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AN ECOLOGICAL SURVEY

IN

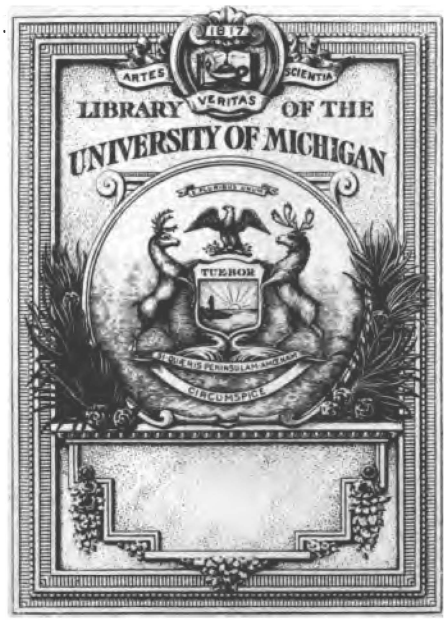
NORTHERN MICHIGAN.

PREPARED UNDER THE DIRECTION OF

CHAS. C. ADAMS.

A Report from the University Museum, University of Michigan, published by the State Board of Geological Survey as a part of the Report for 1905.

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1906



THE GIFT OF

Chas.Christopher Adams

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LETTER OF TRANSMITTAL.

OFFICE OF THE STATE GEOLOGIST,
LANSING, MICH., Oct. 30, 1905.

To the Honorable, the Board of Geological Survey of the State of Michigan:

Hon. Fred M. Warner, President.
Hon. L. L. Wright.
Hon. Patrick H. Kelley, Secretary.

Gentlemen:—I herewith transmit for publication, in the Annual Report of the Board for 1905, the following report. This is a contribution to the Biological Survey of the State, which the Legislature authorized you to supervise and execute by Act No. 250 of the Session of 1905. The following report is the result of a natural history survey made in the Porcupine Mountains and on Isle Royale by a party from the University Museum, University of Michigan. It is not a mere list of plants and animals, but a study of these forms in relation to their surroundings. It is thus a contribution to the natural history of the Upper Peninsula, and in addition to its scientific value will, I trust, be of use to teachers in all parts of this region and stimulate them in the study of the forms of life about them.

Very respectfully,
ALFRED C. LANE.

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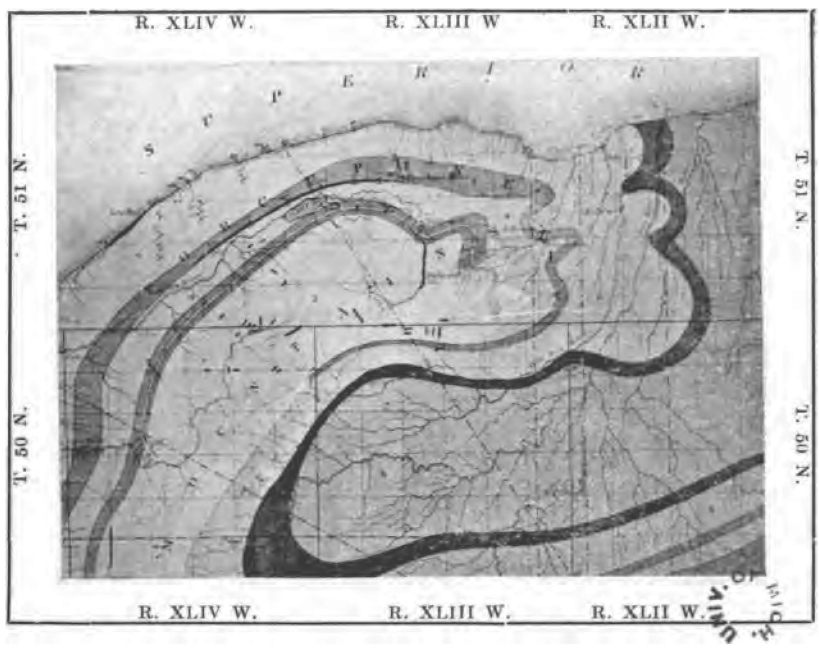


FIG. 1. Geological map of a portion of the Porcupine Mountains, Mich.

2. Quartz-porphyry. 3. Diabase, Diabase-amygdaloid ("Trap"). 4. Sandstone and Conglomerate. 5. Diabase and Diabase-amygdaloid ("Trap"). 6. Sandstone with thin bands of conglomerate. 7. Dark-grey Sandstone and Black Shale.—(After Irving).

TABLE OF CONTENTS.

Introductory Note, by Chas. C. Adams.

ECOLOGICAL PAPERS.

An Ecological Survey in the Porcupine Mountains and Isle Royale, Michigan, by A. G. Ruthven 17
Introduction 17
Part I. Porcupine Mountains 19
1. History 19
2. Geology 19
3. General Topography 20
4. Location of Field Stations 21
5. The Biota Considered by Stations 22
6. Summary 40
7. Interpretations and Conclusions 43
Part II. Isle Royale 48
1. General Geography 48
2. Location of Field Stations 48
3. The Biota Considered by Stations 48
4. Summary and Conclusions 52
Part III. References 53
The Ecological Distribution of the Birds in the Porcupine Mountains, Michigan by Otto McCreary 56
I The Lake Superior Slope of the First Mountain Ridge 56
1. Lake Superior (Station I.) 56
2. Lake Beach (Station I.) 56
3. Cedar Swamp (Station II. Sub. 1.) 57
Clearings in the Cedar Swamp 57
Supplementary Clearing Observations 58
4. Hemlock Forest (Station II. Sub. 2.) 58
Supplementary Clearing Observations 58
5. Hardwood Forest (Station II. Sub. 2.) 58
6. Camp Clearing (Station II. Sub. 3 and 4.) 59
7. Mountain Top and Escarpment (Station III. Sub. 1 and 6.) 59
II. Carp River Valley 60
1. Carp Lake (Station V. Sub 1 and 3.) 61
2. Grassy Marshes (Station V. Sub. 2, and Station IV. Sub. 2.) 61
3. Alders (Station IV. Sub. 2.) 61
4. Damp Woodland (Station IV. Sub. 3.) 62
5. Tamarack Swamp (Station IV. Sub. 4.) 62
6. Carp River (Station IV. Sub. 1.) 62
7. Dry Woodland (Station IV. Sub. 3.) 62
a. Western End 63
b. Eastern End 63
III. Hardwood Forest South of Carp River (Station VI.) 63
IV. Little Carp River Valley 63
1. Little Carp Lake (Station VII. Sub. 1.) 63
2. Beaver meadow (Station VII. Sub. 2 and 3.) 64
V. Summary 64
1. Water Birds 64
2. Birds Frequenting Shores and Banks of Streams 65
3. Birds found in Grassy Marshes and Alders 65
4. Birds Frequenting Tamarack Swamps and Cedar Swamps 66
5. Birds Frequenting Hemlocks and Maples 66
6. Birds Frequenting the Cliff and Mountain Top 67

The Ecological Relations of the Orthoptera in the Porcupine Mountains, Michigan, by Albert Pitts Morse, Research Assistant, Carnegie Institution of Washington 68
1. General Remarks 68
2. Station List 69
3. Systematic List of Orthoptera 71

ANNOTATED LISTS.

List of Stations in the Porcupine Mountains 74
List of Stations on Isle Royale 74
Notes on the Plants of the Porcupine Mountains and Isle Royale, Michigan, by A. G. Ruthven 75
1. Porcupine Mountains 75
2. Isle Royale 86
Annotated List of Molluscs of the Porcupine Mountains and Isle Royale, Michigan, by Bryant Walker and A. G. Ruthven 93
1. Porcupine Mountains 93
2. Isle Royale 96
Spiders and Insects from the Porcupine Mountains and Isle Royale, Michigan, by A. G. Ruthven 100
1. Spiders from the Porcupine Mountains 100
2. Spiders from Isle Royale 100
3. Dragonflies from the Porcupine Mountains 101
4. Butterflies and Moths from the Porcupine Mountains and Isle Royale 102
a. Porcupine mountains 102
b. Isle Royale 103
c. Notes on the Collection of Butterflies, by Prof. A. J. Snyder 103
5. Ants from the Porcupine Mountains 104
6. Ants from Isle Royale 105
The Cold-blooded Vertebrates of the Porcupine Mountains and Isle Royale, Michigan, by A. G. Ruthven 107
1. Fish of the Porcupine Mountains 107
2. Fish from Isle Royale 108
3. The Amphibians of the Northern Peninsula 109
4. The Reptiles of Northern Michigan 110
Annotated List of the Birds of the Porcupine Mountains and Isle Royale, Michigan, by N. A. Wood, Max M. Peet and O. McCreary 113
1. Porcupine Mountains 113
2. Isle Royale 121
Notes on the Mammals of the Porcupine Mountains and Isle Royale, Michigan, by Chas. C. Adams 128
1. Porcupine Mountains 128
2 Isle Royale 131

ILLUSTRATIONS.

			On or opposite page
Fig.	1.	Geological map of a portion of the Porcupine Mountains, Michigan...	4
	2.	Geological section illustrating the structure of the Porcupine Mountains.	13
	3.	Portion of the Porcupine Mountains, showing location of field stations.	15
	4.	General character of the rock beach, breaker line near shore.....	20
	5.	Wave action on the Lower Beach.....	20
	6.	Showing nature of the rock pools, crevice vegetation and lichens on the Middle Beach, and the stunted crevice vegetation of the Upper Beach	24
	7.	General character of the rock beach, breaker line off shore.....	24
	8.	Hemlock forest, showing dense shade and lack of undergrowth.....	28
	9.	Deciduous forest, showing character of undergrowth.....	32
	10.	Escarpment of the First Range, looking west.....	
	11.	"Bald" on the top of the First Range.....	36
	12.	The zone of stunted aspens surrounding the "bald.".....	36
	13.	The zone of heath plants and scattered pines that surrounds the "bald" areas on the top of the First Range, above the aspen zone.....	40
	14.	Face of the cliff and talus slope, looking north from Carp Lake.....	40
	15.	Large rock ledge on the face of the cliff shown in Fig. 14.....	48
	16.	Talus slope, showing the nature of the talus.....	48
	17.	Upper portion of the talus slope.....	60
	18.	General view of the Carp river valley, looking up stream and southeast from Station III. 5.....	60
	19.	Carp river, showing zones of vegetation on the mud flats.....	64
	20.	Beaver meadow, showing grasses and sedges bordered by encroaching willows and alders.....	68
	21.	Map of lower end of Isle Royale, showing the location of field stations	72

INTRODUCTORY NOTE.

During the summer of 1904 the University Museum of the University of Michigan sent a party to Northern Michigan. The aim of the expedition was to make an ecological study of the plant and animal life of the Porcupine Mountains in Ontonagon County and on Isle Royale. The Porcupine Mountains are about 120 miles west of Marquette, on the south shore of Lake Superior; Isle Royale, an island in Lake Superior, is near the north or Canadian shore. Almost nothing has been known of the Natural History of these localities, and collections from these regions have been almost completely lacking in the Museum. Civilization has already exterminated a large number of plants and animals from parts of Lower Michigan, so that it is especially desirable that records and collections be secured from these northern regions ere it becomes too late through the encroachments of civilization.

The expedition was made possible through the generosity of certain public spirited friends of the University, as the funds of the Museum are too limited to carry on this very important line of work, without special aid. The major part of the funds were the combined gifts of Mr. Bryant Walker, of Detroit, Hon. Peter White and Mr. N. M. Kaufman, of Marquette, and to these gentlemen in particular the University Museum is under great obligation. The Board of Regents of the University generously contributed the expense of transportation, not otherwise provided. Through the efforts of Mr. White the party received transportation or special rates in the Northern Peninsula. The Duluth, South Shore & Atlantic R. R. gave a special rate to the party, and the White Line Transportation Co., through Capt. W. H. Singer, general manager, gave free transportation to the party to and from Isle Royale. Through Mr. Henry Russel, the Michigan Central R. R. also gave the party a special rate. The Washington Club of Duluth, through Mr. John Panton, provided the party with excellent field headquarters upon their private grounds on Isle Royale. The Marble Axe Co., of Gladstone, Mich., presented the party with a set of useful camp articles. In addition to the services of the volunteer members of the party and those just mentioned many others have aided in various ways. In behalf of the Museum I wish to express my sincere appreciation for this coöperation.

The field party was in charge of N. A. Wood, the Museum taxidermist. He was assisted by A. G. Ruthven, who had charge of the scientific work, and who directed it along lines outlined by the writer. The other members of the party were Messrs. Otto McCreary, N. F. Macduff, Max M. Peet and W. A. Maclean. All members of the party, except the leader, were volunteers, and thus their contribution to the success of the expedition was of a very substantial nature. Without their aid nothing could have been accomplished. Upon Messrs. Wood and Ruthven fell the responsibility of the party in the field, and to their care and foresight is due, in a large measure, the success of the expedition.

The field party left Ann Arbor, July 11, after three weeks of unfortunate and unavoidable delay, and explored the Porcupine Mountains until August 13. These mountains rise rather abruptly from the south shore of Lake Superior, and in a succession of ridges reach the height of about 1400 feet, at about two miles in the interior. The entire region is inhabited only by scattered trappers, and the forests are practically in their original condition.

From the Porcupines (August 13), the party went to Isle Royale, about 60 miles northwest of Houghton, where they made a hasty examination of the lower end of the island, the party remaining here until September 5. The lateness of the season furnished an excellent opportunity to make observations on the fall migration of the birds, and these notes are of peculiar interest on account of the insular location.

After the return of the party from the field, the preparation of the report was begun at once and has been carried on as rapidly as circumstances would permit. As the volunteer members of the party have been busy with other duties the preparation of the reports, in some cases, represents considerable sacrifice on their part. In particular this has been the case with Mr. Ruthven, upon whom naturally fell the heaviest burden.

A very pleasant feature in connection with the preparation of this report has been the generous coöperation of a large number of naturalists. In behalf of the University Museum I wish to acknowledge our indebtedness to these persons, who have, in addition to furnishing information concerning the collections, and the determination of specimens, in some cases contributed papers. The following list will show by whom the specimens have been determined.

Prof. Bruce Fink, Iowa College, Grinnell, Iowa. Lichens.
Dr. C. A. Davis, University of Michigan. Higher plants.
Mr. S. Alexander, Ann Arbor, Mich. Higher plants.
Dr. J. P. Moore, University of Pennsylvania, Philadelphia. Leeches.
Mr. Nathan Banks, U. S. Dept. of Agriculture, Washington. Spiders.
Mr. E. B. Williamson, Bluffton, Ind. Odonata.
Mr. J. R. De la Torre Bueno, New York. Hemiptera.
Mr. A. P. Morse, Wellesley College, Wellesley, Mass. Orthoptera.
Prof. A. J. Snyder, Springfield, Idaho. Lepidoptera.
Dr. W. M. Wheeler, American Museum Natural History, N. Y. Ants.
Mr. Bryant Walker, Detroit, Mich. Molluscs.
Dr. S. E. Meek, Field Columbian Museum, Chicago. Fish.
Dr. L. Stejneger, Smithsonian Institution, Washington. Amphibia.
Mr. Robert Ridgway, Smithsonian Institution, Washington. Birds.
Mr. H. C. Oberholser, Smithsonian Institution, Washington. Birds.
Dr. C. Hart Merriam, Biological Survey, U. S. Dept. Agriculture, Washington. Mammals.
Mr. W. H. Osgood, Biological Survey, U. S. Dept. Agriculture, Washington. Mammals.
Dr. Glover M. Allen, Boston Soc. Nat. History, Boston. Mammals.

This is also an appropriate place to express our obligations to Dr. A. C. Lane, State Geologist of Michigan, who furnished the party with maps and other information on Isle Royale and the Porcupine Mountains.

We are indebted to Mr. John F. Nellist for the contour map showing the location of the stations in the Porcupine Mountains, which he adapted from the map furnished by Dr. Lane.

A few remarks concerning the character of the field work, upon which the ecological reports have been based, will be of interest and also indicate the general bearing of such work. The aim of the present expedition was not directed primarily along the lines usually followed by natural history surveys. The aim was to secure *ecological facts and relations* concerning the plants and animals of the regions visited. In order to accomplish this, it was necessary not only to collect specimens but also to make observations concerning the relation of plants and animals to their environment. Mr. Ruthven was therefore instructed to run lines of survey across the region examined, in such a way as to include examples of all of the representative habitats or environments. These habitats were then to be examined in as much detail as time permitted. There is nothing unique in this method of selecting special localities, but in the detailed study of these various habitats special attention was given to the *relations of the biota* to its environment.* In this study attention was directed particularly to the forces and conditions composing the environment, in order that the dominant forces might be clearly recognized. This involved a careful analysis of the conditions, as it is only by such means that the laws of change can be recognized, and the dynamics of the habitat be understood. In this way, the habitat can be studied from the standpoint of *processes* rather than from that of the end result or effects of such forces, for it is very evident that if the habitats are to be understood it must be by a study of their laws of change.

Somewhat similar methods have been applied to special problems by a few plant ecologists, notably Cowles and his students, from whom many suggestions have been received, but such methods have not been applied to the study of both the plants and animals, and their interrelations, for any region. In the detailed application of this standpoint to the study of habitats, with its method of description in terms of *processes*, this report (Ruthven's section) is believed to be unique. That the ideal of interpretation, dynamically considered, has not been realized in the present ecological studies, will not be surprising to any one who understands the dynamic relations of ideals, or to one who has ever tried to depart from the customary static methods of working in order to think in terms of processes—dynamically.

As this method of thinking is not generally understood, it is occasionally applied in such a crude and general sense that its bearing can not be grasped when applied to special or concrete problems. There can be no question as to the general validity of this method, but what is now needed is to know how these processes are combined and related to produce particular environmental conditions or situations. It seems a very simple matter to give assent to the idea of the law of change, yet in its practical application this simplicity often vanishes at once when it is seen that it involves the relation of cause and effect. The organic environment is very complex and the ecologist, like the geologist has very frequently to deal with a complex of causes. But to be able even to refer a change to such a complex is often a distinct advance, as this involves a recognition of a problem requiring analysis, which is a further advance.

That these difficulties are not confined to the ecologist alone, but are obstacles which arise in any attempt as scientific interpretation, is worthy of special notice. We are thus able to see why certain naturalists apparently not recognizing or understanding the developmental processes which scientific ideas undergo, nor being acquainted with the tendencies of interpretation, dynamically considered, now making such rapid headway in ecological

*Biota—"the total of animal or plant life of a given region or period." Stejneger.

botany, geography, physiography, geology and psychology, are inclined to look upon such attempts in biology as merely a fad or a personal peculiarity of the student, and not of any particular consequence. Such ideas confuse the incidental with the essential and suggest a complete failure to grasp the situation or to realize the fundamental importance of stating explanations in terms of processes.

Furthermore, in several of the allied sciences, the methods of dynamical interpretation have already made considerable advance. Here then is a resource, at present largely unworked by many biologists, where a wealth of ideas and explanations lie strewn over the surface and only need to be picked up in order to be utilized by those acquainted with this method of interpretation. It is thus very apparent that as soon as ecological phenomena are investigated dynamically and expressed in terms of processes, this science will of necessity become more closely correlated with those allied sciences which have already availed themselves of such methods.

If the signs of the times are now read correctly, the most striking advance in scientific methods of thinking during the present century will be in the direction of interpretation from the standpoint of processes—dynamically.

April, 1905.

CHARLES C. ADAMS,
Curator.
University Museum,
University of Michigan.

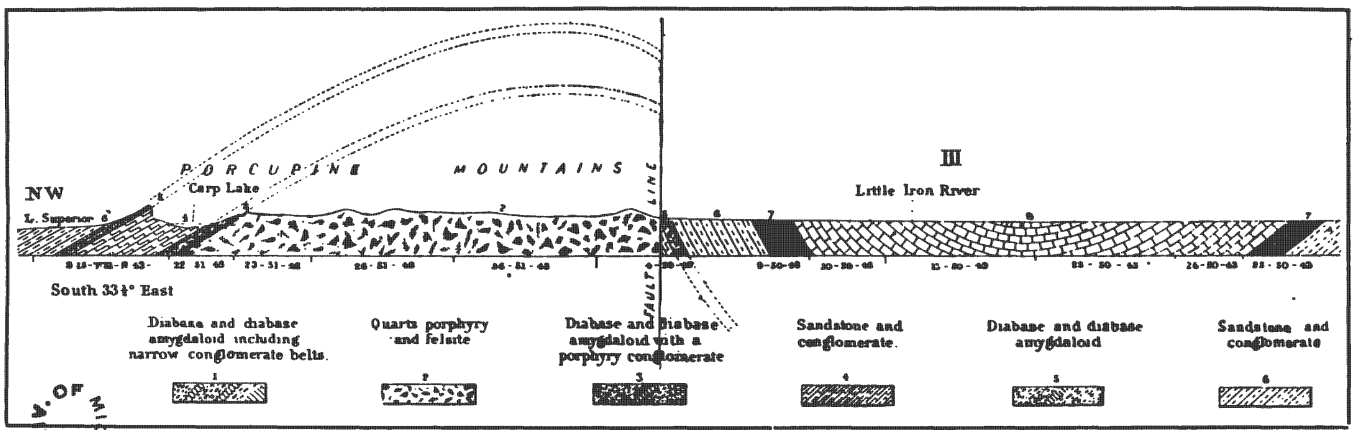


FIG. 2. Geological sections illustrating the structure of the Porcupine Mountains. (After Irving).

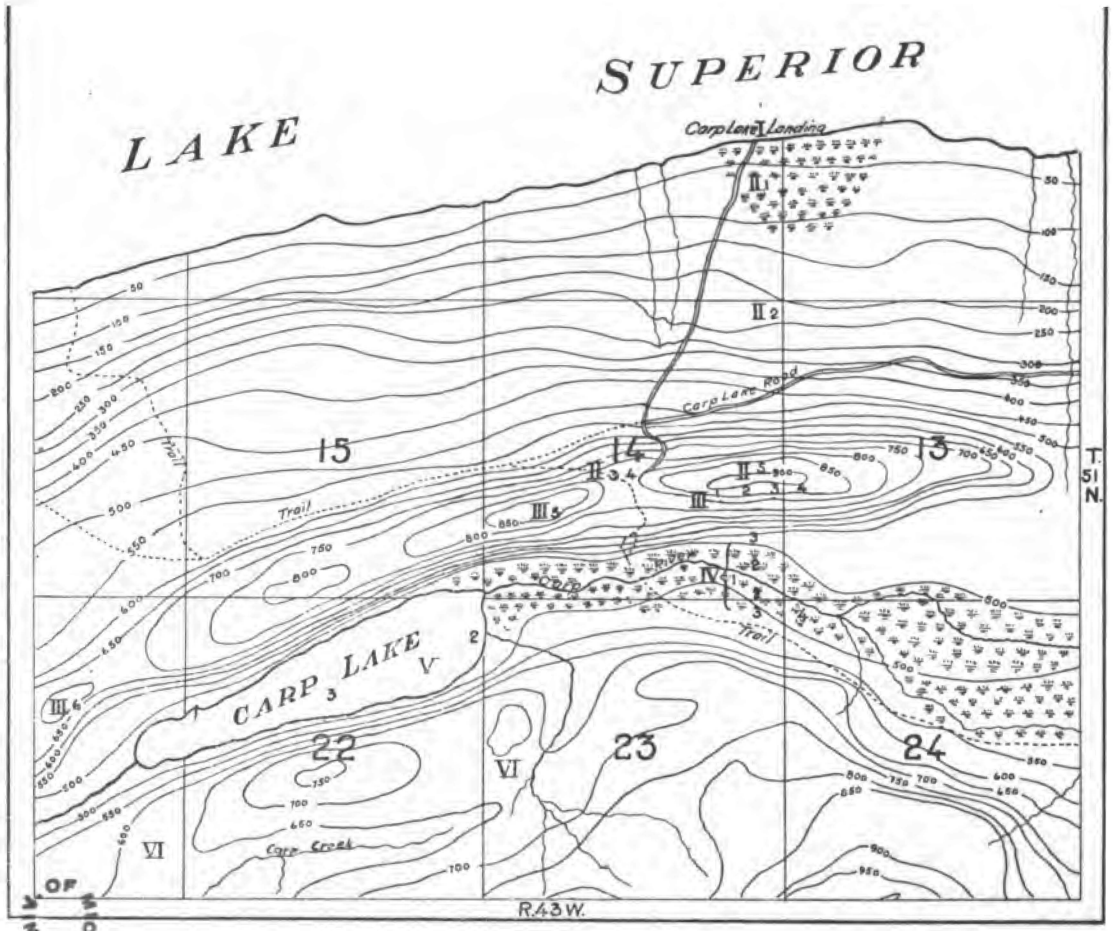


FIG. 3. Portion of the Porcupine Mountains showing location of field stations. Contour interval 50 feet. Altitudes above the level of Lake Superior, 601.19 feet.

AN ECOLOGICAL SURVEY IN THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

A. G. RUTHVEN.

CONTENTS.

Introduction.
Part I. Porcupine Mountains.
1. History.
2. Geology.
3. General Topography.
4. Location of Field Stations.
5. The Biota Considered by Stations.
6. Summary.
7. Interpretations and Conclusions.
Part II. Isle Royale.
1. General Geography.
2. Location of Field Stations.
3. Biota Considered by Stations.
4. Summary and Conclusions.
Part III. References.

INTRODUCTION.

The following report is based upon the results of the University of Michigan Museum Expedition to the Northern Peninsula of Michigan. The field work covered a period from July 13 to September 5, 1904. From July 13 to August 13 was spent in the Porcupine Mountains; the remainder of the time on Isle Royale. After a short reconnaisance, a line was run through that part of the region presenting the greatest variety of habitats, and stations were established on this line at which collecting was done. This plan greatly aided keeping in mind the relation between the physical conditions and the biota, as topographic and vegetational features were made the basis for the location of stations. It also made it possible to examine a great variety of conditions and thus obtain representative collections.

There were six men in the party: Messrs N. A. Wood, Max M. Peet, N. F. Macduff, Otto McCreary, W. A. Maclean, and the writer. Having had some experience in this work, Mr. Macduff assisted the writer in running the line, and while doing this listed the flora of the stations as they were established. Mr. Wood's time was mostly spent in caring for the bird and mammal skins, and in this work he was assisted by Mr. Peet, who, in turn assisted by Mr. Wood did the trapping. Mr. Peet also spent some time

collecting birds. Mr. McCreary devoted his time to the study of the habitats of the birds and to the collecting of ants, and Mr. Maclean to collecting vertebrates alone. The invertebrates and cold blooded vertebrates were collected by the writer, with the assistance of the other members of the party.

Except in the case of the molluscs and birds, no attempt was made to make exhaustive lists of the different groups, owing to the lack of time. The collections include principally the representative forms in the different habitats, as is indicated in the description of the stations and in the annotated lists.

While running the line of survey and establishing the stations, the dependence of the biota on the environmental conditions, and the adjustment between these conditions and the plant and animal societies was given special attention. Much light was thrown on the interpretation of these interrelations by considering the physiography in its dynamic or unstable aspect. The physiography is the resultant of the geological formations and the agencies constantly at work modifying them. Since the biota is dependent on the physical conditions in the different habitats, it is also unstable. A knowledge of the present and past conditions, which can only be obtained through a knowledge of the processes involved, is therefore necessary to explain the origin and distribution of the life of this region.

Both of the localities worked are favorable for study from the ecological standpoint, for the primitive and natural order of life prevails practically free from the disturbing influences of man. The forests have not been lumbered, and, although mining has been done both in the Porcupines and on Isle Royale, the workings were all early abandoned, and the conditions of nature have reverted so nearly to their primitive order that the only evidences now remaining are caved-in shafts, and occasional growths of aspen and birch which mark the site of old clearings. The whole region is wilderness and practically uninhabited. For this reason, field headquarters were established in order to have a suitable place where provisions could be stored, and where the specimens could be properly cared for. Owing to the nature of the woods, travel was arduous and all extended trips had to be made with packs, making it difficult to care for specimens more than two days' journey from camp. This difficulty, in the Porcupine Mountains, was counterbalanced by the rough nature of the topography that made it possible to get a large variety of habitats within a comparatively small area. The territory covered by the survey was, therefore, limited to about twelve square miles, in order that representative habitats might be worked in some detail. On Isle Royale, the low relief made it necessary to extend the line much farther in order to get a variety of habitats. It was, for this reason, impossible to cover the ground in as much detail.

It is well at this time to acknowledge our indebtedness to Mr. David Allie, caretaker of the Carp Lake Mining Property in the Porcupine Mountains, who placed at our disposal a large double shack furnished with bunks, stove and dishes, and aided us in many other ways. We are also indebted to Mr. Charles Preulx and Michael Hollinger, caretakers of the grounds of the Washington Club, Isle Royale, who also assisted us in many ways.

PART I. PORCUPINE MOUNTAINS.

1. HISTORY.

The Porcupine Mountains are situated in the Northern Peninsula of Michigan, in Ontonagon County, near the west end of Lake Superior, between the Iron and Presque Isle rivers. They were acquired by the United States Government from the Mississippi and Lake Superior Chippewa Indians by virtue of a treaty concluded October 4, 1842. The territory included in this treaty was bounded on the north by Lake Superior; on the east by the Chocolate river; on the south by the Michigan-Wisconsin boundary line, and on the west by the Montreal river. Isle Royale was also included.

Shortly after the treaty was concluded, prospecting was begun, and during the period that followed the speculative fever ran high. The mere presence of trap rock was taken as an indication of the presence of valuable lodes of copper, and all the trap in the Porcupine Mountain region was soon secured by permits. Many shafts were sunk, especially in the first range where the junction of the trap and sandstone outcrops on the face of a cliff. It was soon found, however, that in this region there are no well defined lodes, the copper being scattered promiscuously in irregular seams through the trap. Before the expiration of the year 1848, according to Foster and Whitney ('49–'50, p. 80), nearly all of the companies had abandoned their locations, and there was scarcely a white man left in the region.

The workings, with the exception of three or four, were little more than prospect holes, and the impressions left upon the country by the presence of man have nearly all been obliterated. In this condition, the mountains have remained for fifty years. All about them the adjacent country has been lumbered, but, owing to the fact that the pines do not occur in extensive tracts, that the streams are not suitable for logging, and that up to a few years ago it was not thought worth while to lumber hardwoods and hemlock, the forests have thus far escaped destruction. With the exhaustion of the pine in Michigan, however, and the consequently increasing price of lumber, it has become profitable to lumber this timber, and the forests are being rapidly taken off of the Northern Peninsula. The lumbering about Ontonagon has nearly reached the great belt of hemlock on the east and north slopes of the first range. The extensive possessions of the mining companies will protect these forests for a time, but, with the increasing demand for lumber, it will be but a few years until these magnificant forests will be destroyed.

2. GEOLOGY.

It is not the purpose of this report to go into detailed discussion of the geology of the region in question. It is necessary, however, to have a general idea of the geological structure in order to understand the topography, for the topography is largely due to the different degrees of resistance offered by the outcropping rocks to erosion. The structural geology of this part of Michigan has been worked out in detail by several geologists, most notably

by Irving ('83), but little attempt has been made to correlate it with the topography, in which connection it chiefly concerns the distribution of animals and plants.

The rocks of this part of the Northern Peninsula belong to what is known as the Keweenawan Series, and may in a rough way be divided into three classes,—the basic or trap rocks, the porphyries or acid rocks, and the detrital rocks.

The basic rocks make up the greater part of the whole series. They are finely crystalline rocks formed by the slow cooling of molten lavas containing 45 per cent to 50 per cent of silica, and consist of a lower compact portion grading upward into a vesicular or amygdaloidal portion interstratified with bands of unaltered red sandstone and conglomerate which become more numerous near the top. These basic rocks are true eruptives and constitute successive lava overflows from fissure eruptions (Irving, '83, p. 139).

The acid rocks occur between layers of basic rocks and are in part, like the basic rocks, true eruptives. They are composed of materials which fuse with difficulty, owing to the presence of silica, and which consequently cool rapidly into rocks composed of large crystals embedded in a glassy or porcelain like matrix.

The detrital members of the series consist of sandstones, conglomerates and shales formed from acid, or less prominently basic, rocks.

The Keweenawan Series is divided by Irving into two divisions, the Upper and Lower Keweenawan. The Upper Division consists wholly of detrital material, while the Lower consists of alternating flows of lavas and sediments. Most of the Upper Division lies under Lake Superior, but it also underlies the broad plain between Portage Lake and the Porcupine Mountains. This plain is interrupted by the Porcupine Mountains but continues again to the south.

The Keweenawan rocks border nearly the entire area of the Lake Superior basin. Besides forming the larger part of Keweenaw Point and constituting the Michigan shore to the Montreal river, they occur in northern Wisconsin, eastern and northeastern Minnesota and occupy a great area about Lake Nipigon. The outcropping trap rocks in Michigan occur as a range extending from the end of Keweenaw Point southwestward into Wisconsin. From this range the detrital sandstones and conglomerates dip away toward the lake. In the vicinity of the Porcupine Mountains, an outcrop of trap, owing to a fold, leaves the main range and swings away toward the lake, in T. 50 N., R. 44 W., and returning joins the main range in T. 49 N., R. 45 W.; within this fold occur the rugged ranges of the Porcupine Mountains.

3. GENERAL TOPOGRAPHY.

The mountains rise from the south shore of Lake Superior, Fig. 1, in Township 51 North, Ranges 42, and 44 West, as a convex ridge parallel to the lake shore. Back of this ridge they extend to the south as steep ridges and knobs in T. 50 N., Rs. 42, 43, 44 and 45 W., and T. 49 N. Rs. 43, 44, and 45 W. The whole system comprises three fairly distinct parallel ridges that nowhere attain an alpine height; the highest point, according to the charts of the United States Lake Survey, being 1421 feet above the level of Lake Superior or 2022.19 feet above sea level. Unfortunately the territory covered by the topographic map of the Michigan Geological Survey does not embrace this section, so this record has not been verified. The altitudes



FIG. 4. General character of the rock beach, breaker line near shore, station I.



FIG. 5. Wave action on the Lower Beach, station I.

referred to in this report are, unless otherwise specified, above the level of Lake Superior. The elevation above sea level may be obtained by adding 601.19 feet to the given altitude (Wright, '05, p. 36).

The first ridge, rising from the shore of Lake Superior, reaches a height of 850 to 900 feet within a mile and a half. It then decends abruptly 400 feet into the valley of Carp river. This cliff consists of about 200 feet of vertical face, with a steep bare talus slope at the bottom which is composed of angular fragments of trap and sandstone rock weathered from the cliff above. As may be seen from the contour map, this talus slope grades down into the flood-plain of Carp river, except on Sections 21 and 22, T. 51 N., R. 43 W.; here the river widens out to form Carp lake and the talus decends into the lake. This great cliff extends nearly continuously across T. 51 N., R. 43 W., a distance of over six miles. Beyond Carp river the mountains rise in steep ridges and knobs, but with no precipitous cliffs, to the valley of the Little Carp river.

About three miles south of the west end of Carp Lake, on T. 50 N., R. 44 W., Section 2, Little Carp river widens out to form Little Carp Lake. This lake, which marks the end of the line of survey, is about half a mile long and a quarter of a mile in width, with very irregular shores formed by the surrounding hills.

The mountains are most easily reached from Ontonagon, Michigan. From here to Union Bay, there is a good but sandy road. After leaving Union Bay the road enters the mountains and runs along the north slope of the first ridge. This slope is terraced by old beaches which mark higher levels of Lake Superior, and the road ascends the mountains by these natural driveways, ascending from one beach to another in the less difficult places.

It is important to bear in mind that the present topography is not in a static condition but is being constantly changed by the forces acting upon it, and that it will continue to be changed and modified until the land has been reduced to base-level. It must also be borne in mind that forms of life are dependent on the environments formed by the physical conditions. These facts are as important from the ecological as from the physiographic standpoint, for with changes in the physical conditions there are associated changes in the dependent habitats. The present conditions are not sufficient, therefore, to explain the distribution of the present biota, and the past conditions can only be understood through a knowledge of the action of present forces in producing changes in the environments. It is for this reason that the present geological and topographical conditions have been considered.

4. LOCATION OF THE FIELD STATIONS.

The line of survey began at Lake Superior on the north and south line of Sections 11 and 12, Township 51 North, Range 43 West, and from here ran southwest up the north slope of the first range to a saddle in the crest at an elevation of 750 feet on Section 14. From this point a transverse line was run along the top of the range, to the west on Sections 14, 15, and 21, and to the east on Sections 14 and 13. From the saddle on Section 14, the main line was continued due south down the escarpment on the south side of the range, across the valley of Carp river to the east and west line of Sections 14 and 23. From this point it was run southwestward across the intervening ranges to the top of Government Peak on Section 27. Another line was run down the valley of Carp river from the north and south line of Sections 24 and 25 to the West end of Carp Lake on Section 21. Here it

turns to the south, crossing Sections 21 ,28, and 23, Township 51 North, Range 43 West, to Little Carp Lake on Section 2, Township 50 North, Range 44 West. It then turns to the east and follows the valley of Little Carp river about a mile and a half up stream. On these lines stations were established where different conditions prevailed. Their locations, Fig. 3, were as follows:

Station I. Beach of Lake Superior, Secs. 11 and 12, T. 51 N., R. 43 W.

Station II. North Slope of the First Range, Secs. 11, 12, 13, 14, 15, and 16, T. 51 N., R. 43 W.

- Sub. 1. Arbor Vitae Swamp at Foot of Slope, Secs. 11 and 12.
- Sub. 2. North Slope, Secs. 11, 12 and 14.
- Sub. 3. Clearing in the Saddle, Sec. 14.
- Sub. 4. Aspen Zone about Clearing, Sec. 14.
- Sub. 5. Aspen Zone at Top of Ridge bordering the Bare Mountain Top, Secs. 13, 14, 15, 21, T. 51 N., R. 43 W.

Station III. Top of the first Range and the Southern Escarpment Secs. 13, 14, 15 and 21, T. 51 N., R. 43 W.

- Sub. 1. West Slope of the Ridge on Secs. 13 and 14.
- Sub. 2. Bare Mountain Top, Secs. 13 and 14.
- Sub. 3. Zone of Pines crossing First Range, Secs. 13 and 14.
- Sub. 4. East Slope of the Ridge on Sec. 13.
- Sub. 5. Mountain Top on Secs. 14 and 15.
- Sub. 6. Mountain Top on Sec. 21.

Station IV. Carp River Valley on Secs. 13, 14, 23 and 24, T. 51 N., R. 43 W.

- Sub. 1. Carp River, Secs. 14 and 24.
- Sub. 2. Flood-plain, Sec. 14.
- Sub. 3. Valley Slopes, Secs. 14 and 23.
- Sub. 4. Peat Bog, Secs. 14, 23 and 24.

Station V. Carp Lake, Secs. 15, 21 and 22, T. 51 N., R. 43 W.

- Sub. 1. Beach at West End of Lake, Secs. 21 and 22.
- Sub. 2. Delta at East End of Lake, Sec. 22.
- Sub. 3. Carp Lake, Sec. 22.

Station VI. Mountains between the Carp and Little Carp Drainage Systems, Secs. 21, 22, 23, 27, 28, 33, and 34, T. 51 N., R. 43 W.

Station VII. Little Carp Drainage System, Sec. 2, T. 50 N., R. 44 W., and Sec. 34, T. 51 N., R. 43 W.

- Sub. 1. Little Carp Lake, Sec. 2, T. 50 N, R. 44 W.
- Sub. 2. Beaver Meadow along Little Carp River, Sec. 34, T. 51 N., R. 43 W.
- Sub. 3. Little Carp River, Sec. 34, T. 51 N., R. 43 W.

5. THE BIOTA CONSIDERED BY STATIONS.

Station I. The beach of Lake Superior at the point studied is composed of outcropping strata of sandstone tilted at a considerable angle, Fig. 4. The nature of this shore has an important effect on the conditions of the beach. The effect of the beating of the waves of a lake is to cut into the shore as a horizontal saw. If the strata of this shore were perpendicular, the material would fall away from the face of the cliff as it was undermined, and the cliff would be vertical. The strata are inclined, however, so that as the lower part of the shore is cut into, the rock is removed more slowly, in blocks determined by the joint and bedding planes, Fig. 4. The edges of the truncated

strata form the bottom of a wave cut terrace off shore and determine the breaker line, Fig. 7. The submerged edges of these strata continue to be worn off by the abrasion of the material carried by the undertow until the surface of the terrace is more or less uniform.

On account of the exposure and the difficulty of obtaining a foothold, the environmental conditions are very severe, and the biota is limited both in individuals and species. The beach has been divided by physiographers into three parts, the Upper, Middle, and Lower Beaches, according to the influence of the hydro-dynamic factors. These factors, as Cowles ('99, pp. 112-175, and '01, pp. 56-57) has shown, have an important influence upon the environment of plants, so that the beach may be divided into the same divisions for our present purpose.

The Lower Beach is that portion of the shore exposed to the action of the waves during the summer months. At the point studied, Station I, owing to the dip of the strata, the water deepens rapidly off shore, and the breaker line is brought near to the beach, the lower part of which is thus exposed to the full force of the waves, Fig. 5. Exposed as it is alternately to the pounding of the waves and dessication in the sun the conditions are so severe that very little life can exist. The only form that is found here is the snail *Limnaea decollata* that occurs occasionally behind projecting outcrops, where it is to some extent protected from the direct force of the waves. This snail seems to be adapted to habitats of this nature, for it was found elsewhere only in rapid water in the larger rivers (Ruthven, '04, p. 192).

The Middle Beach lies above the Lower Beach and differs from it in not being exposed to the summer waves. It is, however, exposed to the action of the waves during the early winter months, while during the latter part of the winter the ice is shoved upon it in great ridges. It is thus, only during the growing season free from those conditions which make the Lower Beach practically uninhabitated, but certain conditions still make the habitat unfavorrable. Owing to the difficulty in gaining and retaining a foothold, the vegetation consists principally of lichens, *Lecidea lactea* and *Parmelia conspersa*, that are not dependent upon the substratum for nourishment. Along the exposed edges of joint and bedding planes, where disintegration is more rapid, a slight soil accumulates, Fig. 6. These crevices, as may be seen from the photograph, are taken possession of by several of the higher plant forms, but, owing to the short period that this beach is not exposed to the pounding of the waves, only the hardier plants can obtain a foothold, such as the Beach Pea,* Silvery Cinquefoil, Goldenrod, Pale Spiked Lobelia, Harebell and a few grasses, Fig. 6.

The fauna, probably owing in part to the lack of food, is also limited. The insects are represented by the butterflies, *Argynnis atlantis, Phyciodes tharos, Grapta gracilis, Grapta progne, Basilarchia arthemis*, and *Colias philodice*, and the dragonflies, *Aeschna clepsydra* and *Sympetrum costiferum;* forms that also occur on the Upper Beach. The spiders are more characteristic; *Epeira trifolium* and *patagiata* and *Linyphia phrygiana* spin their webs behind the outcropping strata, while *Pardosa lapidicina* runs about over the rocks. The destruction of this rock beach will probably destroy the habitats of these spiders, especially of those that spin webs, as it would be impossible for them to attach their webs on a sandy beach. The butterflies on the other hand are dependent upon the flowering plants, which are essentially crevice forms, so that their habitats would be increased by the comminution of the beach.

*All plant names in this report follow Britton's *Manual of the Flora of the Northern States and Canada*, 1901.

There are numerous pools on this beach, Fig. 6, in the angular spaces formed by the removal, presumably by ice, of portions of rock between the joint planes. These pools are, as a rule, above the reach of the highest waves, so that during the summer they are not flooded by the cold water of the lake. Their temperature is thus higher than the lake water. In several readings taken August 6, 7 and 8, the temperature of the water in these pools varied from 60° F. to 68° which was 10° higher than the lake water as it broke on the lower beach. The vegetation in these pools is very scanty, consisting chiefly of Algae which line the sides. The small number of species is probably due to their isolation and shallowness (6 to 18 inches), and to their smooth sides which make it difficult for the plants to gain a foothold. The fauna is much better represented than the flora. Besides a number of minute forms such as Crustaceans, Hydra, etc., there are a number of the higher aquatic forms characteristic of quiet water habitats. The insects are represented by water-boatmen, water-striders, and caddis-fly larvae, and the snails by *Physa ancillaria, Limnaea desidiosa, Planorbis parvus* and occasionally, near the Lower Beach by *Limnaea decollata*. These forms are found in all of the larger pools with the exception of *Limnaea decollata* which only occurred in the lower pools that are occasionally flooded by the waves. When these pools are flooded by an exceptionally high wave, they are often temporarily united with the lake and with each other which suggests a way by which certain forms may migrate along a shore of this kind. With the destruction of this beach these pool habitats will be destroyed, as pools of this kind cannot exist on a sandy beach.

The Upper Beach is above the reach of both summer and winter waves, and the environmental conditions are consequently more favorable than those of the Lower and Middle Beaches. The principal factor that still makes the habitat an unfavorable one for plants is the poor foothold afforded by the substratum. The soil, however, increases in amount at the edges of the joint planes thus affording a foothold for small trees and shrubs, Fig. 6, and to this soil is added a small amount of humus formed by decaying logs and annuals. Owing to these conditions, the flora presents a curious assemblage of forms. It is composed of the forms of the Middle Beach, Goldenrod, Beach Pea, Vetchling, Lobelia, Hare-bells, etc.; the fern, *Polypodium vulgare;* the heaths represented by the Bearberry, Great Bilberry and Dwarf Huckleberry that constitute the next society, and a number of trees and shrubs such as the Arbor Vitae, Mountain Maple, Mountain Ash, Large-leaved and Quaking Aspens, Juneberry, Eastern Ninebark, Dwarf Cherry, Wild Raspberry and Canadian Buffalo-berry, that in this region form a transitional zone between exposed habitats and the mesophytic forest. The fauna of this beach is in many respects similar to the fauna of the Middle Beach from which it cannot be distinctly separated. The forms found here which are not, as a rule, found also on the Middle Beach are the grasshoppers *Camnula pellucida, Circotettix verruculatus, Melanoplus atlanis* and *Melanoplus femoratus*, and the Lake Superior Chipmunk. The grasshoppers, as a rule, remain closely within the limits of this beach, with the exception of the forms of *Melanoplus* which are occasionally found also on the Middle Beach. The chipmunks are also seldom observed far from the drift logs that characterize this habitat.

The beach as a whole is thus, in a general way, divided into three habitats by the dominance of different processes which bring about different enviromental conditions, but these divisions, as may be seen from the photographs, are not sharply defined. The Lower Beach in general possesses



FIG. 6. Showing nature of the rock pools, crevice vegetation and lichens (white patches) of the Middle Beach, and the stunted crevice vegetation of the Upper Beach, station I.



FIG. 7. General character of the rock beach, breaker line off shore, station I.

little life, but near the upper limit of summer wave action a few straggling annuals come in that characterize the Middle Beach above, while near the upper limit reached by the winter waves and ice a few perennials of the Upper Beach occur. The biotic tension lines between these divisions also undergo occasional fluctuations, since the position of the tension line between the Lower and Middle Beaches is determined by the severity of the summer storms, while between the Middle and Upper Beaches it is determined by the height of the winter waves and ice.

Owing to the action of the waves, the beach as a whole is retreating inland, but as it retreats a wave cut and wave deposited terrace is being formed, and this by shallowing the water carries the breaker line off shore and lessens the effect of the waves, as illustrated in Fig. 7. The conditions of the Lower and Middle Beaches thus become more favorable, resulting in a progessive downward movement of the biota of the Middle and Upper Beaches respectively that decidedly narrows the beach zones.

On the other hand, the sinking of the coast in this region counteracts, in places, the tendency of the submarine terraces to decrease the efficiency of the waves. The deepening of the water near shore caused by this sinking of the coast brings the breaker line nearer shore, thus increasing the efficiency of the waves to such an extent that the beach habitats are being forced back into the adjacent swamps.

Station II. Substation 1. Back of the beach, at the foot of the first range, there often extends for considerable distances a narrow belt of arbor vitae swamp. This swamp owes its origin, according to Wright ('05, p. 37), to the general sinking of the beach of Lake Superior referred to in the discussion of the previous station. Gilbert ('97) in a discussion of this problem states that a general canting or tilting of the Great Lake Basins toward the southwest is taking place, as is indicated by the inclination of the beach lines of post-glacial lakes and by the drowned mouths of the rivers along the coast. It is evident that the rivers of the Porcupine region are drowned, as they are widened near their mouths into broad estuaries with adjacent swamps, and evidence that the tilting of the lake basin that is causing this is going on at the present time may be found in the submergence of standing trees along the lake shore, and in the discrepancy in the length of the section lines between different surveys, (Wright, '05, p. 37).

This sinking of the coast makes the conditions of a narrow zone just back of the beach too wet for some of the mesophytic forest forms that occupy the higher parts of the ridge, but at the same time it makes the conditions favorable for some of the forms of the arbor vitae swamp, so that this area is inhabited by certain forms characteristic of each of these habitats. The tree cover consists principally of the Arbor Vitae, with considerable Balsam Fir and some White Spruce and Paper Birch; the soil cover is characterized by the Running Pine, *Lycopodium clavatum*, and occasional clumps of Blue Flag. The molluscan fauna is very poorly represented, and the only shells collected were a few specimens of *Punctum pygmaeum* and *Zonitoides milium*. A single spider was taken here, *Dolomedes tenebrosus*. The mammals are those of the forest, such as the Southern Varying Hare, Southeastern Red Squirrel, etc., with the exception of the Lake Superior Chipmunk which was occasionally seen near the beach.

If the coast continues to sink, this swamp will approach more closely the conditions of the swamps of the river valleys and will become occupied more exclusively by the biota of the ordinary arbor vitae swamp, while

at the same time it will tend to retreat before the beach and invade the areas at present occupied by the mesophytic forest of the north slope.

Station II. Substation 2. Above the arbor vitae swamp, the north slope of the first range rises steeply to the top of the ridge and is covered by a dense mesophytic forest. The angle of this slope and the fact that it is formed by dipping strata, makes the drainage so rapid that the soil on the upper part tends to be washed downward and to accumulate at the bottom. The humus formed by the fallen twigs and leaves of the forest prevents in part superficial wash, and most of the water, for this reason, is conducted away under ground. The ravines are thus small and the streams transient. The lower parts of the slope support a dense hemlock forest in which there is deep shade, Fig. 8. The tree cover of this part of the forest consists principally of Hemlock associated with the Balsam Fir, Ironwood, Yellow Birch, isolated White Pines and a few Sugar Maples. The undergrowth of Ground Hemlock and Maple is very scanty, and the humus is thus composed chiefly of leaves and twigs of the Hemlock with the exception of localized accumulations of deciduous leaves from the maple underbrush. The soil cover is also scattered and is composed of the Large-leaved Aster, Wild Sarsaparilla, Twinflower, Goldthread, Maidenhair Fern, Wild Spikenard, Rattlesnake Plantain, Dwarf Dogwood, *Clintonia borealis*, and *Lycopodium lucidulum* and *clavatum*.

The fauna of the hemlock forest is also rich in species. Besides many insects and other invertebrates, there are a number of birds and the toad (*Bufo americanus*). The mammals are represented by the Canadian Porcupine, Northern Virginia Deer, Northern Plains Skunk, Woodchuck, Southeastern Red and Northern Flying Squirrels, Northeastern Chipmunk, Star-nosed Mole, Large Bobtail Shrew, and the Northern and Woodland Jumping, Canadian White-footed and Red-backed Mice. Owing to the predominance of conifers, it is to be expected that few shells would occur in this forest, but the accumulated leaves of the maple underbrush counteract the unfavorable nature of the coniferous humus and support a somewhat scattered molluscan fauna composed of *Zonitoides milium, Vitrea ferrea, Euconulus fulvus, Punctum pygmaeum, Helicodiscus lineatus, Strobilops virgo, Zonitoides exigua, Sphyradium edentulum, Carychium exile*, and *Agriolimax campestris*.

On the upper parts of the slope, the soil becomes thinner, and there is a noticeable change in the character of the forest. It is still mesophytic, but the Hemlock, Balsam Fir, Ironwood and Yellow Birch give way to a forest composed of the Sugar Maple, Basswood, and Paper Birch, in which the Sugar Maple predominates. This transition is gradual and while near the top of the ridge the Ironwood and Yellow Birch are practically absent, the Hemlock and Balsam Fir may still persist. The undergrowth in this part of the forest is much better developed, Fig. 9, and consists principally of Maple, Basswood and Ground Hemlock. The ground is covered to a depth of several inches with leaves, and the soil cover, although better developed, is practically the same as in the hemlock forest except that the Large-leaved Aster, Indian Pipe and Goldthread seem to become replaced by *Cinna latifolia*, White-flowering Raspberry, Fly Honeysuckle and Brake.

The changes in the environmental conditions with which are associated the changes in the composition of the flora toward the top of the slope do not seem to influence the fauna to a marked extent. As the tree cover is principally affected, the most marked change in the fauna is seen in the case of the birds, which are more closely associated with this type of vegetation.

Another change is the occurrence, on the upper part of the slope, of the Red-bellied Snake, *Storeria occipitomaculata*, which prefers dry, rather open woods. With the coming in of the deciduous forest, the humus becomes composed of leaves, and with this change in the nature of the humus is associated an increase, at least in the number of individuals, of molluscs. When the fallen leaves are examined, they are found to be connected by a film of water. Among these leaves seemed to be the favorite habitat of all the snails collected in these woods. The forms collected are *Zonitoides exigua Zonitoides arborea*, *Vitrea ferrea*, *Euconulus chersinus polygyratus*, *Helicodiscus lineatus*, *Punctum pygmaeum*, *Cochlicopa lubrica morseana*, *Sphyradium edentulum*, *Pyramidula striatella catskillensis*, *Strobilops virgo*, *Polygyra albolabris*, *Vitrea indentata* and *multidentata*.

It has been suggested (Whitford, '01, p. 301) that the presence of isolated White Pines in the mesophytic forest indicates a former dominance of xerophytic forms. This at once suggests an explanation for the origin of the present biota that is in accordance with the observed facts. When the waters of the glacial lakes receded and left the mountains exposed to denudation, the wash on this slope must have been considerable. The vegetation that first gained a foothold was probably a society analogous to that on the Middle Beach at the present time. These forms would be followed, as the conditions became favorable, by the heath society of the Upper Beach. At the bottom of the slope where the soil was thicker and the superficial wash less, the heaths were probably soon succeeded by the conifers that usually follow the heaths in this region. With the accumulation of humus in the coniferous forest, the superficial wash would become less, while the soil formed on the higher parts of the ridge would be held in front of the forest, permitting the coniferous types to ascend the slope and restrict the area occupied by the heaths.

As the coniferous forest became well developed at the bottom of the slope, owing to the more favorable edaphic conditions brought about by the accumulation of humus, the pine seedlings which require considerable light would no longer be able to develop. The seedlings of the deciduous trees, Maple, Basswood, Hemlock, etc., which would find a favorable habitat in the increased shade and humus of this forest, would then invade the coniferous forest as underbrush, so that, as the pines died off, they would be replaced by the forms of the present forest.

The fauna of this slope would have a history similar in many respects to that of the flora. If the slope was first invaded by the heath plants, it was probably at the same time invaded by the fauna that is associated with this society; a relation which would also hold in the case of the succeeding societies.

The conditions to which the forms in the different societies are adapted, or the habitats, would thus tend to migrate up the slope from the point of invasion, and the mountain top would be the scene of the extinction of the pioneer societies, the last place where they would be found. Since the mountains were islands for some time after the retreat of the ice sheet, the level at which this invasion of life took place presents an interesting question. Evidently it must either have taken place above one of the old beach lines while the mountains were yet islands, or after they had been joined to the main land by the subsidence of the lake. In the latter case, the invasion would have come in near the base of the mountains, as they are entirely surrounded by a low plain, but in either case the succession of societies would have been much the same, with the exception that in the former

case the migration of the societies would also have taken place down the slope, following the receding lake beach.

Station II. Substations 3 and 4. These substations are located in an artificial clearing and will not be discussed. The species that occur here will be found in the annotated lists.

Station II. Substation 5; and Station III. The north slope of the first range rises directly to the top of the ridge at an elevation of about 900 feet. Over the crest there is a sharp descent of several rods to the brink of the precipitous escarpment that overlooks the valley of Carp river, Fig. 10.

The effect of the dynamics of the mountain top are very conspicuous. The exposed rock is unprotected from the forces which cause disintegration, for as fast as it is broken up the particles are washed away, and thus the first soil to accumulate is in the exposed edges of joint planes. The soil washed down the north slope on Section 21, Fig. 11, is checked and held in front of the forest, which advances as the soil becomes sufficient to support it. On Sections 13 and 14, Fig. 10, the forest has advanced to the crest so that no soil from the bald areas is washed down the north slope. The soil formed on the south side of these areas, meeting with no obstruction, is washed over the precipice and accumulates in a narrow strip along the top of the talus slope, while that which is washed laterally from the top into depressions in the crest is also checked to a certain extent by the encroaching forest. The concentration of water in these inequalities causes them to be deepened into ravines, situated at right angles to the crest, and much of the material derived in this way is carried over the cliff and deposited as alluvial cones on the talus slopes below; these alluvial cones join the ravines above forming broad saddles across the ridge, Fig. 10. The face of the cliff is also exposed to weathering agencies that tend to pry loose portions of the rock between the joint planes. The larger fragments fall to the bottom of the cliff and go bounding down the talus slope, often starting minature landslides of the talus material. The slope thus lies at the angle of repose of the material and is very unstable, Fig. 17. As a rule, the larger the fragment the farther down the slope it will go before coming to rest, and the strip of fine material at the top of the slope, which was formed partly from the soil washed over the cliff from the bald areas above, receives constant additions from the fine material that is loosened from the cliff face. Toward the bottom of the slope, the conditions become more stable, and the talus blocks are being disintegrated and decomposed into a residual soil. The mountain top, cliff, and talus slope habitats thus offer virgin conditions for plant and animal societies, and it is in localities such as these that the pioneer societies are found.

If the results of the processes at work on this ridge be summarized, it is evident that they are tending to lower the ridge toward a base leveled plain, thus changing the present conditions toward those found on the lower parts of the north slope.

Station II. Substation 5; and Station III. Substations 1 and 4. The biota of the north slope of the first range, pushes through the saddles and down the alluvial cones on the south side and mingles with the biota of the forest in the valley of Carp River, Fig. 10. From the north side and the saddles it extends upward and surrounds on three sides the bare areas of the higher parts of the ridge, but, owing to the changed environmental conditions, it becomes modified in its composition near the crest. The Hemlock and Balsam Fir and finally the Sugar Maple become replaced by a zone of aspen and oak, consisting principally of the Quaking Aspen, Paper Birch, Red and



FIG. 8. Hemlock forest, showing dense shade and lack of undergrowth, station II. 2.

Burr Oaks, associated with the Mountain Maple, Large-toothed Aspen, Mountain Alder (*Alnus alnobetula*), several willows and scattered Red and White Pine. The underbrush and soil cover of this zone is composed of *Polypodium vulgare*, Juneberry, Scarlet Sumac, Bush Honeysuckle, Eastern Ninebark, Great Bilberry, Round Leaved Dogwood, Dwarf Cornel, Narrow-leaved Cow-wheat, Low Snowberry, *Polypodium vulgare*, and *Lycopodium clavatum, complanatum* and *selago*; *Linnaea americana* may also be mentioned.

Higher up the mountain the soil cover becomes replaced by the Bearberry, Dwarf and Low Black Blueberry, New Jersey Tea, and Creeping Wintergreen. The White Pines still persist, but the shrubs mostly disappear, and the oaks and aspens associated with *Juniperus nana* become very scrubby, often forming small mats on the slight soil, Fig. 12.

As in case of the vegetation, the range of many of the animals of the mesophytic forest reaches an upward limit in the aspen zone, where they occur mingled with other forms that replace them on the bald areas. Thus the molluscs become noticeably fewer in individuals in this zone; *Zonitoides exigua, Cochlicopa lubrica, Vitrea ferrea, Euconulus fulvus, Helicodiscus lineatus and Carychium exile* seem to drop out of the fauna entirely, while *Punctum pygmaeum, Sphyradium edentulum, Zonitoides milium* and *arborea*, and *Strobilops virgo*, by changing their habitats from the damp fallen leaves of the mesophytic forest to the dry soil held by the heaths, are able to persist. Mingled with these forms was found for the first time *Bifidaria curvidens*. Similarly the only grasshopper that occurs in the mesophytic forest (*Tettix*) is replaced in the aspen zone by *Melanoplus luridus, fermoratus* and *islandicus, Chloealtis abdominalis* and *conspersa*, and *Camnula pellucida*, while the Northeastern Chipmunk, Northern Plains Skunk, Woodchuck, and the woodpeckers, owls, chickadees, nuthatches, etc. are mostly replaced by the Lake Superior Chipmunk, Junco, Robin, and Bluebird. The smaller mammals such as the mice, moles and shrews seem to persist without noticeable diminution in abundance.

Station III. Substations 2, 5 and 6. On the mountain top beyond the limit of the aspens and oaks, the biota is composed almost exclusively of the forms that appear in the upper part of the aspen zone. The heaths, represented by the Bearberry and Creeping Wintergreen, with the Dwarf and Low Black Blueberry and New Jersey Tea, form a large dense mat beyond the aspen zone, that extends in long tongues along the crevices on the bare top, Fig. 11. On the denser portions of this mat occur widely scattered White and Red Pines with many dead stumps, Fig. 13.

On the bare mountain top, the flora consists only of the lichens, *Lecidea lactea, Lecanora conspersa* and *cinera, Parmelia conspersa*, and *Stereocaulon coralloides*, on the surface of the rock, and a crevice vegetation of Harebell, Three-toothed Cinquefoil, Wild Wormwood, Evening Primrose, *Panicum xanthophysum, Polypodium vulgare, Polystichium lonchitus, Asplenium trichomanes*, and *Solidago bicolor, lanceolata, juncea* and *erecta*.

The molluscs, *Punctum pygmaeum, Euconulus chersinus polygyratus, Zonitoides milium, Strobilops virgo, Vitrea indentata* and *Bifidaria curvidens*, that characterize the upper part of the aspen zone, also occur in the larger heath mats, associated with *Acanthinula harpa*. *Bifidaria curvidens* greatly predominates in this fauna. Dead specimens of *Helicodiscus lineatus* and *Succinea avara* are often found in the rock crevices near the brink of the cliff, but these were probably blown here as they could hardly exist in this habitat, being moisture loving forms. The characteristic insects of this station are the dragonfly, *Sympetrum obtrusum*, the butterflies, *Argynnis cybele*,

Thecla edwardsii, and the grasshoppers, *Chloealtis abdominalis* and *conspersa*, *Melanoplus fasciatus*, *amplectens* and *islandicus*, *Circotettix verruculatus*, and *Atlanticus pachymerus*.

The Cliff. Owing to the precipitous nature of the cliff, the rock fragments are removed as fast as they are split off the parent rock, and the environmental conditions of the cliff face remain uniformly severe. The only vegetation that can exist consists of the lichens, *Gyrophora* (*Umbilicaria*) *vellea*, *Amphiloma* (*Pannaria*) *languinosum*, and *Biatora lucida*, that manage to obtain a foothold on the face of the rock, but these are invariably destroyed as the rock weathers away. On the ledges, however, where the conditions are more permanent, a number of plant forms may gain a foothold, the extent of the vegetation depending upon the age and size of the ledge. On the fresher ledges the only plants are the lichens, among the representative forms of which may be mentioned *Stereocaulon coralloides*, *Parmelia conspersa* and *Lecidea lactea*. Where a slight soil has accumulated, the Harebell, *Panicum xanthophysum*, *Polystichium lonchitus*, Three-toothed Cinquefoil, and Goldenrods may occur. While on the larger ledges, which often possess several inches of soil, the Bearberry, New Jersey Tea and other forms of the heath society, together with the Juneberry, White and Red Pine, *Juniperus nana*, Arbor Vitae and Northern Poison Oak may obtain a foothold, Fig. 14.

The fauna of the cliff face is also very limited. The ledges are too small to support a characteristic fauna, but ants grasshoppers and dragon-flies are often found here. The butterfly, *Grapta gracilis*, was occasionally seen in considerable numbers on the cliff face, but the only animal that can be said to be characteristic of this habitat is the Raven which nested here.

Station III. Substation 3. Where the cliff is broken by large ledges, Fig. 15, the conditions are more stable, and the vegetation consists principally of a growth of Red and White Pine and an undergrowth of Reindeer Lichens and heath plants, that extends up the cliff and across the mountain top. Where these belts of pine join the mesophytic forests of the north slope and river valley, the undergrowth is predominated by the Sugar and Mountain Maples and Quaking Aspen. The fauna of these belts is peculiar. Although the Pine Warbler and Crossbills are often seen here, the belt is too small to support an extensive pine forest fauna, while at the same time it is, perhaps, the deposit of pine needles that excludes the molluscs of the mountain top and mesophytic forest.

Talus Slope. Where the precipice is not broken by large ledges, the fragments of rock that weather from its face fall to the talus slope below. The finer material collects along the top of the slope, at the foot of the cliff, and supports a vegetation composed of a number of species, Fig. 10. Among the more prominent of these are the Thorn Apple, Red Oak, Quaking Aspen, Wild Red Cherry, Round-leaved Dogwood, Juneberry, Bearberry, New Jersey Tea and scattered White and Red Pine. Below this zone the talus slope is strewn with dead wood and recently fallen trees, mostly pines, Fig. 16. Where the cliff is composed of trap, Substation 6, the blocks which fall from its face are large, and the talus slope is practically devoid of vegetation with the exception of scattered patches of lichens, principally *Parmelia conspersa*, Fig. 17. Where the cliff is composed of sandstone, the talus material is finer and often supports a scattered vegetation of White and Red Pine, Paper Birch, Wild Cherry, Northern Poison Oak, and Virginia Creeper. Toward the bottom of the slope, the first vegetation that occurs are the lichens, principally *Lecidea lactea* and *Parmelia conspersa*, the latter

predominating. These forms cover more or less completely the surface of the talus fragments. Farther down *Stereocaulon coralloides* and *Lecanora conspersa* are added to this society which is dominated on the lower part of the slopes by the Reindeer lichens, *Cladonia rangiferina* and *alpestris*, that often occur superimposed on the remains of the other lichens. These are replaced toward the bottom of the slope by the Bearberry, New Jersey Tea, *Polypodium vulgare*, Raspberry, Wild Red Cherry, Mountain Maple, Paper Birch, Quaking and Large-toothed Aspens, Beaked Hazelnut, Blackberry, Brake, and Bush Honeysuckle, that in turn give way to the typical mesophytic forest forms of the river bottom.

The environmental conditions as regards the fauna are more unfavorable than on the mountain top. The only forms that are found here are a few ants in the narrow zone of vegetation at the top, and occasional grasshoppers and dragon-flies on the bare slope below. Near the bottom of the slope the Lake Superior Chipmunk was often seen running about over the rocks and among the bushes that fringe the forest. Forms from the mesophytic forest of the river valley such as the Garter Snake and Northeastern Chipmunk are also occasionally seen here.

When the biota of the mountain top and north slope are listed by habitats, the genetic explanation suggested for the forest of the north slope is enforced. It is evident that certain groups of forms are, in a general way, dependent on certain environmental conditions. The action of the forces which bring about these conditions tend to modify those that exist at any one time, so that the biota must adjust itself to the new conditions or be exterminated. This is especially noticeable on an elevated area. It was shown in the discussion of the topography that the effect of physiographic processes on the ridge in question was to reduce it to a base-leveled plain. The environmental conditions are thus being changed and modified in the direction of the conditions that prevail on the lowland at the foot of the mountain. These conditions are brought about first on the lower parts of the ridge, so that the habitats of the lowland biota are extended at the expense of cliff habitats, and correlated with the changing conditions a succession of societies occurs. This may be easily seen from the top of the ridge, Fig. 11. The first plants to get a foothold on the bare rocks are those of the lichen society such as *Lecidea lactea* and *Parmelia conspersa*, that form large patches over the exposed rock surfaces. The wash and decay from these mats is at first mostly washed away down the slopes. As soon, however, as the processes of weathering have opened the edges of the joint planes, the soil accumulates in them and with it a small amount of organic material from the lichen mats. The conditions thus become favorable for a crevice vegetation consisting of certain mosses, the Harebell, Cinquefoils, Goldenrods and grasses. As the soil, held in the crevices by the plant roots, increases in amount, the conditions become still more favorable, and the crevices are invaded by the heaths from the extensive mat that surrounds the mountain top on three sides, in front of the mesophytic forest. The dense mats formed by the heaths do much to make the edaphic conditions more favorable by holding the soil as it is formed, checking that which is washed from higher areas, and by accumulating the humus formed by the decay of the vegetation.

The first society to gain a foothold on the lichen mat is represented by the White and Red Pines, and the next by the forms of the aspen zone. In many instances, the Quaking Aspen, which is one of the hardiest plants of this zone, follows the heaths along the crevices before the pines can obtain a foothold, but in any case the pine stage is but poorly represented, probably owing

largely to the exposure of this habitat to wind, Fig. 12. The aspen zone is in turn succeeded by the biota of the mesophytic forest type. This succession prevails on the north, east and west sides of the crest. On the south side, owing to the presence of the precipice, the soil accumulates only to a slight extent and the succession only progresses as far as the heath or pine stage. The biota of the cliff and upper part of the talus slopes are not in the succession, for owing to the fact that the material is removed nearly as fast as it is formed, the conditions remain practically the same, and the forms only gain a temporary foothold. It is true that on the ledges there is a more or less definite succession of societies leading up to the pine stage, but it rarely proceeds beyond this stage, while it is liable to be destroyed before this stage as is shown by the debris that accumulates on the talus below. The biota of these habitats is evidently derived from the mountain top. A large percentage of the seeds of the vegetation on the south side of the crest is washed over the cliff with the soil. Many of the ants and snails of this area probably have a similar fate, while it is a common sight to see grasshoppers on the mountain top caught by the wind, when on the wing, and carried over the precipice to light on the talus slope below. The biota of the narrow strip of finer material at the top of the talus slope, owing to the more favorable soil conditions and the shade furnished by the cliff, is composed of forms that occur in the pioneer societies both on rock and soil habitats, and it is thus a complex pioneer society. The strip of finer material is only formed at the foot of the cliff and migrates with it, leaving its lower edge to be covered by the larger talus blocks as the cliff retreats. The biota thus becomes practically destroyed, and the conditions change toward those of the talus slope. At the foot of the talus slope the conditions are nearly the same as on the mountain top. The pioneer forms are the lichens that cover the rocks and hold the material as the rocks disintegrates. The soil that is formed accumulates rapidly among the talus blocks and becomes in time sufficient to support the reindeer lichen society. As the soil continues to increase, the forms of the heath society push onto this mat, followed in turn by the climax forest society, the pioneer forms of which generally extend well up the slopes. The most prominent form among the pioneers of the climax forest on the talus slopes is the Paper Birch, broken and twisted individuals of which are often found well within the range of falling rock fragments. As Harvey ('03, p. 37) has suggested for Mt. Ktaadn, it seems to be adapted to this habitat by its flexibility.

There is thus a series of lowland societies steadily encroaching on the cliff habitats from all sides, as the physical processes reduce the ridge toward sea level. The order of succeeding societies is generally the same in a particular region. Cowles ('01) and Whitford ('01) both give the pine stage as generally following the heath society in northern Michigan, but on the cliff habitats in the Porcupine Mountains, owing to the effect of the wind and the shallow soil, the coniferous society may be nearly, if not entirely, left out of the succession. In this case, an entire stage in the order of succession is made impossible by a particular combination of the environmental conditions, and the fact is enforced that habitats are composed of a complex of physical conditions. This is further shown by the dwarfed nature of the aspens and oaks that border the "bald" areas. These trees often grow as shrubby mats, owing to the breaking off of their tops by the wind. This is undoubtedly due indirectly to the presence of the escarpment, for on higher ranges to the south, which possess no escarpment, the mesophytic forest covers the highest peaks with no noticeable decrease in the size of the trees.



FIG. 9 Deciduous forest, showing character of undergrowth, station II. 2.

The fate of the pines on the exposed top of this ridge, the scrubby nature of the aspens and oaks, and the fact that the tops of a large percentage of the living pines are dead, suggests that the timber lines on some mountains may be greatly influenced by wind.

Station IV. Substation 3. Beyond the limit of the falling rock fragments on the talus slope, where the rocks have been disintegrated and decomposed to form a soil, the Paper Birch, Mountain Maple, Aspen and Mountain Ash become mixed with the Sugar Maple, Balsam Fir and Basswood, that gradually predominate to the exclusion of the Aspen and Mountain Ash. In the forest near the bottom of the slope, Hemlock forms a part of the tree cover and occasionally predominates to such an extent that a hemlock forest results similar in composition to the hemlock forest at the foot of the north slope. More often, however, the Sugar Maple predominates in this forest, associated with the Balsam Fir, Basswood and Ironwood, with scattered Hemlocks, and White Pines, thus making it similar in composition to the mesophytic forest of the north slope with which it is connected through the saddles. The ground cover and fauna are also practically the same and need not be listed.

Station IV. Substation 2. Owing to the flat nature of its valley, Carp river above Carp Lake is a slow meandering stream that is doing practically no vertical cutting, Fig. 18. It is easily turned from side to side, and, as it is deflected toward one side of its valley, it tends to cut into it, while on the other side of the bend, owing to the decrease in the velocity of the current, part of the load is deposited to form mud flats. The river thus tends to broaden its valley at the expense of the neighboring divides and to build up its flood-plain with a part of the material derived in this way. The material that is not deposited on the mud flats is carried on until the stream reaches Carp Lake, where again owing to its diminished velocity, the stream deposits much of its load in the lake, forming a large delta at the mouth of the river. On the flood-plain of the river, Fig. 18, the deciduous forest either gives way to a coniferous society characterized by the Tamarack, Spruce, Arbor Vitae and Black and White Ash, which in turn grades toward the river into an extensive alder thicket, or, where the valley is narrow, the coniferous society may be nearly or entirely absent, and the hardwood forest grade directly into the shrub society. The shrub society is largely composed of the Hoary Alder (*Alnus incana*) associated with several willows, occasional Tamaracks, and scattered clumps of Red-osier Dogwood. The undergrowth in these thickets is not extensive; among the more noticeable forms are the Skunk Cabbage, Sensitive and Cinnamon Ferns, Skull Cap, and several species of violets.

The fauna is characterized by a great increase in the number of birds; the warblers and sparrows are especially conspicuous. This is also the habitat of the Red Backed Salamander (*Plethodon cinereus*) and the Wood Frog (*Rana sylvatica cantabrigensis*). For some undetermined reason, the molluscs seem to be very poorly represented in this society.

Between the alder thickets and the river, in the broader portions of the valley, there is often a well defined zone of vegetation characterized principally by the Dwarf Cassandra. Between the two societies the Hoary Alder and Dwarf Cassandra occur mingled with the Wax Myrtle, High Bush Blackberry, American Meadow Sweet, and Few Flowering Cranberry. Toward the river, the Hoary Alder, Willows, Red-osier Dogwood and Tamarack occur only in scattered clumps among the Cassandra that forms a low dense thicket. Less prominent but conspicuous forms in this society are the Pale

St. Johns Wort, Joe Pye Weed, Swamp Milk Weed, Running Swamp Blackberry, Marsh Cinquefoil, Ladies Tresses, Marsh Bell Flower, Creeping Snowberry, *Solidago uliginosa*, and a number of grasses and sedges among which are *Eriophorum cyperinum, Calamagrostis canadensis, Deschampsia flexusa, Panicularia canadensis, Scirpus cyperinus, Carex viridula, riparia,* and *filiformis*. Owing to the low height of these forms, the habitat is open, and the fauna is similar in many ways to the fauna of the mountain top, but, owing to its proximity to the river, several new forms are added. The more characteristic forms are the butterflies, *Argynnis cybele var.* (near *leto*), *Argynnis atlantis* and *Basilarchia arthemis;* the dragon flies, *Gomphus spicatus, Lestes unguiculatus, Calopteryx aequabilis* and *Sympetrum obtrusum*, and the grasshoppers, *Atlanticus pachymerus, Stenobothrus curtipennis, Podisma glacialis, Melanoplus islandicus* and *Scudderia pistillata*. It might be expected that this habitat would be favorable for reptiles and amphibians, but while it is the habitat of the Garter Snake, *Thamnophis sirtalis sirtalis*, the dense entangled nature of the vegetation apparently excludes the frogs.

The cassandra zone extends only to the river bank, where it generally mingles with a narrow zone of alders on the low natural levees, but a number of grasses and sedges, *Juncus effusus, Calamagrostis canadensis, Scirpus cyperinus, Dulichium arundinaceum, Carex filiformis, viridula* and *riparia*, push out on the mud flats to the edge of the water, Fig. 19, and form a transition society between the cassandra zone and the aquatic forms of the river.

The fauna of these flats is also transitional between the aquatic and terrestrial habitats. This is illustrated by the presence of the turtle, *Chrysemys marginata*, and the frogs, *Rana clamitans* and *septentrionalis*, which are amphibious and thus intermediate in habits between the two habitats. The birds are the waders and shore birds that find their food here; among these may be mentioned the sandpipers, snipes, herons, and bitterns. Although by no means limited to this habitat, and to be more properly listed with the fauna of the mesophytic forest, the Canadian Porcupine is a conspicuous form on these flats where it may often be seen, singly or in groups of two or three, feeding on the pads of the water lilies.

Owing to the steepness of the sides of the valley, the entire succession of societies is only found in the broader parts, for where the river swings toward the side of the valley the flood-plain is destroyed, and the cassandra, alder and coniferous societies are all limited to a single narrow zone between the river and the deciduous forest.

If the different flood-plain societies be compared with the succession of forms in a tamarack swamp as given by Transeau ('03, pp. 403-404), a remarkable similarity will be revealed. The societies that occur in the bogs of more southern localities are here spread out over the entire flood-plain of the river, and the tamarack swamps of Indiana, Illinois and southern Michigan are minature reproductions of the flood-plain conditions in this region.

Station IV. Substation 4. There are, however, areas where more typical bog conditions prevail, so that in the wider parts of the valley the bog types may attain a much better development. In these areas, the bog societies are not arranged in concentric zones, as in the southern bogs, but are, as the flood-plain societies, more or less parallel to the river. The succession is much the same as on the flood-plain and in the southern bogs. The sedge zone grades into a zone composed largely of Dwarf Cassandra associated with the Rose, Juneberry, High Bush Blackberry, Wax Myrtle, American Meadow Sweet, Swamp Honeysuckle, and Cranberry, that is in turn followed by a society composed largely of Balsam Fir, Tamarack and White Spruce,



FIG. 10. Escarpment of the First Range, looking west, showing the cliff and talus slope, station III. 5, and Carp Lake, station V, in the distance.

Calopteryx aequabilis, *Aeschna clepsydra* and *Plathemis lydia*, and the Kingfisher, Muskrat, etc.

Station V. Substation 3. The biota of Carp Lake indicates that the environmental conditions are very similar to those that exist in the river above it but are even more pond-like. The fish are the same with the exception of the Horned Dace, which was not found here. The Sucker and Yellow Perch seem to predominate. Toward the shore the bottom becomes covered with vegetation, chiefly *Myriophyllum*, among the leaves of which, especially in the axils, occur the snails, *Amnicola limosa* and *Valvata tricarinata*. This society soon becomes mixed with *Potamogeton natans* that forms a large well defined zone. On the inner margin of this zone, the Tape Grass, *Vallisneria spiralis*, often occurs in extensive mats but does not form a definite zone. The next zone of importance is composed largely of the Yellow Pond Lily that is replaced near shore by the Canada Rush, *Juncus canadensis*, that becomes largely mixed in shallow water with the Scouring Rush, *Equisetum fluviatile*.

Station V. Substation 1. Where this marginal rush zone extends to the shore, the bivalves, *Sphaerium simile*, *Anodonta marginata*, and *Pisidium sp.*, and the univalves, *Planorbis bicarinatus*, *campanulatus* and *deflectus* are found in the silt and on the small stones.

On the fine sand of the narrow beach, *Equisetum hyemale* associated with the Horned Bladderwort (*Utricularia cornuta*), Nodding Ladies Tresses, and Seven Angled Pipewort forms a scattered vegetation behind which comes an alder thicket which is followed in turn by the mesophytic forest types.

Station V. Substation 2. The delta that is being formed by the river at the east end of the lake is similar in many ways to the mud flats along the river and presents similar but more extensive environmental conditions. On the submerged part of the delta, *Juncus canadensis* is mostly absent from the rush society which is extensive and composed principally of *Equisetum fluviatile* associated on the inner margin with *E. hyemale* and *littorale*. These forms are replaced on the area that is ordinarily unsubmerged, by *Dulichium arundinaceum*, *Carex filiformis*, *riparia* and *viridula*, associated on the dryer areas with *Calamagrostis canadensis*, *Scirpus cyperinus*, *Agrostis hyemalis*, *Eupatorium purpureum*. *Deschampsia flexusa*, *Panicularia canadensis*, *Solidago uliginosa*, Swamp Milkweed, Nodding Ladies Tresses, Pale St. Johnswort and Marsh Cinquefoil.

The fauna also shows the similarity between the conditions of this habitat and the mud flats. The dragon flies found here are *Enallagma hageni*, *Nehalennia irene*, *Enallagma carunculatum*, *Ischnura verticalis*, *Hagenius brevistylus*, *Gomphus spicatus*, *Aeschna clepsydra* and *Plathemis lydia* Of these *Enallagma hageni* is the characteristic form and occurs in considerable numbers. The birds, as on the mud flats, are the waders and shore forms such as the Carolina Rail, Great Blue Heron, American Bittern, Solitary Sandpiper and Wilson's Snipe. The nature of the habitat is also shown by the presence of most of the amphibian species of the region. The frogs are represented by *Rana pipiens brachycephala*, *clamitans*, and *septentrionalis*. No turtles were observed, but the Garter Snake, *T. sirtalis sirtalis* was taken several times.

The grass and sedge society passes directly into an alder society without an intervening cassandra zone, and the forms of the alder society are in turn followed by the forms of the deciduous forest.

It was shown in the discussion of the topography that the tendency of an



FIG 11. "Bald" on the top of the First Range, station III. 6, showing the bare rock, heath plants in crevices, scattered pines and stunted aspens that characterize this habitat.



FIG 12. The zone of stunted aspens, station II. 5, surrounding the "bald." The pine stumps show the effect of the wind.

agraded stream is to cut into the sides of its valley, and to build up a plain at its own level by the deposition in its channel of the material derived in this way. It was also pointed out that areas representing different stages in this process are characterized by different biota. Since the process is still going on it is necessary to consider the biota in reference to the changing conditions. The nature of the changes which Carp river produces on the topography is determined by its low gradient and slow current. As it meanders over its flood-plain, the mud flats that are formed on the inner side of the bends are extended into the stream by the deposition of material on their inner margin. The quiet water and favorable substratum on the submerged parts of these flats afford a favorable habitat for the pond or quiet water forms of life. As the deposition of the streams during floods builds these flats above the ordinary level of the river, the conditions become unfavorable for the aquatic forms, which are compelled to migrate outward; at the same time, however, they become favorable for the amphibious forms of the grass and sedge zone that gradually push out and occupy the flat as it becomes dry enough. The continued deposition during floods, and the accumulation of plant remains continue to raise the level of the mud flats, and, as the conditions become dryer, they support successively the cassandra, alder and the deciduous forest types of life. Where the river cuts into the sides of the valley, the flood-plain is destroyed, and its societies are limited to a single narrow zone between the deciduous forest and the river; in this zone, the littoral, cassandra and coniferous societies may be entirely lacking, but the alder society is nearly always represented.

Carp Lake may be considered as the river expanded and covering its flood-plain to the sides of the valley, and the changes that are going on are very similar to those that are being produced by the river. The conditions however, are more pond-like for the current that the river possessed above the lake is lost, so that there is no lateral corrasion. Deposition is going on all about the margin, owing to wash from the sides of the valley and the deposits made at the mouth of the river, so that the aquatic conditions are being changed into the terrestrial in a manner analagous to the development of a mud flat into a flood-plain, and the successive zones referred to in the discussion of the biota are steadily encroaching on the lake.

Different stages in the destruction of the lake may be observed nearly every where about its shores, but, owing to the dominance of different factors, the encroaching societies are not always equally developed. The extreme of this is shown on the north shore where, owing to the proximity of the cliff, the talus slope dips into the lake, the fresh talus fragments fall nearly to the water and very little soil has accumulated. There is, therefore, no shelving beach at this point, the aquatic and mud flat societies are absent while the alder zone is represented only by a few forms, the Hoary Alder more conspicuously, and is largely mixed with the Mountain Ash, White and Red Pine and Wild Cherry of the talus slope. At the east end of the lake the grass and sedge zone constitutes the principal society, for, owing to the large amount of material carried by the river, the delta is built up to the level of the lake much faster than it can be raised above it by the accumulation of plant remains and flood deposits, while at the same time owing to the shelving nature of its outer margin, the aquatic zone is also extensively developed. At the west end of the lake, however, the margin is shallow, deposition is slow, and the aquatic societies are the most prominently developed.

But, notwithstanding differences in the rapidity of the process, the lake

is undoubtedly being filled up, and the present environmental and biotic conditions are being changed toward those of the river flood-plain.

Station IV. South of Carp Lake the country is covered by the biota of the deciduous forest type which is essentially the same as on the north slope. The small spring brooks which drain the region, however, bring in a different set of conditions, and may be considered as representative of the headwater conditions of the larger streams. The two studied on Sections 23 and 28, T. 51 N., R. 43 W., are shallow, cold, swift flowing streams from 6 to 15 feet wide with a bottom composed of gravel and stones. The biota is limited in variety probably owing principally to the coldness of the water. There is practically no aquatic vegetation, and the fauna consists chiefly of the snail, *Planorbis parvus*, caddis—and stone-fly larvae, and the frogs, *Rana septentrionalis, clamitans*, and *R. sylvatica cantabrigensis*. On the banks of these streams, however, the conditions are much more favorable. The deciduous trees usually overtop them entirely, so that the humus conditions along the margin are essentially the same as in the forest with the exception of a considerable increase in the moisture content. The flora that lines the creek is composed of such forms as *Caltha palustris, Equisetum sylvaticum, Cinna latifolia, Onoclea sensibilis, Scirpus cyperinus, Osmunda claytoniana*, Skunk Cabbage, *Carex crinita* and *pubescens*, and large mats of *Conecephalus conicus* and *Endocarpon miniatum*. Behind this narrow zone occur occasional clumps of alders (*Alnus incana*), and Mountain Maple.

The molluscan fauna of the creek bank is characterized principally by an increase in the abundance of the forest forms, while among very wet leaves *Physa sayii* is occasionally found.

It will be noticed that the biota of the creek bank is composed of members of the alder, sedge and forest societies of the river valley, but that the forms of the cassandra and coniferous societies are apparently lacking.

Station VII. Practically the same conditions prevail in Little Carp Lake as in Carp Lake, although its smaller size probably affects the biota to some extent. The deciduous forest forms extend down the sides of the bordering hills nearly to the waters edge. Between the forest and the water there is a narrow zone of vegetation the most conspicuous form of which is the Hoary Alder (*Alnus incana*) which is associated with the Few Flowering Cranberry, etc. The rush society in the margin of the water and on the delta (which is mostly submerged) is composed principally of *Equisetum* (*fluviatile* where examined) but for a short distance along the south shore the Canada Rush becomes prominent. As a rule, the aquatic societies are not extensive, the vegetation of the rush societies is scattered even on the delta, while the pond lily zone is only occasionally present.

The bivalve, *Anodonta marginata*, is quite commonly found about the margin of the lake, especially on the delta. The most characteristic fish, at this time of the year, are the Sucker and Horned Dace, the latter being very abundant.

Station VII. Substation 2. Above the lake, Little Carp river is a small meandering stream about 15 feet wide and 2 feet deep. It enters the lake through a narrow valley about one-fourth of a mile long which is crossed at the east end by several beaver dams. Above these dams, the valley widens out into an amphitheater about a mile long by one-fourth mile wide. In the narrow part of the valley near the lake, the space between the river and the foot of the adjacent ridges is occupied by a dense thicket of Hoary Alder, (*Alnus incana*). As the valley widens out above the dams, this alder zone, composed now of the Hoary Alder, *Betula glandulosa*, and several willows, is

separated from the mesophytic forests of the slopes by a coniferous society of Tamarack, White Spruce, White and Black Ash, and follows closely the foot of the ridge. The floor of the valley is occupied by a broad beaver meadow, covered with a luxuriant growth of grasses, sedges and other herbaceous forms, Fig. 20.

Among the conspicuous forms in this meadow may be mentioned *Carex monile, filiformis* and *viridula, Juncus effusus* and *tenuis, Agrostis hyemale, Calamagrostis canadensis, Scirpus cyperinus, Deschampsia flexusa, Panicularia canadensis, Solidago neglecta* and *erecta*, and the Marsh Bellflower, Joe Pye Weed, Swamp Milkweed and Nodding Ladies Tresses. The fauna is composed chiefly of the butterflies, *Basilarchia arthemis, Vanessa antiopa* and *Argynnis cybele*; the dragon-flies, *Sympetrum obtrusum* and *Aeschna clepsydra*; the grasshopper, *Camnula pellucida;* and the amphibians, *Hyla pickeringii* and *Rana clamitans*. This is also the habitat of the Song and Swamp Sparrows, and there was abundant evidence that it was a favorite feeding ground for deer.

Station VII. Substation 3. The dams at the west end of the beaver meadow are not now in repair, so that they influence but little the nature of the river, except as small pools, four or five feet deep, are formed behind them, where the current is deflected to one side. In these pools the characteristic fish is *Couesius plumbeus*, although the Sucker is sometimes found. The fauna of the river, in harmony with the conditions, is composed mostly of brook and creek forms, such as the Shiner, *Nototropis cornutus*, and the Dwarf Stickle Back, *Eucalia inconstans pygmaea*. There is very little aquatic vegetation.

The mud flats along the river are small and practically devoid of vegetation with the exception of scattered grasses, such as *Dulichium arundinaceum* and *Calamagrostis canadensis*, on the dryer portions. The birds that were observed here were the Solitary and Least Sandpipers and the Yellow-legs. On the submerged edges of these flats, the characteristic form is the mollusc *Sphaerium simile* with which is occasionally associated *Anodonta marginata*.

The meadow is the result of an extension of the conditions that normally prevail on the wetter parts of the flood-plain, and with this extension of the habitat there is associated an increase of the grass and sedge zones. When the dams, which are largely formed of Hoary Alder, were constructed, the flood-plain in the broad part of the valley was flooded, and this ponding of the stream resulted in the killing off of the dryer flood-plain flora. It is not probable that the pond covered the entire valley, but the low adjacent ground between the pond and the sides of the valley would be saturated and subjected to floods, making the conditions favorable for the grasses and sedges and an associated fauna, so that a small meadow analagous to the present one probably existed about its margin.

No evidence of the extent of the pond now remains, for with the trapping off of the Beaver the dams were no longer repaired and were broken through by the river. The pond was thus drained and the water resumed its former channel. This resulted in better drainage and a consequently dryer substratum in the meadow, so that the meadow forms were able to follow the water as it retreated, while the conditions are, at the present time, becoming favorable for the higher flood-plain and deciduous forest forms, that are working in about the margin. That the encroachment of the forest forms will ultimately destroy the meadow by narrowing the habitats of the grass and sedge societies, is evident from an examination of the conditions in localities where the Beaver formerly occurred. For instance, there have

been no Beaver on Carp river within the memory of several of the trappers in the region, and yet several of the bends of the river were found to be due to the remains of old dams which were once evidently of considerable size. Now a slight raising of the water level in this valley, such as would be caused by these dams if they were in repair, would cause the plain to be flooded, the trees to be killed off and either a pond or meadow would result according to the height of the dam. It thus seems probable that the present flood-plain societies of Carp river have reoccupied the flood-plain since the Beaver were killed off, which suggests that the history of the meadow on Little Carp river will be similar.

6. SUMMARY.

In order to get at the relation between the physical changes and the biota of the region as a whole, it will be necessary to summarize the present conditions, the biota, the processes that are dominant in the different habitats, and the changes which they are bringing about.

I. Beach. The beach consists of tilted strata of rock that are exposed to the forces of weathering and the action of waves. It may be divided into three parts on the basis of the processes acting upon it. The Lower Beach is exposed to the pounding of the waves, that tend to break up the rock and carry the fragments back in the undertow, building them up in a submarine terrace. The Middle Beach is exposed to the action of waves only during the winter months; during the summer months the forces of weathering predominate and tend to form a soil. This soil tends to be removed during the winter with the exception of a small amount that accumulates in the edges of the joint planes. The Upper Beach is, at present, above the reach of both summer and winter waves and is chiefly exposed to the forces of weathering, which have formed a slight residual soil.

The biota of the beach as a whole is adapted to the conditions that prevail in this habitat, and may be divided into three groups that are closely associated with the physiographic divisions. There is practically no life on the Lower Beach, owing to the pounding of the waves. The life on the Middle Beach consists for the most part of annuals that can obtain a foothold during the summer on the slight soil in the crevices, and a few associated animal forms. The flora of the Upper Beach, in response to the more favorable soil conditions and the absence of wave action, consists of a number of annuals and perennials; while the more favorable food conditions are likewise marked by an increase in the animal forms.

The changes that are taking place are due to the action of waves and weathering. The waves by cutting into the beach cause it to retreat inland, but the submarine terrace built up at the same time tends to cause this retreat to proceed more slowly in its later stages, as the growing terrace carries the breaker line off shore and tends to lessen the effect of the summer and winter waves. This is, in part, counteracted in the Porcupine Mountains by the sinking of the coast line, and the beach as a whole is moving inland. As the force of the waves is diminished, the process of weathering increases in comparative importance, the beach tends to become broken up, and the area of the habitats frequented by the crevice forms increases.

II. 1. Arbor Vitae Swamp. The narrow area back of the beach, at the foot of the north slope is not well drained, and the soil is covered by a thick layer of humus.

The forms adapted to these conditions are plants and animals found in



FIG. 13 The zone of heath plants and scattered pines, station III. 2, surrounding the bald areas, above the aspen zone, on the top of the First Range.



FIG. 14. Face of the cliff and talus slope (looking north from Carp Lake) station III. 5, showing hardwoods in the foreground on the lower part of the talus slope, the bare portion of the talus, and the belt of vegetation (pines, oaks &c.) at the foot of the cliff. The presence of the pines on the cliff show the influence of rock ledges.

swampy areas. If the undrained conditions of these areas are caused by the sinking of the coast, this habitat will tend to become destroyed by the encroachment of the beach conditions. If, on the other hand, this encroachment is relatively slow compared with other changes, the accumulation of the inwash and organic debris will tend to convert such a swamp into a dryer habitat and cause the present biota to be succeeded by a society adapted to the new conditions.

II. 2. North Slope of First Ridge. This slope on account of its relief is well exposed both to the forces of weathering and of denudation and is covered by a layer of soil that becomes thinner near the top of the ridge. Above this soil there is a layer of humus and vegetable mould that tends to conduct the water from the surface, thus greatly diminishing the effects of denudation. (It also furnishes organic constituents to the soil).

These conditions are very favorable for plant life, and the lower part of the slope is covered by a dense forest with which is associated a large number of animals. This biota is composed partly of forms whose principal distribution is in southeastern North America, and partly of those which predominate to the north of the Great Lakes and in the bogs to the south. On the thinner soil near the top of the ridge, those forms of the forest predominate that can live in the more open, poorer soil, and dryer conditions of this habitat.

The processes working on this slope tend to reduce the ridge toward base level and to increase the depth of the soil. The accumulation of humus retards the former process, while the latter proceeds more and more slowly as the soil increases in thickness. Changes are thus taking place very slowly, and the physiographic processes are evidently tending to approach an equilibrium. Near the top of the ridge, owing to thinner layers of soil and humus, the changes are more rapid but in the direction of the conditions that prevail on the lower part of the slope, and the biota adapted to these conditions is pushing up the slope.

III. Mountain Top. On the bare mountain top, the forces of weathering tend to break up the rock into a soil that is washed or blown away nearly as fast as it is formed, except along the joint planes.

The flora consists of rock inhabiting lichens and a number of crevice forms, the fauna of the types frequenting open habitats, such as the grasshoppers, etc.

The soil formed in the crevices is in part held by plant roots, and, since these soil areas are the habitats of the crevice forms of life, as they gradually spread out, the habitats of the rock inhabitating forms are restricted. At the same time, the soil washed down the slope is held at the forest margin, thus permitting the forest societies to encroach on the crevice forms which will thus in time tend to become replaced by the forest forms. This succession of forms is modified by the influence of the strong winds which tend to break down the pioneer trees on the exposed areas.

III. Cliff and Talus Slope. The cliff is constantly exposed to the forces of weathering, for as fast as the rock is broken up it is removed, exposing a fresh surface.

The fauna and flora, owing to the unstable and exposed conditions, are very poor except on the rock ledges, where a slight soil accumulates.

The talus slope at the foot of the cliff is also very unstable and is exposed to the destructive effects of falling rock fragments. Toward the bottom, beyond the limit of falling rocks, the blocks tend to become broken up into a soil.

The biota of the talus slope, on account of the unstable conditions, is also very poor. Toward the bottom of the slope the rocks become covered by a vegetation of lichens, and farther down by a slight soil and the heath and forest societies.

As the cliff is destroyed, the talus slope and the top of the ridge tend to approach. The lower part of the talus slope in time becomes broken up to form a soil, and the deciduous forest types from below tend to spread up the slope thus encroaching on the areas occupied by the cliff and talus slope forms.

IV. Carp River Valley. The sides of the valley of Carp river slope down to a low flood-plain that becomes still lower near the river, grading into mud flats along the stream. The soil is deep and contains a large amount of organic material, and there is a decrease in its moisture content from the mud flats up into the forest.

The aquatic biota is a mixture of pond and river types. The mud flats are inhabited by amphibious forms that are replaced on the dryer parts of the flood-plain by the sedge, cassandra, and alder societies, behind which usually occurs a society of Tamarack, White Spruce and White and Black Ash. On the valley slopes occurs the mesophytic forest type of biota.

The prominent forces at work in these habitats are those of denudation and deposition. The river tends to destroy the adjacent ridges and build up a part of the material derived in this way into mud flats. Deposition during high water builds these flats above the level of the water, and they come in time to form part of the flood-plain. The flood-plain is in turn built up by deposition during floods and by the accumulation of organic remains until the conditions become similar to those in the adjacent forest habitats. The effect of the processes is, therefore, to reduce the country to a level plain thus permitting the encroachment of the forest forms.

V. VII. Carp and Little Carp Lakes. These lakes on account of the similarity of conditions may be considered together. They are, for the most part, shallow throughout. At the east end of each lake, there is a broad delta formed at the mouth of the entering stream.

The aquatic biota is of the quiet water type. At the margin occur the amphibious forms that give way on the dryer ground to the flood-plain and forest forms. The deltas afford conditions similar to those on the mud flats and are occupied by a flora of grasses and sedges, and an associated fauna that is characterized by such forms as the snipes, sandpipers, etc.

The lakes are evidently being filled up, and the conditions are approaching those of the surrounding and encroaching forests.

VII. 2-3. Little Carp River. This is a small meandering stream which evidently at one time was expanded into a pond by the formation of beaver dams across it. As the Beaver were trapped off, the dams were destroyed and the pond became drained.

The biota of this stream consists of brook types. The forms on the mud flats along the stream grade into the flood-plain biota which consists principally of grasses and sedges which ordinarily inhabit the wetter parts of the flood-plain, the higher ground types being limited to a narrow zone in front of the forest.

The changes going on are evidently tending to make the flood-plain dryer, and the forest is encroaching on the meadow. The present extent of the area occupied by the meadow forms is due to the fact that they were able to push in and acquire the territory left by the receding water of the river when the dams were destroyed.

VI. Hardwood Forest. This region has been reserved to the last, for the conditions are evidently those toward which the other habitats tend to be changed under the present conditions. The conditions are similar to those on the north slope, and the whole region is covered by a similar type of biota. This society thus represents the climax society of the region. It consists of the forms that are adapted to or associated with the conditions which prevail in this region in the last stages of the mutual adjustment of all the environmental processes. As the processes become adjusted to one another, the habitat of the climax society is increased at the expense of the other habitats, and the associated biota tends to become of general geographic extent in the region.

7. INTERPRETATIONS AND CONCLUSIONS.

From the conditions of life in this region as summarized above, the following interpretations and conclusions seem justifiable.

Owing to the dependence of forms of life on their environment, biotic changes are necessarily closely related to environmental changes. These biotic changes may occur in two ways; the forms must either be able to respond to the new conditions or be supplanted by other forms. That they tend to become adjusted cannot be questioned, but in many cases at least this adjustment lags behind the changing conditions, and the forms are replaced by others from adjacent habitats which are adjusted to the conditions toward which the particular habitat is changing, thus bringing about a succession of societies.

To understand, therefore, the succession of societies in a region it is necessary to know both the environmental conditions and the processes that modify them. The environmental conditions are brought about by the association of certain environmental factors, such as the geographic, physiographic, organic, edaphic (the chemical and structural composition of the rock and the depth of the soil), time, and climatic factors. These divisions are arbitrary, for the different factors are so intimately related that they can only rarely be separated, and although certain ones may predominate in different habitats, it is impossible, owing to this interrelation, to explain the distribution of animals or plants on the basis of a single factor, for all are more or less involved in the formation of a habitat. This is one of the primary reasons for emphasizing habitat dynamics.

It will be seen by reference to Van Hise ('04, p. 40) that the environmental factors given above are the same as the geological factors in the belt of weathering. Each of these factors is the resultant of various processes (composed in turn of physical forces, heat, light, etc.) which when not in equilibrium tend to become so. The adjustment of these processes to each other brings about changes in the conditions which can only approximately cease when they approach an equilibrium, as, for example, when the topography has been reduced to a base-leveled plain covered by a layer of residual soil. The conditions in habitats where the processes are not in equilibrium are thus being constantly changed in the direction of other habitats in which they have more nearly reached an adjustment, and a succession of societies occurs that only ceases when the processes have become approximately adjusted to each other. The forms that are adapted to the adjusted conditions will constitute the climax society. It is necessary to here emphasize the importance of the organic factor; this must also become adjusted to the others for the entrance of new forms into a region may greatly change the equilibrium of its societies.

The conditions and changes that are going on in this region at the present time have been given in the discussion of the different stations, but, owing to the fact that the relation between environmental changes and the succession of societies has also prevailed in the past, the historic factor in biotic interpretation, the present conditions will not alone explain the present biotic conditions. It is therefore necessary to take into account the conditions that have prevailed in the past. This may be done by reversing the order followed in the discussion and by considering the past in the light of the action of the present processes.

The historical geology of the Lake Superior region has been worked out by Van Hise ('04), and his results are the basis of the following account. During the earliest period the oldest rocks were formed of which we have any knowledge; the crystalline schists, gneisses and granites comprising the Basement Complex (the Kewatin and Laurentian). They form in North America the broad old land area, extending, according to Wilson ('03, p. 617), from Coronation Gulf in the extreme northwest of Canada, southward around Hudson Bay, and northward through Labrador to Baffin Bay and beyond. South of Lake Superior, in Michigan and Wisconsin, there is a continuation of this area, largely buried in Michigan under later deposits but exposed in a large area in Central Wisconsin. There were at least three series of rocks formed upon the Basement Complex before the Keweenawan, but the mountains formed by the elevation and folding of these rocks were reduced to a peneplain before the Keweenawan rocks were laid down. During the period of unstable equilibrium that followed the Huronian Epoch, this peneplain was submerged, and the sediments of the Keweenawan Series were laid down. During their formation, these sediments were covered from time to time by great sheets of volcanic lavas, the products of fissure eruptions. At the close of the Keweenawan Epoch, the land was again elevated and the strata tilted to form great mountains, as is shown by the inclination of the strata in the cross section, Fig. 2. During the subsequent cycle of erosion, the entire thickness of the Keweenawan Series was greatly eroded, and the mountains together with the whole pre-Cambrian area (Wilson, '03, and Weidman, '03) were reduced nearly to sea level.

During Mesozoic times, there was a particularly well marked period of baseleveling that removed the overlying Palaeozoic sediments from the Lake Superior region and reduced the topography to a peneplain. This peneplain, the Jura-Cretaceous, extended over much of the existing land area of North America and has been recognized in Canada (Wilson, '03, p. 658), in the Ozarks (Hershey, '01, pp. 22-24), eastern (Davis, '89, p. 197) and western United States (Woodworth, '94, p. 221). At this time eastern and western North America were separated by the Cretaceous Mediterranean Sea. At the close of the Cretaceous Period, the continent was unified by an elevation of the interior which banished the Mediterranean Sea and put an end to the Jura-Cretaceous peneplain; but in the Tertiary Period that followed, another cycle of erosion occurred which, although not complete in the mountainous regions of North America, sufficed to reduce the northern part of the continent nearly to baselevel (Upham, '04). The surface of the earth in the Great Lakes region at this time probably became covered by a thick mantle of residual soil, owing to the enormous length of time during which it was subjected to disintergrating processes.

The present elevations in the Porcupine Mountain region are evidently formed by the projecting edges of the more resistant basic and acidic lava sheets, while the valleys of Carp and Union rivers are sunk by erosion into

a softer inter-bedded clastic. This contrast between the resistance offered by the sandstone and trap sheets to erosion has given rise, in a small degree, to what Marbut ('96, pp. 29-32) has called step and platform topography. The cross section, Fig. 2, shows that the first ridge is formed by the projecting end of a stratum of trap; if this sheet had been vertical, erosion would have been equal on both sides and the slope on either side would have been the same. But, owing to the fact that the sheet is inclined, the outcropping edge protects the underlying sandstone and a precipitous escarpment is formed. This section also shows that the valley of Carp river is formed by the erosion of the softer stratum of sandstone lying between the escarpment and the second ridge of trap, and that the stream runs along the strike of the rocks, so that it is difficult to believe with Dr. Wright ('05, p. 38) that the valley was formed by the submarine erosion of post-glacial lakes.

If the second sheet of trap was, like the first, underlaid by a bed of detrital material, another escarpment would have been formed. But instead of overlaying an interbedded clastic, it overlies the hard resistant quartziferous porphry that constitutes the central part of the mountainous district. This results in the topography that would prevail if the resistant stratum were vertical, i. e. equal slopes on either side. The topography, however is not of recent origin, and although the physiographic history of this part of Michigan has not been worked out by geologists, one is lead to believe from the work of Wilson in Canada ('03), Weidman in Wisconsin ('03), and Van Hise in northern Michigan ('94 and '96) that the baselevel that is represented by the truncated strata, Fig. 2, probably represents a pre-Cambrian peneplain.

Prof. C. K. Leith has suggested to me in a letter that this structure possibly represents a peneplain of later age than the Wisconsin pre-Cambrian, which it probably intersects at a low angle in a manner similar to the intersection of peneplains of different ages about the Laurentian of Canada as described by Wilson ('03, p. 651). The Porcupine Mountains would thus represent the remains of a peneplain, buried since early geological time under later deposits.

But whether the topography is of pre-Cambrian or later age, it is largely determined by the geological structure and has been comparatively little modified by the ice age. Thus Van Hise ('04, p. 35) has shown that the rocks at present exposed in this part of the Lake Superior region were buried under later deposits all through the Palaeozoic Era and had probably become approximately adjusted to those conditions. Later when they were brought to the surface by the extensive denudation of Cretaceous and Tertiary Periods, and still later when the thin layer of weathered material had been removed by the ice sheets of the Glacial Epoch, this equilibrium was disturbed, and they at once began to adjust themselves to the new conditions—a process that is not yet completed.

At the close of the Tertiary Period, the Tertiary peneplain was destroyed by an elevation of 3,000 to 5,000 feet (Upham, '04, p. 244) over northern North America. Near the culmination of this uplift, three centers of ice accumulation developed in this region and gave rise to the continental ice sheets of the Glacial Epoch.

The glaciers that were formed from these three centers covered Canada and invaded the northern part of the United States at various times, but the final invasion was the most important from the standpoint of the present biota. At this time, ice sheets fed by the different centers united into a

single sheet, the Wisconsin, that covered Canada and moved southward over northern United States, forcing the biota before it. As the ice from the Labradoran center reached the Great Lake region, it was broken up into lobes, the direction of which was determined by the lake basins. The Superior Lobe traveled southwest to the end of the lake. It then spread out laterally, united with the neighboring lobes and moved southward as a continuous sheet.

Thus during the inception of the ice age, certain forces gradually became dominant, throwing the environmental processes out of adjustment, changing the conditions so that the northern forms were able to encroach on the habitats of the more southern societies, thus resulting in a general southward movement of the biota. At the same time, the habitats of the northern forms were destroyed, and their societies were forced southward beyond the limits of glaciation. It may be inferred, from the fossils of boreal forms now found in Pleistocene deposits near the margin of the ice sheet (Adams, '05, p. 55), that the societies during the ice age became adjusted, in a general way, to the conditions beyond the ice margin. But, as the glaciers finally retreated the equilibrium of environmental processes was again disturbed. The conditions changed in favor of the more southern forms which were thus able to extend their habitats into those previously occupied by the boreal types. At the same time, the habitats of the northern forms were extended by the retreat of the ice sheet and a northward migration began (Adams, '02) In this migration the extreme northern types were probably in the lead, and the barren ground left by the retreating glacier was invaded, in all probability, by the lemmings, voles, moles, ptarmigan, etc., representative of the tundra. As the glacier continued to retreat and the conditions became more favorable, the habitats of the tundral types were probably encroached upon by the hares, porcupines, chipmunks and the Lincoln's, White-throated and White-crowned Sparrows, etc., now characteristic of the northern boreal forest of Spruce, Balsam Fir and Tamarack. This biota was in turn succeeded by the deciduous forest type that includes the dominant forms of life in Indiana, Illinois and southern Michigan today. As these southern forms moved northward, they often surrounded groups of boreal plants and animals, as illustrated by tamarack swamps or bogs. These swamps are characterized by a distinctly northern biota consisting of such forms as the Southern Varying Hare, Star-nosed Mole, Red-backed Mouse, Cassandra, Tamarack, Spruce, etc., and are really boreal islands (Bailey, '96) surrounded by the deciduous forest types in the northward migration (Adams, '02, and Transeau, '03).

When the receding edge of the glacier reached the Great Lake region, it was broken into lobes that retreated up the lake basins. As soon as the lobes had retreated beyond the southern watersheds of the Great Lakes, the water accumulated in front of each lobe as an ice dammed lake which drained through the lowest point in the divide (Taylor, '05, p. 97). The lake formed in front of the Superior Lobe drained by way of the St. Croix river through the Mississippi to the Gulf, thus forming a highway for the migrating forms into the Lake Superior region. The Porcupine Mountains, however, owing to the height of the St. Croix outlet, were entirely surrounded by the lake (Wright, '05, p. 38). As the ice retreated, an eastern outlet was opened lower than the St. Croix, and the level of the lake descended; during this descent successive beach lines were cut about the Porcupines until they were finally united with the mainland.

Meanwhile, as the continental ice sheet continued to retreat north of the

Great Lakes, it was followed by plants and animals, so that when it finally disappeared the different forms of life were left distributed in a north and south direction approximately in the order of their northward migration. The wide distribution of the boreal forms in northern North America is thus seen to be very intimately related to the character and extent of the peneplained nature of the region.

Toward the south, with the retreat of the last ice sheet, the boreal forms became restricted to local areas, as in bogs for example. but further north they tend to become of wider distribution. This is shown in the Porcupine Mountains by the general distribution of forms that about Ann Arbor, Michigan are confined to the tamarack swamps, by the presence of boreal forms in the climax forest to the exclusion of more southern forms, and by the fact that there are few forms restricted to the bog societies. That this spreading out of the conditions with which the boreal forms are associated affects the more nearly related habitats first is shown by the number of boreal forms in the flood-plain biota while on the higher ground the southern forms become more numerous. When the present biotic types reached this region, the various societies took possession of the different habitats to which they were adapted, but, owing to the fact that the processes were not in equilibrium these societies could not remain fixed. This is shown, at the present time, where the changes were taking place rapidly, as for example on the mountain top, by the fact that the conditions are being changed in the direction of those that prevail on the low land, and the biota of the cliff habitats is being supplanted by the deciduous forest types which occupy the lower levels where the processes approach an equilibrium. As the processes approach an adjustment, the changes take place more slowly, and the more resistant forms may persist for a considerable time in the succeeding society, as is shown by the presence of the isolated White Pines in the deciduous forest. The deciduous forest society thus represents the climax biota in the Porcupine Mountains, as it is associated with those conditions toward which the other habitats are tending.

From the dynamic nature of the processes that give rise to the environmental factors in the different habitats, it follows that a study of the distribution of forms in a particular region should be made from the standpoint of the processes involved, and, since the conditions in particular habitats may become of geographic extent, the same methods are applicable to general distributional problems. This leads naturally to the conclusion so well expressed by H. R. Mill ('05, p. 10) for geography in general: "Geography was defined long ago as the science of distribution; but the old idea was statical distribution, the laying down on maps of where things are; now we see that we ought to go further and discuss also how the things got there, why they remain there, whether they are in transit and if so how their path is determined. We are learning to look on distribution from its dynamical side, the earth with all its activities being viewed as a machine at work."

PART II. ISLE ROYALE.

1. GENERAL GEOGRAPHY.

Isle Royale is situated in the northwestern part of Lake Superior on the junction of the 89th degree of west longitude with the 48th degree of north latitude, Fig. 21. It lies northeast and southwest nearly parallel to the north shore of the lake. The topography is striking; several nearly parallel ridges separated by broad valleys run the length of the island, and project out into the lake at either end (more conspicuously at the north) as the walls of deep fiords. These ridges are all low, the highest not exceeding 500 feet. The geology and topography have been discussed by Lane ('98) and Irving ('83), and it is sufficient for this report, to say that the topography, as in the Porcupine Mountains, is closely dependent on the geological structure. The ridges consist of the centers of outcropping sheets of lava, while the valleys between are mostly cut in the inter-bedded clastics as in the Porcupine Mountains. The dip of the rocks, is however, toward the Michigan shore, and the escarpments are thus on the north instead of the south side of the ranges. These escarpments are not precipitous in the southern part of the island. There is abundant evidence that the entire island was overridden by the ice sheets of the glacial epoch and that after the final retreat of the glacier it was entirely submerged beneath the Pleistocene Lakes (Lane, '98, pp. 183 and 184). It has not since that time been connected with the mainland, a fact to which many of the peculiarities of its biota are probably due.

2. LOCATION OF FIELD STATIONS. (FIG. 21).

Only the southwestern end of the island was examined. Stations were established as follows:

Station I. Clearing on the Shore of Washington Harbor, Section 29, T. 64 N., R. 38 W.

Station II. Washington River, Section 29, T. 64 N., R. 38 W.

Station III. Trail along the Top of Greenstone Range, T. 64 N., R. 38 W.

Station IV. Washington Creek, Sections 28 and 32, T. 64 N., R. 38 W.

Station V. Tamarack Swamp, Section 20, T. 64 N., R. 38 W.

Station VI. North Slope of Greenstone Range, Section 32, T. 64 N., R. 38 W.

Station VII. Lake Desor, T. 64 N., R. 32 W.

Station VIII. West End of Siskowit Bay, T. 64 N., R. 32 W.

Station IX. Southwestern End of Minong Trap Range, Section 30, T. 64 N., R. 39 W.

Station X. Washington Harbor, T. 64 N., R. 38 W.

3. THE BIOTA CONSIDERED BY STATIONS.

Station I. Clearing on the Shore of Washington Harbor. This station will not be discussed as it is an artificial clearing into which cultivated species



. 15. Large rock ledge on the face of the cliff shown in Figure 14, illustrating the character of the vegetation on a cliff that is broken by ledges.



16. Talus slope, station III. 5, showing the nature of the talus. The influence of the unstable character of the slope upon the vegetation is indicated by the fallen pines.

have been introduced, and which is kept open, so that only in a few places can the succession of forms be observed that would occur if the clearing was left undisturbed. There is evidence, however, in several places, that the pioneer forms are the Quaking and Large-toothed Aspens, and the Paper and Yellow Birch. The animals taken here were probably all forms from adjacent habitats (see annotated lists).

Station II. Washington River. This river is a sluggish meandering stream flowing through a broad flat valley between the Greenstone and Minong Trap Ranges, and emptying into the head of Washington Harbor. The aquatic vegetation is very poor. In the quiet water near the mouth of the river, *Myriophyllum sp.* forms the principal vegetation with *Sparganium eurycarpum*, and *Phragmites communis* in the shallow water near shore. These forms are replaced on the mud flats by a zone of sedges and herbaceous forms among the conspicuous forms of which are *Carex tribuloidea, retrorsa, intumescens* and *trisperma, Juncus effusus*, Joe Pye Weed, *Esclepias incarnata*, and *Spiraea salicifolia*. This society is not extensive but soon grades into the dense thickets of Hoary Alder (*Alnus incana*) that are characteristic of the flood plains in this region. The undergrowth in these thickets is limited to a few forms such as *Caltha palustris*, Skunk Cabbage, *Vagnera trifolia*, and several species of ferns and violets. Where the flood-plain is broad, as toward the mouth of the river, the alder thickets are followed by a society of White and Black Spruce, Tamarack, White and Yellow Birch, and Black Ash, with an undergrowth of *Taxus canadensis*, Mountain Maple, *Andromeda polyfolia, Mitella nuda*, Dwarf Dogwood, *Coptis trifolia, Chiogenes hispidula, Ledum groenlandicum, Vaccinium canadensis*, and *Viburnum opulus*, on a thick carpet of moss. As the valley narrows toward the head of the river, this zone gradually disappears.

As in the case of the flora, the aquatic fauna is limited both in individuals and species. The birds are represented by the Pied Billed Grebe, American Coot and American Merganser; the molluscs by *Planorbis exacuous* and *Physa sp.* among the leaves of aquatic plants, and *Pisidium variabile* and *Pisidium spp.* on the mud bottom. Among the alders are found the sparrows, warblers and thrushes; the toad, *Bufo americanus;* the garter snakes, *Thamnophis sirtalis sirtalis*, and *T. sirtalis parietalis*, and the molluscs, *Carychium exile, Pisidium abditum, Apecta hypnorum, Pyramidula striatella, Zonitoides arborea* and *exigua, Vitrea binneyana* and *Agriolimax campestris*. In the tamarack and spruce forest, the birds are not so numerous, and the sparrows, thrushes and warblers tend to be replaced by the Arctic Three-toed, Downy and Hairy Woodpeckers, the Crossbills and the Sharp-shinned and Sparrow Hawks. Among the molluscs, *Pisidium abditum, Apecta hypnorum* and *Carychium exile* also seem to drop out in this zone, but *Pyramidula striatella, Vitrea binneyana, Zonitoides arborea* and *exigua* were found associated with *Euconulus fulvus* and *E. chersinus polygyratus, Sphyradium edentulum, Acanthinula harpa* and *Pyramidula striatella alba*. Here also the grasshopper, *Tettix acadicus*, and the spider, *Amaurobius bennetti*, are occasionally found in the moss.

Station VI. North Slope of Greenstone Range. On account of the intermediate relation which it bears to the flood-plain of Washington river, Station II, and the top of the Greenstone Ridge, Station III, this station will be considered here. The Tamarack and Black Spruce are replaced on the sides of the valley by a forest composed principally of the Balsam Fir, White Spruce, Paper and Yellow Birch, and large isolated White Pines. The undergrowth consists principally of the Ground Hemlock associated

with the Beaked Hazel and Mountain Maple, forming dense thickets that are almost impenetrable, and in exposed situations, particularly about the shores of the island, with the Mountain Ash. Less conspicuous forms in the undergrowth are the Twin Flower, Rattle Snake Plantain, Dwarf Cornel, *Mitella nuda, Coptis trifolia, Clintonia borealis, Lycopodium annotinum* and *clavatum*, and *Chiogenes hispidula*. The birds are represented chiefly by the Nuthatch, Brown Creeper, and the Downy, Hairy, Arctic Three-toed and Pileated Woodpeckers; the molluscs by *Pyramidula striatella, Zonitoides arborea*, and *Vitrea binneyana;* the reptiles by *Storeria occipitomaculata;* the amphibians by the common toad, *Bufo americanus*, and the mammals by the Canada Lynx, Hudson Bay Red Squirrel, Canadian White-footed Mouse and Hudson Bay Varying Hare.

Station III. Top of Greenstone Range. Toward the top of the slope the White Spruce decreases in abundance and the Balsam Fir and Birches become associated on the top of the ridge with a large predominance of Sugar Maple. This forest extends as a narrow strip along the top of the ridge and contains the only Sugar Maples observed on the island. The undergrowth is essentially the same as in the Balsam Fir and Spruce forest of the slopes, and the only difference in the fauna is the greater development of molluscs; the forms collected are *Pyramidula striatella, P. striatella alba* and *alternata, Zonitoides arborea, exigua* and *milium, Vitrea binneyana, Euconulus fulvus* and *E. chersinus polygyratus*, and *Sphyradium edentulum* among the fallen leaves, and *Vertigo gouldii, Punctum pygmaeum, Carychium exile* and *Vitrina limpida* in the damp humus in the small ravines. Other forms that may be listed here, although they also occur in the Balsam Fir and Spruce forest, are Storer's Snake (*Storeria occipitomaculata*), the garter snakes, *Thamnophis sirtalis sirtalis* and *T. sirtalis parietalis*, and the grasshoppers, *Tettix acadicus* and *Ceuthophilus seclusus*.

Station IV. Washington Creek. The conditions represented here are similar to those which prevail on the head waters of the rivers and along the small streams. Where the valley is narrow (near the mouth, Section 32) the forms of the slope forest extend nearly to the waters edge, being separated from it by a narrow zone of Hoary Alder, *Equisetum arvense, Caltha palustris, Vagnera trifolia, Rhamnus alnifolia* and various grasses and sedges. Up stream, Section 28, the valley is wider, and the coniferous forest of the slope is separated from the stream by a considerable development of bog forms. The arboreal vegetation consists of the Arbor Vitae, Tamarack and Black Spruce, with an undergrowth of *Coptis trifolia, Chiogenes hispidula, Linnaea borealis, Lycopodium clavatum* and *obscurum*, and a thick carpet of *Sphagnum* and other mosses.

There is practically no aquatic flora, and the only aquatic animals found were *Pisidium*, too young to identify.

The molluscs collected in the bog society are *Pyramidula striatella, Zonitoides arborea* and *exigua, Vitrea binneyana, Acanthinula harpa, Vertigo gouldii, Agriolimax campestris* and *Pallifera hemphilli.*

Station V. Tamarack Swamp. On Section 20, T. 64 N., R. 38 W., in the valley of the small stream draining into Huginnins Cove, the bog society attains a considerable development. The Tamarack is the principal tree and is associated with the Balsam Fir, Black Spruce and Black Ash. The undergrowth consists of the Dwarf Dogwood, *Chiogenes hispidula* and *Coptis trifolia* on a thick mat of *Sphagnum* and other mosses. The molluscs found here are *Zonitoides exigua, Z. arborea* and *milium, Vitrea binneyana, Euconulus fulvus, Vertigo gouldii, Pyramidula striatella* and *Euconulus chersinus poly-*

gyratus. A conspicuous feature of the bogs in this region is the lack of undergrowth. As may be seen from the list of species, the forms that compose the undergrowth consist only of a few herbaceous forms, which is in striking contrast to the density of the undergrowth in the surrounding forest.

Station VII. Lake Desor. This lake lies between the Greenstone and Minong Trap Ranges. Its shores are for the most part shelving and covered with a fine silt-like deposit. The islands, however, have uniformly rocky shores. The coniferous forest of the slopes comes down to the margin of the lake where it grades into a narrow zone of Hoary Alder, *Viburnum opulus* and Arbor Vitae that lines the shores. The aquatic flora and fauna is very poor. The marginal forms consist of the plants, *Equisetum sp.*, *Phragmites communis*, *Sparganium eurycarpum*. and occasionally the White Water Lily (*Castalia odorata*); the frog, *Rana sylvatica cantabrigensis*, and the molluscs, *Planorbis bicarinatus striatus*, and *Anodonta marginata*. On the rocky shores of the islands, the vegetation consists of a scattered growth of *Isoetes sp.* and *Phragmites communis* in the water among the rocks, and *Equisetum arvense* on the rocks in exposed places. The animals collected here are the leeches, *Haemopis grandis* Verrill and *Nephelopsis obscura* Verrill, a number of caddis fly larvae, and the molluscs, *Planorbis hirsutus*, *P. exacuous* and *parvus*, and *Physa sp.*

Station VIII. Siskowit Bay. The only part of Siskowit Bay worked was the west end in T. 64 N., R. 32 W. The shore at this point consists of outcropping strata of conglomerate that dip under the bay, and are often broken up into shingle beaches. Owing to the grinding of the waves, there is practically no aquatic life, although a small *Physa* is sometimes found on the larger rocks. In the pools that occur occasionally along this beach behind the outcropping strata, the conditions are more favorable. Small mats of Algae may occur on the rocks and there is a limited fauna of which caddis fly larvae, and molluscs, *Physa sp.* and *Valvata sincera lewisii*, are the principal forms. The beach flora is also very limited, consisting chiefly of Juneberry, *Phegopteris polypodiales*, *Euthamia graminifolia*, *Campanularia rotundifolia* and *Listera convallariodes* that occur in the rock crevices and scattered over the shingle beach.

Station IX. Southwestern End of Minong Trap Range. As may be seen on the map, the Minong Trap Range on Section 30, T. 64 N., R. 39 W. projects into Lake Superior, becoming deeply submerged several hundred yards fromthe mainland. It is also sloping on the south side, owing to the dip of the strata, but on the north side it is precipitous. Near the outer end of the ridge, there are a number of rock pools in the angular spaces formed by the removal of portions of the rock between the joint planes. These are very similar in form and probably in origin to the beach pools in the Porcupine Mountains. The flora of these pools is very limited, but a number of animal forms are found such as the molluscs, *Limnaea sumassi* and *Planorbis parvus*, the water strider, *Gerris remigis*, and caddis-fly larvae. The flora on the outer end of the ridge consists of scattered patches of *Parmelia conspersa*, and a crevice vegetation of *Sibbaldiopsis tridentata* and *Dasiphora fruticosa Campanularia rotundifolia*, *Solidago sp.*, Arbor Vitae and several grasses.

Toward shore a thin soil covers the rock and supports a flora of Reindeer Lichen (*Cladonia rangiferina*), and the heaths, Bearberry, Dwarf Blueberry and New Jersey Tea that are often found growing on the remains of lichen mats. Here also are found *Empetrum nigrum*, and *Lycopodium annotinum*, *clavatum* and *complanatum*. The first tree is the Arbor Vitae

that grows nearly prostrate on the rock, associated with *Juniperus nana*, Mountain Ash, White Pine, and Quaking Aspen. Near the shore the White Spruce, Balsam Fir and Paper Birch come in, forming the forest of the region. The succession on these points is evidently represented by four stages, the lichen-moss, grass-sedge, heath, and coniferous societies. The history of the pools is somewhat different. There is evidence that these are being filled in places by *Sphagnum* and other mosses, and on this moss such bog forms as *Ledum groenlandicum*, Cassandra, Black Spruce and Tamarack are occasionally found. These forms must, however, in time be succeeded by the forms of the upland forest.

In listing the fauna of the outer end of the ridge, the Herring Gull should be mentioned as one of the most characteristic forms, for hundreds of individuals were often observed on this ridge during the summer. As in the Porcupine Mountains, a number of molluscs push out in advance of the forest on the heath mat. In the dry soil among the roots of these plants was found, *Pyramidula striatella*, *Zonitoides exigua*, *Vitrea binneyana* and *Acanthinula harpa*.

Station X. Washington Harbor. As may be seen from the map, Washington Harbor is a long narrow bay lying between the Minong Trap and Greenstone Ranges, on the southwest end of the island. It attains a depth of 6 to 9 fathoms and has a rocky bottom that rises nearly to the surface in places as reefs.

The fauna of the deeper waters, as represented by the collections, consists of the Lake and Brook Trout, Herring, Sucker, Muskallunge, Yellow Perch and *Couesius plumbeus*. Among the rocks near shore the Millers Thumb (*Cottus ictalops*) is found, and the molluscs, *Limnaea stagnalis var.*, *Limnaea summassi*, *Physa sayii*, *Physa sp.* and *Planorbis exacuous*. Of these forms the two Limnaeas were the most characteristic and were particularly abundant on the northeast end of the harbor.

4. SUMMARY AND CONCLUSIONS.

On account of the preliminary nature of the work done on Isle Royale, but few conclusions will be drawn. It will be seen at once, however, that while the biota of the Porcupine Mountains possess many southern forms, the Isle Royale societies are characteristically boreal, the bog forms are less restricted, the sedge, cassandra, shrub and coniferous societies are better represented on the river flood-plains, and many of the forms of the coniferous society occur in the climax forest. This makes the climax forest society of Isle Royale, of the northeastern North American type. The bog forms are thus boreal types having the same affinities, and their spreading out in this region from the restricted habitats which they occupy to the south may be accounted for by the fact that the environmental conditions with which they are associated, toward the north tend to become of general or of geographic extent, so that these forms ultimately come to form the climax society. Thus several forms that about Ann Arbor have been recorded only from tamarack swamps, such as the snails, *Philomycus dorsalis*, and *Pallifera hemphilli* (collected by Miss Jean Dawson), and the Varying Hare, Star-nosed Mole, and Red Backed Mouse, are all boreal species (Bailey, '96), that toward the north tend to become of general distribution.

It will be noticed in the annotated lists, however, that while most of the species have northeastern affinities, a number of forms collected on Isle

Royale are forms of western and northwestern distribution. There are conspicuous examples of this:

1. The snail listed as *Limnaea sumassi* Bd., according to Mr. Bryant Walker, although probably entitled to rank as a distinct variety or species, is very closely related to *L. summassi* Bd. a peculiarly western form originally described from British Columbia.

2. The range of the ant, *Camponotus herculeanus* L. var. *Whymperi* Forel, according to Dr. Wheeler, is not well known, but it has been previously found in the mountains of Colorado and Britsh Columbia.

3. The specimens of the Garter Snake, *Thamnophis sirtalis parietalis*, taken on the island strikingly resemble in coloration western forms from Washington and Colorado, and not those of southern Michigan, that are sometimes referred to this variety.

4. Although not found on the island, the Michigan Grayling, *Thymallus ontariensis*, may also be mentioned in this connection. According to Jordan and Evermann ('96, p. 518), this variety "represents a detached colony left from the post glacial extension of the range of *T. signifer*, of which it was a variety." The range of *T. signifer* is given as "Mackenzie River to Alaska and the Artic Ocean."

5. Another instance of the same nature was the finding of the Devils Club, *Echinopanax horridus* Decsene, by Wheeler ('01, p. 620) on the north end of the island in 1900. The range of this plant, as given by Macoun ('83, p. 189), is the north coast of America and in Alaska; being abundant west, but extremely rare east of the Rocky mountains.

The occurrence of these western and northwestern elements in the biota of Isle Royale is emphasized because, as was said before, the majority of the species are those of the northeastern North American type. Whatever may be the explanation of the occurrence of these western and northwestern forms this far to the east, an important factor is, no doubt, the peneplain nature of the country, which probably formed an extensive highway for boreal forms along the ice margin during the retreat of the last ice sheet.

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THE ECOLOGICAL DISTRIBUTION OF THE BIRDS IN THE PORCUPINE MOUNTAINS, MICHIGAN.

OTTO McCREARY.

The country in which these observations were made is largely included within a narrow area about a mile wide which runs from Lake Superior almost directly south, crossing Carp river about a quarter of a mile east of Carp Lake. Few observations were made south of the Carp river valley.

On account of differences observed in the environments of the bird life of this region, it will be discussed according to the following habitats:

I. THE LAKE SUPERIOR SLOPE OF THE FIRST MOUNTAIN RIDGE.

1. Lake Superior } .....Station I.
2. Lake Beach... }
3. Cedar Swamp.....Station II. Sub. 1.
4. Hemlock Forest.....Station II. Sub. 2.
5. Hardwood Forest.....Station II. Sub. 2.
6. Camp Clearing.....Station II. Sub. 3 and 4.
7. Mountain Top and Escarpment.....Station III. Sub. 1-6.

1. Lake Superior (Station I).

This habitat includes the open water of the lake and is only a feeding place for the birds, as it is impossible for them to nest here.

The water is very cold, the temperature being about 58° F. during the latter part of July. The shores are rocky and steep, the rocks in some places making an angle of 30° with the surface of the water, and on this account, aquatic life, with the possible exception of small algae and invertebrates, was lacking along the edge of the water, so that waterfowls feeding on these would be expected to occur here only occasionally, during the migration season.

The only birds observed, were those of fish eating habits, such as mergansers, loons and gulls. On July 21 a female American Merganser with nine or ten young in the down was seen near the shore. On my approach they swam out into the lake and were soon out of sight behind some rocks that jutted into the water. Two adult Loons were seen the same day, and two days later two Herring Gulls were observed flying over the lake. These were the only birds seen in about fifteen trips made to the lake shore from July 15 to August 13.

2. Lake Beach (Station I).

At this part of the lake shore, the beach is formed by the dipping of the bed rock below the lake, thus making a barren rocky strip, almost destitute of vegetation, between the waters edge and the trees. In addition to the mosses and lichens that grew upon the rocks, the principal plants that

occurred here were goldenrods bluebells, lobelias, etc. that grow in the crevices.

The scarcity of small invertebrates and plants suitable for bird food made this a very poor feeding ground. Indeed the scarcity of bird life here was especially noticeable, as only three birds, the Spotted, Solitary and Least Sandpipers were seen, all of which are shore birds.

Ravens, Crows and Chimney Swifts were seen flying along the shore; the last was probably searching for insects and the first two for fish. Although no dead fish were seen along the shore, no doubt they are occasionally washed up, and these birds were probably patrolling the coast in search of cast up refuse.

3. Cedar Swamp (Station II. 1).

This station extended from the lake beach to the hemlock forest, a distance varying from a quarter to a half mile at different places. The trees were mostly arbor vitae, spruce, Canada balsam and birch, the principal forms being the arbor vitae and balsam. There were several clearings in this substation, and, as the bird life was different at such places than in the woodland, I shall divide this station into two parts, the Woodland and the Clearings.

Woodland.

In some places the woodland has been partially cleared, but where no lumber has been taken out the woods are very dense. The same species of birds, with one or two exceptions, were found in the dense forest as in the open woodland, only there were fewer of them in the former forest. In the very dense forest birds of all species were few and far between. The birds found here were Mangolia Warbler, Black-throated Blue Warbler, Redstart, Winter Wren, Canadian Warbler, Olive-backed Thrush, Golden-crowned Kinglet, Myrtle Warbler, White-throated Sparrow, Brown Creeper, Oven Bird, Crow, Hairy Woodpecker, Purple Finch, Red-eyed Vireo, Cedar Waxwing, Chickadee, Wood Pewee, Ruffed Grouse, Black-throated Green Warbler, Sharp-shinned Hawk, Pileated Woodpecker, Pine Siskin, Mourning Warbler, Raven, and Red-breasted Nuthatch, and Arctic Three-toed Woodpecker. The Black-throated Blue Warbler is characteristic of the undergrowth. The Pine Siskin and Purple Finch were nearly always seen in flocks and roamed about over a large expanse of territory.

The Olive-backed Thrush, Mourning Warbler, Wood Pewee and White-throated Sparrow were found in the open woods.

Clearings in the Cedar Swamp.

There were several clearings in this vicinity, most of them being near the lake. In all of them there were plenty of small trees and brush, in which the birds found favorable conditions.

The birds seen in the clearings were, Black-throated Blue Warbler, Winter Wren, House Wren, Arctic Three-toed Woodpecker, Red-tailed Hawk, Sparrow Hawk, White-throated Sparrow, Crow, Flicker, Purple Finch, Red-eyed Vireo, Chickadee, Canadian Ruffed Grouse, Song Sparrow, Great Horned Owl, Sharp-shinned Hawk, Sparrow Hawk, Pileated Woodpecker, Pine Siskin, American Bittern, Raven, Least Fycatcher, Olive-sided Flycatcher and King Bird.

The Bittern was a straggler, observed once near the lake shore. The Red-tailed Hawk, Raven and Pine Siskins were seen flying overhead, and

the Flickers on the high dead stumps in the clearing. The Purple Finch came to the clearing to feed on the raspberries, and one was shot with part of a berry in its mouth.

Supplementary Clearing Observations.

This clearing is about two miles west of the main line of observation, and one-half mile south of Lake Superior. The conditions here were decidedly swampy, as cat-tails grew in the middle of the logging road in many places. The arbor vitae had been cleared away several years before and the second growth had become quite a factor in the conditions. This growth, together with the underbrush and tree tops, made traveling outside of the logging road very difficult. Here, among a young growth of maple about five or six feet high, was found a family of four Connecticut Warblers.

Other birds seen in this clearing are as follows: Blue-headed Vireo, Red-breasted Nuthatch, Black-throated Blue Warbler, Pileated Woodpecker and White-throated Sparrow.

4. Hemlock Forest (Station II. 2).

This habitat may be called the hemlock belt because the majority of the trees were of this species. The lower part of this station, at the edge of the cedars, was covered with a dense growth of hemlock, while farther up the side of the mountain the proportion of maples increased until finally the hemlocks were nearly all replaced by maples. In the dense hemlock forest there was very little underbrush, but where there were many maples there was always a thick underbrush of young maples and some basswood.

The birds of this Station were: Pine Siskin, Red-eyed Vireo, Cedar Waxwing, Purple Finch, Black-throated Blue Warbler, Chickadee, Hairy Woodpecker, Golden-crowned Kinglet, Brown Creeper, Blackburnian Warbler, Black-throated Green Warbler, Winter Wren, White-throated Sparrow, Oven Bird, Wilson's Thrush, Ruffed Grouse, Olive-backed Thrush, Raven, Pileated Woodpecker, Broad-winged Hawk.

Here, as in the cedars, different species of birds frequented certain places. The Pine Siskins, Purple Finches and Golden-crowned Kinglets were nearly always seen in the hemlocks. The Winter Wrens were observed mostly along streams and in damp places. The Black-throated Blue Warbler was found quite commonly in the underbrush, but where the dense shade prevented an undergrowth, none were observed. The Olive-backed Thrush and White-throated Sparrow were always found in the open woodland.

Supplementary Clearing Observations.

This was a clearing in the hemlock forest about two miles west of the main line of observation and about a quarter of a mile south of Lake Superior.

The birds seen in this clearing were the Purple Finch, Olive-sided Flycatcher, Least Flycatcher, White-throated Sparrow, Song Sparrow and Ruffed Grouse. The Olive-sided Flycatchers were seen sitting on high dead stubs making themselves conspicious by their noise.

5. Hardwood Forest (Station II. 2).

This habitat extended from the hemlock belt through the maples to the aspens about the natural clearing at the top of the cliff. This may be called the hardwood belt because the trees were mostly maple with a few scattered hemlocks, basswood, balsam, and birch. In these woods there was a very thick undergrowth composed mostly of young maples.

The birds observed in this habitat are: Black-throated Blue Warbler, Oven Bird, Black-billed Cuckoo, Cedar Waxwing, Red-tailed Hawk, Flicker, Wilson's Thrush, Red-eyed Vireo, Black-throated Green Warbler, Blackburnian Warbler, Brown Creeper, Chickadee, Pileated Woodpecker, Ruffed Grouse and Olive-backed Thrush. An Oven Bird's nest containing two eggs and one young was found along the path up the mountain on July 16. It was made of coarse grass and leaves, and was placed on the ground. The Olive-backed Thrush, Black-billed Cuckoo, and Flicker were seen near the camp, where the woods were more open.

6. Camp Clearing (Station II. 3-4).

This was the clearing around the camp. It was not more than two acres in extent and was surrounded by a zone of aspens, except on the north where the trees were mostly maple. It was situated at the crest of a low mountain pass, a little more than 750 feet above the level of Lake Superior. It was bounded on the north by Station II. 2, and on the east by II. 2, and III. 1; on the south by IV. 3, and on the west by II. 2, and III. 5; It contained many tall weeds, bushes, and several trees, principally aspen.

The birds found on this station were: Purple Finch, Mourning Warbler, Blackburnian Warbler, Red-eyed Vireo, Black-billed Cuckoo, American Crossbill, Song Sparrow, Downy Woodpecker, Pine Siskin, Sapsucker, Robin, Raven, Sparrow Hawk, Indigo Bunting, Chimney Swift and Cedar Waxwing. The Song Sparrow, Sapsucker and Indigo Bunting were probably accidental here, as only one of each was observed. The Chimney Swift was often seen flying overhead. The Purple Finches and Pine Siskins came to feed on bread crumbs and other refuse from the camp. A pair of adult Mourning Warblers and two young were taken among the bushes in the clearing, July 15.

7. Mountain Top and Escarpment (Station III. 1-6).

From the top of the mountain to the valley of Carp river, there is a precipitous descent of about 400 feet. On top of the cliff and back a few rods from the brink of the precipice, there are no trees except a few scattered pines. The chief vegetation consists of dwarf huckle and blueberries, New Jersey tea, bearberry and other heath plants. The cliff is nearly continuous, but not entirely so, being broken occasionally by gullies. Surrounding the "bald" top of the cliff is a zone of aspen which grades down into the gullies, and down the north slope into the hardwoods. At intervals, where the slope is not so steep, the pines form a narrow belt up the face of the cliff, across the top of the mountain and into the hardwoods beyond, thus surmounting the range.

It is the top of the cliff on the eastern half of Section 14 and western half of Section 13 (III.1, 2, 3) that will be described first.

The western end of the station lies in a gully in Section 14. As the top is approached the aspens become smaller and smaller and finally disappear. Toward the east end of the mountain top, on Section 13, this "bald" area is crossed by a zone of Norway and white pines, many of them being of very large size. The middle portion consists of a precipice and a narrow strip at the top. It differed from the west end in that it contained no aspens, and the pines were so far apart that they had but very little influence upon the general conditions. Probably owing to this reason the bird life on the west end and middle portion was practically identical, and I will describe them together, treating the bird life in the pines separately, as it is entirely different.

Birds were always to be found along the western slope and top (III. 1 and 2), but the small number of species was noticable. The Junco, Cedar Waxwing and Flicker were the only birds that were abundant. The Flicker was often seen on the few tall dead stumps and scattered pines that occurred here, and probably nested in these stumps, as they contained many holes. Both young and adult Juncos were found in abundance and this seemed their natural habitat. The Cedar Waxwing was attracted here by the Juneberries, upon which they were often seen feeding. Crows, Ravens, Chimney Swifts and Red-tailed Hawks were seen flying overhead. Sparrow Hawks came occasionally to feed upon the grasshoppers, but these birds seem to prefer the cliffs to the west of this location.

The birds seen in the pines (III. 3) were the Pine Warbler, Red-breasted Nuthatch, Chickadee, Chipping Sparrow and White-breasted Nuthatch. Two Pine Warblers, evidently a male and female, were seen on the tops of these pines looking for insects. Finally one caught an insect, but instead of eating it the bird perched on a limb, held the insect in its mouth, and scolded. It acted as if it had young near me and was afraid to feed them. Several Chipping Sparrows were seen on the tree tops and one was shot July 19.

The tops of the cliffs west of camp (III. 5) were similar to III. 2, except that the "bald" areas were of greater extent. The same birds that were found in III. 1 and 2 were found here and also a few additional ones.

For some reason, which I cannot explain, Robins, Bluebirds, Blue Jays and Vesper Sparrows were often found on this cliff and seldom in Station II. 1 and 2. A Bluebird's nest containing young was found in a deserted Woodpecker's hole in a Norway pine; Vesper Sparrows and a Scarlet Tanager were seen here once. The former were perhaps migrating, (August 3), while the latter was from the neighboring forest. The Ravens came here n the evening and left in the morning, when nine were counted at one time. A few could be seen about here at almost any hour of the day.

The bird life on the second cliff west of camp was somewhat different from that of the first as no Robins, Bluebirds, or Vesper Sparrows were seen here, while a Phoebe was seen here and not on the other cliffs. Two Bald Eagles were observed flying overhead.

II. CARP RIVER VALLEY.

This region extended from the foot of the talus slope south to the elevation on the other side of the river valley, a distance of about a quarter of a mile. From west to east, it extended from the outlet of Carp Lake as far up the Carp river as we could ascend in a boat, a distance of about one and a quarter miles.

Within this area are included several different varieties of conditions, and these furnish the basis for the following habitats:

1. Carp Lake.....Station V. 1, and 3.
2. Grassy Marshes.....Station V. 2, and IV. 2.
3. Alders.....Station IV. 2.
4. Damp Woodland.....Station IV. 3.
5. Tamarack Swamp.....Station IV. 4.
6. Carp River.....Station IV. 1.
7. Dry Woodland.....Station IV. 3.
   a. Western End.
   b. Eastern End.



FIG. 17. Upper portion of the talus slope, station III. 6, showing the angle of slope, and the lichens (light colored patches) on the rocks. The birches in the background are on the lower part of the slope.



FIG. 18. General view of Carp river valley, looking up stream and southeast from station III. 5. Note the alder and cassandra vegetation bordering the river, station IV. 2.

1. Carp Lake (Station V. 1 and 3).

The lake is about a mile long, a quarter of a mile wide, and comprised, in extent, about one-half of the station. The western half of the lake extended from the foot of the talus slope to the foot of the ridge on the other side, while the eastern half differed from it principally in having a narrow strip of land between the waters edge and the foot of the talus slope on the north side.

Bordering most of the lake there is just enough beach to walk on, except on the northwest shore where it is somewhat wider. On the southwest and southeast shores of the lake, there are small grassy marshes, and at such places bulrushes and sedges grow along the edge of the water.

On the south side arbor vitae, maples, alders, and other trees grow along the edge of the beach. These trees were usually not more than twenty feet high and are so close together that it was almost impossible to penetrate them. At other places there is a fringe of alders along the beach.

Very few birds were seen on the lake; a Loon, was upon the water August 10; Kingfishers were often seen flying across the lake, now and then diving for a fish; an Osprey was observed several times doing the same thing, and a Great Blue Heron was twice seen flying across the lake and once in the sedges. A Swamp Sparrow, a Solitary Sandpiper and Crows were observed on the beach.

2. Grassy Marshes (Station V. 2, IV. 2).

There were two of these grassy marshes. One at the east end of Carp Lake and another a mile and a quarter up Carp river. Both were overgrown with tough marsh grass and were too small to be of any special importance as a bird habitat.

Song Sparrows and Swamp Sparrows came out of the alders to feed but the only birds taken characteristic of grassy marshes were the Wilson's Snipe and Carolina Rail. The former was taken in the marsh, up the river, and the latter in the marsh at the east end of the lake.

3. Alders (Station IV. 2).

The alders occupied the bottom land along either side of Carp river. There are many willows, dogwoods, and cassandra bushes among the alders, and together they formed a thicket so dense, that it was impossible to see more than a few yards.

The birds of this habitat were the White-throated Sparrow, Red-eyed Vireo, Black-throated Green Warbler, Redstart, Oven Bird, Swamp Sparrow, Mourning Warbler, Olive-backed Thrush, Downy Woodpecker, Kingfisher, Sharp-shinned Hawk, Cedar Waxwing, Chestnut-sided Warbler, Chickadee, Canadian Warbler, Rose-breasted Grosbeak, Wilson's Thrush, Black-billed Cuckoo, Alder Flycatcher, Song Sparrow, American Bittern, Ruffed Grouse, Least Flycatcher, Red-winged Blackbird, Water Thrush, and Black-throated Blue Warbler.

The Canadian and Chestnut-sided Warblers and Red-winged Blackbird probably did not breed in this zone, as they were not seen here until after the first of August.

The Kingfisher, American Bittern and Sharp-shinned Hawk were seen along the edge of the river. Only one of each of the last two were seen. The Hawk was on the bank eating a grouse and the Bittern was standing

on an alder that leaned out over the river. Kingfishers were often seen flying up and down the river and would alight upon the overhanging branches to watch for fish.

A Cedar Waxwing's nest was found in an alder. This nest was made of mud and dead grass and was built in the top of the shrub. The nest was found July 28, but contained no eggs.

Almost all of the birds among the alders appeared quite tame, for as soon as I would go into the bushes some bird would begin to scold, nearly always a White-throated Sparrow, and the rest of the birds would come to see what the trouble was about. Redstarts, Mourning Warblers, Black-throated Green Warblers, Oven Birds, Red-eyed Vireos, Swamp Sparrows, Song Sparrows, Wilson's Thrushes, Winter Wrens, Water Thrushes and a Rose-breasted Grosbeak came within a few feet of me. Even the shy Olive-backed Thrush would come within a rod to scold. It was very interesting to observe the marked curiosity which they showed.

4. Damp Woodland (Station IV. 3).

This was a small strip of maple and ash between the alders, and the maple forest of the slopes. The birds seen here were: Red-eyed Vireo, White-throated Sparrow, Winter Wren, Water Thrush, Black and White Warbler, and Least Flycatcher.

The trees of this piece of woodland were not very high but were so crowded that they produced a dense shade. This was perhaps the reason why there were so few birds seen here, and why those seen were near the margin.

5. Tamarack Swamp (Station IV. 4).

About a half mile east of the lake where the river turns to the south, there is, on the west bank, a tamarack swamp. The trees of this swamp are arbor vitae, and tamarack, which about the margin of the swamp grow much thicker than in the center.

The birds observed were as follows: Purple Finch, White-throated Sparrow, Magnolia Warbler, Cedar Waxwing, Red-breasted Nuthatch, Red Crossbill, White-winged Crossbill, Olive-sided Flycatcher, Pine Siskin, Golden-crowned Kinglet and Ruffed Grouse. The two species of Crossbills were probably attracted here by the seeds of the tamarack cones, as the crops of five specimens all contained tamarack seeds. The Red-breasted Nuthatch nested here, as an adult bird was seen feeding three young. The Olive-sided Flycatchers were seen on the tops of tall dead trees.

6. Carp River (Station IV. 1).

About a mile and a quarter east of Carp Lake, the river becomes so narrow that the alders which line the banks meet above the middle of the stream and obstruct further passage with a boat. Where the alders line the bank there were few places for wading birds, but where there were grassy mud flats between the water and the shrubs Solitary Sandpipers were to be seen at almost any time. The Snipe, however, was only seen July 17 and 18. The only birds seen on the river were Hooded Mergansers.

7. Dry Woodland (Station IV. 3, North of Carp River).

This is the upper part of the strip of woodland lying between the cliff and Carp Lake, on the north side of the valley, and occupies the lower part

of the talus slope. The trees here were mostly maple, birch and aspen, with a few pines scattered among them. At the eastern end the forest was open, while the trees of the western end were so close as to make a dense shade. On account of the difference of the character of the two portions, they will be taken up separately.

Western End. Here, where the trees were thick, few birds were seen. The different species noticed were as follows: Blackburnian Warbler, Kingfisher, Sparrow Hawk, Red-eyed Vireo, Wilson's Thrush, Canadian Warbler, Blue Jay and Redstart. There was a Sparrow Hawk's nest situated high up in a dead tree, in what seemed to be a deserted Woodpecker's hole. The young of the Wilson's Thrush, still unable to fly, were found here.

Eastern End. The birds found in this end of the forest were: Black-throated Blue Warbler, Robin, Ruffed Grouse, Flicker, Downy Woodpecker, Oven Bird, Olive-backed Thrush, Red-eyed Vireo, Black-billed Cuckoo, Blackburnian Warbler and White-throated Sparrow. In the evening and morning the song of the Olive-backed Thrush could be heard almost everywhere in the tree tops, and they seemed to be quite numerous, but in the daytime this bird was seldom heard. The probable explanation of this is that they went into the alder thickets to the south.

III. HARDWOOD FOREST SOUTH OF CARP RIVER (STATION VI.).

The trees along the trail to Government Peak were mostly maple, birch and hemlock, except in low places along the small streams, where there was much arbor vitae and balsam.

Observations along the trail were made July 26 and the following birds were seen in the forest: Oven Bird, Golden-crowned Kinglet, Scarles Tanager, Red-eyed Vireo, Magnolia Warbler, Black-throated Blue Warblert Wood Pewee, Winter Wren and Olive-backed Thrush. The Magnolia, Warbler, Wood Pewee and Winter Wren were seen along a stream.

An Olive-backed Thrush's nest was found on top of a small hemlock about ten feet high beneath a larger tree. The nest was composed of leaves, rootlets, and grasses, and was lined with still smaller grasses and rootlets, and contained two bluish green eggs with cinnamon brown spots.

IV. LITTLE CARP RIVER VALLEY.

1. Little Carp Lake (Station VII. 1).

This lake is small, being about one-half mile long and a quarter of a mile wide. The only observations made upon the bird life on the lake shore were in an open spot at the east end. Only one bird was seen on the water, a Pied-billed Grebe, on August 2.

The open area was at the foot of a small hill which arose precipitously out of the lake to a height of about fifty feet. There was very little soil, which accounts for the absence of an extensive vegetation. Observations were made on August 2 and 3 and the birds seen were: Blue Jay, Junco, Humming Bird, Yellow-bellied Sapsucker, Hairy Woodpecker, White-throated Sparrow, Wood Pewee, Purple Finch, Chimney Swift, Raven, Kingfisher, Cedar Waxwing, Flicker and Song Sparrow. The Chimney Swift and Raven were seen flying overhead.

2. Beaver Meadow (Station VII. 2 and 3).

This meadow was along Little Carp river, about a quarter of a mile east of Little Carp Lake. It was about a mile long and a quarter of a mile wide, the Little Carp river running through the middle of it. The ground was quite marshy in many places and was covered with grass, there being no trees in the meadow. There were several willow and alder bushes at the east end. The surrounding trees were alder, tamarack, arbor vitae, balsam and birch.

Observations were made on August 3, and the birds seen here were: Kingfisher, Solitary Sandpiper, Cedar Waxwing, Red-eyed Vireo, Swamp Sparrow, Song Sparrow, White-throated Sparrow, Marsh Hawk, Pine Siskin, Hairy Woodpecker, Tree Swallow, White-winged Crossbill, Yellow-legs, Least Sandpiper, Red-breasted Nuthatch.

The Kingfisher, Solitary Sandpiper, Least Sandpiper, and Yellow-legs were seen along Little Carp river. The Tree Swallow, Marsh Hawk and Pine Siskin were seen flying overhead, and the Song Sparrow and Swamp Sparrow were seen feeding in the grass, while the rest were seen in the trees around the edge. The Crossbills were seen in tamarack trees at the edge of the marsh. As it was August 3 when I was at the beaver meadow, I cannot say which birds bred there and which were migrants.

V. SUMMARY.

On glancing over the list of birds found at the different stations, it will be noticed that some birds were found at only one or in a few stations, while others were found in nearly all of them. At some stations a certain species of bird would be quite numerous, while another only a short distance away, would contain none of these. From such facts we must conclude that some birds are found only in certain situations which possess definite environmental conditions. There were also a number of birds observed which were too rare to determine what kind of localities they preferred; still others were only seen flying overhead. Regarding abundance, at one extreme were the rare forms and at the other those found almost everywhere. The rare birds were: Myrtle Warbler, Great Horned Owl, Black and White Warbler, Indigo Bunting, Broad-winged Hawk, Humming Bird, Arctic Three-toed Woodpecker, Connecticut Warbler, Blue-headed Vireo, Rose-breasted Grosbeak, Scarlet Tanager, House Wren, King Bird, White-breasted Nuthatch and Phoebe. The birds only seen flying overhead were: Red-tailed Hawk, Chimney Swift, Bald Eagle, Tree Swallow and Marsh Hawk. The birds of general distribution were: Ruffed Grouse, Red-eyed Vireo, Black-throated Green Warbler, Chickadee, Purple Finch, Black-throated Blue Warbler, Sharp-shinned Hawk, Cedar Waxwing, Oven Bird and Wilson's Thrush.

In the case of birds with a restricted range, the limiting area was occasionally very sharply defined, while in other cases it was difficult to recognize these limits. Examples of the former are the water and shore birds, of the latter, the Golden-crowned Kinglet and Pine Siskin. The distribution of the water and shore birds was the most sharply defined, and, as they are the simplest to place, I will begin my summary with them. In connection with these I will also mention other birds found in association with the shores of the lakes and rivers.

1. Water Birds. Of the water birds only a few species were observed. The Herring Gull, Loon and American Merganser were found on Lake



FIG. 19. Carp river, station IV, showing zones of vegetation on the mud flats



FIG. 20. Beaver meadow, station VII. 2, showing grasses and sedges bordered by encroaching willows and alders. Tamarack and spruce in the background.

Superior. A Loon was once seen on Carp Lake and a Pied-billed Grebe was seen on Little Carp Lake. The only water bird found on the rivers was the Hooded Merganser which was taken on Carp river.

Although not an aquatic bird, I will mention the Osprey here as it was seen flying over the water. It was first seen near the mouth of Union river and afterwards over Carp Lake. It would circle around above the water until it saw a fish and then it would plunge into the water after it. As far as observed most of these efforts were successful.

2. Birds Frequenting Shores and Banks of Streams. Shore birds were most abundant along Carp and Little Carp rivers; only a few were seen on the lake beaches. The Solitary Sandpiper was the only one seen in all the places mentioned. The Lesser Yellow-legs was seen only along Little Carp river. The Least Sandpiper was seen along Little Carp river and on the Lake Superior beach. The Spotted Sandpiper was seen only on the Lake Superior beach. These birds were always seen near the waters edge except when on the wing. A Snipe was seen at the edge of the water along Carp river, in the neighborhood of a grassy marsh.

Another bird that was characteristic of the rivers and small lakes was the Kingfisher, which was nearly always seen at the edge of the water, but never on the ground. It always lit on some bush or tree, and was most frequently seen on trees overhanging the water. The Great Blue Heron was seen standing on the edge of Carp Lake once, and several times it was seen flying over.

Besides the birds characteristic of the waters edge, birds from the alders and birds of general distribution were often observed on the beach of Carp Lake and Lake Superior. This includes such birds as the Song Sparrow, Swamp Sparrow, Crow and Raven.

3. Birds Found in Grassy Marshes and in Alders. Closely associated with the birds of the water's edge were the birds of grassy marshes and alders along the streams. The birds often seen in the grassy marshes were the Wilson's Snipe, Rail, Song Sparrow, and Swamp Sparrow. The Rail was only seen once in the grassy marsh east of Carp Lake.

The Song Sparrow and Swamp Sparrow are not confined to the grassy marshes, since both were also found in the alders. The Song Sparrow was also found in the camp clearing (Station III. 3) and in one of the clearings in the arbor vitae swamp (Station II. 1), so that the Song Sparrow may be said to inhabit clearings both natural and artificial, and the Swamp Sparrow may be said to inhabit marshy clearings. In this case I have classed the alders as a natural clearing because there were no trees among the bushes.

The only bird confined to the alders was the Alder Flycatcher, but several others, of limited distribution, were found here, such as the Redstart, Swamp Sparrow, Mourning Warbler, Olive-backed Thrush, Black-billed Cuckoo, Least Flycatcher, Song Sparrow, and Water Thrush.

The Redstart was rather common here and among the cedars near the shore of Lake Superior (Station II. 1) and was also seen along Little Iron river. It seems to keep near water and near the ground, as it was very seldom seen in the high trees.

The Mourning Warbler was found here, but also in the bushes of the camp clearing, and along the path to the lake in the cedar swamp (Station II. 1). Thus it is seen that this bird is not usually found in thickly forested woodland but is more decidedly a bird of the bushes or thickets.

The Olive-backed Thrush was found on the mountain top, in the river

valley, and in the bushes around the edge of the clearings or in partially cleared woodland. In the mornings and evenings it also appeared abundant among the scattered trees at the base of the talus slope. It was never found in dense woodland.

The Black-billed Cuckoo was often seen among the alders, in the scattered trees at the foot of the talus slope, and in the aspens surrounding the camp clearing. These facts show that it was a bird of the open woodland.

The Least Flycatcher was found in the alders and in a clearing in a hemlock forest; the former a natural, and the latter an artifical clearing. It was also seen in damp woodland south of Carp river, on the edge of a clearing.

The Water Thrush was seen in two other localities, the damp woodland south of Carp river, and along the road to Ontonagon near Lake Superior.

4. Birds Frequenting Tamarack Swamps and Cedar Swamps. . The lowlands have all been dealt with, with the exception of the tamarack swamps and cedar swamps. The former was not entirely true to its name, as about half of the trees were cedar. The birds of these swamps deserving mention are as follows: Magnolia Warbler, Canadian Warbler, Sparrow Hawk, and Olive-sided Flycatcher, Red-breasted Nuthatch, Red Crossbill, White-winged Crossbill, Winter Wren, White-throated Sparrow, Golden-crowned Kinglet and Pine Siskin.

The Magnolia Warbler was found only in the cedar and tamarack swamps or along small streams where the arbor vitae grew.

The Canadian Warbler was found near Lake Superior shore and near Carp Lake and always in the more or less open woods.

The Sparrow Hawk was seen in a clearing among the cedars, and had a nest just south of the cliff in a limbless tree which stood above the tops of the surrounding trees. It was also often seen on the top of the cliff and around the camp clearing.

The Olive-sided Flycatcher was found in the tamarack swamp in Carp river valley and in a hemlock clearing near Lake Superior. It was always seen on the top of a dead tree, usually on the highest perch in the neighborhood.

The Red-breasted Nuthatch was seen in the tamarack swamp, and among the pines at the top of the mountain. It can, therefore, be classed with the birds characteristic of the coniferous forests.

The Red, and White-winged Crossbills were numerous in the tamarack swamps, the White-winged Crossbill being seen only in such places. The Red Crossbill came to the camp clearing several times. The cause for their occurrence in the tamaracks is that these are the only conifers whose seeds could be obtained for food.

The Golden-crowned Kinglets and Pine Siskins were very abundant among the coniferous trees, and were seldom seen where these were lacking. The Pine Siskin occasionally came to the camp clearing.

The Winter Wren and White-throated Sparrow were found in the lowlands and about half way up the mountain side. The White-throated Sparrow frequented the open woodland and the edge of the clearings. The Winter Wren was found in the more dense parts of the forests and near streams.

5. Birds Frequenting Hemlocks and Maples. Nearly all the birds that were found in these two stations were also found in the cedar swamp to the north (II. 1) or belonged to the list of rare birds. There were a number of birds that were generally distributed in all the woodland between the Lake Superior and Carp river which, with the exception of the Blackburnian Warbler,

seemed to be more abundant in these two stations. To this class belong the following: Oven Bird, Blackburnian Warbler, Hairy Woodpecker, Brown Creeper and Pileated Woodpecker.

6. Birds Frequenting the Cliff and Mountain Top. The birds characteristic of this station were the Raven, Pine Warbler, Robin, Bluebird, Flicker, Junco and Chipping Sparrow.

The two specimens of Pine Warbler, which were observed several times, were always found among the pines that grew on the top and south slope, so it may be said to be characteristic of the pines.

The Robin and Bluebird were often observed on the bare top of the cliffs, and occasionally the Robin was seen in the camp clearing near by. The Robin and the Bluebird are early migrants and may have settled here because it was on the south side of the mountain and well exposed to the sun and protected from the north winds.

The Flicker was found here and in a clearing along the south shore of Lake Superior. The Junco was abundant here and was seen in a dry sandy clearing near Ontonagon. It was also abundant on the dry knoll at the edge of Little Carp Lake so that this bird and the Flicker may be said in this region to inhabit dry clearings. They are also examples of the tendancy of natural clearing birds to spread into the artificial clearings.

The Chipping Sparrow was found here among the pines and on the dry knoll above mentioned.

The Blue Jay was found on the south slope of the cliff from the top to the edge of Carp Lake and on the dry knoll.

I have here only attempted to give the distribution of the birds as I found them in the Porcupine Mountains. The distribution of many of these birds may be very different in other localities. This would be an interesting field for study in other regions.

I am under obligations to the University Museum for the opportunity to make these observations, and I am also much indebted to Mr. Charles C. Adams for assistance in preparing this paper for publication.

THE ECOLOGICAL RELATIONS OF THE ORTHOPTERA IN THE PORCUPINE MOUNTAINS, MICHIGAN.

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1. GENERAL REMARKS.

The Orthoptera collected by Mr. A. G. Ruthven in the Porcupine Mountains represent two families of the *Saltatoria* and comprise two species of *Locustidae* and 14 species of *Acridiidae*. The collection was made between July 13 and August 12, 1904. Though the list is far from complete, it may be said, in general, that the species obtained are representative elements of the orthopterous fauna of the Canadian and cooler parts of the Transition zones of the central portion of the continent. The commingling of species is especially interesting, and in itself would suffice to indicate, within relatively narrow limits, the locality from whence the collection was derived and the environmental conditions present.

While data in addition to those of date, locality, and general character of the station are lacking—no notes on individual captures or particular species and their relation to the environment in this instance being available—I have no doubt that the ecological relations of the species secured are essentially the same as in other quarters of the eastern section of the country. This judgment is confirmed by the careful collecting notes and discriminating observations of Mr. Morgan Hebard in reference to the Orthoptera of the Keweenaw Bay region (Rehn, Entom. News, Sept., Oct., 1904). I have elsewhere (Pub. No. 18, Carnegie Inst. of Wash., p. 15 et seq.) classified the Acridian societies of eastern North America and discussed some of their more salient features. The same classification is followed in the present paper.

The Acridians secured represent several distinct societies and habitats. These habitats, or complexes of environmental conditions, when viewed from the standpoint of locust biology, may be arranged in three major groups:

1. Bare rock and soil surfaces of the lake shore, clearing, mountain top, or talus slope, either wet or dry,—these are inhabited by campestral geophilous locusts.
2. Areas clothed with a low vegetal growth of grasses or other herbaceous plants, such as meadows, fields, clearings, etc., likewise varying greatly in moisture content of soil, and often extremely limited in size,—these are the haunts of campestral phytophilous locusts.
3. Thickets of shrubs or stunted undergrowth bordering forest edges and openings, either along the lake shore, about clearings, or on the mountain top,—here dwell the sylvan phytophilous species.

Of the Locustarians collected, one species is a bush-dwelling form, nearly related to the katydid; the other, a shield-backed grasshopper, is a typical thicket-inhabiting species.

As is evident from Mr. Ruthven's field notes on the general character of the stations, and also from a consideration of the station lists of Orthoptera, almost every station contains two or more locust societies. These societies comprise one or more characteristic species of locusts which find their preferred haunts within a relatively narrow range of physical conditions and are practically characteristic of such habitats. It should be pointed out, however, that in the heart of its range a species is usually more generally distributed, and less restricted to its special habitat, than elsewhere; furthermore, that accidental occurrences are not infrequent and can be correctly estimated as such only by careful observation or experience. "One swallow does not make a summer," and the capture of a single specimen of a locust in a given locality does not necessarily indicate either an austral or a boreal climate, a campestral or a sylvan habitat.

It is scarcely necessary to state that the abundance and extent of the area occupied by the various elements of the locust fauna will inevitably be affected by the physical and organic agencies controlling the condition of the environments they inhabit, and, other things being equal, will change as they change. On the advent of new conditions one of three things will happen: either the species will become adapted to its changed environment, will emigrate, or will die out in that particular spot—probably the latter. There is every reason to think that with increasing deforestation of the territory, the thamnophilous locusts will increase in numbers; and that, if settlements and clearings multiply, so will the campestral locusts.

The avenue of ingress of the orthopterous fanua into this territory, it is believed, was on the southwest, along the continuous land surface, following the retreat of glacial conditions. This avenue was probably the only practicable one open to the flightless thicket-dwelling forms, and was doubtless followed by most, or all, of the flying species as well.

For further information in regard to the biology of the Orthoptera herein mentioned, the following works should be consulted, in addition to those already referred to:

Blatchley, W. S.—The Orthoptera of Indiana.—27th Annual Report of the Department of Geology and Natural Resources of Indiana.

Morse, Albert P.—Notes on the Acridiidae of New England.—Psyche, vols. VII, and VIII.

The former of these contains a valuable bibliography.

2. STATION LIST.

Station I. Beach of Lake Superior. Species taken: *Chloealtis abdominalis*, *Camnula pellucida*, *Circotettix verruculatus*, *Melanoplus atlanis* and *Melanoplus femoratus.*

Habitats represented and characteristic species.

1. Exposed rock or soil surfaces: *Circotettix verruculatus*, (*Camnula pellucida*).
2. Grassy places—dry: *Melanoplus atlanis* and *Camnula pellucida.*
3. Grassy places—moist: *Melanoplus femoratus.*
4. Thickets—forest edge: *Chloealtis abdominalis.*

Station II. North Slope of First Range. Species taken:

Sub. 2.—Hardwood Forest.—*Tettix brunneri.*

Habitats represented and characteristic species.

The single species taken is not typical of forested environment, usually occurring on bare soil.

Sub. 3.—*Clearing in Saddle.* Species taken: ***Chloealtis conspersa, Stenobothrus curtipennis, Circotettix verruculatus, Melanoplus extremus,*** and ***Melanoplus femoratus.***

Habitats represented and characteristic species. (No notes on conditions at this station have been submitted, but the habitats are probably the following:)

1. Exposed rock or soil surfaces: ***Circotettix verruculatus.***
2. Grassy places—moist: ***Stenobothrus curtipennis, Melanoplus extremus*** and *Melanoplus femoratus.*
3. Thickets—edges of clearing (sometimes in dry, grassy places): *Chloealtis conspersa.*

Sub. 5.—*Aspen Zone Bordering Bare Mountain Top.* Species taken: *Melanoplus fasciatus.*

Habitats represented and characteristic species.

1. Thickets—usually xerophytic: *Melanoplus fasciatus.*

Station III. Top of First Range and Southern Escarpment. Species taken:

Sub. 1.—West Slope of Ridge (aspen zone).—*Chlbealtis abdominalis, Chloealtis conspersa, Camnula pellucida, Melanoplus fasciatus, Melanoplus femoratus* and *Melanoplus luridus.*

Sub. 2.—Bare Mountain Top (heath and grass vegetation).—***Chloealtis abdominalis,*** *Chloealtis conspersa, Circotettix verruculatus, Melanoplus fasciatus* and *Melanoplus islandicus.*

Sub. 3.—Zone of Pines crossing Mountain Top.—*Melanoplus fasciatus.*

Sub. 4.—East Slope of Ridge (aspen and scrub oak vegetation).—*Melanoplus fasciatus* and *Atlanticus pachymerus.*

Sub. 5.—Mountain Top.—*Chloealtis abdominalis, Chloealtis conspersa, Melanoplus fasciatus, Melanoplus femoratus, Circotettix verruculatus* and *Atlanticus pachymerus.*

Sub. 6.—Mountain Top.—*Melanoplus amplectens.*

Habitats represented and characteristic species.

1. Exposed rock surfaces:—*Circotettix verruculatus.*
2. Grassy places—(usually moist):—*Melanoplus femoratus.*
3. Thickets:—*Chloealtis conspersa* and *abdominalis, Melanoplus amplectens, fasciatus,* and *islandicus, Atlanticus pachymerus.*

Station IV. 2. Carp River Valley Flood-plain (characterized by cassandra thickets, grasses and sedges). Species taken: *Stenobothrus curtipennis, Podisma glacialis, Melanoplus islandicus, Atlanticus pachymerus, Scudderia pistillata.*

Habitats represented and characteristic species.

1. Grassy places—moist:—*Stenobothrus curtipennis.*
2. Thickets:—*Podisma glacialis, Melanoplus islandicus, Atlanticus pachymerus.*
3. Bushes, leafage of:—*Scudderia pistillata.*

Station VII. 2. Beaver Meadow along Little Carp River. Species taken:—*Camnula pellucida.*

Habitats represented and characteristic species.

1. Grassy places—moist. The species of locust taken here is not characteristic of such conditions, but it is a very common and widely distributed species in the boreal zones, and may occur almost anywhere, especially in grassy places. Its preferred haunts are on dry upland soils.

3. SYSTEMATIC LIST OF THE ORTHOPTERA.

Porcupine Mountains.

ACRIDIIDAE.

1.	*Tettix brunneri* Bol.	1 ♂, Station II.
2.	*Chloealtis abdominalis* Thom.	1 ♂, Station III., Substation 1.
	" "	1 ♂, III., 2.
	" "	2 ♂, 3 ♀, III., 5.
	(juv. spec. do.)	♀, juv. in the 5th stage, I.
	"	♂, juv. in the 5th stage, III., 2.
	"	2 ♀, juv. in the 5th stage, III., 2.
	"	♀, juv. in the 4th stage, III., 2.
	"	♀, juv. in the 5th stage, III., 5.
3.	*Chloealtis conspersa* Harr.	1 ♀, II., 3.
	" "	1 ♀, III., 1.
	" "	1 ♀, III., 1, long-winged.
	(juv. spec. do.)	♂, juv. in the 5th stage, III., 1.
	"	♂, juv. in the 4th stage, III., 2.
4.	*Stenobothrus curtipennis* Harr.	2 ♀, II., 3.
	" "	2 ♂, IV., 2.
	" "	1 ♀, IV., 2.
5.	*Camnula pellucida* Scudd.	1 ♀, III., 1.
	" "	1 ♂, I., beach.
	" "	1 ♀, I., beach.
	" "	2 ♀, VII., 2.
6.	*Circotettix verruculatus* Kirb.	1 ♀, II., 3.
	" "	3 ♂, III., 2.
	" "	1 ♂, III., 2.
	" "	1 ♀, III., 2.
	" "	1 ♀, III., 2.
	" "	1 ♀, III., 5.
	" "	2 ♂, I., beach.
	" "	1 ♀, I., beach.
7.	*Podisma glacialis* Scudd.	1 ♀, IV., 2.
8.	*Melanoplus amplectens* Scudd.	1 ♀, III., 6.
9.	*Melanoplus atlanis* Ril.	1 ♂, I., beach.
10.	*Melanoplus extremus* Walk.	2 ♀, II., 3.
11.	*Melanoplus fasciatus* Barnst.-Walk.	1 ♂, II., 5.
	" "	1 ♀, II., 5.
	" "	1 ♂, III., 2.
	" "	1 ♂, III., 2.
	" "	4 ♀, III., 2.
	" "	1 ♂, III., 3.
	" "	1 ♀, III., 3.
	" "	1 ♂, III., 4.
	" "	1 ♂, 4 ♀, III., 5.
12.	*Melanoplus femoratus* Burm.	4 ♂, II., 3.
	" "	8 ♀, II., 3.
	" "	1 ♀, III., 1.
	" "	1 ♂, III., 5.
	" "	2 ♀, I., beach.
	" "	1 ♂, I., beach.
	(juv. spec. do.)	2 ♀, juv. in the 5th stage, II., 3.

13.	*Melanoplus islandicus* Blatchl.	1♀, II., 5.
	" "	1♂, III., 2.
	" "	1♀, IV., 2.
14.	*Melanoplus luridus* Dodge.	1♂, III., 1.

LOCUSTIDAE.

15.	*Scudderia pistillata* Brunn.	1♀, IV., 2.
16.	*Atlanticus pachymerus* Burm.	1 juv. ♀, III., 4.
	" "	1♀, III., 4.
	" "	1♀, IV., 2.
	" "	1♂, III., 5.

Isle Royale.

The following species were identified from this locality; no field notes accompanied the specimens.

1.	*Tettix acadicus* Scudd.	1♀, III.
2.	*Camnula pellucida*, Scudd.	2♂, 2♀, II.
3.	*Ceuthophilus seclusus* Scudd.	1♂, III.
	" "	1♀, III.

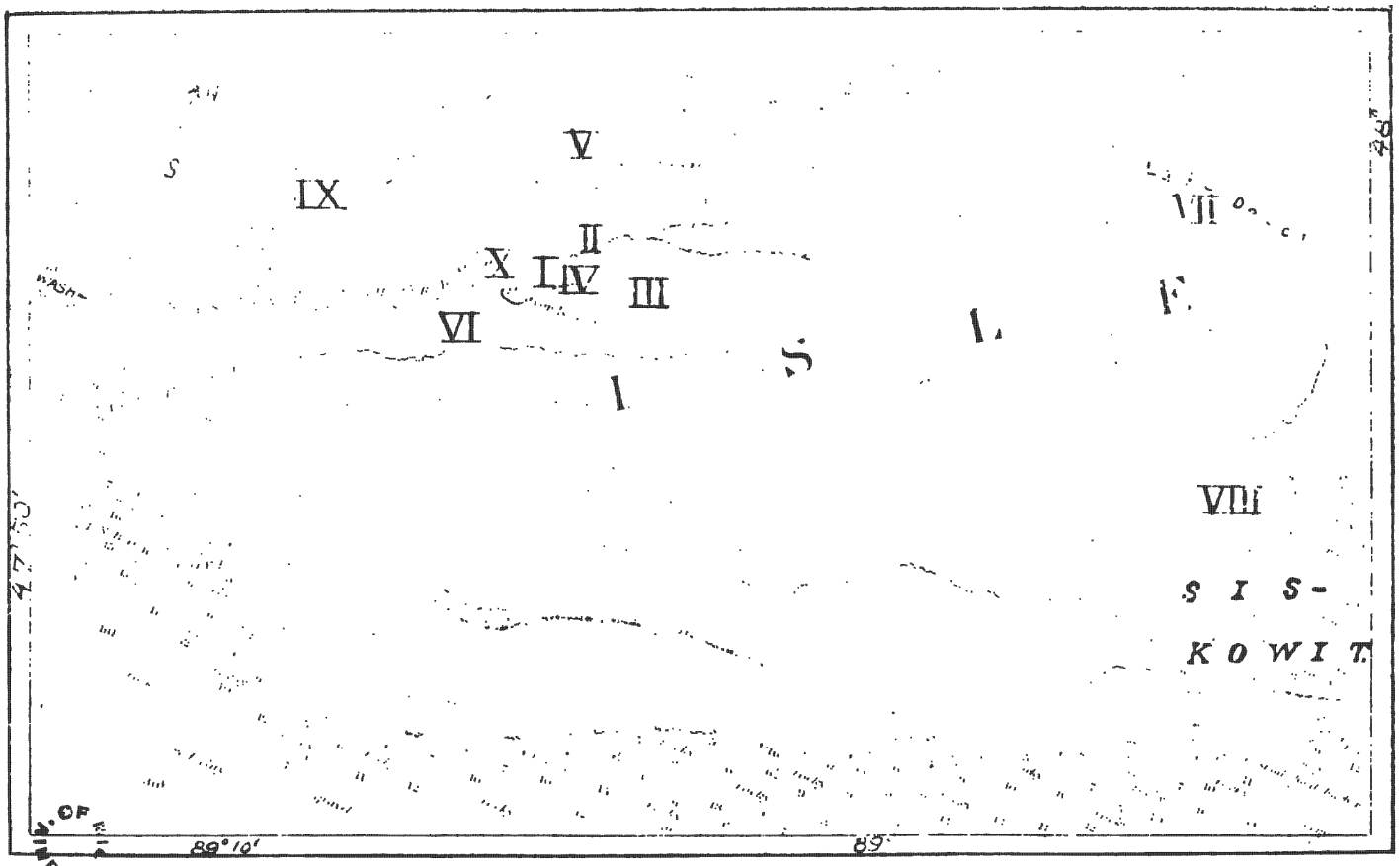


FIG. 21. Map of lower end of Isle Royale, showing the location of field stations. Scale, 2 miles to the inch. (From U. S. Lake Survey Chart).

ANNOTATED LISTS.

LIST OF STATIONS IN THE PORCUPINE MOUNTAINS.

See Fig. 3.

Station I.—Beach of Lake Superior, Secs. 11 and 12, T. 51 N., R. 43 W.

Station II.—North Slope of First Range, Secs. 11, 12, 13, 14, 15, and 16, T. 51 N., R. 43. W.

Sub. 1.—Arbor Vitae Swamp at Foot of Slope, Secs. 11 and 12.

Sub. 2.—North Slope, Secs. 11, 12, and 14.

Sub. 3.—Clearing in the Saddle, Sec. 14.

Sub. 4.—Aspen Zone about Clearing, Sec. 14.

Sub. 5.—Aspen Zone at Top of Ridge bordering the Bare Mountain Top, Secs. 13, 14, 15, 21, T. 51 N., R. 43 W.

Station III.—Top of the First Range and the Southern Escarpment, Secs. 13, 14, 15, and 21, T. 51 N., R. 43 W.

Sub. 1.—West Slope of the Ridge on Secs. 13 and 14.

Sub. 2.—Bare Mountain Top, Secs. 13 and 14.

Sub. 3.—Zone of Pines crossing the First Range, Secs. 13 and 14.

Sub. 4.—East Slope of the Ridge on Secs. 13 and 14.

Sub. 5.—Mountain Top on Sec. 14 and 15.

Sub. 6.—Mountain Top on Sec. 21.

Station IV.—Carp River Valley on Secs. 13, 14, 23, and 24, T. 51 N., R. 43 W.

Sub. 1.—Carp River, Secs. 14 and 24.

Sub. 2.—Flood-plain, Sec. 14.

Sub. 3.—Valley Slopes, Secs. 14 and 23.

Sub. 4.—Peat Bog, Sec. 14, 23 and 24.

Station V.—Carp Lake, Secs. 15, 21 and 22, T. 51 N., R. 43 W.

Sub. 1.—Beach at West End of Lake, Secs. 21 and 22.

Sub. 2.—Delta at East End of Lake, Sec. 22.

Sub. 3.—Carp Lake, Sec. 22.

Station VI.—Mountains between the Carp and Little Carp Drainage Systems, Secs. 21, 22, 23, 27, 28, and 34, T. 51 N., R. 43 W.

Station VII.—Little Carp Drainage System, Sec. 2, T. 50 N., R. 44 W., and Sec. 34, T. 51 N., R. 43 W.

Sub. 1.—Little Carp Lake, Sec. 2, T. 50 N., R. 44 W.

Sub. 2.—Beaver Meadow along Little Carp River, Sec. 34, T. 51 N., R. 43 W.

Sub. 3.—Little Carp River, Sec. 34, T. 51 N., R. 43 W.

LIST OF STATIONS ON ISLE ROYALE.

See Fig. 21.

Station I.—Clearing on the Shore of Washington Harbor, Sec. 29, T. 64 N., R. 38 W.

Station II.—Washington River, Sec. 29, T. 64 N., R. 38 W.

Station III.—Trail along the Top of Greenstone Range, T. 64 N., R. 38 W.

Station IV.—Washington Creek, Secs. 28 and 32, T. 64 N., R. 38 W.

Station V.—Tamarack Swamp, Sec. 20, T. 64 N., R. 38 W.

Station VI.—North Slope of Greenstone Range, Sec. 32, T. 64 N., R. 38 W.

Station VII.—Lake Desor, T. 64 N., R. 32 W.

Station VIII.—West End of Siskowit Bay, T. 64 N., R. 32 W.

Station IX.—Southwestern End of Minong Trap Range, Sec. 30, T. 64 N., R. 39 W.

Station X.—Washington Harbor, T. 64 N., R. 38 W.

NOTES ON THE PLANTS OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

A. G. RUTHVEN.

This list has been prepared from the collections and field notes of Mr. N. F. Macduff, and the field notes of the writer. To Mr. Macduff, who devoted his time to collecting and listing the plants, many of the determinations and most of the annotations are due. The writer was able to add many localities to the list while locating the different stations. We are indebted to Dr. C. A. Davis and Mr. S. Alexander for the determination of the Pteridophytes and Spermatophytes in the herbarium, and to Prof. B. Fink for the determination of the Lichens. The nomenclature followed is that given in Britton's "Manual of the Flora of the Northern States and Canada," (1901). For the general habitat conditions and associations, reference should be made to the discussion of the stations on pp. 22-40, 48-52.

1. PORCUPINE MOUNTAINS.*

Lichens

1. *Amphiloma* (*Pannaria*) *languinosum* (Ach.) Koerb. Found only in shady places on the cliff face, III.
2. *Biatora lucida* (Ach.) Fr. Associated with *Amphiloma languinosum* on the cliff face, III.
3. *Cladonia alpestris* (L.) Rabenh. Occurs in mats, covering the talus blocks toward the bottom of the slopes where a slight soil has accumulated, III.
4. *Cladonia rangiferina* (L.) Hoffm. Abundant on the lower part of the talus slopes with *C. alpestris*, also on ledges of the cliff that possess a slight soil, III, and in the pine zone, III. 3.
5. *Endocarpum miniatum* (L.) Sch. Covering the rocks in very damp places on the banks of Carp creek, VI.
6. *Gyrophora* (*Umbilicaria*) *vellea* (L.) Nyl. Only found on the cliff face, III.
7. *Lecidea lactea* Flk. This species is one of the pioneer forms on rock habitats and was found associated with *Parmelia conspersa* and *Lecanora cinerea* on the mountain top, cliff face and talus slopes, III; also on the Middle Beach of Lake Superior, I.
8. *Lecanora conspersa*. With *Parmelia conspersa* and *Lecidea lactea* on ledges on the cliff, and on the talus slopes, III. Apparently a pioneer form in rock habitats.
9. *Lecanora cinerea* (L.) Sommerf. A pioneer form in rock habitats,

*A list of plants from the Porcupine Mountains was published by W. A. Burt in 1848. Jackson, 1st Sess. 31st Cong., Vol. 3, pp. 876–882.

occurring on the Middle Beach of Lake Superior, I, and on the mountain top, cliff and talus slopes, III.

10. *Parmelia conspersa* (Ehrh.) Ach. This is the most characteristic form on rock habitats in this region. It occurs abundantly on the Middle Beach of Lake Superior, I, and on the mountain top, cliff, and talus slopes, III.

11. *Peltidea (Peltigera) aphthosa (L.)* Ach. Found quite commonly on rocks in the pine zone, III. 3, and with the Cladonias near the bottom of the talus slopes, III.

12. *Stereocaulon coralloides* Fr. On the mountain top, cliff, and talus slopes, III.

13. *Sticta pulmonaria* (L.) Schau. Occasional on the trunks of fallen tamarack trees, IV. 4.

Ophioglossaceae Presl. Adder's-Tongue Family.

14. *Botrichium virginianum* (L.) Sw. In the climax forest, II. 2, IV. 3, VI.

Osmundaceae R. Br.

15. *Osmunda cinnamomea* L. Cinnamon Fern. Occasional in the alder thickets along Carp river, IV. 2.

16. *Osmunda claytoniana* L. Clayton's Fern. In hardwood forest, II. 2, VI, (Macduff).

Polypodiaceae R. Br. Fern Family.

17. *Polypodium vulgare* L. In exposed situations, occurring commonly on the Upper Beach of Lake Superior, I; on the bald areas on the mountain top, III. 2, 5, 6; in the aspen zone, II. 5, and III. 1, 4; in the pine zone, III. 3, and on the lower parts of the talus slope.

18. *Adiantum pedatum* L. Maiden-hair Fern. Common in the mesophytic forest, II. 2, IV. 3, VI.

19. *Pteridium aquilinum* (L.) Kuhn. Brake. In open places in the forest, II. 2, IV. 3, VI, becoming more abundant in the open woods toward the top of the ranges and on the foot of the talus slope. Especially abundant in the aspen zone bordering the mountain top, II. 5, III. 1, 4. Also in the pine zone, III. 3.

20. *Asplenium trichomanes* L. Spleenwort. In rock crevices on the mountain top, III. 2, 5, 6, and on ledges and in crannies on the cliff face, III.

21. *Polystichum lonchitis* (L.) Roth. Holly-fern. In rock crevices on the mountain top, III. 2, 5, 6; on ledges on the cliff face, and in front of the forest on the lower part of the talus slopes, III.

22. *Dryopteris spinulosa* (Retz) Kuntze. In the hardwood forest, II. 2. Common.

23. *Onoclea sensibilis* L. Sensitive Fern. In the alder thickets along Carp river, IV. 2, and on the banks of Carp creek, VI.

Equisetaceae Michx. Horsetail Family.

24. *Equisetum sylvaticum* L. In the forest in the valley of Carp river, IV. 3, and on Government Peak, VI, (Macduff).

25. *Equisetum littorale* Kuehl. On the delta of Carp river, V. 2.

26. *Equisetum fluviatile* L. On the submerged part of the delta in Carp Lake, V. 2; about the margin of Carp Lake, V. 1, and about the margin and on the delta of Little Carp Lake, VII. 1.

27. *Equisetum hyemale* L. About the shores of Carp Lake, V. 1, and on the delta, V. 2.

Lycopodiaceae Michx. Club-Moss Family.

28. *Lycopodium selago* L. Common in the aspen zone, II. 5; also found in the pine zone, III. 3.

29. *Lycopodium lucidulum* Michx. A common plant in the ground cover of the hardwood forest, II. 2; VI.

30. *Lycopodium clavatum* L. Running Pine. In the arbor vitae swamp, II. 1; in the hardwood forest, II. 2, and in the aspen zone, II. 5, III. 1, 4.

31. *Lycopodium complanatum* L. Common in the aspen zone, II. 5, III. 1, 4. Often extending out on the heath mats.

Pinaceae Lindl. Pine Family.

32. *Pinus strobus* L. White Pine. Large isolated trees occur through the hardwood forest, II. 2, IV. 3, VI. More abundant in the aspen zone, II. 5. Occurs principally as a scattered growth with *P. resinosa* on the heath mats on the mountain top, on the ledges on the cliff face, and on the talus slopes, III, forming belts of denser growth where the cliff face is broken by large ledges.

33. *Pinus resinosa* Ait. Red or Norway Pine. Associated about equally with *P. strobus* on the mountain top, cliff, and talus slopes, III. Not present in the hardwood forest.

34. *Pinus divaricata* (Ait.) Gord. Labrador or Gray Pine. Several specimens observed on the heath mat on the mountain top, III. 5.

35. *Larix laricina* (Du Roi) Koch. American Larch. Tamarack. Occasional in the cassandra and alder thickets along Carp river, IV. 2, in the broader portions of the flood-plain, and about the beaver meadow on Little Carp river, VII. 2; often forming in the last two habitats a zone with *Picea canadensis* and *Abies balsamea* between the alder thickets and the deciduous forest of the slopes. Predominates in peat bogs, forming a nearly pure stand, IV. 4.

36. *Picea canadensis* (Mill.) B. S. P. White Spruce. Occasional in the arbor vitae swamp, II. 1; in the tamarack swamp, IV. 4; in the coniferous zone behind the alder thickets in the valley of Carp river, IV, and about the beaver meadow on Little Carp river, VII. 2.

37. *Tsuga canadensis* (L.) Carr. Hemlock. This tree nearly always forms a small portion of the tree cover in the hardwood forest, II. 2, IV. 3, VI. Occasionally, as at the foot of the north slope of the first range and on the south slope of the second range, it predominates, forming dense forests with little underbrush.

38. *Abies balsamea* (L.) Mill. Balsam Fir. Widely distributed, occurring, but never predominating, in the climax forest, II. 2, IV. 3, VI. It also occurs with the Spruce and Tamarack in the coniferous society in the valley of Carp river, IV. 2; about the beaver meadow on Little Carp river, VII. 2, and in the tamarack, IV. 4, and arbor vitae swamps, II. 2; being more abundant in these coniferous societies.

39. *Thuja occidentalis* L. White Cedar. Arbor Vitae. This tree occurs in the rock crevices on the Upper Beach of Lake Superior, I; occasionally on the cliff face, III, and about the margins of Carp, V, and Little Carp Lakes, VII. It is more characteristic, however, of the swampy areas at the foot of the north slope, II. 1, and in the river valleys, IV. 2, where it forms a dense and almost impenetrable growth.

40. *Juniperus nana* Willd. Low Juniper. Characteristic of the "bald" areas of the mountain top, III. 1, 2, 4, 5, 6, spreading out from the crevices as circular mats over the rocks.

Taxaceae Lindl. Yew Family.

41. *Taxus canadensis* Marsh. Ground Hemlock. Forms, with young Sugar Maples, the principal undergrowth of the hardwood forest, II. 2, IV. 3, VI.

Naiadaceae Lindl.

42. *Potamogeton natans* L. Common Floating Pond-weed. Occasional in Carp river, IV. 1, and forms a well defined zone in shallow water about the margin of Carp Lake, V. 1.

Alismaceae DC. Water-Plantain Family.

43. *Sagittaria sp.* Arrow-head. Near the margin of the water on the mud flats, IV. 1, and delta, V. 2, of Carp river.

Vallisneriaceae Dumort. Tape-grass Family.

44. *Vallisneria spiralis* L. Tape-grass. Forms extensive mats in the shallow water at the west end of Carp Lake, V. 1, and occasionally about the margin of Little Carp Lake, VII. 1.

Gramineae Juss. Grass Family.

45. *Panicum xanthophysum* A. Gray. Slender Panicum. In the rock crevices on the mountain top, III. 2, 5, 6.

46. *Cinna latifolia* (Trev.) Griseb. Occasional in the hardwood forest, II. 2, IV. 3, and along the banks of Carp creek, VI.

47. *Agrostis hyemalis* (Walt.) B. S. P. Rough Hair-grass. On the delta of Carp river, V. 2, and in the beaver meadow on Little Carp river, VII. 2.

48. *Calamagrostis canadensis* (Michx.) Beauv. Blue Joint-grass. In the cassandra zone, on the dryer parts of the mud flats, IV. 2, and delta V. 2, of Carp river, and in the beaver meadow on Little Carp river, VII. 2.

49. *Deschampsia flexuosa* (L.) Trin. Wavy Hair-grass. In the cassandra zone, IV. 2, and on the delta, V. 2, of Carp river; also in the beaver meadow, VII. 2, on Little Carp river.

50. *Panicularia canadensis* (Michx.) Kuntze. Rattlesnake-grass. Cassandra zone, IV. 2, and delta, V. 2, of Carp river; also in the beaver meadow, VII. 2, on Little Carp river.

Cyperaceae J. St. Hil. Sedge Family.

51. *Dulichium arundinaceum* (L.) Britton. Dulichium. Near the submerged margins of the mud flats and deltas of Carp and Little Carp rivers.

52. *Scirpus cyperinus* (L.) Kunth. Wool-grass. In the cassandra zone and on the mud flats, IV. 2, and delta, V. 2, of Carp river; and on the mud flats and beaver meadow along Little Carp river, VII. 2. Also along the bank of Carp creek, VI.

53. *Carex monile* Tuckerm. A prominent sedge in the beaver meadow on Little Carp river, VII. 2.

54. *Carex riparia* Curtis. In the cassandra zone and on the mud flats,

IV. 2, and delta, V. 2, of Carp river. Also about the shore of Carp Lake, V. 1.

55. *Carex filiformis* L. In the cassandra zone, on the mud flats, IV. 2, and delta, V. 2, of Carp river; and in the beaver meadow and on the mud flats on Little Carp river, VII. 2.

56. *Carex crinita* Lam. On the banks of Carp creek, VI.

57. *Carex viridula* Michx. In the cassandra zone and on the mud flats IV. 2, and delta, V. 2, of Carp river; and in the beaver meadow and on the mud flats of Little Carp river, VII. 2.

58. *Carex pubescens* Muhl. Along the banks of Carp Creek, VI.

Araceae Neck. Arum Family.

59. *Spathyema foetida* (L.) Raf. Skunk Cabbage. Occasional in the alder thickets along Carp river, IV. 2, and along the banks of Carp Creek, VI.

Eriocaulaceae Lindl. Pipewort Family.

60. *Eriocaulon septangulare* With. Seven-angled Pipewort. Common on the shores of Carp Lake, V. 1.

Juncaceae Vent. Rush Family.

61. *Juncus effusus* L. Bog Rush. Common on the mud flats, IV. 2, and delta V. 2, of Carp river. Also abundant in the beaver meadow and on the mud flats on Little Carp river, VII. 2.

62. *Juncus tenuis* Willd. In the beaver meadow and on the mud flats of Little Carp river, VII. 2.

63. *Juncus canadensis* J. Gay. Canada Rush. In shallow water about the margin of Carp Lake, V, and Little Carp Lake, VII. 1.

Convallariaceae Link. Lily-of-the-valley Family.

64. *Clintonia borealis* (Ait.) Raf. Yellow Clintonia. A very common form in the hardwood forests, II. 2, IV. 3, VI.

65. *Vagnera racemosa* (L.) Morong. Wild Spikenard. In the hardwood forest, II. 2, IV. 3, VI.

Iridaceae Lindl. Iris Family.

66. *Iris versicolor* L. Larger Blue Flag. On the mud flats and in the cassandra and alder thickets along Carp river, IV. 2; also in the beaver meadow on Little Carp river, VII. 2, and in the arbor vitae swamps, II. 1.

Orchidaceae Orchid Family.

67. *Gyrostachys cernua* (L.) Kuntze. Nodding Ladies Tresses. On the shores of Carp Lake, V. 1; on the delta, V. 2, and occasionally in the cassandra zones on Carp river, IV. 2. Also in the beaver meadow on Little Carp river VII. 2.

68. *Peramium pubescens* (Willd.) Mac M. Downy Rattlesnake Plantain. Generally distributed through the hardwood forest, II. 2, IV. 3, VI; also occurring in the tamarack swamp, IV. 4.

Salicaceae Lindl. Willow Family.

69. *Populus grandidentata* Michx. Large-toothed Aspen. In the hardwood forest bordering the beach of Lake Superior, I, the clearing, II. 2, and

mountain top, II. 5, III. 1 and 4. Also on the lower part of the talus slope, III, and in burnings.

70. *Populus tremuloides* Michx. American or Quaking Aspen. The principal form of the forest bordering open localities; adjoins the beach of Lake Superior, I, the clearing, II. 4, and the mountain top, II. 5, III. 1 and 4. Also conspicious on the lower part of the talus slopes, III, and in burnings, VI.

71. *Salix spp.* Willow. A number of willows occur in the alder and cassandra zones along Carp river, IV. 2; in the beaver meadow on Little Carp river, VII. 2, and in the aspen zone on the mountain top, II. 5.

Myricaceae Dumort. Bayberry Family.

72. *Myrica cerifera* L. Wax-myrtle. In the cassandra zone along Carp river, IV. 2.

Betulaceae Agardh. Birch Family.

73. *Ostrya virginiana* (Mill.) Willd. Iron-wood. Occasional in the hardwood forest, II. 2, IV. 3, VI.

74. *Corylus rostrata* Ait. Beaked Hazel-nut. In the woods on the lower part of the talus slopes, IV. 3; pushing out beyond the forest with the birches and often extending well up the slope, III.

75. *Betula papyrifera* Marsh. Paper or Canoe Birch. Throughout the climax forest, II. 2, IV. 3, VI. Also a prominent form on the lower part of the talus slopes, IV. 3.

76. *Betula lutea* Michx. Yellow Birch. Occasional through the forest II. 2, IV. 3, VI. More conspicious in the hemlock forests.

77. *Betula glandulosa* Michx. Glandular or Scrub Birch. Common about the margin of the beaver meadow, VII. 2; with *Alnus incana* and several willows encroaching on the meadow.

78. *Alnus alnobetula* (Ehrh.) K. Koch. Green or Mountain Alder. A few shrubs occur in the aspen zone bordering the mountain top, III. 5.

79. *Alnus incana* (L.) Willd. Speckled or Hoary Alder. Nearly always present along streams, forming dense thickets. Along Carp river, IV. 2, between the cassandra and coniferous zones on wide parts of the flood-plain, and between the river and the forest where the flood-plain is narrow. Where a cassandra zone is present, there is nearly always a narrow strip of alders along the natural levees, separating the cassandra zone from the river. Also common about Carp Lake, V. 1; Little Carp Lake, VII. 1, and the beaver meadow, VII. 2.

Fagaceae Drude. Beech Family.

80. *Quercus rubra* L. Red Oak. A prominent form in the aspen zone, II. 5, III. 1, 4, bordering the mountain top. Also on the fine material at the top of the talus slope and on the ledges on the cliff face, III.

81. *Quercus macrocarpa* Michx. Burr Oak. In the aspen zone, II. 5, bordering the mountain top.

Nymphaeaceae DC. Water-lily Family.

82. *Nymphaea advena* Soland. Large Yellow Pond Lily. Abundant in Carp river, IV. 1, and near the margin of Carp Lake, V. 3.

83. *Castalia odorata* (Dryand.) Woodv. and Wood. Sweet-scented White

Water Lily. Several specimens were found in Carp river, IV. 1, which was the only locality in which it was observed.

Ranunculaceae Juss. Crowfoot Family.

84. *Caltha palustris* L. Marsh-marigold. In the alder thickets along Carp river, IV. 2; also common on the banks of Carp creek, VI.

85. *Coptis trifolia* (L.) Salisb. Gold-thread. Common in the hardwood forest, II. 2, IV. 3, VI, and in the tamarack swamp, IV. 4.

Sarraceniaceae LaPyl. Pitcher-Plant Family.

86. *Sarracenia purpurea* L. Pitcher-plant. Found commonly in the peat bog, IV. 4, and on a Sphagnum growth in the beaver meadow, VII. 2. Not observed elsewhere.

Rosaceae B. Juss. Rose Family.

87. *Opulaster opulifolius* (L.) Kuntze. Eastern Ninebark. Upper Beach of Lake Superior, I; in the aspen zone bordering the mountain top, II. 5, and on the rocky bluff at the east end of Little Carp Lake, VII.

88. *Spiraea salicifolia* L. American Meadow-sweet. In the cassandra zone on Carp river, IV. 2, and about the margin of the beaver meadow on Little Carp river, VII. 2.

89. *Rubus parviflorus* Nutt. White-flowering Raspberry. In the aspen zone about the clearing, II. 4, and mountain top, II. 5; in the open woods near the top of the slope, II. 2, and in burnings, VI. Very common in exposed situations. Locally known as the Thimbleberry

90. *Rubus strigosus* Michx. Wild Red Raspberry. On the Upper Beach of Lake Superior, I; in the aspen zone about the clearing, II. 4, and on the mountain top, II. 5. Also at the foot of the talus slopes, III.

91. *Rubus nigrobaccus* Bailey. High Bush Blackberry. Frequent in the cassandra zone, IV. 2, especially near the margin of the alder thickets.

92. *Rubus hispidus* L. Running Swamp Blackberry. Common in the cassandra zone on Carp river, IV. 2, and in the beaver meadow, VII. 2.

93. *Comarum palustre* L. Marsh Cinquefoil. In the cassandra zone, IV. 2, and on the delta of Carp river, V. 2, and in the beaver meadow on Little Carp river, VII. 2.

94. *Dasiphora fruticosa* (L.) Rydb. In the cassandra zone, IV. 2, and on the delta, V. 2.

94a. *Potentilla argentea* L. Silvery Cinquefoil. In rock crevices on the Middle and Upper Beaches of Lake Superior, I.

95. *Sibbaldiopsis tridentata* (Soland.) Rydb. Common in the rock crevices on the mountain top and on the cliff face, and among the rocks on talus slopes, III.

Pomaceae L. Apple Family.

96. *Sorbus americana* Marsh. American Mountain Ash. Common on the Upper Beach of Lake Superior, I, and at the foot of the talus slopes, III. Also occurs on the rocky bluff at the east end of Little Carp Lake.

97. *Aronia nigra* (Willd.) Britton. Black Chokeberry. Occasional on the lower part of the talus slopes, III.

98. *Amelanchier canadensis* (L.) Medic. Juneberry. Common on the Upper Beach of Lake Superior, I; in the aspen zone bordering the mountain

top, II. 5, III. 1, 4; on the ledges of the cliff; at the bottom and top of the talus slopes, III, and in the tamarack swamp, IV. 4.

99. *Crataegus sp.* Thorn-apple. Occasional on the cliff face and on the fine material at the top of the talus slopes, III.

Drupaceae DC. Plum Family.

100. *Prunus pumila* L. Dwarf Cherry. On the Upper Beach of Lake Superior, I, and in burnings, VI.

101. *Prunus pennsylvanica* L. f. Wild Red Cherry. Common on the lower parts of the talus slopes and on the finer material at the top, III, Also occurs on the ledges of the cliff, III, and in burnings, VI.

Papilionaceae L. Pea Family.

102. *Lathyrus maritimus* (L.) Bigel. Beach Pea. Upper and Middle Beaches of Lake Superior, I.

103. *Lathyrus ochroleucus* Hook. Cream-colored Vetchling. Upper Beach of Lake Superior, I.

Anacardiaceae Lindl. Sumac Family.

104. *Rhus glabra* L. Scarlet Sumac. In the aspen zone about the clearing, II. 4, and mountain top, II. 5. Also scattered over the talus slopes, III.

105. *Rhus microcarpa* (Michx.) Steud. Northern Poison Oak. On the talus slopes and cliff face, III.

Aceraceae St. Hil. Maple Family.

106. *Acer saccharum* Marsh. Sugar or Rock Maple. The principal forest tree of the region, forming, with a small portion of Balsam Fir, Basswood and Hemlock, the climax forest of the region, II. 2, IV. 3, VI.

107. *Acer spicatum* Lam. Mountain Maple. Occurs as a scattered undergrowth in the hardwood forest, II. 2, IV. 3, VI; becoming more abundant in the open woods toward the talus slopes, III, mountain top, II. 5, and beach of Lake Superior, I.

Rhamnaceae Dumort. Buckthorn Family.

108. *Ceanothus americanus* L. New Jersey Tea. A prominent plant in the heath society on the mountain top, III. 2, 5, 6, and at the foot of the talus slope. Also occurs on the finer material at the top of the talus slope and on ledges of the cliff.

Vitaceae Lindl. Grape Family.

109. *Parthenocissus quinquefolia* (L.) Planch. Virginia Creeper. Occasional on the talus slopes and cliff face, III.

Tiliaceae Juss. Linden Family.

110. *Tilia americana* L. Basswood. Occasional in the hardwood forest, II. 2, IV. 3, VI.

Hypericaceae Lindl. St. Johns-wort Family.

111. *Hypericum ellipticum* Hook. Pale St. Johns-wort. On the delta, V. 2, and in the cassandra zone, IV. 2, on Carp river; and in the beaver meadow on Little Carp river, VII. 2.

Violaceae DC. Violet Family.

112. *Viola spp.* A number of species of violets occur in the forest, II, 2, IV. 3, VI., and in the alder thickets, IV. 2.

Eleagnaceae Lindl. Oleaster Family.

113. *Lepargyraea canadensis* (L.) Greene. Canadian Buffalo-berry. Upper Beach of Lake Superior, I.

Onagraceae Dumort. Evening-primrose Family.

114. *Chamaenerion angustifolium* (L.) Scop. Fire-weed. In the clearing, II. 3, at the foot of the talus slopes, III, and almost universally in burnings, VI.

115. *Onagra biennis* (L.) Scop. Common Evening-primrose. In the rock crevices on the mountain top, III. 2, 5, 6. Also on ledges on the cliff face.

Haloragidaceae Kl. and Garke. Water-milfoil Family.

116. *Myriophyllum sp.* Water-milfoil. The common aquatic plant in Carp river, IV. 1, Carp Lake, V. 3, and Little Carp Lake, VII. 1.

Araliaceae Vent. Ginseng Family.

117. *Aralia nudicaulis* L. Wild Sarsaparilla. Common throughout the forest, II. 2, IV. 3, VI.

Umbelliferae B. Juss. Carrot Family.

118. *Heracleum lanatum* Michx. Cow-parsnip. Common in the clearing, II. 3.

Cornaceae Link. Dogwood Family.

119. *Cornus canadensis* L. Low or Dwarf Cornel. Generally distributed, occurring in the hardwood forest, II. 2, VI; in the aspen zone, II. 5, and extending, to some extent, on the heath mat beyond the aspen zone on the mountain top, III. 2, 3, 5, 6. Also common in the tamarack swamp, IV. 4.

120. *Cornus circinata* L'Her. Round-leaved Dogwood. Common in the aspen zone, II. 5, about the mountain top; and at the bottom and top of the talus slopes, III.

121. *Cornus stolonifera* Michx. Red-osier Dogwood. Quite common in the alder zone along Carp river, IV. 2, Carp Lake V. 1, Little Carp Lake, VII. 1, and in the beaver meadow on Little Carp river, VII. 2.

Pyrolaceae Agardth. Wintergreen Family.

122. *Chimaphila umbellata* (L.) Nutt. Pipsissewa. Prince's Pine. Occasionally in the hardwood forest, II. 2, and in the pine zone, III. 3.

Monotropaceae Lindl. Indian-pipe Family.

123. *Monotropa uniflora* L. Indian-pipe. In damp shady places in the climax forest, II. 2, IV. 3, VI.

Ericaceae DC. Heath Family.

124. *Ledum groenlandicum* OEder. Labrador Tea. Common in the tamarack swamp, IV. 4.

125. *Chamaedaphne calyculata* (L.) Moench. Dwarf Cassandra. Forming dense thickets in the wider parts of the flood-plain of Carp river, IV. 2. Also present, but not forming extensive thickets, about the beaver meadow on Little Carp river, VII. 2.

126. *Epigaea repens* L. Trailing Arbutus. Occasionally seen in the pine zone on the mountain top, III. 3.

127. *Gaultheria procumbens* L. Creeping Wintergreen. A common plant in the undergrowth of the aspen zone, II. 5, III. 1 and 4, and in the heath mats on the bald areas, III. 2, 5, 6.

128. *Arctostaphylos uva-ursi* (L.) Spreng. Red Bearberry. The principal heath plant in the aspen zone, II. 5, III. 1, 4, and in the mats on the mountain top, III. 2, 5, 6. Also occurs on ledges of the cliff, at the bottom and top of the talus slopes, III, and on the Upper Beach of Lake Superior, I.

Vacciniaceae Lindl. Huckleberry Family.

129. *Vaccinium uliginosum* L. Great Bilberry. Upper Beach of Lake Superior, I, and in the aspen zone on the mountain top, II. 5.

130. *Vaccinium canadense* Richards. Canada Blueberry. In a moist ravine through the hardwood forest in the valley of Carp river, IV. 3, and in the tamarack swamp, IV. 4.

131. *Vaccinium pennsylvanicum* Lam. Dwarf or Low-bush Blueberry. A prominent form in the undergrowth of the aspen zone surrounding the mountain top, II. 5, and in the heath mat on the bald areas, III. 2, 5, 6. Also on ledges on the cliff face, at the top and bottom of the talus slopes, III, and on the Upper Beach of Lake Superior, I.

132. *Vaccinium nigrum* (Wood) Britton. Low Black Blueberry. Associated with *V. pennsylvanicum* in the aspen zone on the mountain top, II. 5, III. 1, 4; on the bare top, III. 2, 5, 6; on ledges on the cliff face, and on the talus slopes, III.

132. *Chiogenes hispidula* (L.) T. and G. Creeping Snowberry. Common in the tamarack swamp, IV. 4.

Oleaceae Lindl. Olive Family.

134. *Fraxinus americana* L. White Ash. Occasional in the tamarack swamp, IV. 4; with the conifers and alders in broad portions of the flood plain of Carp river, IV. 2, and about the beaver meadow, VII. 2.

135. *Fraxinus nigra* Marsh. Black Ash. Associated with *F. americana.*

Asclepiadaceae Lindl. Milkweed Family.

136. *Asclepias incarnata* L. Swamp Milkweed. Occasional in the cassandra zone, IV. 2, and on the delta, V. 2, of Carp river. Also in the beaver meadow on Little Carp river, VII. 2.

Labiatae B. Juss. Mint Family.

137. *Scutellaria sp.* Skullcap. An unidentified species of this genus occurs commonly in the alder thickets along Carp river, IV. 2, and along Carp creek, VI.

Scrophulariaceae Lindl. Figwort Family.

138. *Melampyrum lineare* Lam. Narrow-leaved Cow-wheat. In the aspen zone bordering the mountain top, II. 5, III. 1, 4.

Lentibulariaceae Lindl. Bladderwort Family.

139. *Utricularia cornuta* Michx. Horned Bladderwort. On the beach of Carp Lake, V. 1.

Rubiaceae B. Juss. Madder Family.

140. *Galium triflorum* Michx. Sweet-scented or Fragrant Bedstraw. Common in the more open woods near the top of the first ridge, II. 2.

Caprifoliaceae Vent. Honeysuckle Family.

141. *Viburnum opulus* L. High Bush-cranberry. Along the banks of Carp river, IV. 2, and about the shores of Little Carp Lake, VII. 1.

142. *Viburnum pauciflorum* Pylaie. Few-flowered Cranberry-tree. On Carp river in the cassandra zone, IV. 2, and tamarack swamp, IV. 4; also about the shores of Little Carp Lake, VII. 1.

143. *Linnaea americana* Forbes. American Twin-flower. Of general distribution throughout the hardwood forest, II. 2, IV. 3, VI; becoming more abundant toward the top of the slopes and in the aspen zone bordering the mountain top, II. 5.

144. *Symphoricarpos pauciflorus* (Robbins) Britton. Low Snowberry. In the aspen zone bordering the mountain top, II. 5, III. 1, 4.

145. *Lonicera oblongifolia* (Goldie) Hook. Swamp Fly-Honeysuckle. In the shrub zone of the tamarack swamp, IV. 4.

146. *Lonicera ciliata* Muhl. American Fly Honeysuckle. In the hardwood forest, II. 2, and VI.

147. *Diervilla diervilla* (L.) Mac M. Bush Honeysuckle. Common in the aspen zone bordering the clearing, II. 4, and mountain top, II. 5, III. 1, 4. Also occurs on the lower part of the talus slopes, III.

Campanulaceae Juss. Bell-flower Family.

148. *Campanula rotundifolia* L. Harebell. In the rock crevices of the Middle and Upper Beaches of Lake Superior, I, and mountain top, III. 2, 5, 6. Occasional on ledges of the cliff and on the talus slopes, III.

149. *Campanula aparinoides* Pursh. Marsh Bellflower. In the cassandra zone, IV. 2, and on the delta, V. 2, of Carp river; and in the beaver meadow on Little Carp river, VII. 2.

150. *Lobelia spicata* Lam. Pale Spiked Lobelia. In the rock crevices of the Middle Beach, and on the thin soil on the Upper Beach of Lake Superior, I.

Compositae Adans. Thistle Family.

151. *Eupatorium purpureum* L. Joe-pye-weed. In the cassandra zone IV. 2, and on the delta, V. 2, of Carp river; and in the beaver meadow on Little Carp river, VII. 2.

152. *Solidago bicolor* L. White Goldenrod. In the rock crevices and on the thin soil of the mountain top, III. 2, 5, 6.

153. *Solidago erecta* Pursh. Slender Goldenrod. In the crevices on the bare mountain top, III. 2, 5, 6. The specimens collected, according to Dr. C. A. Davis, are not typical but are nearest to this form.

154. *Solidago uliginosa* Nutt. Bog Goldenrod. Common in the cassandra zone, IV. 2, and on the delta, V. 2, of Carp river, and in the beaver meadow of Little Carp river, VII. 2.

155. *Solidago neglecta* T. and G. Swamp Goldenrod. Middle and Upper Beaches of Lake Superior, I, and in the beaver meadow on Little Carp river, VII. 2.

156. *Solidago juncea* Ait. Early or Sharp-toothed Goldenrod. Common in the aspen zone, II. 5, and on the bare mountain top, III. 1, 2, 4, 5, 6.

157. *Euthamia graminifolia* (L.) Nutt. Associated with *S. juncea*, II. 5, III. 1, 2, 4, 5, 6.

158. *Aster divaricatus* L. White Wood Aster. Apparently of general distribution in the hardwood forest, II. 2, IV. 3, VI.

159. *Aster macrophyllus* L. Large-leaved Aster. Occasional in damp shady woods, II. 2, IV. 3, VI.

160. *Artemisia caudata* Michx. Tall or Wild Wormwood. Occasional in the aspen zone surrounding the mountain top, II. 5, III. 1, 4.

2. ISLE ROYALE.

Polypodiaceae R. Br. Fern Family.

1. *Polypodium vulgare* L. In the rock crevices on the end of the Minong Trap Range, IX, and in the rock crevices and on the shingle beach at Siskowit Bay, VIII.

2. *Adiantum pedatum* L. Maiden-hair Fern. Occasional in the Balsam Fir and Spruce woods, VI.

3. *Pteridium aquilinum* (L.) Kuhn. Brake. In the coniferous forest on the north side of the Greenstone Range near the shore of Lake Desor. Also about the margin of the clearing, I.

4. *Phegopteris phegopteris* (L.) Underw. On the shores of Siskowit Bay, VIII.

Equisetaceae Michx. Horsetail Family.

5. *Equisetum arvense* L. On the shore of Siskowit Bay, VIII, and on the shores of the islands in Lake Desor, VII.

Lycopodiaceae Michx. Club-moss Family.

6. *Lycopodium obscurum* L. Ground Pine. In the tamarack and spruce woods in the valley of Washington river, II.

7. *Lycopodium annotinum* L. On the beach at Grace Harbor; with the heaths on the Minong Trap Range, IX, and in the coniferous forest, VI.

8. *Lycopodium clavatum* L. Running Pine. In the coniferous and deciduous forests, VI, and III; on the beach at Grace Harbor, and on the Minong Trap promontory, IX.

9. *Lycopodium complanatum* L. In the alder thickets along Washington river, II. and with the heaths on the Minong Trap promontory, IX.

Isoetaceae Underw. Quillwort Family.

10. *Isoetes sp.* Among the rocks in shallow water about the islands in Lake Desor, VII.

Pinaceae Lindl. Pine Family.

11. *Pinus strobus* L. White Pine. Large isolated trees occur scattered through the forest, III, and VI. Young trees occur on the jutting promontories on the southwestern end of the island, IX. A few trees also occur with *P. resinosa* on a small strip of rock beach on the north shore of Lake Desor, VII.

12. *Pinus resinosa* Ait. Norway or Red Pine. Large trees occur occasionally in the coniferous forest on exposed slopes, VI. A few trees were also found on the rocky promontory, IX, and with *P. strobus* on a small strip of exposed beach on the north shore of Lake Desor, VII.

13. *Larix laricina* (Du Roi) Koch. Tamarack. Occurs along the flood-plains of the streams, where the valleys are broad, II, IV. It becomes more abundant in bogs, forming a nearly pure stand, V. Also occurs occasionally in the old beach pools on the Minong Trap promontory, IX.

14. *Picea canadensis* (Mill.) B. S. P. White Spruce. Generally distributed. It occurs with the Tamarack and Black Spruce on the flood-plains, II, IV, and forms an important part of the coniferous forest of the slopes, VI, but becomes less abundant toward the top of the higher ridges, III. With the Balsam Fir and Paper Birch, it succeeds the heaths and Arbor Vitae on the rocky promontories, IX.

15. *Picea mariana* (Mill.) B. S. P. Black Spruce. This tree is associated with the Tamarack and White Spruce on the flood-plains of the streams, II, IV. It also occurs occasionally in the old pools on the Minong Trap promontory, IX.

16. *Abies balsamea* (L.) Mill. Balsam Fir. This tree is generally distributed, occurring in the river valleys, II, IV, and on the ridges, III, VI. It apparently forms, with the White and Yellow Birch and White Spruce, the principle forest of the island.

17. *Thuja occidentalis* L. White Cedar. Arbor Vitae. This tree is most abundant in the valleys along streams, IV, where it occasionally forms dense growths. It is also found, however, on the shores of Lake Desor, VII, and about Washington Harbor, X; while on the Minong Trap promontory, IX, it is the first tree to gain a foothold, and may be seen growing in the crevices, nearly prostrate on the rock.

18. *Juniperus nana* Willd. Low Juniper. Common on the rock surfaces. of the Minong Trap promontory, IX.

Taxaceae Lindl. Yew Family.

19. *Taxus canadensis* Marsh. Ground Hemlock. This is one of the most characteristic forms of the Isle Royale forest. It forms a dense and almost impenetrable undergrowth throughout the coniferous woods, VI, but it is not as abundant in the flood-plain societies, II, IV. In the bogs it may be nearly or entirely wanting, and in the deciduous forest along the top of the Greenstone Range, III, it is often replaced over small areas by *Corylus rostrata.*

Sparganiaceae Agardh. Bur-reed Family.

20. *Sparganium eurycarpum* Engelm. In the margin of Washington river near its mouth, II, and about the shores of Lake Desor, VII.

Gramineae Juss. Grass Family.

21. *Phragmites phragmites* (L.) Karst. Reed. Along the margin of Washington river near its mouth, II, and about the shores of Lake Desor, VII.

Cyperaceae J. St. Hil. Sedge Family.

22. *Carex intumescens* Rudge. Along Washington river, II.
23. *Carex retrorsa* Schwein. Along Washington river, II.
24. *Carex trisperma* Dewey. Along Washington river, II.
25. *Carex tribuloides* Wahl. Along Washington river, II.

Araceae Neck. Arum Family.

26. *Spathyema foetida* (L.) Raf. Skunk Cabbage. In alder thickets, along Washington river, II, and Washington creek, IV.

Juncaceae Vent. Rush Family.

27. *Juncus effusus* L. Soft or Bog Rush. Along the shore of Washington river, II.

Convallariaceae Link. Lily-of-the-Valley Family.

28. *Clintonia borealis* (Ait.) Raf. In the forests on the flood-plain of Washington river, II, and on the adjacent ridges, III, VI.
29. *Vagnera racemosa* (L.) Morong. Wild Spikenard. In the alder thicket near the mouth of Washington creek, IV.
30. *Vagnera trifolia* (L.) Morong. Three-leaved Solomon's Seal. Found commonly in the alder thickets along Washington river, II, and Washington creek, IV.
31. *Streptopus amplexifolius* (L.) DC. In the alder thicket along Washington creek, IV.
32. *Salomonia biflora* (Walt.) Britton. Hairy Solomon's Seal. In moist places in the coniferous forest, VI.

Iridaceae Lindl. Iris Family.

33. *Iris versicolor* L. Large Blue Flag. In low places about the shores of Lake Desor and on the smaller islands, VII.

Orchidaceae Lindl. Orchid Family.

34. *Listera convallarioides* (Sw.) Torr. On the shores of Siskowit Bay, VIII, and Grace Harbor.
35. *Peramium pubescens* (Willd.) MacM. Downy Rattlesnake Plantain. Common in the coniferous forest, VI.

Salicaceae Lindl. Willow Family.

36. *Populus grandidentata* Michx. Large-toothed Aspen. In burnings and on the margin of clearings. Found in the large clearings at Siskowit

Bay, VIII, and Washington Harbor, I; and on the cliffs along the northwest shore of the island.

37. *Populus tremuloides* Michx. American Aspen. This tree occurs in the same conditions as *P. grandidentata* but is more abundant. It was abundant in the burnings and clearings at Siskowit Bay, VIII, and Washington Harbor, I. It also occurs on the rocky promontories at the southwest end of the island, IX, on the cliffs along the northwest shore of the Isle, and on the smaller islands in Lake Desor, VII. It prefers dry open habitats and is one of the first trees to encroach on the clearings.

38. *Salix spp.* Willow. Several undetermined willows occur in the alder zone along the streams, II, IV, and about Lake Desor, VII.

Betulaceae Agardh. Birch Family.

39. *Corylus rostrata* Ait. Beaked Hazel-nut. As underbrush through the forest, III, VI, with the Ground Hemlock. Often forming in small areas a nearly pure stand.

40. *Betula papyrifera* Marsh. Paper or Canoe Birch. Of general distribution, being a prominent form in the coniferous and deciduous forests, although it predominates in neither. It is the chief deciduous tree on this part of the island, owing to its general distribution.

41. *Betula lutea* Michx. f. Yellow Birch. This birch is of general distribution in the forests of the slopes, VI, and river valleys, II, but is apparently more abundant in the former.

42. *Alnus incana* (L.) Willd. Speckled or Hoary Alder. Forms extensive thickets along the streams, II, IV, about the shores of the Isle, and on low ground around Lake Desor, VII.

Santalaceae R. Br. Sandalwood Family.

43. *Comandra livida* Richards. Recorded by Mr. Macduff as occurring in an alder thicket near the mouth of Grace creek.

Nyphaeaceae DC. Water Lily Family.

44. *Castalia odorata* (Dryand) Woodv. and Wood. Sweet-scented White Water Lily. In a small shallow bay at the west end of Lake Desor, VII. The only place observed.

Ranunculaceae Juss. Crowfoot Family.

45. *Caltha palustris* L. Marsh-marigold. This species seemed to be characteristic of the alder thickets, II, IV.

46. *Coptis trifolia* (L.) Salisb. Gold-thread. Of general distribution in the river valleys, II, IV, and V, and on the slopes, III and VI.

Saxifragaceae Dumort. Saxifrage Family.

47. *Mitella nuda* L. Occasional in the Tamarack and Spruce forests along Washington river, II, and in the Balsam and Spruce forests of the slopes, VI.

Rosaceae B. Juss. Rose Family.

48. *Opulaster opulifolius* (L.) Kuntze. Eastern Ninebark. About the shores of Siskowit Bay, VIII; on the Minong Trap promontory, IX, and about the shores of the islands in Lake Desor, VII.

49. *Spiraea salicifolia* L. Willow-leaved or American Meadow-sweet. This shrub was found along Washington river, II, between the alder and sedge zones, where the latter was well developed.

50. *Rubus parviflorus* Nutt. White-flowering Raspberry. In sunny spots in the woods, III, VI, also along the shore of Washington Harbor, X.

51. *Rubus arcticus* L. Arctic Raspberry. In the bogs, IV, and V. Apparently not common.

52. *Rubus strigosus* Michx. Wild Red Raspberry. In burnings and clearings, Siskowit Bay, VIII, and at Washington Harbor, I.

53. *Potentilla argentea* L. Silvery or Hoary Cinquefoil. On the shingle beach at Siskowit Bay, VIII.

54. *Sibbaldiopsis tridentata* (Soland.) Rydb. Three-toothed Cinquefoil. On the shingle beach and in the rock crevices at Siskowit Bay, VIII, and in the rock crevices on the Minong Trap promontory, IX.

55. *Dasiphora fruticosa* (L.) Rydb. Shrubby Cinquefoil. In the rock crevices on the Minong Trap promontory, IX.

Pomaceae L. Apple Family.

56. *Sorbus americana* Marsh. American Mountain Ash. In rocky exposed situations, especially about the shores of the island and on the islands in Lake Desor, VII.

57. *Amelanchier canadensis* (L.) Medic. June-berry. On the shore at Siskowit Bay, VIII, and Grace Harbor; also in burnings and clearings, and on the small islands in Lake Desor, VII.

Drupaceae DC. Plum Family.

58. *Prunus pumila* L. Sand Cherry. In the clearing at Siskowit Bay, VIII, and on the rocky bluffs along the northwest shore of the island.

59. *Prunus pennsylvanica* L. f. Wild Red Cherry. On the islands in Lake Desor, VII.

Papilionaceae L. Pea Family.

60. *Lathyrus maritimus* (L.) Bigel. Beach Pea. On shingle beaches in the bays on the southwest end of the island (Macduff).

61. *Lathyrus ochroleucus* Hook. Cream-colored Vetchling. As the last.

62. *Empetrum nigrum* L. Black Cranberry. With the heaths on thin soil on the Minong Trap promontory, IX.

Aceraceae St. Hil. Maple Family.

63. *Acer saccharum* Marsh. Sugar or Rock Maple. Only found on the top of the Greenstone Range, III, where it predominates in a narrow strip along the crest of the ridge. This is the only hardwood forest on the south end of the island, and it is reported by Mr. Hollinger to extend the length of the island.

64. *Acer spicatum* Lam. Mountain Maple. This shrub is generally distributed as undergrowth in the forest, III, VI, with *Taxus canadensis* and *Corylus rostrata*. Although more abundant than the latter, it does not form as large a proportion of the undergrowth as the former.

Rhamnaceae Dumort. Buckthorn Family.

65. Rhamnus alnifolia L'Her. In the alder thickets, II, IV.

66. *Ceanothus americanus* L. New Jersey Tea. With the heaths on the Minong Trap promontory, IX.

Violaceae DC. Violet Family.

67. *Viola spp.* Violet. A number of species of violets were observed in the woods and alder thickets, but, as they were not in bloom, they were not identified with certainty..

Haloragidaceae Kl. and Garcke. Water-milfoil Family.

68. *Myriophyllum sp.* An unidentified species was abundant in Washington river near the mouth, II.

Araliaceae Vent. Ginseng Family.

69. *Aralia nudicaulis* L. Wild Sarsaparilla. Generally distributed throughout the forests of the slope, III, VI, and river valleys, II, IV.

Cornaceae Link. Dogwood Family.

70. *Cornus canadensis* L. Dwarf Cornel. Generally distributed through the forests of the slopes, III, VI, and in the forest of the river valleys, II, IV, V. It also occurs with the heaths on the Minong Trap promontory, IX.

71. *Cornus stolonifera* Michx. Red-osier Dogwood. Occasional in the tamarack-spruce forests of the river bottoms, II, IV, V. Also about the shore of Lake Desor, VII.

Pyrolaceae Agardh. Wintergreen Family.

72. *Chimaphila umbellata* (L.) Nutt. Pipsissewa. Prince's Pine. In damp woods, III, and VI.

Monotropaceae Lindl. Indian-pipe Family.

73. *Monotropa uniflora* L. Indian-pipe. Occasional in shady situations in the forest, III, VI, and in the tamarack and spruce woods in the river valleys, II, IV and V.

Ericacae DC. Heath Family.

74. *Ledum groenlandicum* OEder. Labrador Tea. In the tamarack-spruce forest, on the flood-plain of Washington river, II, and on the Sphagnum in old pools on the Minong Trap promontory, IX.

75. *Andromeda polifolia* L. Wild Rosemary. In the tamarack and spruce woods on the flood-plain of Washington river, II.

76. *Chamaedaphne calyculata* (L.) Moench. Dwarf Cassandra. On the Sphagnum growth in old rock pools on the Minong Trap promontory, IX.

77. *Arctostaphylos uva-ursi* (L.) Spreng. Red Bearberry. On the thin soil on the outer end of the Minong Trap promontory, IX. With the other heaths, it follows the crevice grasses and sedges.

Vacciniaceae Lindl. Huckleberry Family.

78. *Vaccinium pennsylvanicum* Lam. Dwarf or Low-bush Blueberry. *Distribution as the last.*

79. *Chiogenes hispidula* (L.) T. and G. Creeping Snow-berry. Common in the low tamarack-spruce woods along Washington river, II, and Washington creek, IV. Also in low spots in the slope forest, VI, and tamarack swamp, V.

Oleaceae Lindl. Olive Family.

80. *Fraxinus nigra* Marsh. Black Ash. Occasional in the tamarack and spruce woods on the flood-plain of Washington river, II, and in the bog, V.

Asclepiadaceae Lindl. Milkweed Family.

81. *Asclepias incarnata* L. Swamp Milkweed. Occasional in the grass and sedge zone along Washington river near its mouth, II.

Caprifoliaceae Vent. Honeysuckle Family.

82. *Viburnum opulus* L. High Bush-cranberry. In the tamarack and spruce woods, II, and about the shores of the islands in Lake Desor, VII.

83. *Viburnum pauciflorum* Pylaie. Few-flowered Cranberry-tree. In a bog near the mouth of Grace creek (Macduff).

84. *Linnaea americana* Forbes. American Twin-flower. Of general distribution throughout the forest, II, III, VI.

85. *Lonicera oblongifolia* (Goldie) Hook. Swamp Fly-honeysuckle. In the slope forest, VI, (Macduff).

86. *Lonicera ciliata* Muhl. American Fly-honeysuckle. Occasional in the slope forests, VI, (Macduff).

87. *Diervilla diervilla* (L.) MacM. Bush Honeysuckle. In the clearings at Siskowit Bay, VIII, and Washington Harbor, I.

Campanulaceae Juss. Bell-flower Family.

88. *Campanula rotundifolia* L. Harebell. In the rock crevices on the Minong Trap promontory, IX, and in the rock crevices and on the shingle beach at Siskowit Bay, VIII.

89. *Lobelia spicata* Lam. Pale Spiked Lobelia. In the rock crevices on the Minong Trap promontory, IX.

Compositae Adans. Thistle Family.

90. *Eupatorium purpureum* L. Joe-Pye-Weed. Among the sedges along Washington river, II. Also on the Sphagnum in the abandoned rock pools, IX.

91. *Euthamia graminifolia* (L.) Nutt. Bushy or Fragrant Goldenrod. On the shores of Siskowit Bay, VIII, and in the rock crevices on the Minong Trap promontory, IX.

ANNOTATED LIST OF THE MOLLUSCS OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

BRYANT WALKER AND A. G. RUTHVEN.

This list has been prepared from the collections and field notes made by A. G. Ruthven. The species of *Pisidium*, *Sphaerium* and *Vertigo* were identified by Dr. V. Sterki, the Slugs by Dr. H. A. Pilsbry, and the remainder of the collection by Bryant Walker.

1. PORCUPINE MOUNTAINS.

1. *Agriolimax campestris* (Binn.). This species was found among the fallen leaves in the hardwood forest, II. 2, and under a pine log in the aspen zone on the mountain top, III. 1.

2. *Palhifera hemphilli* (W. G. Binn.). As represented by the collections, this slug is quite generally distributed. It was found among the fallen leaves in the deciduous forest, II. 2; beneath a fallen pine log in the pine zone, III. 1, and under the bark of a tamarack log, IV. 4.

3. *Zonitoides arborea* (Say). III. 1. A number of specimens of this species were taken under fallen pine trees among the bearberry and huckleberry bushes in the aspen zone. IV. 4. Several specimens were found beneath the bark of decaying tamarack and cedar logs in the tamarack swamp. VI. A few specimens were taken in the moist humus about the roots of ferns on the bank of Carp creek, and among the moist decaying leaves on higher ground.

4. *Zonitoides milium* (Mse.). III. 2. Individuals of this species were collected in the dry earth about the roots of the New Jersey tea on the mountain top; in the humus about the roots of an arbor vitae in the cedar swamp, II. 1, and in the humus in the hemlock woods, II. 2.

5. *Zonitoides exigua* (Stimp.). II. 2. A number of individuals were found among the fallen leaves in the hemlock and maple woods. Several were also found in decaying cedar and tamarack logs in the tamarack swamp, IV. 4.

6. *Vitrea ferrea* (Mse.). IV. 4. A few individuals of this species were taken in a fallen tamarack log in the peat bog.

7. *Vitrea indentata* (Say). II. 2. Under dead moist leaves in the hardwood forest. III. 1. Under fallen logs and in the soil in the aspen zone on the mountain top. III. 2. In the dry earth in crevices and held by the roots of the heath plants on the bare mountain top, and among the roots of the New Jersey tea in the aspen zone, III. 4. Also found under the bark of fallen tamarack logs in the tamarack swamp, IV. 4.

8. *Vitrea multidentata* (Binn.). III. 1. Several specimens were taken under the bark of a fallen pine in the aspen zone at the top of the first range.

9. *Pyramidula alternata* (Say). II. 3. Specimens of this form were found crawling about on a log in the clearing, early in the morning while the dew was heavy.

10. *Pyramidula striatella catskillensis* Pils. This species was collected

among the damp leaves in the woods toward the bottom of the slope, II. 2, and near the top under fallen pine logs among the heath plants, III. 1. It was also found in the tamarack swamp, IV. 4, in decaying arbor vitae and tamarack logs.

11. *Pyramidula asteriscus* (Mse.). IV. 4. Two were found beneath the bark of fallen tamarack trees in the peat bog. This is the only station at which this species was taken.

12. *Helicodiscus lineatus* (Say). Among the damp fallen leaves in the hardwoods, II. 2; near the bottom of the slope, III. 1; in fallen tamarack logs in the tamarack swamp, IV. 4; in the damp humus about the roots of ferns on the banks of Carp creek, VI. This species seems to prefer a damp habitat, and the dead shells found in the crevices of the cliff face and among the talus blocks were probably blown there.

13. *Acanthinula harpa* (Say). III. 2. A number of specimens were collected in the dry soil held by the grasses and heath plants on the mountain top. This is one of the characteristic molluscs of this exceedingly dry and exposed habitat.

14. *Punctum pygmaeum* (Drap.). II. 1. A few specimens were collected in the damp humus among the roots of an arbor vitae in the swamp. II. 2. Found to occur quite abundantly among damp leaves in the hardwood forest. III. 1. A few individuals were found under fallen logs among the huckleberry bushes in the aspen zone. III. 2. Several taken in the dry earth about the roots of New Jersey tea on the mountain top. IV. 4. A few found beneath the bark of fallen tamarack trees in the peat bog.

15. *Sphyradium edentulum* (Drap.). II. 2. Among the damp leaves in the hardwood forest; also found under fallen pine trees in the aspen zone, III. 1, and in decaying tamarack and arbor vitae logs in the tamarack swamp, IV. 4.

16. *Polygyra albolabris* (Say). III. 1. Several specimens were taken beneath fallen logs in the aspen zone on the mountain top, and among the damp leaves in the hardwood forest, VI.

17. *Polygyra sp.* [young, probably *albolabris* (Say)]. III. 2. In the dry earth about the roots of the bearberry on the mountain top.

18. *Polygyra fraterna* (Say). II. 3. On a log in the clearing after a heavy dew. VI. Among the damp leaves in the forest.

19. *Strobilops virgo* (Pils.). Found in the damp leaves of the hardwood forest near the bottom of the slope, II. 2; under logs in the aspen zone near the top, III. 1; in the dry earth among the roots of the heath plants on the mountain top, III. 2, and among the roots of the blueberry in the aspen zone, III. 4. It was also found in decaying tamarack logs in the tamarack swamp, IV. 4; a few in the humus beneath a hemlock on II. 2, and in the moist loam about the roots of ferns on the banks of Carp creek, VI.

20. *Bifidaria curvidens* (Gld.). This species was taken under logs in the aspen zone on the mountain top, III. 1, and on the bald areas, III. 2, in the dry earth held by the heath plants.

20a. *Vertigo gouldii* Binn. Taken in the Porcupine Mountains, and at Limestone Mountain in the summer of 1903. These specimens have only recently been identified and with the following species constitute the forms listed in the 1903 list as *Vertigo sp.* (Sixth Report Mich. Acad. Sci. 1904, p. 190).

20b. *Vertigo ventricosa elatior* Sterki. See 20a.

21. *Cochlicopa lubrica morseana* (Doh.). This species was only found in damp leaves in the hardwood forest, II. 2, and in the moist humus on the banks of Carp creek, VI.

22. *Euconulus chersinus polygyratus* (Pils.). II. 2. Among the damp leaves in the hardwood forest. III. 1. Under fallen logs in the aspen zone about the mountain top. III. 2. In the dry soil in rock crevices and among grass roots near the brink of the precipice. VI. In the loam on the bank of Carp creek.

23. *Succinea avara* Say. III. 2. A few shells were found in crevices in the rock on the brink of the cliff. These specimens were probably blown here as the animal is said to prefer a damp habitat.

24. *Carychium exile* H. C. Lea. II. 2. Several individuals of this form were taken in a very moist place among fallen leaves in the hardwood forest. Also found in very wet humus about the roots of ferns on the banks of Carp creek, VI.

25. *Limnaea decollata* Migh. Occurs quite frequently in the rock pools of the Middle Beach, and behind projecting outcrops on the Lower Beach of Lake Superior, I, where they were protected from the full force of the waves.

26. *Limnaea desidiosa* Say. I. Occurs quite numerously in the rock pools of the Middle Beach, and has been dredged in Lake Superior at a depth of 8 to 13 fathoms (Baker).

27. *Physa sp.* (too young to identify). IV. 1. Found on the under side of lily pads in Carp river.

28. *Physa sayii?* Tapp. (young specimen). VI. Found in very damp leaves on the bank of Carp creek.

29. *Physa ancillaria* Say. *var.* I. In the rock pools of the Middle Beach of Lake Superior.

30. *Planorbis campanulatus* Say. Taken on the under side of lily pads and among the leaves of submerged water plants on Carp river, IV. 1, and on the larger stones forming the bottom near the shore of Carp Lake, V. 1.

31. *Planorbis bicarinatus striatus* Baker. V. 1. Found on the stones composing a strip of shingle beach on Carp Lake.

32. *Planorbis exacuous* Say. IV. 1. Taken on the under side of water lily leaves in Carp river.

33. *Planorbis parvus* Say. I. This species was found in several of the pools on the Middle Beach of Lake Superior, both on the bare rock and in the slight algal growth that lines the sides. It was also found among the leaves in the bottom of a pool formed by a spring in the forest, II. 2, and in considerable abundance on the under side of the larger rocks that lie loosely in the bed of Carp creek, VI. Dredged in Lake Superior at a depth of 8-13 fathoms (Baker).

34. *Planorbis deflectus?* Say. (immature). V. 1. Found on the small stones forming the bottom of Carp Lake just off shore. VII. 3. On the submerged sticks of a beaver dam on Little Carp river.

35. *Planorbis hirsutus* Gld. IV. 1. Among the leaves of a submerged aquatic plant in Carp river, about two feet below the surface of the water.

36. *Ancylus parallelus* Hald. IV. 1. On the stems and under side of lily pads in Carp river.

37. *Valvata tricarinata* (Say). V. 3. Among the leaves of submerged aquatic plants in Carp Lake.

38. *Amnicola limosa* (Say). IV. 1. Abundant on the stems and under side of lily pads, and among the leaves of submerged aquatics in Carp river. Also common on the stems and among the leaves of submerged aquatic plants in Carp Lake, V. 3.

39. *Anodonta marginata* Say. V. 1. Occurs quite numerously in Carp Lake, just off shore on a bottom of either silt or pebbles, and in considerable

numbers among the rushes on the delta of Little Carp river, VII. 1. VII. 3. One specimen was also taken on a mud flat in Little Carp river, near the lake.

40. *Sphaerium simile* (Say). V. 1. This species was found in the mud at the outlet of Carp Lake, and on the mud flats of Little Carp river, VII. 3.

41. *Sphaerium rhomboideum* (Say). V. 1. Partially buried in the fine silt covering the bottom of Carp Lake just off shore.

42. *Pisidium sp.* V. 2. Beneath a partly submerged log on the delta of Carp river.

43. *Pisidium sp.* (immature). II. 2. Among the leaves in a spring pool in the hardwood forest.

2. ISLE ROYALE.

1. *Agriolimax campestris* (Binn.). Among fallen alder leaves on a wet flat along Washington river, II, and in the humus of the cedar swamp, IV.

2. *Agriolimax*? (specimen mutilated). VIII. One specimen taken on the under side of a stone in shallow water at Siskowit Bay.

3. *Pallifera hemphilli* (W. G. Binn.). IV. A specimen of this slug was found in swamp humus on Washington creek.

4. *Vitrina limpida* Gld. VI. Several specimens were taken in decaying spruce logs in the coniferous forest. Found also in the damp fallen leaves, in the deciduous forest, III.

5. *Zonitoides arborea* (Say). II. On Washington river among the fallen leaves in an alder thicket on a wet mud flat, and among the leaves and under the bark of fallen spruce and birch trees on dryer ground. III. Found among the leaves and under the rocks in the deciduous forest. IV. A few specimens taken in the humus of a cedar swamp on Washington creek. V. Collected in the moss in the tamarack swamp. VI. Several found beneath the bark of fallen spruce trees in the coniferous forest.

6. *Zonitoides milium* (Mse.). Specimens of this form were collected among the leaves and in fallen birch logs in the deciduous forest, III; in the moss of the tamarack swamp, V, and beneath the bark of fallen spruce trees, VI.

7. *Vitrea binneyana* (Mse.). II. Taken among the fallen leaves in an alder thicket on a mud flat on Washington river, and in the moss in the coniferous forest bordering the river. Specimens were found under stones and among the fallen maple leaves in the deciduous forest, III; in the humus of the cedar swamp, IV; in the fallen spruce logs in the coniferous forest, VI, and in the moss of the tamarack swamp, V. A few specimens were also found in the moss among the bearberry bushes on the Minong Trap promontory, IX.

8. *Zonitoides exigua* (Stimp.). II. Found among the fallen leaves of an alder thicket on a very wet mud flat, and in the moss covering the ground in the coniferous forest bordering the river. Collected among the fallen leaves in the deciduous forest, III; in the moss of the arbor vitae swamp, IV, and in the moss of the tamarack swamp, V. Also found in the moss among the bearberry bushes on the Minong Trap promontory, IX.

9. *Pyramidula alternata* (Say). III. Among the damp fallen leaves, beneath the bark of fallen birch logs, and under stones in the deciduous forest.

10. *Pyramidula striatella* (Anth.). This species was collected on Washington river, II, among the fallen leaves of alders on a mud flat, and in the moss in the coniferous forest, bordering the river. It was also collected in

the deciduous forest, III, among the damp fallen leaves and under rocks; in the humus of the cedar swamp, IV; in the moss in the tamarack swamp, V, and in the moss among the heath plants on the Minong Trap promontory, IX.

11. *Pyramidula striatella alba* (Walker). II. In the moss forming the ground cover of the coniferous forest. III. Several specimens were also collected among the damp fallen leaves in the deciduous forest.

12. *Pyramidula asteriscus* (Mse.). III. Taken among the fallen leaves in a moist ravine in the deciduous forest.

13. *Acanthinula harpa* (Say). II. This species was found to occur in the moss ground cover of the coniferous forest bordering Washington river; in the humus of the arbor vitae swamp, IV, and in the moss about the roots of the heath plants on the Minong Trap promontory, IX.

14. *Punctum pygmaeum* (Drap.). III. Several specimens of this form were collected among the damp fallen leaves in the deciduous forest.

15. *Sphyradium edentulum* (Drap.). II. Beneath the bark of a fallen log in the coniferous forest along Washington river, and among the fallen leaves in the deciduous forest, III.

16. *Euconulus fulvus* (Drap.). This shell was found beneath the bark of a fallen birch tree in the coniferous forest, II; among the fallen leaves in the deciduous forest, III, and in the moss of the tamarack swamp, V. A few dead shells were also found in the sediment in the bottom of Grace creek.

17. *Euconulus chersinus polygyratus* (Pils.). Collected in the moss and decaying logs in the coniferous forest on the flood-plain of Washington river, II; among the fallen leaves in the deciduous forest, III, and beneath the bark of a decaying tamarack stump, V.

18. *Vertigo ovata?* Say. A defective specimen was found in the humus of the arbor vitae swamp, IV.

19. *Vertigo gouldii* Binn. Among the fallen leaves in the deciduous forest, III, and in the moss of the tamarack swamp, V.

20. *Vertigo sp.* In the moss about the foot of a tamarack, V.

21. *Carychium exile* H. C. Lea. This species was found among the fallen alder leaves on a very wet flat along Washington river, II, and among the fallen maple leaves in the deciduous forest, III.

22. *Limnaea stagnalis* L. *var.* This snail is very abundant about the shores of Washington Harbor, X. The specimens collected were attached to the larger rocks that are not readily moved by the action of the surf.

23. *Limnaea* n. sp.? (related to *L. sumassi* Bd., but probably undescribed). X. This form is also abundant in Washington Harbor, and with *Limnaea stagnalis* constitutes the characteristic molluscan life of this station. The specimens collected were found clinging to the rocks under the same conditions as *L. stagnalis*. It was also found to occur commonly in the rock pools on the Minong Trap promontory, IX.

24. *Physa sayii* Tapp. *var.* X. This form was found only in Washington Harbor, where it occurs on the rocks near shore.

25. *Physa sp.* (probably *sayii* Tapp.). VIII. A few specimens were found at Siskowit Bay, attached to stones in the back water pools on the beach.

26. *Physa sp.* Under this head are grouped a number of immature shells collected in Lake Desor, VII, in the fine silt near shore and attached to large rocks about the islands; among the leaves of submerged aquatic

plants in Washington river, II, and attached to the rocks about the shore of Washington Harbor, X.

27. *Aplexa hypnorum* (L.). II. Found only among the fallen alder leaves on a wet flat on Washington river.

28. *Planorbis bicarinatus striatus* Baker. VII. This species was found in the silt near shore and on the rocks off the islands of Lake Desor.

29. *Planorbis exacuous* Say. II. A number of specimens were taken among the leaves of submerged aquatic plants in Washington river. It was also found on the rocks in shallow water about the islands of Lake Desor, VII, and in Washington Harbor, X.

30. *Planorbis parvus* Say. III. Collected among the leaves in the bed of a dry creek in the deciduous forest. Also found in the rock pools on the Minong Trap promontory, IX, and clinging to the rocks in shallow water about the islands of Lake Desor, VII.

31. *Planorbis hirsutus* Gld. This species was only found in Lake Desor, VII, where it occurs on the rocks in shallow water about the islands.

32. *Valvata sincera lewisii* Curr. VIII. A few specimens of this species were found on the rocks in a back water pool at Siskowit Bay.

33. *Anodonta marginata* Say. VII. Several specimens were collected in shallow water at the west end of Lake Desor, among a scattered vegetation of equisetum and water lilies. This is the only place where mussels were found on the south end of the island, with the exception of a broken shell in Washington Harbor, X, although a careful search was made for them about the shore of the harbor and in Washington river.

34. *Pisidium abditum* Hald. *var.* II. Several specimens were colected among the wet fallen leaves in the alder thicket, on the bank of Washington river.

35. *Pisidium variabile* Pme. II. Among the leaves of a submerged aquatic plant in Washington river.

36. *Pisidium sp.* Pisidia which could not be identified were collected on water plants in Washington river, II; in the silt in the bottom of Washington creek running through the arbor vitae swamp, IV, and in the debris in the bottom of Grace creek, near its mouth.

The following general observations on the collection will call attention to the specimens of special interest and to their faunal affinities. So far as Isle Royale is concerned, the fauna is purely boreal; the land species, as far as they go, are the same (with one exception) as those of the Porcupine Mountains, Ontonagon County. The only species not found in Ontonagon County is *Pyramidula striatella* Anth. The occurrence of the typical form of *striatella* on Isle Royale while the Ontonagon County form is uniformly var. *catskillensis* Pils., is very curious. *Catskillensis* is the characteristic form of Northern Michigan. It has been traced from Beulah, Benzie County, Mich. north through the Grand Traverse region, Mackinac Island and the St. Mary's river, to Marquette, Baraga and Ontonagon Counties. At Charlevoix both forms occur, while specimens from Crooked Lake, Emmet County, are rather intermediate. On the main land of the Upper Peninsula thus far only the variety has been found.

Among the aquatic species, however, Isle Royale furnishes some interesting forms. The form of *Limnaea stagnalis* is a peculiar and well marked

one, quite different from any of the described forms. The occurrence of the *Limnaea* related to *L. sumassi* Bd. on Isle Royale is a very interesting discovery, and, whether distinct or merely a variety of that form, is new to the Michigan fauna. Originally described from British Columbia *L. sumassi* is peculiarly a western species, and its occurrence so far east, if these shells are referred to it, is quite unexpected. *Planorbis bicarinatus striatus* Baker has not before been listed in the Michigan fauna, as it was described since the last (1894) general catalogue of the Mollusca of the State was published. It is, however, a form of general distribution through the northern part of the state and occurs occasionally in the southern counties. (Raisin river, Monroe Co. and Orchard Lake, Oakland Co.). The *Pisidia* are represented by several interesting forms, some of which are probably undescribed species, but the amount of material is at present too meager to justify a decisive opinion. It is a matter of regret that this interesting group was not more largely represented in the collection. The collection from the Porcupine Mountains is necessarily largely the same as that made in 1903, and affords no occasion to vary the opinion as to the general character of the fauna already expressed in the report on these collections.*

The specimens of *Cochlicopa lubrica* from the hardwood forest, II. 2, are the elongated slender form described by Doherty as *morseana*. It has not been listed before from this State. *Acanthinula harpa* and *Zonitoides asteriscus* are boreal species, the former hitherto found only at Beulah, Benzie Co., Charlevoix and Petoskey, and the latter at Charlevoix. Their occurrence on Isle Royale and in Ontonagon County are the first records for the Upper Peninsula. *Pallifera hemphilli* W. G. Binn. is a new species for Michigan and a very interesting one. It was originally described from Mount Mitchell, N. C. and Lulu, Hall Co., Ga. Dr. Pilsbry says, "It looks as though *hemphilli* might be a Canadian form which extends down the mountains. I have seen it also from the mountains in Pennsylvania."

*Sixth Report Mich. Acad. Science, 1904, p. 192.

SPIDERS AND INSECTS FROM THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

A. G. RUTHVEN.

With the exception of the Odonata and Orthoptera, no attempt was made to make extensive collections of the different groups of invertebrates, and the lists comprise only the more characteristic forms in the different habitats studied. The collections were, for the most part, made by the author with the assistance of the other members of the party, except in the case of the ants which were collected largely by Mr. Otto McCreary. We are indebted to the following persons for the determination of the collections:

Spiders.—Mr. Nathan Banks, U. S. Department of Agriculture.

Dragonflies.—Mr. E. B. Williamson, Bluffton, Ind.

Butterflies and Moths.—Prof. Arthur J. Snyder, Springfield, Idaho.

Ants.—Dr. W. M. Wheeler, American Museum of Natural History.

1. SPIDERS FROM THE PORCUPINE MOUNTAINS.

1. *Gnaphosa conspersa* Thor. III. 1. Taken under a pine log among the dwarf huckle-and blueberry bushes in the aspen zone, August. 6.

2. *Linyphia phrygiana* Koch. I. Taken on the leeward side of projecting outcrops of rock on the beach of Lake Superior, July 21. Also occurs in Europe (Banks).

3. *Epeira trifolium* Hentz. I. This spider occurs numerously along the beach of Lake Superior. It weaves its web behind projecting outcrops of rock, and when surprised runs swiftly into the rock crevices. The webs are often filled with small white moths, July 30.

4. *Epeira patagiata* Clerck. I. This species was found under the same conditions as *Epeira trifolium*. Also occurs in Europe (Banks).

5. *Lycosa gracilis* Bks. III. 1. In a shallow hole in dead grass under a fallen pine log in the aspen zone, August 6.

6. *Pardosa lapidicina* Th. I. This species was taken on the beach of Lake Superior, July 30. It was observed quite frequently running about over the rocks, and dodging into the crevices when pursued.

7. *Pardosa. sp.* (probably *lapidicina*). I. Several immature specimens were taken on the rocks of the Lake Superior beach, July 21.

8. *Dolomedes tenebrosus* Hentz. II. 1. A specimen of this spider with its egg mass was taken on a cedar stump in the arbor vitae swamp, August 25.

2. SPIDERS FROM ISLE ROYALE.

1. *Amaurobius sp.* V. One specimen was found in the Sphagnum moss in a tamarack swamp, August 22.

2. *Amaurobius bennetti* Blackw. II. One specimen was taken in the moss ground cover of the balsam and spruce forest on the flood-plain of Washington river, August 26.

3. *Lycosa pratensis* Em. IX. Several specimens were found in the moss about the roots of the dwarf blueberry bushes on the Minong Trap promontory, September 2.

4. *Xysticus sp.* IX. One specimen was taken in the same habitat as the last, September 2.

Mr. Banks remarks in a letter, concerning the collection, that these species are all fairly common throughout the northeastern United States.

3. DRAGONFLIES FROM THE PORCUPINE MOUNTAINS.

1. *Calopteryx aequabilis* Say. IV. 2. A male was taken among the alder bushes along Carp river, August 5, and a female flying up the river, IV. 1, on August 12.

2. *Lestes unguiculatus* Hagen. II. 3. A male was taken in the clearing on August 12. III. 2. Two females were taken on the "bald" crest of the first range, resting on goldenrods, July 18. IV. 2. One male was taken on a cassandra bush in the valley of Carp river, August 5.

3. *Nehalennia irene* Hagen. V. 2. A female was collected on a grass stem on the delta of Carp river, August 12.

4. *Enallagma hageni* Walsh. V. 2. Twenty-one males and one female were taken on the delta of Carp river, on August 12, and four males on July 21. This is the only station at which this form was observed. It occurs here, however, abundantly, and is the characteristic species of this marsh.

5. *Enallagma carunculatum* Morse. V. 2. A single specimen of this form, a male, was taken on the delta of Carp river, August 12.

6. *Enallagma sp.* V. 2. A male was taken on the delta of Carp river on August 12.

7. *Ischnura verticalis* Say. V. 2. A female was taken on the delta of Carp river, July 21, resting on a grass stem, and a male and female in the same locality on August 12.

8. *Hagenius brevistylus* Selys. V. 1. Only one specimen of this form was collected, a female taken on Carp Lake, on an alder branch overhanging the water, August 10.

9. *Gomphus spicatus* Hagen. A male was taken in the clearing, II. 3, on July 16, a female, flying about among the cassandra bushes on the flood-plain of Carp river, IV. 2, August 5, and five males on the delta of Carp river, V. 2, July 21. The habitat of this form seems to be the marsh and river. The specimen taken in the clearing was the only specimen observed away from water.

10. *Aeschna clepsydra* Say. I. Several individuals resembling this form were observed, flying back and forth along the beach of Lake Superior on July 30. II. 3, 4. Two males and two females were taken about dusk on July 16, flying about the clearing and in and out among the surrounding aspens. V. 2. A male and female were captured in coitu among the grasses and sedges on the delta of Carp river, on August 8. IV. 1. Individuals resembling this form were often seen in the evening, flying up and down Carp river, and along Little Carp river, VII. 3, and over the lake, VII. 1, on August 3. This species seemed to occur generally along the streams, except in the evening, when it was also observed flying back and forth in the woodland clearings. The individuals seen flying over Little Carp Lake often made sudden swerves close to the surface, and nearly every time, as they flew upward again, they were followed by the snout of a hungry dace, but in no instance observed was the fish successful.

11. *Sympetrum obtrusum* Hagen. II. 3. One female was taken on July 16; many others were seen in the clearing at various times. II. 4. Five males and one female were taken in the aspen zone that surrounds the clearing, July 15 and 16. II. 5. Two males and two females were taken on the heath undergrowth in the aspen zone bordering the north side of the bald crest of the ridge, July 15. III. 1, 2. Several individuals of the genus, thought to belong to this species, were seen at different times, flying about over the heath plants, and in the aspen zone on the mountain top. III. 3. One specimen was taken among the pines on July 19. III. 4. Two males and one female were taken on July 15 in the aspen zone that borders, on the east, the bald crest of the first range. IV. 2. Three males were taken among the cassandra bushes along Carp river on July 5. VII. 2. One taken and several seen on the beaver meadow on Little Carp river, August 3. This form seemed to occur most numerously in the cassandra zones and beaver meadows along the streams, although it was also observed to occur quite commonly in hardwood clearings and on the bald crests. It is not strictly confined to the clearings, however, but seems to occur in equal abundance in the aspen zones.

12. *Sympertum costiferum* Hagen. I. One male was taken on July 30, flying about over the beach of Lake Superior. This was the only specimen taken. Three others which resembled this form were seen resting on the beach, but they eluded capture. None were observed at any other station.

13. *Plathemis lydia* Drury. IV. 1, V. 2, VII. 2. No specimens of this form were taken, but a dragonfly was observed several times on the mudflats of Carp river, on the marsh at the east end of Carp Lake, and on the beaver meadow, that can be referred to this species with little doubt.

4. BUTTERFLIES AND MOTHS FROM THE PORCUPINE MOUNTAINS AND ISLE ROYALE.

a. Porcupine Mountains.

1. *Argynnis cybele* Fab. II. 3. One specimen of this form was taken on the flower of a cow parsnip in the clearing, July 20, and one on a goldenrod on the mountain top, III. 2, on August 10. Argynnid forms resembling this species were often seen about the clearing, "balds" and river valley, but how many of these were to be referred to the species, and to the following variety, was not determined.

The observations and collections indicate that both the variety and typical forms prefer an open sunny habitat.

2. *Argynnis cybele* Fab. *var.* (near *leto*). For a discussion of this variety see Prof. Snyder's comments on the collection at the close of the Isle Royale list. II. 3. One specimen was taken, flying about the clearing, July 21, and one on Carp river, IV. 2, flying about among the cassandra bushes on August 12.

3. *Argynnis atlantis* Edwards. Specimens of this species were collected on the beach of Lake Superior, I, August 11, in the clearing, II. 3, July 16, and in the valley of Carp river, IV. 2, August 12.

4. *Phyciodes tharos* Drury. I. Two were taken, flying over the beach of Lake Superior, July 30 and August 11, and two on a harebell on July 17. II. 3. Two specimens were also found on a cow parsnip flower in the clearing, July 16. This species like the Argynnids, seems to prefer open sunny habitats.

5. *Grapta gracilis* Grote and Robinson. I. Five specimens were taken on the rocks and flying about over the beach of Lake Superior on August 11. II. 3. One was collected in the clearing, August 7, and one on the face of the cliff, III. 6, August 11. This form is the characteristic butterfly of

the beach. The one captured in the clearing was the only one observed there. They were numerous on the face of the cliff, but, owing to the difficulty in scaling the precipice, only one could be secured. Both on the cliff face and beach, they made but short flights when disturbed, and if not pursued soon settled on the rocks again. After alighting they settled close to the rocks with their wings outspread, now and then raising them above their back, but quickly lowering them again.

6. *Grapta progne* Cramer. I. One specimen of this butterfly was taken, flying over the beach of Lake Superior, August 11.

7. *Vanessa j-album* Boisduval and Leconte. This form was taken on the beach of Lake Superior, I, on August 11. Two individuals were collected in the clearing, II. 3, on August 5, and August 7. III. 2. One specimen was also found on the talus slope, July 21.

8. *Vanessa antiopa* Linn. I. One taken on the beach of Lake Superior, August 11. This butterfly was not often seen. It was twice recognized in the clearing, II. 3, once on the shore of Carp Lake, V. 1, and once in the beaver meadow on Little Carp river, VII. 2.

9. *Basilarchia arthemis* Drury. This form was found to occur on the beach of Lake Superior, I, in the clearing and surrounding aspen zone, II. 3, 4, in the cassandra zone on Carp river, IV. 2, and in the beaver meadow. It is a very common form in this region, being apparently of general distribution in clearings

10. *Thecla edwardsii* Saunders. III. 2. One specimen was collected on a goldenrod on the mountain top, August 10.

11. *Colias philodice* Godart. I. Two specimens were taken on harebells on the beach of Lake Superior, August 30, and three flying about, August 11. II. 3. One was found on a cow parsnip in the clearing, August 7. "Yellow" butterflies were not often observed

12. *Catocala unijuga* Walker. II. 3. One specimen was found in a crevice between the logs of the camp shack in the clearing, August 5.

13. *Hypoprepia miniata* Kirby. III. 6. On a huckleberry bush on the "bald" mountain top, August 11.

14. *Actias luna* Linn. II. 2. A single specimen was taken on a hemlock, July 15.

b. Isle Royale.

Basilarchia arthemis and *Colias philodice* were both common in the clearings. One specimen of *Vanessa antiopa* was seen in a clearing, September 3.

c. Notes on the Collection of Butterflies, by Prof. A. J. Snyder.

Of all the lot the most interesting are the two varieties of the female of *Argynnis cybele*, which so closely resemble the female of *Argynnis leto* as to startle one. The same form was found in the Lake Superior region by Mr. Bates of Chicago. I believe two specimens of this form are now in the collection of Mr. John Healey of Chicago. The two specimens listed above well illustrate geographic variation.

Dr. Holland speaks of *Carpenterii*, the variety of *cybele* found in New Mexico and Colorado, and claims a similar form is found in Labrador and Canada; also on the mountains of Carolina. The largest forms of *cybele* I have seen are from Tennessee. *Argynnis leto* is a western species common in Utah and some parts of Colorado. The dark female, at its best, is a handsome specimen, and that a female of *cybele* should be found in the Superior country is enough to make one question the ancestory of *leto*. Of one thing we are

certain, altitude and latitude both tend to make smaller and darker colored specimens of a species.

5. ANTS FROM THE PORCUPINE MOUNTAINS.

1. *Formica impexa* Wheeler.* III. 6. A colony of this form was found beneath a loose stone among the huckleberry bushes on the mountain top, August 12, 1904 (not 1902 as given by Wheeler).

"*Worker.* Length 3.3—6 mm.

"With the habitus of *Formica rufa.* Mandibles 8 toothed. Clypeus broadly rounded in front, not produced in the middle, carinate its entire length. Head excluding the mandibles, distinctly longer than broad even in the largest workers. Cheeks rather long, straight, subparallel. Posterior border of head straight, posterior corners rounded. Joints 1-4 of antennal funiculus decidedly longer and more slender than the remaining joints. Thorax of the *rufa* type, but with the epinotum very low and rounded. Petiole rather thick anteroposteriorly, its anterior surface convex in profile, its posterior flattened, its edge, especially in smaller workers, very blunt. Seen from behind the node is produced upwards in the middle and is of rather variable outline, being notched in the middle in some specimens, but oftener more or less rounded.

"Mandibles lustrous, finely and sharply striated. Surface of clypeus uneven. Frontal area shining. Remainder of body opaque, distinctly but finely shagreened.

"Whole body and appendages covered with very minute white pubescence, which is rather sparse on the head and thorax, but dense and concealing the ground surface on the gaster. Body, antennal scapes, and legs covered with robust, obtuse, erect or suberect, whitish or yellowish hairs. On the gaster they are uniformly distributed and very conspicuous in certain lights. They are also very numerous and prominent on the upper surface of the thorax, clypeus, front, vertex, posterior corners and lower surface of the head. They are absent or very sparse on the cheeks, pleurae and coxae. On the legs they are prominent both on the flexor and extensor surfaces.

"Head and thorax red. Gaster black. All specimens, even the largest are more or less infuscated as follows: Mandibles, anterior border of clypeus and apical half of funiculi dark reddish brown. Ocellar triangle, upper surface of pro- and mesonotum, much of the upper portion of the petiole, legs and coxae, except their articulations, more or less blackened. In the largest workers the fore coxae are largely red. Anal region and articulations of legs yellowish. In the smallest workers the infuscation is more extensive, involving the whole of the posterior portion of the head and the epinotum.

"Described from twelve workers taken August 12, 1904 by Mr. O. McCreary from a colony nesting under a stone in the Porcupine Mountains, Ontonagon county, Michigan. Types in the American Museum of Natural History, cotypes No. 32,925 in the University Museum, University of Michigan, Ann Arbor, Mich.

"*F. impexa* is allied to *F. oreas* Wheeler and *F. microgyna* Wheeler, with which it agrees in having erect hairs on the antennal scapes. It differs from *F. oreas* in the much stiffer and less abundant erect and obtuse hairs on the head and thorax, the prominent hairs on the gaster, the longer head, more opaque surface of the head and thorax, etc. In most of these characters

*Wheeler, W. M. New Species of Formica. Bull. Amer. Mus. Nat. His., XXI, p. 273, 1905.

it also differs from the typical *microgyna*. The erect hairs on the gaster of *impexa* are much more robust and obtuse than in the latter species. The new species also resembles *F. difficilis* Emery and notably its var. *consocians* Wheeler, except in pilosity and the absence of any yellow color on the basal gastric segment.

"It is very probable that the female of *F. impexa* is aberrant, either in being very diminutive like the females of *F. difficilis* and *F. microgyna* or in having an unusual color like the female of *F. oreas*. Until this sex of *impexa* is discovered there may be some doubt as to whether the form should be regarded as a species distinct from *rufa*. That it differs very markedly in pilosity from all the hitherto described subspecies and varieties of *rufa*, there can be no doubt." W. M. Wheeler.

2. *Formica fusca* L. var. *subsericea* Say. III. 6. On the rocks at the foot of the talus slope and at the foot of the cliff, August 12. Also found in an ant hill in the clearing, II. 3, and under the loose stones on the mountain top, III, August 6.

3. *Formica fusca* L. var. *argentata* Wheeler. III. 1, 2. A number of colonies were found under the loose rocks on the mountain top, especially among the heath plants.

4. *Formica fusca* L. var. *neorufibarbis* Emery. II. 4. A colony of this species was found in a decaying aspen log, August 8.

5. *Formica lasioides* Emery. var. *picea* Emery. III. 2. Collected under the loose stones on the mountain top, August 11.

6. *Brachymyrmex heerii* Mayr. subsp. *depilis* Emery. III. 6. Under stones on the mountain top, August 12. III. 2. Taken among the heath plants on the mountain top, July 18.

7. *Tapinoma sessile* Say. (small var.). III. 1. Under the stones in the aspen zone near the top of the first range, August 11, and on III. 6, under the loose stones on the side of the mountain near the top on August 12.

8. *Camponotus herculeanus* L. var. *whymperi* Forel. III. 2. A colony was found in a dry decaying pine log on the bare mountain top, August 6. and in a decaying pine log on the mountain top, III. 6, August 12.

9. *Lasius brevicornis* Emery. III. 2. Beneath the loose rocks on the mountain top, August 11.

10. *Spenamma* (*Aphaenogaster*) *fulvum* Roger. var. *rude* Emery. III. 6. Collected beneath the stones near the top of the mountain, August 12, and under stones and fallen pine logs in the aspen zone near the top of the ridge, August 6.

6. ANTS FROM ISLE ROYALE.

1. *Formica sanguinea* Latr. subsp. *aserva* Forel. I. One colony found in the clearing, August 18.

2. *Formica fusca* L. var. *subsericea* Say. I. Several colonies were found in the clearing, August 18.

3. *Formica fusca* L. var. *neorufibarbis* Emery. I. In the humus beneath a decayed stump in the clearing, August 18. III. In a decayed log on the top of the ridge, August 20.

4. *Camponotus herculeanus* L. var. *whymperi* Forel. I. Found on sides of a log shack, August 18, and feeding on a fish head in the clearing, September 1.

5. *Leptothorax canadensis* Prov. var. I. One colony found in the clearing, August 18.

Dr. Wheeler makes the following comments on the collection: "The

collection is a very interesting one. All the forms are subboreal and characteristic of the hills or mountains of the northern states or British Columbia. The new *Formica* [*impexa*] is especially interesting. Unfortunately only workers are represented. The female is probably an aberrant form like the female of *F. oreas* or *F. ciliata*. All the other species are well known, with the exception of *F. aserva* and *Camponotus whymperi*. The latter occurs in the mountains of Colorado and British Columbia."

THE COLD-BLOODED VERTEBRATES OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

A. G. RUTHVEN.

The list of fish in the following report is entirely the result of the work of this expedition, and we are indebted to Dr. S. E. Meek of the Field Columbian Museum, Chicago, for the identification of the specimens.

The list of amphibians and reptiles is intended to include the data at present available to the author on the occurrence of these animals in the Northern Peninsula. It is of necessity far from complete, as very little collecting has been done in this region, and the records that have been made are scattered. For the latter reason it was thought best to bring together all available information. The sources of the records are the collections made for Mr. Bryant Walker about Limestone Mountain, Baraga County, and in the Porcupine Mountains, Ontonagon County, in the summer of 1903*; the collections and field notes of the Museum Expedition in the Porcupine Mountains and on Isle Royale, during the summer of 1904; records and collections made about Marquette by Dr. E. R. Downing of the Northern State Normal School, and specimens in the University Museum collected by Dr. A. E. Foote on Isle Royale. A few notes have also been added from specimens collected during the summer of 1905, by Dr. C. A. Davis of the Michigan Geological Survey.

The amphibians, with the exception of the Marquette specimens, have been identified by Dr. Stejneger of the United States National Museum; the Marquette specimens, and the reptiles were identified by the writer, unless otherwise stated.

1. FISH FROM THE PORCUPINE MOUNTAINS.

1. *Catostomus commersonii* (Lacépede). Fine Scaled or Common Sucker. IV. 1. Ten specimens were taken in the deeper holes in Carp river near Carp Lake, July 16, on a bottom of fine mud. V. 3. Twelve specimens were collected near the center of Carp Lake on July 16. VII. 1. One was taken and several others seen off the edge of the delta of Little Carp river, August 3. VII. 3. Two specimens were collected in a pool about five feet deep behind a beaver dam on Little Carp river, August 3. This is the characteristic and common fish in the deeper waters of this region.

2. *Semotilus atromaculatus* (Mitchell). Horned Dace. IV. 1. Thirteen specimens were taken in Carp river on July 16 and 18. This fish seemed to occur only in small numbers in the deeper water near the lake, but farther up stream, where the current is more rapid, it was very abundant, although the bottom was still composed of mud and debris. No specimens were taken in Carp Lake, but it is abundant in Little Carp Lake, VII. 1, where

*Ruthven, A. G.—Notes on the Molluscs, Reptiles and Amphibians of Ontonagon County, Michigan. Sixth Annual Report Michigan Academy of Science, pp. 188–192.

thirty-four specimens were taken, August 3. In the latter, locality they were observed repeatedly about dusk to jump partly out of the water in pursuit of dragonflies.

3. *Nototropis cayuga* Meek. IV. 1. Four specimens were taken off a mud flat in Carp river on July 16, among a vegetation of water lilies.

4. *Nototropis hudsonius* (DeWitt Clinton). Spawn Eater or Shiner. IV. 1. Four specimens were taken off a mud flat in Carp river, and many others in Carp Lake, V. 3, in about six feet of water, off a gravelly shore, July 16.

5. *Nototropis cornutus* (Mitchell). Shiner; Red Fin. VII. 3. One specimen of this form was taken in Little Carp river. This fish was observed to occur much more numerously up stream, where the current was swift and the bottom composed of gravel, than in the deeper water near the lake.

6. *Couesius plumbeus* (Agassiz). VII. 3. Six specimens of this fish were collected in Little Carp river at about the middle of the beaver meadow, where the stream is shallow, current quite rapid, and the bottom composed of small stones.

7. *Salvelinus fontinalis* (Mitchell). Brook Trout. Owing to the preference of this species for clear cold streams with a swift current and gravel bottom, it is not surprising that it does not occur in Carp Lake or Carp river within the mountains. It is reported by Mr. Allie, of the Carp Lake Mine, to be abundant in Little Carp Lake during the spring and early summer, but we were unable to obtain any in August.

8. *Thymallus ontariensis* (Cuvier and Valenciennes). Grayling. This fish was not taken, but specimens were seen by the writer in the summer of 1903, which had been taken in Little Carp river, near Lake Superior.

9. *Eucalia inconstans pygmaea* (Agassiz). VII. 3. One specimen was taken in Little Carp river on August 3, where the current was quite rapid and the bottom composed of fine silt. Several others were seen in a small creek cut in the loam of the beaver meadow.

10. *Percopsis guttatus* Agassiz. Trout Perch. IV. 1. Three specimens were collected in shallow water off a mud flat in Carp river, and in the deeper waters of Carp Lake, V. 3. This genus and species were originally described by Agassiz[1] from specimens taken in the Lake Superior region. Its habitat is given by Forbes[2], as apparently deeper waters, not often found in streams, and by Jordan and Evermann,[3] as "cold or clear lakes and rivers." It, however, occurs in the Porcupine Mountains, in quite shallow water. This may be due to the fact that it is a northern form, and that in this region the conditions to which it is adapted are more widespread than toward the south.

11. *Perca flavescens* (Mitchell). Yellow Perch. IV. 1. Four specimens were collected in the deeper parts of the river near Carp Lake, and twenty-five in the lake, V. 3. These specimens were all obtained in the deeper parts of the lake and river, where there was considerable vegetation and muddy bottom.

2. FISH FROM ISLE ROYALE.

1. *Catostomus commersonii* (Lacepede). Common Sucker. X. Often seen in large schools near the shore of Washington Harbor. The conditions were: bottom rocky, and little or no vegetation.

[1]Agassiz, Louis. Fishes of Lake Superior compared with those of the other Great Canadian Lakes. p. 284. Lake Superior its Physical Character, Vegetation, and Animals. Boston, 1850.

[2]Forbes, S. A. A Catalogue of the Native Fishes of Illinois. Rep. Ill. State Fish Com., 1886, p. 96.

[3]Jordan and Evermann. The Fishes of North and Middle America. Bull. U. S. Nat. Mus., No 47, Pt. I, p. 784.

2. *Couesius plumbeus* (Agassiz). The type of this species was from Lake Superior.* It occurs abundantly in Washington Harbor, X, where eight specimens were taken, August 31, just off shore, on hooks baited with worms.

3. *Argyrosomus artedi* (LeSueur). Lake Herring. X. The Herring was observed in large schools in Washington Harbor at different times; one was taken in a gill net out in the harbor, and one near shore in about fifteen feet of water, August 31.

4. *Cristivomer namaycush* (Walbaum). Lake Trout. X. This fish was taken at various times by trolling off rocky reefs in Washington Harbor and along the north shore of the island. The weight of those taken varied from 5 to 12 pounds.

5. *Salvelinus fontinalis* (Mitchell). Brook Trout. This trout occurs abundantly in Washington river, II, and individuals were often observed in the Herring schools in Washington Harbor, just off shore, X.

6. *Lucius masquinongy* (Mitchell). Muskallunge. X. But one specimen of this fish was observed, which was speared with a cant hook near the shore of Washington Harbor on August 2. Weight 13 pounds.

7. *Perca flavescens* (Mitchell). Yellow Perch. X. Occasionally taken in Washington Harbor on hooks bated with worms.

8. *Cottus ictalops* (Rafinesque). Millers Thumb. X. Occurs among the large rocks along the shore of Washington Harbor.

3. THE AMPHIBIANS OF THE NORTHERN PENINSULA.

1. *Plethodon glutinosus* Green. Slimy Salamander. I have examined a specimen of this salamander collected by Dr. E. R. Downing at Marquette. He reports it as occurring commonly in that locality.

2. *Plethodon cinereus erythronotus* Green. Red-backed Salamander. Specimens of this form were taken in decayed logs, especially in damp places, at Limestone Mountain, Baraga County, in August, 1903, and in the Porcupine Mountains in August and September, 1903. It is also reported by Dr. Downing from Marquette.

3. *Diemyctylus viridescens* Raf. Green Triton or Newt. I have examined a specimen of this form taken by Dr. Downing from a small tributary to Dead river, near Marquette.

4. *Bufo americanus* (Lec.). Common Toad. Found commonly in the woods both at Limestone Mountain and in the Porcupine Mountains in the summer of 1903, and in the Porcupine Mountains and on Isle Royale, in the same habitat, in the summer of 1904. It is reported by Dr. Downing as common at Marquette. There are also four specimens in the University Museum collected by Dr. A. E. Foote on Isle Royale, where the notes of the Museum Expedition indicate that it is very common.

5. *Hyla pickeringii* Storer. Pickering's Tree Frog. A specimen of this little frog was taken on a fern in a damp ravine at Limestone Mountain in the summer of 1903, and another on a rush in the beaver meadow on Little Carp river, VII. 2, in the Porcupine Mountains on August 3, 1904. A specimen was also taken by Dr. C. A. Davis near Winona, Houghton County, on September 1, 1905.

6. *Hyla versicolor* Lec. Chameleon Tree Frog. Dr. Downing writes me that he has taken this species at Marquette. There is also a record in the University Museum (Museum Catalogue, Vol. 2, p. 196) of a specimen

*Agassiz, *loc. cit.*, p. 366.

(No. 7457) taken on Isle Royale by Dr. Foote, which I have been unable to verify.

7. *Rana pipiens brachycephala* Cope. Leopard Frog. The distinction between the typical form of this species and the so-called variety *brachycephala* does not seem to be a good one. If it is, the specimens recorded from the Northern Peninsula, according to Dr. Stejneger, probably belong to the variety. The specimens collected on the shores of Carp Lake in the summer of 1903, and recorded as *R. pipiens*,* belong to this form. Specimens were also taken here, V. 1, 2, during the summer of 1904, and Dr. C. A. Davis captured four specimens near Winona, Houghton County, September 1, 1905. The "Leopard Frog" is abundant about Marquette, according to Dr. Downing. Owing to the resemblance between this species and *R. palustris* Lec. several specimens from the Porcupine Mountains were listed provisionally as *palustris* in the 1903 list. These have all been identified by Dr. Stejneger as *R. pipiens brachycephala.*

8. *Rana septentrionalis* Baird. Mink Frog. This species is more aquatic than the other members of the genus found in this region, and specimens are thus more difficult to capture. A number of specimens were taken along the shores of Carp Lake, V. 1, and river, IV. 1, in the summer of 1904. It is also reported by Dr. Downing at Marquette, and there is in the University Museum a specimen taken by Dr. A. E. Foote on Isle Royale, that is labeled *R. clamitans*, but, owing to its condition, it is impossible to tell whether it is to be referred to this species or *clamitans*. As it is labeled *clamitans*, however, it should probably be listed with that species.

9. *Rana clamitans* Daud. Green Frog. This is probably the most common frog in the Northern Peninsula, at least in the western part. Several specimens were taken in Otter river near Limestone Mountain in August, 1903, and it was found to be abundant in Carp, IV. 1, and Little Carp river, VII. 3, and Lakes, V. 1, and VII. 1, in 1903 and 1904. At least one of the two specimens listed as *catesbiana* in the 1903 list belongs to this species, and perhaps also the other. They are both characterized by an obscurity of the dorso-lateral folds. In the former specimen this obscurity is more pronounced than in the latter, but Dr. Stejneger states that the slight webbing of the toes in the latter indicates that it, also, belongs to this species.

10. *Rana catesbiana* Shaw. Bull Frog. See *R. clamitans*. Dr. Downing reports this species from Marquette, but it is doubtful whether his specimens are to be referred to this species or, as the Porcupine Mountain specimens, to *clamitans*.

11. *Rana sylvatica cantabrigensis* Baird. Cambridge Frog. This variety of the Wood Frog is one of the most common amphibians in the localities where collecting has been done in the Upper Peninsula. It was found to be abundant in damp woods, especially about springs, both at Limestone Mountain and in the Porcupines, during the summers of 1903 and 1904. A single specimen was also taken on the shore of Lake Desor, Isle Royale; this was, however, the only one seen on the island. To this variety are to be referred the specimens that were listed in 1903 as *R. sylvatica.*

4. THE REPTILES OF NORTHERN MICHIGAN.

1. *Storeria occipitomaculata* (Storer). Storer's Snake. A single specimen of this snake was taken in the Porcupine Mountains in 1903, and a number of specimens collected about Marquette by Dr. Downing have been examined.

*Ruthven, *loc. cit.*, p. 191.

During the summer of 1904, eight specimens were taken on Isle Royale. These snakes, as has been stated by Smith,* appear to be somewhat nocturnal although not strictly so, and the specimens found on Isle Royale were taken, for the most part, under stones in the coniferous, VI, and deciduous forest, III. On September 3, after a heavy frost, four adult specimens, very sluggish on account of the cold, were found under a stone in the woods. These were brought to Ann Arbor alive. One of these snakes, University Museum Catalogue No. 33408, during the night of September 7 gave birth to a single young, and the next morning was found dead; the young one died the following night. The mother was examined at once, and six entire and two mutilated embryos were removed. As the mutilated specimens were nearest the opening of the oviduct, it is possible that they may have been killed by an injury to the mother in rolling over the stone under which she was found, and prevented the birth of those that lay behind them. The young snake was 45 mm. long, of a rich dark brown above, and pink below. As in the adult specimens, the pink was confined to the center of the gastrosteges, not extending to the edges. The upper occipital spot was bright yellow and well defined; the laterals smaller and less distinct, although plainly present.

Another adult, University Museum Catalogue No. 33409, died on September 10. This is also a female and possesses four nearly mature embryos in the right oviduct. The left oviduct is flattened out against the dorsal body wall and contains but one very small embryo which lies in the lower part of the oviduct; notwithstanding its small size, however, it is evidently nearly mature, as the yolk has entirely disappeared.

During the night of September 19, a third specimen, University Museum Catalogue No. 33410, gave birth to nine young, one of which was dead. The fourth specimen, University Museum Catalogue No. 33411, during the night of September 26 gave birth to seven young, one of which was dead. These records are interesting on account of the questions which they raise, as to the size of the young at the time of hibernation. On the Isle, during the first part of September, the nights were cold, and heavy frosts occurred frequently, so that the specimens found in the morning were very sluggish, and the time of hibernation was probably near at hand.

Since the above was written, the University Museum has received two specimens from Dr. C. A. Davis, which were taken on Paint River, near Crystal Falls, Iron County, on August 22, 1905.

2. *Diadophis punctatus* (L.). Ring-necked Snake. Specimens of this snake have been taken by Dr. Downing at Marquette.

3. *Thamnophis sirtalis sirtalis* (L.). Common Garter Snake. Specimens of the Common Garter Snake have been taken at Marquette by Dr. Downing, and near Limestone Mountain (1903), in the Porcupines (1903 and 1904), and on Isle Royale (1904). They are more commonly found along the streams, although they are also often found in forest clearings. The University Museum has recently received a specimen from Dr. C. A. Davis, which was taken in the woods near Bessemer, Gogebic county, August 28, 1905. There are four specimens (No. 7454) listed in the University Museum Catalogue, Vol. 2, p. 196, as taken on Isle Royale by Dr. Foote. These specimens are probably the basis for Smith's Isle Royale locality.†

4. *Thamnophis sirtalis parietalis* (Say). Pacific Garter Snake. This

*Smith, W. H. Report on the Reptiles and Amphibians of Ohio, p. 698. Geological Survey of Ohio, Vol. IV., 1882.

†Smith, loc. cit., p. 680.

snake has been listed from the Lower Peninsula,* but I have never seen a specimen from southern Michigan that could be definitely referred to this variety. *Sirtalis* forms with a varying amount of red on the skin between the lateral spots are often found about Ann Arbor, but the amount of red is so small that it is generally more satisfactory to classify the specimens with the typical form. During the past summer, however, three specimens were taken on Isle Royale, II, III, that strikingly resemble specimens from Colorado and Washington and can only be referred to the variety. The dorsal row of spots, as in typical specimens of the variety, are fused into a band along either side of the dorsal stripe, which is united below with the row of spots above the lateral stripes. Between the scales the skin is Orange Red Tint No. 1 (using Milton Bradley colors). One of these is a female containing 28 embryos not yet mature, as a large yolk body is present.

5. *Thamnophis saurita* (L.). Riband Snake. There is a record in the University Museum Catalogue, Vol. 2, p. 196, of a specimen (No. 7452) of this snake taken on Isle Royale by Dr. Foote, which I have been unable to verify.

6. *Chrysemys marginata* Agassiz. Painted Tortoise. A number of specimens were taken on Carp river, IV. 1, in the Porcupine Mountains in 1904. It is also reported from Marquette by Dr. Downing.

*Clark, H. L. Notes on the Reptiles and Batrachians of Eaton County. Fourth Annual Report Michigan Academy of Science, pp. 192–194.

ANNOTATED LIST OF THE BIRDS OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.*

N. A. WOOD, MAX M. PEET, AND O. McCREARY.

1. PORCUPINE MOUNTAINS.

The following observations upon the birds cover a period from July 13 to August 13, 1904. For the determination of certain specimens from both the Porcupine Mountains and Isle Royale, we are indebted to Mr. Robert Ridgway and Mr. H. C. Oberholser of the Smithsonian Institution, and to Dr. C. Hart Merriam, Chief of the Biological Survey of the U. S. Department of Agriculture.

1. *Podilymbus podiceps.* Pied-billed Grebe. Station VII. Sub. 1. One seen on Little Carp Lake, August 3. VII. 3. One was seen August 7, on Little Carp river.
2. *Gavia imber.* Loon. I. One seen on Lake Superior August 5, and two July 21. V. 3. One seen on Carp Lake August 10.
3. *Larus argentatus.* Herring Gull. I. Several adults observed at various times along the lake. Common at Ontonagon, Mich., July 12, 13, and August 13 and 14.
4. *Merganser americanus.* American Merganser. I. An adult female and nine or ten young were seen July 21 on Lake Superior.
5. *Lophodytes cucullatus.* Hooded Merganser. IV. 1. Adult female and young found on Carp river, July 19 and 20; also observed July 18.
6. *Botaurus lentiginosus.* American Bittern. I. One seen in the bushes along the lake shore, August 12. IV. 1. One seen along Carp river July 18, and one shot July 19.
7. *Ardea herodias.* Great Blue Heron. IV. 1. One seen July 16. V. 2. One adult male in breeding plumage seen at Carp lake, August 6. One was seen flying across Carp Lake, July 30.
8. *Porzana carolina.* Sora. V. 2. An adult male taken on the delta at the eastern end of Carp Lake, August 5.
9. *Gallinago delicata.* Wilson Snipe. IV. 1. An adult male taken along Carp river, July 19. One observed feeding July 17. IV. 2. One seen in a grassy marsh along Carp river, July 18.
10. *Actodromas minutilla.* Least Sandpiper. I. One seen along the Lake Superior shore, July 21. VII. 2. Adult male taken and several specimens seen at the beaver meadow on August 3.
11. *Totanus flavipes.* Yellow-legs. VII. 2. Immature and adult males taken at the beaver meadow August 3.
12. *Helodromas solitarius.* Solitary Sandpiper. I. One seen on the Lake Superior beach, July 27. IV. 1. Immature males, adult male and females, taken along Carp river, July 27 and 28. Common along Carp river, July

*A preliminary note was published by N. A. Wood, Auk, XXII, pp. 175–178, 1905.

18 and August 10. VII. 2. Several were seen along Little Carp river in the beaver meadow.

13. *Actitis macularia.* Spotted Sandpiper. I. One male taken on the Lake Superior beach August 13. IV. 1. Two seen along Carp river, August 3.

14. *Bonasa umbellus togata.* Canadian Ruffed Grouse. II. 2. Several bevies of quite small young were seen July 17. Both old and young were seen several times. II. 3. Large bevies of young were seen in a clearing near camp. An adult bird was killed in the camp clearing by a Sharp-shinned Hawk. II. 5. A female with a large bevy of young was seen July 18. A large flock of young, unable to fly, and several nearly full grown were seen August 1. III. 2. Several flocks of both young and adults were seen on the mountain top during July. IV. 3. Both young and old were seen several times in the forest.

15. *Circus hudsonius.* Marsh Hawk. II. 3. An adult female was seen fighting with a Sparrow Hawk, August 8. IV. 2. A male was observed hunting, August 3. V. I. One was seen along the shore of Carp Lake August 3. VII. 2. One was seen near the beaver meadows, August 3.

16. *Accipiter velox.* Sharp-shinned Hawk. II. 1. An adult male taken July 27 and a female July 26. II. 3. One seen July 13 in the camp clearing. Several were seen below camp toward the Carp river. III. 5. They were frequently seen circling over the cliff in the morning. IV. 2. An adult female taken, August 7, near Carp river.

17. *Buteo borealis.* Red-tailed Hawk. II. 2. Two were seen flying overhead July 20. II. 3. One seen circling over the clearing August 8. III. Seen flying overhead on July 20, and at other times.

18. *Buteo lineatus.* Red-shouldered Hawk. One seen July 13 in the hemlock forest near Union Bay. The bird was on a tall dead tree, which afforded a good view of it (Wood).

19. *Buteo platypterus.* Broad-winged Hawk. II. 2. Young male, female and adult female taken August 12. The only ones seen.

20. *Haliaetus leucocephalus.* Bald Eagle. III. 5. One seen circling over the cliff, July 31, and two were observed on wing July 29. V. One was seen circling over Carp Lake July 29. Two were observed at Union Bay on July 23.

21. *Falco columbarius.* Pigeon Hawk. Several were seen at Union Bay and two were taken July 23.

22. *Falco sparverius.* American Sparrow Hawk. II. 1. Female taken in cedar swamp July 23. II. 3. One young female was taken August 4. Several were seen August 8, both young and adults. An immature male was taken July 28. These Hawks came into the camp clearing searching for grasshoppers. III. 5. Frequently observed sitting on dead stubs near the edge of the cliff in the early morning. IV. 3. A nest with young was found in an old pine stub in the hardwoods, July 16. Observed several times flying along the river. VII. 1. Seen at Little Carp Lake, August 3 and 7.

23. *Pandion haliaetus carolinensis.* Osprey. V. 3. One seen over Carp Lake July 23, and on August 10. One was also observed at Iron river, northeast of the Porcupines, July 13.

24. *Asio magellanicus occidentalis.* Great Horned Owl. II. 1. Young of the year taken and two others seen July 26. One seen among the hemlocks and maples, July 30.

25. *Coccyzus erythropthalmus.* Black-billed Cuckoo. II. 2. Was heard many times in the hardwood forest. II. 3. One was seen July 17 near the

camp. Late in the evening, about 9 p. m. of July 20, one was heard. One was seen July 15 in the aspens. An adult female was taken July 21. IV. 2. The call was heard many times in the alders. IV. 3. One was seen in the woods at the foot of the talus.

26. *Ceryle alcyon.* Belted Kingfisher. II. 3. One alighted upon the house top. IV. 2. Two birds were seen many times along Carp river. V. 3. One seen near Carp Lake July 16 and an adult female was taken July 28. VII. 1 and 2. Several were observed at Little Carp Lake and at the beaver meadows, August 2 and 3.

27. *Dryobates villosus.* Hairy Woodpecker. II. 1. One adult male was taken July 21 in the cedar swamp. II. 2. A young male was taken July 22, and adult females July 24 and 29. II. 3. An adult female was taken August 10 in the clearing. III. A male and female were seen August 10 on a dead Norway pine. III. 5. Often found on the dead stubs on top of, or overhanging the cliff. VII. 1. One seen at Little Carp Lake, August 7. VII. 2. One seen at the beaver meadow, August 3.

28. *Dryobates pubescens medianus.* Downy Woodpecker. II. 3. Young males were taken near camp August 2 and August 7, and an adult male was taken July 28. III. 3. Male and female seen near camp, August 10 on Norway pines. III. 5. Only seen once, August 12, upon a decayed pine stump. IV. 2. One seen in the tag alders, July 27. IV. 3. One was seen in the maples at the foot of the cliff, July 28. VII. One was seen August 6, at Little Carp Lake.

29. *Picoides arcticus.* Arctic Three-toed Woodpecker. II. 1. One was seen on the road to camp, July 13, and an adult male was taken July 21.

30. *Sphyrapicus varius.* Yellow-bellied Sapsucker. II. 3. A young female was taken near camp July 28. VI. One seen near Little Carp Lake, August 3, and again on August 9. One was seen at Little Iron river, east of the Porcupines, July 13.

31. *Coephloeus pileatus abieticola.* Northern Pileated Woodpecker. II. 1. A young female was taken July 27. II. 2. An adult female was taken August 1 in the hardwoods. "A young male was taken July 28. This I called to the tree nearest to me by clapping my hands, the method suggested in Chapman's Handbook. Two were called on this occasion and came within easy gun shot. After being called, they alighted and kept up a calling and drumming noise." (Peet). "In the hardwood forest I saw a dead hard maple which showed to good advantage the work of this bird. The tree contained many holes, some from 10 to 20 inches long; others 6 to 8 inches wide and deep. These birds seem to have the habit of working a tree very thoroughly." (Wood). VI. Several were seen and heard August 7 and 8, in the vicinity of Little Carp Lake. One was seen about a mile south of Carp Lake, on a hemlock. One was seen near Union Bay, east of the Porcupines, in a forest of large hemlocks with scattered white pine and a few maples, July 13.

32. *Colaptes auratus luteus.* Northern Flicker. II. 1. Several were seen in a clearing near the Lake Superior shore, August 4. II. 2. A young male was taken July 19. II. 3. One was seen July 17 flying over camp. III. 2. Several were seen and a young male was taken July 26, on the mountain top. Common, especially the young. III. 1. Several seen at different times on the stumps on the face of the cliff. IV. 3. One seen July 15, in the hardwoods near camp.

33. *Chaetura pelagica.* Chimney Swift. I. Several seen, flying overhead, along the Lake Superior shore, July 27. II. 3. Several were seen

in the evening of August 9 about camp, and an adult female was taken. IV. From the mountain top these birds were seen many times on wing over the valley of Carp river, July 19 and 20. V. Observed flying over Carp Lake on several occasions. Seen at the mouth of Carp river, July 31.

34. *Trochilus colubris.* Ruby-throated Hummingbird. VII. A female came many times to feed from flowers within about 20 feet of our breakfast camp fire, at Little Carp Lake, August 7. Another was seen at Little Carp Lake, August 9.

35. *Tyrannus tyrannus.* Kingbird. II. 1. Seen near the Lake Superior shore August 13. VI. One was seen near Little Carp Lake, August 7. On August 8 four birds, two young and two adults, were seen at a small lake two miles southwest of Little Carp Lake.

36. *Sayornis phoebe.* Phoebe. III. 5. Was seen on the south side of the cliff north of Carp Lake, July 29.

37. *Nuttallornis borealis.* Olive-sided Flycatcher. II. 1. Adult male and female were taken July 27, and an adult male was seen, and a female taken August 4, in an arbor vitae clearing near the Lake shore. IV. 4. Two birds were seen in a tamarack swamp, July 28.

38. *Contopus virens.* Wood Pewee. II. 1. An adult female was taken July 30. II. 2. Several were seen in open woodland. One nest was found July 23 in a tree, about 60 feet from the ground. VI. One was heard on the trail to Government Peak, July 26.

39. *Empidonax trailli alnorum.* Alder Flycatcher. IV. 2. Observed catching insects along the bank of Carp river. Several were seen in the alders along the river July 18. An adult male and female were taken July 22; these were among the willows when shot.

40. *Empidonax minimus.* Least Flycatcher. II. 1. Two were seen in a clearing in the arbor vitae swamp near the lake shore, and an adult male and female were taken July 27. IV. 2. Several were seen along Carp river, August 6, and two were seen in the alders along Carp river, July 18.

41. *Cyanocitta cristata.* Blue Jay. III. 5. Several seen at top of bluff July 23, and a female was taken July 17. IV. 3. Often seen along the river bank; an adult male shot July 18. VII. Several were seen at Little Carp Lake August 3, and one was seen August 7.

42. *Perisoreus canadensis.* Canada Jay. VI. One was seen near Little Carp Lake, August 7.

43. *Corvus corax principalis.* Northern Raven. I. Observed several times near Lake Superior. II. 3. One was seen flying over camp July 15, and one was heard August 12. One alighted upon the roof of the barn and was seen in the vicinity of the camp several times. III. Seen flying over the mountain top. III. 5. Often seen flying over the cliff, between July 5 and July 26. Adult males were taken, August 5 and July 30, on the cliff. Usually seen flying toward this cliff toward evening, about a dozen in a flock. IV. Was seen flying over the valley many times. V. Nine were counted flying over Carp Lake July 29. VII. One was seen at Little Carp Lake, August 2.

44. *Corvus brachyrhynchos.* American Crow. I. Common on the shore of Lake Superior. II. 3. One seen upon a dead tree near camp. III. 2. Observed flying overhead. III. 5. Common on the bluff July 15, and on July 18 several were seen on a dead pine. IV. 2 and 3. Often seen at the foot of the cliff, near the river, resting on tall tamaracks.

45. *Agelaius phoeniceus.* Red-winged Blackbird. IV. 2. Several were seen August 6, and on August 8 a young male was taken.

46. *Carpodacus purpureus.* Purple Finch. II. 1. Was often seen in the coniferous trees. An adult female was taken July 27. II. 3. "I found these very plentiful, and they did not appear to be paired. The males and females usually coming in separate flocks." (Peet). An adult male was taken July 14, and both sexes again July 15. These birds visited the camp for table refuse. IV. 2. Was seen feeding in the tamaracks August 3 and 4. VII. Observed at Little Carp Lake, August 2.

47. *Loxia curvirostra minor.* American Crossbill. II. 3. Adult male and female were taken at camp, August 5. These birds often came to camp to pick up crumbs. IV. 4. An adult male was taken August 4. A small flock was seen near the upper part of the river, August 5. Observed feeding among tamaracks, August 3 and 4.

48. *Loxia leucoptera.* White-winged Crossbill. IV. 4. Adult male and three females were taken August 5. The crops of these birds were full of tamarack seeds. VII. 2. A flock was seen at the beaver meadow, August 3.

49. *Spinus pinus.* Pine Siskin. II. 2. Common among coniferous trees July 13 and August 12. II. 3. A female came to camp and was seen to pick up some hair and fly away. Adult males were taken at camp, July 15 and 25, and August 9. The birds about camp showed little fear, and would fly within about three feet of one, to pick up crumbs. The males secured had very large testes. IV. 4. They were observed many times in the tamarack swamp August 3 and 4. VII. 2. Were seen near the beaver meadow, August 3.

50. *Pooecetes gramineus.* Vesper Sparrow. III. 2. Several were seen on the top of the mountain, August 10. III. 5. Several were seen on the top of the cliff on July 26; a large flock was also seen here August 3. They appeared to be migrating.

51. *Zonotrichia albicollis.* White-throated Sparrow. II. 2. An adult female was taken July 22 and an adult male August 5, in the hardwoods. II. 3. One was heard singing at dusk, July 18, in the clearing. IV. 2. One adult male was taken July 21 near Carp river, and an adult female was taken August 5. Often seen and heard singing towards evening along the river. IV. 4. Several were seen in a tamarack swamp July 28. VII. Several were seen at Little Carp Lake August 7. VII. 2. A number were seen at the beaver meadow, August 3. One was seen on the road from the Porcupines to Ontonagon August 14.

52. *Spizella socialis.* Chipping Sparrow. III. 2. An adult male was taken July 20. III. 5. Several were seen on the top of the cliff July 26, and a small flock on August 3. VII. Seen at Little Carp Lake August 2.

53. *Junco hyemalis.* Slate-colored Junco. III. 2. Abundant at all times on top of the cliff. Many were seen with insects, as if caring for young; they were always in the open or near the edge of a clearing (Peet). III. 5. On the top of the mountain a female was seen feeding young on July 27, and an adult female was taken July 17. VII. Observed at Little Carp Lake, August 2.

54. *Melospiza cinerea melodia.* Song Sparrow. II. 1. One was seen in a clearing near Lake Superior, July 25. II. 3. An adult female was taken, July 21, near camp. IV. 2. A young female was taken near Carp river. Adults were observed feeding fully fledged young, July 22.

55. *Melospiza georgiana.* Swamp Sparrow. IV. 2. Very common in the valley. Adult males were taken July 21 and 22, and young females July 28 and 31. The adults were observed feeding fully fledged young July 22. VII. 2. Observed at the beaver meadow, August 3.

56. *Zamelodia ludoviciana.* Rose-breasted Grosbeak. III. 5. One seen at the edge of the cliff July 23. IV. 2. One was seen in the alders July 23. A young male and female were taken in the tamaracks, August 5.

57. *Cyanospiza cyanea.* Indigo Bunting. II. 3. An adult female was taken while eating weed seeds in the clearing near camp, July 21. This was the only one seen.

58. *Piranga erythromelas.* Scarlet Tanager. III. 5. Adult male and female were seen July 15, and an adult male was seen July 26. VI. One was heard along the trail to Government Peak, July 26.

59. *Tachycineta bicolor.* Tree Swallow. VII. 2. One was seen at the beaver meadow, August 3.

60. *Ampelis cedrorum.* Cedar Waxwing. II. 1. One adult female was taken August 13; was frequently observed along the lake shore. II. 2. Seen flying overhead. II. 3. An adult male was taken July 19. These birds came repeatedly to the camp to pick up crumbs, etc. near the door of the shack. III. 2. Frequently seen on the top of the cliff and observed feeding on berries. III. 5. Several were seen July 26, along the edge of the cliff. Frequently observed at this locality, always in flocks. IV. 2. Very common along Carp river. An adult female was seen August 2 building a nest in the alders overhanging Carp river. VI. Several were seen at a small lake below Little Carp Lake on August 7.

61. *Vireo olivaceous.* Red-eyed Vireo. II. 1. Abundant at this station. II. 2. One was heard in the hardwoods July 14. An adult male was taken July 20. Several were seen with young just able to fly. II. 3. At camp an adult male was taken July 19, and young were taken July 15 and 20. These birds were common about camp, in the aspens. IV. 2. On July 22 one was seen singing in the alders. Abundant along the river. VII. 2. Seen near the beaver meadow, August 3.

62. *Vireo solitarius.* Blue-headed Vireo. II. 1. An adult male and female were taken July 27. IV. 4. Were seen in a tamarack swamp, and an adult male and female were taken August 5.

63. *Mniotilta varia.* Black and White Warbler. VI. The only one seen was on a small maple tree south of Carp river, August 5.

64. *Dendroica caerulescens.* Black-throated Blue Warbler. II. 2. A pair was found July 17, whose actions indicated a nest was near. A young bird in the down and an adult male were taken July 20. Several were seen on August 1. An abundant bird at this station, the young and adults were common in the hardwoods and usually in low brush. An adult female was taken July 16. II. 3. A female seen feeding young near the edge of a clearing July 20. II. 5. Many seen whose restless manner indicated a nest. Usually seen in young maples about four feet high. II. 2. Frequently in the low growth along the path in the hardwoods. IV. 2. Often seen in the bushes bordering Carp river. VI. Several males and females were seen in the vicinity of Little Carp Lake, August 7.

65. *Dendroica coronata.* Myrtle Warbler. I. Adults and young birds were seen in the brush near the shore of Lake Superior, July 16. III. 3. A young male was taken August 10. Several birds were seen in a flock among the tops of the Norway pines.

66. *Dendroica maculosa.* Magnolia Warbler. II. 1. A male was seen and a female taken July 21. Was always to be found among cedars near Lake Superior. Two were seen, August 1, on damp land quite thickly overgrown with bushes and tall grass. IV. 4. An adult male was taken July 21. Several were seen feeding in the tops of tamarack trees, and heard

singing July 28. On July 18 they were also observed in the tamaracks. VI. Seen near a stream on the trail to Government Peak July 26.

67. *Dendroica pensylvanica.* Chestnut-sided Warbler. IV. 2. An adult female was taken July 28, and several were seen near Carp river.

68. *Dendroica blackburniae.* Blackburnian Warbler. II. 1. A pair with two young were seen in the tops of birches, July 14. On August 1 several adults and young were seen in birches on marshy land. II. 2. Observed several times between July 13 and 30. II. 3. A female, with young in the down, were taken July 14. A young male was taken July 19. Several were seen near camp with young. II. 5. Small flocks of adults and young were seen several times feeding in the tops of young maples. IV. 3. Seen at the foot of the talus slope among the maple trees July 15.

69. *Dendroica virens.* Black-throated Green Warbler. II. 1. An adult male taken July 30, along the lake shore. II. 2. Common in the hardwoods; an immature male was taken July 20, and an adult July 18. III. 2. Several were seen feeding in the tops of Norway pines on the mountain top August 10. III. 5. Seldom seen at this station. A young male was seen here July 20. IV. 2. An immature male was taken August 5. Common among the alders along Carp river.

70. *Dendroica vigorsii.* Pine Warbler. III. 2. Seen carrying food to young in top of a Norway pine, at the edge of the cliff.

71. *Seiurus aurocapillus.* Oven-bird. II. 2. A nest containing two eggs and one young bird was found in the leaves near the path through the hardwoods, July 15. Young in nearly all stages of plumage were seen. Two were seen in the maple undergrowth, August 11, and a young male was taken July 21. II. 5. An adult male was taken in a trap set for mammals near the top of the bluff, July 15. Many young birds were seen, usually on the ground among the bushes, but sometimes running ahead in the path like quail (Peet). III. 2. Several were seen singly in the aspens bordering the bare mountain top. IV. 2. Seen several times among the alders along Carp river.

72. *Seiurus noveboracensis.* Water Thrush. IV. 2. Seen several times in the alders along Carp river, one was seen July 22. A bird was seen July 13 east of the Porcupines, on the road to Ontonagon.

73. *Geothlypis agilis.* Connecticut Warbler. II. 1. Adult females were taken July 27 and August 4. On July 27, four of these birds were seen in a marshy strip of land thickly overgrown with birch and long grass, but shaded with large hemlocks.

74. *Geothlypis philadelphia.* Mourning Warbler. II. Seen among the brush of open woodland, August 4. II. 3. A female and her young were taken July 15. An adult male was taken at the camp, July 14. Two females were seen, each with one young bird just able to flutter along in the low weeds. When the young were shot the females remained near by and kept up a sharp chirping and jerking movement of the body. Two males were taken, one of these appeared greatly excited when approached and flew from tree to tree among the young aspens, grasping the trunk of the trees so that its body was at right angle to the tree. They remained within about five feet of the ground (Peet). IV. 2. Was seen several times among the alders along Carp river and last seen August 5. VII. An adult and one young bird were seen among the brush on a bluff at Little Carp Lake, August 7.

75. *Geothlypis trichas brachidactyla.* Northern Yellow-throat. IV. 2. One was seen, scolding vigorously, in the brush near the boat landing, July

22, on Carp river. VII. 1. One was seen at Little Carp Lake, August 7 among the low brush growing on a rocky bluff over the lake.

76. *Wilsonia canadensis.* Canadian Warbler. II. 1. Seen several times among cedars along the Lake Superior shore, July 13-August 2. An adult female was taken August 2. IV. 2. An adult female was taken July 31 and again on August 2. One was seen July 15 with an insect in its bill and acted as if young were near.

77. *Setophaga ruticilla.* American Redstart. II. 1. An adult male was seen July 16, and several were observed in tall birches on July 17, near the Lake Superior shore. An adult male was taken July 17. IV. 2. An adult female was seen near Carp Lake, August 6. Many were seen in the brush along the river at various times. One was seen on the road to Ontonagon, July 14.

78. *Troglodytes aedon.* House Wren. II. 1. A young female was taken in a clearing July 25. There were several observed at this place in a dense brush pile. II. 2. A young male was taken July 24, in the hardwoods.

79. *Olbiorchilus hiemalis.* Winter Wren. II. 1. A small family was seen July 21, and a young male was taken July 23. Abundant at this station. IV. 2. An adult female and two young were taken August 10. Often seen among the alders along Carp river. VI. Several were seen near streams on the trail to Government Peak, July 26.

80. *Telmatodytes palustris.* Long-billed Marsh Wren. IV. 2. One male was taken near Carp river, July 22.

81. *Certhia familiaris americana.* Brown Creeper. II. 1. The first ones were seen July 13, but were frequently observed after that date. II. 2. A large flock of adults and young were seen among the hemlocks, July 15. An adult female and young were taken July 19.

82. *Sitta carolinensis.* White-breasted Nuthatch. III. 3. One was heard in the pines, July 20.

83. *Sitta canadensis.* Red-breasted Nuthatch. II. 1. This species was seen twice in the cedar swamps near Lake Superior, July 21 and 27. III. 3. One was seen, July 20, in the pines on the mountain top. IV. 4. An adult male and female, and two young males were taken July 27 in a tamarack swamp. Several were seen here again August 4. VI. One was seen near the beaver meadow August 3.

84. *Parus atricapillus.* Chickadee. II. 2. Adults were seen feeding fully fledged young in the aspens, along the path through the hardwoods, on July 15. Young were taken July 21. II. 3. A young bird was taken July 15, and an adult male and a young female were taken July 21. Often seen in the aspens about camp, usually with young which they were feeding. III. 5. Several were seen feeding in the Norway pines on top of the cliff, July 23. IV. 4. Several observed in a flock of Golden-crowned Kinglets in a tamarack swamp, August 11. VI. Quite common near Little Carp Lake on August 7.

85. *Regulus satrapa.* Golden-crowned Kinglet. II. 2. Young in the down taken July 2. Several seen in the hemlocks July 17. Abundant among the hemlocks, July 13 to August 12. Large flocks of young and adults seen in the tops of the tallest hemlocks on July 14. II. 3. Young birds were taken July 14 in the clearing. IV. 2. A young female was taken July 27. Several were seen with Chickadees August 11. Many were seen along the Carp river at various times. IV. 4. They were abundant in the tamarack swamps, August 4 and 5.

86. *Hylocichla ustulatus swainsonii.* Olive-backed Thrush. II. 1. An

adult female was taken July 22, with the tough thickened skin on the abdomen characteristic of a breeding bird. II. 2. Often seen in an open woodland, July 13 to August 12. III. 2. One specimen seen August 1. IV. 2. A young male taken July 29. The song was heard in the evening and morning in the woods at the foot of the cliff, but during the day the bird retired to the alders along the river valley. It stopped singing the last week in July. VI. A nest containing two eggs was found on the trail to Government Peak July 26.

87. *Hylocichla fuscescens.* Wilson Thrush. II. 3. Heard singing near camp during the evening of July 18. IV. 2. Young taken July 22 along Carp river.

88. *Merula migratoria.* American Robin. II. 3. An adult male was taken July 30, and another was seen near camp on August 10. III. 2. One was seen July 20. III. 5. An adult male was seen on the top of the bluff July 23. This is apparently a rare bird in the Porcupines.

89. *Sialia sialis.* Blue Bird. III. 2. Several seen near the edge of the cliff on August 10. III. 5. An adult female was taken July 19. "A nest was found in a Norway pine stub on the top of the cliff July 23. The old birds fed the young every 5 to 8 minutes during the half hour they were observed. The parents were quite tame as they fed the young while I stood within 15 feet" (Wood).

2. ISLE ROYALE.

The observations and records incorporated in the following notes were made at the southwestern or lower end of the Isle, in the vicinity of Washington Harbor. A few observations were also made in the vicinity of Siskowit Bay on the south coast. The time spent on the island covered the period from August 16 to September 5, 1904.

On account of the lateness of the season, but little could be determined concerning the breeding birds. The migrants were already abundant. This was evident on account of the abundance of the Chipping Sparrow, Sharp-shinned and Sparrow Hawks. Many of these migrating birds were so abundant and of such general occurrence that little could be learned of their habitat relations. Perhaps the limited extent of the island, as a feeding ground, emphasized the apparent abundance.

1. *Podilymbus podiceps.* Pied-billed Grebe. II. Two were seen on Washington river, August 17, and several more August 30. A young bird, in the first plumage, was taken August 18, and young birds were again taken August 24 and 25.

2. *Gavia imber.* Loon. VII. Two were seen on Lake Desor, August 24, and again August 30.

3. *Larus argentatus.* Herring Gull. VII. One adult was seen at Lake Desor on August 24. IX. The rocky promontories were often white with these gulls. They would swim about in the lake and then fly back to the rock. X. These birds were very abundant in the harbor, where they were seen every day. On August 19, a small island north of the mouth of Washington Harbor was almost completely covered with them. On August 31, flocks were observed feeding in the harbor.

4. *Merganser americanus.* American Merganser. II. A young female, in the down, and an adult, were taken August 31. An adult and five young were observed on Washington river, August 31. VII. A young bird, in the down, was taken August 21. X. An adult bird and several young were observed August 19.

5. *Querquedula discors.* Blue-winged Teal. II. Three were seen on Washington river August 30. X. A flock of 25 or 30 were seen in the harbor August 30.

6. *Botaurus lentiginosus.* American Bittern. II. One was seen flying along the river on August 24 and again on August 30.

7. *Ardea herodias.* Great Blue Heron. I. One was seen flying over camp, August 21. X. One was seen flying over the harbor on August 30.

8. *Porzana carolina.* Sora. II. One was seen near the margin of the river August 22. Adult males were taken on both August 24 and 25. One was again observed at the edge of the river in tall grass, August 28; also observed on August 30, near the river.

9. *Fulica americana.* American Coot. II. One was seen August 22 on the river, and an adult female was taken August 24.

10. *Gallinago delicata.* Wilson's Snipe. I. One seen August 17 and 25 near the harbor.

11. *Actodromas minutilla.* Least Sandpiper. X. One seen August 28 and September 4, along the shore of Washington Harbor.

12. *Totanus flavipes.* Yellow-legs. I. An adult female was taken August 26 from a small flock which came into the clearing at the house. X. One was seen on the dock in the harbor, August 25.

13. *Helodromas solitarius.* Solitary Sandpiper. II. An adult male was taken August 17, a female August 18, and a young bird September 3. It was common along Washington river August 17 to September 3. X. Several were seen at the edge of the harbor September 4.

14. *Actitis macularia.* Spotted Sandpiper. X. One was seen on the shore at Washington Harbor, August 28.

15. *Pediocaetes phasianellus.* Sharp-tailed Grouse. I. A resident reports that "prairie chickens" come to the clearing in the fall. VIII. Several were seen in a clearing at Siskowit Bay, August 29. This was the only species of grouse seen on the island by the party.

16. *Accipiter velox.* Sharp-shinned Hawk. I. Very abundant. Young males were taken between August 16 and 31, and young females August 21, 23 and 31. One adult female was taken August 27. Several were seen every day about the camp and in the clearings along the river. "Very abundant in clearings, showing little fear until fired upon repeatedly. They were very ferocious; one caught a Sora Rail while on the wing, and tore it to pieces within 15 feet of me. It grasped its prey from beneath by darting under it, turning over, and thrusting its claws into its victim's breast" (Peet). VII. One was seen at Lake Desor, August 24.

This was an abundant bird from August 17 until September 3, and showed a decided preference for clearings and open woodland, where it found several kinds of sparrows and warblers, in whose company it seemed to migrate.

17. *Accipiter cooperii.* Cooper's Hawk. X. One seen over the harbor. "This bird flew over the boat as I was fishing on August 19" (Wood).

18. *Buteo borealis.* Red-tailed Hawk. I. One was seen flying over camp, August 28.

19. *Buteo lineatus.* Red-shouldered Hawk. II. One was seen September 4.

20. *Haliaetus leucocephalus.* Bald Eagle. X. A fine adult was seen at Washington Harbor, August 16. An adult bird was perched upon a stump near the water's edge, at the mouth of Washington river, *on August 27.* On August 31, this eagle was again seen. A resident reports

that its mate was killed last year, and that the pair had lived here for many years (Wood).

21. *Falco columbarius.* Pigeon Hawk. I. An adult female was taken August 30. One was seen near the camp on August 31 and September 1. II. An adult male was taken August 23, and two were seen September 1.

22. *Falco sparverius.* American Sparrow Hawk. I and II. Adult males were taken August 16 and 23, adult females August 23 and 27. This was the most common hawk frequenting the clearing about the harbor. Observed catching grasshoppers in the clearings. Several were caught in steel traps baited with meat. Observed in abundance from August 16 to September 5.

23. *Pandion haliaetus carolinensis.* Osprey. II. An adult female was taken August 26, and one was seen August 25. X. One was seen over the harbor on August 20.

24. *Asio accipitrinus.* Short-eared Owl. I. One was seen at the edge of the clearing August 17, and one was found dead near the camp on August 16. This species was not seen after August 17. It probably migrated (Wood).

25. *Asio magellanicus occidentalis.* Great Horned Owl. II. Three were seen August 22 near the river. Near by, in a clearing, four were found about dark August 26, and three were taken.

26. *Ceryle alcyon.* Belted Kingfisher. II. One or two were seen nearly every day from August 16 to September 1, along Washington river. An adult female was taken August 26. They were occasionally seen pursued by Sharp-shinned Hawks. When the hawk was nearly upon it, the Kingfisher would throw up its bill and ward it off, in a manner similar to that stated for herons when pursued by hawks (Peet). VII. One was seen at Lake Desor on August 24. X. Occasionally seen along the harbor.

27. *Dryobates villosus leucomelas.* Northern Hairy Woodpecker. I. One was seen September 1. II. One was seen August 16 and again on 19. III. Adult females were taken August 20 and on September 1. IV. Two were heard along the creek in the cedar swamp, August 4.

28. *Dryobates pubescens medianus.* Downy Woodpecker. I. A young male was taken August 29. IV. An adult male was taken August 18. VII. Seen at Lake Desor, August 24. A common bird of general distribution.

29. *Picoides arcticus.* Arctic Three-toed Woodpecker. II. An adult female was taken, August 31. One was seen each day August 28, 29 and 30. This was a rare bird in the vicinity of Washington Harbor.

30. *Sphyrapicus varius.* Yellow-bellied Sapsucker. II. A young female was taken August 22, along Washington river, in the coniferous forest. Apparently a rare bird in this vicinity.

31. *Coephloeus pileatus abieticola.* Northern Pileated Woodpecker. II. and III. An adult male and a young female were taken August 19. An adult male was taken August 30, and five other birds were seen. Quite common in the forest and were heard or seen almost every day. "One specimen, after being shot at, was called back by continued clapping of the hands, although under other circumstances, they are very shy and difficult to approach. On rainy mornings they were very noisy" (Peet). "They were very noisy in the morning about sunrise, but on cloudy days they continued their pounding and calling for several hours" (McCreary).

32. *Colaptes auratus luteus.* Northern Flicker. II. Very abundant in the clearings along Washington river. One was shot August 16. VII. One was seen September 3 at Lake Desor.

33. *Chordeiles virginianus.* Night Hawk. I. Young females were taken August 16, and an adult male was taken August 23. A very common bird, frequently seen in the evening catching insects over the grass and water. Found roosting on the ground in clearings. None were observed after August 29.

34. *Chaetura pelagica.* Chimney Swift. I. Several were seen flying overhead on August 16, 17, 19 and 23, at the camp clearing.

35. *Trochilus colubris.* Ruby-throated Hummingbird. I. It was reported, as have been seen hovering about flower beds at the camp clearing. II. One was seen August 30 along the road through the coniferous forest.

36. *Sayornis phoebe.* Phoebe. I. An adult male was taken August 26 near camp. II. An adult female was taken August 18 and others were seen, at various times, between August 17 and 28, along the road in or near clearings.

37. *Nuttallornis borealis.* Olive-sided Flycatcher. I. Occasionally seen on dead trees in the clearings. II. An adult male was taken August 18, and was common from August 17 to August 28. IV. Seen on August 18 in a cedar swamp.

38. *Empidonax minimus.* Least Flycatcher. II. Often seen between August 19 and September 3. III. An adult male was taken August 31. Common.

39. *Cyanocitta cristata.* Blue Jay. II. An adult male was taken August 19, and a young female August 18. Very common about the deserted mining camps. Seen August 22 and 28, along the road. Adults moulting.

40. *Perisoreus canadensis.* Canada Jay. II. An adult male and female were taken August 25. Found about the deserted mining camps. Adult males were seen August 18, 22, and September 1, and females August 19 and 23. A common bird. VII. A number were seen at Lake Desor, August 24. They were very quiet and were not seen until we started to fry our bacon in front of the tent. Several then came flying from different directions and perched on the spruce boughs just above us, hopping about until we left camp, when they flew down about the ashes in search of scraps. (Ruthven).

41. *Corvus corax principalis.* Northern Raven. I. An adult female was taken August 23. II. On several mornings a flock of six was seen in a clearing. One was shot August 17. X. Eight were seen August 19, near the entrance to Washington Harbor; on August 30, three were seen flying over the Harbor. Reported to be a resident bird. The adult specimens taken were moulting.

42. *Corvus brachyrhynchos.* American Crow. I. This species was not as common about the clearing as were the Ravens, and was much more shy. Early in the morning of September 4, one came to the clearing and perched on the roof of an old log house, a few rods from camp. II. Two were seen nearly every day along the river.

43. *Agelaius phoeniceus.* Red-winged Blackbird. I. An immature female was taken August 26.

44. *Agelaius phoeniceus fortis.* Northern Red-winged Blackbird. I. Young males were taken August 18 and 26, and an adult female was taken on August 29. II. Several flocks (species uncertain) numbering about 15 or 20 specimens, were seen in the clearing. Only one male in black plumage was seen. Common. VII. An adult female was taken on August 24.

45. *Quiscalus quiscula aeneus.* Bronzed Grackle. II. An adult female

was taken August 19 in the clearing along the river. This was the only specimen seen and was found feeding in front of a deserted cabin.

46. *Loxia leucoptera.* White-winged Crossbill. II. Only small flocks were seen August 18, 26 and 30. IV. A small flock was seen on August 18.

47. *Astragalinus tristis.* American Goldfinch. II. A flock was seen August 19, and several were seen on August 17.

48. *Spinus pinus.* Pine Siskin. II. Frequently seen in flocks between August 18 and September 5.

49. *Passerculus sandwichensis savanna.* Savanna Sparrow. I. Young males were taken August 17 and 26, and adult females were taken August 30, and 31. This species was seen in flocks all over the clearing about camp, and was very tame, even coming into the houses. Very common after August 26 along roads and in the clearings. During the last week in August this species became abundant and was very tame. After September 1 it began to leave and nearly all were gone by September 5.

50. *Zonotrichia leucophrys.* White-crowned Sparrow. II. Two specimens were seen near the deserted mining camps September 1. On August 29 two were seen along Washington river. One was taken August 28.

51. *Zonotrichia albicollis.* White-throated Sparrow. I. One was seen at the edge of the clearing on August 24, and on September 1 and 4. II. An adult female and a young male were taken August 19. Young and the adults were seen almost every day along the river. VII. One was heard at Lake Desor on August 24.

52. *Spizella socialis.* Chipping Sparrow. I. Young males were taken August 17 and 27, and young females August 24 and 27. Very common in the camp clearing. II. Abundant in the clearing.

53. *Spizella pallida.* Clay-colored Sparrow. I. An adult male was taken August 25, and one was seen August 26. II. One was seen each day on August 28 and 31, in the clearing.

54. *Junco hyemalis.* Slate-colored Junco. I. An adult male was taken August 29. II. It was very common in the clearings between August 28 and September 5.

55. *Melospiza cinerea melodia.* Song Sparrow. I. One was seen August 24. II. Common from August 17 to 28, among brush in the clearings.

56. *Melospiza lincolnii.* Lincoln's Sparrow. II. An adult male was taken September 1, in the undergrowth of a white cedar swamp.

57. *Ampelis cedrorum.* Cedar Waxwing. I. A young male was taken and a flock was seen August 18. II. Several were frequently seen along Washington river. Several nests were found August 28 in alders about six to ten feet from the ground. These nests had recently been used (Wood). An old bird was seen feeding four young that had just left the nest, September 1. An abundant species.

58. *Vireo olivaceus.* Red-eyed Vireo. II. Adult males were taken August 23 and September 5.

59. *Vireo philadelphia.* Philadelphia Vireo. II. One was seen September 1, along the road through the coniferous forest.

60. *Mniotilta varia.* Black and White Warbler. II. One was seen August 24 (Wood).

61. *Helminthophila rubricapilla.* Nashville Warbler. II. One was seen August 28. IV. A young male was taken August 18.

62. *Helminthophila peregrina.* Tennessee Warbler. I. An adult male was taken August 22 and a young male September 4. II and III. Three birds were seen August 24. Very common in woodland. Not seen before

August 22, after that date they were quite common until September 4. Evidently a migrant.

63. *Dendroica caerulescens.* Black-throated Blue Warbler. II and III. An adult male was taken August 17. A male and female were seen August 25 and one was seen August 24. Common, a few seen nearly every day from August 17 to September 4.

64. *Dendroica coronata.* Myrtle Warbler. I. A young male was taken August 29. II and III. An adult female was taken September 3. A few seen nearly every day from August 20 to September 3. Apparently migrating. Common.

65. *Dendroica maculosa.* Magnolia Warbler. II. An adult male was taken August 30, and an adult female September 3.

66. *Dendroica striata.* Black-poll Warbler. I. A young male was taken August 26, and two were seen September 4, near the camp. II. Young males were taken August 26 and 30.

67. *Dendroica virens.* Black-throated Green Warbler. II and III. One seen on August 24, and three on August 25. Seen every few days between August 18 and September 3. An adult male was taken September 1. Of general occurrence. Common.

68. *Dendroica palmarum.* Palm Warbler. I. An adult male was taken August 26 and September 4, and a young male was taken August 29. Many were seen at camp September 4, and were quite tame. These birds were abundant in the clearing about camp and even came close to the house, September 1. Generally found in bushes along clearings. During the night of September 3, a wave of this species occurred, and in the morning of September 4, large numbers of these birds were observed in the brush in the clearing, some specimens even coming about the camp.

69. *Seiurus aurocapillus.* Oven Bird. II. One was seen August 24. VII. An adult female was taken August 24.

70. *Seiurus noveboracensis notabilis.* Grinnell's Water Thrush. I. An adult male was taken August 26. II and III. One was seen on each of the following dates, August 18, 22, 24, 28 and 31. An adult female was taken August 24. IV. On September 1, one was heard singing a low sweet song in a cedar swamp. (Wood).

71. *Wilsonia pusilla.* Wilson's Warbler. II. An adult male was taken August 30, in alder bushes near a small stream. Evidently a migrant.

72. *Setophaga ruticilla.* American Redstart. I. Several were seen August 24, 27 and September 4. II. A young male was taken August 17. A few were seen every few days from August 17 to September 4.

73. *Olbiorchilus hiemalis.* Winter Wren. II and III. Individuals were seen August 20, 25, 30 and September 1, 3, and 4. A young male was taken August 31. IV. "An adult female was taken September 1 in a dense cedar swamp. I awakened her curiosity so much by making a chirping sound that she hopped upon a bush in full view thus allowing a chance to secure her." (Wood).

74. *Certhia familiaris americana.* Brown Creeper. II. One was killed August 19 and one seen August 20, and 22.

75. *Sitta carolinensis.* White-breasted Nuthatch. VII. An adult male taken August 24 among birch trees on the hillside.

76. *Sitta canadensis.* Red-breasted Nuthatch. II, III and IV. Adult females were taken August 17, 18 and 25. Many were seen almost every day between August 16 and September 5. VII. Abundant August 24. *A very abundant bird* of general distribution in the forest.

77. *Parus atricapillus.* Chickadee. II, III and IV. An adult male was taken August 17. Many were seen almost every day between August 16 and September 5. VII. Abundant August 24. Very abundant, of general distribution in forests.

78. *Regulus satrapa.* Golden-crowned Kinglet. II, III and VI. It was often seen feeding in spruce and balsam trees in company with the Chickadee and Red-breasted Nuthatch. Many were seen almost every day between August 16 and September 5. VII. Abundant at Lake Desor, August 24. Abundant and of general distribution in the forest.

79. *Regulus calendula.* Ruby-crowned Kinglet. II. An adult female was taken August 28, and one or two were seen on each of the following days, August 29, 30, and September 3 and 5.

80. *Hylocichla ustulatus swainsonii.* Olive-backed Thrush. II and III. An adult male was taken September 1, and a young male on August 24. Some were seen every few days in underbrush, they were very shy.

81. *Merula migratoria.* Robin. I. One was seen on August 16. II. One was also seen along the river on August 23.

NOTES ON THE MAMMALS OF THE PORCUPINE MOUNTAINS AND ISLE ROYALE, MICHIGAN.

CHAS. C. ADAMS.

The specimens obtained by the expedition were largely collected and prepared by Max Minor Peet assisted by N. A. Wood. Mr. Wood secured the series of notes from Mr. Haring, a former fur dealer, concerning early mammal records. Other members of the party, A. G. Ruthven, O. McCreary and W. A. Maclean, also contributed notes, specimens or both.

I take pleasure in expressing our obligations to Dr. C. Hart Merriam, Chief of the Biological Survey of the U. S. Department of Agriculture, for kindly determining a representative series of specimens, and for the determinations made by Mr. W. H. Osgood of the same Survey; also to Dr. Glover M. Allen of the Boston Society of Natural History, for valuable suggestions and for the determination of the deer and bats. The other specimens collected have been named by a careful comparison with the determined series.

1. PORCUPINE MOUNTAINS.

1. *Odocoileus virginianus borealis* (Miller). Northern Virginia Deer. Near Station II. 2, but on Section 15, an adult male was taken in the hardwood forest, August 1, and a fawn, August 14, on Section 18. V. 2. "After sundown a deer came down into the marsh at the east end of Carp Lake, also a young buck about a year old, and later on a doe with a small fawn" (Maclean). VII. 1. "After sundown, August 3, nine deer were seen about the margins of Little Carp Lake, where they were feeding on the grasses and sedges. During September, 1903, deer were often surprised during the night, standing in the water at the margin of Carp Lake. Trappers reported that the flies were especially abundant this year" (Ruthven). During the past season this habit was not observed. Trappers reported that flies were not abundant owing to late spring frosts, and attributed the absence of the deer from the lake, during the night, to this cause.

2. *Sciurus hudsonicus loquax* Bangs. Southeastern Red Squirrel. II. 1. Two adult females were taken. August 21 and 28, in the cedar swamp. IV. An adult male was taken July 29.

3. *Tamias striatus lysteri* (Rich.). Northeastern Chipmunk. II. 2. An adult female was taken August 10. III. 4. A male was taken July 20. II. 3. On July 20, an adult male was taken at the camp clearing. IV. 3. August 2, an immature male was taken in the hardwood forest of the river valley.

4. *Eutamias quadrivittatus neglectus* (Allen). Lake Superior Chipmunk. II. 1. Seven specimens, young and adults of both sexes, were taken between July 21 and August 12, at the edge of a cedar swamp and along the Lake Superior shore. VII. 1. An adult female was taken, August 11, on a rocky bluff on Little Carp Lake.

5. *Marmota monax* (Linn.). Woodchuck. II. 2. An adult female

was taken July 28 (No. 32139). This is a very dark specimen when compared with the normal form found at Ann Arbor, Mich. The long over hair, especially on the top of the head, the rear of the back and the tail, is very dark brown or black. The pale under fur is also darker than in normal specimens. The hair on the lower parts of the body is much more rufous and darker than in the normal form. II. 3. In the camp clearing, an adult and one young of the normal color were seen.

6. *Sciuropterus sabrinus* (Shaw). Northern Flying Squirrel. II. 2. Two adult females were taken in the hardwood forest, August 3 and 4. III. 5. In the aspen zone near the mountain top, an adult female was taken July 29.

7. *Castor canadensis* Kuhl. American Beaver. IV. 1. Old beaver dams were observed on Carp river, and relatively fresh ones on Little Carp river, VII. 3, by Ruthven. Mr. David Allie, of the Carp Lake Mine, reported that the last beaver taken on Carp river was about 1898. VII. 3. No fresh signs of beaver were observed on Little Carp river. Allie reported them to occur on the river below Little Carp Lake. Beaver cuttings were secured from the dams on Carp and Little Carp rivers.

8. *Peromyscus canadensis* (Miller). Canadian White-footed Mouse. II. 2. Four males taken August 3, 11, and 13, were referred to *canadensis* by the U. S. Biological Survey. Two males taken August 8 (No. 32193) and August 6 (No. 32197), and an immature male taken July 24 (No. 32198), apparently belong here. This was one of the most common mammals in the mountains.

9. *Evotomys gapperi* (Vigors). Common Red-backed Mouse. II. 2. Two males were taken in the hardwood forest, August 3 and 13. III. 5. Two pair of adults were taken in the aspen zone bordering the mountain top between July 22 and 30. IV. 4. Two adult females were taken August 6 and 7, in the tamarack swamp.

In the Porcupines this mouse is thus seen to frequent a variety of habitats, the hardwood forest, the aspen zone, and the tamarack swamp. Farther south it is more closely restricted to cool swamps.

10. *Fiber zibethicus* (Linn.). Muskrat. IV. A few specimens were seen along Carp river, July 16, by Maclean and McCreary. VII. 1. One specimen was shot at Little Carp Lake, August 7, by Peet.

11. *Zapus hudsonius* (Zimm.). Northern Jumping Mouse. II. 2. An immature male was taken, July 30, in the hardwood forest. VII. 1. An immature male was taken on a rocky bluff along Little Carp river, August 11.

12. *Napæozapus insignis* (Miller). Woodland Jumping Mouse. II. 2. Three adult males were taken in the hardwoods, between August 4 and 13.

13. *Erethizon dorsatum* (Linn.). Canadian Porcupine. II. 2. An adult female and a pair of young were taken in the hardwood forest between July 23 and August 8. An adult male was shot, July 13, in the hardwood forest near the base of the mountain slope. II. 3. Three females were taken, during July, in the camp clearing. IV. 1, and V. 1. Porcupines were frequently seen, by Ruthven, in the river and lake both during the day and night, eating leaves of the yellow water lily. (This habit is shown in Fig. 19).

This interesting animal was very abundant and of general distribution in the forest.

14. *Lepus americanus virginianus* (Harlan). Southern Varying Hare. II. 3. An adult female was taken, August 9, in the camp clearing. It had evidently been suckling young and was in full summer pelage. The yellowish rufous pelage is much more marked than in the Hares from Isle Royale

(var. *americanus*). The white outer ear margin is only feebly developed. IV. 2. A young female was taken, Aug. 21, in the alders along Carp river. In this specimen the rufous tints are very pronounced on the upper side of the legs and on the pectoral region. The outer margin of the ear is of a distinctly yellowish white color.

15. *Lynx ruffus* (Gueld.). Bay Lynx; Wild Cat. · IV. 2. A weathered skull was found in the alder bushes along Carp river, by Ruthven. Trappers reported this species common.

16. *Canis occidentalis* Richardson. Gray Wolf. The trappers reported them common. Near the Porcupines, during the winter of 1902-'03, a trapper was reported to have been treed by a pack. Wolves are reported to have killed many deer near the Porcupines, during the past winter of 1904-'05.

17. *Taxidea taxus* (Schreber). Badger. Trappers reported that occasionally specimens were found.

18. *Mephitis hudsonica* (Rich.). Northern Plains Skunk. II. 3. Young and three adults of both sexes were secured between July 15 and July 30, in the clearing about camp. They were very abundant. A large adult male was taken, July 30, which weighed eight pounds. II. 2. Two specimens were seen by Ruthven along the road through the hardwood forest in September, 1903. On the morning of July 15, Wood found a young skunk in a trap, held fast by the foot. Another of about the same size was observed running about the captive, making frequent attempts to liberate it by biting the trap and pulling with its fore feet.

The skunks found in the traps were not at all violent in their attempts to escape and could easily be approached and killed with a noose.

This is a northern plains and Rocky Mountain species. These northwestern affinities suggest an origin from that direction, by way of Minnesota.

19. *Putorius cicognani* (Bonap.). Small Brown Weasel. Near II. 2. An adult female was taken along a corduroy road through the hardwoods on Section 17. Dr. Merriam wrote in 1896, "It probably also occurs in Northern Michigan and Wisconsin." (N. A. Fauna No. 11, p. 11).

20. *Ursus americanus* Pallas. Black Bear. III. Fresh signs were observed several times on the mountain top, where Allie reports that they often came to feed upon the dwarf and low black blueberries. A cub was observed here, August 5, by Allie.

Trappers reported them quite common in the mountains. An adult bear was killed, July 11, 1904, at Iron river, near the Porcupine Mountains.

21. *Sorex hoyi* Baird. Hoy's Shrew. III. 5. A pair of adult specimens were found in the aspen zone on the mountain on July 29, and August 2. IV. 4. One specimen was taken, August 12, in the tamarack swamp.

This is said to be the smallest North American mammal, and is without doubt the smallest one in Michigan.

22. *Blarina brevicauda* (Say). Large Bob-tailed Shrew. II. 2. Adult shrews of both sexes were taken in the hardwoods during August. II. 3. Three adult females were taken in the clearing. III. 5. Adults of both sexes were taken in the aspen zone surrounding the mountain top.

This shrew and the White-footed Mouse were the most common small mammals in the mountains.

23. *Condylura cristata* (Linn.). Star-nosed Mole. II. 2. A pair of moles was taken, September 2, 1903, by Ruthven, in the hardwood forest, on the mountain slope above the camp. This was about 800 feet above *lake level.* The line of their tunnel was intersected by a cutting, at the base



of which was an old ore bucket into which they had apparently fallen and drowned. Farther south these animals are closely confined to swamp land.

24. *Myotis subulatus* (Say). Say's Bat. II. 3. Three adult males were taken in camp, August 13, by Peet.

Supplementary Notes.

The following notes were secured by Mr. Wood from Mr. C. E. Haring of Ontonagon, Michigan. Mr. Haring and his brother bought furs from the Indians and trappers between 1860 and 1875. Unless otherwise specified these records refer to Ontonagon County.

Caribou. He had no authentic record of this species.

Moose (Alce). A moose was taken at Union Bay in 1864, and one at Gogebic Lake, Gogebic County in 1863.

Deer. Are more abundant now than formerly.

Beaver. Was yet common in 1860.

Canada Lynx. Was twice as abundant as the Wild Cat. At the present time this species is rare.

Wild Cat. Common.

Panther. Had no experience with them but had heard authentic reports of their occurrence before 1860.

Wolf. Was very common and killed many deer.

Red Fox. Was common; cross fox rare, and silver gray fox very rare.

Otter. Several skins were secured each year about 1860.

Wolverine. At Rockland, five were bought by his brother, J. M. Haring, between 1865 and 1875. This is the only Michigan (?) locality known to the writer. Of course the animals may not have been killed near Rockland, but may have come from a distance. Hon. Peter White, of Marquette, informs me, that, although he has made inquiry for many years, he has been unable to obtain authentic records of the Wolverine in Michigan.

Fisher. Common in 1860; a few skins secured each year.

Martin. Very common in 1860. A few have been taken in recent years.

Mink. Common.

Racoon. A very few have been taken.

2. ISLE ROYALE.

1. *Rangifer caribou* (Gmelin). Woodland Caribou. An Indian trapper reported that fresh tracks were seen during July, 1904, in a clearing near Siskowit Bay.

2. *Sciurus hudsonicus* Erx. Hudson Bay Red Squirrel. II. Nine specimens were taken in the coniferous forests, both young and adults. The resin on the hair about the mouth shows that both young and adults feed upon the coniferous seeds. Two of the specimens are old females which have reared young, as shown by the scanty hair on the belly; in both, four nipples had been functional. III. A young and adult male were taken in the deciduous forest along the Lake Desor trail.

There is considerable variation in the color of the upper side of the tail in the Isle Royale specimens. The median rufous band is quite pronounced in two specimens.

A winter skin, taken by a trapper, lacks the distinct lateral black line, found in the summer specimens and has a faint rufous stripe extending from the ears to the subterminal black bar on the tail. The shorter tails, with