotected north shore of Sand Point (5). It also occurred, but in lesser numbers, along the protected south shore (7) of the Point, and on the unprotected, sandy, west shore of Stony Island (5). All of the shells are the small Great Lakes form. The beaks are considerably eroded. The largest male shell measures:

length 75mm., height 53mm., breadth 39mm., the largest female: length 70mm., height 49mm., breadth 42mm. The average specimen is considerably smaller.

99. **Lampsilis multiradiata** (Lea).—A single female specimen of this shell was obtained from the lower portion of the Pigeon River (21). It measures: length 58mm., height 36mm., breadth 23mm.

100. **Lampsilis luteola** (Lamarck).—This was the most abundant, widely distributed and variable unione in the region studied. The small Great Lakes form was found exceedingly abundant along the unprotected, sandy shores of Sand Point (5). It was also obtained, but in lesser numbers, from the protected sedge marshes (7) and the deep littoral habitat (1) off Sand Point, and the unprotected, sandy beaches of Stony Island (5) and near Little Oak, and Hat Points (5). The largest examples measure: male, length 64mm., height 37mm., breadth 23.5mm.; female, length 52.5mm., height 34.5mm., breadth 20mm.

The large river form occurred in considerable numbers in the lower portion of Pigeon River (21) and in the ox-bow pond (22) off the river near its mouth, and in small numbers in Rush Lake, in places where the bottom is mucky (11) or marly (13) and off Dune Point (15) where the bottom is sandy with a very thin layer of marl. The largest examples measure: male, length 119mm., height 66mm., breadth 42.5mm.; female, length 101mm., height 63mm., breadth 36.5mm. The specimens from Rush Lake are smaller; the largest specimen, a male, measures 86.5mm. in length.

As will be seen from the above measurements, the males in this region appear to attain a greater size than the females; this is true both in the thirty-odd specimens collected from the Pigeon River and in the specimens from Sand Point, which number about one hundred.

The few shells collected from Rush Lake were found entirely buried in the light muck, each with only a funnel-shaped cavity about four inches deep leading down to the siphons. When disturbed in this position, the mollusc, by suddenly ejecting water, caused the sides of the funnel to cave in and completely bury it. The ejection of the water appeared to be done by the sudden closing of the valves, as is common among bivalves when disturbed.

101. **Lampsilis recta,** var. **sageri** (Conrad).—A single male specimen of this Great Lakes form was obtained from shallow water along the unprotected sandy shore of Sand Point (5) off Twin Bars. It measures: length 87mm., height 37mm., breadth 20mm. The beaks are quite heavily eroded.

102. **Lampsilis nasuta** (Say).—This species was found quite

abundantly along the unprotected sandy shore of Sand Point (5), in shallow water. A single specimen was also collected in a similar locality off the shore of Stony Island. The beaks are considerably eroded. A large specimen from Sand Point measures: length 66mm., height 31mm., breadth 18mm.

103. **Lampsilis iris** (Lea).—A single specimen of this shell was obtained from the lower portion of Pigeon River (21), in quite shallow water. It measures: length 74mm., height 42mm., breadth 18mm. The beaks are somewhat eroded.

104. **Strophitus edentulus** (Say).—A single shell of this species was found in about four feet of water off the south, protected shore of Sand Point (7). It measures: length 83.5mm., height 43mm., breadth 33mm.; the beaks are quite heavily eroded.

105. **Anodonta marginata** Say.—This species was obtained in considerable abundance in Rush Lake, in places where the bottom was mucky (11), and off Dune Point (15), where the bottom was sand with a very thin cover of marl. A representative example measures: length 86mm., height 45mm., breadth 31mm. In mucky places these shells buried themselves as has been described for *Lampsilis luteola*.

106. **Anodonta grandis** Say.—A few specimens of the typical form of this species were collected in the lower part of the Pigeon River (21) and in the ox-bow pond off the river (22). The largest shell measures: length 118mm., height 65mm., breadth 39.5mm.

107. **Anodonta grandis,** var. **footiana** (Lea).—A single depauperate and deformed specimen of this form was obtained from the lower portion of the Pigeon River (21) and three shells of the lake form were collected from the unprotected sandy shore of Sand Point (5). The largest of the latter measures: length 85mm., height 44mm., breadth 33mm. The beaks are considerably eroded.

108. **Anodonta grandis,** var. **gigantea** (Lea).—This form was obtained abundantly in Rush Lake, in places where the bottom was mucky (11) or marly (13), or sandy, as off Raymond's and Dune Points (14, 15). It did not bury itself in the muck as did *Anodonta marginata* and *Lampsilis luteola*. An average example measures: length 115mm., height 63mm., breadth 40mm.

109. **Anodontoides ferussacianus,** var. **subcylindraceus** (Lea).—A juvenile individual of this species was found on the unprotected north shore of Sand Point (5). It was obtained in great abundance in the lower portion of the Pigeon River (21) and in the ox-bow pond off from it (22). A representative example measures: length 66mm., height 32.5mm., breadth 25mm.

110. **Anodontoides ferussacianus,** var. **modestus** (Lea).—This species occurred in considerable abundance in the ox-bow pond (22)

off the Pigeon River. An example measures: length 141mm., height 69mm., breadth 54.5mm.

111. **Alasmidonta calceola** (Lea).—This species appeared to be very rare in this region, only one specimen being found. It was collected on Little Oak Point, where it had been washed up alive into very shallow water on the bare sand beach (5) apparently from somewhat deeper water. The shell is quite small, being only 26mm. long, and is quite thin; the beaks are very heavily eroded, the left valve being worn thru in two places.

112. **Unio gibbosus** Barnes.—A single valve of this species was picked up along the sandy unprotected shore of Sand Point (5) and an entire specimen was obtained from a similar locality on Stony Island. Both are the small Great Lakes form: one of the shells measures: length 60mm., height 31mm., breadth 31mm.

113. **Quadrula undulata** (Barnes).—A few dead shells of this species were obtained from the Pigeon River, both in the upper and the lower portions (23, 21). It seems probable that the shell is still living in the lower part. An example measures: length 94mm., height 73mm., breadth 31mm.

114. **Quadrula rubiginosa** (Lea).—A single dwarfed shell of this species was obtained from the lower portion of the Pigeon River (21). It measures: length 49mm., height 37.5mm., breadth 20.5mm.

Sphaeriidae.

115. **Sphaerium solidulum** (Prime).—This species was found in considerable abundance among algae, principally consisting of *Vaucheria*, along the banks in both the upper and the lower portions of the Pigeon River (23, 21). The largest shell measures: length 11.5mm., height 9.5mm., breadth 7mm.

116. **Sphaerium striatinum** (Lamarck).—This species was collected, together with the preceding species, but in lesser abundance, from both the upper and the lower portions of the Pigeon River (23, 21). The largest shell measures: length 11.5mm., height 8mm., breadth 5.75mm.

117. **Sphaerium sulcatum** (Lamarck).—Considerable numbers of this shell were obtained from Rush Lake, on the gravelly and sandy bottom off Raymond's, Dune, and Fourth Points (14, 15, 16). It was not found in .such abundance as *Sphaerium flavum* off Raymond's Point, but this was the only habitat where the latter was found. A representative example measures: length 18mm., height 12.5mm., breadth 9mm.

118. **Sphaerium occidentale** Prime.—Together with *Lymnaea palustris* and *Musculium truncatum*, this species appeared to be one of

the dominant shells of the temporary swamp habitat (18), probably on account of a similar ability to withstand considerable dessication. It was collected in such places on Sand Point, North and Stony Islands, and near Rush Lake. It was also obtained, but in lesser abundance, from the perennial swamps (19) on Sand Point and near Rush Lake. A large shell measures: length 7.75mm., height 7mm., breadth 4.5mm.

119. **Sphaerium flavum** (Prime).—As mentioned above, this species was found in great abundance in Rush Lake, off Raymond's Point (14). An example measures: length 11.75mm., height 9mm., breadth 7mm. The beaks of the older specimens are considerably eroded.

120. **Musculium truncatum** (Linsley).—In this region, this species occurred most commonly, along with *Sphaerium occidentale*, in the annual swamps (18). It was found in considerable abundance in such places on Sand Point and near Rush Lake. It was also found, but in lesser numbers, in a perennial swamp (19) on Sand Point, and off Dune Point (15) and among *Sphagnum* in a tamarack swamp (42) at Rush Lake. The specimens obtained are small; the largest one measures: length 8mm., height 6.75mm., breadth 4.25mm.

121. **Musculium securis** (Prime).—This species was found quite abundantly in Turtle Bay (8), in the sand dune lakes along the north shore (9) and in the perennial swamps (19) of Sand Point; in perennial swamps on Stony Island and near Rush Lake (19); and in an old stone quarry (20) and among *Sphagnum* in a tamarack swamp (42) near Rush Lake. The shells are small thruout the region, those from the sand dunes especially so, and are labeled "small form" by Dr. Sterki. The largest shell from this locality measures: length 5,5mm., height 4.75mm., breadth 3.25mm. A representative example from another habitat on Sand Point measures: length 7mm., height 6.5mm. breadth 4.25mm.; a more slender, truncate example from Turtle Bay measures: length 6.5mm., height 5mm., breadth 3.75mm.

122. **Musculium partumeium** (Say).—A few specimens of this shell were obtained in a temporary swamp (18) on Sand Point and in one near Rush Lake. They are marked "small form" in Dr. Sterki's identification; an example measures: length 8.75mm., height 7.5 mm., breadth 4.5mm.

123. **Musculium ryckhaltii** (Norman), var.—A few specimens that were thus identified by Dr. Sterki were collected in a perennial swamp (19) on Stony Island. One measures: length 5.5mm., height 5.5mm., breadth 3.75mm.

Musculium sp?—Shells too young to be identified were collected off Fourth Point (16) at Rush Lake.

124. **Pisidium abditum** Haldeman.—A few specimens of this species

were obtained among algae in the Pigeon River (22) and from an old stone quarry (20) near Little Oak Point. One of the former measures: length 3.25mm., height 2.75mm., breadth 2mm.

125. **Pisidium compressum** Prime.—A single living specimen of this shell was collected off Dune Point (15) in Rush Lake. It measures: length 2.5mm., height 2.25mm., breadth 1.5mm.

126. **Pisidium compressum, var. rostratum** Sterki.—A single valve of this form was collected off Dune Point (15) in Rush Lake. It measures: length 3mm., height 2.5mm., breadth (estimated for the complete shell) 2mm.

127. **Pisidium variabile** Prime.—A few dead specimens of this shell were found off Dune Point (15), in a somewhat muck-covered portion. One measures: length 3.5mm., height 3.5mm., breadth 2.5 mm.

128. **Pisidium vesiculare** Sterki.—A small number of specimens, a very few of which were living, were obtained from shallow water off Dune Point (15). An example measures: length 2.25mm., height 2mm., breadth 2.25mm.

129. **Pisidium splendidulum** Sterki.—This shell appeared to be the most abundant species of *Pisidum* in the places where it occurred. It was found in considerable numbers off Dune Point (15) and in lesser numbers off Fourth Point (16). An individual measures: length 2.25mm., height 2mm., breadth 1.5mm.

130. **Pisidium roperi** Sterki.—A few individuals of this species were obtained from a tamarack swamp (42) near Rush Lake. A representative example measures: length 3.75mm., height 3mm., breadth 2.25mm.

131. **Pisidium medianum** Sterki. A few specimens were obtained from Rush Lake, off Dune Point (15). Dr. Sterki notes that some of these are somewhat deformed. One of the more typical shells measures: length 2.5mm., height 2.25mm., breadth 2.5mm.

132. **Pisidium strengii** Sterki.—A few dead valves of this species were obtained from the shallow water off Dune Point (15) in Rush Lake. An example measures: length 2.5mm., height 2mm., breadth 1.5mm.

Pisidium sp?—A few indeterminate valves were collected from Dune Point (15) in Rush Lake.

Ann Arbor, Mich., June, 1910.

THYSANOPTERA AND ORTHOPTERA.

BY A. FRANKLIN SHULL

GENERAL INTRODUCTION.

When the field party of the Biological Survey of the State of Michigan was organized for the season of 1908, and I was asked to take charge of the entomological studies, I was given pretty free rein to limit the field as seemed best. While no opportunity was lost to collect in all orders of insects wherever this was practicable. I elected to work chiefly on the Thysanoptera and Orthoptera, laying emphasis upon the former. One of the least known and one of the best known groups of insects thus became the centers of attention. The data secured on these orders is thought to be of sufficient interest to warrant publication, to the exclusion of the scattering information obtained on other groups.

I wish to express my appreciation of the assistance and interest, in all my work, of the Chief Field Naturalist, Dr. A. G. Ruthven. Acknowledgments are made to the other persons to whom I have become indebted in the progress of the work, in the introductions to the discussion of the groups.

THYSANOPTERA.

INTRODUCTION.

In a list of literature dealing with Thysanoptera, which is fairly complete up to the time of its publication, Hinds (1902, pp. 221-231) includes 480 titles. The earlier papers were nearly all of a systematic nature, as are also many of the more recent ones. Many of the references are to textbooks or other compilations, and do not represent original work. A considerable number were issued from experiment stations or were published in agricultural periodicals, and were naturally concerned chiefly with the economic importance of the group,—the dangers of epidemics of thrips and the means of combating them. A few were written primarily as contributions to anatomy. Others were published by economic botanists interested particularly in the relation of thrips to plants.

When the papers falling into one or another of the above categories are deducted, the number which treat of the biological aspect is so small as to plainly indicate the need of work from the standpoint of the biologist. It is not intended to decry the publications mentioned, for many of them contain necessary and valuable contributions; I merely call attention to the paucity of biological investigations represented by them. It is true that some of the experiment station workers have studied the life histories of individuals; and they and others have accumulated a certain amount of data on habits, but any one acquainted with the present state of knowledge of the order Thysanoptera must feel that there are large gaps waiting to be filled.

This report is intended as a small beginning toward the obliteration of the vacant spots. While some systematic work was done, the new results of which were published in an earlier paper (Shull, 1909), the biological aspect was made the principal subject of investigation. Much work that was highly desirable could not be undertaken, owing to the limitations of field work. Perhaps the most crying need now is the definite and accurate working out of the life cycles of the various species. This is sure to yield information of considerable biological interest.

In addition to the acknowledgments made in the general introduction to this paper, I wish to express my thanks to Dr. W. E. Hinds for verifying or correcting my identifications of a number of species of the Thysanoptera collected; to Mr. E. P. Van Duzee for the identification of a bug found predaceous on thrips; and to Mr. C. K. Dodge for the determination of most of the plants on which thrips were collected. Assistance pertaining exclusively to the description of new species in my earlier paper (Shull, 1909) was acknowledged in that paper.

SCOPE OF INVESTIGATIONS.

All studies and collections of Thysanoptera were made in Huron County, Michigan, between June 15 and August 27. (See map.) The localities most thoroughly studied were Sand Point, from base to tip; Stony Island, the middle one of three islands which partly enclose Wild Fowl Bay, south of Sand Point; and the region north and east of Rush Lake. Some collections were made in the immediate vicinity of Caseville; a few habitats were examined near Bayport; and a hasty survey was made of North Island, north of Stony Island.

A brief description of these regions will be to the point. The shore of Lake Huron was bordered, at nearly every part of the region studied, by smooth beaches and a strip of sand dunes, of variable width. It thus happened that the great majority of localities studied were of a sandy nature. (Pls. I, II, III.) Sand Point, which projects about four miles westward into the bay, north of Wild Fowl Bay, was nearly all sand and comparatively well wooded. Two or three small lakes or ponds were found on it, and several interior places were quite wet when work was begun in June, but were rapidly drying. At the base of the point was a treeless area of several hundred acres called the "prairie", which was said to have been quite marshy in the spring, but was nearly dry during the summer. (Pl. VI.) Inland from this "prairie" was clay farming country. At Caseville the sandy strip was very narrow, the clay country reaching almost to the lake. On Stony Island, with an area of some 900 acres, the sand was least in evidence of any of the localities studied. Good sand beaches were almost wanting, rocks were scattered rather profusely over the bottom in shallow water, and on the west side of the island there was an outcropping of bed rock. (Pl. XIV.) In the interior were several small ponds (Pl. VIII b) and dry marshes; on the east the island was bordered by low wet areas (Pl. V).

Rush Lake, four or five miles to the east of Caseville, occupies a depression lying landward of the oldest sand dune, on the north of it. (Pls. IX, Xa.) . Between it and Lake Huron is a strip of sand ridges roughly parallel to each other, the whole strip averaging perhaps a mile in width (Pl. IV b). Rush Lake itself is about two miles long northeast and southwest, by a mile wide, and is comparatively shallow. The bottom is covered in most places with a layer of soft, decaying plant remains, so deep in places that it is difficult to find bottom. Several small islands, some of which seem almost to float on the water, so unsteady are they, are found at various points in the lake. In the water such plants as pickerel weed, water lilies, rushes, Equisetum, and sedges are found. Inland from this lake is clay country under cultivation. Rocks are found only near the shore and were studied by me in only one place near Rush Lake, namely, at Hat Point several miles to the northeast, on the shore of Lake Huron. Here the rock stands boldly out into the water, forming a blunt promontory with vertical or overhanging walls to a height of some 20 feet above the water.

This brief description of the region studied will suffice to indicate the character of vegetation which might be expected, and the insect fauna which might depend on the vegetation or directly on the nature of the region itself.

Six principal objects were kept in view throughout the study: (1) To discover what species existed in a given limited region, including any new species; (2) to devise a scheme of ecology applicable to Thysanoptera; (3) to study the habits of the members of the group, with especial reference to their dissemination; (4) to determine their abundance; (5) to study the life cycle of the more abundant species, in so far as it could be done without breeding them; and (6) to consider the economic features of the order. Naturally, some of these received more attention than others.

In pursuit of the first two objects, I aimed to examine the flowers of every species of plant that bloomed during my stay in the region, and the leaves of nearly all species. Some species were examined many times. I searched the leaves, I believe, of every species of tree, and the bark of many of them. Practically all the mosses and many of the fungi and lichens were examined, but without success. The various grasses were examined, and the turf sifted. All the insect-galls that came to my notice were searched. I estimate that one part or another of over four hundred species of plants were examined. It is not to be supposed, however, that the list of plants infested even approaches completeness; for many unsuccessful examinations of a given flower does not even make it probable that it is not sometimes infested. For example, the flower of Black-eyed Susan (*Rudbeckia hirta*) was searched in vain over thirty times in as many different localities, until a single specimen of *Euthrips tritici* was taken on it.

METHODS OF COLLECTING AND PRESERVING SPECIMENS.

There are two ways of collecting thrips. (1) One can go into the field armed with paper bags and other light receptacles, gather flowers, leaves, etc., promiscuously, and examine them at leisure at home or in the laboratory. (2) Vials of the killing fluid may be carried on field trips and the insects placed directly in them. In the latter case it is necessary to take specimens of only such plants as require identification. The former method has the advantage of rapidity and of requiring the minimum of time in the field. Its disadvantages are that rare material is likely to be lost or overlooked in the bags, and that one can never be sure just what part of the plant bore the thrips in the field. It is more important in many cases, I believe, for reasons which are explained under the heading of Ecology, to know the nature of the part of the plant inhabited by thrips than to know the species of plant. I have therefore rejected the method of collecting in bags, except when material was abundant, and then only after carefully noting the exact location of the thrips on the plant.

Specimens intended for immediate mounting were put directly into xylol, as Hinds (1902, p. 85) recommends. They adhered very readliy to a camel's-hair brush moistened with xylol, and came off as soon as they were dipped into the vial. After remaining in this for from one to several hours, they were mounted in balsam on slides. If left in xylol for a longer time, they tended to become brittle, and antennae were frequently broken between the second and third segments. The wings were usually spread by shifting the cover glass slightly after it had settled on the insect. A twisting motion accomplished this more readily than a direct lateral shift, and thick balsam was found better than thin. If the covers were moved gently, no serious injury was done; such injury as was done was usually due to brittleness caused by remaining too long in xylol, and would not have been avoided by adjusting the wings with fine bristles before applying the cover. In point of time required, at least, the method of shifting the cover glass has much in its favor, and this is no small item to the field worker. Known species can usually be identified without exposing the entire wing. If it was found that specimens thus mounted could not be determined with certainty, or that they were undescribed species not fully exposed to view, they were dissolved from the slide with xylol and remounted more carefully.

In some cases, species were taken in series too extensive to be mounted on slides. These were plunged into a killing fluid in the hope of preventing distortion. Carnoy's solution was used in the field, though I have employed others at different times. Final preservation was in 95% alcohol. Distortions were not wholly prevented, however, the insect being in nearly every case somewhat longer and more slender than in life.

ECOLOGY OF THE THYSANOPTERA.

Scheme of Classification.

It has been found impracticable to classify Thysanoptera according to the ecological schemes in use for this and many other groups. Jordan (1888, p. 603) divided Thysanoptera into three classes according to the food. The first was the flower-inhabiting class; the second included those which live on the under side of leaves; the third was made to comprise all other forms, such as those living on roots, under bark, on lichens, on fungi, under wet or dry leaves, or under decaying plant matter. This last category is too inclusive to be satisfactory from an ecological point of view.

The same species (*Euthrips tritici*) may be found on Kentucky blue grass (*Poa pratensis*) which grows in dry to moderately moist open situations everywhere; on Canada thistle (*Cirsium arvense*) and dog-fennel (*Anthemis cotula*) growing along roadsides; on the beach-pea (*Lathyrus maritimus*) and Pitcher's thistle (*Cirsium pitcheri*) which grow on sandy beaches; on the swamp rose (*Rosa carolina*) and cinquefoil (*Potentilla fruticosa*) growing in half-dry marshes; on heal-all (*Prunella vulgaris*) and woodland sunflower (*Helianthus divaricatus*) in open woods; on the button-bush (*Cephalanthus occidentalis*) and swamp milkweed (*Asclepias incarnata*) standing at the edges of ponds; and on pickerel weed (*Pontederia cordata*) which grows in shallow water sometimes far from the nearest land. It is therefore impossible to classify species of Thysanoptera as campestrian or sylvan, xerophile or hygrophile, as Morse (1904, p. 14) has proposed for Orthoptera. A glance at the list of plants infested by a single species makes it evident, furthermore, that thrips in general cannot be grouped according to their food plants. The same species sometimes feeds on plants of widely different orders. This is especially true of certain members of the suborder Terebrantia, of which *Euthrips tritici* (p. 208) and *Thrips tabaci* (p. 211) are the most common representatives in Huron County. The suborder Tubulifera is somewhat less general in food habits, but even among some of these the few plants inhabited by one species belong to very different groups.

The nature of the place inhabitated by species, however, is usually rather definite and characteristic of that species. An inspection of the habitats given in the annotated list of species (p. 207 *et seq*) will make this clear. One class of species, of which *Thrips tabaci* is typical, is to be found in chinks and crevices of plants, almost everywhere if the tissues are sufficiently tender. Among the florets of various compositae is a favorite situation. A single flower of the common white yarrow (*Achillea millefolium*) may harbor dozens of them, and one head of Canada thistle (*Cirsium arvense*) has been known to contain over a hundred of *Euthrips tritici*. Other flowers, if not large or open, furnish the right location. One umbel of the common milkweed (*Asclepias syriaca*) contained several hundred. But flowers are not alone in the list. I have found *Thrips tabaci* among the young buds and in tufts of small leaves of burdock (*Arctium minus*), among buds of boneset (*Eupatorium perfoliatum*) and in young curled leaves of balsam-poplar (*Populus balsamifera*). Other species live in narrow crevices in the bark of various trees.

More open and exposed situations, on the other hand, are the home of other species. Thus, *Anaphothrips striatus* was found rather common on the upper side of the leaves of wild rye (*Elymus canadensis*) and of sea sand-reed (*Ammophila arenaria*). On the former plants the adults showed a slight preference for the curled portions of the leaves, but many adults were also found wholly exposed, and the larvae were about as abundant on the flat leaves as on the rolled ones. Specimens of *Ctenothrips bridwelli* were found on the leaves of the star-flowered Solomon's seal (*Smilacina stellata*), and *Phyllothrips aspersus* on leaves of sweet-scented grape (*Vitis vulpina*), both without apparent attempt at concealment.

These examples are given, merely to indicate the character of the places occupied by the different groups of species. The complete list of plants is given for each species under the heading of "habitat" in the annotated list of species. Those species which inhabit narrow crevices I designate "interstitial"; those in exposed situations, "superficial". These classes may be conveniently subdivided according to the scheme given below. The species belonging to each class are indicated in their proper places, arranged alphabetically, not taxonomically.

1. Interstitial, living in closely concealed situations.
   a. Anthophilous division, dwelling in flowers.
      Aeolothrips fasciatus
      Anthothrips niger
      Anthothrips verbasci
      Chirothrips manicatus
      Euthrips tritici
      Euthrips fuscus
      Scirtothrips ruthveni

Thrips physopus
Thrips tabaci
b. Phlœophilous division, inhabiting bark.
Allothrips megacephalus
Neothrips corticis
Trichothrips beachi (?)
Trichothrips tridentatus
2. Superficial, living in exposed situations.
a. Poephilous division, living on grasses.
Anaphothrips striatus
Aptinothrips rufus (with its variety *connaticornis*)
Baliothrips basalis
b. Phyllophilous division, found on leaves other than grasses.
Ctenothrips bridwelli
Heterothrips salicis
Phyllothrips aspersus
Trichothrips brevicruralis

It is not meant by this classification that a given species is to be found only in the situations designated. Even *Euthrips tritici*, which is almost exclusively anthophilous, was taken on leaves of blackberry (*Rubus canadensis*), and in several other equally superficial situations. Some species really belong to more than one group. For example, *Chirothrips manicatus* is to be found on grass and in flowers. Such as these have been placed in the group which the majority of collections would indicate as the principal one. Other species have been found in too small numbers to warrant as yet a final ecological grouping. These are placed tentatively in the groups indicated by the few collections made. Further work is needed on the less common species; but care should be taken to note the condition of the individuals when captured. Thus, while some species undoubtedly live all the year round under bark scales, others apparently only hibernate there. Such species belong to the group indicated by their habitat during their season of activity.

Factors determining Habitat.

The question naturally arises, what are the factors which determine the habitat of a given species? Why is one species nearly always in flowers, another exclusively on bark? In the great majority of cases, the home of any animal is where proper food may be found or its enemies avoided or both. Other factors, such as climatic conditions, often play a rôle, but in a cosmopolitan order like the Thysanoptera this rôle can not, I believe, be other than a minor one. To the question regarding the factors determining the habitat of thrips, therefore, two answers suggest themselves: (1) The character of the food, and (2) the amount of protection afforded. If either of these factors predominates over the other in the case of an individual species, the effect of this predominance should be evident in the local distribution. (1) If character of food is exclusively, or even chiefly, responsible for the habitat, almost any part of a plant, provided it is tender enough to be pierced or rasped by the mouth parts of thrips, should be infested. At least we should expect the whole plant to be infested unless the enemies of and checks to Thysanoptera were powerful enough to remove them from the exposed portions of the plant after these were once infested. Furthermore, nearly related plants should be infested by the same species of thrips, whether or not they afford equal protection. No test of the influence of the character of food on the choice of food plants can be made by examining plants which afford abundant protection but have unpalatable juices, like the dandelion (*Taraxacum officinale*), or plants that have palatable juices but afford no protection. For what may seem to us highly unpalatable may be quite agreeable to thrips. (2) If, on the other hand, the protection afforded by a plant is the chief factor in determining whether it is likely to be inhabited by thrips, the exposed portions should not be occupied in equal degree with the concealed portions; and nearly related species of plants, which afford unequal degrees of protection, should be unequally infested.

The large number of plants on which *Thrips tabaci* and *Euthrips tritici* have been taken, in nearly every case from the flowers, close tufts of leaves, or some other equally concealed situation, suggests at once that for these two species, at least, the protection is the determining factor. It is interesting to note that on white clover (*Trifolium repens*) *Euthrips tritici* was often abundant, and on red clover (*Trifolium pratense*) not uncommon; while on the closely related yellow, and white, sweet clovers (*Melilotus officinalis* and *M. alba* respectively), on which the flowers are much more widely separated than in the species of *Trifolium*, and hence offer little protection, the same species of thrips was rare. The specimens of *Melilotus* examined were in localities in which these thrips were fairly abundant on other plants, so that opportunity was present for them to infest the sweet clovers also. From these observations, and the large number of unrelated or distantly related plants on which *Thrips tabaci* and *Euthrips tritici* may be found, I conclude that the local distribution of these two species is determined largely, and perhaps almost exclusively, by the protection afforded by the inhabited plants.

With two of the poephilous species, *Anaphothrips striatus* and *Aptinothrips rufus*, the case seems to be different. The former species was often found quite exposed on grass blades; or when found in concealed situations, it was usually among the young blades that were not yet unrolled (e. g., on sea sand-reed, *Ammophila arenaria*), and here the location may have been determined by the greater tenderness of the young leaves. Owing to the comparative scarcity of *Aptinothrips rufus* on blue grass (*Poa pratensis*), and to its sluggishness, I have no direct observations upon the degree of concealment of this species. But judging from the ease with which it could be swept from the grass with a net, I am inclined to place it among the superficial species, as shown in the classified list above. An examination of the habitat of *Anaphothrips striatus* (see p. 210) shows that it was captured in a large majority of cases from grasses; and *Aptinothrips rufus* with its variety *connaticornis* was swept or sifted only from grass collections that were largely, or exclusively made up of blue grass (*Poa pratensis*). It would appear from these observations that the local distribution of these two species of thrips is determined chiefly by the character of the food; while the fact that the adults of *Anaphothrips striatus* were more abundant on rolled leaves of wild rye (*Elymus canadensis*) than on flat ones would indicate that protection is a minor factor in distribution,—unless, indeed, it should be found that some of those which had been on exposed surfaces were washed off by rain, or captured by enemies, factors which have nothing to do with the distribution of the thrips in the first place.

Another species may be considered, namely, *Anthothrips verbasci*. Although hundreds of specimens were collected, not a single specimen was taken from any other plant than the common mullein (*Verbascum thapsus*). I have found as many as 874 specimens of this species, young and adults together, on a single spike of mullein about 17 cm. long. There seems no doubt that this species desires protection, for when disturbed both young and adults crawled away among the mullein buds or seed capsules. However, when the spike was crowded, a number of adults could often be found on the under side of leaves and on the stem, some of them more than 30 cm. below the spike. I have also transplanted these thrips from a spike of mullein to the leaves of a plant in its first year, which had no spike. Specimens thus transplanted were thriving two weeks after the change, at which time observations ceased. Here, apparently, is a species that seeks protection, but endures exposure rather than quit its food plant.

It is unnecessary to go into detail regarding each species. Using such data as has been employed in the case of the five species mentioned, namely, *Euthrips tritici*, *Thrips tabaci*, *Anaphothrips striatus*, *Aptinothrips rufus*, and *Anthothrips verbasci*, I have grouped all the species taken according to the factor which I believe plays the chief rôle in determining their habitat. The arrangement follows:

Habitat determined chiefly by food.

Anaphothrips striatus
Anthothrips verbasci
Aptinothrips rufus (with its var. *connaticornis*)
Baliothrips basilis
Ctenothrips bridwelli
Heterothrips salicis
Phyllothrips aspersus
Phyllothrips citricornis

Habitat determined chiefly by protection.

Aeolothrips fasciatus
Anthothrips niger
Chirothrips manicatus
Euthrips tritici
Euthrips fuscus
Scirtothrips ruthveni
Thrips physopus
Thrips tabaci

Factor determining habitat doubtful.

Allothrips megacephalus
Neothrips corticis
Trichothrips beachi
Trichothrips tridentatus
Trichothrips brevicruralis

The last group, comprising the doubtful species, is made necessary because specimens have been taken in too small numbers to justify a classification. It seems probable that the phlœophilous species (*Allothrips megacephalus*, *Neothrips corticis*, and *Trichothrips tridentatus*) will be found only on bark, and the few collections made suggest that some may be so highly specialized as to inhabit almost exclusively the bark of one species of tree.

Whether this is to be taken as indicating that the insects are influenced by food, or by protection, to choose the bark habitat can only be decided when the food of phlœophilous species is known. It is conceivable that they may feed upon the bark itself, or upon mucor or lichens growing on the bark. Several guesses have been made on this point, without, however, any evidence in support of them. I am unwilling, until more data are at hand, to hazard a conjecture as to the factor determining their habitat.

HABITS OF THYSANOPTERA.

Locomotion.

Crawling seems to be the only method of locomotion common to all thrips. Many are wingless, which precludes flight, and of both winged and wingless species a considerable proportion apparently do not leap. Crawling may be quite rapid, as, for example, in *Thrips physopus,* which crawls 1 inch in about a second, or very slow, as in *Aptinothrips rufus,* which travels 1 inch in 10 or 12 seconds in the average specimen. The tests were made on a sheet of smooth paper. In their natural habitat crawling may be much slower. Thus, for example, *Anthothrips verbasci* crawls more rapidly on paper than it does in the spikes of mullein (*Verbascum thapsus*), which is covered with large branching hairs. Temperature seems to have some effect on the general activity of thrips, and so to alter the rate of crawling. For example, *Chirothrips manicatus,* though at all times slow, would allow me, on cool mornings in August, to separate the florets of timothy between which it was located, and to push it with my brush before it would move. Sex also apparently has an influence on the rate of crawling. Thus, in *Euthrips tritici,* the female is larger than the male and nearly always crawls more rapidly, though the male is usually quicker in its individual movements, as Jordan (1888, p. 610) points out for the Terebrantia in general. It would doubtless be better here to say that rate of crawling is correlated with size, rather than with sex. In *Anthothrips verbasci,* where there is less difference in size between male and female, the male is rather the more active crawler; and occasionally even in *Euthrips tritici* the male crawls more rapidly, the female in one instance crawling 1 inch in 3.5 sec., the male 1 inch in 2.0 sec. These unusual cases are probably determined by physiological state.

Among the more rapid crawlers are *Euthrips tritici, Ctenothrips bridwelli, Thrips physopus, Thrips tabaci,* and *Aeolothrips fasciatus.* Several of the others, especially *Aptinothrips rufus* and the phlœòphilous species, are quite sluggish. Between these are all gradations of rapidity of crawling. It is interesting to note that the active species, when disturbed, nearly always come out of their concealed places if they are so located, and either take to flight, or crawl away along exposed surfaces. Of the more sluggish species, at least *Anthothrips verbasci* and the phlœophilous ones crawl at once, when disturbed, into some other neighboring crevice.

Flight is the chief method of locomotion for several species, and is of particular interest, as is shown later on, because of its relation to the dissemination of these insects. Three species, *Euthrips tritici, Thrips physopus* and *Thrips tabaci,* were found to be preeminently fliers;

Aeolothrips fasciatus, and probably *Trichothrips beachi* and *Ctenothrips bridwelli*, fly often; *Anaphothrips striatus*, *Chirothrips manicatus* and *Scirtothrips ruthveni* flew occasionally; *Anthothrips verbasci* and *A. niger* rarely; and *Aptinothrips rufus*, *Allothrips megacephalus*, *Neothrips corticis* and *Trichothrips brevicruralis* never.

The first two species were the best subjects for observations on flight. Large specimens of *Thrips physopus* found on dandelion (*Taraxacum officinale*) were especially favorable if placed on white paper. The method of flight is therefore described wholly from *Thrips physopus* and *Euthrips tritici*. The individual did not usually fly from a steeply inclined plane. It crawled up to the top of some eminence before attempting to spread its wings. If, as soon as it had reached such an eminence, its support were turned so as to leave the thrips at the bottom instead of at the top, the insect usually turned and crawled up again. The turning could often be repeated many times, until finally the thrips apparently lost its hold and dropped.

When the thrips had reached the point from which it was to take its flight, it began to curve up its abdomen at frequent intervals (0.7 sec. to 2.0 sec. were observed). The purpose of this was apparently to comb out the long fringes which border the hind margins of both wings, and which in the resting position of the wings lie nearly parallel to the longitudinal axis of the insect. There are many spines on the sides of the abdomen which doubtless serve as teeth to the comb. The abdomen was usually curved up several times in succession, in some cases eight or ten times. After this, I have seen a large female rest quietly with her abdomen raised and wings spread for two seconds or longer without any attempt at flight. Very often after combing out the hind fringes with the abdomen several times, the wings were laid back in resting-position, and the hind legs thrown over them. There followed a series of movements somewhat resembling those of a fly in cleaning its wings, during which the abdomen was slightly curved with its convex side upward. Apparently only the hind tibiae covered the wings; these tibiae are usually furnished with prominent spines. Furthermore it seemed that they did not extend to the posterior (inner when at rest) edge of the wings, so that the tibiae combed out only the costal fringes.

Meanwhile the legs were placed in a rather definite position, the middle legs nearly at right angles to the long axis of the body, the other two pairs very obliquely forward and backward respectively. Inasmuch as the direction of flight was usually more nearly perpendicular than parallel to the supporting surface, I judge that the middle legs are most effective as aids in starting flight. This seems the more probable, since in many cases the hind legs had scarcely finished combing the costal wing fringes when flight occurred, thus hardly giving them time to get a secure footing.

After few or many of these movements had been made, the insect would fly, and there was apparently no way of determining when it was ready to do so. Sometimes the abdomen was raised but once; in other cases I have found the entire preparation for flight to occupy over 20 seconds. The abdomen was sometimes lowered after combing the wings and before flight began, but flight was often commenced while the abdomen was still elevated.

The flight is irregular and dancing, often not unlike that of a very small midge in a swarm. The rapidity of flight varied considerably in different species and in different individuals of the same species. One specimen of *Euthrips tritici* flew about 30 cm., another 45 cm., in one second. The only specimen of *Ctenothrips bridwelli* which was timed flew about 90 cm. per second.

Leaping. The more active species, like *Thrips tabaci* and *Euthrips tritici,* frequently leaped for short distances. Hinds (1902, p. 112) has described leaping as being effected by elevating the abdomen and bringing it down forcibly upon the surface on which the insect rests. After many careful observations I am convinced that the movement of the abdomen is not the cause of the leap, for the abdomen was sometimes plainly still elevated when the leap occurred, and at other times the abdomen was lowered before the leap occurred, the two acts being separated by an observable interval. Furthermore, if the insect was suddenly disturbed, it sometimes leaped without raising the abdomen. Often the leap was preceded by all the movements of combing the wings with both abdomen and legs; in such cases the leap might well have been only an unsuccessful flight. Specimens of *Euthrips fuscus* taken elsewhere in September usually raised the abdomen when about to leap. As this is a wingless species, it is not certain what function, if any, may here be served by raising the abdomen; it may be merely to throw the center of mass farther forward over the middle legs, and so prevent the anterior end of the body from being unduly raised by the act of springing, or it may be functionless.

Leaping is insignificant from the standpoint of dissemination, for a leap assisted by the wings was usually found to be only 10 to 20 mm., rarely more than 25 mm., while a leap without the assistance of the wings varied from 3 to 10 mm. As a means of escaping from sudden danger, however, springing is probably quite effective.

Reproduction.

Copulation. I have observed this many times in *Anthothrips verbasci,* representing the Tubulifera, and several times in *Euthrips tritici* among the Terebrantia. My observations on the former species confirm in the main the description given by Jordan (1888, p. 583). Copulation in *Anthothrips verbasci* was not uncommon at the end of July, when it was observed on separating the seed capsules of spikes of mullein (*Verbascum thapsus*). In every case observed the male and female met while crawling in opposite directions. When the two were side by side, the male turned and crawled upon the back of the female. His abdomen was curled down by the side of hers, usually on the right side but observed at least once on the left, and brought into contact with the female's at the base of the tube. In most cases the female crawled a short distance, say 5 or 6 mm. with the male on her back. The male then turned aside and crawled from the back of the female, the abdomens separated, and both insects crawled away in the same direction as they were going when they met. In one instance the female kept on crawling when the male tried to mount her back, and the genital openings were never brought into contact. The next male she met, however, was permitted to complete the act. The whole of a successful copulation occupied 16 to 18 seconds. Jordan (1888, p. 583) states that the male creeps up behind the female, and that copulation lasts about half a minute. In other particulars his description for the entire suborder Tubulifera agrees very well with my observation on *Anthothrips verbasci*.

In the suborder Terebrantia, however, there is a substantial disagreement between Jordan's account (1888, p. 584) and observations made on *Euthrips tritici*. Jordan dismisses copulation in this suborder with the statement that the male is carried around on the back of the female, and that his abdomen is bent beneath hers. In the three cases which I have to record, the males were not being carried. Two of these copulating pairs were rather forcibly ejected from flowers by gently squeezing the latter between the fingers, hence it was not to be expected that the insects were necessarily in their natural position relative to each other. In both cases the male projected laterally from the female, or at an angle backward as stated by Mr. Frederick Gaige, who observed one of these pairs. The male of one pair was mounted, and its external genitalia found to be considerably distorted. The third pair was observed on the silks of common field corn (*Zea mays*). I am certain in this case that I did not in any way prevent the thrips from maintaining their natural positions. The abdomens were in contact at or near their tips, and the two individuals faced in opposite directions. Both were resting directly on the corn-silks. When I moved the silks, the female crawled away, dragging the male after her for a short distance.

Many thrips have a tooth on the tarsus, which Hinds (1902, p. 99) supposes enables the insects to go through small passages. The same author states, however, that this tooth is sometimes larger in the male than in the female, an observation confirmed by Hood (1908 a, p. 371) for *Neothrips corticis* and by my own work. Furthermore, the tooth is sometimes present in the male and wanting in the female. It seems to me more probable, since the tooth is located on the inner side and hence is not in a position to be thrust into plant tissues, that it serves rather to enable the male to hold on to the back of the female. I am led to this belief the more strongly, notwithstanding the fact that the females of some species also possess these teeth, because the tarsi of the majority of the members of the suborder Terebrantia are unarmed; and I believe it will be found on further observation that in most of the species of this suborder the males are not carried by the females during copulation. However, the Aeolothripidae have armed tarsi and it will be interesting to learn how they copulate.

Mode of Reproduction. It is not known of any one of the species taken, so far as I can learn, what the method of reproduction is throughout the season under natural conditions. At least one species (*Anaphothrips striatus*) has been bred parthenogenetically in the laboratory (Hinds, 1902, p. 163). The male exists, however, for out of some two hundred specimens collected at fourteen different times and places at intervals from June 15 to August 20, two individuals were males. Both of these were taken from sea sand-reed (*Ammophila arenaria*) on July 7. The male of this species has not, so far as I know, been known hitherto. It seems very doubtful if these rare males ever fertilize any eggs. Other species whose males are unknown or rare are presumably either exclusively or occasionally parthenogenetic. I have found no evidence in any species that the males are common only at certain times of the year.

Those species whose copulation has been observed (*Euthrips tritici* and *Anthothrips verbasci* in my own work) are of course presumably bisexual; and the fact that males are common in both these species throughout the active season suggests that they may be exclusively bisexual. Yet, it may easily be that females of any of these species, in the absence of males, reproduce parthenogenetically. There is need of further study of every species to determine this matter of parthenogenesis.

Dissemination.

Local distribution. A species which can and does readily change its location, especially over considerable distance at one time, should be nearly equally distributed over its habitat wherever external conditions are the same. Such a species, unless it were a social one, if unusually abundant in one place, whether or not it actually lacked room there, would tend to spread to places where competition was less. If, conversely, a given species is found crowded in certain localities when other similar, but less crowded, situations are open to it, it may safely be taken for granted that the species does not disseminate readily. The tendency to spread should vary inversely as the difference in the numbers occupying the two neighboring similar situations, other things being equal.

This test was applied to determine the rapidity of dissemination of Thysanoptera. A short time spent in collecting thrips in settled country was sufficient to make it evident that even with the same species, individuals were more abundant in certain localities than in others only a short distance away where, to all appearances, the conditions of life were precisely the same. Thrips living among the florets of white clover were collected in patches where the clover was equally abundant, and equally large and fresh; yet one patch often yielded many more specimens on a given number of heads than did the other.

Where this difference was noted, one of the localities where collections were made was nearly always near a road, the other in a wood or field a greater or less distance from the road. To test whether this were generally true, different kinds of flowers were examined along different kinds of roads. The character of the road was noted in every case, especially as to its direction and the amount of travel over it. Some roads running north and south, others east and west were examined. Only such flowers were examined as yielded thrips in large enough numbers to make a fair test, and care was taken to select flowers of approximately the same size and age. Two localities were examined only when the flowers were about as abundant and as evenly distributed in one as in the other. No counts were made except where the two localities were connected by a series of flowers as close together as in the localities examined, so that migration from one to the other could easily have been effected. Six flowers were examined in each locality. Only one flower was examined on a single plant, and plants were selected at about equal intervals from each other in the two localities. The results are given in Table I.

TABLE I.—Showing the number of thrips in flowers near a road and in similar flowers some distance from the road.

Name of Flower.	No. of thrips in 6 flowers near road.	Distance of thrips in preceding column from road in feet.	No. of thrips in 6 flowers at a distance from road.	Distance of thrips in preceding column from road in feet.	Character of road.
Canada thistle...	377	6	72	75 to 100	Much traveled; R. F. D. route; E. and W.
White clover....	40	6	22	165	Leads to 3 houses; E. and W.
Canada thistle...	149	20	128	325	Private road leading to 1 house; N. and S.
White clover....	92	4	34	400	Much traveled; R. F. D. route; N. and S.
Dandelion......	135	6	31	150	Leads to 4 houses; E. and W.

It seems evident from the figures that thrips were generally more abundant near a road than at some distance from it. I have noticed this to be true in many cases where I did not count the individuals. For example, I collected from nearly two hundred heads of an undetermined species of thistle extending in a continuous line along a ditch, from a well traveled public highway back into the fields. No two successive plants were more than about six feet apart. I would estimate that thrips were about twice as abundant near the road as at a distance of 70 yards from it. These thrips were exclusively *Euthrips tritici*, those of Table I were principally of this species. The same relative abundance of thrips near roads was noticed in a number of other instances, and in no case, apparently, were there fewer near the road than in similar situations farther from it.

If this variation in the abundance of thrips in different localities is really due to a lack of a tendency to migrate, as I have supposed, interesting information regarding the rapidity of their dissemination may be gained by noting how rapidly the numbers of thrips diminish in passing from the point of greatest abundance. Individuals were counted in a number of places at different distances from a road. The same care was taken to select flowers of approximately the same size and age, to have them equally abundant, etc., as in the previous counts (Table I). The road was a well traveled Rural Free Delivery route and ran north and south; the flower examined was white clover (*Trifolium repens*); and the thrips, as before, were chiefly *Euthrips tritici*. The results are given in Table II.

TABLE II. — Showing the number of thrips taken from 6 heads of white clover (*Trifolium repens*) at different distances from a highway.

Number of thrips in six heads of clover.	Distance from the road in feet.
92	4
81	8
46	20
35	40
39	80
35	165
45	240
48	320
34	400

The figures seem to show that the decrease in numbers in passing from the road is all in the first 40 feet, or perhaps even in the first 20 feet.

Tendency not to migrate. If this tendency to remain crowded in one place rather than fly away is as marked as the figures seem to show, it ought to be capable of demonstration in the laboratory. With this point in view, two heads of Canada thistle (*Cirsium arvense*) were brought in and placed in water. One, in its prime, or perhaps slightly past, was from a bunch which averaged more than 75 thrips per flower, and seemed as badly infested as the others. The other was an opening bud in which the tips of the bracts had separated so as to expose the tips of the florets, but none of the florets were open, and I could find no thrips among them. The bud and the flower were placed about 3 cm. apart. The leaves immediately below them touched so that migrating thrips could crawl, as well as fly, to the opening flower. At the end of 24 hours the bud had nearly all its florets open, but contained no thrips; the older flower was decidedly brownish already, but apparently as badly infested as before. In 48 hours the older flower was quite brown and was becoming dry; it bore 6 thrips. The younger flower seemed past its prime and contained about 15 thrips. Here was an opportunity to migrate to better material and to less crowded quarters which was not seized until drying plant tissues compelled it. The significance of the small number (15) found on the younger flower, as compared with the probable 75 that were on the older one, is pointed out elsewhere.

Possible factors operating against migration. In an attempt to explain this variation in number in different localities, it is to be determined why the thrips remain near the road. There are several possible solutions. (1) The conditions may be most favorable near the roads. (2) They may be incapable of sustained flight, while leaping or crawling is wholly inadequate to cover considerable distance. (3) They may fly long distances, but without aim, so that most of the migrating ones are lost. Or (4) they may be simply inert, that is, they may "prefer" remaining in tolerably favorable circumstances to flying away to a fate unknown. While I may not be able to answer the question definitely, I hope to eliminate some of the suggested answers, and to establish a strong probability.

(1) Preference of location. The only difference I could detect between the situations near the road and those back in the fields was a larger or smaller amount of dust in the former. Inasmuch as the food of thrips is apparently the juice or tissues of the plants, dust can hardly be other than a deterrent factor, if it is a factor at all. The care taken to have all the flowers practically alike, equally abundant, and evenly distributed, precludes, I believe, any likelihood that anything could have made one situation better than the other.

(2) Incapability of sustained flight. The ability to fly may be more directly tested. As stated above, the rate of flight in the species observed was 30 to 90 cm. per second. It is evident that flight must be wholly unsuccessful in the face of even an ordinary wind. But with the wind, or in calm weather, the case may be different. Owing to the small size of the insect, it is generally impracticable to observe their flight for any great distance. By darkening a room everywhere except a portion of one window which admitted direct sunlight, and releasing a thrips in the beam of light, where it could be observed against a dark background as it flew towards the window, I have been able to trace continuous flight for about three meters. But there is indirect evidence of much greater distances. Partly to test this, and partly to observe the reaction of thrips to light, two adjoining rooms were darkened, except a south window in one of them. There was an open door between the two rooms so that the farthest side of the second room was

lighted directly from the window some 8 or 9 meters away. A bag containing a number of thrips was opened and set in the darkened room near the farthest wall. The thrips were not disturbed, so that they had opportunity to arrange their wings for flight. Four minutes later the window was carefully examined and the thrips counted. The results are given in Table III below. These rooms were not used for laboratory purposes, hence it is not probable that any thrips other than those confined in the bag were afterwards found at the window. One specimen was found on the outside of the glass, where it might easily have crawled through broken glasses or other holes, so that the number of thrips found at the window may not be complete. The experiment was repeated another day, after making sure that there were no thrips on the window previously to releasing those in the bag. Both counts are given in the table. The numbers in the third column are computed on the assumption that, were the insects not attracted by the light, they would fly along approximately horizontal lines in all directions from the starting-point.

TABLE III. — Showing the number of individuals of *Euthrips tritici* which flew to a window 8 or 9 m. distant, probably at a single flight.

Approximate number of thrips in the bag.	Number of thrips found at window after 4 minutes.	Number which should, by the laws of chance, have reached the window.
120	12	2.2
45	6	0.86

The numbers show conclusively enough, I think, that this species of thrips is positively phototactic. But the point I wish to make here is that these specimens must have gone to the window by a single flight, a distance of 8 or 9 meters.

Studies of the thrips on Rush Lake seem to give evidence of longer flights. Rush Lake is an old hollow lying landward of the first sand dune to be thrown up, that is, the one farthest from Lake Huron. It is being gradually filled up, and much of the bottom is now very soft ooze formed of decaying plant material. In this the pickerel weed (*Pontederia cordata*) is one of the most common plants. In some places it grows in great patches in which the plants are not over a few inches or at most a few feet apart. Elsewhere there are isolated clumps, separated from all other vegetation by as much as a hundred meters or more. These plants die down beneath water in the winter, so that no thrips can hibernate on them. Any specimens, therefore, that are found on them in the summer must have come to them the same season. Search was made in the spikes of this plant, and quite a few thrips were found, some of them on plants that were separated by about 100 meters from all other vegetation of any kind.

At first thought this might seem proof positive that one or more thrips had flown at least this distance of 100 meters. But it is conceivable that the insects were blown, or fell, into the water nearer shore, and then drifted to the pickerel weed. If this is to occur, the thrips must be able to float on the water and to remain there some time without serious injury. To determine this, specimens of *Thrips physopus* and *Anthothrips verbasci* were placed in water. Most of the former species adhered to the surface film. At the end of 50 hours they were removed, and in a few minutes were crawling rather actively about. Some of this species, however, parted from the surface film and sank to the bottom; when removed at the end of 50 hours they did not revive. The specimens of *Anthothrips verbasci* all floated on the surface. I tried to force them down into the water, but adhering air bubbles brought them back every time to the surface. After 72 hours, they were removed; one began to crawl in less than three minutes, and the rest shortly afterwards. Other drowning experiments, performed for another purpose, are described under the head of "Enemies and Checks."

It seems probable, therefore, that thrips could drop into the water and float to plants at a considerable distance from the shore. If this was the case at Rush Lake, and the thrips fell into the water near the shore after only a short flight, which is the point at issue, the plants near the windward side of the lake would stand a better chance of being infested than those on the leeward. Since thrips do not readily migrate until forced to do so by drying tissue, as I have shown above, and since the spikes of *Pontederia* last for several weeks, the plants near the windward side of the lake should, on the supposition of short flights and drifting on the water, bear more thrips at any time during their active season than plants on the leeward side. In Table IV, I give some observations on this point. Examinations were all made in two days time, so that seasonal variations in the abundance of the insects would not vitiate results. Prevailing winds were, as usual in this region, westerly.

TABLE IV.—Showing number of thrips taken in spikes of Pickerel weed (*Pontederia cordata*) in various parts of Rush Lake.

Location of pickerel weed examined.	Number of thrips taken on 16 spikes.
20 m. from northwest shore	2
200 m. from west end	1
200 m. from west end	0
500 m. from west end	0
Middle of lake	2
Middle of lake	1
100 m. from southeast shore	1
50 m. from southeast shore	1
150 m. from south shore	0
30 m. from east shore	2

These figures go to show that there are no more thrips in one part of the lake than in another, and hence to oppose the view that they have drifted to the plants on the water. It would be expected, furthermore, if this drifting occurred, that many specimens would drift across the lake without meeting any plants, and could be found on the leeward side. Two hours careful towing at the surface on the southeast side of the lake with a muslin net after a long-continued northwest wind, however, failed to secure a single specimen.

I have concluded, therefore, that the thrips did not drift to the pickerel weed, but flew to it. This would involve flights of at least 100 m., and I know of no reason why single flights should not be much longer. It is barely possible that the thrips have been carried to the plants, for there are a few private boats on the lake, but the traffic is slight, and the boats usually carry only passengers, which does not present a very likely method of transporting thrips for considerable distances. Moreover, if this were the method of dissemination, one would expect to find more thrips on the *Pontederia* near the boat-landings than elsewhere, which was not the case. If it is true that thrips fly long distances, they do not remain near roadsides because they are incapable of sufficiently long flight.

(3) Aimlessness of flight. This factor can not, I believe, be operative in the cases examined. Except where positive phototaxis may explain the direction of their flight, I believe their migrations to be practically aimless. For thrips do not apparently see obstacles or enemies several centimeters away; and in the experiment described above in which a fresh and an old thistle head were placed 3 cm. apart, only 15 of the probable 75 thrips on the old head migrated to the fresh one. Supposing their flight to be aimless, if the distribution of the food plants were irregular, then many individuals would probably be lost by flying to locations where there were no plants. But in the cases ex-

amined the flowers were nearly uniformly distributed, and were abundant, so that an insect might have flown almost anywhere and still have been within easy reach of food and protection.

(4) Inertia. Three tangible factors which might have explained the crowding of thrips near roadways have been examined and found insufficient. There remains one possible factor, namely, inertia. The meaning of this term is explained at the beginning of this section. There can be no direct evidence that inertia accounts for the non-migration of thrips from roadways. It is merely the one factor that is left after the other conceivable factors have been eliminated. By proposing the name "inertia" for what I suppose to be the responsible factor in preventing migration, I do not mean to imply that any thing very definite is known about it, but, on the other hand, it is not merely a name. It is employed for convenience to indicate that we are here dealing with an internal factor, in contradistinction to the several external factors which have been excluded.

It is to be noted that so far no explanation has been offered for the congregation of thrips along the roadways in the first place. This I suppose to be due to traffic. Uzel (1905, p. 368) mentions the possibility of artificial spreading, as advocated by Blanchard (1851), but is inclined to discount its efficiency. Loads of hay in summer probably contain thousands of thrips, since the insects remain in flowers until the latter are rather dry. Many of these flowers (e. g., clover) are dropped by the roadside. Loads of hay or straw in winter may bear hibernating individuals or eggs. Bouquets may transport a few, especially in or near cities. Passing vehicles may intercept the flight of thrips and carry them for longer or shorter distances. Stock pasturing along the road, or the clothing of pedestrians probably carry some; for after walking through a patch of white clover bearing thrips I have several times found some of the insects on my leggings. Phlœophilous species are doubtless carried in logs where lumbering is practised. Inasmuch as the phenomenon of abundance near roads may be the cumulative effects of years, the young remaining near their place of birth, I believe the above considerations are sufficient to account for the observed greater abundance of thrips along highways.

It would be interesting to test this view by studying a region about to be thrown open to settlement, both before its opening and at intervals thereafter. If my interpretation is correct, it should be possible to observe the gradual increase in the relative abundance of thrips near lines of traffic.

ENEMIES AND CHECKS.

Predaceous Animals. Among these, spiders must probably be numbered, as I have seen the empty skins of *Anaphothrips striatus* entangled in the webs of small spiders on rolled leaves of wild rye (*Elymus canadensis*). In several instances mites were found attached to thrips, as is well known, usually near the base of the abdomen but in one case at the articulation of the hind femur and tibia. The most common insect enemy which I have noted is a small black bug (*Triphleps insidiosus*) mentioned by Osborn (1888), found in flowers, on some grasses, in terminal bunches of leaves, in fact almost anywhere where thrips may be found. It was quite common on the blades and among the silks and husks of common field corn (*Zea mays*), and its presence was so closely associated with the presence of thrips that I used it as a means of finding the latter. Thrips lived quite commonly concealed at the bases of the blades of corn, but not nearly on all, nor even on a large proportion of the leaves. On those leaves where *Triphleps insidiosus* was found, there were usually thrips. The bug would go about with its long beak thrust forward and when it came upon a thrips, it would crawl up to the latter, pierce it near the middle of the body, and bear it away impaled on its beak. Rove-beetles (*Staphylinidae*) were often found in flowers with thrips, but as this family is not generally predaceous, they may not attack thrips. Certain members of the *Staphylinidae* live symbiotically with ants, but the advantages derived from the ants can hardly also be derived from thrips.

It seems quite probable that such insectivorous birds as the ruby-throated humming-bird (*Trochilus colubris*), which visits flowers, would devour thrips. The stomach of one individual which was captured in August was examined for these insects, but the only contents besides some plant hairs and pollen grains were legs of small spiders together with irregular chitinous pieces which were probably portions of the bodies of the same animals. This single stomach-examination, does not, however, even make it probable that thrips are not sometimes captured by humming-birds.

Rains. This seems to be the great enemy of thrips. It has been noticed many times that these insects are less abundant in wet seasons than in moderately dry ones. During the summer it seemed to me that thrips were not as common immediately after a rain as they were before, but as hard rains were uncommon in Huron County during the season, I have no definite data on this point. I have, however, attempted to determine experimentally the relations of thrips to water, and to observe the effect of rain in their natural habitat. It was noticed that, on the spikes of mullein (*Verbascum thapsus*), during or after a rain, specimens of *Anthothrips verbasci* were not as abundant on the side which the rain struck as on the protected side. Definite counts were made in a number of instances. A row of buds, flowers or seed capsules, was gently examined one at a time, and the thrips on or between them were counted. Usually a row two buds wide through the length of the spikes was examined, first on one side and then on the opposite. A strip about four buds wide thus remained undisturbed on each side between the rows counted. It seemed scarcely probable that insects as sluggish as *Anthothrips verbasci* would crawl past these four buds when disturbed, and be counted again on the other side; but to insure that no error was in this way introduced into the total result, sometimes the leeward side was counted first, sometimes the windward. The results appear in Table V.

TABLE V.—Showing the number of individuals of *Anthothrips verbasci* taken on the leeward and on the windward side of spikes of mullein (*Verbascum thapsus*) during or shortly after a rain.

No. of spike.	Number of thrips. Leeward side. Young.	Leeward side. Adult.	Windward side. Young.	Windward side. Adult.	Side counted first.	Time elapsing after rain before count was made.
1	6	0	4	0	Leeward	During rain.
2	18	4	5	0	Windward	During rain.
3	152	24	129	52	Leeward	3 hours.
4	34	7	31	4	Windward	4 hours.
5	15	14	10	10	Windward	2 hours.
6	12	11	10	3	Leeward	2 hours.
7	16	11	8	6	Windward	2 hours.
8	4	2	7	0	Leeward	During rain.
9	12	0	2	0	Windward	During rain.
10	8	0	3	0	Leeward	During rain.
11	46	10	30	3	Windward	During rain.
Total	323	83	239	78		
Total exclusive of 3 and 4	137	52	79	22		

A count of thrips was made in like manner at times not closely following a rain. The spikes were dry, and the times were so chosen that they must have been dry at least several days before the counts were made. One set of counts was made with reference to the direction of wind. The results are given in Table VI.

TABLE VI. — Showing number of individuals of *Anthothrips verbasci* taken on the windward and the leeward sides of spikes of mullein (*Verbascum thapsus*) during dry weather.

No. of spike.	No. of thrips on windward side. Young	No. of thrips on windward side. Adult.	No. of thrips on leeward side. Young.	No. of thrips on leeward side. Adult.
1	8	12	3	15
2	19	6	12	0
3	135	6	137	3
Total	162	24	152	18

Similar counts made with reference to the direction of the sun are recorded in Table VII.

TABLE VII. — Showing the number of individuals of *Anthothrips verbasci* taken on the sunny and shady sides of spikes of mullein (*Verbascum thapsus*) at times not closely following a rain.

No. of spike.	No. of thrips on sunny side. Young.	Adult.	No. of thrips on shady side. Young.	Adult.
1	13	6	11	8
2	28	1	32	1
3	2	2	3	4
4	138	11	109	8
Total	181	20	155	21

Some irregularities were of course introduced into the above counts because it was a matter of judgment to determine whether the rows of buds examined on opposite sides of a spike were equal. The work was done carefully, however, with this source of error constantly in mind. It is thought, therefore, that if there was any marked tendency of the thrips to congregate on a definite side of the spike, it would be noticeable in the counts. In Table VI, there is a larger number of thrips on the windward side in every case, but the difference is too small to indicate any preference for that side. In Table VII, the total shows a small majority of thrips on the sunny side; but in two of the individual cases the majority were on the shady side, and in another case the two numbers were equal. Defects and differences in the plant tissues on different sides could not readily be measured, and were not taken into account.

I conclude from these data that in dry weather thrips distribute themselves uniformly over symmetrical spikes. During rains, however, or shortly after them, it appears from Table V that there is a tendency to favor a definite side of the spike, namely, the one protected. In only two cases out of the eleven was the number of thrips greater on the windward than on the leeward side; in one of these (No. 8) the number was quite small; in the other (No. 3) the observations were not made until 3 hours after rain had ceased, and the spikes were practically dry already. The total of the eleven counts shows a decided majority of thrips on the leeward side, in the ratio of 1.28 to 1. If Nos. 3 and 4 be rejected as belonging more properly to dry weather counts, the number on the leeward side bears to that on the windward side the ratio of 1.87 to 1. I conclude from these figures that this species (*Anthothrips verbasci*) is somewhat influenced by the rains.

If, then, a thrips is in a position where it cannot well escape the water, or is too sluggish to crawl away when once wet, it is interesting to know what will happen. It was stated under the heading "Dissemination" that when specimens of *Thrips physopus* were immersed in water they were all dead at the end of 50 hours. To determine the maximum time of immersion that could be endured, several groups of larvae of *Anthothrips verbasci* were enclosed in draw-string muslin bags, and sunk in water. Care was taken on immersion that all air bubbles should be removed from the bags. At the end of various intervals a bag was opened and the condition of the thrips noted. The results are shown in Table VIII.

TABLE VIII. Showing condition of larvae of *Anthothrips verbasci* after immersion in water for various periods.

No. of group.	Time in water in hours.	No. of thrips immersed.	No. alive on removal from water.	Time elapsing after removing until larvae began to crawl, in minutes. First larva.	Last larva.
1	19.4	5	5	2	70
2	28.3	5	5	40	90
3	38.0	5	1	90	

It appears from these figures that a rain lasting 40 hours, or keeping the plants wet for that length of time, would probably be fatal to all larval thrips of this species which could not escape to a protected situation. Passing showers, on the other hand, occurring infrequently, would have little effect on them. It is probable, however, that even brief showers, occurring at frequent intervals, would in time have a detrimental effect.

SYSTEMATIC AND DETAILED TREATMENT OF SPECIES.

For the identification of the twenty-one species of Thysanoptera which I have collected in Huron County, the following key has been compiled. Little attempt has been made, beyond the separation into suborders and families, to arrange the species taxonomically. This is especially true of the Tubulifera, in which there are fewer clues to relative specialization than among the Terebrantia. In the latter suborder, the arrangement of species in the key is roughly that of ascending specialization, as adopted by most workers on Thysanoptera. This lack of arrangement need not be a serious defect, inasmuch as the taxonomic order is preserved in the "List of Species" which follows, and the purpose of the key is only the identification of species.

Key to the Species of Thysanoptera taken in Huron County, Michigan.

1. a. Terminal segment of abdomen conical or bluntly rounded, not a tube. Female with curved, saw-like ovipositor. Suborder *Terebrantia.*
   b. Terminal segment of abdomen a slender, slightly tapering tube. Female without ovipositor. Suborder *Tubulifera.*

Suborder *Terebrantia.*

2. a. Ovipositor of female curved with concave side up. Fore-wings with distinct cross veins. Antennae nine-segmented. Family *Aeolothripidae.*
   b. Ovipositor of female curved with concave side down. Fore-wings without distinct cross veins. Antennae six-to nine-segmented (nine only in genus Heterothrips). Family *Thripidae.*

Family *Aeolothripidae.*

3. Single species found. Wings with three white bars, at base, middle, and tips respectively. *Aeolothrips fasciatus*, p. 207.

Family *Thripidae.*.

4. a. Antennae nine-segmented. *Heterothrips salicis*, p. 208.
   b. Antennae eight-segmented (sixth segment may be apparently divided by an oblique groove). (5).
   c. Antennae seven-segmented. (11).
   d. Antennae six-segmented. *Aptinothrips rufus* var. *connaticornis*, p. 211.
5. a. Second segment of antenna elongated on its outer side to form a conspicuous, more or less angular process. *Chirothrips manicatus*, p. 208.
   b. Second segment of antenna symmetrical. (6).
6. a. Prothorax without any prominent spines. (7).
   b. Prothorax bearing few or many conspicuous spines (8).
7. a. Always wingless. Eyes small, composed of but few facets. Ocelli wanting. Sixth segment of antennae apparently not divided by an oblique grove. *Aptinothrips rufus*, p. 210.
   b. Usually winged. Eyes of normal size. Ocelli present. Sixth segment of antenna apparently divided by an oblique groove.

Anaphothrips striatus, p. 210.

8. a. With one conspicuous spine at each posterior angle of the prothorax. No other prominent prothoracic spines. . *Scirtothrips ruthveni*, p. 208.
   b. With prominent spines at all four angles of prothorax. (9).

9. a. General color nearly black. *Ctenothrips bridwelli*, p. 210.
   b. General color yellow, usually tinged with orange or pale brown. Genus *Euthrips* (10).

10. a. General color light brown. Body comparatively broad. Wings very short, appearing to be wanting. Sluggish habits. *Euthrips fuscus*, p. 210.
    b. General color yellow, tinged with orange on thorax. Body more slender. Wings nearly always present and of full length. Active. *Euthrips tritici*, p. 208.

11. a. Maxillary palpi two-segmented. Wings with a conspicuous white area at base. Sluggish habits. *Baliothrips basalis*, p. 212.
    b. Maxillary palpi three-segmented. Wings without conspicuous white area at base. Very active insects. Genus *Thrips* (12).

12. a. General color yellow. Four to six widely separated spines on fore vein in distal half of fore-wing. *Thrips tabaci*, p. 211.
    b. General color brown to black. Usually only three widely separated spines on fore vein in distal half of fore-wing. *Thrips physopus*, p. 212.

Suborder *Tubulifera*.

Family *Phloeothripidae*.

13. a. Body slender. Head at least one and one-half times as long as broad. Genus *Phyllothrips* (14).
    b. Body stout. Head less than one and one-half times as long as broad. (15).

14. a. Last three segments of antenna yellow. Spines prominent on prothorax. *Phyllothrips citricornis*, p. 214.
    b. Last three segments of antenna brown. Spines inconspicuous on prothorax. *Phyllothrips aspersus*, p. 214.

15. a. Antennae seven-segmented. *Allothrips megacephalus*, p. 214.
    b. Antennae eight-segmented (last two segments may be immovably joined). (16).

16. a. Seventh segment of antenna separated from eighth by a mere groove, not a movable joint. *Neothrips corticis*, p. 214.
    b. Joint between seventh and eighth segments of antenna movable. (17).

17. a. Length of abdomen not more than twice its breadth. *Trichothrips beachi*, p. 213.
b. Length of abdomen plainly more than twice its breadth. (18).

18. a. Wingless. Opaque black. *Trichothrips brevicruralis*, p. 213.
b. Winged. Black species are more or less transparent. (19).

19. a. Fore-wings not narrowed in middle. *Trichothrips tridentatus*, p. 214.
b. Fore-wings narrowed in middle. Genus *Anthothrips* (20).

20. a. Postocular bristles always well developed. Prominent spines at anterior angles of prothorax. *Anthothrips verbasci*, p. 213.
b. Postocular bristles usually wanting. Anterior angles of prothorax without spines. *Anthothrips niger*, p. 213.

List of Species.

The brief descriptions of species given in this list are intended merely to indicate the general appearance of the insect in its natural habitat. The colors are those seen by reflected light only. Thus, many species appear black by reflected light, whereas under the miscroscope with transmitted light they are brown. For descriptions of species sufficiently complete for identification, the reader is referred to the works of Hinds (1902), Hood (1908), Franklin (1907), and Shull (1909).

The term "habitat" is used, in accordance with the best modern usage, to mean the character of the place inhabited by a species, not the state, country, or region where it has been collected. For the latter, the term "range" or "province" should be used. Under the heading "habitat" is given every species of plant and the part of the plant on which each species of thrips was captured. This is done, not because the species of plant is important in itself, but because the character of the habitat is in this way most accurately described. The scientific name of the plant is given, except in the case of one or two common cultivated forms. The names are those used in Gray's Manual (7th edition, 1908), and the authority for the names has therefore been omitted.

The species of thrips are here arranged in what is supposed to be approximately their natural order, the most specialized last. The arrangement is based largely on the degree of fusion of the segments of the antennae and palpi; the fewer the segments the greater the specialization.

Aeolothrips fasciatus (Linn.).—This species is comparatively large, as thrips go. The female is deep brown, the male much paler. There are three conspicuous white bars on the wings. The insect is quite active, and belongs among the interstitial species.

Taken at intervals from June 24 to August 18.

Habitat. In flower of hedge bindweed, *Convolvulus sepium;* in flowers of pumpkin, *Cucurbita pepo;* swept from blue grass, *Poa pratensis;* among florets of heal-all, *Prunella vulgaris;* among florets of goldenrod, *Solidago canadensis;* and in heads of white clover, *Trifolium repens.*

Heterothrips salicis Shull.—This insect is of moderate size, black, and of sluggish habits. It is apparently one of the superficial species.

Taken at two places, on July 14.

Habitat. On outside of catkins, not among the florets, and on the leaves of the pine-cone gall, of the willow, *Salix fluviatilis.*

Chirothrips manicatus Haliday.—This species is of moderate size, and deep brown to black in color. It is usually more or less concealed (interstitial), but occasionally exposed (superficial). It is never very active.

Taken from June 24 to August 16.

Habitat. Among chaff scales of common oats, *Avena sativa;* among seeds in head of redtop, *Calamagrostis canadensis;* in flowers of harebell, *Campanula rotundifolia;* in flowers of beach pea, *Lathyrus maritimus;* on upper side of leaves of tall millet grass, *Milium effusum;* among florets of timothy, *Phleum pratense;* swept from blue grass, *Poa pratensis;* in heads of white clover, *Trifolium repens;* and at bases of leaves of field corn, *Zea mays.*

Scirtothrips ruthveni Shull.—This is a pale yellow species of rather small size. It lives in moderately exposed situations, and, although it leaps if disturbed, it is not nearly so agile as *Thrips tabaci,* which it resembles in general form and color. *Anaphothrips striatus,* which also resembles this species in a general way, does not leap at all. Only the females are known.

Taken in three localities, July 9 to July 15.

Habitat. Among terminal leaves of dogwood, *Cornus stolonifera;* on the leaves and in the flowers of the linden, *Tilia americana;* and among the florets of red clover, *Trifolium pratense.*

Euthrips tritici (Fitch).—This is one of the commonest of all the species found here. If a medium-sized thrips of yellowish color, perhaps tinged with orange or brownish, issues from any concealed place, as from a composite flower, and crawls rapidly away or at once takes to flight, the chances are many to one that it is *Euthrips tritici.* The males are abundant also. So far as food plants are concerned, this species seems to be but little restricted, as the list below will show.

Taken June 24 to August 21.

Habitat. Among florets of white yarrow, *Achillea millefolium;* in flowers of alfalfa; in tufts of young leaves of ragweed, *Ambrosia artemisiifolia;* in flowers of anemone, *Anemone canadensis;* among ray florets of dogfennel, *Anthemis cotula;* among young buds and florets of burdock, *Arctium minus;* in flowers and in terminal bunches of leaves of swamp milk-weed, *Asclepias incarnata;* and in the flowers of the common milk-weed, *A. syriaca*, and pleurisy-root, *A. tuberosa;* among florets of large-leaved aster, *Aster macrophyllus*, and the flat-top white aster, *A. umbellatus;* in flowers of American sea-rocket, *Cakile edentula;* in flowers of the marsh harebell, *Campanula aparinoides*, and of the common blue-bell, *C. rotundifolia;* in and among the flowers of the buttonbush, *Cephalanthus occidentalis;* among florets of young head, and among seeds, of green-foxtail, *Chaetochloa viridis;* among florets of Canada thistle, *Cirsium arvense*, of the common thistle, *C. lanceolatum*, and of Pitcher's thistle, *C. pitcheri;* in flowers of virgin's bower, *Clematis virginiana;* inside of corolla and inner side of stamens of hedge bindweed, *Convolvulus sepium;* in flowers of dogwood, *Cornus stolonifera;* inside and outside of corolla of field pumpkin, *Cucurbita pepo;* in flowers of swamp loose-strife, *Decodon verticillatus;* upper side of leaves of barnyard grass, *Echinochloa crusgalli;* among bases of stamens of great willow herb, *Epilobium angustifolium;* among florets of sweet scabious, *Erigeron annuus*, and of daisy fleabane, *E. ramosus;* in flowers of wormseed mustard, *Erysimum cheiranthoides;* among florets of trumpet-weed, *Eupatorium purpureum;* in flowers of false fox-glove, *Gerardia pedicularia;* among rays of woodland sunflower, *Helianthus divaricatus;* among florets of Canada hawk-weed, *Hieracium canadense;* in flowers of Kalm's St. John's Wort, *Hypericum kalmianum*, and of common St. John's Wort *H. perforatum;* in flowers of beach pea, *Lathyrus maritimus;* among florets of cylindric blazing-star, *Liatris cylindracea;* in flowers of butter-and-eggs, *Linaria vulgaris;* in and among flowers of cardinal flower, *Lobelia cardinalis;* in flowers of cut-leaved water hoarhound, *Lycopus americanus;* in flowers and about seed-pods of narrow-leaved cow-wheat, *Melampyrum lineare;* in flowers of white sweet clover, *Melilotus alba*, and of yellow sweet clover, *M. officinalis;* in and among flowers of pepper-mint, *Mentha piperita;* in flowers of square-stemmed monkey-flower, *Mimulus ringens;* among flowers and buds of pale wild bergamot, *Monarda mollis;* in flowers of cultivated bean, *Phaseolus vulgaris;* in flowers of cultivated pea, *Pisum sativum;* swept from blue grass, *Poa pratensis;* in and among florets of water persicaria, *Polygonum amphibium;* among florets of pickerel weed, *Pontederia cordata;* in flowers of shrubby cinque-foil, *Potentilla fruticosa*, and of rough cinquefoil, *P. monspeliensis;* among flowers of *Prunella vulgaris;* in flowers of shin-leaf, *Pyrola elliptica;* among petals and between petals and sepals of swamp rose, *Rosa carolina;* on upper side of young leaves, and in flowers of Millspaugh's blackberry, *Rubus canadensis;* among rays of black-eyed Susan, *Rudbeckia hirta;* among carpels and above bases of petals of broad-leaved arrowhead, *Sagittaria latifolia;* outside of flowers and on pedicels of liveforever, *Sedum purpureum;* in flowers of nightshade, *Solanum dulcamara,* and of common potato, *S. tuberosum;* among florets of goldenrod, *Solidago canadensis;* in flowers of nodding ladies' tresses, *Spiranthes cernua;* in flowers of linear-leaved loose-strife, *Steironema quadriflorum;* among florets of tansy, *Tanacetum vulgare;* in flowers of linden, *Tilia americana;* among florets of red clover, *Trifolium pratense,* and of white clover, *T. repens;* in and among flowers of mullein, *Verbascum thapsus;* in tassels, in bunches of young leaves, among husks, and at bases of older leaves of field corn, *Zea mays.*

Euthrips fuscus Hinds.—This is a shorter insect than the preceding, and is of a brownish yellow color, and much more sluggish. It does not fly, its wings being exceedingly short. It is found in more or less protected situations in grasses and flowers. In other regions, I have taken it much more abundantly in various grasses, but nearly always in concealed places.

Taken July 31 to August 20.

Habitat. Sifted from blue grass, *Poa pratensis;* among florets of dandelion, *Taraxacum officinale.*

Ctenothrips bridwelli Franklin.—This is a large, black thrips, not as readily put to flight as many species, but a vigorous flier once it takes to wing. It is very spiny, and lives on exposed leaf-surfaces.

Taken July 28.

Habitat. On both upper and under surfaces of leaves of false lily-of-the-valley, *Maianthemum canadense,* and of star-flowered Solomon's seal, *Smilacina stellata.*

Anaphothrips striatus (Osborn).—This species is found chiefly on grasses, often in wholly exposed situations. It is a little smaller than the commonest species, *Euthrips tritici,* is of a clouded yellow color, and does not leap. Males are exceedingly rare, and the female is known to be parthenogenetic.

Taken at intervals from June 24 to August 21.

Habitat. Upper side of leaves of sea sand-reed, *Ammophila arenaria;* among buds and on young leaves of burdock, *Arctium minus;* upper and under side of leaves of common oats, *Avena sativa;* upper side of leaves of barnyard grass, *Echinochloa crusgalli;* upper side of leaves of nodding wild rye, *Elymus canadensis;* swept from blue grass, *Poa pratensis;* on leaves of blackberry, *Rubus canadensis;* on leaves and husks of field corn, *Zea mays.*

Aptinothrips rufus (Gmelin). — This is a very sluggish, wingless species found only in grass. Often when collected it is found in the soil at the bases of the grass, but some careful investigations which I have made show that it is probably always in or on the grass, and only drops to the ground when disturbed. It is yellow, and is quite slender.

Its slow crawling is often almost a wormlike movement. It has a variety *connaticornis* Uzel which has only six segments in the antenna instead of eight but is otherwise like the typical insect.

Taken June 24 to August 24.

Habitat. Found only on blue grass, *Poa pratensis,* or swept from mixtures of grasses containing blue grass.

Thrips tabaci Lindeman. — Next to *Euthrips tritici,* this is the most abundant species in the region studied. It may usually be distinguished at sight from the female of *Euthrips tritici* by its smaller size and paler color, the orange or brownish tinge being wanting. From the males of *Euthrips tritici,* it often cannot be distinguished without microscopic examination. Both species are found in the same kinds of places, namely, concealed situations almost anywhere on plants, but chiefly in flowers. Both are active species, and fly on slight provocation.

Taken July 7 to August 22.

Habitat. Among florets of common white yarrow, *Achillea millefolium;* among petals and sepals of water plantain, *Alisma plantago-aquatica;* among leaves and seeds of tumble-weed, *Amaranthus graecizans,* and of rough pig-weed, *A. retroflexus;* in terminal bunches of young leaves of ragweed, *Ambrosia artemisiifolia;* among, not in, the flowers of pearly everlasting, *Anaphalis margaritacea;* among florets of dogfennel, *Anthemis cotula;* in flowers of spreading dogbane, *Apocynum androsaemifolium;* among buds and florets, and on very young leaves, of burdock, *Arctium minus;* in flowers of common milk-weed, *Asclepias syriaca;* among florets of large-leaved aster, *Aster macrophyllus,* and of flat-top white aster, *A. umbellatus;* in flowers of American sea-rocket, *Cakile edentula;* in and among flowers of button-bush, *Cephalanthus occidentalis;* among florets of young heads of green foxtail, *Chaetochloa viridis;* in flowers, near base of corolla, of snake-head, *Chelone glabra;* among florets of common thistle, *Cirsium lanceolatum;* inside of flower and on inner side of stamens of hedge bindweed, *Convolvulus sepium;* in flowers of swamp loose-strife, *Decodon verticillatus;* upper side of leaves and in heads of nodding wild rye, *Elymus canadensis;* in flowers of great willow herb, *Epilobium angustifolium;* among ray florets of sweet scabious, *Erigeron annuus;* and of daisy fleabane, *E. ramosus;* in flowers of treacle mustard, *Erysimum cheiranthoides;* among buds of boneset, *Eupatorium perfoliatum,* and among florets of trumpet-weed, *E. purpureum;* in flowers of small-flowered gerardia, *Gerardia paupercula;* and of false fox-glove, *G. pedicularia;* among rays of woodland sunflower, *Helianthus divaricatus;* among florets of Canada hawk weed, *Hieracium canadense;* among florets of cylindric blazing-star, *Liatris cylindracea,* in flowers of butter-and-eggs, *Linaria vulgaris;* in and among flowers of water hoarhound, *Lycopus americanus;* in flowers of white sweet clover, *Melilotus alba*, and of yellow sweet clover, *M. officinalis;* in and among flowers of peppermint, *Mentha piperita;* among buds and flowers of pale wild bergamot, *Monarda mollis;* in and among flowers of catnip, *Nepeta cataria;* in corolla tubes of common evening primrose, *Oenothera biennis;* in flowers of ditch stone-crop, *Penthorum sedoides;* in flowers of cultivated pea, *Pisum sativum;* swept from timothy, *Phleum pratense*, and blue grass, *Poa pratensis;* in and among florets of water persicaria, *Polygonum amphibium;* in and among flowers of pickerel weed, *Pontederia cordata;* among young terminal leaves, especially on the dorsal side of those still curled up, of balsam poplar, *Populus balsamifera;* among petals of silvery cinquefoil, *Potentilla argentea*, and in flowers of rough cinquefoil, *P. monspeliensis;* on bases of petals, beneath stamens, of swamp rose, *Rosa carolina;* above bases of petals and among carpels of broad-leaved arrowhead, *Sagittaria latifolia;* in flowers of hemlock water-parsnip, *Sium cicutaefolium;* in flowers of nightshade, *Solanum dulcamara*, and of common potato, *S. tuberosum;* in flowers and on upper side of bases of leaves of goldenrod, *Solidago canadensis;* in flowers of nodding ladies' tresses, *Spiranthes cernua;* in flowers of wood sage, *Teucrium canadense*, and of hairy germander, *T. occidentale;* in and among flowers of mullein, *Verbascum thapsus;* among buds of blue vervain, *Verbena hastata;* in tassels, among terminal leaves on young stalks, among husks and silks, and at bases of older leaves of field corn, *Zea mays*.

Thrips physopus Linnaeus.—This species is larger and darker than its congener, *T. tabaci*, its color being practically black. It is exceedingly active; one can scarcely touch the flower in which it lives without driving it forth. It takes to flight at once, and is a good flier.

Taken July 7 to August 15.

Habitat. Among petals and sepals of water plantain, *Alisma plantago-aquatica;* in flowers of swamp milkweed, *Asclepias incarnata;* inside corolla of field pumpkin, *Cucurbita pepo;* in flowers of swamp loosestrife, *Decodon verticillatus;* in flowers of Kalm's St. John's Wort, *Hypericum kalmianum;* among small terminal leaves of spotted touch-me-not, *Impatiens biflora;* in and among the flowers of cardinal flower, *Lobelia cardinalis;* in flowers of ditch stone-crop, *Penthorum sedoides;* in and among florets of water persicaria, *Polygonum amphibium;* among curled terminal leaves of balsam-poplar, *Populus balsamifera;* in flowers of hemlock water parsnip, *Sium cicutaefolium;* among florets of dandelion, *Taraxacum officinale;* in heads of white clover, *Trifolium repens*.

Baliothrips basalis Shull.—This is a comparatively large thrips, black with a white bar across the thorax, due to the white basal areas on the wings. It lives typically in exposed places on grass. It is very sluggish, crawling but slowly and perhaps never flying.

Taken August 6 and August 13.

Habitat. Found only on upper and under sides of leaves of tall millet grass, *Milium effusum.*

Suborder *Tubulifera.*

Family *Phlocothripidae.*

Anthothrips niger (Osborn). — This is a fairly large thrips, quite black. I have rarely seen it fly, and it crawls but moderately well. It is one of the interstitial species.

Taken at intervals from July 4 to August 13.

Habitat. Among florets of white yarrow, *Achillea millefolium;* among florets of boneset, *Eupatorium perfoliatum;* in heads of red clover, *Trifolium pratense,* and of white clover, *T. repens.*

Anthothrips verbasci (Osborn). — This is a larger insect than the preceding, and has more spines. It is more readily distinguished in the field by the plant on which it occurs than by any visible character, for it was taken only on mullein, and no other thrips that resembles it was ever found on the same species of plant. I am not certain that I have ever observed it in flight. It usually seeks concealed places on the plant, but has been found on exposed surfaces of the leaves.

Taken July 10 to August 24.

Habitat. Among buds, flowers and seed-pods, and on stems and leaves of mullein, *Verbascum thapsus.*

Trichothrips beachi Hinds. — This is a very stout-bodied Phloeothripid, of a brown color. Little is yet known of its habits.

The only specimen collected was taken July 12.

Habitat. It is not known from what source this one specimen came. It alighted on my hand while I was examining a stem of wild yam, *Dioscorea villosa.* It did not come from the yam, for I had just completed examining every leaf on both sides, and the stem, and the only thrips on it were some unknown larvae. The surrounding plants from which it might most easily have come were: dogwood, *Cornus paniculata;* button bush, *Cephalanthus occidentalis;* sweet-scented grape, *Vitis vulpina;* and swamp white oak, *Quercus bicolor.* Hinds (1902, p. 193) has taken this species under quince bark.

Trichothrips brevicruralis Shull. — The few specimens yet known of this species are all wingless, and are of opaque black color. They are of inactive habits, and live in moderately exposed places.

Only specimens taken, July 14.

Habitat. Among leaves of pine-cone gall on willow, *Salix fluviatilis.*

Trichothrips tridentatus Shull. — Only two adult specimens were collected. These are deep brown to black, with grayish wings over the back. They were accompanied by reddish larvae, doubtless of the same species.

Taken August 25.

Habitat. Under scales of bark of white oak, *Quercus alba.* Reddish larvae, indistinguishable, apparently, from those which accompanied the adults of this species, were also found on another white oak over a mile away. This suggests that the species may be somewhat limited in its habitat.

Phyllothrips aspersus (Hinds). — This is a long, comparatively slender insect, living typically wholly exposed on leaves. It is brown to black in color.

Only two specimens taken, July 13.

Habitat. On leaves of sweet-scented grape, *Vitis vulpina.*

Phyllothrips citricornis Hood.—This species resembles the preceding, but can be distinguished by its usually larger size, its much more conspicuous prothoracic spines, and by the fact that the distal three segments of the antenna are lemon yellow, not brown.

Three specimens taken, July 13.

Habitat. On leaves of sweet-scented grape, *Vitis vulpina.*

Neothrips corticis Hood.—This species is small, compared with most other members of its family. It is of a brown color, and sluggish habits, and lives under bark scales. All the specimens yet known are wingless.

Taken August 24.

Habitat. Under scales of bark of American elm, *Ulmus americana.*

Allothrips megacephalus Hood.—This resembles in a general way the preceding species. There is no easy way of distinguishing the two at a glance. Under the microscope, however, this species is found to have only seven segments in the antenna; all other members of the family Phloeothripidae have eight segments.

Taken August 24.

Habitat. Under scales of bark of black ash, *Fraxinus nigra.*

Summary of Principal Results.

1. Twenty-one species of Thysanoptera were taken, of which five were new.
2. As regards habitat, thrips are of two general types, (1) those that live in concealed places, and (2) those that live on exposed surfaces.
3. The habitat of some species is apparently determined by food; that of others by protection.

4. The method of flight and leaping was found to be somewhat different from that previously described.
5. The method of copulation in those members of the suborder Terebrantia which were observed is different from that found among the Tubulifera, in that the males are not carried by the females.
6. Thrips of certain species are more abundant near highways than elsewhere. This is probably due primarily to the fact that they have been carried thither by traffic. Their failure to migrate from the roads is not due to any preference for the roadsides, nor to inability to fly far, nor to accident in attempted migrations; but is apparently due to an internal factor.
7. Of the checks to Thysanoptera, rains are probably most efficient. The larva of one species was found susceptible to the effects of water to the degree that it could endure complete immersion for 28 hours, but not for a much longer period.
8. The distribution of thrips on their food-plants is not dependent on the direction of wind or sunlight.
9. A detailed record of the habitats from which each species was collected has been preserved.

Discussion of Economic Aspect.

This phase of the subject has engaged the attention of entomologists for years, and numerous papers have been issued from the experiment stations. It will therefore be but briefly discussed here.

Owing to the fact that the regions studied were for the most part in unsettled regions, I accumulated little data regarding the relation of Thysanoptera to cultivated plants. In only one situation did I find thrips doing any very noticeable damage to wild plants. This was the work of *Ctenothrips bridwelli* on star-flowered Solomon's seal (*Smilacina stellata*) and false lily-of-the-valley (*Maianthemum canadense*), on Sand Point. These plants were found abundantly on but one small area, and here was the only locality in which *Ctenothrips bridwelli* was taken. It may prove that this species is comparatively highly specialized with respect to its food. The leaves of the plants were nearly always considerably blotched with white or yellowish, and many of them were less than half green. At the time when the specimens were captured here, they were not numerous, but must have been abundant earlier in the season.

On wild rye (*Elymus canadensis*) in one location, near a fisherman's camp, I found as many as twenty-four adults and larvae of *Anaphothrips striatus* on a single young blade near the top of the stalk. Fungous diseases, however, were so prevalent on these plants that their weakened condition could not safely be attributed to thrips.

Canada thistle (*Cirsium arvense*) and the common mullein (*Verbascum thapsus*) were among the most badly infested plants found. Where a hundred or more of *Euthrips tritici* can be taken from a single flower of the former plant, and 874 larvae and adults of *Anthothrips verbasci* from one small spike of the latter, it would seem that they could do considerable damage. Infested plants, however, were apparently as healthy as others which were nearly or quite free from thrips. I do not know what effect their feeding may have on seed-production in the infested flowers.

It would seem, from the abundance of the various species, that damage to cultivated plants is chiefly to be expected from *Euthrips tritici* and *Thrips tabaci*. Owing to their apparent tendency not to migrate, marked attacks may be expected to be more or less local. A general plague is hardly probable. The fact, furthermore, that these two species are very general in food habits, probably aids in preventing serious outbreaks. For they are as likely to attack weeds as cultivated plants, and in such cases may even prove to be beneficial.

In the case of other species, such as the poephilous group, which are more restricted in their choice of food, outbreaks are more to be feared. Thus, some of the principal crops of this region, as wheat or oats, are open to the attacks of grass-inhabiting thrips, especially *Anaphothrips striatus;* and timothy is often attacked by *Chirothrips manicatus,* though I have not, for reasons stated under the heading of Ecology, included it among the poephilous species.

The manner of taking food is still somewhat in doubt. It is generally supposed that they subsist chiefly by sucking plant juices, though partly by biting or rasping the tissues themselves. Thrips are too small to observe readily in the act of eating. Sections of a few individuals which I have made, however, show the contents of the digestive tract to be rather too homogeneous to contain much of the plant tissue. If they live by sucking juice, the standard method of combating them is by contact poison, for example, kerosene emulsion. This may well be applied in the case of superficial species, but the interstitial ones are usually too well concealed to be reached. It would be well nigh impossible to attack thrips in this manner, even if it were desirable to do so, on plants like the Canada thistle or dandelion. In case contact poison can be applied, the practicability of the method depends on the value of the crop in danger, and the character of the season. Hooker (1906, p. 4) estimates the maximum cost of spraying, in the case of tobacco, at twenty dollars per acre per season. Cultural methods are also to be recommended. For details of these and other methods, the experiment station literature should be consulted.

ORTHOPTERA.

INTRODUCTION.

The collection of Orthoptera obtained on the Biological Survey during the summer of 1908 was of all the groups of insects, except the Thysanoptera, the most representative. While the collection is not supposed to be complete, the number obtained in the various families and the data secured both for individual specimens and for certain groups as a whole, seem to call for a separate report. The group is so much better known than the Thysanoptera that little was attempted in a biological way except the ecology. This little included some observations of economic interest. The almost uniform nature of the small region studied prevented the finding of a great variety of Orthoptera and made it impracticable to work out any consistent scheme of ecology for the whole order. The results are therefore given largely in detail without any attempt at present to relate the facts to each other.

For the identification of the collection, I am indebted to Prof. A. P. Morse.

ECONOMIC CONSIDERATIONS.

The agriculturist is accustomed to look upon grasshoppers, crickets, etc., as a sort of harmless annoyance. Except in certain regions they have never appeared in such numbers as to carry devastation with them. Few people, therefore, realize the economical importance of these insects, or have a knowledge of the amount of damage they may do under ordinary circumstances.

An opportunity to test their damage, in what seems to me to be a fairly accurate way, was presented in the latter part of the period spent in the field. In general, the method consisted in determining the number of Acridiidae present on a given area, and the amount of vegetable matter eaten in a given time by a single individual. The former determination was made in a field of blue grass and timothy where Acridiidae of various species were quite abundant, but not more abundant, I believe, than they often are. The conclusions I reach, therefore, will apply, not to an average season, but to what would be called in the northern or eastern states "a grasshopper year".

The details of counting the grasshoppers were as follows: I would move cautiously into the grass so as not to flush the insects until I had approached within several feet of them. Then fixing my eyes on some spot. I took a quick step, and noted as accurately as possible the exact point where two neighboring grasshoppers arose. They were so close together that this could easily be done. The distance between these points was then measured. It was further required that the two members of each pair should be in a line approximately north and south. If they had been taken in any direction whatever from each other, it is conceivable that the grasshoppers might be arranged in long lines bounding open figures that contained few or none of them, so that the apparent number of individuals would have been much greater than the actual number. I believe this difficulty to have been obviated by selecting insects situated in a definite direction from each other. An average of twenty measurements gave 12.9 inches as the distance between each two grasshoppers.

The accuracy of the method was roughly tested by trying to count the specimens that arose as I walked slowly through the grass. This could, of course, be only approximately done. The insects arose 5 feet on either side of me, and at each step I counted all that flew. Locustidae were omitted when they were recognized, as they usually could be by their flight. My steps averaged 2.5 feet in these tests, and the average of a large number of counts showed that 28 grasshoppers were flushed at each step. There are several sources of error in this method, some of which tended to increase the number counted, others to diminish it. Among the former is the fact that many of the grasshoppers flew forward and were counted at the next step. The numbers were probably diminished, on the other hand, by failure of many of the insects in the edge of the ten-foot strip supposed to be included, to fly when I moved. If 12.9 inches was the true distance between two specimens, and they be supposed to be arranged in squares, then 21 or 22 should have been flushed at each step. The fact that 28 were flushed at each step shows that my estimate probably does not make the number too high. In this case, again supposing the grasshoppers to be arranged in squares, there were about 37,878 of them per acre.

The amount of food eaten by a single individual was determined by caging a specimen of *Melanoplus bivittatus femoratus* and feeding it known amounts of grass. Blades of timothy of approximately equal width (4 mm.) were put in the cage after measuring their length. As they became dry, they were replaced with fresh grass, and the length of the uneaten grass was deducted from that put in. That it had not shrunken in length by drying was shown by measuring other blades before and after drying. Of such grass blades, 50.4 inches were eaten in 24 hours. After returning to laboratory facilities, the same aggregate length of similar leaves of timothy was collected and allowed to become as dry as it would at room temperature in ordinary atmosphere. It was then found that it weighed 127 mg.

From the data thus secured I compute that the grasshoppers in a field of 27 acres may, in a grasshopper year, devour one ton of cured hay per week. I am unable to state whether the eating of parts of a timothy plant stimulates the rest to grow more rapidly. If it does not, the farmer may compute, from the prevailing price of hay, how much he can afford to spend in preventing the appearance of unusual hordes of grasshoppers.

DIURNAL ACTIVITY OF ACRIDIIDAE.

While collections of this family were being made it became a matter of some interest to know whether grasshoppers were more active at one time of day than at another. Casual observations indicated that there was a difference, but these observations were not trusted. Actual counts were made under several different circumstances. The first counts were made in a small cleared spot in the woods on Sand Point. The area was elliptical, measuring perhaps four by eight rods. Small bushes and herbs covered the ground, and several stumps, logs, and brush heaps were present. The number of grasshoppers in such a place was limited. They were discovered by beating the weeds and bushes carefully for five minutes. The operation was repeated in a similar manner in the same clearing at intervals during most of the forenoon. Unfortunately the counts could not be continued during the day. The results are given in Table I.

TABLE I.—Showing the number of Acridiidae that were flushed in a clearing in five minutes, at different times.

Time of making count.	Number of grasshoppers flushed. Adult.	Immature.
6:30 a. m.	0	3
7:40 a. m.	4	9
8:30 a. m.	4	9
9:30 a. m.	3	13
10:30 a. m.	2	9

A second series of counts was made on one of the sparsely grass-covered dunes along the north beach of Sand Point. The sand sloped strongly toward the north. At each count an area was included which could just be carefully beaten in three minutes. Each time the same area was beaten and the results are given under "Area No. 1" in Table II below. To check the results obtained by beating the same area many times, a second area was beaten each time; but in each count "Area No. 2" was a different one from any other area recorded in the same column. Temperatures were read just after making the counts.

TABLE II.—Showing the number of grasshoppers flushed in three minutes on a sand dune at different periods of one day.

Time of making count.	Temperature in °C.	Number of grasshoppers flushed. Area No. 1. Adult.	Area No. 1. Immature.	Area No. 2. Adult.	Area No. 2. Immature.
7:35 a. m.	22.4	4	0	7	3
8:35 a. m.	23.0	15	1	30	1
9:35 a. m.	24.2	12	1	23	0
10:35 a. m.	23.0	14	0	27	0
11:35 a. m.	22.8	9	1	22	0
12:20 p. m.	23.0	11	2	22	1
2:00 p. m.	22.0	9	1	15	1
4:30 p. m.	23.8	9	1	20	0

A third series of counts was made in a field of timothy and blue grass stubble. The number of grasshoppers flushed while I walked a distance of 30 yards east or west was determined. Adults could not be distinguished from immature individuals.

TABLE III.—Showing the number of grasshoppers flushed from a strip 30 yards long in timothy and blue-grass stubble at different periods of one day.

Time of making observations.	Temperature in °C.	Number of grasshoppers flushed.	Direction of walking while flushing.	Maximum distance from path at which individuals were flushed, in feet.
7:30 a. m.	21.3	178	east	2.0
8:25 a. m.	22.1	213	east	3.5
9:30 a. m.	23.0	254	east	6.0
10:35 a. m.	24.1	263	east	6.0
12:15 p. m.	?	151	west	5.0
1:55 p. m.	26.3	163	east	4.0
3:15 p. m.	27.0	152	east	5.0

From these observations there seems little doubt that the insects are more active in the middle or latter half of the afternoon. Table I shows little except the comparative sluggishness of the grasshoppers in the early morning. Table II is of particular interest because of the nearly uniform temperature, notwithstanding which there is a noticeably greater activity during the morning hours. The fact that the two lowest counts, however, were obtained at the two lowest temperatures (see 7:35 a. m. and 2:00 p. m.) gives room for supposing that temperature is partly responsible for the difference in activity. This is not borne out by Table III, unless it be further supposed that increase of temperature is accompanied by increase of activity up to a temperature of about 24° C., and that further increase of temperature is productive of a decrease of activity. This is entirely possible, but I lack data to decide positively.

The results should be of interest not merely to a collector, but to those who have recourse to mechanical means of killing the insects as an economic measure.

ECOLOGY.

An attempt was made, after collecting the season's data, to fit these into the scheme of ecology proposed by Morse (1904, p. 14) for the Acridiidae. This scheme was borrowed at least in part from the botanists and transferred bodily to the insects. When my data for the various families were studied, it soon became apparent that the scheme was not readily applicable to other families than the Acrididae; it was clearly not practicable to classify many of the specimens taken as hygrophile or xerophile, sylvan or campestrian, humicolous, arenicolous, or saxicolous. With the Acridiidae, the case was somewhat better; but even here there were many contradictions. The same species was often found in very different localities, for example in marshy spots or in the driest fields, on humous soil or on nearly bare sand. This may be attributable to the nature of the region. There were no large unbroken areas of uniform character, so that every location was practically on the edge of some habitat of a different kind. Contradictions in habitat may thus be accounted for by chance migrations, without necessarily supposing the insect to have no preference for one location. Under such circumstances, the only way to arrive at a satisfactory knowledge of the ecology is to collect immense numbers and depend upon majorities to decide the usual habitat. Such large numbers were not collected. It appears that the best way to arrive at a consistent scheme is to collect thoroughly over extensive uniform areas. Until this is done, it is of little value to work out an ecological classification or try to fit the data into an old scheme. I have therefore given detailed information regarding each species in the list which follows.

LIST OF SPECIES.

The following list contains the names of all the species of Orthoptera collected, with dates of earliest and latest capture, character of places in which they were taken, and such other information as may prove of interest. No more apology is offered for including some facts already known in regard to habits than for restating those that were previously known regarding habitats; knowledge of both habits and ecology of most insects is in an incipient stage which warrants repetition of observed facts.

Order *Orthoptera.*

Family *Blattidae.*

Ischnoptera pennsylvanica (De Geer).

June 15 to August 14.

Under boards, driftwood, or logs, or in rotten timbers, in dry or wet sandy places; in cracks of floors and woodwork of buildings.

Ischnoptera uhleriana Saussure.

June 15 to August 15.

Under driftwood or logs, moist or dry situations; usually in sandy but sometimes in humous soil.

Ischnoptera intricata Blatchley.

August 14 and 15.

Under logs in sandy woods, rather moist or quite dry situations.

Ischnoptera immature and indeterminate.

June 15 to August 14.

Taken in same situations as the adults of the three preceding species, usually with the latter.

Family *Phasmidae.*

Diapheromera femorata (Say).

July 12 to August 24.

On leaves and twigs of trees and small bushes of various species.

Family *Acridiidae.*

Subfamily *Tettiginae.*

Nomotettix cristatus Scudder.

July 3.

On wet leaf-covered soil in dense woods.

Tettix granulatus (Kirby).

August 12.

On bare ground and in short blue grass in damp woods.

Tettix ornatus (Say).

August 12.

Open grassy spot in edge of damp woods.

Tettix hancocki Morse.

June 15.

On sandy grass plot.

Tettix immature, probably *ornatus* (Say).

July 30 to August 12.

Short grass in open woods or fields.

Tettigidea parvipennis (Harris).

August 12.

Open grass-plot in edge of damp woods.

Tettigidea parvipennis pennata Morse.

June 22 to July 1.

On sand beaches with or without vegetation.

Subfamily *Tryxalinae.*

Pseudopomata brachyptera Scudder.

Immature June 23; adults June 27 to July 21.

In open woods, in patches of tall grass, and on grassy sand dunes.

The males were often found in song, especially in the morning. They usually perched on some dead grass stem, drew up the tibiae against the femora like a folding pocket-rule, and scraped the leg up and down over the wing covers. This is the common method of stridulation in the suborder Tryxalinae. The rate of stridulation varied in this species from $5\frac{1}{2}$ to 9 double strokes (up and down) per second, and some twenty complete vibrations were made in succession, followed by a period of rest about half as long.

Pseudopomata brachyptera reversa Morse.

July 6.

Grassy sand dunes.

Unlike the preceding form, all the specimens of this variety alighted on green and not dead stems.

Orphulella pelidna (Burmeister).

July 14.

On bare sand in open, partially grass-covered woods.

Chloealtis conspersa Harris.

June 25 to July 23.

In grassy places, either in the open or in open woods, on sandy or humous soil, wet or dry locations; on bare sand or on gravel, and on sparsely vegetated sand ridges.

This is a clumsy insect, leaping several inches to two or three feet when disturbed. It hops about from one dead grass-stem to another, and being of a brownish gray color, almost exactly that of the sand, it was often difficult to detect because of its sluggishness. It rarely seeks concealment. The males were often found in song, the method of making music being the same as that described for *Pseudopomata brachyptera*. The rate of stridulation appears to vary with the temperature, being more rapid at higher temperatures than at lower ones.

Chloealtis conspersa var. **prima** Morse.

July 17.

Coarse gravel near bushes in edge of woods.

Stenobothrus curtipennis (Harris).

July 12 to July 30.

Open woods; low underbrush; stubble fields; grass in moist or dry places, even on sand dunes.

The males were found in song during the latter half of the period during which this species was captured. The method of making music is the same as in the other species of this subfamily, and the rate likewise appears to depend on the temperature.

Stenobothrus curtipennis longipennis Scudder.

July 30.

In timothy and blue-grass stubble.

Subfamily *Oedipodinae*.

Arphia tenebrosa Scudder.

July 21 to August 3.

Grassy locations, either meadows or open woods, often on sandy soil.

The flight of this species is often accompanied by a rapid clacking of the wings. When this occurs, the flight is irregular and butterfly-like. Without clacking, flight is direct and well-controlled. A flight of 13 yards without clacking occupied 3.2 seconds, while one of 12 yards with clacking required 4.8 seconds. All the individuals observed alighted on sand.

Chortophaga viridifasciata (De Geer).

July 1 to July 20.

On grass and among low bushes on a moist beach.

Camnula pellucida (Scudder).

July 4 to August 12.

In grassy meadows or woods, along roads, or among small herbs; moist or dry places; sandy or clayey soil; tall or short grass.

This species was exceedingly abundant in grassy fields. Usually it was easily flushed and leaped three or four feet, alighting on the ground unless the grass was dense; but some individuals concealed themselves in clumps of grass when approached.

Camnula pellucida, probably, immature.

June 25 to August 12.

In same locations as adults (*vide supra*), and, in addition, among low underbrush.

Hippiscus tuberculatus (Palisot de Beauvois).

June 15 to August 3.

On bare or grass-covered sand, and in open woods where the ground is covered with a sparse growth of grass.

The male of this species is a ready flier, and sometimes quite hard to catch. The female is heavy and clumsy. The specimens observed always alighted on the ground. Examination of a considerable quantity of faeces of a female of this species indicates that its food had been almost exclusively the sea sand-reed, *Ammophila arenaria*.

Dissosteira carolina (Linnaeus).

July 7 to August 6.

Grassy fields, roadsides, open woods, clearings, on sand dunes (among grass or on the bare sand), hay or wheat stubble,—in fact, almost anywhere.

This is one of the most nearly universal of all the Acridiidae in the region studied, though not as abundant as several others.

Dissosteira carolina, probably, immature.

June 29 to July 24.

In same locations as the adults (*vide supra*), and, in addition, among low underbrush.

Spharagemon bolli Scudder.

July 7 to August 3.

Meadows, clearings, roadsides, sand dunes, beaches,—all at least partly grass-covered.

The flight of this species is often accompanied by a rattling of the wings. It alights upon the sand or soil, not on the vegetation.

Spharagemon bolli, probably, immature.

June 30 and July 3.

Localities similar to those given above for the adults.

Spharagemon wyomingianum (Thomas).

July 11 to July 24.

Grass plots, damp or dry; tall weeds; open sandy woods; bare or grassy beaches.

The habits of this species are similar to the preceding. Flight is usually accompanied by a rattling of the wings unless the insect is frightened. About 25 or 30 yards may be covered at a single flight, but usually much less.

Scirtetica marmorata (Harris).

July 20 to August 3.

Open woods, grassy clearings, and roadsides in woods.

This species flies with a clacking of the wings which is so rapid as to be almost a buzz.

Trimerotropis maritima var. **interior** E. M. Walker.

July 4 to August 3.

Grassy sand dunes and semi-vegetated beaches.

This is a vigorous flier. A single flight covering 30 yards was not uncommon, while one individual supposed to be of this species was seen to fly up over the tree tops and was more than a hundred yards away when it passed out of sight. When flushed, they start off with direct and vigorous flight as if intending to go a long distance, but very often after flying eight or ten yards they turn suddenly to the left or right, execute a short half-turn of a spiral, and alight on the sand or ground facing the disturber.

Circotettix verruculatus (Kirby).

July 12 to August 3.

Open woods and clearings, grassy roadsides and sand dunes.

A favorite spot for this blackish species was a burned-over area near Caseville, where they were almost indistinguishable when at rest. If not disturbed, they would rise in the air, one, two, or three at a time, and execute an irregular flight during five or six seconds. One remained in the air 24.5 seconds. Often they took a spiral course, not moving far from the place where they arose, but sometimes they would move off slowly in one direction. They never rose more than two to four feet from the ground during such a flight. They invariably clacked loudly with their wings during all or a part of each flight, unless flushed, when flight was almost noiseless except just before alighting.

Subfamily *Acridiinae.*

Melanoplus atlanis (Riley).

June 30 to August 6.

Open woods, among grass or leaves; sandy or gravelly beaches at least partly covered with grass or low bushes; grassy roadsides or other grass plots, either dry or moist; among low herbs or tall weeds.

Next to *M. bivittatus femoratus*, this species was the most frequently captured of any in the genus.

Melanoplus dawsoni (Scudder).

July 12.

Grassy places in meadows or open woods.

Melanoplus fasciatus (Barnston-Walker).

June 29 to August 3.

Open woods, low underbrush, grass plots sometimes sandy.

Melanoplus femur-rubrum (De Geer).

July 12 to August 6.

Among grass or weeds, or in stubble fields, always in dry places.

Melanoplus foedus Scudder.

June 22 to August 3.

On bare or somewhat grassy beaches, or in sandy woods, always in dry places. Found on sand or soil, not on vegetation.

Melanoplus minor (Scudder).

June 30 to August 3.

Open woods sparsely grown with grass; among tall weeds; grassy roadsides.

Melanoplus luridus (Dodge).

August 18.

The only specimens were taken in copulo in open, somewhat grassy woods.

Melanoplus bivittatus femoratus Scudder.

June 29 to August 4.

Among low underbrush; in open woods; sparsely grass-covered dunes; wet grassy swales; among low herbs of various kinds and taller weeds; at edges of ponds; in hay or grain stubble; on sandy or gravelly beaches; and on bare rock outcroppings.

This was the most nearly universal species of the whole family, though in point of numbers it easily yielded first place to *Camnula pellucida*. Some individuals quickly sought concealment in bunches of grass when disturbed, and were very hard to flush, sometimes difficult to see. Other individuals flew on the slightest disturbance.

Family *Locustidae.*

Subfamily *Phaneropterinae.*

Scudderia texensis Saussure-Pictet.

August 25.

Tall grass in dry meadow.

Scudderia curvicauda (De Geer).

July 14 to August 4.

Tall grass, in wet or dry places; one specimen taken in underbrush in woods.

At night the song of the males was a monotonous "katy-did-she-did" of three to seven syllables without noticeable accent on any of them. These syllables were sounded at the rate of about five per second on the evenings when they were counted, but the rate probably varied with temperature, etc. During the day the same song was compressed into a single rasping syllable with a rising inflection. Usually it could not be resolved into separate parts, but an occasional note, produced more slowly than the rest, showed that this daytime note is the same as that composed of disparate syllables which is usual at night.

Scudderia pistillata Brunner.

August 21.

On grass and weeds in dry locations.

Scudderia furcata Brunner.

August 18.

On grass on a broad, flat, and wet beach.

Scudderia immature and indeterminate.

June 29 to July 28.

On grass and in open woods, on small bushes or herbs.

Subfamily *Conocephalinae.*

Conocephalus ensiger Harris.

Immature July 18; adults July 23 to August 16.

On tall grass in either wet or dry situations.

The song of the male is a rapid succession of rasping notes with a very strong accent on alternate syllables, continuing several minutes without interruption. After a brief rest, sometimes for less than a second, the song is again taken up and lasts for a similar period. The rate varies with the temperature, an increase of 1° C. in the temperature being accompanied by an increase of about 11 in the number of accented syllables per minute.

Orchelimum vulgare Harris.

July 9 to August 18.

Grassy places, usually rather wet, but sometimes on quite dry sand dunes.

This was probably the most abundant species of the entire family. Certainly it was the most conspicuous because of its song. This is a long *zee-e-e-e,* followed by a *tsit-tsit-tsit,* all repeated over and over again. It may be heard by day or night throughout the season. The rate of stridulation here also appears to be related to temperature, but not so clearly as in *Conocephalus ensiger* because there is great individual variability.

Orchelimum immature and indeterminate.

June 25 to July 23.

On grass, sedges, ferns, etc., sometimes in dry situations, but usually at the edge of ponds and marshes.

Xiphidium fasciatum (De Geer).

July 13 to August 14.

On grass, either tall or short, in dry or moderately wet places, or in open woods; also in hay or grain stubble.

The song of the male is a miniature reproduction of that of *Orchelimum vulgare*, mentioned above, but is so faint as to be scarcely audible at a distance of five or six feet.

Xiphidium brevipenne Scudder.

August 1 to August 16.

On grass, in wet or dry places, or on bushes.

Xiphidium nigropleura Brunner.

July 16 to August 15.

Meadows or clearings, wet or dry, tall or short grass.

Xiphidium immature and indeterminate.

June 26 to July 24.

Same locations as adults, but found earlier in the season.

Subfamily *Stenopelmatinae*.

Ceuthophilus terrestris Scudder.

August 12.

Under damp, decaying logs.

Ceuthophilus seclusus Scudder.

August 12 to August 15.

In or under damp decaying logs.

Ceuthophilus meridionalis Scudder.

August 11 to August 15.

In or under decaying logs, usually damp, but sometimes quite dry.

Ceuthophilus neglectus Scudder?

August 13.

Under damp log in a cedar swamp.

Family *Gryllidae*.

Subfamily *Gryllinae*.

Nemobuis fasciatus (De Geer).

Immature July 16; adults July 30 to August 12.

Among tall or short grass, in open woods or fields, usually in dry situations but sometimes moist; also under boards and stones near grassy places.

Gryllus pennsylvanicus (Burmeister).

June 15 to August 15.

In or under rotten logs in moist places, sometimes in grass or on sandy soil.

Gryllus immature and indeterminate.

July 1 to August 6.

Semi-vegetated beaches; grassy roadsides; open sandy woods; grassy clearings, among underbrush; in tall grass.

Subfamily *Oecanthinae.*

Oecanthus niveus (De Geer).

August 12.

Among raspberry bushes in the edge of a wood, and other low bushes near dwellings.

The first specimens were taken on the above date, but their song was heard at night about a week earlier. The song of this species, like that of several of the Locustidae, varies in rate with temperature and humidity.

Oecanthus fasciatus Fitch.

August 12 to August 20.

On grass or bushes in dry situations.

Oecanthus fasciatus var. **quadripunctatus** Beutenmüller.

August 6 to August 20.

Dry grassy or weedy locations.

Oecanthus immature and indeterminate.

July 14 to August 6.

Same situations as adults.

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MALLOPHAGA.

By

CHARLES ALBERT SHULL AND M. A. CARRIKER, JR.

INTRODUCTION.

Among the smaller orders of insects, none offers more interesting problems to the biologist than the Mallophaga. Until recent years little attention had been given to these obscure parasitic forms; but the splendid work of Kellogg and others in the closing years of the last century aroused much interest in them, and has led to a constantly and rapidly increasing knowledge of the order.

One of the problems which must be more fully investigated is that of the distribution of the various species, not from the geographical standpoint, for this depends upon the distribution and migration habits of the hosts, but from the standpoint of host distribution of the insects. More information is imperative before any general conclusions concerning the order can be drawn.

Many of the species are as yet reported from but a single host, and, indeed, the presence of certain species of Mallophaga on certain hosts is in many instances so characteristic that the relation has proven one of the surest means of identification to the amateur. It is usual to find that any particular species is confined to a small group of closely related hosts, and that within a group of hosts some of the parasites may be of close relationship. The possible significance of these facts in tracing the lines of evolution among the birds and Mallophaga must not be overlooked, but no sure conclusions can be drawn until a far greater mass of data on the distribution has been accumulated. General distribution on varied hosts may indicate antiquity, and restriction a more recent origin. The presence of a single species on a few closely related birds may be accounted for by supposing that the parasite inhabited the ancestral birds, and has been transmitted unchanged to all the branches of the family. The importance of a fuller study is seen at once, and any contribution to the knowledge of these insects is of great biological interest.

HINTS ON COLLECTING.

In order that records may be accurate, the collector of Mallophaga should remember that when a bird has been killed and the body becomes cold the lice will leave the host and wander about for some time before death. This habit has led to some inaccuracy in records, as the straggling lice are taken from birds which they normally never inhabit. This is especially true when a number of birds are placed in a hunting bag together. The accuracy of the records of the present collection has been marred by several such cases of undoubted straggling. The birds should be examined at once, if possible, or bagged in light, tight paper bags, or wrapped in such a way as to preclude straggling.

The best method of removing the lice from the feathers is by means of a camels hair brush dipped in xylol. But here again care is necessary, for the lice on being touched with the fluid often bite the brush and are hard to remove. Small lice may easily be overlooked and finally removed along with the specimens from another bird. Great care should be taken to remove every specimen from the brush before using it on other birds.

The specimens should be put into xylol immediately on removal, if the lice are to be mounted at once, and in a few hours they can be placed on slides with Canada balsam. If they are not to be mounted at once it is better to put them into 95% alcohol until they can be mounted.

In my own collecting the birds are taken alive, if possible, and held on a table covered with white paper. Very small quantities of xylol are introduced among the feathers, and the odor causes the lice to come out to the surface or crawl off upon the paper where they are readily seen, even if quite small. In this way I have been able to find specimens on birds where I had not been able to discover them by the most careful visual examination.

THE HURON COUNTY COLLECTION.

The specimens of Mallophaga on which the present report is based, the first important collection of material in this order from Michigan, were taken from the birds secured by the members of the biological expedition sent to the sand region along the south shore of Saginaw Bay (Huron County), by the Michigan Geological and Biological Survey, in the summer of 1908.

The collection was examined by Mr. M. A. Carriker, Jr., during his brief stay in Boston, Mass., just preceding his departure for South America on a long collecting trip, and I am much indebted to him for the identification of the species, as well as for valuable notes concerning some of them. The twenty-nine different species taken on this survey represent seven of the twenty-three known genera, distributed as follows:—eight belong to the genus *Docophorus*, seven to the genus *Nirmus*, six to the genus *Colpocephalum*, two to the genus *Trinoton*, one to the genus *Laemobothrium*, one to the genus *Nitzschia*, and four to the genus *Menopon*. The four new species and one new subspecies occurring in this collection were described and figured by Mr. Carriker and have been published elsewhere (1910). Two of the new species belong to the genus *Colpocephalum*, as does also the new subspecies; one to the genus *Nitzschia;* and one to the genus *Menopon*. Conspicuous for its absence is *Docophorus communis*, one of the most widely distributed species known, but this is due to the small number of passerine birds from which parasites were taken. The fact that five new forms were discovered in a collection of twenty-nine species is remarkable, and should stimulate the collection of a large amount of material in this order from the state.

LIST OF SPECIES.

The species are listed in the same order within the genera as that used by Kellogg (1900) in his list of Mallophaga published by the U. S. National Museum. The genera are arranged in accordance with the several keys which Kellogg has published (1903).

Docophorus lari Denny.—A number of specimens, male and female, of this easily recognized species were taken from *Larus argentatus* Pontoppidan. It was originally described from three species of gulls, *Larus islandicus* (=*L. glaucus*), *L. tridactylus* (=*Rissa tridactyla*), and Denny reports it also from *L. rissa* (=*Rissa tridactyla*), *L. marinus*, *L. argentatus*, and *L. ridibundus*.

Docophorus icterodes Nitzsch.—This parasite is one of the very commonest found on ducks, and was taken on the black duck, *Anas rubripes* (Brewst.), and on the wood duck, *Aix sponsa* (L.). Two specimens were recorded from the pine warbler, *Dendroica vigorsii* (Aud.), but as *D. icterodes* is found only on ducks, this record is without doubt due to straggling. I am informed by Dr. Ruthven that on the same day that the warbler was captured several specimens of both black ducks and wood ducks were taken, so that the straggling is readily accounted for, and this latter record should not stand.

Docophorus fusiformis Denny.—Three specimens, male and female, were taken from the sanderling, *Calidris leucophaea* (Pallas). It was described originally from *Pisobia minuta*, and has been found on other species of that genus. The specimens agree closely with the figures of Piaget and Kellogg.

Docophorus cordiceps Giebel.—A single specimen, male, of this species was found on the least sandpiper, *Pisobia minutilla* (Vieill). It has been found on species of *Tringa* by Kellogg, and is reported from a considerable number of Limicolae from Europe. It is probably closely confined to this order of birds.

Docophorus halieti Osborn.—A considerable number of specimens of different ages, both male and female, were taken from the bald eagle, *Haliaeetus leucocephalus* (L.). The specimens agree closely with Osborn's description (1896), but no figures of this species have been published. Osborn described it originally from the same host from Florida, and states that it is nearest to *D. intermedius* Piaget which was described from *H. vocifer.*

Docophorus coccygi Osborn.—Four specimens, three males and one female, taken from the yellow-billed cuckoo, *Coccyzus americanus* (L.). The specimens were compared with Osborn's type, a male, by Mr. Carriker, and found to agree perfectly. The species was first described from the same host, and I am not aware of its having been found on any other host as yet. It resembles *D. latifrons* Nitzsch but differs from it in having a narrower clypeus, and in the markings of the ventral surface.

Docophorus latifrons occidentalis Kellogg.—Several specimens of a *Docophorus* probably referable to this form were found on *Coccyzus americanus* (L.). The head markings show fairly distinct, although little can be determined in regard to the thorax and abdomen. Kellogg (1899) describes this variety from *C. americanus occidentalis* (Ridgw.) which is practically the same host, so that there is little doubt of the identity of these immature specimens.

Docophorus incisus Kellogg.—Two females and one male of this species were taken from the blue bird, *Sialia sialis* (L.). The species was described from the same host by Kellogg, who found it also on the cedar waxwing (*Bombycilla cedrorum* Vieill.). The rather narrow, deeply incised clypeus makes this species easily recognizable. Otherwise it somewhat resembles *D. communis* Nitzsch.

Nirmus furvus ravus Kellogg.—Two females and one male of this variety of *Nirmus furvus* Nitzsch were recorded from the wood duck, *Aix sponsa* (L.), but in as much as this parasite has been found only on the Limicolae, being described from *Actitis macularia* (L.), this record of it from the Anseres is doubtful. The doubt is much strengthened by the fact that on the same day that this wood duck was captured (Aug. 10, '08) a spotted sandpiper, *Actitis macularia* (L.), was also taken. It is undoubtedly a case of straggling. This variety of *N. furvus* is easily recognized from *furvus* by the general dark chestnut coloration of the abdomen, the absence of a median uncolored line across the first six or seven segments of the abdomen, and the absence of distinct abdominal blotches.

Nirmus complexivus Kellogg and Chapman.—This species occurs widely distributed among the Limicolae but is apparently sharply confined to them. In this collection it was found on the semipalmated plover, *Aegialitis semipalmata* Bonap., least sandpiper, *Pisobia min-*

utilla (Vieill.), sanderling, *Calidris leucophaea* (Pallas), pectoral sandpiper, *Pisobia maculata* (Vieill.), knot, *Tringa canutus* (L.), turnstone *Arenaria interpres* (L.), and is also recorded from the red-breasted nut hatch, *Sitta canadensis* (L.). Of course this last record from the Passeres is simply a case of straggling. This nuthatch was the only bird taken on August 25 other than semipalmated plover, sanderling, and yellowlegs. One of these Limicolae was certainly the host of the single specimen of *N. complexivus* found on the nuthatch. Kellogg and Chapman describe it from *Calidris leucophaea* (Pallas) and *Pisobia minutilla* (Vieill.). It combines several characters presented as diagnostic of older species, whence its name.

Nirmus actophilus Kellogg and Chapman.—Two females from the sanderling, *Calidris leucophaea* (Pallas). It is common on this host, Kellogg reporting it on nine out of fifteen birds. It is well marked and easily recognized from the other species of *Nirmus* common on the Limicolae.

Nirmus parallelus Osborn.—A single female of this species was taken on the greater yellowlegs, *Totanus melanoleucus* (Gmel.). The species was described by Osborn from *Oxyechus vociferus* (L.). Its general form is much like that of *Lipeurus baculus*, the body being very long and slender, the abdomen parallel-sided, and the legs like the *Lipeuri;* but the antennae are alike in both sexes, and it is a *Nirmus*. Among the *Nirmi* it most nearly resembles *N. boephilus* Kell., and Osborn remarks: "Kellogg's description of *N. boephilus* from a female specimen from the same host agrees quite closely in most respects, but differs in the proportions of the head. The types for my description being now in the Boston Society of Natural History, a detailed comparison is impossible. Comparisons of a greater series of specimens will very likely prove their identity, in which case Kellogg's name will have priority." On this point Mr. Carriker says: "I have examined the type (Osborn's) of *N. parallelus* and compared it with specimens in my own collection which I have identified as *N. boephilus* and find that the two are quite distinct."

Nirmus boephilus Kellogg.—A single female of this parasite was found on the semipalmated plover, *Aegialitis semipalmata* (Bonap.). Kellogg described it from a female taken on the killdeer, *Oxyechus vociferus* (L.). It is a long slender species with parallel sides, and a distinct brown marginal band on head, thorax, and abdomen.

Nirmus candidus Nitzsch.—Four specimens, male and female, from the flicker, *Colaptes auratus luteus* (Bangs.), are undoubtedly this form. Mr. Carriker's notes regarding these are as follows: "These specimens agree almost exactly with Giebel's description of the species (Insecta Epizoa, p. 149), but without a good plate and a more detailed description it is impossible to be certain that these specimens are not subspecifically distinct from Nitzsch's specimens. Piaget says (Les Pediculines. p. 138), that *N. stramineus* Denny is a synonym of this form, but from Denny's description and plate (which are fairly good) they seem to me to be distinct." The original description was from specimens taken from *Picus canus*, and it has been recorded on *Picus viridis*. In this country Osborn has reported a species believed to be *candidus* from *Centurus carolinus* (L.).

Nirmus simplex Kellogg.—Two specimens, male and female, from the robin, *Planesticus migratorius* (L.). They were first described by Kellogg from the same host, and these specimens agree very well with his description and figure.

Colpocephalum bicolor Piaget.—A young freshly moulted female taken on the turnstone, *Arenaria interpres* (L.), probably belongs to this species, since it was first described from the same host. This species is not included in Kellogg's list of North American Mallophaga.

Colpocephalum spinulosum obscurum Carriker.—The description of this new subspecies of *C. spinulosum* Piaget, as prepared by Mr. Carriker, has been published in the Entomological News (1910.) It is of the same size as *C. s. minor* Kellogg, but differs from it in the proportions of the head, and in a number of details of color pattern. A male and female from the turnstone, *Arenaria interpres* (L.), were the only specimens obtained.

Colpocephalum ocularis Carriker.—This easily distinguished new species has been described and figured by Mr. Carriker in the Entomological News (1910). The two most striking features are the peculiar V-shaped ocular bands, and the spindle-shaped, constricted abdomen. A single female was taken on the turnstone, *Arenaria interpres* (L.). Careful search should be made on other specimens of this bird to find the male belonging to the species.

Colpocephalum subpustulatum Carriker.—Only one specimen, a female, was found belonging to this new species, which has been described and figured elsewhere with the other new species by Mr. Carriker (1910). It is distinguished from *C. pustulosum* Piaget, which species it most nearly resembles, by the absence of the conspicuous double row of clear pustules on the abdomen and on the posterior margin of the head; by the absence of long hairs anywhere except on the temples; and by the absence of the fringe of fine hairs at the posterior extremity. It was captured on the belted kingfisher, *Ceryle alcyon* (L.). Mr. Carriker states in his notes that this is the "first record for a species of this genus on any member of this family. Osborn has recorded *C. pustulosum* Piaget from the kingfisher but it was probably a specimen of the present form, as the two have a superficial resemblance." The genus *Colpocephalum* is wide spread among the birds, being found on half a dozen different orders.

Colpocephalum osborni Kellogg.—A considerable number of specimens, male and female, from the bald eagle, *Haliaeetus leucocephalus* (L.). The species was described from the white-tailed kite, *Elanus leucurus* (Vieill.). Its nearest relatives are the European species *C. dissimile* Piaget and *C. tricinctum* Nitzsch.

Colpocephalum quadrimaculatus Carriker.—A single male of this species was taken on the red-winged blackbird, *Agelaius phoeniceus* (L.). Mr. Carriker says concerning it: "This is the first specimen of this beautiful species that I have seen since describing it some years ago from a single male taken on the American crossbill, *Loxia curvirostra minor* (Brehm). The type was collected by myself from a freshly killed specimen taken in a region where no red-winged blackbirds are found, so that its occurrence on this host is rather peculiar. It seems probable that there is room for doubt as to the host." It has not been possible to determine the possibility of this being a case of straggling on account of the fact that the specimen was taken early in the season, before the work had been well systematized. The insect note-book failed to give the exact date of capture of this specimen, so that the other birds captured that same day are not known. It should be said, however, that no crossbills were observed by the party.

Colpocephalum sp (?)—A young male just emerging from the egg, probably belonging to this genus, was taken from Wilson's black cap, *Wilsonia pusilla* (Wils.). It could not of course be identified.

Trinoton luridum Nitzsch.—A single specimen, female, of this common parasite of the ducks was taken from the black duck, *Anas rubripes* (Brewst.). It is closely confined to the ducks, and is easily recognized by the characteristic markings and large size.

Trinoton lituratum Nitzsch.—A single specimen, female, of this species was taken from *Anas rubripes* (Brewst.). It too is confined closely to the ducks. It may be recognized by its broad outline, and by the characteristic brown markings on the head and thorax. It is very interesting to know that mites infest bird lice as parasites. A number of mites were found clinging to the sides of this species of *Trinoton*.

Laemobothrium giganteum Nitzsch.—A considerable number of specimens of this gigantic bird louse were taken from the bald eagle, *Haliaeetus leucocephalus* (L.). The largest specimen measures 11mm. in length, and about 2.2mm. in abdominal width. This is the only representative of the genus in this collection.

Nitzschia latifrons Carriker.—The description and figure of this new species of one of the smallest genera of the order were prepared by Mr. Carriker and have been already published (1910). It most nearly resembles *N. pulicaris* Nitzsch, and *N. bruneri* Carriker, but can be distinguished at once by the broad, flatly rounded forehead, a character which suggested the name. A number of specimens, male and female, were taken from the bank swallow, *Riparia riparia* (L.).

Menopon loomisii Kellogg.—Four specimens of this species were obtained from the wood duck, *Aix sponsa* (L.). They agree perfectly with the specimens first taken by Kellogg from *Oidemia deglandi* Bonap.

Menopon praecursor Kellogg.—Three specimens, one male and two females, were taken on the flicker, *Colaptes auratus luteus* (Bangs). The species was first described from *Centurus uropygialis* by Kellogg, and Carriker states that he took a variety of this species (*M. praecursor meridionale*) from *Centurus hoffmanni* from Costa Rica. This is the first record of it on the flicker.

Menopon hirsutum Carriker.—A single female taken from the downy woodpecker, *Dryobates pubescens medianus* (Swains.). The description and figure were prepared by Mr. Carriker for previous publication (1910), as in the case of the other new species. Carriker states that it is very different from any species of *Menopon* heretofore described from the woodpeckers, and seems to have no near relative.

Menopon mesoleucum americanum Kellogg.—A large number of specimens of this common crow parasite were taken from the crow, *Corvus brachyrhynchus* (Brehm.). This variety of *M. mesoleucum* was first described from the same host, and the species has been found on other species of *Corvus* in Europe. The striking color markings make it easy to recognize, as it does not resemble closely any nearly related form.

Menopon sp (?).—Several immature specimens of a *Menopon* were found on the towhee, *Pipilo erythrophthalmus* (L.), and on the yellow-billed cuckoo, *Coccyzus americanus* (L.). They could not be satisfactorily identified.

List of Hosts with Parasites.

In this list of hosts with parasites the hosts have been arranged in accordance with the check list of the American Ornithologist's Union.

Larus argentatus (Pontoppidan).
  Docophorus lari Denny.
Anas rubripes (Brewster).
  Docophorus icterodes Nitzsch.
  Trinoton luridum Nitzsch.
  Trinoton lituratum Nitzsch.
Aix sponsa (L.).
  Docophorus icterodes Nitzsch.

Nirmus furvus ravus Kellogg. [Straggler from *Actitis macularia* (L.) probably.]
Menopon loomisii Kellogg.
Tringa canutus (L).
Nirmus complexivus Kellogg and Chapman.
Pisobia maculata (Vieill.).
Nirmus complexivus Kellogg and Chapman.
Pisobia minutilla (Vieill.).
Docophorus cordiceps Giebel.
Nirmus complexivus Kellogg and Chapman.
Calidris leucophaea (Pallas).
Docophorus fusiformis Denny.
Nirmus complexivus Kellogg and Chapman.
Totanus melanoleucus (Gmel.).
Nirmus parallelus Osborn.
Aegialitis semipalmata (Bonap).
Nirmus complexivus Kellogg and Chapman.
Nirmus boephilus Kellogg.
Arenaria interpres (L.).
Nirmus complexivus Kellogg and Chapman.
Colpocephalum bicolor Piaget.
Colpocephalum spinulosum obscurum Carriker.
Colpocephalum ocularis Carriker.
Haliaeetus leucocephalus (L.).
Docophorus halieti Osborn.
Colpocephalum osborni Kellogg.
Laemobothrium giganteum Nitzsch.
Coccyzus americanus (L.).
Docophorus coccygi Osborn.
Docophorus latifrons occidentalis Kellogg.
Menopon sp (?).
Ceryle alcyon (L.).
Colpocephalum subpustulatum Carriker.
Dryobates pubescens medianus (Swains.).
Menopon hirsutum Carriker.
Colaptes auratus luteus (Bangs).
Nirmus candidus Nitzsch.
Menopon praecursor Kellogg.
Corvus brachyrhynchus (Brehm).
Menopon mesoleucum americanum Kellogg.
Agelaius phoeniceus (L.).
Colpocephalum quadrimaculatus Carriker. Straggler (?).

Pipilo erythrophthalmus (L.).
Menopon sp. (?).
Riparia riparia (L.).
Nitzschia latifrons Carriker.
Dendroica vigorsii (Aud.).
Docophorus icterodes Nitzsch. Straggler from duck.
Wilsonia pusilla (Wils.).
Colpocephalum sp. (?).
Sitta canadensis.
Nirmus complexivus Kellogg and Chapman. Straggler from Limicolae.
Planesticus migratorius (L.).
Nirmus simplex Kellogg.
Sialia sialis (L.).
Docophorus incisus Kellogg.

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FISH.

BY ADELBERT L. LEATHERS.

GENERAL DISCUSSION.

The fish inhabiting the waters in and about the sand region of Huron County, Michigan, were studied as carefully as the season, the limited time, and the means at hand would permit. The object of this study was not so much the investigation of particular problems as to increase our knowledge of the distribution of the species in the state.

The aquatic habitats of the sand region present a number of peculiarities which have a profound influence upon the number and distribution of the fish. The lakes and ponds have neither outlets nor inlets, and the water they contain and their permanence is thus largely governed by the amount of rainfall in their immediate vicinity. The sandy soil permits the excess of water to escape without overflowing, except where the banks are low and then only when the rainfall is excessive. The bottoms of the lakes and ponds were originally sandy but they are now covered by an ooze resulting from the disintegration of aquatic vegetation.

Long Lake, Orr Lake and Rush Lake are examples of the larger bodies of quiet water. Long Lake (Pl. XIIa) appears to be without a fish fauna. Grass Lake apparently contains only the mud minnow, which, however, seems to thrive there. Rush Lake (Pl. IX), the largest and deepest of the lagoon lakes of Huron County, although outside of the sand region proper, presents similar conditions. It has no outlet through which fish would be liable to enter or escape, and the only inlet is a county drain connecting it with a marshy region located within its hydrographic basin. This lake has extensive shallow areas where the bottom is composed of ooze that overlies the sandy substratum to a depth of from two to five feet. During the driest part of the season about a third of this area is exposed, although the fall of the lake is not more than six inches below the average level. Towards the north shore, however, there are areas of open water which have a depth of six or seven feet. The fish fauna is quite abundant and varied, but minnows, catfish and pike are apparently the most numerous forms.

The streams in the sand region all communicate with Saginaw Bay, and consequently their fish faunas do not suffer permanently from adverse conditions. The habitats consist of two types—the flowing water type and the stagnant water type. The flowing water type differs from the stagnant water type chiefly in the amount of vegetation and mud which is present. In the former the vegetation is confined to the flags and rushes along the margin and the filamentous algae in the slack water pools. The streams are all more rapid in their upper than in their lower courses, and the lower parts, being nearly on a level with Saginaw Bay, show transitional conditions between the stream and lake. Pigeon River (Pl. Xb, XIb) exhibits these conditions very plainly. The upper part is shallow and rapid, but near the lake there is a stretch of slowly flowing water about a half-mile long and eight to ten feet deep. Mud Creek and the county drain near Bayport drain the same general area. They carry only a small amount of water at any season, and still less during the driest part of the year. During the dry times they consist principally of scattered pools, but the lower portion, which is at the lake level, contains about two feet of water throughout the year.

The stagnant water habitats associated with the streams are characterized by conditions intermediate between those of a flowing stream and those of a lagoon lake. They have quite clear water with a mud bottom and an abundant aquatic flora. The oxbow pond at Caseville is an example of this type. It was originally formed by the artificial cutting off of the bend of the river to straighten the course of the latter, but it has now become a typical ox-bow pond. (Pl. XIa.) The bottom has become covered with mud and the waters are now filled with aquatic vegetation, with an abundance of duckweeds (Lemnaceae) and filamentous algae near the surface. It lacks a current during the greater part of the year, but retains a connection at one end with the lower part of Pigeon River.

Another habitat that deserves special mention is found in the bays along the coast. The principle one of these studied is Turtle Bay (Pl. XIIIb), on the south side of Sand Point, the largest of the partially inclosed bodies of water along the shore. It is cut off from Wild Fowl Bay by a sand spit, but still opens at one end by a narrow, shallow passage which is gradually being filled. The water within is clear and the bottom muddy. The vegetation is abundant and varied—cat-tails, bulrushes and arrow-leafed plants grow along the shore, and pond-lilies, pond weeds, etc., in the deeper waters.

The waters of Saginaw Bay north of Sand Point offer a very uniform environment. (Pl. Ia). The water is shallow and the bottom uniformly sandy. There is no vegetation over this area and no shelters, except a few artificial ones. The fish of the deeper waters outside the shore area could not be examined in detail, but they were investigated to some extent by following the catches of the commercial fisheries of the Orr Fish Company, which operated a string of ten nets on the north shore of Sand Point. These nets extended from a depth of about eight feet to a depth of almost thirty feet, the whole string forming a complete fish barrier a mile and three quarters long.

In Wild Fowl Bay, which is south of Sand Point, the bottom was more muddy and supported some vegetation. The fish were investigated chiefly by set lines.

In the course of the work an attempt was made to ascertain the number and kinds of fish to be found in the different habitats both by direct observation and by use of the dip-net, fyke net, trammel net, lines and spears. I realize that the results are very incomplete, but I believe they are reliable as far as they go, and submit them for their bearing upon the distribution of the species in the state.

I wish to acknowledge my indebtedness to Dr. A. G. Ruthven for assistance in editing this paper and for the table of habitat distribution and the bibliographical references. I am also under obligations to Mr. Seymour Bower, Director of the Michigan Fish Commission, for the tabular statement of the products of the Saginaw Bay Fisheries for 1908, and to Dr. S. E. Meek, of the Field Museum of Natural History, for the identification of a number of species.

As a summary I append tables giving the habitats in which the different species were found and the value of the different food fish taken in Saginaw Bay in 1908.

Habitat Distribution of Fish taken in the Sand Dune Region.

Species.	Saginaw Bay, deep water.	Saginaw Bay, shore.	Turtle Bay.	Orr Lake.	Pond on Sand Point.	Pigeon River near mouth.	Pigeon River in clay country.	Ox-bow Pond at Caseville.	Rush Lake.	County Ditches.	Mud Creek.
Amia calva	....	....	×	....	....	×	×	....	....	....	....
Lepisosteus osseous	....	....	×	×	....	....	....	....	....	×	×
Ameiurus natalus	....	....	....	....	....	×	×	....	×	×	×
Ameiurus vulgaris	....	....	×	....	....	....	....	....	×	....	....
Ameiurus nebulosus	....	....	×	....	×	....	....	×	....	....	....
Ameiurus melas	....	....	×	×	....	×	×	....	×	×	×
Ameiurus lacustris	....	....	×	....	....	....	....	....	....	....	....
Noturus flavus	×	....	....	....	....	....	....	....	....	....	....
Shilbeodes gyrinus	....	....	....	....	×	....	....	....	....	....	....
Carpiodes thompsoni	×	....	×	....	....	....	....	....	....	....	....
Catostomus catostomus	×	....	....	....	....	....	....	....	....	....	....
Catostomus commersonii	×	×	....	×	....	×	....	....	....	....	....
Moxostoma aureolum	×	....	....	....	....	×	....	....	....	....	....
Pimephales notatus	....	....	....	×	....	....	....	....	×	×	×
Semotilus atromaculatus	....	....	....	×	....	....	×	....	....	×	×
Abramis crysoleucas	....	....	×	....	....	....	....	×	×	....	....
Notropis cayuga	....	....	....	×	....	....	×	....	×	×	×
Notropis hudsonius	....	×	....	....	....	....	....	....	....	....	....
Notropis cornutus	....	×	....	....	....	....	×	×	....	....	....
Notropis rubrifrons	....	×	....	....	....	....	....	....	....	....	....
Notropis whipplii	....	....	....	....	....	×	....	....	....	....	....
Anguilla chrysypa	×	....	....	....	....	....	....	....	....	....	....
Coregonus quadrilateralis	×	....	....	....	....	....	....	....	....	....	....
Coregonus clupeiformis	×	....	....	....	....	....	....	....	....	....	....
Argyrosomus artedi	×	....	....	....	....	....	....	....	....	....	....
Umbra limi	....	....	×	....	×	....	×	....	×	×	×
Lucius vermiculatus	....	....	....	....	....	....	×	×	....	×	....

Habitat Distribution of Fish taken in the Sand Dune Region.—Continued.

Species.	Saginaw Bay, deep water.	Saginaw Bay, shore.	Turtle Bay.	Orr Lake.	Pond on Sand Point.	Pigeon River near-mouth.	Pigeon River in clay country.	Ox-bow pond at Caseville.	Rush Lake.	County Ditches.	Mud Creek.
Lucius lucius	....	....	×	×	....	×	×	....	×	×	....
Fundulus diaphanus	....	....	....	....	....	....	....	....	....	×	....
Percopsis guttatus	....	×	....	....	....	....	....	....	....	....	....
Pomoxis sparoides	....	....	×	....	....	×	....	....	....	....	....
Ambloplites rupestris	....	×	×	×	....	×	....	×	....	×	×
Eupomotis gibbosus	....	×	....	....	....	....	....	....	×	×	....
Micropterus dolomieu	....	....	....	....	....	×	×	....	....	....	....
Micropterus salmoides	....	×	....	×	....	×	....	×	....	×	×
Stizostedion vitreum	×	×	....	....	....	×	....	....	....	....	....
Perca flavescens	×	×	×	×	....	×	....	....	×	×	×
Percina caprodes	....	×	×	....	....	×	....	....	....	....	....
Hadropterus aspro	....	×	....	....	....	×	....	....	....	....	....
Etheostoma iowae	....	....	×	....	....	×	....	....	....	....	....
Boleichthys fusiformis	....	×	×	....	....	×	×	....	×	....	....
Aplodinotus grunniens	×	....	....	....	....	....	....	....	....	....	....
Cottus ictalops	....	×	....	....	....	....	....	....	....	....	....
Lota maculosa	×	....	....	....	....	....	....	....	....	....	....

Statement of fish caught in Saginaw Bay in 1908, giving number of pounds of each kind of fish and the total value of each kind.

Kinds.	*Pounds.*	*Value.*
Whitefish	253,184	27,067.19
Lake Trout	21,314	1,398,18
Pike Perch	778,214	74,256.84
Herring	4,569,381	73,483.87
Sturgeon	1,994	1,597.36
Bass	258	21.30
Saugers	3,850	163.09
Perch	1,983,920	32,877.25
Suckers	821,853	13,386.69
Catfish	62,987	2,912.42
Cavaire	617	266.75
All other kinds	373,125	7,933.40
	7,970,697	234,464.34

LIST OF SPECIES.

1. **Icthyomyzon concolor** (Kirtland). Silver lamprey.—Seldom seen by the commercial fisherman of this region and very little of its destructive work was noticed hence I have concluded that it is not abundant.

2. **Lepisosteus osseus** (Linnaeus). Long-nosed gar.—This fish is quite common in the sand region, especially in the shallower waters of the bayous and stagnant mouths of streams. Taken in Orr's fish-trap, Turtle Bay, Mud Creek, and the county drain near Bayport. Recorded from Saginaw Bay by Cope (1864, 276) under the name *Lepidosteus huronensis.*

3. **Amia calva** Linnaeus. Dogfish; bowfin; grindle fish; mudfish; brindle fish; poisson de Marais.—Common throughout the region. Specimens were taken in Orr's fish-trap, Turtle Bay, and the upper and lower parts of the Pigeon River.

4. **Ameiurus natalis** (Le Sueur). Yellow catfish; catfish.—This species is very generally distributed and fairly abundant. Taken in the Pigeon River, Caseville marsh (a marsh joining both with the Pigeon River and Saginaw Bay), Rush Lake (deeper part), Mud Creek, and the county drain near Bayport.

5. **Ameiurus vulgaris** (Thompson). Long-jawed catfish.—Not found abundantly in any place. Only a few specimens were taken and these were all from the following places: Orr's fish-trap, Rush Lake (deeper part), Turtle Bay.

6. **Ameiurus nebulosus** (Le Sueur). Common bull-head; horn-pout; catfish.—Found abundantly in the following places: Turtle Bay, Wild Fowl Bay (near Turtle Bay), ox-bow pond at Caseville, pond near Turtle Bay on Sand Point.

7. **Ameiurus melas** (Rafinesque). Bull-head; black bull-head; small black catfish.—This species is the most abundant of the cat-fishes of this region. It was found in great numbers in the following places: Turtle Bay, Pigeon River, marsh on lake shore near Pigeon River, Mud Creek, county drain near Bayport and in the county drain and in the marsh at the west end of Rush Lake, as well as in the deeper part of the lake itself.

8. **Ameiurus lacustris** (Walbaum). Great fork-tailed cat; Mississippi cat; Florida cat; great catfish of the lakes.—A single specimen was taken in Turtle Bay. They are caught on set lines in from 2-10 feet of water in various parts of Wild Fowl Bay, especially near the Sand Point shore, where they are fairly abundant.

9. **Noturus flavus** Rafinesque. Yellow stone-cat; common stone-cat.—This species was taken only in the deeper waters of Saginaw

Bay, at a considerable distance from the shore. Specimens were taken in Orr's fish-trap, and in Wild Fowl Bay in water from 8-10 feet deep and one-half mile from shore.

10. **Schilbeodes gyrinus** (Mitchill). Tad-pole cat.—Specimens of this species were found only in very stagnant and muddy pools. Taken in the county drain at Rush Lake, and in the pond near Turtle Bay on Sand Point.

11. **Carpiodes thompsoni** Agassiz. Lake Carp.—This species appears to be rather common for it was frequently seen in Turtle Bay and along the shore of Wild Fowl Bay, and was often taken in Orr's fish-trap. A small specimen from Mud Creek possesses only four rows of extra large scales on the sides. Recorded from Saginaw Bay by Cope (1864, 285; 1871, 483.)

12. **Catostomus catostomus** (Forster). Northern sucker; long-nosed sucker; sturgeon sucker.—This sucker is taken frequently in the pound nets along the shore of Saginaw Bay. Our specimens were taken from Orr's fish-trap or found dead along shore just after a storm.

13. **Catostomus commersonii** (Lacépède). Common white sucker; brook sucker.—This fish is abundant along the shores of Saginaw Bay. Specimens were taken in the following places: Orr's fish-trap, county drain near Bayport, Mud Creek, Pigeon River (lower part) and the beach on Sand Point (dead). Michael (1905, 10) states that this species is recorded by the U. S. Fish Commission from Saginaw Bay and Caseville.

14. **Moxostoma aureolum** (Le Sueur). Red-horse; mullet.—This fish was rather uncommon. Specimens were taken in Turtle Bay and in the lower part of the Pigeon River. Recorded by Cope (1864, 285; 1871, 476-477) from Saginaw Bay, under the name of *Ptychostomus aureolus* Ag., and stated by Michael (1905, 11) to be recorded by the U. S. Fish Commission from Saginaw Bay and Caseville.

15. **Pimephales notatus** (Rafinesque). Blunt-nosed minnow.—Found in Rush Lake, Mud Creek, and county drain near Bayport.

16. **Semotilus atromaculatus** (Mitchill). Horned dace; creek chub.—The Horned Dace was not found to be abundant. It was taken in the upper part of the Pigeon River, Mud Creek, and county drain near Bayport.

17. **Abramis crysoleucas** (Mitchill). Golden shiner; roach; bream.—Found abundant in the ox-bow pond at Caseville, and in Rush Lake. Specimens were taken in Turtle Bay. Recorded by Cope (1864, 281) from Saginaw Bay under the name of *Plargyrus americanus* Cope.

18. **Notropis cayuga** Meek. Cayuga minnow.—Specimens were

taken in the upper part of the Pigeon River, in Rush Lake, Mud Creek, and the county drain near Bayport.

19. **Notropis hudsonius** (De Witt Clinton). Spawn-eater; spot-tailed minnow; shiner.—This species was found commonly along the sandy shore of Saginaw Bay, especially on the north side of Sand Point.

20. **Notropis cornutus** (Mitchill). Shiner, red fin; dace.—Found in small numbers in the upper part of the Pigeon River, and in the ox-bow pond at Caseville. It was exceedingly numerous along the shore of Sand Point where on calm days the young could be seen in immense schools.

21. **Notropis rubrifrons** (Cope). Red-fronted minnow.—Common along the shore of Sand Point.

22. **Notropis whipplii** (Girard). Silver-fin.—Apparently not common. A single specimen was taken in the lower part of the Pigeon River.

23. **Anguilla chrysypa** Rafinesque. Common eel; fresh-water eel. —The fishermen occasionally take this eel in Orr's fish-trap.

24. **Coregonus quadrilateralis** Richardson. Pilot fish; Menominee whitefish; shadwaiter; round whitefish.—Reported to have been taken occasionally both at Caseville and Bayport.

25. **Coregonus clupeiformis** (Mitchill). Common whitefish.—This species spawns on the broad sand flats off Sand Point, and specimens are taken in limited numbers the year round on these grounds. This is the commercial whitefish of the county and is, next to the sturgeon, the most valued fish. It forms the most profitable part of the commercial fishermen's catch. Specimens were taken in Orr's fish-trap.

26. **Argyrosomus artedi** (Le Sueur), Lake herring; Michigan herring; cisco.—Like the common whitefish, the herring is also abundant along the broad flat to the north of Sand Point and is taken in immense numbers during November and December. Although it brings only a small price per pound, it is considered a profitable part of the seasons catch and is much depended upon. Specimens were taken from Orr's fish-trap.

27. **Cristivomer namaycush** (Walbaum). Lake trout.—Recorded by Cope (1865, 80) from Saginaw Bay, under the name *Trutta namaycush*.

28. **Umbra limi** (Kirtland). Mud minnow; dogfish.—This fish was found to be very common in the following places: ponds near Turtle Bay, stagnant pools of the upper part of the Pigeon River; Rush Lake (shallow water at south side); Mud Creek, and county drain near Bayport.

29. **Lucius vermiculatus** Le Sueur. Little pickerel.—Only a few

specimens were taken, all of these being from the following places: ox-bow pond at Caseville, upper part of Pigeon River, and county drain near Bayport. A specimen was taken from the crop of an American bittern shot on Sand Point.

30. **Lucius lucius** (Linnaeus). Common pike; lake pickerel; grass pike.—Very common in the larger inland bodies of water. Taken in the upper and lower parts of the Pigeon River; ox-bow pond at Caseville, and in the deeper waters and the adjacent county drain at Rush Lake.

31. **Lucius masquinongy** (Mitchell). Muskallunge.—Recorded from Saginaw Bay by Cope (1865, 80; 1869, 410) and Goode (1884, 465) under the name *Esox nobilior* Thompson.

32. **Fundulus diaphanus** (Le Sueur). Spring minnow; barred killifish; toothed minnow; horse minnow.—Found in small numbers in the Caseville marsh and in the county drain at Rush Lake.

33. **Percopsis guttatus** Agassiz. Trout perch.—Large numbers of dead individuals were found on the shores of Sand Point.

34. **Pomoxis sparoides** (Lacépède). Calico bass; grass bass; strawberry bass.—This species is apparently uncommon in the region studied. One specimen was taken in Turtle Bay and another in the lower part of the Pigeon River. Recorded from Saginaw Bay by Cope (1865, 84) under the name of *Hyperistius hexacanthus* (Gill).

35. **Ambloplites rupestris** (Rafinesque). Red-eye; goggle-eye; rock bass.—Common and widely distributed in the sand region and adjacent waters of Saginaw Bay. Found in Orr's fish-trap, Turtle Bay, Pigeon River, ox-bow pond at Caseville, Caseville marsh, Mud Creek, county drain near Bayport, and under Orr's fish house on Sand Point.

36. **Eupomotis gibbosus** (Linnaeus). Pumpkin-seed; sunny; common sunfish.—Like the rock bass this species is very common and widely distributed in the region. It was taken in Turtle Bay, upper and lower parts of the Pigeon River, and in the deeper waters and adjacent county drain and marsh (west end of lake) at Rush Lake.

This fish was abundant in Turtle Bay and was observed breeding there. As said before, this bay is a shallow body of water measuring from four and a half to six feet in depth and comprises about fifteen acres. The conditions are well suited to the life of the common sunfish, the bottom being muddy, the water shallow, quiet, and warm, and the vegetation abundant.

Individuals were found with nearly ripe eggs as early as June 23, and males with milt were found as late as August 20. The only case of spawning was observed on July 5. Nest building was watched closely in connection with a number of individuals in different localities, and the following was the general method. The nests, which are well known and easily recognized as saucer-shaped depressions, were usually located in comparatively shallow water, the depth ranging from six inches to two or three feet. The fish began operations by removing any plant material that was present. The loose material was rooted or bunted out of the way and the attached stalks were seized in the mouth and dragged away, little judgment being used in the method of seizing. When the aquatic vegetation had been cleared away sufficiently, the clearing away of the sediment was begun. This the fish accomplished with a long sweeping stroke of the tail. The movement of the body caused by the sweeping tail was largely but not entirely compensated for by an opposing motion of the pectorals, so that a slow progressive motion took place. This forward movement was accompanied by a depression of the tail or caudal fin, so that the fish lay vertically in the water. The result of these sweeping strokes was the production of a current in the water which carried out the debris.

The sweeping was quite vigorous, especially as the breeding season approached, so that the mud and fine sand were swept aside exposing the coarse gravel or the roots of aquatic plants. Often the mouth was brought into play in removing the gravel and small stones. The final result of the sweeping and handling of the plants and gravel was a shallow depression of some ten to eighteen inches in diameter by two to four inches in depth.

The single case of spawning that was observed from first to last took place as follows. At about half-past three on a warm sunny afternoon (June 5) my boat glided over a nest where the owner poised a moment and then disappeared among the weeds near by. I paused, and it was not long before he returned from his concealment showing little fear of me. He was a splendid big fellow, six to eight inches long, with a little greenish blue showing on his muzzle as from a scar. By this mark he was easily recognized. Directly beneath me, in about two feet of water, I observed him stroking vigorously with his pectoral fins and tail. The result of this motion was to produce currents as shown by the disturbed particles on the bottom, yet was so compensated for that the position of the fish was not changed. While performing in this way the male stayed within about two inches of the bottom.

This exercise was occasionally interrupted by the unwelcome approach of a few minnows (*Notropis* sp.), and by the fish leaving the nest suddenly. These sudden departures were accomplished by quick movements very similar to those shown in fright. That they were not from fright, I was able to demonstrate by attempting to frighten him. He would allow me to chase him all over the nest with a stick without once leaving the nest. Finally he returned from one of his trips in company with a fish a trifle shorter than himself and differing in color in that the back was a lighter brown and the body was banded. In the lighter colored bands, one could distinguish golden or orange-colored scales mingled with others of a lighter shade. Upon entering the nest, the newcomer, a female, came a little in advance and to all appearances freely entered the nest. When once in the nest, she avoided the owner for a time, dodging this way and that, but after a few seconds she allowed him to come abreast. In this position they circled about for a few seconds, keeping the axis of their bodies parallel and stroking in unison. Finally the female began to vary her motion by rotating or turning her body so as to lay almost completely on her side, recovering her original upright position by a quick stroke to resume her movement about the nest. I counted eleven such circles in a minute, including the movements associated with the turning of the body upon its side and the recovery of the upright position. During this entire process, the male retained an upright position in close proximity to the ventral surface of the female, the ventral surfaces of the two being very near together at the time when the female was in a horizontal position. At the time that the female made the quick motion of the tail that returned her to the upright position, a little cloud of sperm intermixed with eggs could be observed streaming in a general direction past the male and toward the bottom. The spawning took place close to the bottom where weeds and roots were present, and the body of the female seemed actually to strike them at the time of the sudden movement.

Spawning was continued from eignt to ten minutes (the actual time occupied was observed for five minutes and the remainder estimated) with only an occasional intermittance of a few seconds. At the time, towards the last of the interval, when the male was disturbed, the female remained rather quiet and exhibited every mark of fatigue, such as the rapid movement of the opercular and sluggishness of other parts of the body. At intervals, especially towards the last, the female would appear to avoid the male and he would bunt into her side above the ventral fins. These bunts were followed in every case by spawning which extended over an appreciable time. At the end, the male made a bunt at the female and she quickly left the nest, pursued by him.

37. **Micropterus dolomieu** Lacépède. Large-mouthed black bass. —Generally not abundant but somewhat more common locally. Specimens were taken in Orr's fish-trap, and in the upper and lower parts of the Pigeon River. Recorded from Saginaw Bay by Cope (1865, 83) under the name of *Micropterus fasciatus* Gill.

38. **Micropterus salmoides** (Lacépède). Large-mouthed bass.—Rather more common than the preceding species but still not abundant. Taken in Pigeon River, ox-bow pond at Caseville, Mud Creek, county drain near Bayport, and Turtle Bay.

39. **Stizostedion vitreum** (Mitchill). Wall-eyed pike; pike perch; glass-eye; yellow pike; blue pike.—Very common in Saginaw Bay and in the open waters of the lake. This species is, with the exception of the herring and then only during the fall, the most abundant fish taken in the pound nets. Several specimens were taken in Orr's fish-trap, on the north shore of Sand Point, and in the lower part of the Pigeon River.

Said by Michael to be recorded by U. S. Fish Commission from Saginaw Bay and Caseville. Recorded from Saginaw Bay by Cope (1865, 82) and Milner (1872, 11, 34) under the name *Stizostedion americanus*, and by Goode (1884, 420).

40. **Perca flavescens** (Mitchill). Yellow perch; common perch; ringed perch.—Very common and only a little less numerous than the preceding species in the habitats in which they are found together, but much more widely distributed. Specimens were taken in Orr's fish-trap, north shore of Sand Point, Turtle Bay, Pigeon River (lower part), Mud Creek, county drain near Bayport, and the county drain and marsh (at west end) at Rush Lake as well as in the deeper waters of the latter. Recorded from Saginaw Bay by Cope (1865, 82) and Goode (1884, 415-416).

41. **Percina caprodes** (Rafinesque). Log perch; rock fish; hog fish.—Not uncommon in the lower part of the Pigeon River, off the north shore of Sand Point, and in Turtle Bay.

42. **Hadropterus aspro** (Cope and Jordan). Black-sided darter.—Specimens were taken in the upper and lower parts of the Pigeon River, and on the north shore of Sand Point.

43. **Etheostoma iowae.** Jordan and Meek. Iowa darter.—Taken in the lower part of the Pigeon River, and in Turtle Bay on Sand Point.

44. **Boleichthys fusiformis** (Girard). Spindle darter.—Found commonly in both the upper and lower parts of the Pigeon River, on the north and south shores of Rush Lake, along the shore of Sand Point, and in Turtle Bay.

45. **Roccus chrysops** (Raf.). White bass.—Recorded from Saginaw Bay by Cope (1865, 83) and by Goode (1884, 430). The latter writes as follows: "On the fishing grounds of Saginaw Bay, including also those of Charity Islands, a few white bass are occasionally taken in May and the first part of June." They were never abundant in this region.

46. **Aplodinotus grunniens** Rafinesque. Fresh-water drum; sheepshead.—Taken in the pound nets by the commercial fishermen all along the shore.

47. **Cottus ictalops** (Rafinesque). Miller's thumb; blob; muffle jaw; bullhead; springfish.—Apparently rare in the sand region and adjacent waters of Saginaw Bay. A single specimen was taken on the north shore of Sand Point.

48. **Lota maculosa** (Le Sueur). Lawyer; ling; burbot; aleky trout; mother of eels; eel-pout.—Not common. A few specimens were taken from Orr's fish-trap, and one was found dead on the shore of Sand Point in August.

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The literature that deals with the fish of this region is, so far as we have been able to find, restricted to those of Saginaw Bay.

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LAKE HURON
PORT AUSTIN LIGHT HOUSE
POINT AUX BARQUES
BURNT CABIN POINT
AUSTIN
BRIDGTOWN
POINT AUX BARQUES LIGHTHOUSE.
HURON
GORE
BLOOMFIELD
RUBICON
HARDWOOD POINT
REDMAN
RAPSON
Diamond Creek
PORT HOPE
Willow River

NORTHERN PART OF HURON COUNTY, SHOWING LOCALITIES STUDIED.

AMPHIBIANS AND REPTILES.

BY ALEXANDER G. RUTHVEN.

GEOGRAPHIC RELATIONS OF THE FAUNA.

The writer gave particular attention to the amphibians and reptiles on this expedition, and in this work he was assisted very materially by the other members of the party. To one interested in the herpetology of Michigan the results obtained in this summers work are very gratifying; for while our Michigan fauna is composed of species which are of wider range in eastern North America, and thus for the most part well known, comparatively little is known of the distribution of many of these forms in the state. This is particularly true of the north and south distribution, an interesting question in view of the intermediate position of the state between northern and southern faunas. The remarks on the general nature of the fauna of Michigan in an earlier paper in this report apply equally to this group, and we find as we go northward that the species that inhabit the extreme southern tier of counties gradually drop out of the fauna until few are left on our northern boundary. In the case of amphibians and reptiles, however, we do not, as in the case of mammals and birds, have many other forms coming into the fauna from the northward, and the explanation is that these groups are preeminently tropical and are in this region reaching the outskirts of their range. This is less true of the amphibians than of the reptiles, for the former have a greater capacity for enduring cold. It is thus not surprising that the only two forms that enter our region from the north belong to the genus *Rana* (the frogs). These species are *Rana cantabrigensis* and *R. septentrionalis*, both of which are of decidedly northern distribution, the latter not occurring in the southern peninsula, so far as we know, and both ranging through the northern peninsula and far into Canada.

From these general remarks, it will be seen that the reptile-amphibian fauna of the region studied may be divided into three groups:

1. Those forms that are known to occur throughout the state, or at least range well north of this latitude. The species that fall into this group need no discussion here. They include most of the amphibians and may be enumerated as follows: *Bufo americanus*, *Rana pipiens*, *R. clamitans*, *Hyla pickeringi*, *H. versicolor*, *R. sylvatica cantabrigensis*, *Ambystoma jeffersonianum*, *Diemictylus viridescens*, *Plet-*

hodon cinereus, Storeria dekayi, S. occipitomaculata, Thamnophis sirtalis, Liopeltis vernalis, Chrysemys cinerea, Chelydra serpentina.

2. Those forms that are not known to extend far north of latitude 44° north, but are nevertheless known to occur near this latitude and might reasonably be expected here. The Huron County records of these species, which are listed below, are of value as adding to our knowledge of their distribution within the state. They are *Chorophilus nigritus triseriatus, Thamnophis sauritus, Lampropeltis doliatus triangulus, Natrix sipedon, Sistrurus catenatus* and *Emydoidea blandingi.* Further investigation will undoubtedly result in the placing of some of these forms in the first group.

3. Those forms of southern distribution that were not definitely known to occur in the lower peninsula as far north as this latitude. Here belong *Eumeces quinquelineatuus, Elaphe vulpinus, Heterodon platyrhinus* and *Thamnophis butleri.* This group is a very interesting one from the standpoint of Michigan herpetology, as it gives us more exact data on the northern limit of these species, and may indicate a more southern element in the fauna of this coast than in that of the interior.

Eumeces quinquelineatus. "The *Eumeces quinquelineatus* is distributed throughout the eastern district, with the exception of the Canadian and Hudsonian subdistricts, and throughout the Austroriparian, excepting the Texan district. The most northern locality from which I have seen a specimen is Michigan, as pointed out by Hallowell." (Cope, 1898 p. 638). The Michigan specimen referred to by Cope was taken at Flint, Michigan, and hitherto has been the most northern record for the state.

Elaphe vulpinus. The fox snake does not extend as far south as do most of the species that make up the Michigan fauna. The only Michigan record known to the writer, previous to this expedition, was Grosse Isle (Cope, 1898, p. 832) and "from the vicinity of Saginaw Bay" (Miles 1861, p. 234). Other specimens were recorded from this coast in 1909 (Ruthven 1909) so that, as it was found to be rather abundant in the sand region and on Stony Island, it is now known to extend up the east coast of Michigan as far north as this latitude. It probably occurs in suitable habitats farther north in the lower peninsula, for it is known from the upper peninsula (Ruthven 1910).

Heterodon platyrhinus. This species occurs throughout the eastern forest region, from Florida northward. It was to have been expected in the state, but up to 1909 its status was very doubtful. The reliable records seem to show that it is primarily confined to the sandy regions in southern Michigan, as far north as Oscoda County and Manistee

(Ruthven 1909). We found the species not uncommon in the sand region.

Thamnophis butleri. This garter-snake inhabits Indiana, Ohio, western Pennsylvania and southern Michigan. The most northern record for the species, as well as for the state, has hitherto been Oakland County, Michigan. Three specimens were found in Huron County,—two on Stony Island and one at Rush Lake (neither locality in the sand region),—which extends the range considerably to the northward.

It will be seen that of the forms in this group *Eumeces quinquelineatus* and *Thamnophis butleri* probably also occur in the interior of the state, so that the milder climate of this coast cannot be said to be of influence in introducing them farther northward than in the interior. On the other hand, if *Elaphe vulpinus* and *Heterodon platyrhinus* also occur in the interior it is not a little singular that they have not been found at Ann Arbor, Lansing, or Olivet. At first sight it appears that this distribution may be accounted for on the basis of temperature, for both species may be called abundant in the sand region, and, furthermore, *Eumeces quinquelineatus* is certainly much more common there than in the interior. In this connection it is interesting to note that these forms are apparently not only confined to this general region but also to the very limited confines of the sand region, which the more equable temperature of this coast would not require, that *Heterodon platyrhinus* prefers sandy regions and has been found elsewhere in lower Michigan only in such areas (Ruthven, 1909), and that *Elaphe vulpinus* and *Eumeces quinquelineatus* were by far the most abundant in this region in the dryest and sandiest habitats. In view of these things I believe the explanation for the fact that these forms are here introduced beyond the major part of their range, or at least occur here more abundantly than in the interior, is to be found not so much in the more equable temperature as in the higher summer temperature, sandy soil and general aridity of the upland habitats of the sand region.

HABITAT RELATIONS OF THE FAUNA.

As regards their habitat relations the amphibians and reptiles of the region studied fall into several groups, the forms of which are particularly adapted to the conditions of life in the habitats in which they are found.

A. *Aquatic habitats.* None of the reptiles and amphibians obtained are deep water, aquatic-breathing forms, although the fishermen informed us that *Necturus maculosus* is frequently found in their pound-nets off Sand Point. Most of the forms that are associated with the aquatic habitats are air breathers during a part or all of their existence, and few are peculiar to those habitats. Some of them are terrestrial except in the larval state or during the breeding season (Hylidae, Ranidae, Ambystomadae), while others are always air breathers but live in the water except during the breeding season (Testudinata), and one other *Natrix sipedon*, only takes to the water to obtain food and escape enemies. *Diemyctilus viridescens* is unique in that it is an aquatic form in the larval state, a terrestrial air-breather the second year, and a partially aquatic breather in the adult state.

This fauna, not being strictly an aquatic one, is not dependent upon continuous waterways in its migrations. The presence of bodies of water is, however, an indispensible condition in the environment, and the forms, being weak swimmers, prefer the quiet water conditions of ponds, small lakes and bays to those in the large bay. There is a considerable number of ponds, small lakes and quiet bays in the sand region which accounts for the abundance of this fauna. Many of these are transient but they are mostly large enough to presist until after the larval stages of the amphibians that breed in them are passed, and other forms are rarely found in such places.

B. *Swamp habitats.* Here may be grouped (a) the grassy marshes that exist throughout the sand region and on Stony Island, and the grass zones about many of the bodies of water, and (b) the timbered swamps. These two kinds of swamps have in common the adult stages of *Hyla pickeringi*, *Bufo americanus* (see p. 262), *Rana pipiens*, and the garter-snakes, *T. sirtalis* and *T. sauritus.* Characteristic of the grass swamps are the adult stages of *Chorophilus nigritus triseriatus*, *Sistrurus catenatus* and *Liopeltis vernalis*, while *Plethodon cinereus*, *Hyla versicolor*, *Rana sylvatica cantabrigensis* and *Ambystoma jeffersonianum* were characteristic of the wooded swamps. The abundance of these habitats in this region together with the numerous ponds explains the abundance of the forms enumerated above. It should be noted that some of these species are occasionally found also upon the sand ridges, these being usually the ones most capable of resisting dessication, e. g., *Rana pipiens*, *Bufo americanus*, *Liopeltis vernalis*, *Hyla versicolor*, and the garter-snakes.

C. *Sand ridge habitat.* As stated elsewhere, the numerous sand ridges are the prevailing feature in the topography of the sand region. These ridges although clothed with vegetation are rather open, and the soil although covered with herbaceous plants is loose and dry. The habitat is thus a dry hot one during the summer months. Amphibians are quite scarce here, but the conditions are more favorable for reptiles, and the fact that the number of characteristic forms is small is due in large part to the fact that only a few species get as far north as this latitude. To this group, however, belong the hog-nosed snake (*H. platyrhinus*), the fox snake (*Elaphe vulpinus*) and the skink (*Eumeces quinquelineatus*). Being dry habitat forms we should expect these species, if present in the fauna, to seek this habitat, but, while they may also be occasionally found in the adjoining clay country, I believe that one cause of their abundance in this region is the xerophilous nature of the terrestrial habitats (see p. 28 *et seq*). Three other species, *Lampropeltis doliatus triangulus*, *Storeria dekayi* and *S. occipitomaculata*, were practically confined to this habitat, but this was probably not due to the aridity of the conditions but merely to the fact that they prefer high terrestrial conditions and have been able to persist here.

Other forms that occur in, but are not peculiar to, this habitat are the ubiquitous garter snakes (*T. sirtalis*, *T. sauritus*), the green snake (*Liopeltis vernalis*), and the tree toads, *Hyla versicolor* and *H. pickeringi*, all species which occur also in the swamps.

LIST OF SPECIES.

Amphibia.

1. **Necturus maculosus** Rafinesque. Mud-puppy.—No specimens of this amphibian were observed, but the fishermen informed the writer that individuals were frequently caught in the pound-nets off Sand Point.

2. **Plethodon cinereus** (Green). Red-backed salamander.—We found this salamander much less common than might be expected. Only 15 specimens were secured, and these were all taken east of Caseville, in and under moist decaying logs in the swamps between the sand ridges. Individuals were also taken in the clay country immediately adjoining—in the low woods at the east end of Rush Lake.

3. **Ambystoma jeffersonianum** (Green). Jefferson salamander.—This little salamander apparently occurs throughout the sand region. It was found under logs in damp places—usually in the swamps among the ridges. On Sand Point a number of specimens were taken under decaying logs on the fossil beaches. It was also found in the woods at the east end of Rush Lake.

Both spotted and uniformly black specimens were taken. In the spotted individuals the ground color was black above and blackish slate beneath, and the spots, both above and below, dark blue (about CC. 403).*

*Klincksieck and Valette, Code des Couleurs, Paris, 1908.

4. **Diemictylus viridescens** Rafinesque. Newt.—As was to have been expected, this amphibian was comparatively common in the region explored. Adults were secured in the permanent ponds on Stony Island and throughout the sand region, from Sand Point to Rush Lake. Larvae were found in a pond on Stony Island, and the terrestrial form was found under logs in the woods on Stony Island and in a swale back of the beach on the north side of Sand Point.

5. **Bufo americanus** Le Conte. Toad.—Singularly enough this amphibian could not be found in the sand region proper, except on the low ground about the mouth of the Pigeon River. Specimens were also found on Stony Island and in the woods at the east end of Rush Lake.

6. **Hyla versicolor** Le Conte. Tree toad.—A series of eleven specimens of this amphibian was obtained. It was found to be relatively common in all of the sand region localities investigated and on Stony Island. The immature individuals (July 11 and 15) were taken about the margins or in the recently dry beds of ponds; the adults on plants, the walls of shacks, etc., in wooded swamps and even on the dry ridges.

7. **Hyla pickeringi** Holbrook. Spring peeper.—As *H. versicolor* the spring peeper is not uncommon in the sand region, and it was also observed on Stony Island. Adults were taken on the vegetation in the wooded swamps on Sand Point, Hat Point and Rush Lake, in the grassy margins of ponds on Sand Point and Stony Island, and a single specimen on the beach near the extremity of Sand Point. On the prairie at the base of Sand Point immature individuals were found on the sites of ponds that had recently become dry (July, 3).

8. **Chorophilus nigritus triseriatus** (Wied). Swamp tree-toad.—A few adult specimens of the swamp tree-toad were secured at the following places: Stony Island, North Island, Sand Point, woods at east end of Rush Lake. These were all taken in grassy areas, except the single specimen from the last named locality. On July 11, a great number of immature specimens were taken on the mud beds of dried-up ponds, on the prairie at the base of Sand Point.

I hesitate to refer the Michigan representative of this genus to the subspecies *triseriatus*, for the relations of the forms of this group do not seem as yet to be satisfactorily worked out. I am unable to distinguish the specimens from Huron County, as well as those from Ann Arbor, from Iowa material, all of these specimens having a rather short hind-limb (the length to the heel equaling the distance from the anus to some point between the ear and eye) and a rather prolonged snout; characters that seem to refer this form to the *triseriatus-septentrionalis* section of the genus rather than to the *feriarum-nigritus* section.

9. **Rana sylvatica cantabrigensis** (Baird). Wood frog.—This species was common in the swamps between Sand Point and Rush Lake. It was only very rarely found on the sand ridges. I have elsewhere (Ruthven, 1909, p. 116) given my reasons for referring these specimens to the variety *cantabrigensis*.

10. **Rana pipiens** Schreber. Leopard frog.—Common in suitable habitats everywhere in the region studied.

11. **Rana clamitans** Latreille. Green frog.—Although not as abundant as the leopard frog, the green frog was found to be not uncommon in the ponds and swamps of the sand region, between Sand Point and Hat Point, and individuals were occasionally found on the beach of Saginaw Bay. It was also a common form on Stony and North Islands.

12. **Rana catesbeana** Shaw. Bull frog.—This species was found in numbers in Rush Lake and in the county ditches near by, but nowhere else in the region.

Sauria.

13. **Eumeces quinquelineatus** (Linneaus). Blue-tailed skink.—The expedition secured a large series of this lizard, which is very fortunate in view of the fact that the species is apparently becoming rare in the regions that it formerly occupied in the state, as the woods are removed by lumbering and fire. We found it throughout the sand region, from Sand Point to Hat Point, but it was much more abundant on Sand Point, probably for the reason that this region has not been so extensively burned over. A careful search failed to discover it on Stony Island.

In the woods of the sand region it was found on the dry ridges, under and in decaying logs, where it fed on the insects that frequent such situations. It was, however, much more common than elsewhere under the drift logs on the fossil beaches, and also on the middle beach on the present shore, at the extremity of Sand Point. The logs strewn along the fossil beaches were in an advanced stage of decay, and usually consisted of an outer shell of better preserved wood covering a mass of decomposed debris, the decomposition taking place most rapidly next to the ground. This apparently furnished a very favorable habitat for these lizards, great numbers of which were found in the decomposed material when the outer shell of the log had been removed. (Pl. XVI.)

The eggs were laid in the same material, the female generally scooping out a small hollow in the bottom of which the eggs were partially buried in the debris. Both in the woods and on the beaches nests were occasionally found in the sand beneath a log or board where there was only a small amount of decaying wood, but in every case there was at least a small amount. Females taken on June 19 were pregnant, containing large eggs apparently nearly ready to be laid. The first sets observed were on July 2, and on and after this date nests of eggs were found in numbers. Everything went to show that the eggs are mostly laid about the first of July. None were observed before this date, and those collected on July 2 were all clean—they usually become much stained from the decaying wood after being in the nest for some time. The number of eggs in the set was counted in eight instances and were as follows: 6, 6, 8, 8, 9, 11, 13, 14. An examination of the pregnant females shows that the number in each set varies with the size (age?) of the female, the smaller ones having 6 to 8 eggs, the larger ones 9 to 14. It is interesting to compare this with the statement of Ditmars (1907, 202) that he found the normal numbers to be 3 or 4, and that of Strecker (1908, 169) "the several sets that I have examined were all of 8 eggs each."

It was interesting to observe the behavior of the female when with her eggs. As is well known she remains with them until they are hatched, but for what purpose is not evident. We usually found them coiled about the eggs, but sometimes they simply lay beside them. In any case there seemed to be no attempt to come in immediate contact with the eggs, and indeed this would have been impossible in most instances, as the eggs themselves were not even in contact with each other, being somewhat scattered about in the decaying debris. However, there seemed to be a disposition on the part of the female to keep her set together; several times I saw a female leave her position and crawl about the eggs, and when she encountered one which I had displaced, lick it and then nose it back with the others. If care was taken in removing the outer shell of the log to expose the nest, the female would remain with the eggs, only burying herself deeper in the loose debris when her head was exposed to the light.

The first young of the year were observed on July 31, when a female was found under a small log on a sand beach, coiled about a nest of 8 eggs from which the young were emerging. In life the ground color of the young was black; the stripes yellow (CC. 202), the tail bright blue (CC. 436).

One of the enemies of the skink is the milk snake (*Lampropeltis doliatus triangulus*) that captures it in decaying logs.

Serpentes.

14. **Heterodon platyrhinus** Latreille. Hog-nosed snake.—This species was found throughout the sand region from Sand Point to Rush Lake, and a specimen was collected at Port Austin by Miss Crystal Thompson of the University of Michigan Museum. The sand country evidently furnishes favorable conditions for this snake, for it could not be called uncommon, and specimens of large size were obtained. One female (University of Michigan No. 37746) taken on June 21 was 898 mm. in length and had a girth of 125 mm.

Mr. Yax, a resident, informed us that specimens were occasionally killed in the clay country near the sand region, but all of the information that we could gather from the residents was to the effect that it was seldom found outside of the sand region.

The color pattern of blotches is distinct in all of the specimens obtained; indeed all but two are brightly colored, having a considerable amount of bright yellow or orange in the ground color. (Pl. XVII b.)

Museum Number.	Locality.	Dorsals.	Supralabials.	Infralabials.	Oculars.	Urosteges.	Gastrosteges.	Total Length.	Tail Length.	Remarks.
36162	Port Austin	25–23–21–19	8	9–10	12					
37746	Sand region	25–23–21–19	8	10–11	12	42	135	898	150	♀
37954	Sand region	27–25–23–21–20	8	10	10–11	36	131	455	59	♀
37744	Sand region	25–23–21–19	8	10	10–11	33	130	479	64	♀
37741	Sand region	25–23–21–19	8	10	9–11	42	137	442	62	♀
37737	Sand region	25–23–21–19	8	10	9–10	38	134	466	64	♀
37739	Sand region	25–23–21–19	8	10	9–10	40	120	658	123	♂
37738	Huron Co.	27–25–23–21–19	8	10–11	10	49	119	403	72	♂
37735	Sand region	25–23–21–19	7–8	9–10	11	49	126	342	60	♀
37736	Sand region	25–23–21–19	8	9	9–10	49	127	207	35	♀
37740	Sand region	25–23–21–19	8	10–11	10–11	42	134	510	75	♀

15. **Elaphe vulpinus** (Baird and Girard). Fox snake.—As elsewhere stated (Ruthven 1909 and 1910), the southern Michigan localities in which this species has been found are: Grosse Isle, Pearl Beach, St. Clair County, Hensens Island, Lake St. Clair, and vicinity of Saginaw Bay. It was found to be comparatively common in the sand region. Specimens were secured on Sand Point and Stony Island, and the residents reported that it was often found in the region northeast of Caseville.

In most of the individuals from the sand region the upper surface of the head is dark reddish brown (color of those examined in life CC. 112-113). For this reason it is called the copper-head by the residents, and thus confused with the true copper-head, and consequently dreaded for its supposed venomosity. This is rather remarkable for most individuals are exceedingly docile, only occasional ones attempting to bite when handled. A specimen taken among the drift logs on the fossil beach at the extremity of Sand Point had recently eaten four young rabbits. (Pl. XVIIa.)

Museum Number.	Locality.	Dorsals.	Supralabials.	Infralabials.	Oculars.	Temporals.	Urosteges.	Gastrosteges.	Total Length.	Tail Length.	Remarks.
37628	Sand Point	27–25–23–21	8	9–10	1–2	2–4 2–3	63	201	1220	180	♂
37745	Sand Point	25–27–25–23–21	8–9	10	1–2	2–3	58	211	1370	160	♀
37630	Sand Point	....	7	9–11	3–5 2–4	1–2	50	207	1070	147	♀
37627	Sand Point	25–23–21	8	11	1–2	2–3 2–4	54	209	310	45	♀
37629	Stony Isl.	23–21	8	10–11	1–2	2–4	65	200	936	155	
37625	Sand Point	25–23–21	8	10–11	1–3 1–2	2–4	57	212	1242	158	♀
37626	Sand Point	27–25–23–21	9–8	11	1–2	2–3	64	203	1024	159	♂

16. **Storeria dekayi** (Holbrook). Little brown snake.—This little snake was found on Stony Island and Sand Point and at Caseville and Rush Lake, but not in numbers. It was found in two habitats—grassy swamps and pine woods on the sand ridges.

Museum Number.	Locality.	Dorsals.	Supralabials.	Infralabials.	Oculars.	Temporals.	Urosteges.	Gastrosteges.	Total Length.	Tail Length.	Remarks.
37732	Rush Lake	17	7	7	1–2 1–1	1–2 1–3	57	125	281	70	♂
37952	Caseville	....	....	....	......	......	....	......	......	....	immature.
37742	Sand Point	....	....	....	......	......	....	......	......	....	immature.
37730	Sand Point	17	7	7	1–2	1–2	55	126	276	70	♂
37729	Stony Isl.	17	7	7	1–2	1–3 1–2	46	133	330	66	♀
37731	Sand Point	17	7	7	1–2	1–3 1–2	47	127	,341	72	♀

17. **Storeria occipitomaculata** (Storer). Red-bellied snake.—Only two specimens of the red-bellied snake were taken—both on the pine ridges of Sand Point. One of these, taken on August 1, had large eggs in the oviducts. The number of specimens taken does not necessarily indicate the abundance in view of the small size and secretive habits of the species.

Museum Number.	Locality.	Dorsals.	Supralabials.	Infralabials.	Oculars.	Temporals.	Urosteges.	Gastrosteges.	Total Length.	Tail Length.	Remarks.
37728	Sand Point	15	6	7	2–2	1–2	44	121	272	54	♀
37727	Sand Point	15	6	7	2–2	1–2	41	122	215	44	♀

18. **Liopeltis vernalis** (De Kay). Green snake.—The green snake was only observed on Sand Point, where several specimens were seen but only one secured. This specimen, an adult female, was taken in the woods on a low sandy ridge on the south side of the Point. The scutellation is as follows: dorsals 15, supralabials 7, infralabials 8, oculars 2-2, temporals 1-2, urosteges 71, ventrals 129. Total length 387, tail 115.

19. **Lampropeltis doliatus triangulus** (Boie). Milk snake.—The milk snake was a common form throughout the region studied.

Specimens were taken on Stony Island and Sand Point, and at Rush Lake. They were mostly found in the decaying logs on the fossil beaches and pine ridges, where they fed, in part at least, on the Michigan mouse (*Peromyscus maniculatus bairdii*) and blue-tailed skink (*Eumeces quinquilineatus*), as remains of these animals were found in the stomachs examined.

Museum Number.	Locality.	Dorsals.	Supralabials.	Infralabials.	Oculars.	Temporals.	Urosteges.	Gastrosteges.	Total Length.	Tail Length.	Remarks.
37663	Sand region	21–19–17	7	9	1–2	1–3	46	202	235	31	♀
37660	Sand Point	21–19–17	7	7–8	1–2	1–3 2–3	42	204	789	97	♀
37662	Stony Isl.	21–19–17	7	9	1–2	2–3	48	195	837	120	♂
37661	Sand Point.	21–19–17	7	8–7	1–2	2–3	51	202	777	115	♂
37653	Sand Point.	21–19–17	7	9	1–2	2–3	42	202	459	57	♀

20. **Thamnophis sirtalis** (Linnaeus). Garter-snake.—It is hardly necessary to state that *T. sirtalis* occurred everywhere in the region studied, being more abundant in open swampy situations than elsewhere. Specimens were taken on North Island, Stony Island, and at various places in the sand region, between Sand Point and Hat Point.

21. **Thamnophis butleri** (Cope). Butler's garter-snake.—In his monograph of the genus (1908, 92) the writer stated that, owing to the abundance of this species in the localities representing the known northern limit in the state (Oakland County), this snake would probably be found to extend considerably farther north. This was confirmed by its discovery in Huron County. Three specimens were secured by the expedition, two on Stony Island and one in the clay country south of Rush Lake, none being found in the sand region. It is evidently very rare, if present at all, in the sand region. Whether or not it is abundant in the clay country remains to be discovered, as we could not investigate this region in detail.

This species seems to feed less upon frogs than do its relatives *T. sirtalis* and *T. sauritus*, which is not surprising in view of its small mouth. One specimen taken in a marsh on Stony Island had recently eaten an earthworm, and another taken under a stone on the shore of Stony Island had eaten a number of leeches.

Museum Number.	Locality.	Dorsals.	Supralabials.	Infralabials.	Oculars.	Temporals.	Urosteges.	Gastrosteges.	Total Length.	Tail Length.	Remarks.
37725	Stony Island	19–17	6	8	1–3	1–1	62	140	518	122	♀
37724	Stony Island	19–17	6	8	1–2 1–3	1–2 1–1	51	139	444	95	♀
37723	Rush Lake	19–17	7	8	1–3	1–1	59	141	426	96	♀

22. **Thamnophis sauritus** (Linnaeus). Ribbon snake.—It has been the experience of the writer that this snake is generally much less common in Michigan than its relative *T. sirtalis*. We found that this was decidedly not the case in the sand region and the neighboring islands of Huron County, where it is apparently quite as abundant as *T. sirtalis*. It was found everywhere, both in the swamps and on the ridges, in the sand region and on Stony Island.

23. **Natrix sipedon** (Linnaeus). Water-snake.—This water snake was found throughout the region investigated—Stony Island, North Island, Sand Point and Rush Lake. It was not numerous in the sand region, but was found at almost every permanent pond. It was more abundant at Rush Lake, and very numerous on Stony Island.

Nearly all of the smaller specimens (450 mm. and less) were found under loose stones, driftwood etc., on the shores, only the larger individuals roaming about. Two specimens (taken on August 17 and 21) were about to give birth to young; indeed, three young emerged and escaped when one of these snakes was picked up.

Museum Number.	Locality.	Dorsals.	Supralabials.	Infralabials.	Oculars.	Temporals.	Urosteges.	Gastrosteges.	Total Length.	Tail Length.	Remarks.
37646	Stony Island	23–21–19–17	8	10	1–3	1–3	60	144	700	150	♀
37651	Stony Island	23–21–19 17	8	10	1–4 1–3	1–3 1–2	61	138	662	154	♀
37644	Sand Point	23–21–19–17	8	10	1–3	1–2 1–3	59	144	577	124	♀
37640	Rush Lake....	21–23–21–19–17	8	10	1–3	1–3	67	145	606	144	♀
37654	Stony Island..	23–21–19–17	8	10	1–3	1–3	63	144	282	65	♀
37641	Rush Lake....	23–21–19	8	10	1–3	1–3	60	143	417	91	♀
37642	Sand Point...	23–21–19–17	8	10	1–3	1–3	65	137	731	177	♀
37659	Hat Point....	21–23–21–19–17	9	10	1–3	1–2 1–3	65	147	266	60	♀
37653	North Island..	23–21–19–17	8	10	1–2 1–3	1–3	62	142	718	163	♀
37648	North Island..	23–21–19–17	8	10	1–3	1–2	59	143	357	78	♀
37647	Stony Island..	23–21–19–17	8	10	1–3	1–3	56	144	327	67	♀
37655	Stony Island..	23–21–19–17	8	10	1–3	1–3	56	144	......	......	♀
37650	Stony Island..	23–21–19–17	8	10	1–3	1–2 1–3	70	141	410	99	♂
37652	Stony Island..	23–21–19–17	8	10	1–3	1–3	59	140	458	100	♀
37649	North Island..	21–23–21–19–17	8	10	1–3	1–3	59	139	447	96	♀
37645	Rush Lake....	23–21–19–17	7? 8	10 11	1–3	1–3	....	145	......	......	♀
37643	Rush Lake....	23–21–19–17	8	10	1–3	1–3	61	144	......	......	♀

24. **Sistrurus catenatus** (Rafinesque). Massauger; rattlesnake.—The rattlesnake was found on Sand Point but nowhere else in the sand region, although we have records from the residents that cover the area from Bay Port to Hat Point. It was doubtless formerly common throughout the sand region, the numerous swamps affording very favorable conditions. Stony Island is locally notorious for its abundance of rattlesnakes, and it merits its reputation. About the swamps on the island we found the rattlers almost as abundant as the garter-snakes, although more difficult to capture as they frequented the tall marsh grass, and were often able to elude capture even after we had seen them. A single specimen was taken on North Island where they are also said to be abundant.

Frogs were found in the stomachs of some of the individuals taken, and these probably form the bulk of the food. The remains of snakes were found in two specimens; one of these was a rattlesnake, the other could not be identified. The condition of the devoured snakes leaves little doubt that they were eaten after having been dead for a considerable time.

Museum Number.	Locality.	Dorsals.	Urosteges.	Gastrosteges.	Total Length.	Tail Length.	Remarks.
37633	Stony Island......	25-23-21-19	22	144	555	40	♀
37631	Stony Island......	25-23-21-19	27	141	710	70	♀
37639	North Island......	25-23-21-19	23	147	676	58	♀
37638	Stony Island......	25-23-21-19	29	143	694	75	♂
37637	Stony Island......	25-23-21-19	27	142	718	78	♂
37636	Sand Point.......	25-23-21-19	28	137	694	74	♂
37635	Stony Island......	25-23-21-19	28	141	413	42	♂
37634	Stony Island......	25-23-21-19	28	134	360	42	♂
37632	Stony Island......	25-23-21-19	30	139	577	67	♂

Testudinata.

25. **Chelydra serpentina** (Linnaeus). Snapping turtle.—A considerable number of snapping turtles were taken in Turtle Bay (on the south side of Sand Point) and in the lower part of the Pigeon River at Caseville, by means of the fyke-net. Several specimens were also taken in the woods on Sand Point.

26. **Emydoidea blandingi** (Holbrook). Blanding's turtle.—We did not find this turtle abundant anywhere in the region explored. Three specimens were found wandering about on the pine ridges on Sand Point, one was taken in a fyke-net set in Turtle Bay, and a small specimen was taken on the margin of a pond on Stony Island. The writer observed a few others in Long Lake, Sand Point, and in the ponds on Stony Island.

27. **Chrysemys cinerea** (Bonn.). Painted turtle.—A large series of specimens of the painted turtle was secured, as the species was very common throughout the region. It was taken or observed on Stony and North Islands, on Sand Point, in the Pigeon River at Caseville, and at Rush Lake. Most of the specimens from Sand Point, particularly those taken in Long Lake, have red plastrons and more or less red on the carapace due to a deposit of some chemical substance from the water. The coloring is so regular that it appears at first sight to be due to pigment.

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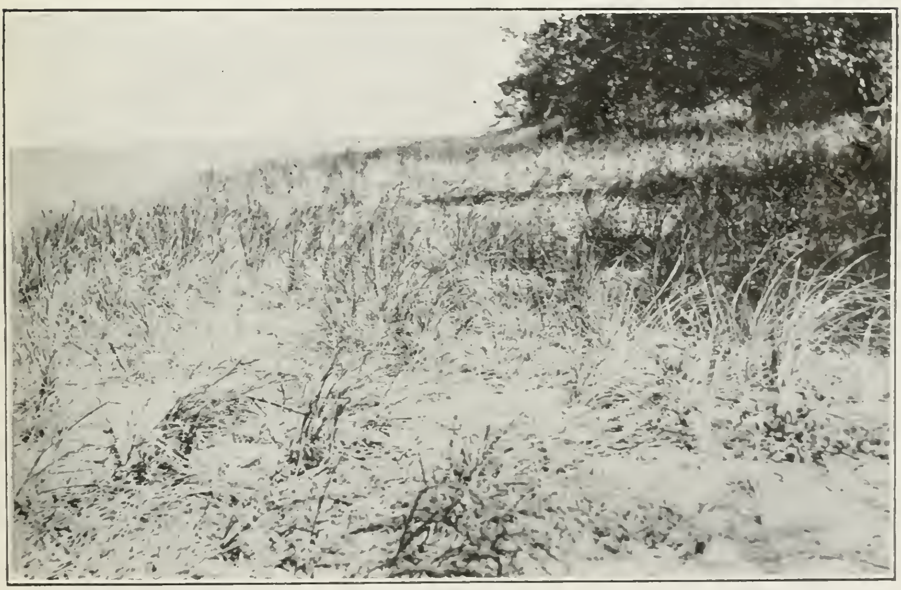
(A) BEACH ON THE NORTH SIDE OF SAND POINT.



(B) FACE OF OUTER DUNE AT OAK POINT. NOTE SAND-BINDING GRASSES.

(A) NORTH SIDE OF SAND POINT TOWARD THE END. NOTE SPARSE VEGETATION ON WINDWARD SIDE AND GREATER GROWTH ON LEEWARD SIDE OF BEACH DUNES.

(B) LOOKING NORTHEAST AT THE WEST SIDE OF OAK POINT. EMBRIONIC BARRIER BEACH, SANDSPITS AND ENCLOSED LAGOONS. THESE SAND AREAS ARE SOON CLOTHED WITH THE USUAL DUNE SPECIES.

(A) SAND FLAT WEST OF LITTLE OAK POINT. NOTE EMBRIONIC DUNES.

(B) BLOWOUT IN OUTER DUNE RIDGE, SHOWING OLD BEACH UPON WHICH THE DUNE IS SUPERIMPOSED.

(A) FOSSIL BEACH NEAR THE END OF SAND POINT.

(B) JACK PINE FOREST ON THE MORE RECENT DUNES. RIDGES CLOTHED WITH PSAMMOPHYTES, VALLEYS MOSTLY NEARLY RAISED TO BASE LEVEL, UNDERGROWTH BEGINNING TO BE MESOPHYTIC.

(A) GRASSY MARSH ON STONY ISLAND.

(B) GRASSY MARSH ON STONY ISLAND.

(A) PRAIRIE AT THE BASE OF SAND POINT. PHRAGMITES ASSOCIATION WITH "WOODY ISLANDS," THE LATTER TERRACED.

(B) MARGIN OF THE PRAIRIE AT THE BASE OF SAND POINT. PHRAGMITES ASSOCIATION IN THE FOREGROUND. ALNUS ASSOCIATION IN BACKGROUND.

(A) OPEN MARSH AT THE EAST END OF RUSH LAKE.

(B) OPEN MARSH ABOUT TURTLE BAY ON SAND POINT.

(A) GRASSY SWALE BETWEEN SAND DUNES NEAR RUSH LAKE.

(B) PERMANENT POND ON STONY ISLAND.

(A) GENERAL VIEW OF RUSH LAKE.

(B) RAYMOND'S POINT ON THE NORTH SHORE OF RUSH LAKE.

(A) DUNE POINT ON THE NORTH SHORE OF RUSH LAKE.

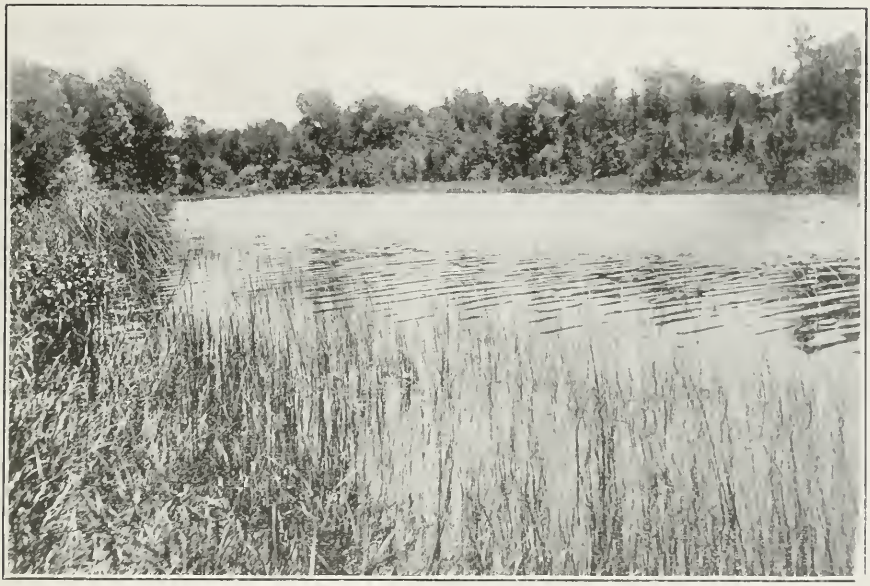
(B) PIGEON RIVER ABOVE CASEVILLE.

(A) LOOKING INTO THE OX-BOW POND OFF THE PIGEON RIVER AT CASEVILLE.

(B) DEAD-WATERS OF THE PIGEON RIVER ABOVE CASEVILLE.

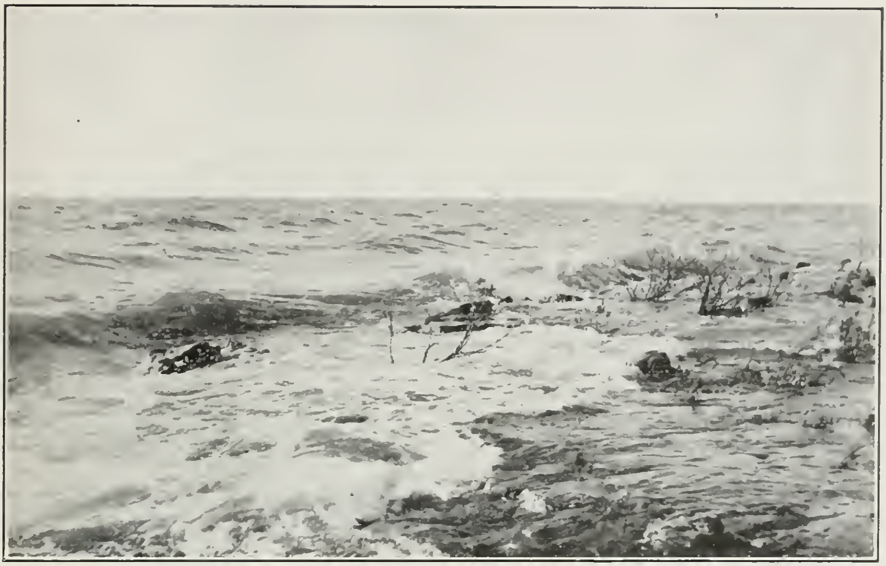
(A) GENERAL VIEW OF LONG LAKE, SAND POINT. SHOWING SCIRPUS AND JUNCUS ASSOCIATIONS IN THE WATER AND CAREX ASSOCIATION ON THE WATER-SOAKED EDGE.

(B) END OF LONG LAKE, SAND POINT. ASSOCIATIONS AND PROGRESSIONS AS IN TURTLE BAY.



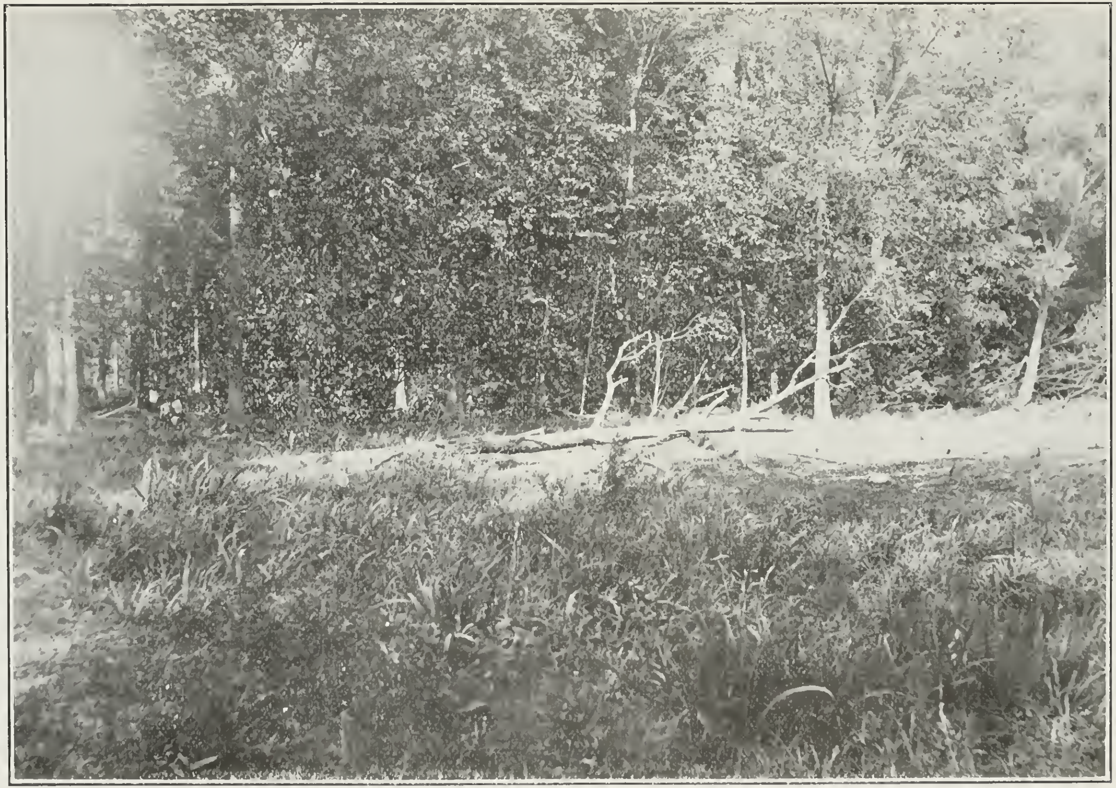
(A) MARGIN OF LONG LAKE, SAND POINT.

(B) TURTLE BAY, SAND POINT. QUIET WATER AND RESULTANT HYDROPHYTES. LARGE AREAS OF LILY PADS INTERSPERSED WITH ALISMA, SAGITTARIA AND POTAMOGETONS; SEDGE AND PHRAGMITES ASSOCIATIONS ON THE BORDER.

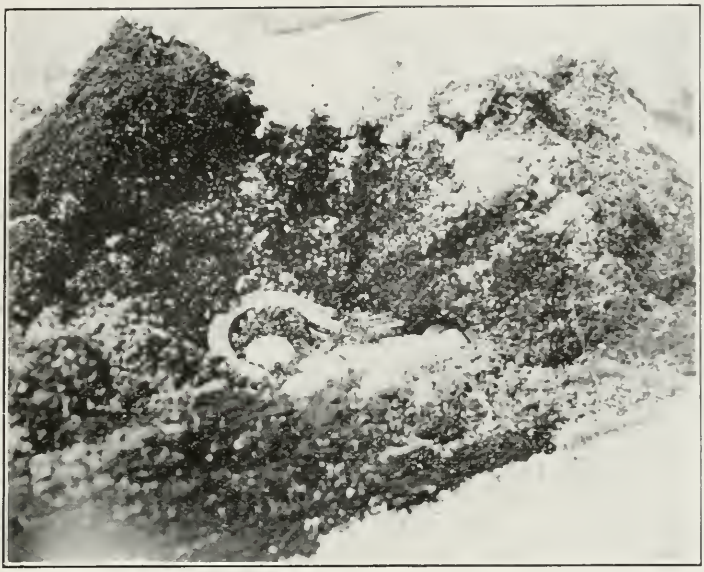


(A) ROCK BEACH ON STONY ISLAND.

(B) ROCK BEACH ON STONY ISLAND.



WOODED SWAMP AT EAST END OF RUSH LAKE.



(A) NEST AND EGGS OF *EUMECES QUINQUILINEATUS* IN DECAYING LOG. PARENT SKINK PARTLY COILED ABOUT EGGS.

(B) NEST AND EGGS OF *EUMECES QUINQUILINEATUS* IN DECAYING LOG. PARENT SKINK PARTLY COILED ABOUT EGGS.

(A) *ELAPHE VULPINUS.*

(B) *HETERODON PLATYRHINUS.*

(A) IMMATURE AMERICAN BITTERN.

(B) NEST AND EGGS OF OVENBIRD.

NEST AND EGGS OF SPOTTED SANDPIPER.

BIRDS.

BY NORMAN A. WOOD AND FREDERICK GAIGE.

GENERAL DISCUSSION.

The following observations on the birds of the sand region of Huron County, Michigan, were made by the writers while attached to the biological survey in the summer of 1908. The senior writer reached Sand Point, which was the first locality studied, June 13, and from that date remained upon the Point, making daily observations upon the birds, until August 27, when the party left the field. The junior writer joined the party on Sand Point on June 21 and remained there until July 12. On the latter date he went with three other members of the expedition to Stony Island, remaining there until July 19. The time between July 19 and 29 was again spent on Sand Point, and the rest of the time (until August 27) in the vicinity of Rush Lake. (See map.)

It may be seen from this itinerary that three distinct localities were studied: the sand region between Sand Point and Hat Point, Stony Island, and the clay country at Rush Lake. In the sand region the habitat conditions are dominated by the sandy soil. The ridges are covered with open growths of jack pine and the swamps with dense growths of maple, cedar etc., or with grasses and sedges. The clay country at Rush Lake, on the other hand, is largely taken up with open fields. (See plates.)

We hoped to be able to make a comparison between the avifaunas of the three regions, but enough time could not be given to the ornis of the clay country. For this reason, in the following list of the birds that occur in the clay country but not in the sand region, as far as our observations go, we have excluded all species that we believe may confidently be expected to occur in the sand region: Killdeer (as a breeder), bob-white, phoebe, horned lark, bartramian sandpiper, bobolink, meadow lark, bronzed grackle, vesper sparrow, grasshopper sparrow and migrant shrike.

The conditions on Stony Island differ from those of the other two regions in that the soil is not sandy nor the vegetation cleared away, the highland being largely covered by a dense growth of deciduous trees and the lowland principally by large wooded and grassy swamps.

The conditions on the island may thus be considered similar to those of the clay country before the latter was cleared. We give a list of the species observed on the island between July 12 and 19: Herring gull, common tern, black duck, American bittern, great blue heron, American woodcock, spotted sandpiper, killdeer, mourning dove, bald eagle, great horned owl, yellow-billed cuckoo, black-billed cuckoo, belted kingfisher, northern downy woodpecker, flicker, whip-poor-will, chimney swift, ruby-throated hummingbird, kingbird, crested flycatcher, phoebe, wood pewee, least flycatcher, American crow, bobolink, cowbird, red-winged blackbird, meadow lark, Baltimore oriole, bronzed grackle, American goldfinch, vesper sparrow, chipping sparrow, field sparrow, song sparrow, swamp sparrow, towhee, indigo bird, eave swallow, barn swallow, tree swallow, bank swallow, cedar waxwing, red-eyed vireo, northern yellow-throat, American redstart, catbird, house wren, long-billed marsh wren, white-breasted nuthatch, black-capped chickadee, American robin, bluebird.

It will be seen from this list that the ornis of the island is in no way peculiar except for the presence of certain species that frequent it as a secluded locality.

To summarize the results of our work in the sand region, we have divided the birds into two groups—the residents and migrants—in the following list. Birds are classed as breeding if found nesting (species starred) or if very young birds incapable of prolonged flight were noted; as residents, when not found breeding, if the species was observed before the beginning of the migration. Probably a large percentage of the latter were in reality breeders. These lists may be considered exhaustive only as regards the summer and fall birds. As it was summer when the observations were made nothing of the spring, late fall, and winter migrants could be noted. Even a few resident species have probably been overlooked, for birds are frequently shifting and may remain but a brief time in one locality.

Summer Residents: Loon, Herring Gull, Common Tern, Hooded Merganser, Mallard, Black Duck, Wood Duck, American Bittern, Great Blue Heron, Green Heron, Black-crowned Night Heron, Virginia Rail, Florida Gallinule, Coot, American Woodcock, Spotted Sandpiper, Killdeer, Ruffed Grouse, Mourning Dove, Cooper's Hawk, Bald Eagle, Osprey, Great Horned Owl, Yellow-billed Cuckoo*, Black-billed Cuckoo, Kingfisher, Hairy Woodpecker, Northern Downy Woodpecker, Red-headed Woodpecker*, Flicker*, Whip-poor-will, Night Hawk*, Chimney Swift*, Ruby-throated Hummingbird*, Kingbird*, Crested Flycatcher*, Phoebe*, Wood Pewee*, Blue Jay, Crow*, Cowbird, Red-winged Blackbird*, Baltimore Oriole*, Bronzed Grackle (?), Purple Finch, American Goldfinch*, Vesper Sparrow, Chipping Sparrow*, Field Sparrow*, Song Sparrow*, Swamp Sparrow, Towhee*, Indigo Bunting*, Scarlet Tanager, Purple Martin, Cliff Swallow, Barn Swallow*, Tree Swallow*, Bank Swallow*, Rough-winged Swallow*, Cedar Bird*, Red-eyed Vireo*, Black and White Warbler, Yellow Warbler, Chestnut-sided Warbler, Blackburnian Warbler, Black-throated Green Warbler, Pine Warbler*, Oven-bird*, Northern Yellow-throat*, American Redstart*, Catbird*, Brown Thrasher, House Wren*, Winter Wren, Carolina Wren, Long-billed Marsh Wren, White-breasted Nuthatch, Black-capped Chickadee*, Blue-gray Gnatcatcher*, Wilson's Thrush*, Robin, Bluebird*.

Doubtful Summer Residents: Yellow-bellied Sapsucker, Prairie Warbler, Canadian Warbler, Rose-breasted Grosbeak.

Migrants: Pied-billed Grebe, Ring-billed Gull, Knot, Pectoral Sandpiper, Least Sandpiper, Red-backed Sandpiper, Semipalmated Sandpiper, Sanderling, Greater Yellow-legs, Yellow-legs, Semipalmated Plover, Turnstone, Sharp-shinned Hawk, Sparrow Hawk, Yellow-bellied Flycatcher, Alder Flycatcher, Least Flycatcher, Savanna Sparrow, Golden-winged Warbler, Nashville Warbler, Cape May Warbler, Black-throated Blue Warbler, Yellow-rumped Warbler, Magnolia Warbler, Baybreasted Warbler, Grinnell's Water Thrush, Mourning Warbler, Wilson's Warbler, Brown Creeper, Red-breasted Nuthatch, Red-Tailed Hawk, Red-Shouldered Hawk.

Migrants began to appear in the sand region about August 1. The exact observations will be found in the list of species. In regard to the migration one thing that was very striking was the apparent difference in the routes of the warblers and sandpipers. At Sand Point the warblers were very abundant during the migration, while sandpipers, particularly three or four species, were rather scarce. Between Oak and Hat Points this condition was reversed; only a few warblers were noted, while the beach from Oak Point northward fairly teemed with sandpipers. One could stand there and see the latter coming in flocks from across the Bay, lighting on the beach to feed and working continually northward along the shore. They were first seen in large numbers on August 20, and did not seem to diminish up to August 27, on which date the party left the region. In fact some species, as the turnstone, seemed to be increasing in numbers. The first of these migrants were seen farther north along the beach than Oak Point (where the largest flocks seemed to alight), between Hat Point and Port Crescent. Here a small flock of sanderling was seen August 18, and two semipalmated sandpipers were noted the same day. Later they struck the beach farther down, mostly about Oak Point, a few even as far west as Sand Point. Few probably cross farther west than Sand Point, as there are no suitable beaches.

The facts seemed to show that the warblers cross the Bay nearer its head, and that the sandpipers strike across nearer the mouth, probably not only because they are stronger fliers but also because the best beaches are nearer Lake Huron. The sandpipers seemed without exception to follow the beach north and east and probably continue round the end of the thumb, and from some point on the east coast fly down to southern Ontario.

The following list gives the results of our work upon the ornis of the region. Besides the collecting of specimens and the recording of observations, however, stomachs and parasites were saved in every case. The former are reserved for future study, the latter have been reported upon elsewhere in this volume by Prof. Shull.

LIST OF SPECIES.

1. **Podilymbus podiceps.** Pied-billed grebe.—Michigan: Common as a migrant and locally common as a breeder throughout the state.

On August 15, two were seen at Rush Lake and three at Turtle Bay on the south side of Sand Point, August 24. It was not found breeding, although at Rush Lake and also on the Point the conditions seemed favorable. We were told by residents that it is very abundant in the spring.

2. **Gavia immer.** Loon.—Michigan: Common as a migrant and locally common as a breeder throughout the state.

One specimen was seen flying over Sand Point early in the morning of June 16. This bird no doubt had a nest along the marshy shore of Wild Fowl Bay. Mr. Frank Brackenbury, a fisherman, told us that in the spring of 1908 more than twenty-five loons were found in the pounds and entangled in the nets on one line of fish stakes. It is well known that this species lives on fish which it pursues to a great depth and is often caught on set lines as well as in gill and pound nets.

3. **Larus argentatus smithsonianus.** American herring gull.—Michigan: Common as a migrant and locally common as a breeder north of latitude 44°.

The herring gull was first seen June 17, when about twenty-five lit on the top of the fish stakes on the north side of Sand Point. After this date it was seen here only occasionally until August 17, after which it was common every day. On July 15, it was seen at Stony Island, and at Oak Point four were seen on August 2, and afterward occasionally during our stay near there. The fishermen said that a few of this species breed each year on Little Charity Island, a small rocky island about twelve miles to the north of Sand Point. They also reported the species as very abundant both in spring and fall. After August 17 we saw large flocks flying over the bay often alighting on the fish stakes that extend for a mile or more out from shore. They generally kept well out from the shore and did not often alight on the beach, although one was observed on the beach at Hat Point, August 18, and another feeding near the fish house on Sand Point on August 23. Near the end of Sand Point the low sand bar about thirty rods from the beach was a favorite resort of the gulls. They lit and rested there even when the waves were so high as to sweep entirely over them at intervals. Several times a number of ring-billed gulls were seen with these flocks.

4. **Larus delawarensis.** Ring-billed gull.—Michigan: This species is given as a scarce migrant throughout the state, but our observations seem to show that it is not an uncommon one along the Great Lakes. Major Bois* says it breeds near the Neebish Islands, Upper Peninsula.

Only observed at Sand Point. It was first seen August 12, with a flock of herring gulls, and after this nearly every day during our stay. Early in the morning of August 22, flocks of two, three or more were seen flying along the beach west of the fish house. These were mostly out of range of the gun but with the field glass could be easily identified, not only by the smaller size but also by the black band at the end of the tail. The tail band is very conspicuous, especially in the juvenile and immature birds, and the flight also is lighter than that of the herring gull. Individuals were seen to fly and pick up food from the surface of the water. In the throat of one examined, we found a large cicada, and there were others in the stomach. On August 12, we saw numbers of them in company with herring gulls and the common tern on a sand bar near the end of the Point, where they seemed to be resting and at times feeding.

5. **Sterna hirundo.** Common tern.—Michigan: Common summer resident, breeding north of latitude 44°.

Observed all along the shore of Saginaw Bay. The first one was seen on July 15, on Stony Island. The first record for Sand Point was on August 12, when they were observed along the north beach. After this date they were frequently seen in the latter place. The birds observed flew over the water and seldom came very near the shore. When they did, they flew quite high. The only exception was one morning when a wounded bird fell into the water a few rods from shore. In response to its calls over fifty of this species were in a few minutes swooping down to the injured one, calling and seeming to lose all timidity. A fisherman told us that they breed on some islands near Thunder Bay, Alpena County, and also that they were very abundant near Sand Point in the spring and fall.

*Bulletin of the Mich. Ornith. Club, Vol. 1, p. 18.

6. **Mergus americanus.** American merganser.—Michigan: This is a common migrant and summer resident, breeding north of latitude 44°.

One was seen near the end of Sand Point in the water of the bay July 11, and another was in Turtle Bay on the south side of the Point on July 18. The nest of this species was not found by our party, but Mr. Edward Arnold* found it nesting on North and Stony Islands.

7. **Lophodytes cucullatus.** Hooded merganser.—Michigan: Common migrant and summer resident, breeding north of latitude 44°.

A small flock was seen in the rushes at the extreme end of Sand Point on August 12, and a female was seen on Long Lake near the end of the Point on June 24. The fisherman told us that the species was very common at the Point both in the spring and fall, and that it breeds on Charity Island.

8. **Anas platyrhynchos.** Mallard.—Michigan: Common migrant and summer resident: breeds throughout the state in suitable localities. (On North Island, May 12, 1903, Arnold. *loc. cit.*)

A flock of eight was seen flying near the end of Sand Point on June 14, and no doubt bred in the wet marshes somewhere in the vicinity. The fishermen told us that it is abundant at Sand Point and Rush Lake in spring and fall.

9. **Anas rubripes.** Black duck.—Michigan: Common migrant and summer resident, breeding in suitable marshes inland, as well as along the Great Lakes.

A flock of ten was seen June 14 near the end of Sand Point, and single birds were seen after this in the grassy swamp that bordered the bay. At Rush Lake they were common after August 10, and one was seen on Stony Island on July 12. On June 15, two females were seen to fly up from a wet grassy marsh near the end of the Point. These birds circled about the marsh several times and then lit near the spot where they were flushed. Later other birds were seen with broods of young that were unable to fly, and these seemed to feed among the islands of rushes and tall grass near the end of the Point. After the young became large enough to fly we often saw them flying across the Point to Turtle Bay on the south side, where they seemed to feed on the wild rice, generally returning to spend the day in the shelter of the rush islands. At Rush Lake the crop and stomach of the single bird taken was found to be full of the roots of the wild celery, and the shallow water where the ducks fed was covered with the plants which had been pulled up, only the roots being eaten.

*Bull. Mich. Ornith. Club, Vol. IV, p. 71.

10. **Aix sponsa.** Wood duck.—Michigan: Common summer resident, breeding in suitable localities throughout the state.

This species was seen in flocks at Rush Lake on August 10. Three were also seen on Turtle Bay on Sand Point on August 22, and on the same date we saw one on Long Lake. The birds seen at Rush Lake were no doubt raised in the vicinity as the young were not fully feathered. The crop and stomach of one was full of the tubers of Potamogetan, and one taken in Turtle Bay on Sand Point had eaten many flowers of wild rice. One of the residents near Rush Lake said that he had found the nest of this species in that vicinity.

11. **Botaurus lentiginosus.** American bittern.—Michigan: Common summer resident; breeds throughout the state.

This species was seen on Sand Point, at Rush Lake and on Stony Island. The species was common throughout the region. We found an adult female and one young bird nearly feathered on the grassy prairie near the base of the Point, on July 8. It also bred on Stony Island, where an adult was seen on July 13, and two young on July 14. (Pl. XVIII a.)

12. **Ardea herodias.** Great blue heron.—Michigan: Common summer resident; breeds all over the state in colonies.

This bird is a rather common one in the sand region, and specimens were seen at various times between Sand Point and Rush Lake, and on Stony Island. We frequently saw them fly out to the fish pounds and alight on the stakes where they watched for fish. When the latter came near the surface, a quick stroke with the herons bill either killed or disabled it, so that it could be eaten or carried to the young in the nest. They often killed fish of a pound weight, and we saw them make regular excursions to these pounds for fish. We also saw them wading in the grassy marshes near the west end of the Point, and they must have bred somewhere in the vicinity.

13. **Butorides virescens.** Green heron.—Michigan: Common summer resident: breeds in all suitable localities throughout the state.

One was seen on Sand Point (July 10) and one at Rush lake (August 10). No nests were found, as the swamps where they breed were inaccessable in early summer on account of high water and myriads of mosquitoes. The one seen at Sand Point was flying along the south shore.

14. **Nycticorax nycticorax naevius.** Black-crowned night heron.—Michigan: Rare summer resident: doubtless breeds.

This bird was seen as follows: one on Sand Point on June 22 and

*Arnold, Edward, Bull. Mich. Ornith. Club, Vol. IV, p. 71.

one on July 25, one at the end of the line of fish stakes about one mile north of Sand Point on June 27, and one on Stony Island, July 12.

Early in the morning of June 22 we heard a strange squawk from a heron perched in a tree at the edge of a grassy inland swamp, and when the bird was flushed it proved to belong to this species. Again on July 25 we saw three flying over to the south near the same spot. At an old camp site on the south shore of the point we found a pair of legs of this species nailed to a tree. Mr. Brackenbury told us that a short-legged, short-necked, spotted or striped heron with a thick heavy bill was caught in a net about one of the fish pounds early last spring, and this was no doubt an immature bird of this species.

15. **Rallus virginianus.** Virginia rail.—Michigan: Common summer resident, breeding throughout the state.

One was seen on Sand Point on August 17, and another at Rush Lake on August 6. The only bird seen on Sand Point was flushed from the rushes bordering the east side of Wild Fowl Bay; the one at Rush lake was seen in a grassy marsh at the edge of the lake.

16. **Gallinula galeata.** Florida gallinule.—Michigan: Abundant summer resident throughout the southern peninsula, breeding in grassy swamps. (We know of no records for this species from the Upper Peninsula.)

A single bird was heard calling in the marsh which surrounded the small lake near the base of Sand Point, but none were seen.

17. **Fulica americana.** American coot.—Michigan: Abundant summer resident, breeds locally in wet marshes throughout the state.

One individual was seen in Saginaw Bay, off the north side of Sand Point, and another was seen near Rush Lake (August 6), where it was reported by the residents as common in spring and fall.

18. **Philohela minor.** American woodcock.—Michigan: A common summer resident and breeder throughout the state.

Two were seen at the edge of a thicket near the base of Sand Point on July 10, three in a damp wooded swamp at Stony Island on July 13, a dead bird was found in the road near Rush Lake on August 4, and one was flushed in a low wet thicket near Rush Lake on August 13.

Mr. Wallace of Bayport told us that in October this species is usually very abundant on Stony Island, Sand Point, and in the upper part of Huron County generally, where they stop on their southern migration to feed in the low woods and thickets.

19. **Tringa canutus.** Knot.—Michigan: A rather rare migrant not known to breed in the state.

On August 20, while observing the incoming flocks of sanderling, turnstones and other migrating sandpipers on the sand flat west of

Oak Point, Ruthven observed three of these birds flying toward the beach. Two of these were taken, and the following day he took another (probably the third one of the three seen the day before) from a flock of spotted sandpipers on the beach just northeast of Little Oak Point. These were the only ones observed.

20. **Pisobia maculata.** Pectoral sandpiper.—Michigan: This species is a common migrant, but not a breeder, in the state.

One was seen on the beach near Oak Point on August 24. This specimen was feeding with a flock of sanderling and was the only one seen.

21. **Pisobia minutilla.** Least sandpiper.—Michigan: A common migrant but does not breed in the state.

First seen at Sand Point on August 18, and at Oak Point on August 14. These birds were rather common after these dates, and were found in company with semipalmated sandpipers which greatly outnumbered them.

22. **Pelidna alpina sakhalina.** Red-backed sandpiper.—Michigan: A common migrant, not breeding in the state.

A flock of about twenty were seen flying along the beach near Oak Point on August 20. These birds still retained the black patch on the belly which served in part to identify them.

23. **Ereunetes pusillus.** Semipalmated sandpiper.—Michigan: A common migrant, not breeding in the state.

This species was first seen at Sand Point and also at Oak Point on August 18. Small flocks were seen feeding all along the beach, but it was more common on the sand flat at Oak Point.

24. **Calidris leucophaea.** Sanderling.—Michigan: An abundant migrant along the shores of the Great Lakes, not known to breed in the state.

It was first seen at Sand Point on August 8, and east of that place at Hat Point on August 18. After August 20, it became very common all along the beach from Sand Point eastward. It was, however, most abundant along the beach from the sand flat at Oak Point eastward, flocks of from twenty to sixty being commonly observed.

Nearly all of the birds were in the fall plumage. The first one seen, August 8, was an adult female and still partly retained its spring plumage, and a male, August 20, was also in changing plumage. In common with most species of waders the adult birds migrated first, and the later ones were juvenile and immature. They were very fearless and ran along the beach at the waters edge within a few feet of us. They apparently fed principally on insects, but they were often seen to pick up small fish, swallowing them whole if small, or picking them to pieces if too large.

25. **Totanus melanoleucus.** Greater yellow legs.—Michigan: Rather common migrant; does not breed in the state.

This species was only seen at Oak Point, where it was first observed on August 20, on the sand flat. It was afterwards observed several times in small numbers on the expanse of mud left by the drying-up of a large pond just south of Oak Point.

26. **Bartramia longicauda.** Bartramian sandpiper.—Michigan: Not uncommon summer resident; breeds in low grassy fields. It seems to be gradually becoming less common in all parts of the state.

Observed several times (first on August 3) in the fields about Rush Lake.

27. **Actitis macularia.** Spotted sandpiper.—Michigan: Abundant summer resident, breeding all over the state in suitable situations.

Common along the beach of Saginaw Bay and on the shores of Stony Island. A nest found at the end of Sand Point (June 16) was built in a slight depression in the ground, very poorly lined with dead weeds and grasses, and contained two eggs. Another nest was found. June 29, which contained four eggs. This nest (Pl. XIX) was built several yards from the water on the beach side of the first sloping sand dune, and its only shelter was the short thin dune grass. It was not disturbed, and on July 17 the eggs were hatched and near the nest we found the old bird. This bird was very anxious and fearless and alternately tumbled about our feet and fluttered off, trying to lead us away. Looking carefully over the ground we saw a downy young in plain sight, but squatting flat on the sand, and within a small area the other three. The old bird was a male bird, the female (?) being down on the beach at some distance from the nest.

28. **Oxyechus vociferus.** Killdeer.—Michigan: Common migrant and summer resident; breeds throughout the state in open fields.

Rare in the sand region and on Stony Island, during the breeding season, but common afterwards. Previous to August 10 it was seldom seen in the sand country and then only along the beach. On July 9, four were seen on the beach at Sand Point, and, on August 4, several were seen at Oak Point. After August 10 they were seen in numbers all along the beach, particularly at Oak Point. It was not found breeding in the sand country, due no doubt to lack of suitable conditions, but it was a not uncommon breeder in the clay country about Rush Lake.

29. **Aegialitis semipalmata.** Semipalmated plover.—Michigan: Common migrant along the Great Lakes, breeding rarely (Charity Island, May 20, 1903. Arnold.*)

*Bull. Mich. Ornith. Club, Vol. IV, pp. 74-75.

First seen on August 3 and again on August 17 at Sand Point. Observed several times between Oak Point and Hat Point after August 22. The species was the first migrant wader seen. The bird seen on August 3 was a fine adult female in breeding plumage; an old male in the same plumage was seen on August 17, but the birds that came later all seemed to be immature. A flock of about fifteen was seen feeding on the mud in a recently dry pond on Oak Point, August 28, the last day of our stay.

30. **Arenaria interpres morinella.** Ruddy turnstone.—Michigan: Rather common migrant along the shores of the Great Lakes.

After August 20 (first record) this species was observed commonly along the beach, although usually in small numbers and in company with sanderling, semipalmated plovers or spotted sandpipers. The only flock seen was on August 27, when five were seen at Oak Point.

31. **Colinus virginianus.** Bob-white.—Michigan: Common resident; breeds throughout the state but not so commonly in the Upper Peninsula.

One was heard calling at the base of Sand Point on July 16, and another in the clay country near Rush lake on July 19. This species preferred the vicinity of cultivated fields and occurred in the sand region only as a straggler. It was not uncommon on the farms about Rush Lake.

32. **Bonasa umbellus.** Ruffed grouse.—Michigan: Common resident and breeder as far north as latitude 44°. In northern Michigan *B. u. togata* is the common form.

The species was quite common in the wooded swamps and was often seen in patches of blueberries in the burnings. In July and August, berries with grasshoppers picked up in the same localities formed a good share of their food. The juneberry seemed to be a favorite food, and a juvenile bird on July 10 had its crop full of these fruits. We often saw bevies of old and young in the roads that crossed the Point in all directions. An adult female and ten young were seen at Sand Point on July 10, and a good sized covey near Oak Point on August 25.

33. **Zenaidura macroura carolinensis.** Mourning dove.—Michigan: Common summer resident and an occasional winter resident, especially in southern Michigan; breeds all over the state.

This bird was only seen a few times in the sand country and once on Stony Island, but was more common in the clay country. Only one nest was found and that was in the hardwoods at the base of Sand Point.

34. **Circus hudsonius.** Marsh hawk.—Michigan: A common summer resident throughout the state, breeding locally on the ground in marshes.

Occasionally observed in the sand country, but no nests were found. It undoubtedly breeds in the clay country, as it was quite common on the farm land south of Rush Lake.

35. **Accipiter velox.** Sharp-shinned hawk.—Michigan: Common migrant but rare summer resident; breeds in northern Michigan.

The only bird seen was observed at the end of Sand Point on August 18, where it was circling over the tops of the trees. It was a female and no doubt a migrant from across the bay.

36. **Accipiter cooperii.** Cooper's hawk.—Michigan: A common summer resident, and an occasional winter resident in southern Michigan, breeding throughout the state in heavy woods.

On June 17, an old male was taken at the end of Sand Point, and the female was seen a few days later. This pair no doubt bred on or near the Point. On August 11, two birds were seen near Rush Lake. These are the only records secured.

37. **Buteo borealis.** Red-tailed hawk.—Michigan: A common summer resident and an occasional winter resident in southern Michigan, breeding all over the state in heavy woods.

The only bird of this species seen was observed by Wood on August 10. We could see no reason why this hawk was not common in the sand country, unless the numerous eagles kept it away.

38. **Buteo lineatus.** Red-shouldered hawk.—Michigan: Common summer resident, breeding throughout the state in the more open woods.

Two individuals of this species were observed, both at Rush Lake, on July 29 and August 5.

39. **Haliaeetus leucocephalus.** Bald eagle.—Michigan: Not uncommon summer resident and an occasional winter resident; breeds in tall trees along the Great Lakes.

Eagles were common all along the shore of the bay and on Stony and North Islands, being seen almost every day. Often as many as three or four different birds could be distinguished in a day. It breeds in several places in this region and old or immature birds were seen every day by some of our party. A nest was found on North Island (Arnold*), one was reported on Charity Island, and another was found in the woods near the base of Sand Point.

The birds observed by us fed largely, if not entirely, on fish that were cast upon the beach, especially on the north side of Sand Point. The writers observed only two adult birds to pick up fish from the water, and these may have been dead. On the steep sand dunes west of the fish camp were several tall Norway pines that were used as perches for observation and rest. The birds may have roosted in

*Bull. of the Mich. Ornith. Club, Vol. IV, p. 71.

them, as they were seen there many times very early in the morning, sometimes two in one tree. We often saw the tracks in the beach sand, where the birds had picked up fish which were always carried away to trees (generally dead ones) and eaten. Under these trees (of which we found several on the Point) the bones of fish were found in large quantities. These eagles were very tame and quite often allowed us to approach within a few rods. This was probably due both to the fact that no one troubled them and because a number of them were young of the year. We did not notice eagles hunting any of the ducks or other birds, nor did we see them mobbed by the jays or crows, although the latter species was very common. On several occasions we saw eagles coming across the bay from the direction of Charity Island, where Arnold* found them breeding in 1902 and 1903.

40. **Falco sparverius.** American sparrow hawk.—Michigan: Abundant summer resident, and also an occasional winter resident in southern Michigan, breeding in holes in trees throughout the state.

Observed at Sand Point on August 15 and 18, and three times in the sand country at Rush Lake after August 7. The species did not breed on the Point, although there were many trees with suitable cavities, and plenty of food in the way of small birds, grasshoppers and mice. Three were seen on August 18 that were no doubt migrants from across the bay, as they were near the end of the Point, where most of the migrants were first seen.

41. **Pandion haliaetus carolinensis.** American osprey.—Michigan: Scarce summer resident; breeds about lakes throughout the state.

One was seen near the end of Sand Point on June 14, and one at Rush Lake, August 5. These were the only ones observed.

42. **Otus asio.** Screech owl.—Michigan: Common resident, breeding in hollow trees throughout the state.

Not observed in the sand country. Two were seen on August 8, and others were heard several times afterward in the clay country near Rush Lake.

43. **Bubo virginianus.** Great horned owl.—Michigan: A common resident and breeds all over the state.

Observed several times in the sand country and on Stony Island. This species was not a rare breeder in the sand country, and was often mobbed by the crows. A family of three young birds and one adult was observed on July 17 and 18 on Stony Island, and a breeding record for North Island is given by Arnold.†

44. **Coccyzus americanus.** Yellow-billed cuckoo.—Michigan:

*Bull. of the Mich. Ornith. Club, Vol. IV, p. 74.
†Bull. Mich. Ornith. Club, Bull. Vol. IV, p. 71.

Common summer resident; breeds throughout the southern peninsula.

This bird was common on Stony Island and throughout the sand country, being observed many times at various points between Sand Point and Hat Point. It was a common breeder in the region, and nests were found as late as August 27 (at Rush Lake). A nest found by Wood on August 8 contained three eggs of this species and one of the black-billed cuckoo. This nest was built in a tall willow bush at the edge of an open swamp near the south side of the Point and was flat and frail. On Stony Island it was observed most frequently in low dense woods.

45. **Coccyzus erythrophthalmus.** Black-billed cuckoo.—Michigan: Common summer resident, breeding throughout the state.

This species occurred on the Point as often as the preceding species, and was seen or heard nearly every day. In the sand country at Rush Lake it was not as common as the yellow-billed but still was seen quite frequently. It was also common on Stony Island, being somewhat more abundant than the preceding. Both species were partial to the edges of the wooded swamps and were also seen in the poplar zone just outside the willows, and occasionally on the ridges near the swamps. This species was a common breeder on Stony Island and was often seen and heard there.

46. **Ceryle alcyon.** Belted kingfisher.—Michigan: Common summer resident all over the state, breeding in holes dug in banks of earth generally near the water.

Observed along the shore of the sand country, on Stony Island and at Rush Lake. The species was a rare breeder on Sand Point, and few were seen until the young made their appearance, about July 18. After this date a family ranged along the beach on the south side, and another on the north side of the Point. A family was seen on Stony Island that had evidently bred there. We often saw them perched on dead stubs and on bushes near the waters edge, watching for the schools of small minnows that on still days came to the very edge of the beach, where they were easily caught by the kingfishers. We also saw them frequently on the fish stakes about the pounds. At Rush Lake they were more abundant than along the bay, and were seen along the open ditches and small ponds as well as on the lake itself.

47. **Dryobates villosus.** Hairy woodpecker.—Michigan: Common resident throughout the state, except on Isle Royale where it is replaced by *D. v. leucomelas.* Breeds in holes which it excavates in dead trees.

Occasionally observed in the sand country between Sand Point and Rush Lake. It was rather rare, and nests were not found, although it no doubt bred in the region. It was usually seen in the dead trees on the ridges.

48. **Dryobates pubescens medianus.** Northern downy woodpecker.—Michigan: Common resident throughout the state, breeding in holes which it excavates in dead trees.

Common in the sand country and on Stony Island. It was a common breeder, and after July 30 families of young were seen throughout the sand region, searching for food on the oaks and pines.

49. **Sphyrapicus varius.** Yellow-bellied sapsucker.—Michigan: Common summer resident north of latitude 42°, breeding in holes which it generally excavates in living trees.

A single specimen was observed in the sand country at Rush Lake on August 24.

50. **Melanerpes erythrocephalus.** Red-headed woodpecker.—Michigan: An abundant summer and an occasional winter resident, breeding in holes in trees throughout the state.

This species was rare on the Point, as only two pair were found. It was also rather rare in the clay country, and was not seen in the sand region about Rush Lake. A nest was located in a large dead white pine stub, and the young were first seen July 23. On bright days the young were seen climbing about on the home stub, and calling to the parents for food which was brought to them quite regularly.

51. **Colaptes auratus luteus.** Northern flicker.—Michigan: An abundant summer and an occasional winter resident, breeding throughout the state, mostly in holes in dead trees.

Occasionally observed throughout the sand country, but abundant only on Stony Island, and in the sand region during migration—after August 14. After migration had begun, we often saw flocks of eight or ten birds feeding on the blueberries and juneberries, or dusting in the sand.

52. **Antrostomus vociferus.** Whip-poor-will.—Michigan: Common summer resident; breeds all over the state in low wet woods.

Rather common in the sand region and heard at Stony Island. As was to be expected, this bird was heard much oftener than seen, but one pair frequently came about the camp and was seen several times. Individuals were seldom flushed in the daytime, but on August 20 one was raised at the edge of a thicket near a wooded swamp. On August 19, two were flushed on the sand dunes near Saginaw Bay near Rush Lake. Only two breeding pairs were located, both on Sand Point.

53. **Chordeiles virginianus.** Nighthawk.—Michigan: Common summer resident; breeds all over the state.

This species was more common than the preceding one and occurred throughout the sand region. Nests were only found in the burned clearings on Sand Point. On June 16, the writer flushed two birds from the ground on the top of one of the burned over ridges near camp on Sand Point, that evidently had a nest nearby. On August 3, a female was flushed in a burning, which immediately fell to the ground, fluttering along as though wounded. On searching closely a very young bird in the down was found. Ten of these birds were seen flying over the camp at Rush Lake, on August 9.

54. **Chaetura pelagica.** Chimney swift.—Michigan: Common summer resident, breeding throughout the state.

The swift was not commonly observed in the sand country, but was more abundant about Rush Lake and on Stony Island. Only one nest was found at Sand Point. This was built on the inside of the north gable of the fish house and was firmly glued to the rough boards. At Rush Lake the species was not uncommon and was seen nearly every day. On Stony Island, July 15, a nest which contained four young birds was found in an old chimney, and on July 16 another nest with four eggs was found on the inside of an old ice house. On July 14, at Stony Island, a flock of about thirty was seen flying over the woods.

55. **Trochilus colubris.** Ruby-throated hummingbird.—Michigan: Common summer resident, breeding throughout the state.

Observed occasionally throughout the sand country and on Stony Island, but less commonly on Sand Point. No nests were found on Sand Point, although the species no doubt bred there. At Rush Lake two nests were found. One of these (found on August 14) was not completed, and the female was at work covering it with lichens. But two birds were seen on Stony Island.

56. **Tyrannus tyrannus.** Kingbird.—Michigan: Common summer resident, breeding throughout the state.

Commonly observed in the sand country and on Stony Island. The kingbird was a common breeder both in the sand and clay regions; in the former nesting in the scrub oaks as well as in the jack pines. On Sand Point, two nests were found on July 1, one containing three eggs and the other two young, and, on July 4, a set of three fresh eggs was found. Another found on July 10 had two young that were nearly fledged. At Rush Lake, on July 29, a nest was found on a low swampy island about five hundred yards from the shore. The three birds in this nest were nearly fledged. On Stony Island, the birds were most common about the clearings. It is remarkable that all of the nests found by our party contained only two or three eggs with one exception, a set of four, for at Ann Arbor the usual complement seems to be four or five.

57. **Myiarchus crinitus.** Crested flycatcher.—Michigan: Common summer resident, breeding all over the state with the possible exception of the extreme northern part of the upper peninsula.

Common at Sand Point, but apparently not so abundant in the sand region to the east or on Stony Island. It was a common breeder on Sand Point and nested in the cavities of the oak trees which bordered the low thickets. A pair was seen on Stony Island on July 14.

58. **Sayornisphoebe.** Phoebe.—Michigan: Common summer resident, breeding all over the state.

Very common about the clearings on Stony Island, but only occasionally observed in the sand country at Sand Point and at Rush Lake before August 1. In August they become more abundant as migrants in the sand region. A few probably nest in the sand region, but no nests were found. A pair nested in the fish house on Stony Island, and the nest contained four eggs on July 17.

59. **Myiochanes virens.** Wood pewee.—Michigan: Common summer resident, breeding throughout the state.

Abundant throughout the sand region and on Stony Island. It was one of the most common breeders on Sand Point, and its nests were often found in jack pine as well as scrub oak trees. On July 4 a nest containing three eggs was found, and on July 1 another with three young. All but one had only three eggs. Several nests were found at Rush Lake, the first on August 7.

60. **Empidonax flaviventris.** Yellow-bellied flycatcher.—Michigan: Scarce migrant and summer resident, breeding in extreme northern portion. Summer resident in latitude 45° 20′. (Gibbs*.)

Two individuals (probably migrants) were seen in small oak trees at the end of Sand Point on August 18. These were the only ones seen.

61. **Empidonax traillii alnorum.** Alder flycatcher.—Michigan: Common summer resident, breeding throughout the state.

Two were seen in a willow swamp near Turtle Bay on the south side of Sand Point on August 26. These may have been migrants.

62. **Empidonax minimus.** Least flycatcher.—Michigan: Common summer resident, breeding throughout the state.

This species was apparently a rare breeder in this region as only two individuals were seen—one on Stony Island, July 15, and one on Sand Point, August 18.

63. **Otocoris alpestris praticola.** Prairie horned lark.—Michigan: Common summer resident, breeding throughout the state except in extreme northern portion.

*Bull. U. S. Geol. and Geogr. Survey of the Territories, Vol. V, p. 488.

It was not observed in the sand country. A large flock was seen on July 29, and five more on August 4, in cultivated fields near Rush Lake.

64. **Cyanocitta cristata.** Blue jay.—Michigan: Abundant resident, breeding throughout the state.

This species was a rare breeder in this region, and was very rarely seen or heard. It was reported to be more common in winter.

65. **Corvus brachyrhynchos.** American crow.—Michigan: Abundant migrant and summer resident, also an occasional winter resident in southern portion; breeds throughout the state.

Abundant throughout the sand region and on Stony Island. It was an abundant breeder, and many nests were found in the jack pine trees. They were very tame and daily patrolled the beaches for the dead fish that drifted up in varying numbers, and apparently made up a large portion of their food. The residents told us that a few crows often wintered in the region.

66. **Dolichonyx oryzivorus.** Bobolink.—Michigan: Abundant summer resident, breeding throughout the state except in the extreme northern portion.

Five were seen at Stony Island during the week of July 13, and others in the fields near Rush Lake. Not seen at Sand Point until August 8. It no doubt bred on Stony Island and in the cultivated fields near Rush Lake. On Sand Point there was no favorable location for nests, and no birds were seen until August 8, when large flocks came to the large grassy swamp at the base of the Point. The latter were all in fall plumage, and may have wandered from the clay country to the east or have migrated across the bay from the northwest.

67. **Molothrus ater.** Cowbird.—Michigan: Abundant summer resident and breeds all over the state except in extreme northern portion.

This species was a common one on the Point but was only seen in small numbers until August, when flocks of twenty or thirty were seen. It was also common on Stony Island. On August 6, a female red-eyed vireo was seen feeding a young cowbird larger than herself. Eggs were found in nests of the ovenbird, cedar-bird and wood pewee.

68. **Agelaius phoeniceus.** Red-winged blackbird.—Michigan: Abundant summer resident; breeds all over the state.

This species was found in marshy places throughout the sand region and on Stony Island. On June 24, a nest was found in the open wet marsh near the end of Sand Point. It was built in a low willow bush and contained two fresh eggs. On July 8, several pairs were found nesting in the large grassy marsh at the base of Sand Point, and nearly all of the nests contained young too small to leave them. On Stony Island it was probably the most common bird and by July 15 had commenced to flock. Large flocks were seen daily in August at Sand Point and Rush Lake.

69. **Sturnella magna.** Meadow lark.—Michigan: Abundant summer and an occasional winter resident, breeding throughout the state except in extreme northern portion.

Several individuals were seen in the marsh on Stony Island, and the species was common in the fields at Rush Lake. It was not seen in the sand region. On August 15 a nest with two young birds was found at Rush Lake. It probably bred also on Stony Island.

70. **Icterus galbula.** Baltimore oriole.—Michigan: Common summer resident, breeding throughout the state except in extreme northern portion.

Observed in the sand country only at Sand Point, where a single bird was seen on June 25 and three more on August 3. One specimen was seen on Stony Island. Not uncommon in the clay country near Rush Lake. We secured no breeding records for the sand region. A family with several young was seen at Stony Island on July 13.

71. **Quiscalus quiscula aeneus.** Bronzed grackle.—Michigan: Abundant summer resident, breeding throughout the state.

Observed but once in the sand region (at Sand Point on June 22), but common on Stony Island and in the clay country at Rush Lake. It was observed in flocks on Stony Island on July 15 and July 17. At Rush Lake it was common until August 10, when all apparently left the region.

72. **Carpodacus purpureus.** Purple finch.—Michigan: Common migrant and not uncommon summer resident, breeding north of latitude 43° 30′.

Only observed on Sand Point, where it was a rare breeder. No nests were found, but the adult birds were seen from June 16 until August 27, when we left the Point. On July 27, the writer saw two males fluttering their wings and singing before a female as though courting her. She finally flew away and both males followed.

73. **Astragalinus tristis.** American goldfinch.—Michigan: Abundant summer and common winter resident in southern portion.

Common throughout the sand region, on Stony Island, and in the clay country near Rush Lake. After July 1, a favorite food of the goldfinch in this region was the seed of the thistle, which was common on the sand dunes along the beaches.

74. **Poœcetes gramineus.** Vesper sparrow.—Michigan: Abundant summer resident, breeding throughout the state.

Single birds were seen on Sand Point on June 15, August 20, and August 22 and on Stony Island on July 12. Not observed elsewhere in the sand region except once at Rush Lake. Common in the fields at Rush Lake.

75. **Passerculus sandwichensis savanna.** Savanna sparrow.—Michigan: Abundant migrant and scarce summer resident; breeds locally north of latitude 42°.

A single bird was found on a sand dune on Sand Point, June 14, and another in a field near Rush Lake on July 30. These were the only specimens seen.

76. **Coturniculus savannarum australis.** Grasshopper sparrow.—Michigan: Rather common summer resident south of latitude 43°, breeding in grassy fields.

A single bird of this species was seen in a hay field near Caseville, on July 29.

77. **Spizella passerina.** Chipping sparrow.—Michigan: Abundant summer resident, breeding throughout the state.

Abundant throughout the sand region and in the clay country at Rush Lake. Only two birds seen on Stony Island. It was a very common breeder in the sand country and nested in jack pine growths as well as in the more open oak openings. The first young were observed on July 3, and they soon became very abundant.

78. **Spizella pusilla.** Field sparrow.—Michigan: Abundant summer resident, breeding throughout the state.

Rather common throughout the sand region, and a nest and one family observed on Stony Island on July 18. It was a very common breeder on Sand Point, nesting in low bushes in the burnings and clearings generally, but it was not as common elsewhere in the sand region. On July 2, the young birds were ready to fly. The family observed on Stony Island consisted of five birds.

79. **Melospiza melodia.** Song sparrow.—Michigan: An abundant summer and an occasional winter resident in the southern portion, breeding throughout the state.

Common throughout the sand region and on Stony Island. The species was a common breeder in the sand region, seemingly prefering the edges of swamps and thickets. It was the most abundant bird along the beach, being characteristic of the shrub zone along the top of the dunes. Young birds were seen first July 2. Wood saw large flocks of this species on August 22 at the extreme end of Sand Point, in the low willows which cover an extensive area there. Many of these (if not all) were no doubt migrants. At Rush Lake it was also very common, and many nests were found, each containing three young.

80. **Melospiza georgiana**. Swamp sparrow.—Michigan: Common summer resident, breeding throughout the state.

Found in grassy marshes in the sand region, but not common. Two birds seen in the large marsh on Stony Island. With the exception of those seen on Stony Island, the species was found during the breeding season only in the large grassy swamp at the base of Sand Point. Several male birds were observed singing on July 8 and 9, in the tall grass and clumps of wild rose and willow that are scattered through the marsh and margin the surrounding forest, but it was impossible to locate a nest. This species was again seen at the edge of Turtle Bay on the south shore of Sand Point, on August 22, in some bushes at the edge of Long Lake, and in a wet marsh at Rush Lake on August 1 and 13.

81. **Pipilo erythrophthalmus**. Towhee.—Michigan: Abundant summer resident, breeding throughout the state.

Very abundant in the sand region. One pair observed on Stony Island. The towhee was a very abundant breeder on Sand Point, nesting in the fallen tree tops and at the edge of the swamps and thickets that were not too wet. The young birds began to leave the nests on July 1, and after that date were very common. We saw them feeding on the juneberries and blueberries, which were very plentiful and furnished food for many species. A nest containing three young was found in the sand dunes at Rush Lake on August 8. The pair at Stony Island was observed on July 16.

82. **Zamelodia ludoviciana**. Rose-breasted grosbeak.—Michigan: Common summer resident, breeding all over the state with the exception of Isle Royale.

This species was very rare in the sand region and was seen only twice—on July 12 at Sand Point and on July 30 at Rush Lake.

83. **Passerina cyanea**. Indigo bunting.—Michigan: Common summer resident, breeding all over the state with the exception of Isle Royale.

Very common on Stony Island and Sand Point, but apparently not as common elsewhere in the sand region. Common in the clay country at Rush Lake. It was a very common breeder on Sand Point and was seen practically every day, until August 17, in the open woods and burnings near the edges of swamps and thickets. A nest with three eggs was found, July 1, in a low oak on a dune. The first young were seen on June 29. Migration probably took place about the middle of August, for it was not observed after the 17th.

84. **Pirango erythromelas**. Scarlet tanager.—Michigan: Com-

mon summer resident, breeding all over the state with the exception of Isle Royale.

Observed four times on Sand Point and once in the clay country at Rush Lake. It is probably to be considered as a rare breeder in this region, for during the breeding season it was observed only twice, on June 26 and June 30 (Sand Point). An immature male in fall plumage was seen on August 24 and another on August 25. These were with flocks of warblers and were probably migrants.

85. **Progne subis.** Purple martin.—Michigan: Common summer resident, breeding throughout the state with the exception of Isle Royale.

Common about the towns in the sand region (Bayport and Caseville), but only occasionally elsewhere. It apparently did not breed on Sand Point, but several breeding pairs and nests were observed at Bayport, on June 13. The nests were built on cornices of the hotel and stores. We saw single pairs on August 2 and 5 flying over the water along the north beach of Sand Point. There was a small colony at Caseville, where we saw them several times, and they were also occasionally seen about Rush Lake.

86. **Petrochelidon lunifrons.** Cliff swallow.—Michigan: Common summer resident, breeding throughout the state.

Several flocks observed on Sand Point, August 12, and a single bird on Stony Island, July 16. The species occurred in the sand region only as a migrant. The only record was secured on August 12, when early in the morning several flocks were seen near the end of Sand Point. In company with barn and bank swallows, these birds were slowly flying down the Point, feeding on the way. The single bird seen on Stony Island was also with a flock of barn swallows.

87. **Hirundo erythrogaster.** Barn swallow.—Michigan: Abundant summer resident, breeding throughout the state.

A rare breeder, except about the towns, but a common migrant in the sand region, and a common breeder in the clay country at Rush Lake and on Stony Island. The only pair that nested on the Point had a nest on top of a door on the west side of a fish house, and on June 15 the five eggs were nearly ready to hatch. A severe storm washed this nest away on July 17, and for five days the old birds flew about in distress. On July 22 we saw them carrying nesting material into a large house on the shore nearby, and here they built a second nest on a high rafter in the peak, where they raised a brood of young which were still in the nest on August 4. On the latter date, flock after flock of this species were coming from the west and northwest across the bay from the direction of Point Lookout. These birds were in company with bank and tree swallows. On August 10, another migration took place, but these birds did not stop to feed on the way, flying on down the north beach in loose straggling flocks, accompanied by a few flocks of chimney swifts. At Rush Lake this bird was a common breeder, nesting in the farm buildings in the clay country, and was seen daily during August. They bred in numbers in the fish house on Stony Island, and many nests were found, each containing eggs and young, during our stay there.

88. **Iridoprocne bicolor.** Tree swallow.—Michigan: Common summer resident, breeding throughout the state.

Uncommon as a resident on Stony Island and Sand Point but common as a migrant in the latter place. Not observed elsewhere. The species was first seen on Stony Island, July 12, in company with barn swallows, and a single nest containing young birds was found two days later. On Sand Point, it was first seen on July 15, and on the following day about fifty were seen near Turtle Bay. These acted like visitors, and were not seen again. On August 4, at the end of Sand Point, we saw several small flocks migrating in company with barn and bank swallows, and again on August 10, a few were seen under the same conditions. The bulk of the migrants were seen after August 13.

89. **Riparia riparia.** Bank swallow.—Michigan: Abundant summer resident, breeding all over the state.

Not common in the sand region during the breeding season; more abundant after August 18. Observed on Sand Point, at Rush Lake and on Stony Island. Only two colonies were found. On Sand Point a small colony (six pairs) nested in the steep sand dune west of the fish house, where the waves had washed away the beach and left a vertical face exposed. On June 18 we found the birds about this spot and the next day one of the nests was dug out. It was about 20 inches from the entrance and about ten inches below the surface. The nest was made of grass and grass roots, and beautifully lined with white gull feathers arranged so that they stood on end, thus forming a cup nearly closed at the top. It contained five eggs slightly incubated. This colony had left before the migration of this species on August 4 and 10, but a few birds were seen on the Point as late as August 24. The other colony was found on August 3 in a sand bank between Oak and Little Oak Points, and the young were nearly full grown. The few birds seen on Stony Island were in flocks of barn swallows.

90. **Stelgidopteryx serripennis.** Rough-winged swallow.—Michigan: Common summer resident, breeding throughout the state with the exception of Isle Royale.

Apparently rare both as a breeder and migrant in the sand region. Only observed on Sand Point. Only two pair of rough-winged swallows were found breeding. The nests were in the bank on Sand Point near those of the bank swallow described above. The nests of the rough-winged could be identified by the more elliptical shape of the entrance. We found the nest about twenty-four inches from the entrance, and back of it, in a small pocket, the female. The nest was made of small twigs and stems of grass and was lined principally with fine blades of grass and pieces of birch bark, but two pieces of fish bones, a wing of a maple seed and small pieces of dried water plants were also found in the structure. It contained seven fresh eggs. These were a little larger than those of the bank swallow and more obtuse. During July a few birds were seen among the colony of bank swallows but apparently left with them about August 1, as none were seen later in the swallow migrations of August 4 and 10.

91. **Bombycilla cedrorum.** Cedar waxwing.—Michigan: Abundant summer and occasional winter resident in southern portion.

Common throughout the sand country, on Stony Island, and in the clay country at Rush Lake. The cedar-bird was one of the characteristic breeders in the sand country, nesting almost exclusively in the jack pine trees. The first nest found was just commenced on June 19; one on June 29 contained four fresh eggs; another June 30 was just commenced. Others were found in different stages throughout July, and as late as August 6 one found near Rush Lake was just commenced. They were placed from twelve to thirty feet from the ground and were strongly built of fibres and roots. One nest near camp on Sand Point was composed almost entirely of cotton which the birds had picked from an old mattress on the ground. Throughout the month of August small flocks of this species were seen flying about Sand Point, often feeding on the wild red cherry trees near Long Lake.

92. **Lanius ludovicianus migrans.** Migrant shrike.—Michigan: Common summer resident, breeding throughout the state except the extreme northern portion.

This species was not seen in the sand region even during the migration, but was not uncommon in the fields about Rush Lake.

93. **Vireosylva olivaceus.** Red-eyed vireo.—Michigan: Abundant summer resident, breeding all over the state.

Very common throughout the sand region and on Stony Island. This bird was one of the most abundant breeders in the sand region, nesting generally in the oak trees. Nests were found as early as June 25 (Sand Point) and as late as July 25 (Sand Point). On the latter date, young birds began to appear. When we called birds by sucking the back of our hands, this species was nearly always the first to appear. It was still on Sand Point when we left the field, August 27.

94. **Mniotilta varia.** Black and white warbler.—Michigan: Common migrant and summer resident: breeds throughout the state.

Not observed commonly in the sand region during the breeding season, but abundant after August 1. It was a rare breeder on Sand Point. A female that acted like a nesting bird was seen near the edge of a thicket on June 22. Others were seen on July 3 and 4. We first saw the young on July 18, when a family was seen at the edge of a thicket, where they no doubt were raised. It was seen in small flocks during the rest of July. From August 1 to 4 a migration wave of warblers reached Sand Point, and this species became very common, a few being observed in every flock. At Rush Lake they were not observed so commonly until August 10. They were still very common all over the sand region when the party left the field, August 27. They were the most curious of the warblers, often coming within a few feet of one when called by chirping. When feeding they seemed to prefer the larger limbs and trunks of the trees and were often found feeding on the trunks of the willow bushes at the edge of the thickets, going over them like a nuthatch or chickadee, in whose company they often fed. They were also often seen on the low jack pines and in the oaks.

95. **Helminthophila chrysoptera.** Golden-winged warbler.—Michigan: Not uncommon summer resident, breeding throughout the state with the exception of Isle Royale.

Apparently a rare migrant in the sand region. The species was only observed on Sand Point. The first one seen was on August 5, when the water thrush was also first noted. Another was seen August 6. All of these were in the thick willow-poplar thickets at the end of the Point. Four more were seen on August 7, in thick willows at the edge of an open swamp. They were very shy and wild and could be seen only by hiding and chirping softly. If this was done, and one of these birds was within hearing, it would cautiously work its way toward us but would disappear at the slightest movement. The last one was seen August 14, and, although these habitats were worked daily during our stay, no more were seen.

96. **Helminthophila rubricapilla.** Nashville warbler.—Michigan: Common migrant and summer resident, breeding north of latitude 44°.

Apparently to be considered only as a migrant in the sand region; seen at Sand Point and Rush Lake. It was first found on July 24 at the edge of a small thicket near the end of Sand Point. It seems safe to conclude that the two birds seen on this date were not residents, as we had worked that locality for more than a month and had not seen or heard one. The species was found breeding in Iosco County, in June 1907, by Miss Harriet Wright, of Saginaw, so it had only to migrate across Saginaw Bay to get to the Point. The first ones seen were juvenile and immature birds, but after the migration wave of August 5 and 6, it became very common at Sand Point and adults were seen. It was seen but once at Rush Lake—a male on August 27. The species was very tame and when called would come from the thick willow and poplar swamps and feed within a few feet of us, especially the young ones. It seemed to prefer to feed low down in such thickets, but was also seen in low oak and pine trees. It was still common when we left Sand Point, August 27.

97. **Dendroica tigrina.** Cape May warbler.—Michigan: Rather rare migrant, breeding to the north of Michigan; no breeding records for the state.

This species was a common migrant on Sand Point but was only observed once elsewhere—a single bird at Little Oak Point on August 21.

The first bird seen was in a small jack pine at the end of the Point, on August 14. The night preceding August 18 was clear and cool with a strong northwest wind and several warblers appeared. The Cape May came in small flocks of ten to twenty birds and the next day was found all over the Point. All stages of plumage were seen from the plainly colored juveniles to the highly colored and striped adults. It was one of the most common warblers when we broke camp on August 27. Its food seemed to be found only on the jack pine trees, and none were observed feeding on other trees. The young birds of this species may be known by the peculiar dark streaks on the sides and breast, and by the golden color of the feathers about the ear coverts, also by the actions, for while feeding this species has a slow creeping movement and was often seen clinging to the under side of the pine cones like the red-breasted nuthatch, which was nearly always in their company and fed largely on the same food. When the small flock of warblers passed on to other trees, the nuthatches usually followed and again fed with them. The flocks seen first were composed of juvenile and immature birds while the last ones seen, August 25 and 27, were nearly all adults.

98. **Dendroica aestiva.** Yellow warbler.—Michigan: Abundant summer resident, breeding all over the state.

A rare breeder but common migrant in the sand region. Observed at Sand Point and Rush Lake. Common breeder in the clay country at the latter place. It was first observed on July 3, when a single pair was seen in the willows at the margin of the large meadow at the base of Sand Point. This pair acted like nesting birds and must have had a nest nearby. The species did not become common until August 1, when it was seen in company with other migrating warblers. It was not seen after August 13.

99. **Dendroica caerulescens.** Black-throated blue warbler.—Michigan: Common migrant and summer resident, breeding north of latitude 44°.

This species was observed but once, on August 25, when two males were seen on a low jack pine on Sand Point. These birds were with a small flock of Cape May warblers. It was found breeding in Iosco County, in June, 1907, by Miss Harriet Wright, of Saginaw, and in Ogemaw County, June 19, 1903, by E. H. Frothingham. Later in the season it probably crosses Saginaw Bay to the Point in numbers.

100. **Dendroica coronata.** Myrtle warbler.—Michigan: Abundant migrant and summer resident, breeding north of latitude 44°; a common breeder on Isle Royale.

Only observed on Sand Point, where it was a common migrant after August 18. The first ones seen—near the end of the Point—were all young birds and looked like sparrows with their dull streaked coloration, but a close examination would reveal the yellow rump patch. The first adult birds were seen on August 24. After this date they were common and were generally seen in the taller jack pines, sometimes in company with the Cape May and bay-breasted warblers. Each flock of warblers was often accompanied by a family of chickadees and red-breasted nuthatches. They were still common when we left the Point, August 27.

101. **Dendroica magnolia.** Magnolia warbler.—Michigan: Abundant migrant and summer resident, breeding north of latitude 44°; a common breeder on Isle Royale.

Only observed on Sand Point, where it was a common migrant. The first one, a young male, was seen, on August 19, in a dense willow thicket near the end of the Point. On August 24, the species became common in the thickets all over the Point, and many were still there when we broke camp on August 27. It was not observed outside of the swamps, and could only be seen by calling.

102. **Dendroica pennsylvanica.** Chestnut-sided warbler.—Michigan: Abundant summer resident, breeding locally throughout the state with the exception of Isle Royale.

Evidently a rare breeder in the sand region; not observed on Stony Island. On Sand Point, July 29, an adult male was heard singing in a bushy clearing, where no doubt it had a nest. On July 22, an immature male was seen, after which no more were seen until August 7, when a few were observed in company with a flock of migrating bay-breasted warblers at the end of the Point. These had probably crossed the bay during the night, as the spot had been most thoroughly worked the day before, and none of either species were seen. On August 10, a male was seen in the jack pines on a sand dune north of Rush Lake. It was not observed after August 14.

103. **Dendroica castanea.** Bay-breasted warbler.—Michigan: Common migrant especially in the fall; breeds in extreme north portion (Isle Royale, July 7, 1905).

Common migrant on Sand Point. Not observed elsewhere in the sand region except a single individual near Rush Lake, on August 10. The first bird was seen on August 6. After August 14, it was seen in flocks, often in company with blackburnian warblers. On August 25, we observed several flocks near camp on Sand Point, feeding in the large oak trees but seldom in the pine or other trees. They were common when we left camp on August 27.

104. **Dendroica blackburniae.** Blackburnian warbler.—Michigan: Common migrant and summer resident, breeding north of latitude 43°.

Common on Sand Point. A single bird observed at Rush Lake. This species was a common breeder on the Point and was seen or heard singing nearly every day. It frequented the tops of the tallest jack pines, where it no doubt nested, but no nests were found although many pairs were watched carefully. Our inability to locate nests was due to the height of the trees and the multitude of mosquitoes that bred and lived near the haunts of this species, and made it almost impossible to continue long observations. On July 24, a brood of nearly fledged young was found and watched while the parents fed them. When we left the Point, on August 27, the species was abundant.

105. **Dendroica virens.** Black-throated green warbler.—Michigan: Abundant migrant and common summer resident, breeding north of latitude 43°.

A rather rare breeder but common migrant in the sand region. This species was found in the jack pines on the dunes southwest of Caseville, on July 7. No nests were found, as this locality was not worked in detail, but the birds were singing, and, on July 24, a juvenile bird was taken there as it was being fed by the female. This bird was very young and the nest must have been close by. Other young birds were seen on the Point at the same time. About August 1 it became very common in flocks, no doubt from across the bay, as it was found breeding in Iosco County in June, 1907, by Miss

Harriet Wright. On August 20, the last one was seen on the Point. In the sand region about Rush Lake a few birds were seen between August 10 and 20.

106. **Dendroica vigorsii.** Pine warbler.—Michigan: Not uncommon migrant and summer resident, breeding locally throughout the state except on Isle Royale.

This species was the most common warbler that bred in the sand region, and it was also a common migrant. Nests were found in the tops of small jack pine trees. The following observations are from notes of the senior writer: "On June 16, while tramping through the sand dunes near the end of the Point, I saw a female on the ground collecting material for a nest. With her bill full, she flew into the top of a jack pine about thirty feet high. Here she disappeared, and I next saw her on the ground with more material which she carried to the same place in the jack pine. With the glass the foundation of a nest was found, and the bird was watched for a long time as she flew back and forth. The male came and chased her away among the tree tops, but soon I heard his song and found him perched on a dead limb of a white pine nearby, while the female worked steadily on. The male was not seen to help with the nest building, but stayed near by and kept singing his sweet clear trill. Both birds were very tame and often came within a few feet of me. About thirty hours later the nest seemed nearly complete. It was a beautiful cup-shaped affair, quite deep and round, and was placed in a thick bunch of short stems and small cones that were woven into it. The outside was made of pieces of bark fibre and grass or weed stems, and the walls seemed ready for the lining, which was not seen as the nest was blown away a day or two afterward."

On July 7, a female was observed about a pile of chips near camp where she seemed to be picking up food and carrying it to a thick bunch of jack pines not far away. On July 13 the first young were seen, as they were being fed by the female, and they became common about July 25. These local birds were all gone by August 3, and none were seen on the Point until August 18, when small flocks were again common all over the Point, with other migrating warblers that no doubt came from across Saginaw Bay. (The species was found breeding in Iosco County in June, 1907, by Miss Harriet Wright.)

At Rush Lake the species was also not uncommon and became numerous on August 10 and 11, but was seen but once after the latter date.

107. **Dendroica discolor.** Prairie warbler.—Michigan: Scarce summer resident, breeding locally north of latitude 42°.

This species was a rare migrant in the sand region. It was observed first on August 10, when a male was seen in the jack pines on the sand dunes between Rush Lake and Saginaw Bay, and four more were noted between this date and August 18. Four of these were immature birds and had evidently been bred nearby. On Sand Point it was seen first (at the west end) on the morning of August 15. This bird (an adult male) was feeding in a small jack pine. On August 17, at the same place, a large flock of warblers that included several of this species was seen. Still another (the last one observed) was seen in a thicket near the same place on August 24.

108. **Seiurus aurocapillus.** Oven-bird.—Michigan: Abundant summer resident, breeding throughout the state.

Rather a common breeder in the sand region, and observed in the clay country near Rush Lake. Not seen on Stony Island. A nest with three eggs was found on Sand Point, at the edge of an old fallen tree top on the edge of a wooded swamp. (Pl. XVIII b.) This nest was built in, and partly covered by, dry oak leaves. No more eggs were laid in this nest, and the young were soon hatched and gone. The young birds were often seen in the thickets, between July 15 and 25, and the species was still common on the Point when we left, on August 27.

109. **Seiurus noveboracensis notabilis.** Grinnell's water thrush.—Michigan: Not uncommon as a migrant; may breed on Isle Royale.

This species was not an uncommon migrant in the sand region, and was found in dry willow thickets and at the edge of wet swamps on Sand Point and in the region of Rush Lake. It was observed as early as July 30, at Rush Lake, but the first records for Sand Point were on August 5, 6 and 7, when several were seen. The same habitat was thoroughly worked again on August 8, but not a bird could be found, and no more were seen until August 24, when a single bird was observed in a damp willow-poplar thicket. Nearly all of the individuals found were on the ground not far from the water. Only three were seen at Rush Lake, between July 30 and August 13, and all in low wet thickets.

The Michigan water-thrushes have usually been referred to the typical form, and Ridgway* gives the breeding ground of Grinnell's as "North and west of Lake Superior." If this is the true breeding range these records show a migration to the southeast. The whole subject of Michigan water-thrushes is in need of careful examination to determine the status of the two forms in the state. The probabilities seem to be that the typical form (*noveboracensis*) does not enter our limits, although one of the Isle Royale specimens has been so

*Birds of North and Middle America. Vol. II, p. 646.

identified by Mr. Dett Miller. He also says of a single specimen taken at Rush Lake on August 5, "it is not a typical specimen but is nearer *noveboracensis*, especially in measurements. If it were not for its smaller size it might equally be refered to either form."

110. **Oporornis philadelphia.** Mourning warbler.—Michigan: Common migrant and summer resident, breeding north of latitude 43° but not found on Isle Royale.

This species was a rare migrant on the Point, and was first seen on August 17, when the writer called one out of a tangle of fallen tree tops. The next and last one seen was at the edge of a poplar thicket near camp. At Rush Lake the only one seen was on August 22, in a brush pile in low woods in the clay country.

111. **Geothlypis trichas brachidactyla.** Northern yellow-throat.—Michigan: Common summer resident, breeding throughout the state with the exception of Isle Royale.

Common throughout the sand regior in July and August and on Stony Island in July. This species was one of the common breeders on Sand Point, and was found in the usual habitat, i. e., in grassy swamps and adjacent thickets and on the edges of ponds. No nests were found, but the young made their appearance about July 1, and females were seen as late as July 20. At Rush Lake it was common in the clay country as well as in the sand region.

112. **Wilsonia pusilla.** Wilson's warbler.—Michigan: Scarce migrant, not known to breed in the state.

This species was a rare migrant in the sand region. It was first seen on August 20, when an adult male was noted in a willow thicket near the end of Sand Point. This was the only adult bird seen, but on August 22 several immature birds were observed in the tops of the thick willow bushes near the edge of Long Lake, and on August 24 one was called out of a thicket at the edge of a wooded swamp near camp. This was the last one seen. At Rush Lake, only one bird was seen (August 2) in low, wet woods.

113. **Wilsonia canadensis.** Canadian warbler.—Michigan: Common migrant but scarce summer resident, breeding north of latitude 44°.

An uncommon migrant in the sand region. This warbler was one of the earliest migrants, as an adult male was seen by Wood on July 30. This bird was in low heavy woods near the center of Sand Point, and was called out of a big pile of white pine tree tops left by the lumbermen the winter before. It was in fine plumage, with the exception of the first three primaries of each wing and the outside tail feathers which were only half-grown. This was the only bird seen until August 10, when a juvenile male was seen; and a very few more were observed between this date and August 24, when the last one was seen. At Rush Lake, one was seen on August 4 and several small flocks on August 13, all in the clay country. Those seen on the latter date were the last ones noted.

114. **Setophaga ruticilla.** Redstart.—Michigan: Abundant summer resident, breeding all over the state.

This species was the most common warbler breeding in the sand region and on Stony Island. It was found in all sorts of habitats throughout the region, but more especially in the timbered swamps. It was still to be seen when we broke camp on August 27.

115. **Dumatella carolinensis.** Catbird.—Michigan: Abundant summer resident, breeding all over the state.

Found throughout the sand region but not commonly. A single bird seen on Stony Island. The catbird was a rare breeder on Sand Point, and but two pairs were seen. On June 30 a nest with three eggs was found near the shore of Long Lake, and at Rush Lake a nest with one egg was found near Oak Point on August 20. During the migration in August, one or two birds were seen almost daily near the latter place, but it never became common.

116. **Taxostoma rufum.** Brown thrasher.—Michigan: Abundant summer resident, breeding all over the state except in the extreme northern portion and Isle Royale.

Very rare in the sand region, and observed only on Sand Point. One was found dead on the south shore of Sand Point on June 27 (this may have drifted in from another place), and a single bird was seen on the Point, July 9. At Rush Lake one was seen in the cultivated land east of the lake, on July 30. These were the only birds seen in the ten weeks work.

117. **Thryothorus ludovicianus.** Carolina wren.—Michigan: Rare summer resident in extreme southern portion; breeds rarely as far north as latitude 44°.

Five individuals were observed by Wood on Sand Point. On August 13, the senior writer was calling near the end of Sand Point, and out of a tangle of fallen tree tops a female juvenile wren of this species appeared. On August 18 and 19 two others were seen near the same spot, one of which was an adult female, and on August 24 a juvenile male was found in our camp shack. On August 26, the fifth and last one was seen, near the road not far from camp. These birds apparently represented a brood that had been reared on the Point.

The finding of a brood of this species in the sand region is very interesting, as it is supposed to be characteristic of the Carolinian zone and the most northern records for the state are, a bird taken at

Ann Arbor, on December 14, 1890, one taken near Detroit, August 11, 1906, by P. A. Taverner* and the nest with young found near Ann Arbor by Mr. A. D. Tinker,† June 20, 1909. The presence of this brood so far north of the usual range seems to indicate that the warmer (than the interior) climate of this coast may serve to introduce this southern form farther northward than in the interior.

118. **Troglodytes aedon.** House wren.—Michigan: Abundant summer resident, breeding all over the state with the exception of Isle Royale.

Common throughout the sand region and in the clay country at Rush Lake; apparently rather common on Stony Island. The species was a common breeder in the sand region and was found nesting in cavities in trees and about the old shacks. On June 27, Wood found a nest in a low dead poplar stub at the edge of a poplar thicket on Sand Point. It contained seven young about half fledged. During July many broods of young were seen in the tops of the fallen trees all over the Point, and on July 31 a nest with two well fledged young was found. When we left camp, on August 27, a few of this species were still to be seen.

119. **Nannus hiemalis.** Winter wren.—Michigan: Common summer resident, breeding all over the state north of latitude 44°.

This species was a rare migrant in the sand region. It was first seen at Rush Lake on August 4 and again on August 13. On Sand Point it was only seen on August 24. It may easily have been more common than our records indicate, for it is a very difficult bird to see, as it rarely leaves the fallen tree tops and brush piles.

120. **Telmatodytes palustris.** Long-billed marsh wren.—Michigan: Abundant summer resident, breeding locally throughout the state with the exception of Isle Royale.

Apparently a rare breeder in the sand region and on Stony Island. The long-billed marsh wren was seen on Sand Point only at Turtle Bay on the south side, where thick tall grass and rushes with some blue flags afforded cover and nesting sites. A male was taken here on July 22 and others seen. There was a colony of this species in the grass-covered area at the east end of Rush Lake, on August 10, and a single bird was found in the marsh on Stony Island.

121. **Certhia familiaris americana.** Brown creeper.—Michigan: Common migrant and rare summer resident, breeding in extreme northern portion.

A rare migrant in the sand region. An adult male was seen at Rush Lake on July 30, and a juvenile male on Sand Point, August

*The Auk, Vol. XXIV, p. 147.
†The Auk, Vol. XXIV, p. 434.

6. After the latter date it was observed occasionally at different places in the sand region.

122. **Sitta carolinensis.** White-breasted nuthatch.—Michigan: Common resident, breeding all over the state.

A rare breeder in the region. Observed at several places between Sand Point and Hat Point, and a single bird on Stony Island. Notwithstanding the fact that there were many apparently suitable cavities for them to nest in, only a very few of these birds were seen during July. It was seen more often after the young made their appearance, about August 1, but never became common anywhere in the region. The single bird seen on Stony Island was taken on July 14.

123. **Sitta canadensis.** Red-breasted nuthatch.—Michigan: Common migrant and summer resident, breeding north of latitude 44°.

A rather common migrant in the sand region, at least on Sand Point. The species became common about August 15, after which date it was seen almost daily with flocks of warblers and chickadees. It seemed to prefer to feed in the jack pines, where they were seen climbing up and down over the branches and cones, and even hanging, back down, like the chickadees. A number could be seen with nearly every flock of Cape May warblers, feeding with them and following them from tree to tree. Only two were seen at Rush Lake, August 25, and these were with a flock of chickadees.

124. **Penthestes atricapillus.** Black-capped chickadee.—Michigan: Common resident, breeding all over the state.

Common throughout the sand region and on Stony Island. The chickadee was not rare as a breeder in the sand region and was quite common during migration. It nested in cavities in dead trees, generally near the edge of the wooded swamps. On July 3, the first juvenile birds were seen (on Sand Point), and from about August 5 it was seen daily in company with the flocks of warblers that fed all over the Point; no large flock of any species of the latter being without a few chickadees. During August it was very common in both the sand region and clay country about Rush Lake.

125. **Polioptila caerulea.** Blue-gray gnatcatcher.—Michigan: Common summer resident, breeding all over the state except in extreme northern portion and Isle Royale.

This species was a rare breeder and only observed on Sand Point. A pair was seen on July 1, and the next day a juvenile bird was noted. It was also seen on July 24 and 30, but not after the latter date. This species is said to be characteristic of the Carolinian zone, but in

Michigan it breeds well north of northern boundary of this zone as defined by Merriam.*

126. **Hylocichla fuscescens.** Wilson's thrush.—Michigan: Common summer resident, breeding all over the state.

Apparently rather rare on Sand Point but very common in the sand region northeast of Caseville. It was a rare breeder on Sand Point. Its habitat was the thick bushes between the swamps and burnings. It was seen on June 15, 23, and 30, but rarely after the latter date. Near Rush Lake it was a common breeder in the sand country, and several could often be heard singing at one time all during August. A nest containing two eggs was found, on August 17, on a sand dune near Hat Point.

127. **Planesticus migratorius.** Robin.—Michigan: Abundant summer resident, breeding all over the state.

Apparently a rather rare breeder in the sand region and on Stony Island, but common as a migrant. No nests were found, but it was observed as early as June 27 on Sand Point, July 12 on Stony Island and July 29 at Rush Lake. Only two birds were seen on Stony Island. It became very common in the sand region in August. Large flocks were seen on August 14 near the camp on Sand Point, feeding on the juneberry and blueberry bushes, and a few were seen feeding on the wild red cherry near Long Lake on August 22. At Rush Lake it became very common after August 10, when large flocks were seen in both the sand region and clay country. Many in the former habitat fed among the blueberries.

128. **Sialia sialis.** Bluebird.—Michigan: Common summer resident throughout except on Isle Royale.

A rather uncommon breeder in the sand region but more common as a migrant. A single bird observed on Stony Island, July 12. Only a pair or two of bluebirds were noticed on Sand Point, between June 17 and August 1. On June 27, a brood of young still being fed by the parents were seen flying about a burning on the sand ridges. After August 1, they became common on Sand Point, and they were also common at this time at Rush Lake, both in the sand region and clay country but particularly in the latter. After August 15, there was a decided decrease in numbers.

*Life Zones and Crop Zones of the U. S., U. S. Dept. of Agr., Div. of Biol. Surv., Bull. No 10.

MAMMALS.

BY N. A. WOOD.

INTRODUCTION.

The mammals were not given particular attention on this survey, and the following notes mostly concern the species that were encountered in the course of the work on the other groups. The list therefore purports to be neither a complete synopsis of the mammalian fauna of the region nor a discussion of the local records secured. The specimens and notes were mostly secured by the writer on Sand Point and by Dr. Ruthven at Rush Lake and on Stony Island, but a few skins were purchased, and notes were secured from various residents in the vicinity. We are particularly under obligation to Messrs. L. H. Fittenger and Austin Yax for records of species now rare or extinct in the region. We are indebted to the U. S. Biological Survey for the identification of the mice in the collection.

LIST OF SPECIES.

1. **Cervus canadensis** (Erxleben). Wapiti; American elk.—Mr. Fittenger informed us that in 1856 the elk was not uncommonly found on Sand Point, and that he shot a specimen on the shore of Mud Lake (at the base of the Point) in September of that year.

2. **Odocoileus americanus** (Erxleben). Virginia white-tailed deer.—Mr. Fittenger informed us that while camping on Sand Point in 1857-8 he saw numbers of this species and shot several. They have long been extinct in this region, but, on July 5, a buck and two does swam over from Stony Island, where they had been placed by Mr. Wallace, and remained here all summer. They apparently found plenty of food on the Point, and on the first of September were in fine condition. This region should make a fine preserve for deer.

3. **Sciurus rufiventer** E. Geoffroy. Fox squirrel.—This species occurs throughout the sand region, but was seldom seen. It was only observed on Sand Point. Mr. Yax informed us that it was often found on the sand ridges north of Rush Lake.

4. **Sciurus hudsonicus loquax** Bangs. Noisy chickaree; red squirrel.—The red squirrel was of general occurrence but not abundant in the sand region and on Stony Island.

5. **Tamais striatus lysteri** (Richardson). Lyster's chipmunk.—This species was rather rare on Sand Point, but quite common in the sand region east of Caseville. It was not observed on Stony Island.

6. **Marmota monax** (Linnaeus). Woodchuck.—The woodchuck was common throughout the sand region, and burrows were rather numerous on the ridges.

7. **Mus musculus** (Linnaeus). House mouse.—It is hardly necessary to state that this species was found about the fisherman's shacks throughout the sand region.

8. **Peromyscus leucopus noveboracensis** (Fischer). Deer mouse. —Although not as plentiful as the Baird's field mouse, this species was found rather commonly on Sand Point. It was taken in traps set both in the woods and along the beach, but was most common under log piles and old boats along the shore. The only other place that it was taken was in a cedar swamp at the east end of Rush Lake, but it probably occurs throughout the sand region.

9. **Peromyscus maniculatus bairdi** (Hoy and Kennicott). Baird's field mouse.—This mouse is probably common in suitable habitats throughout the sand region. It was abundant in the drift wood along the beach on the north side of Sand Point (Pls. Ia, IVa), particularly on the fossil beaches, and a single specimen was taken from a milk snake found on the north shore of Stony Island. It was not found elsewhere, but was not looked for east of Caseville. The sandy beach is the principal habitat in which we have seen Michigan and Ontario specimens of this species.

10. **Microtus pennsylvanicus** (Ord). Pennsylvania meadow vole. —This species was not seen anywhere in the sand region, although looked for in the more favorable places. It was, however, taken in the clay country just southeast of Rush Lake.

11. **Fiber zibethicus** (Linnaeus). Musk rat.—This was not an uncommon species about the edges of the inland lakes and ponds. It was found both on Sand Point and at Rush Lake.

12. **Zapus hudsonius** (Zimmerman). Woodland jumping mouse. —The only specimens of this species seen were a female and seven young that were taken from a burrow in a low sand ridge at the east end of Rush Lake, on August 12.

13. **Sylvilagus floridanus mearnsi** Allen. Mearns' cottontail.—The cottontail was not very common in the sand region, but was of general distribution. The scarcity is probably to be attributed to the abundance of great horned owls, eagles and foxes. It was also found on Stony Island and in the clay country at Rush Lake.

14. **Lepus americanus** Erxleben. American hare.—The writer thought he observed this hare two or three times on Sand Point, but

no specimens were secured. The residents informed us that in the winter they were common in the swamps on Sand Point and to the east of Caseville, and that a great number are killed each season. We are indebted to Mr. Yax for a specimen taken January 24, 1909, in the sand region near Rush Lake.

15. **Lynx canadensis** (Kerr). Canada lynx.—While trapping on Sand Point in 1855-6, Mr. Fittenger took fifteen individuals of this species. He was apparently very sure of the identity of the form, distinguishing it from the wild cat by the long ear tufts.

16. **Lynx ruffus** (Guldenstaedt). Wild cat; red lynx.—Mr. Fittenger claimed to have trapped many individuals of this species on Sand Point, in 1856-7, and there seems good reason to believe that it is still to be found in the sand region. We saw many tracks that we believe were made by wild cats, and Mr. Kelly, a resident living east of Caseville, informed us that individuals are still occasionally shot in that vicinity.

17. **Canis occidentalis** (Richardson). Timber Wolf.—Mr. Fittenger told us that this species was common on Sand Point in 1855-6. At the present time it is without doubt entirely extinct.

18. **Vulpes fulvus** (Desmarest). Red fox.—Although hunted with dogs in the winter and now mostly driven out of the neighboring region, the red fox is very common in the sand region and on Stony Island. In July it was a very common occurrence to find turtle nests that had been dug out, and the contents destroyed by these animals. Both on Sand Point and east of Caseville we could also almost any morning find many tracks on the sand beach, where the animals were probably looking for fish. Individuals were seen several times. Ruthven saw one on a moonlight night on the beach near the west end of Sand Point, and another in a marsh on the north side of Rush Lake. Mr. Fittenger informed us that he captured one of the silver variety on the Point, in the winter of 1855-6.

19. **Ursus americanus** Pallas. Black bear.—Black bears were shot on Sand Point as late as 1855-6 and on North Island in 1863 by Mr. Fittenger and his brother.

20. **Procyon lotor** (Linnaeus). Raccoon.—The raccoon probably occurs throughout the sand region at the present time. A single track was seen on Sand Point, and a specimen was secured from Mr. Austin Yax that was taken by him at the east end of Rush Lake, in August 1908. Mr. Yax stated that it was not uncommon about Rush Lake.

21. **Mephitis olida** Boitard. Eastern skunk.—This skunk was common in the adjacent clay country, but, with the exception of a

track seen by Wood near Turtle Bay on Sand Point, it was not noted in the sand region.

22. **Mustela americana** Turton. American martin.—Mr. Fittenger trapped one of this species on Sand Point in the winter of 1855-6. This was the only one that he had ever seen in the region.

23. **Putorius vison** (Schreber). Mink.—The mink was not found on Sand Point, but was observed at Caseville and on Stony Island, being quite common in the latter place.

24. **Putorius noveboracensis** Emmons. Northern weasel.—The only weasel seen during the summer was on the south shore of Rush Lake. On August 4, while standing on the bank of the county ditch which empties into the lake at the southeast end, Ruthven saw a specimen of this species run down a log on the opposite side of the water, jump in, swim across, and disappear in the underbrush. After leaving the field Mr. Austin Yax sent us a specimen which he trapped at Rush Lake.

25. **Sorex personatus** Geoffroy. Common shrew.—A single specimen was taken in a cedar swamp at the east end of Rush Lake, on August 19.

26. **Lasionycteris noctivagans** (Le Conte). Silver black bat.—A single specimen of this species was found under the bark of a Norway pine stump (July 1) on Sand Point.

APPENDIX A.

Temperature Records for June, July and August on Sand Point.

	Max.	Min.		Max.		Min.			Max.		Min.	
June.	Woods.	Woods.	July.	Woods.	Beach.	Woods.	Beach.	August.	Woods.	Beach.	Woods.	Beach.
15	68	......	1	81	....	62	......	1	88	98	....	....
16	84	45	2	72	80	58.5	......	2	82	82	65	62
17	80	53	3	72	76	64	......	3	95	103	70	62
18	93	62	4	87	100	65	60	4	93	103	64	54
19	92	75	5	89	100	68	64	5	86	96	74	62
20	93	71	6	96	110	74	69	6	86	104	71	65
21	93.5	65	7	77	78	71	67	7	78	85	66	56
22	92	69	8	91	98	57	56	8	81	81	66	57
23	96	68	9	94	102	63	59	9	81	95	68	58
24	89	76	10	95	100.5	62	56	10	81	95	56	45
25	83	65	11	103	113	76	72	11	86	90	62	52
26	93	54.4	12	96	102.5	70	66	12	82	89	60	48
27	97.6	59	13	91	103	67	62	13	86	96	67	57
28	91	66.4	14	88.5	96.5	62	57	14	83	86	66	57
29	81	69.3	15	82	90	64	60	15	84	94	68	68
30	83.6	61	16	83	86	53	48	16	88	92	67	56
......	......	......	17	86	88	67	62.5	17	86	94	65	56
......	......	......	18	74	70	68	62	18	84	88	74	64
......	......	......	19	83	82	62.5	59.5	19	74	74	66	60
......	......	......	20	81.5	92	56	50	20	67	82	64	55
......	......	......	21	92	101	62	56	21	81	88	59	51
......	......	......	22	86	90	72	66	22	75	88	56	45
......	......	......	23	90	94	58	54	23	76	92	65	54
......	......	......	24	84	86	53	60	24	72	72	55	42
......	......	......	25	84.5	85.5	53	58	25	72	72	62	62
......	......	......	26	92	93.5	63	58	26	73	78	50	37
......	......	......	27	96	101.5	61	56	27	82	92	56	45
......	......	......	28	90	96	68	62.5	28	......	......	52	40
......	......	......	29	96	110.5	68.5	63.5	29	......	......	58	46
......	......	......	30	98.5	113	71.5	66.5	......	......	......	....	....
......	......	......	31	83	86	71	67	......	......	......	....	....

In the woods the thermometer was placed about four feet from the ground in a low swale near the middle of Sand Point, and was shaded from the sun.

The thermometer on the beach was two feet from the ground, fully exposed to the sun, and placed near the top of the outermost dune on the north side of Sand Point.

APPENDIX B.

Additional Remarks on the Biota and Climate of the Sand Dune Region.

BY ALEXANDER G. RUTHVEN.

Since this report was written the United States Weather Bureau has issued a bulletin (V) "on the length of the crop-growing season, as determined from the average of the latest and earliest dates of killing frost". According to the charts in this paper the influence of the lakes in checking early and late frosts is not as great along the east as along the west coasts, but still appreciable. The average date of the first killing frost in the autumn comes between 5 and 10 days later and the last killing frost in the spring probably about 5 days earlier on the east coast than in the interior, and the former about 5 days earlier and the latter about 10 days later than on the west coast in the same latitude. This is in harmony with the fact that there are apparently only a few southern forms that push farther northward along the east coast than in the interior.

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