TRANSACTIONS

OF THE

WISCONSIN ACADEMY

OF

SCIENCES, ARTS AND LETTERS

VOL. XXXVII

NATURAE SPECIES RATIOQUE

MADISON, WISCONSIN
1945

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The publication date of Volume 36 (1944) was January 12, 1946.
The publication date of Volume 37 (1945) is April 10, 1947.

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THE DISTRIBUTION OF WISCONSIN HARES

ALDO LEOPOLD
Department of Wildlife Management
College of Agriculture, University of Wisconsin

Both of the hares of Wisconsin have changed their original range boundaries. The jackrabbit is spreading rapidly eastward; the snowshoe hare has been, at least until recently, shrinking slowly northward. This paper aims to record their distribution as of 1944, and to discuss briefly the probable reasons for boundary changes.

The present ranges are mapped in Figures 1 and 2. A portion of the "stations" on these maps were accumulated since 1928 by questioning students, farmers, game wardens, sportsmen and technical field men. Another portion was obtained by questionnaires and correspondence in 1944.* A final and very valuable series of historical records was contributed by Dr. A. W. Schorger.

JACKRABBIT *(Lepus townsendii companius.* Hollister)

Former status. Cory, in his "Mammals of Illinois and Wisconsin" (1912), lists the jackrabbit as "not yet recorded from Wisconsin (although it) has been taken in the eastern border of Iowa . . . and in extreme southeastern Minnesota" (6:265).

Cory was mistaken, for the following captions will show at least five occurrences of jackrabbit in Wisconsin prior to the publication of Cory's book in 1912:

Grant County, 1888. Assemblyman Lloyd Rundell, who grew up on a farm 12 miles north of Platteville in Grant County, remembers the killing of a jackrabbit on about February 21, 1888. The animal was shot by Albert Warne and William Gubbel

* I wish in particular to acknowledge the help of Arnold S. Buss, Donald Euers, John T. Curtis, W. S. Feeney, William H. Field, H. M. Fuley, Fred Gardner, Albert Gastrow, Wallace Grange, Arthur S. Hawkins, S. W. Hayner, Karl W. Kahmann, Helmer Mattison, John O'Donnell, A. J. Peterson, Lloyd Rundell, Raymond Schenk, A. W. Schorger, Clarence A. Searles, Herbert L. Stoddard, and G. A. Weitz.

of Livingston. I have a letter from Albert Warne dated February 12, 1945, reciting all the details. This letter leaves no doubt as to the identity of the animal. The year is certain because the event followed the historic blizzard of January 12, 1888. The letter indicates that jackrabbits were previously unknown in that locality.

Iowa County, 1897. Dr. A. W. Schorger has discovered the following in the Madison *State Journal* for January 5, 1898 (p. 1): "A genuine jackrabbit, weighing over 8 pounds, was killed in the town of Arena a few days ago by Walter A. Cook. Harry Smith, of this city, has just returned from a hunting trip

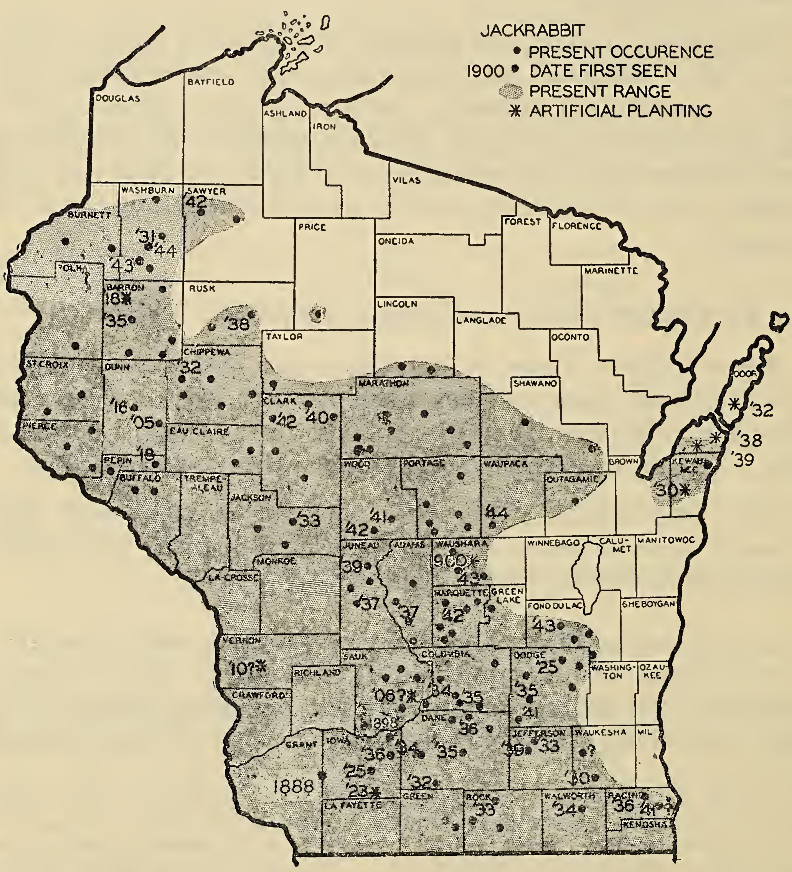

FIG. 1.—Range of the Jackrabbit in Wisconsin as of 1944.

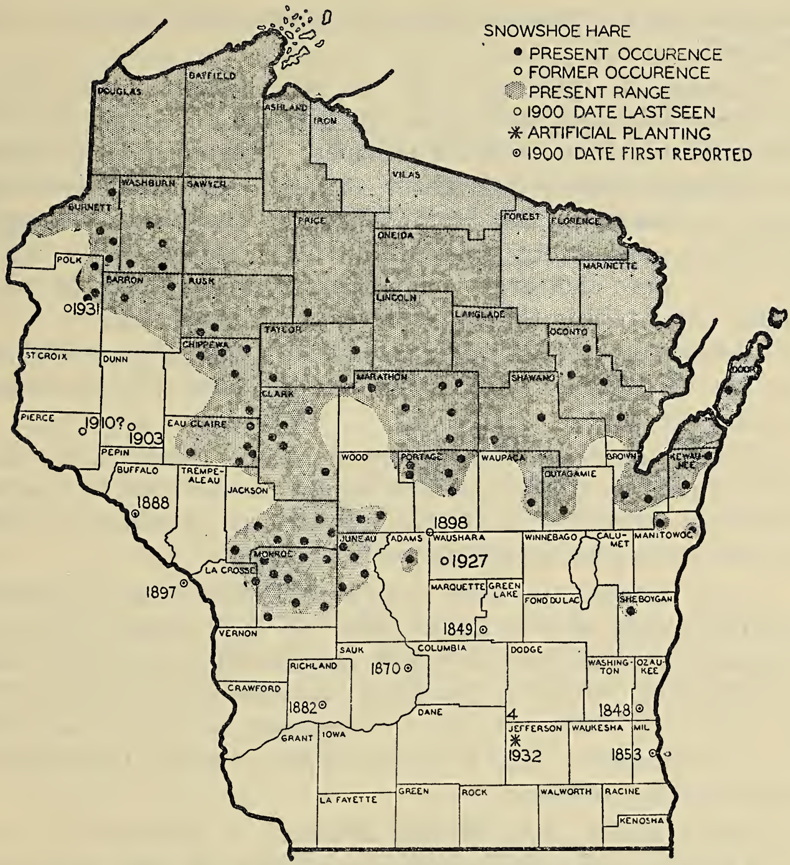

FIG. 2.—Range of the Snowshoe Hare in Wisconsin as of 1944.

in Arena and brought it home with him." This record is unmistakable, but it contains no inference as to whether jackrabbits in Iowa County were something new. It does imply that they were scarce.

Sauk County, 1906? Herbert L. Stoddard, whose boyhood home was in Sauk County, writes me under date of January 7, 1945: "To the best of my recollection there were a few jackrabbits on what is known as the Sand Prairie, some 8 or 10 miles west of Prairie du Sac, when I first came to Wisconsin about 1906–7. Later they increased, and by 1915–1920 they were quite numerous . . . Ed Ochsner (now deceased) told me that they were brought in from elsewhere, and liberated on the Prairie."

Through the courtesy of Dr. A. W. Schorger, I am able to quote the following note made by him on February 16, 1935 after a conversation with Ed Ochsner: "Regarding jackrabbits he (Ochsner) stated that about 40 years ago a saloon-keeper moved to Prairie du Sac from Nebraska. The children brought with them some young jackrabbits which escaped. After that a pair or so were shot every winter, but they have become fairly common only within the past ten years." (About 1925.)

Ed Ochsner, in 1921, told Paul Jones, a competent naturalist, that jackrabbits had been planted on the Sand Prairie "about 25 years ago."

Albert Gastrow, a life-long resident of Prairie du Sac and field companion of Herbert Stoddard, tells me that he can remember jackrabbits on the Sand Prairie as far back as 1898, but that he has no recollection of a planting.

I have entered the Sauk colony on Figure 1 as a probable planting dating back to about 1906, but it is evident from the foregoing evidence that the colony may be older, and that it may be indigenous. Whatever its origin, an increase in numbers began about 1925. When I came to Wisconsin in 1924, jackrabbits were present on the Sauk Prairie, but absent from Dane County, which lies east of Sauk.

Dunn County, 1905. Helmer Mattison of Menomonie, a reliable trapper and a field companion of Irven O. Buss, wrote me in July 1944: "The first jack I know of was on the Fall City Prairie about 1905 in the town of Spring Brook . . . My father's farm was in the town of Spring Brook 2½ miles west of Fall City. My folks bought this farm in 1898 as wild land."

Jackrabbits were apparently absent here prior to about 1905, but moved in as the region was cleared for farming. Mattison knows of no local plantings, nor have I found any reports of plantings in that region.

Waushara County Planting, 1900. As will be described later, a well-authenticated planting of jackrabbits was made in Waushara County in 1900, and is locally believed to account for the present local stock (17).

As against these five positive records, Dr. A. W. Schorger has contributed seven others which are either negative or doubtful as to jackrabbits. These, however, are in part positive as to snowshoe hare, and hence are quoted later under the discussion of snowshoe hare.

While Cory overlooked the jackrabbit, it is clear that the species must have been scarce when his book was published in 1912, and for a long time prior to 1912, else some report of its presence in the state would have come to Cory's notice. Cory's omission of the jack has been perpetuated in the subsequent books on the mammals of this region (2, 8).

Cory must have had some inkling that the jackrabbit might be about to spread eastward, for he reports the species as "not *yet* recorded from Illinois or Wisconsin."

There are a good many early reports of large rabbits in southern Wisconsin, but these are usually inconclusive because it is uncertain whether they refer to jackrabbits or to snowshoe hares. I have already published one report of "large white rabbits" in Trempealeau County about 1876 which may refer to either species (12:95–96).

Plantings. At least part of the present jackrabbit population stems from plantings. I have gathered reports of ten plantings of jackrabbits imported into Wisconsin from western states:

No.	*County*	*Year*	*Number Planted*	*Remarks*
1	Waushara	1900	12	4 males, 8 females, from Nebraska, in March, by Guy Mumbrue and W. A. Baugh, N. of Wautoma. Success: Stock spread N. and W. (17)
2	Sauk	before 1906?	?	A colony existed here perhaps as early as 1898, but its origin is uncertain.
3	Vernon	1910?	?	At Viroqua. Said to have survived.
4	Barron	1918?	?	Near Cumberland. Success unknown. (17)
5	Iowa	1923	10	6 miles E. of Mineral Point.
6	Iowa	1928	12	6 miles E. of Mineral Point.
7	Kewaunee	1930	24	In April, by Dr. V. T. Laurent, between Luxemburg and Ellisville. Now spread E. to Algoma, W. to Sugarbush in Brown Co. where one was killed Jan. 1945.

No.	County	Year	Number Planted	Remarks
8	Door	1932	?	Near Whitefish Bay, by Mr. Machek. Survived a few years, now gone.
9	Door	1938	40–50	Near Sawyer, by Arden Robertson. Stock from Rago, Kansas. One killed Dec. 20, 1944 by Ervin Serville.
10	Door	1939	?	In Brussels and Claybank townships, by Justin Shutawar of Forestville. Now established across the base of the Door Peninsula.

Not all of these reports are equally dependable. Numbers 1, 7, 8, 9, and 10 are supported by satisfactory corroborative detail. Numbers 1, 7, and 10 resulted in the establishment of a population on range previously vacant.

Could all of the present stock have originated from plantings? Not unless additional successful plantings, unknown to me, were made in southwestern Wisconsin before 1888 (Grant County record), and in northwestern Wisconsin before 1905, (Dunn County arrival). Two plantings (No's. 1 & 2) preceded the arrival in Dunn County, but they lie too far south and east to account for the Dunn County stocks.

At this late date there is only one final proof of indigenous jackrabbits: the identification of bones from Indian middens.

The general progression of arrival dates in Figure 1 is clearly from westward to eastward, and this supports the theory that the bulk of the present stock originated by natural spread from the Mississippi River counties, or even from points west. The upper Mississippi is frozen in winter, and presents no barrier to winter movement.

Reasons for Spread: Present Habitat. The present jackrabbit range, as depicted in Figure 1, consists of two zones: a peripheral northeastern fringe of cutover pine lands, and an interior block of rich dairy farms in the southwestern counties originally consisting largely of prairie. The jackrabbit had to cross this prairie farm zone in order to reach the peripheral cutover zone. Unless the spread eastward represents response to some long climatic cycle, we must look to land-use changes in the prairie farm zone to explain the inception of the eastward movement in this mammal.

It is now well known, both from vegetative evidence (15) and recorded history (18:13; 19:13) that prior to 1840, Indian fires tended to keep what is now the prairie farm zone in prairie vegetation, whereas after 1840 there was widespread encroachment of oak–hickory forest on the unplowed portions. This trend toward reforestation perhaps explains the scarcity of jackrabbits up to Cory's time.

By 1900 intensive dairy farming began to reverse this trend toward more woodlots in the farming zone, while the fires which followed lumbering created large grassland areas in the former pineries. These changes presumably set the stage for the recent eastward extension of the jackrabbit range. The occupation of the prairie farm zone by jackrabbits was largely completed in the 1930's, and this brought the frontier to the edge of the cutovers, the invasion of which is now proceeding at a rapid rate. (See arrival dates in Figure 1.)

While the two zones were both being deforested from 1900 to about 1930, the inauguration of state-wide forest fire protection in about 1930 has now reversed the trend of plant succession in the cutovers, and this will ultimately constrict and localize the jackrabbit in the peripheral fringe. In the farm zone, on the other hand, the tendency toward deforestation is being accelerated by the pasturing of woodlots, drouth, oak wilt disease (10) and (since the war started) by boom prices for oak logs and railroad ties. Brushy fence rows are being cleared up, partly to combat the cornborer, while roadside growths are disappearing due to the widening of roads and the mechanical mowing of road-shoulders. All those changes doubtless tend either to encourage the jackrabbit, or to discourage his cover-demanding competitors and predators.

While the jackrabbit now occupies most of the state, his population density, unlike that in the western states, is very light. Jacks are most abundant on the flat, wide prairie ridges of the southwestern counties, but even there the density probably seldom exceeds three or four individuals per farm. In the peripheral fringe, some of the counties showing three or four stations in Figure 1 may support only a few dozen individuals, and these are for the most part confined to sandy "barrens," or to large areas of abandoned fields not yet reclaimed by woody vegetation.

The eastward spread of the jackrabbit frontier is known to occur not only by the slow advance of a solid front, but by outliers thrust suddenly far ahead of the main front, and later incorporated in it. Thus in 1930 Professor John T. Curtis found a jackrabbit skeleton in Waukesha County near Mukwanago, at which time the species was not yet known to have entered Dane County, and the nearest known "front" lay 75 miles to the west. Jackrabbits have not occurred regularly in Waukesha County until very recently.

These two types of spread by an expanding population are similar to those already described for Hungarian Partridge (13).

SNOWSHOE HARE *(Lepus americanus phaennotus)*

This paper follows the taxonomy of Hamilton (8:376), and takes no account of the possible existence of two subspecies in Wisconsin.

The south boundary of the snowshoe hare range during the pre-settlement period undoubtedly lay far south of the present boundary (Figure 2), and may have extended as far south as Chicago. Kennicott, in 1855, makes this qualified assertion, quoted by Cory (6:264): "It has been stated that a number were shot on the present site of the city of Chicago in the winter of 1824." This is possible, for the tamarack bogs constituting the southerly habitat of the snowshoe extended as far south as Chicago.

If the original range did extend into Illinois, then one would expect to find reports of early colonies in the numerous tamarack bogs of southeastern Wisconsin. I have found no such reports; my records of former occurrences are confined to recent years, and to the counties immediately adjoining the present boundary. Dr. A. W. Schorger, however, has contributed seven records, all preceding 1900, and scattered widely over the southern counties almost to the Illinois boundary. I present Schorger's records in chronological order:

Ozaukee County, 1848. C. T. Ficker settled in the town of Mequon in the winter of 1848–49. His journal, recently published (7:349) says "There are no German rabbits here, though there are wild hares which in summer have a gray appearance, in winter white." Ozaukee County is still rich in bogs, but there was no prairie. Ficker's description certainly refers to snowshoe hare.

Green Lake County, 1849. John Muir's parents settled on a farm near Kingston in 1849. In his "Boyhood and Youth" Muir says (16:181) "Hares and rabbits were seldom seen when we first settled in the Wisconsin woods, but they multiplied rapidly after the animals that preyed upon them had been thinned out, and food and shelter supplied in grain fields and log fences and the thickets of young oaks that grew up in pastures after the annual grass fires were kept out."

Green Lake was partly prairie, but it also had many tamarack swamps, and Muir's hares were clearly snowshoes.

Milwaukee County, 1852. Increase H. Lapham, a versatile naturalist, mentions a specimen of *Lepus americanus* from Milwaukee preserved in the collection of the Natural History Society at Madison (11:340).

Sauk County, 1870. W. H. Canfield came to Sauk County in 1840. In 1870 he published the third of a series of recollections, in which is this item: "Northern Hare. Seldom seen. Gray rabbit. Scarce when the country was new, but now very plenty. Water rabbitt. That resorts to water when pursued, sinking below the surface except the nose and eyes." (5:39)

Canfield was originally attached to a government surveying party. Schorger considers him observant and generally reliable. His "water rabbit," however, was certainly a swimming cottontail. Cottontails swim freely when pressed by hunters or dogs.

There is a large tamarack swamp on Leech Creek northeast of Baraboo. While the tamaracks are now but a remnant, the locality is logical as an early location for a colony of snowshoes.

Richland County, 1882. The Richland Centre *Republican and Observer* for Nov. 23, 1882 (p. 8) contains notice of a "side hunt" in which a hare rated 75 points and a rabbit 25. There is a large tamarack bog just south of Richland Centre. It is a logical location for former snowshoe hares.

Buffalo County, 1888. L. Kessinger, in his county history, gives a list of animals, in which this item occurs: "Northern Hare. Changeable fur; rare." The jackrabbit is of course also changeable, but Kessinger's correct nomenclature leaves little doubt that he is reporting snowshoes. The tributaries of the Mississippi in Buffalo County include swamps suitable as habitat.

Winona, Minn., 1897. L. H. Bunnell came to the La Crosse region of Wisconsin in June, 1842. He was familiar with the

Mississippi Valley from Prairie du Chien northward. The following note, published at Winona, Minn. in 1897, does not refer to any exact locality, but to the valley in general. He says (4:333) "Rabbits are also quite common in the neighborhood, and the northern hare occasionally appears, but as far as I know, the real jackrabbit of the plains has not been seen in the Mississippi bottoms; though his fur becomes, in winter, almost as white as that of the hare, and one is sometimes mistaken for the other. A full-grown jackrabbit is considerably larger than either the northern hare or the English hare."

I have mapped Bunnell's report as Winona for lack of any specific location.

Additional records of snowshoe may, in time, be discovered in Indian middens. Bones from one such a midden at Aztalan, in Jefferson County, have been partially reported (3:386). Three "rabbits" are listed as found among the Aztalan bones, but the southern swamp rabbit is one of the three. The improbability of this canebrake species in Wisconsin casts doubt on the dependability of all three identifications.

The present south boundary of the snowshoe, as depicted in Figure 2, refines somewhat the boundaries published by Cory and Hamilton, but it is nevertheless a crude affair, for it perforce ignores the fact that most marginal colonies are isolated islands, whereas in Figure 2 only four extreme cases are so mapped. Wallace Grange tells me that parts of the range in Wood, Brown, Kewaunee Counties, and southern Door County consist of islands. I know that some of the colonies in Outagamie, Portage, Juneau, Monroe, Jackson and Polk Counties are islands, but I lack precise information necessary to map them as such.

Recent Trends. Wallace Grange, who undoubtedly understands the snowshoe hare better than any other present Wisconsin naturalist, thinks that the northward recession of the boundary ceased about 1930, and that since 1930 snowshoes in the peripheral counties have trended upward in numbers and perhaps southward in distribution. The eleven extinguished colonies, recorded in Figure 2, all disappeared before 1931. A regression of agricultural settlement and drainage, together with an improvement in forest fire control, both followed by an upward trend in plant succession, also occurred during the early

1930's. Hence the southern boundary may, in general, be regarded as stabilized since 1930.

The following instances illustrate the extinguishment of peripheral colonies prior to 1930:

Polk County. Snowshoes were seen at Balsam Lake, in the center of the county, in 1931, but not since. C. A. Weitz, the conservation warden, has sent me convincing evidence of three relic colonies existing to the east and north of Balsam Lake in 1943 and 1945, but in each case the colony is very small. In this county the pre-1930 recession perhaps still continues.

Dunn County. Helmer Mattison of Menominee, a thoroughly competent woodsman, writes me: "The last snowshoe hare that was in Dunn County that I know of was shot on my father's farm in the town of Spring Brook, 2½ miles west of Fall City, December 25, 1903. My folks bought this farm as wild land in 1898. I don't know of any snowshoe rabbits now further south than the northern half of Barron County."

Waushara County. Dr. A. W. Schorger saw a snowshoe hare near Pine Lake, Hancock township, on August 21, 1927. One of my students, F. N. Hamerstrom, Jr., lived near Pine Lake during 1939 and 1940, but cannot remember evidence of snowshoes at this point. Jack Worden, the conservation warden, says there are no snowshoes in the county now, and that the last one he saw was near Pine Lake "about 15 years ago." I conclude that the hare recorded by Schorger was about the last survivor of a relic colony.

The process of shrinkage is evidently not yet everywhere arrested. Clarence Searles of Wisconsin Rapids, who operates a cranberry marsh near the most easterly of the two remaining colonies in Wood County, writes me: "Snowshoe hares were quite plentiful in the swamps of central Wood County until about 15 years ago. In a swamp on our property they were common, but now they are rare, although still present."

Jefferson County Planting. The human itch to plant strange rabbits has found expression not only in jackrabbits, but also in this species. Hawkins (9:60) records a planting of two snowshoes in 1932 by Peter Dietrich in a tamarack swamp on his farm near Faville Grove in Jefferson County. There is no evidence of establishment, and the tamaracks fell victim to some insect or disease about 1942. This same disorder swept most of the tamarack bogs in the southeastern counties, and will profoundly affect their flora and fauna.

Status in Northern Wisconsin. While shrinking at their periphery up to 1930, snowshoe hares in northern Wisconsin reach high levels at each peak of their cycle. These high populations are usually spotty, but where they occur they often inflict heavy damage on forest reproduction and forest plantations (1). This damage, however, is in my opinion more localized in both time and space than that now done by deer (14). It occurs largely in brushy cover, in winter, and at intervals of 10 years. Deer damage, on the other hand, is not confined either to cover or to winter, and there is no population cycle to create periods of respite. Both species browse as high as they can reach from a standing position, but the leader of a forest tree does not become deer-proof until eight feet above the snow, whereas it becomes hare-proof much earlier.

Wallace Grange has pointed out that the same browsing which makes the snowshoe a nuisance in forest plantations results in valuable thinnings in over-dense thickets of jackpine reproduction. The snowshoe seems to be the only native mammal capable of maintaining a dense population in the monotype of young jackpines which now covers large areas of outwash sand in northern Wisconsin.

Summary

The development of agriculture has had opposite effects on the two hares of Wisconsin. It has drawn the jackrabbit frontier eastward from the prairies, while pushing back the snowshoe frontier northward toward the Canadian zone.

The spread of the jackrabbit did not begin until about 1900, when intensive dairying began to shrink the woodlots of southern Wisconsin. This trend promises to continue.

Having crossed the southern dairy belt, the jackrabbit was free to invade the burned cutovers to the north, and is now doing so. This extension of the range, however, will hardly persist, for fire protection now permits the advance of the forest succession in the former cutovers.

The present jackrabbit population originated in part from plantings, but the bulk of it probably represents natural spread from the West.

The snowshoe hare once inhabited swamps in southern Wisconsin and perhaps in northeastern Illinois, but the exact location of the original southern frontier is unknown. The species has receded slowly northward, but the south boundary has become stabilized since 1930.

The gross ranges of two hares now overlap in a large block of central Wisconsin counties, but they seldom occupy identical niches. In the zone of overlap the jackrabbit inhabits barrens and abandoned farms; the snowshoe, on the other hand, is largely confined to swamps, jackpine thickets, and brushy lands.

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A WINTER RABBIT BROWSE TALLY ON THE UNIVERSITY OF WISCONSIN ARBORETUM[1]

ROBERT A. McCABE
Arboretum Biologist, Department of Wildlife Management, University of Wisconsin

In southern Wisconsin during the winter of 1944–45 rabbits damaged more trees and shrubs than in any winter for the past twenty-five years. My observations cover only the period since 1930, but the above conclusion is substantiated by older observers who are acquainted with the nature and severity of outbreaks of rabbit damage.

The observations and measurements here reported were made at the University of Wisconsin Arboretum, a thousand-acre tract which lies partly within the city of Madison, on the south shore of Lake Wingra. This area is ideally suited to measuring the extent of rabbit damage, first, because it has diversified soils, topography and plant associations; second, because the rabbits are only lightly hunted; and third, because many woody species not found elsewhere have been planted in the park and horticultural sections and in the two nurseries.

The cottontail rabbit *(Sylvalagus floridanus mearnsii)* is common throughout southern Wisconsin and is the only rabbit found in the Arboretum.

Severe rabbit damage occurs in a given locality only in certain winters. The winter of 1943–44 had only an average amount of browsing by rabbits, whereas in the winter of 1944–45 there was exceptional browsing on most woody plants. The three most likely reasons are: (1) that there were more rabbits on the area; (2) that the plants were more palatable; and (3) the weather conditions were more extreme.

The logical assumption might be that there were more rabbits. This was not the case. On a 250-acre trapping area (Fig. 1) 38 rabbits were caught in 900 trap nights during December, 1943. The same area produced 39 rabbits in 900 trap nights in

[1] Journal Paper Number 7, University of Wisconsin Arboretum.

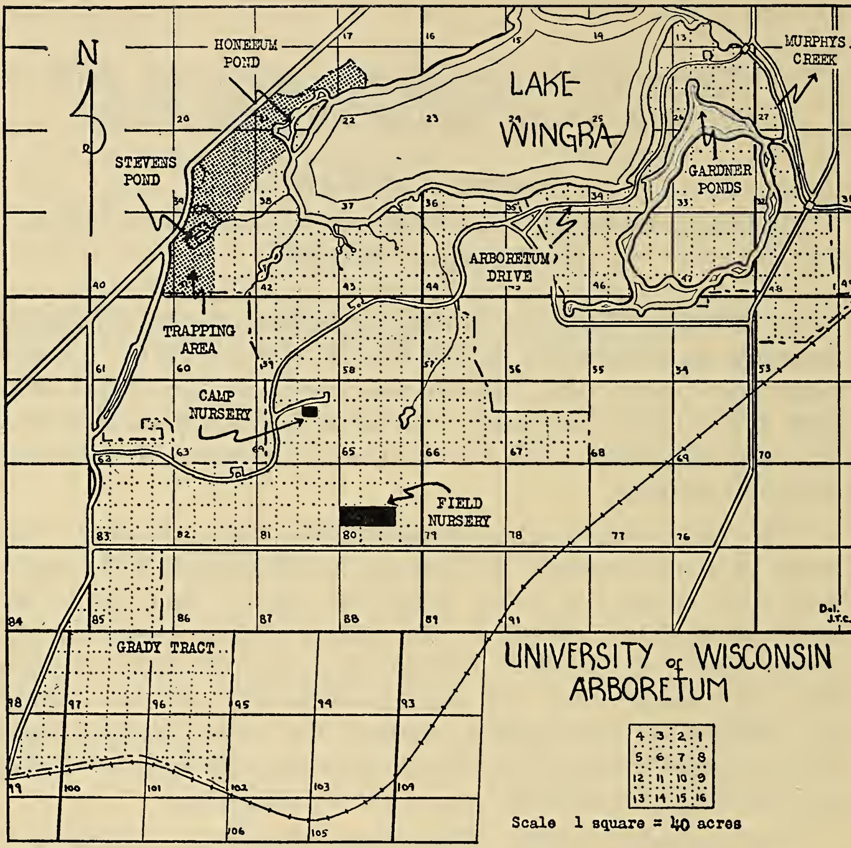

FIGURE 1.

December, 1944, thus indicating that the rabbit density was the same during the two winters. Rabbits were relatively abundant both years.

I found no evidence of a differential palatability between the two years. While I believe that browse foods do change in palatability, the only evidence I have to support this contention as follows:

First, Aldo Leopold (unpublished) observed a given stand of elderberry *(Sambucus* sp.*)* each winter from 1935 through 1945 and found that browsing occurred only in February, 1940. The browsing in this case was severe. During the ten-year period many of the more apparent variables, such as cover changes, rabbit densities, etc., were active, supporting the belief that the single year of heavy browse was due to change in palatability of the elderberry.

Second, just beyond the extreme northeast corner of the Arboretum the city of Madison has its brush dump, which is filled with the fall prunings from city parks and roadsides. Here I found that these prunings, cut a month or two previously, had "cured" and become more palatable than live, green twiggage of the same species. This was particularly true of American elm and cottonwood, where the cured material was heavily browsed but the living plant only slightly browsed.

Whether this apparent change in plant sugars (curing) occurs in live trees and shrubs, I do not know, but if it does it could account for year to year, season to season, and location to location changes in palatability that I suspect exist.

The weather influence can be divided into two parts, temperature and snowfall. The mean temperature averaged lower in 1944–45 (18.9° F.) than in 1943–44 (23.1° F.) for the trapping period. Neither year can be considered as severely cold, as there were no prolonged periods of sub-zero weather. Most important, I found no correlation between the daily temperature and daily catch (Table 1), indicating that temperature alone was not a factor causing excessive browsing.

The most apparent difference between the two winters under discussion was the length of time snow covered the ground. In 1943–44 there were only two periods of 11 and 14 days when there was snow, with a maximum depth of 3.1 inches, whereas in 1944–45 there were 76 consecutive days from November 29 to February 13 when snow covered the ground, with a maximum depth of 15.4 inches. The blanketing of the ground obviously limits the rabbits' food supply to the palatable bark of woody plants that extend above the snow, and the longer the snow remains the greater the damage to the available supply. The protracted period when the ground was covered with snow was in my opinion the reason for the severe browse in 1944–45.

My field observations indicate that certain plant species are preferred browse while others are not. This is not an original observation, as other writers (see Discussion) have also pointed this out. There are, however, several mechanical qualities of the woody plants that appeared to influence the browsing.

TABLE 1

December		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Temperature (F°)	'43	40	34	30	39	31	28	26	20	6	2	4	14	22	30	32	30	19	4	2	14	29
	'44	34	30	30	28	29	26	22	20	18	16	26	20	18	4	16	23	7	7	9	8	7
Snowfall (inches)	'43	0	0	T*	0	0	0	0	T	T	0	0	0	0	0	0	0	0	0	0	0	0
	'44	.18	0	T	T	0	.3	.06	T	T	0	.03	0	T	.02	T	0	0	.03	.07	T	0
Snow on ground (inches)	'43	0	0	0	0	0	0	0	T	T	0	0	0	0	0	0	0	0	0	0	0	0
	'44	4.6	4.5	4.3	4.3	4.1	6.0	8.2	8.2	8.0	7.7	7.4	7.4	7.1	7.1	7.4	7.2	7.2	7.2	9.3	9.1	8.9
Total catch (including repeats)	'43	....	....	5	4	8	6	7	4	3	6	5	2	1	2	1	2	1	3	0	2	1
	'44	....	....	....	4	6	3	1	7	4	6	9	11	10	12	14	11	9	13	....	....	....

* Indicates trace.

FIG. 2.—Wild crab *(Pyrus ioensis)* showing the severe girdling on the young, smooth-barked trunk and the older, roughened trunk untouched.

FIG. 3.—Cottonwood *(Populus deltoides)* branches six inches in diameter browsed by rabbits in the Madison brush dump. Note that the roughened areas along the branches were not browsed.

FIG. 4.—Mountain ash *(Sorbus americana)* two inches in diameter and eight feet tall which will not survive the rabbit browsing.

FIG. 5.—Honey locust *(Gleditsia triancanthos)* showing trunk and lower limbs girdled. Compare size with field glasses at base of tree.

It was noted that when the bark of a given species became roughened by the overlapping unsloughed layers of corky material, it was seldom browsed, but prior to this stage it might be severely gnawed. This was particularly true in wild crab *(Prunus* sp. – Fig. 2) and hackberry *(Celtis occidentalis)*, where most of the available smooth-barked trees were killed by debarking and the smooth-limbed branches were damaged. The roughness of the bark discouraged browsing.

Just north of Murphy's Creek in the brush dump mentioned earlier, rabbits completely girdled a six-inch (dia.), smooth-barked, upper branch of a cottonwood (Fig. 3) and left other rough sections of the same branch untouched.

Roughness alone is not an infallible index of immunity, for common nine-bark, with its rough peeling bark, was the only member of the rose family not browsed, while wild grape, equally rough and peeling, was browsed. Also, the smooth bark of mulberry was not touched in 100 trees examined.

In several species, namely shagbark hickory *(Carya ovata)*, alternate-leaved dogwood *(Cornus alternifolia)* and red maple *(Acer rubrum)*, there were a number of plants that were scarred by what appeared to be repeated attempts at debarking but which left only single scars or tooth marks which failed to reach the soft bark. The trees thus scarred had smooth bark and were over ⅝″ in diameter. Those trees of the same species but smaller in diameter were severely debarked and pruned. In these cases it appeared toughness of the bark discouraged browsing.

Spiny growths such as prickles and thorns were no hindrance to hungry rabbits, for several species of rose *(Rosa* sp.), honey locust *(Gleditsia triacanthos)*, prickly gooseberry *(Ribes cynosbati)*, prickly ash *(Zanthoxylum americanum)*, and red raspberry *(Rubus strigosis)* were both debarked and pruned.

Rabbit damage is most acute in the vicinity of dens and protective cover, but observations here reported were made in all sections of the Arboretum so that the measurements are of an average cross section.

The diameter of the stem browsed was measured with a caliper and read to the nearest eighth of an inch.

In recording the browse on a large area of many interspersed plants, some relative categories were necessary, hence two groupings in Table 2, *relative abundance* and *amount of damage,* use

TABLE 2

Species	Common Name	Relative Abundance	Amt. of Damage	Size of Stem Browsed	Type of Damage	Location on Map	Plants Examined	Remarks
Taxaceae								
Taxus cuspidata (intr.)	Japanese yew	D	O	....	....	58–14	5	
Pinaceae								
Pinus resinosa (intr.)	Red pine	A	C	....	P	80–11 82–11	100	needles eaten aver. ht. 7′
Pinus strobus (intr.)	White pine	A	B	under ½″	P	80–11 82–11	100	needles eaten aver. ht. 3′
Pinus banksiana (intr.)	Jack pine	A	A	under ½″	P	67–4 80–11	200	lower limbs brwsd aver. ht. 7′
Pinus sylvestris (intr.)	Scotch pine	D	B	under ½″	P & B	58–4	17	needles eaten
Pinus nigra (intr.)	Austrian pine	D	D	under ½″	P	58–4	10	needles eaten
Pinus mughus (intr.)	Mugho pine	D	D	under ¼″	P	64–7	13	needles eaten
Picea pungens (intr.)	White spruce	B	O	....	....	64–7 80–11	200	aver. ht. 2′
Picea abies (intr.)	Norway spruce	D	C	under ¼″	P	80–12	100	some needles eaten aver. ht. 4′
Thuja occidentalis (intr.)	Arbor vitae	B	O	....	....	21–10 65–7	100	aver. ht. 8′
Juniperus virginiana (intr.)	Red cedar	C	A	under 1⅛″	P & B	65–6 65–4	80	aver. ht. 7′
Juniperus communis var. *depressa* (intr.)	Prostrate juniper	C	C	under 1⅛″	P & B	65–6 65–4	35	

Larix laricina (intr.)	Tamarack	C	B	under ¼″	P	65–9 48–12	100	37% of 100 3/1 seedlings
Pseudotsuga taxifolia (intr.)	Douglas fir	D	O	....	....	39–13 64–3	25	
Abies balsamea (intr.)	Balsam fir	D	D	under ¼″	P & B	39–13	25	lower branches and needles browsed
Salicaceae								
Salix nigra	Black willow	A	A	under 1½″	P & B	wet marsh general	100	
Salix longifolia	Sandbar willow	B	A	under ½″	P & B	65–12	200	***
Salix alba var. *vitellina* (intr.)	Russian willow	A	A	under ½″	P & B	34–8 25–9	100	
Salix discolor	Pussy willow	B	A	under ½″	P & B	43–1 48–6	30	
Populus deltoides	Cottonwood;	A	C	under ½″	P & B	32–14 41–12	100	
Populus tremuloides	Quaking aspen	A	D	under 1″	B	general	100	felled trees brwsd
Populus grandidentata (possibly intr.)	Large-toothed aspen	C	D	under ½″	B	82–13	20	
Juglandaceae								
Juglans cinerea	Butternut	C	B	under 1¼″	P & B	64–6 64–7	100	aver. ht. 4′
Carya ovata	Shagbark hickory	A	B	under ⅝″	P & B	43–14 general	100	

*** Indicates that the browsing was lethal to some plants.

TABLE 2 *(continued)*

Species	Common Name	Relative Abundance	Amt. of Damage	Size of Stem Browsed	Type of Damage	Location on Map	Plants Examined	Remarks
Betulaceae								
Betula alba var. *papyrifera* (mostly intr.)	Paper birch	C	B	under 7/8″	P	82–11 65–6	40	
Betula nigra (intr.) . . .	River birch	C	B	under 1/2″	P & B	34–10 80–11	100	35% browsed
Betula pumila var. *glandifera* and *Betula sandbergii* . .	Bog birch	A	A	under 1/2″	P & B	42–7	100	***
Betula lutea (intr.) . . .	Yellow birch	D	A	under 5/8″	P & B	43–6 64–7	4	***
Ostrya virginiana	Ironwood	C	A	under 3/4″	P & B	80–13 80–14	25	aver. ht. 4½′
Corylus americana . . .	Hazelnut	A	B	under 1/2″	P	65–10 general	100	
Alnus incana (intr.) . .	Tag alder	C	A	under 1/4″	P	61–4 61–6	25	lower branches only
Fagaceae								
Quercus alba	White oak	A	A	under 3/4″	P & B	83–10 general	60	seedlings 3-5″ ***
Quercus velutina	Black oak	A	D	under 1/4″	P	96–5 96–16	130	
Quercus rubra	Red oak	A	A	under 3/4″	P & B	83–10 general	100	***

Quercus macrocarpa	Bur oak	A	B	under ½″	P & B	64–9 80–11	100	
Utricaceae *Ulmus americana*	American elm	B	C	under ¾″	P & B	64–7 general	35	
Ulmus parvifolia (intr.)	Chinese elm	D	A	under 1½″	P & B	64–7	5	95% barking aver. ht. 9′
Morus rubra (intr.)	White mulberry	C	D	under ½″	P & B	64–7 26–6	100	
Celtis occidentalis	Hackberry	C	A	under ⅝″	P & B	64–7 80–11	100	***
Berberaceae *Berberis thunbergii* (intr.)	Japanese barberry	C	A	under ½″	P & B	64–6	25	
Saxifragaceae *Ribes cynosbati*	Prickly gooseberry	A	D	under ¼″	P	43–13 80–14	50	
Ribes americanum	Am. black currant	A	O	....	....	46–3 38–15	100	
Ribes alpinum (intr.)	Alpine currant	D	A	under ½″	P & B	64–3	15	
Rosaceae *Amelanchier canadensis* (intr.)	Service berry	D	B	under ½″	P & B	62–4 64–5	25	
Amelanchier laevis (intr.)	Allegheny service berry	D	A	under ½″	P & B	62–4 64–5	4	
Cotoneaster racemiflora soongorica (intr.)	Cotoneaster	D	A	under 1″	P & B	64–7	6	***

***** Indicates that the browsing was lethal to some plants.**

TABLE 2 *(continued)*

Species	Common Name	Relative Abundance	Amt. of Damage	Size of Stem Browsed	Type of Damage	Location on Map	Plants Examined	Remarks
Crataegus sp. . . . . (mostly intr.)	Hawthorn	C	A	under 1 ½″	P & B	64–7 general	100	
Malus ioensis. . . . . . . (mostly intr.)	Flowering crab	A	A	under 2″	P & B	64–4 82–2	40	***
Malus pumila (intr.)	Apple	C	A	under 1 ⅝″	P & B	80–15 82–11	10	Old, prostrate trees
Physocarpus opulifolius.	Common nine-bark	B	O	. . . .	. . . .	80–11 general	100	
Prunus nigra.	Wild plum	C	B	under ⅜″	P & B	58–3 66–12	100	***
Prunus pennsylvanica	Pin cherry	C	B	under ¾″;	P & B	64–7 82–3	100	
Prunus serotina.	Black cherry	A	B	under ⅝″	P & B	65–3	100	
Prunus virginiana. . . .	Choke cherry	B	C	under ¼″	P	58–2 21–11	100	aver. ht. 7′
Rosa blanda . . . . (mostly intr.)	Prairie rose	B	B	under ¼″	P & B	82–2 general	30	
Rosa palustris.	Swamp rose	C	B	under ¼″	P	41–4 21–13	25	
Rosa rubiginosa (intr.)	Sweet briar	D	A	under ¼″	P	64–7	25	

Rosa setigera	Climbing rose	B	A	under ½″	P & B	41–4 21–13	50	
Rubus sp.	Blackberry	A	A	under ½″	P & B	82–5 82–11	100	
Rubus occidentalis	Black raspberry	A	A	under ½″	P & B	58–14 general	150	
Rubus strigosus	Red raspberry	A	A	under ½″	P & B	48–4 48–12	150	
Spirea tomentosa (intr.)	Steeple bush	D	A	under ½″	P & B	41–5 general	35	95% pruning
Strobus americana (intr.)	Mountain ash	D	A	under 2″	P & B	80–11 64–6	54	aver. ht. 8′ ***
Leguminosae *Amorpha canescens* (mostly intr.)	Lead plant	D	O	. . . .	. . . .	98–8 97–6	25	
Amorpha fruticosa (intr.)	Indigo bush	D	A	under 1″	P & B	64–7	38	***
Caragana arborescens (intr.)	Siberian pea tree	D	A	under ½″	P & B	64–7	16	aver. ht. 3′ ***
Gleditsia triacanthos (intr.)	Honey locust	D	A	under 1½″	P & B	80–11	55	aver. ht. 7′ ***
Gleditsia triacanthos f. inermis (intr.)	Thornless honey locust	D	A	under 1½″	P & B	80–11 64–7	12	
Robina pseudo-acacia (intr.)	Black locust	B	C	under ⅜″	P & B	80–14	50	

*** Indicates that the browsing was lethal to some plants.

TABLE 2 *(continued)*

Species	Common Name	Relative Abundance	Amt. of Damage	Size of Stem Browsed	Type of Damage	Location on Map	Plants Examined	Remarks
Rutaceae								
Ptelea trifoliata (intr.)	Wafer ash	D	C	under 1½″	B	64–5 64–12	25	aver. ht. 5½′
Zanthoxylum americanum.......	Prickly ash	C	O	....	....	97–10	100	
Anacardiaceae								
Rhus aromatica (intr.)	Fragrant sumac	C	A	under ½″	P & B	58–4 41–4	50	Only trace of barking
Rhus copallina (intr.)	Dwarf sumac	D	B	under ½″	P & B	64–6	10	
Rhus glabra.........	Smooth sumac	A	A	under 1½″	P & B	58–4 general	100	***
Rhus toxicodendron...	Poison ivy	B	A	under ⅜″	P & B	81–15 80–11	100	berries not eaten
Rhus typhina (intr.)..	Staghorn sumac	A	A	under 1½″	P & B	58–3 65–7	150	***
Aquifoliaceae								
Ilex verticillata (intr).	Winterberry	C	A	under ¼″	P	64–7 41–4	100	
Celastraceae								
Celastrus scandens....	Climbing bittersweet	C	B	under ⅜″	P & B	44–11 39–13	25	
Evonymus atropurpurens (intr.)......	Wahoo	D	A	under 1″	P & B	64–7	25	***

Aceraceae								
Acer negundo	Box elder	A	O	....	....	general	100	all sizes
Acer rubrum	Red maple	B	A	under ½″	P & B	82–11 80–11	100	***
Acer saccharum (intr.)	Sugar maple	B	A	under ½″	P & B	82–11 64–7	100	***
Acer spicatum (intr.)	Mountain maple	D	A	under ½″	P & B	64–7	20	
Rhamnaceae								
Ceanothus americanus	New Jersey tea	C	C	under ¼″	P	82–2 66–9	25	
Vitaceae								
Parthenocissus quinquefolia	Virginia creeper	B	O	....	....	81–15 80–14	35	
Vitis vulpina	Wild grape	B	C	under ⅝″	P & B	66–12 58–6	25	***
Tiliaceae								
Tilia americana	Basswood	D	A	under 1¼″	P & B	80–14 82–14	15	***
Cornaceae								
Cornus alternifolia (intr.)	Alternate-leaved dogwood	C	C	under ½″	P & B	64–6 58–13	4	
Cornus amomum	Silky dogwood	A	C	under ½″	P & B	39–15 64–7	100	
Cornus racemosa	Gray dogwood	A	B	under ½″	P & B	general	500	***

*** Indicates that the browsing was lethal to some plants.

TABLE 2 *(continued)*

Species	Common Name	Relative Abundance	Amt. of Damage	Size of Stem Browsed	Type of Damage	Location on Map	Plants Examined	Remarks
Cornus stolonifera....	Red-osier dogwood	A	C	under ½″	P & B	general	150	
Cornus stolonifera var. *flaviramea* (intr.) ..	Yellow-osier dogwood	D	C	under ½″	P & B	34–14	14	
Oleraceae								
Fraxinus americana.. (partly intr.)	White ash	C	D	under ¼″	B	64–7 80–11	100	aver. ht. 3′
Fraxinus nigra...... (partly intr.)	Black ash	C	D	under ¼″	P	64–7	100	
Fraxinus pennsylvanica, var. *lanceolata*.. (partly intr.)	Green ash	C	D	under ¼″	P	64–7	100	
Syringa japonica..... (intr.)	Japanese tree lilac	D	O	....	....	64–6	4	aver. ht. 7′, diam. 2″
Syringa villosa, josikaea, chinensis, persica, etc. (intr.)	Horticultural lilacs	B	D	under ¼″	P	64–6	50	
Syringa vulgaris..... (intr.)	Common lilac	D	C	under ½″	P & B	97–5 64–6	10	suckers browsed also
Rubiaceae								
Cephalanthus occidentalis (intr.).....	Button bush	C	C	under ½″	P & B	64–7 41–4	25	

Caprifoliaceae								
Lonicera tatarica (intr.)	Tartarian honeysuckle	A	B	under 1″	P & B	48–12 general	100	
Sambucus canadensis	Common elderberry	A	B	under ⅝″	P & B	general	100	
Sambucus pubens (intr.)	Red-berried elder	D	O	....	....	21–10 64–7	51	
Symphoricarpos occidentalis (intr.)	Wolfberry	D	B	under ¼″	P	64–7	23	
Viburnum dentatum (intr.)	Arrow wood	C	B	under ½″	P & B	41–5 39–13	50	
Viburnum lentago	Nannyberry	C	B	under ½″	P & B	39–14 general	125	***
Viburnum opulus (intr.)	Euro. high-bush cran-berry	C	A	under ¼″	P & B	41–5	50	
Viburnum opulus, var. sterilis (intr.)	Snowball	D	C	under ½″	P & B	41–3 34–14	5	
Viburnum prunifolium (intr.)	Black haw	D	A	under ½″	P & B	21–11	6	***
Viburnum pubescens (intr.)	Downy viburnum	C	D	under ¼″	P	41–5 21–11	21	
Viburnum trilobum (intr.)	Amer. high-bush cran-berry	B	B	under ½″	P	64–7 41–3	100	

*** Indicates that the browsing was lethal to some plants.

a relative classification. An abundant species is designated by *A*, moderately abundant as *B*, uncommon as *C* and rare as *D*. Likewise the amounts of damage are not uniform for all sections, and the column *amount of damage* uses the following classification: *A* for severe, *B* for moderate, *C* for slight, *D* for trace and *0* for none.

Type of damage is designated by two letters. *D* indicates debarking, which means the gnawing away of the outer bark and cambium, usually exposing the dead wood. *P* indicates pruning or nipping off of branches, twigs or young shoots and seedlings.

The two main areas where a species was examined are numbered and refer to locations on the Arboretum base map (Fig. 1).

Discussion

Why rabbits eat certain plants in winter is still a moot question despite scientific efforts to chemically analyze some of their food (Dalke and Sime 227:1941) and to pigeon-hole their feeding behavior. *What* rabbits eat in particular areas is known. There are, however, certain observations regarding winter feeding that are not experimentally tested, but which bear on the question of palatability.

The roughness of bark as previously discussed is known to inhibit browsing, but is this a mechanical difficulty, one of taste, or does the rabbit not know how to hull off the undesirable bark to get at the green edible material? I believe the rabbit incapable of the squirrel's ability to hull the non-edible covering of potential food.

Some smooth-barked trees remained untouched after an initial attempt at browsing. Other trees of the same species but smaller in diameter were severely gnawed, indicating that toughness (or hardness) of the bark discouraged browsing. This appears to be the rabbits' aversion to "hardtack" bark when smaller tender shoots are available.

A large diameter alone was of little consequence in preventing browsing. Mountain ash *(Strobus americana)* (Fig. 4) was girdled and killed when two inches in diameter, as was honey locust *(Gleditsia triacanthos)* (Fig. 5). In both cases the trees were six to eight feet tall. Some old, prostrate apple trees eight to ten inches in diameter were likewise severely browsed.

In the case of the brush-pile browsing also mentioned earlier, there is a possibility that green-cut twigs and branches that are allowed to "cure" become more palatable than in the green state.

Numerous instances point to the fact that once a plant is injured, for example by trampling or scuffing along a foot trail, it is very apt to be browsed. Sometimes the plant so scuffed may be inferior food, yet it will be lightly browsed, perhaps by different rabbits, for several successive nights. The inferior plant may never be severely damaged, nor will the same species close by be touched. It may be that this is "inquisitive browsing," or that the aroma released when the bark is broken makes the twig temporarily attractive. Red osier and gray dogwood and Tartarian honeysuckle are some of the more abundant poorer foods eaten after they have been injured.

A preference rating of winter foods is good only for the area in which it was made. Within the confines of the Arboretum there were two large areas (65–7 and 59–1) where the choice of wild foods was limited, and there gray dogwood was severely browsed. In the two nurseries (64–7 and 80–11) where the choice of plants was much greater, only a trace of gray dogwood browsing was recorded. Thus a survey of either section alone would have conveyed an erroneous impression.

This difference in preference between regions on a geographic scale is recorded in the literature. Hosley (1938 – cited by Sweetman), Todd (1927) and Trippensee (1938) found that arbor-vitae *(Thuja occidentalis)* was eaten, while Sweetman (1944) and the present study record it as untouched. Also Sweetman (1944), Dalke and Sime (1941), Hosley (1938) and Trippensee (1938) agree that smooth sumac *(Rhus glabra)* is only slightly browsed, but my observations substantiate Hendrickson (1938), who states that it is severely browsed.

Likewise, differences between years were noted by Dalke and Sime (1941) who showed that in a feeding experiment during the winters of 1937 and 1938 where penned rabbits were fed known quantities of twiggage from 24 species of woody plants, the preference varied considerably between the two years. In any feeding experiment there are of course numerous variables that influence preference; however, Arboretum field observations substantiate this preference variation between years. Such plants as red osier dogwood, red cedar and Tartarian honeysuckle are browsed in some winters and not in others. The severity of browse on certain species, for example plum, choke cherry, hickory and elm, also varies greatly between winters.

I further believe that in a year of high rabbit density and severe browsing, food preferences may be obscured because of food shortage. Or put another way, browse preferences may change with food availability.

Since evergreens are important from forestry, game cover and landscaping points of view, they were given particular attention. No debarking was noted on red pine *(Pinus resinosa)*, white pine *(Pinus strobus)* or jack pine *(Pinus banksiana)*, but needles of all three species were eaten in small amounts and the lower branches of some white and jack pines were pruned. Red cedar *(Juniperus virginiana)* and prostrate juniper *(Juniperus communis)* are trees very rarely if ever damaged by rabbits, but this winter they were severely browsed and pruned. Several hundred white cedars *(Thuja occidentalis* – average height eight feet) were untouched, as were five hundred white spruce *(Picea alba)* that average two feet in height. This is interesting in view of the fact that at the Faville Grove Wildlife Area at Lake Mills (Jefferson Co.), Wisconsin, 25 miles east of the Arboretum, white spruce could not be used for wildlife cover plantings because rabbits killed and stunted the trees by over-browsing.

To eliminate what was at first thought to be a weakness in other browse studies, namely the relative classification of the amount of damage, a numerical standard was worked out. This involved taking the percent of browsed stalks per 100 plants. This system if adhered to would have created an inaccurate picture. The percentages kept changing as more time was put on the survey and as more areas were covered; so that in the end I was certain that my relative appraisal was more reliable than the numerical values. I am now satisfied to accept the relative classifications of other observers as an "accurate" picture of rabbit browse for the year and area covered.

In short, I believe that experiments and field observations of rabbit feeding leave much to be desired in answering the question of "Why the differential palatability of winter foods?" The object of this report is to record the kind and amount of browse in a year of severe rabbit damage, and to interpret some of the Arboretum browse observations in light of rabbit abundance, cover and available plants.

Summary

During two winters of similar rabbit density and temperature, but dissimilar snow cover, rabbit browsing was much heavier during the snowy winter.

A browse tally of 108 woody species showed 41% severely browsed, 8% unbrowsed. Within a given species browsing ceased when the bark became rough. While not proven, toughness (hardness) of bark is likewise thought to inhibit browsing. Large diameter did not discourage browsing and the diameters at which woody plants were not eaten varied between species.

Prickles and thorns on plants had no hindering effect on rabbit browsing. In some species partial curing of cut twiggage seemed to increase the palatability. Scuffed shoots and branches along foot trails were readily browsed while the same species close by but not scuffed or broken was untouched.

Within a given species, palatability varies in different years.

Acknowledgments

Appreciation is expressed to Professor Aldo Leopold for editing the manuscript; to Professor G. W. Longenecker for aid with identification of horticultural plants; and to Professor N. C. Fassett for reading the manuscript and checking the taxonomic material.

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THE RUFFED GROUSE IN EARLY WISCONSIN

A. W. SCHORGER

The ruffed grouse during the period of settlement was commonly called "pheasant" or "partridge." The latter name prevails at the present time. La Hontan[1] was one of the first writers to mention this bird in the state. While at Green Bay in September, 1688, he was served two wood-hens *(Gelinotes de bois)* at a feast. Our ruffed grouse is closely related to the wood-hen, or hazel-hen *(Bonasa sylvestris)* of Europe.

Two forms of this bird have been described for the state by Aldrich and Friedmann.[2] *Bonasa umbellus medianus* is found in the southern part and *Bonasa umbellus togata* in the northern.

The ruffed grouse is a bird of the thickets and the margins of the forest. Where there has been little or no experience with man, it is surprisingly unwary. The "educated" bird, however, furnishes most difficult hunting. Eternal vigilance is required to obtain a shot. Where the cover is dense this grouse may disappear in a flash, or there may be only a roar of wings to indicate its former presence. In hilly country, as you toil up one slope the bird goes down the other. Also it has the reprehensible habit of allowing the hunter to walk past, then zooming away behind his back. H. W. Herbert,[3] a noted sports writer of a century ago, considered it too difficult to shoot to make good sport. A Milwaukee sportsman,[4] writing of the ruffed grouse in 1856, states that it is so difficult to secure that those obtained are killed incidentally by hunters while in pursuit of other game. He adds: "There is another peculiarity about him that is unpleasant to the sportsman. He seems to have no local attachments. You may find a place where the partridge abounds one day, and on the next you may hunt that same place all day and not find a single bird."

The paucity of early references to the ruffed grouse in Wisconsin shows that it was not favored by gunners. This condition changed as the other upland game birds became less plentiful, and eventually the hunting of the partridge was looked upon as a princely recreation. Van Dyke[5] appreciated fully the aesthetics of the sport, for he wrote: "Imagine a long, easy, sun-kissed slope in the most beautiful section of the magnificent 'Badger state'—time mid-afternoon. Half of this slope is gleaming stubble which rolls in sleepy, golden billows to a strand of dull crimsons and cooling bronze, where the waist-high scrub oaks and briars and dwarf hazels weave together, glowing like some huge rare rug of Orient spread over the everlasting hills. Beyond all this, stern ramparts of grim grey stone hearsed with sombre pines, beneath which trail heavy crimson banners of creepers, as though flung earthward in grief for the passing glory of the year. . . . Along a certain Wisconsin steep runs a peculiar step-like formation—a smooth pathway one third of a mile long. Upon one side and for many feet above rises a huge slope of forested rock, which, upon the outer side of the path, falls away into a dim ravine, so deep that only the tallest of its tree-tops rise above the level of the path. . . . The ruffed grouse love such places as they love the old logging roads and ancient trails."

Historical Review.

It is remarkable that none of the early travelers in northern Wisconsin recorded the ruffed grouse as abundant at any time. Henry[6] was at Michilmackinac, Michigan, in the fall of 1761. He states: "The neighboring woods abounded in partridges and hares. . . ." While on the Muskegon River, Michigan, in January, 1820, Hubbard[7] trapped daily from "one to a dozen partridges." Returning to Wisconsin, Carver[8] writes of "the brown, the red, and the black" partridges encountered in 1766. Presumably he refers to color phases of the ruffed grouse and to the spruce grouse. Few men had as good opportunities to make observations as did Schoolcraft,[9] yet he barely mentions the bird: an Indian boy on the St. Croix River was useful for killing partridges. Lapham[10] gives "the pheasant and prairie hen *(T. umbellus* and *T. cupido)*" as abundant in the woods and prairies of southern Wisconsin.

Rev. Ely[11] was a missionary in the Fond du Lac (Duluth–Superior) district from 1833 to 1854, and resided at Superior. Though he made numerous journeys overland, the ruffed grouse is seldom mentioned, and never as abundant. For example:

> December 15, 1835. Fond du Lac. "Almost daily Peter takes Rabbitts and occasionally Partridges."

April 30, 1839. Fond du Lac. "The shots we heard [from the north shore] were discharged at partridges. Henry had been hunting."

August 9, 1839. Between La Pointe and Fond du Lac. "Have had a couple of partridges to cook with them. Every day – 7th 2, 8th 1, 9th 2."

October 20, 1839. River St. Croix. "The boys brought 2 partridges."

October 20, 1846. West of La Pointe. "Killed two partridges."

The Lac Vieux Desert region was reported by Capt. Cram,[12] in 1841, to be "tolerably well provided" with partridges and other game. Mills[13] walked from Stillwater, Minnesota to Superior in the summer of 1856. The only game mentioned as killed were six partridges. Most observers were impressed by the scarcity of game on the southern shore of Lake Superior. The Indians subsisted largely on fish and provisions obtained from the traders. Andrews[14] reported in 1853: "Game has become exceedingly scarce in these thickly wooded regions, only a few bears, rabbits, and porcupines and some partridges being found in the woods. . . ." A party of four men that left Ontonogan, Michigan, on December 5, 1855, travelled by trail to Wausau, Wisconsin and reported that no game was found "except a few partridges."[15]

Owing to a better habitat provided by more open country the situation was entirely different in the southern half of the state. Fonda[16] states that "pheasants" were abundant along Bloody Run (Mill Coulee), near Prairie du Chien, in 1834. Rodolph,[17] who came to Lafayette County in 1834, mentions the drumming of the cock "pheasant" and that "the country was full of game; prairie chickens, partridges, quails, . . ." In 1837 Gen. Smith[18] visited southwestern Wisconsin and found that "pheasants also are in great numbers." That same year Keyes[19] came to Jefferson County, where game, including partridges, was abundant. Quarles[20] wrote quaintly from Kenosha County on February 14, 1839: "We have lived like heroes, a plenty of venison Racoon Patridges Prairie hens. . . ." The town of Taycheedah, Fond du Lac County, was settled in 1838. Among the upland game birds, "patridges" were found.[21] . . . In January, 1839, "wild turkies, partridges, . . ." were offered abundantly in the village of Milwaukee.[22]

Distribution.

The ruffed grouse formerly occurred in every county in Wisconsin. As would be expected, it was not common in the virgin coniferous and hardwood forests of the northern portion of the state. Lumbering eventually produced a wide range of desirable territory. The prairie regions with their "oak openings" in the central, southern, and western portions of the state provided good cover. Where the prairie escaped burning for a few years, thickets filled the border between the woods and the prairie. The forests that escaped burning were likewise filled with brush. Clark,[23] who came to Madison in 1840, wrote: ". . . almost the entire area of what is, at this day, the beautiful city of Madison, . . . was then, and for some years later, almost an impassable forest, with a dense undergrowth of young trees and briars, through which I used to make my way hunting for partridges, and other game, with great difficulty."

Settlement for a time improved and increased greatly the cover for ruffed grouse through decrease in burning. "Snap Shot"[24] wrote from Oregon, Dane County: "It sounds strangely to one who has hunted here off and on for ten years to hear that 'ruffed grouse are more numerous than quail in Wisconsin now'; but such is the fact. Ten years ago the quail whistled from every fence-corner while the 'partridge' was a bird you saw rarely and momentarily in the woods. Now the quail, sadly thinned out by the severe winters . . . while the ruffed grouse are growing more numerous every year. They are very plenty this season. . . . The cover here is getting to be abominable, a perfect tangle of scrub-oak, choke-cherry, wild crab-apple, hazel-brush, frost grape and a variety of briars, with now and then a little patch of tolerably clear poplar for relief."

"Atticus"[25] wrote from Racine in 1844: "Pheasants, or partridges as they are sometimes called, are killed in considerable numbers." In 1852, the ruffed grouse was reported by Hoy[26] as common in all the timbered districts of Wisconsin. A year later, Barry[27] considered this grouse abundant. By 1885 it had become scarce within twenty miles of Racine, though when Hoy[28] arrived there in 1845 it was abundant.

The western portion of Wisconsin remained for many years excellent territory for ruffed grouse. On February 13, 1869, Gibbs[29] wrote of the Lake Pepin region: "We hear the whirr of the ruffed-grouse frequently as we startle them from their thickets. In the fall of the year they are abundant in these woods, and a party camping near any of the creeks can have them for boiling at their log fire with little trouble . . . on Lost Creek . . . some years ago . . . in the month of October . . . these grouse were so plenty that while one of us was starting up the fire in the morning, another might take his gun, step into the thickets anywhere and return in fifteen minutes with enough for breakfast. In the evening, an hour or so before sunset, we could hear a noise like distant thunder occasioned by their flying down from the bluffs to feed upon the birch and alder buds along the bank of the stream. Last fall, too, they were reported to be very plenty in this neighborhood. . . . This grouse is called 'partridge' and 'pheasant' in the Northwest."

Ruffed grouse seem to be unable to exist on other than very large islands. Palmer[30] wrote in 1913 that this species was introduced successfully on Washington Island, Door County, Wisconsin, in 1900. Correspondence with residents of this island has resulted in the unsatisfactory information that there are a few to none to be found there at the present time. Madeline Island, one of the Apostle group, has an area of 22.5 square miles and is 1.8 miles distant from the mainland. I have covered this island on foot from end to end on several occasions and never saw a ruffed grouse. None of the inhabitants interrogated had ever seen one on the island. The sharp-tailed grouse is periodically common. It is highly improbable that a ruffed grouse could cover the distance of 1.8 miles except in winter and by resting on the ice. Blanford[30a] makes the preposterous statement that two birds flew from Hook Mountain to Sing Sing, a distance of 4.5 miles. No proof was offered.

Decline.

There are probably not more than six counties in the state where the ruffed grouse is now extinct. The decline began about 1870 in the southern portion of the state. This year the open season was shortened a month for the eleven southernmost counties. The chief factor in the decline was, and continues to be, grazing. Kumlien,[31] in 1891, said of this grouse: ". . . in all settled parts of the state it is steadily diminishing in numbers. The most deadly enemy of this bird is the skunk which has increased in numbers within the last quarter century." A more correct appraisal was made in 1903: "Common resident in favored sections of the south and central parts of the state, and almost abundant in some of the northern counties. The gradual clearing up of underbrush and tangled thickets, and the pasturing of woodland lots have driven the 'partridge' from many of its old haunts."[32] Hollister,[33] in 1919, reported that it had been extinct at Delavan for five or six years. He doubted if any were to be found in Walworth County. Extinction was attributed to the pasturing of woodlots and to cats.

The rate of the decline is difficult to estimate due to the failure to recognize cycles. In 1870, it was said for the vicinity of Watertown:[34] ". . . occasionally partridges were to be met within our timber lands . . . but now, we understand, the partridges have become almost extinct"; however, in 1874 they were "pretty plentiful" in Watertown[35] at fifty cents a pair.

There are few data on which to determine the population density at any one period. In the summer of 1877, King[36] made a census of birds along four routes near Whitewater, Jefferson County. No ruffed grouse were reported for three of the routes, while ten were found on the fourth route covering a distance of three miles. If these birds represented a single covey, a sparse population is indicated. In 1902 it was estimated that there was a pair of ruffed grouse "for nearly every piece of woods of ten acres or more in extent" in Sheboygan County.[37]

Migration.

It has been recognized for over a century that there was a fall movement of the ruffed grouse in considerable numbers. It is a moot question if this movement should be considered a migration in the sense that there is a return of a portion of the population from more than an insignificant distance. Until more is known about the phenomenon, it is safer to look upon it as a redistribution. Audubon[38] wrote: "The Ruffed Grouse, although a constant resident in the districts which it frequents, performs partial sorties at the approach of autumn. These are not equal in extent to the peregrinations of the Wild Turkey . . . but are sufficiently so to become observable during the seasons when certain portions of the mountainous districts which they inhabit become less abundantly supplied with food than others. These partial rovings might not be noticed, were not the birds obliged to fly across rivers of great breadth, as whilst in the mountain lands their groups are as numerous as those which attempt these migrations; but at the north-west banks of the Ohio and Susquehanna rivers, no one who pays the least attention to the manners and habits of our birds, can fail to observe them. The Grouse approach the banks of the Ohio in parties of eight or ten, now and then twelve or fifteen. . . . This usually happens in the beginning of October. . . . In the month of October, 1820, I observed a larger number of Ruffed Grouse migrating from the States of Ohio, Illinois and Indiana into Kentucky, than I had ever before remarked. During the short period of their lingering along the north-west shore of the Ohio that season, a great number of them was killed, and they were sold in the Cincinnati market for so small a sum as 12½ cents each."

It was believed that the ruffed grouse was partially migratory at the approach of winter, the birds leaving the hills for more sheltered situations in the lowlands. Nuttall,[39] in travelling nearly the length of New Hampshire, in November, 1831, did not see a single grouse and assumed that the migration had taken place.

There is no reliable information on the maximum distances that the ruffed grouse cover in the autumn movement. Herbert[3] makes the bold statement that single birds or small groups will wander ten to twelve miles entirely on foot. Schley[40] did not believe that the species was migratory, or that the autumn movement was either extensive or general. Rarely, he found a bird two or three miles from woodland, on one occasion four miles from any woods or thickets. In Manitoba, on October 14, 1884, Thompson[41] shot "a large full plumaged male partridge on the open prairie, at least a mile from cover of any kind."

The cause of the autumnal wanderings, in the opinion of Van Dyke,[5] might be due to the retention of a trace of an old instinct to migrate. On several occasions he found single birds within the limits of the town in which he resided, a mile and a half from the nearest possible grouse cover. According to Brewster[42] it was commonly believed in the Lake Umbagog region of Maine that the species "came and went at infrequent and irregular intervals." He gives several examples of mass movements. On one occasion, prior to 1870, one of his guides shot a ruffed grouse. At the report of the gun, so many birds arose that the woods seemed filled with them. When followed, they all travelled southward in successive flights.

"Crazy Flight."

The appearance of ruffed grouse in unusual places is a part of the fall redistribution. One of the most sensible views of this movement is that of Eaton:[43] "In the fall, just before the trees drop their leaves, there is a dispersal of grouse in all directions from the locality where they were reared. They then appear in unusual places. . . . At this time of the year, many suppose that grouse become bewildered, and they certainly exhibit strange instincts at this season. . . . I am inclined to think that grouse at this season are not afflicted by any nervous disease, but have an instinct to wander into new localities, an impulse which is of value to the species in restocking depleted coverts, and in introducing new strains of blood in different localities, thus maintaining the vigor of the breed."

Several other explanations have been offered to account for the "crazy flight." It is a quite old observation that the ruffed grouse shows sexual activity beyond the breeding period. Kendall[44] wrote: "It was in October, I think, at any rate in the fall of the year, that I once observed a male Grouse treading a hen." The opinion has been advanced by Clarke[45] that the persistence of this sexual activity may be the cause of the abnormal fall flights. If the flights were produced by sexual stimulus, it is logical to assume that there would be more cases in spring than in fall; however, spring occurrences have been recorded rarely. In the spring of 1911 a partridge flew through the window of a church at Jordan Station, Ontario.[46] Gross[47] mentions an adult male that struck a building in New Brunswick, Maine, on April 14, 1924. Only two cases occurring in spring were found for Wisconsin.

A few wandering grouse were examined by Gross[47] and found to contain helminth parasites. He suggested that parasitism might cause the peculiar behaviour. Much more data is required to establish this affliction as a cause.

The flight seems to be due to an innate urge to disperse in autumn. Only a given density of population is tolerated. Clarke[45] considers it normal for the family group to persist throughout the winter. The evidence is rather to the contrary. This grouse will frequently assemble to roost, or to feed in the morning and evening, yet remains more or less solitary throughout the day. Eaton[43] mentions that the broods disperse for the winter. At

6.00 A. M. on the morning of March 9, 1902, Brewster[42] watched nine grouse in an apple tree that they had selected for budding in his orchard at Concord, Massachusetts. They left one or two at a time "but in three or four different directions, thus indicating that they had come from divers places."

Ruffed grouse were extremely abundant in Outagamie County, Wisconsin, in the summers of 1882 and 1883; yet in winter Grundtvig[48] found them "only singly." In the fall of 1883, the following note from Lacon, Marshall County, Illinois, appeared: "The ruffed grouse are very much more plentiful in this immediate vicinity this autumn than at any time since their first appearance here about 25 years ago, yet next year at this time they may have almost entirely disappeared, though none may have been shot. Right now here they are having what is known as 'crazy grouse times,' i.e., the coveys have separated, and individuals are liable to be found anywhere, even in town."[49]

There is a far greater shifting of the population, even when it is sparse, during the nonbreeding season than is generally assumed. In my journal is the following entry for January 7, 1928: "There must be some movement of this species for I do not find them near town [Madison] except in winter." Data on spring flights are few in comparison with autumn, as would be expected in view of the winter mortality. King[50] gives a winter loss of 20 percent for certain areas in Minnesota, while on two areas in New York the adult losses from September, 1936 to September, 1937 were 63.5 percent and 45.4 percent, respectively.

The best data on the spring shift are given by Bump.[52] An area of 500 acres of good grouse cover contained 40 grouse in the fall of 1933. By April, 1934 the population was reduced to four by intensive hunting. Though the area was entirely surrounded by open land for a distance of 800 feet, except for a small tongue of brush, 12 grouse had moved into the area by the end of the first month. A census showed 83 grouse present on the area on the first of September.

There are some data available on the carrying capacity of grouse habitats, or what may be called the density of population tolerated by the species. King,[50] after a study of seven years' duration found that the maximum breeding population was one bird for four acres. In New York, Edminster[53] found the saturation point to be a bird to four acres. He adds: "In every case where this density was surpassed in early fall, immediate reaction set in in the form of dispersion and accelerated decimation."

Particularly pertinent are the findings of Errington[54] on the winter-carrying capacity of marginal grouse territory in southern Wisconsin. One bird required from 15 to 200 acres in various areas in Dane County and six acres in the Baraboo Hills, Sauk County. Assuming an extreme case, that ten members of a brood survived until fall in Dane County, it is to be expected that in the trial and error search for suitable wintering grounds, the excess grouse will wander to considerable distances, and some will be found in unusual places. It is doubtful if, in poor grouse territory, more than a fraction of the dispersed birds will survive the winter.

The age of the "crazy" birds has been recorded in only a few instances, but both old and young birds have struck buildings. Forbush[55] quotes E. S. Thompson as saying that the trait is shown by young birds during the first season, occasionally in the second,* but never afterwards. Normally there are more young than adult birds in autumn; so it is to be expected that the majority of the birds showing this behaviour would be young of the year.

The ruffed grouse is not as skillful in avoiding obstacles in the wild as is generally supposed. Every observant hunter will recall hearing the sound produced by the wings striking twigs. Forbush[55] saw a grouse strike a limb and fall to the ground. He mentions a case where a grouse impaled itself on the broken end of a dead limb. Most villages appear like an inviting forest to a grouse approaching from a distance. Naturally it would be confused greatly by buildings with which there is no background of experience and which it is not structurally fitted to avoid. The short, broad wings are suited only for short, rapid, direct flight. It has a wing area of only 1.02 sq. cm. per gram of body weight, rendering it elephantine in maneuverability in comparison with a bird like the pigeon hawk *(Falco c. columbarius)* having long, pointed wings, and a wing area of 2.37 sq. cm. per gram of body weight.[56]

There are many references in the literature to the appearance of grouse in unusual places, and striking buildings and

* No reliable method is known for determining the age of a ruffed grouse after it is one year old.

other objects in autumn. Appendix 1 contains about 80 cases found for Wisconsin. In three or four instances the bird was given as a prairie chicken, obviously in error. The cases are given in some detail for the purpose of furnishing data for further analysis of this behaviour when additional information becomes available.

Analysis of the Wisconsin data shows that:

1. The flights extended from September 17 to November 16, the majority during the first half of October.
2. Where the time of day is given, the flights occurred in the morning and evening.
3. There is a tendency for more cases to occur in years of a high population than in a low.
4. Spring "crazy flights" are comparatively rare and take place in April.

Our knowledge of the subject may be summarized as follows:

1. The initial fall dispersal appears to be due to population pressure. It is similar to that of the quail when its population is high.[57] Owing to the unevenness of grouse populations, areas may exist in every year where there is population pressure.
2. There are insufficient data to show that either sexual activity or parasitism is a factor in the dispersal. Neither would account for the similar behavior of quail.
3. There is more or less shifting of the population throughout the year except during the nesting period.
4. The greater number of "accidents" during the fall may be attributed to greater activity and poorer visibility due to the presence of foliage.

Food.

The diet of the ruffed grouse is decidedly varied. Its food habits in Wisconsin and elsewhere[58] have been investigated extensively. King[59] did the pioneer work in the state: "Of six specimens examined two had eaten twenty-four caterpillars; one, the grub of a beetle; one, two grasshoppers; one, seven harvestmen; one, fruit; one, foliage; one, seeds; one, partridge-berries; and three, buds." A chick, approximately a week old, had eaten 13 caterpillars, the grub of a beetle, and seven harvest-men.

King[59] mentions that an adult bird taken in October had eaten 304 buds of the white birch. The observation that budding begins in Wisconsin in October, while other foods are available, was also made by Grange.[60] He noticed that the grouse began to bud at dawn, or just before, on very cold mornings, and states: "It would almost seem that the colder the morning, the earlier the breakfast of the ruffed grouse." Evening feeding is prolonged to twilight.

There is no reference to injury to fruit trees in Wisconsin. Maynard[61] took 180 apple buds from the crop of a bird shot at 10.00 A. M. Weed and Dearborn[62] state: "In isolated cases ruffed grouse cause some damage to fruit-trees by eating the buds in winter. The extent of the injury which a grouse is capable of doing in a season may be estimated from the contents of a crop examined by us. It was taken from a female shot in January, and contained 347 apple-tree buds, 88 maple buds, and 12 leaves of sheep-laurel. This was of course a single meal, and, as two such meals are eaten per day, it must be reckoned as half the daily consumption." Based on observations at Concord, Brewster[42] was of the opinion that the budding of apple trees was not harmful. In fact, the operation prevented the trees from overbearing, so that they yielded a crop of apples annually instead of every other year.

Some stomach examinations of Wisconsin birds were made by Bennetts.[63] The gizzards of two birds collected in Washington County on September 6, 1899, contained the seeds of: *Prunus serotina,* wild black cherry; *Gramineae,* probably *Andropogon sorgum; Rhus vernix,* poison sumac; *Cornus asperfolia,* rough-leaved dogwood; *Viola obliqua* Hill, hooded blue violet.

The stomachs of 14 birds taken in Barron County between November 10–20, 1899 contained no insect remains, though the stomachs of insectivorous birds collected at the time were filled with them. They contained: seeds of *Rhus hirta* L., staghorn sumac; *Thuja occidentalis,* arbor vitae; *Morus rubra,* red mulberry; *Liliaceae,* some member of; *Polygonum dumetorum,* hedge buckwheat; *Mitchella repens,* partridge berry; *Smilax,* sp.; *Crataegus crus-galli,* cockspur thorn; *Cruciferae,* sp.; both fertile and sterile catkins of *Betula lutea,* yellow birch, and *Betula papyrifera,* paper birch; leaves of *Fragaria canadensis* Mich., northern wild strawberry, and *Hepatica triloba,* round-leaved hepatica.

The crops of ruffed grouse taken in northern Wisconsin in the fall of 1914 were found by Betts[64] to contain the catkins of hazel (apparently *Corylus rostrata*); and of ten birds collected in Chippewa County, November 25–28, 1915, seven had eaten the pods of the hog peanut (*Amphicarpoea*), that was abundant. The crop of one bird contained: 37 pods of *Amphicarpoea*; 130 seeds of *Amphicarpoea*; 105 small reddish leaf buds; 17 seeds of *Desmodium*; 36 green leaflets of clover; three green leaflets of strawberry; one leaf and one berry of wintergreen; the remains of an insect; and one small pebble.

Gross[65] reported on the examination of the crops and stomachs of 1055 ruffed grouse, of which 32 came from Wisconsin. Vegetable matter from 129 sources constituted 98.57 percent of the food eaten by birds taken in October, November, and December. Regardless of the season, animal food is of minor importance to the adult grouse.

The ruffed grouse is not listed by Guthrie[66] among the birds that eat snakes. One shot at Green Bay,[67] Wisconsin, September, 1867, was found to have eaten a snake seven inches in length. It has been stated that in Maine it is common for this grouse to eat snakes.[68] Roberts[69] cites a case of a ruffed grouse that choked to death in its attempt to swallow a garter snake.

The ruffed grouse is so accustomed to a vegetable diet of low nutritive value that a food problem occurs but rarely. During the winter months when snow covers the ground, it subsists on the buds and tips of twigs of various trees, a source of food that is always readily available except after a heavy sleet storm.

Weather.

The oldest and commonest explanation offered in Wisconsin for a low ruffed grouse population was a cold, wet spring that caused the sitting bird to abandon its eggs or "drowned" the young. It is now known that young grouse cannot be reared successfully without insect food. A cold, wet spring that restricts insect activity to the point where few are available results in a low survival of the young birds.

The ruffed grouse is about as weather-proof as any of our birds. The chief source of mortality is imprisonment by a crust that forms on the snow under which the bird has gone to roost. Reports of casualties of this nature are numerous; however, Clarke[45a] mentions that only seven of his correspondents had actually seen grouse killed in this manner. There are statements from Hudson[70] and Richland Center[71] that the winter of 1872–73 had been very severe on partridge and other small game, and that some had been killed. A thaw followed by a freeze in January, 1888, is said to have killed large numbers of partridge and other grouse in the northwestern part of the state.[72] The following statement appeared at Grand Rapids (Wisconsin Rapids):[73] "Word comes to us that a great many partridges, prairie chickens and grouse are found beneath this heavy crust dead. It is thought that the first night it froze so hard . . . they were unable to extricate themselves in the morning and died. These facts were obtained from men residing on the cranberry marshes." The same condition prevailed at Friendship[74] and Eau Claire.[75] It has been questioned if ruffed grouse are ever caught in this manner.[76]

Some information on mortality of ruffed grouse in Wisconsin due presumably to severe winter weather, or to a sleet storm (in 1917) was collected by Leopold.[77]

In February, 1922 there was a severe storm in northwestern Wisconsin. A thunderstorm on the 19th was followed by zero weather on the evening of the same day in Outagamie County. The afternoon of the 21st there was a blizzard with sleet and snow that lasted through the 23rd. Four partridges that had died from starvation were found in Center Swamp near Appleton on March 1, and others were found subsequently. Hundreds were reported near starvation. Birch trees were cut down and the ice knocked from the branches to expose the buds. The birds are stated to have gone to the fallen trees in large numbers.[78] Barber[79] published a photograph of several of the dead birds.

An interesting case is mentioned by Clarke[45a] of a bird that had eaten such a large quantity of wet buds that the crop was extended beyond the ability of the feathers to cover the bare skin. The crop and its contents were frozen. During severe weather this species can succumb to cold when occupying an arboreal roost. Two birds were found frozen to death on the Presidential Range, New Hampshire, a crust preventing them from burrowing into the snow.[80]

The death of partridges from a hail storm on July 5, 1871, in Sauk County, must be considered as very unusual.[81]

Cycles.

It is an old observation that ruffed grouse have years of scarcity and abundance. Phillips[82] mentions that New York had a closed season as far back as 1708, and Massachusetts in 1818.

His inference that "colonial legislators were concerned with cyclic scarcity just the same as they are now" is hardly justifiable. Any clear-cut idea of a grouse cycle as understood today did not appear until the latter half of the past century. In 1883 the following concrete statement was published: "The periodical disappearance of the ruffed grouse is a topic of much animated discussion. . . . We have noted the facts for forty years, but an explanation of them is yet to be found. In a certain locality where the birds have been abundant the supply will begin to decrease, and in three or four years the game will have become almost extinct. Then the number will gradually increase, and in time the shooting will be good."[83]

There began to appear about 1880 a series of sporadic attempts to discover causes for the death or decline of this grouse. Many explanations have been offered. Webster[84] thought that the young birds were destroyed by the larvae of the hippoboscid fly, *Olfersia americana* Leach. An observer reported that grouse were very scarce in western Ontario in 1883, where they had been plentiful two years previously, and suggested that the decimation was caused by some disease.[85] Grinnell[86] reported the occurrence of avian tuberculosis in a Wisconsin ruffed grouse that had died after a confinement of six weeks. The ideas were advanced by Widmann[87] in 1907 that the decline of the ruffed grouse in Missouri might be due to the chigger (*Trombidium*); or that the old custom of burning the forest was responsible for an undesirable habitat.

The great scarcity of grouse in the northeastern section of the United States in 1907 drew considerable attention to the phenomenon. Burns[88] mentioned that the species reached a peak in population in Pennsylvania in 1906. Very few eggs hatched in the spring of 1907 and sitting birds died on the nest from a disease resembling roup. A special report was prepared by Woodruff,[89] who gave the following probable causes:

1. Unusual abundance of foxes, and especially goshawks during the winter of 1906–07.
2. Extremely cold, wet, late spring of 1907 that impaired the vitality of adult females and young.
3. An epidemic of some disease, or parasite, or both.

No better explanations than the above were advanced by Forbush.[90]

At this time the goshawks fed largely on ruffed grouse in Rhode Island,[91] and probably other places where grouse were plentiful. Hunters are fond of something as tangible as "vermin" to account for a decline, but sufficient data have been accumulated within recent years to show that predators are practically without influence on the cycle.

It was observed in the autumn of 1886 that the prairie chickens shot at Plover, Wisconsin, had an unusual number of "wood ticks" on their necks.[92] This grouse reached a low in the cycle the following year. Brewster[42] considered the tick the most destructive agent to ruffed grouse. He was convinced that the ticks killed the young birds by piercing their tender skulls, but this seems highly improbable. In this connection I have been told by old residents of northern Wisconsin that wood ticks are much more plentiful now than they were formerly. The tick also has its ups and downs. Mrs. Kinzie's[93] party landed on an island at the northern end of Lake Winnebago in July, 1832 and was soon driven out by the "myriads" of wood ticks.

The first direct evidence that ticks could produce disease in grouse was obtained by Parker and Spencer.[94] They induced an infection in blue grouse with the tick *Haemaphysalis leporis-palustris,* a carrier of tularemia. Green and Wade[95] inoculated ruffed grouse in Minnesota with a strain of *Bacterium tularense,* obtained from a human case of tularemia, and found that the birds died within three to nine days.

There is confusion regarding the species of tick that occurs most frequently on the ruffed grouse. *Haemaphysalis cinnabarina* is thought to have mainly avian hosts. In 1926 Allen and Gross[97] reported this tick as occurring on ruffed grouse in Maine, Michigan, and Alberta. Clarke[45b] could not positively identify any tick other than *H. cinnabarina* on the grouse taken in Ontario and Manitoba. The rabbit tick, *H. leporis-palustris,* has been considered the parasite occurring on ruffed grouse from Wisconsin, Minnesota, and westward. In 1932 Gross[96] stated that *H. leporis-palustris* had been collected from birds taken throughout the range of the ruffed grouse. *Haemaphysalis cinnabarina* and *H. punctata* were found less frequently. The two chief species have been found on both birds and mammals. I have been informed (*in litt.*) by Dr. C. L. Larson, U. S. Public Health Service, that the two species can be differentiated clearly.

The ruffed grouse seems to be subject to most of the endoparasites, ectoparasites, and bacterial diseases to which avian flesh is heir.[96] The decline is due to the very low survival of young birds. Clarke[98] believes that the "die-off" is due mainly to the bacterium, *Leucocytozoon bonasae.* It is impossible at the present time to point with certainty to a single disease, or to a single other agency, as a cause of the periodic decimation.

An interesting attempt was made in the state of New York to correlate the weather conditions with the major declines. The conclusions were: "Analyses of the weather records reveal that, with respect to years of major decline, unusually severe conditions of temperature and precipitation occurred during February and March of the preceding year, and that during the year in question June temperatures, particularly in the first half of the month, were well below normal. In years of minor shortage, the same combination of conditions was involved, but the degree of severity was less or in reverse order. It is significant that each time this combination of conditions occurred in successive years a grouse decline occurred, and that every time a grouse decline occurred these weather conditions prevailed. While it does not seem logical that this correlation should be accidental, the mechanism by which it might operate to affect grouse is quite obscure. In any case local weather variations from normal certainly are not the primary causes."[99]

Neither the rapidity nor the severity of the decline is uniform. Phillips[100] mentions that the decline is more severe in primitive areas than in partly cultivated regions, a statement in which Leopold[77a] is in agreement. The die-off, however, hits peak and sparse populations alike.[50] This indicates that some disease is endemic in all grouse populations and that a period of approximately ten years is required for a lethal stage to be reached.

The decline is generally abrupt the first year and continues for two additional years, but an apparent low may be reached in two years. One of the New England grouse investigations was begun because of a "depression cycle that started very abruptly after an apparently successful breeding season in 1924."[100] A hunter wrote from Appleton, Wisconsin, November 10, 1890: "Some two weeks ago I took a few days' outing for partridges (ruffed grouse), and went to a section where two years ago there were thousands. With the aid of a pair of very lively cockers I could not find an average of three in a day in the very finest cover."[101]

It has been satisfactorily demonstrated that shooting does not influence the grouse cycle.[50] The winter losses in the Lake Superior region varied from 45.4 to 70 percent, in all cases except one being above 50 percent. Hunters took only 33 percent of the birds on eight sections of the Superior National Forest.[102] In the state of New York a three-year survey showed a smaller density of population for the refuge area than for the public shooting ground area.[103] Fisher,[104] in Michigan, found that the number of birds killed by hunters did not exceed on the average 14 percent of the population.

Length of Cycle.

The first systematic attempt to determine the length of the grouse cycle was made by Criddle.[105] He found that the pattern of fluctuation of the ruffed grouse differed only slightly from that of the sharp-tailed grouse. Leopold and Ball[106] considered that the fluctuations of the three species of grouse, including the prairie chicken, took place simultaneously. Clarke[45c] subscribed to this opinion since there was no evidence that the cycle varies for the different species in the same locality.

The length of the cycle was found by Criddle[105] to vary from nine to 11 years. This finding was confirmed by Clarke[45d] for the ruffed grouse of Ontario. Bump[107] compiled all the information available for the northcentral states. From the admittedly insufficient date, he found the following:

Abundant	*Scarce*
1880–83	1884–85
1887–89	
1892	
1901	1907–08
1911–13	1917
1919–24	1927–30
1931–33	

He concluded that the median of periods of abundance may fall eight to 13.5 years apart. Similar data for the northeastern states showed the median period of abundance to be 12.2 years. However, in the state of New York[99] major declines were noted in 1896–97, 1907, 1916–17, and 1927, with minor scarcities in 1904 and 1924. This shows a quite uniform cycle of approximately ten years in length. The data on the annual kills in Pennsylvania[108] for the years 1915–1942 do not show a well-defined low or high for the period 1930–1942.

The data at present available are insufficiently extensive and reliable to prove that the cycle is even as regular as nine to 11 years. On the basis of Clarke's[45e] data, Fallis[109] states that a peak was to be expected in Ontario in 1941; however, no well-marked peak year was shown from the information collected from 1935 to 1943. The "highs" ran from 1938 through 1941 in various parts of the province. This indicates that maximae and minimae for the four regions in Ontario vary considerably more than the one to two years stated by Clarke.[45f]

The Cycle in Wisconsin.

A study of the cycle of the ruffed grouse in Wisconsin from 1880 to 1929 was made by Leopold,[77b] who obtained the following highs and lows for that portion of time where the present study overlaps:

High	1880–85	1891	1897	1901–02	1907	1912
Low	1886	1895	1899–1900	1905	1908	1919

A summary of the status of the ruffed grouse in Wisconsin from 1839 to 1908 is given in Appendix 2. The data prior to 1850 are too few to be of value in determining the length of the cycle. In the previous study of the prairie chicken and sharp-tailed grouse[110] it was comparatively simple to determine the lows, but not the highs; with the ruffed grouse just the reverse is the case. Hunting the ruffed grouse, in comparison with gunning for prairie chickens, was not nearly so popular. The fewer the ruffed grouse, the fewer the statements to be found. As it increased in numbers it received a corresponding increase in attention. For example, during the high of 1887 there were 25 favorable statements, one "fair," and one unfavorable as to the number of birds; and for the 1898 high there were 25 favorable, one "fair," and five unfavorable reports. During 1888, 1889, and 1890 the number of favorable statements decreased to 14, 5, and 3 respectively. One of the great difficulties in attempting to determine the lows, aside from the paucity of reports for those years, is that from 1854 to 1907 there was seldom a year when there were not one or more statements that ruffed grouse were plentiful or "more numerous than usual." This shows the unevenness of local populations.

Below are given the years showing highs for the ruffed grouse, and for comparison the lows of the prairie chicken:

Ruffed Grouse Highs

1857	1866	1877	1887	1898	1906

Prairie Chicken Lows (Schorger)

1857	1867	1878	1887	1897

There is uncertainty as to the accuracy of the year 1857. It was selected because the population appeared to be at a high level for the period 1854 through 1857; also it was reported as "abundant" at Madison and in the Milwaukee market during the winter of 1857–58. In 1866, when there was a definite high for the state, "an uncommonly large number" of ruffed grouse were offered for sale in Madison.[111] This gives a cycle of nine years for Madison for this particular period.

The data show an eight to 11-year cycle for the ruffed grouse and a nine to 11-year cycle for the prairie chicken. Leopold[77b] had to depend largely upon the memories of the men whom he contacted for his early data, and up to 1897 they vary considerably from contemporaneous accounts. His 1901–02 highs were evidently minor bulges. My data show a decided decrease in 1899, a rise from 1900 through 1902, then a minor decrease in 1903, followed by a rise to a peak in 1906.

The kills of ruffed grouse in Wisconsin during recent years were:

Year	*Grouse*	*Year*	*Grouse*
1931	38,885(?)	1939	144,002
1932	317,007	1940	256,804
1933	318,410	1941	353,461
1934	131,762	1942	421,728
1935	72,778	1943	354,448
1936	Closed	1944	138,106
1937	Closed	1945	Closed
1938	71,489		

The data show a cycle of nine years between the peaks that occurred in 1933 and 1942. The peaks are less definite, however, than the years of sharp decline, 1934 and 1944, that show a ten-year cycle. The extremely "spotty" nature of ruffed grouse populations is now fully recognized. In order to arrive at the length of a cycle with any degree of accuracy, it is necessary to collect data for a long period of years in a great number of localities covering an area the size of a commonwealth. The annual kills, if collected consistently, will probably furnish as good information as can be obtained.

It seems quite improbable that in Wisconsin the cyclic decline of the ruffed grouse has been coeval with that of the prairie chicken and sharp-tailed grouse. Opinions collected by Leopold[112] were about equally divided between the prairie chicken and ruffed grouse being the first to die off. Wherever a direct comparison was found, ruffed grouse were usually reported plentiful and prairie chickens scarce. This statement holds for Mineral Point, 1886, Sparta, 1887, Ladysmith, 1903, and Solon Springs, 1904.[113] Comparison of the cyclic highs of the ruffed grouse with the cyclic lows of the prairie chicken, as given above, shows that in every case the prairie chicken die-off occurred first.

APPENDIX 1

WISCONSIN RECORDS OF RUFFED GROUSE FOUND "OUT OF BOUNDS"

1870

On September 29, one alighted on a store in Portage.[1]

[1] Portage *Register* Oct. 1.

1873

On October 10, a ruffed grouse smashed a glass over a quarter of an inch in thickness in a store on Main Street in Madison and was killed.[1]

[1] Madison *Democrat* Oct. 10.

1874

On September 28, one alighted in an open window of the court house in Green Bay.[1]

Early in October, partridges "were carelessly fooling around private residences within the city limits" of Grand (Wisconsin) Rapids.[2]

[1] Green Bay *Advocate* Oct. 1. [2] Grand Rapids *Reporter* Oct. 8.

1877

Early in October, one flew through the window of a jewelry store in Geneva.[1]

Another was found, the end of September, associated with a flock of chickens at Janesville.[2]

Early in October, one flew through two panes of glass in a restaurant at Eau Claire.[3]

[1] Lake Geneva *Herald* Oct. 1. [2] Janesville *Gazette* Sept. 27. [3] Eau Claire *Free Press* Oct. 4. [4].

1882

On October 26, a bird was killed by striking the shutters of a house at Melrose, Jackson County, "in a heavy fog."[1]

On September 20, a "young partridge" flew into a meat market at Peshtigo and was captured.[2]

The latter part of September, one was killed by striking a house in Stevens Point.[3]

[1] Black River Falls *Banner* Nov. 3. [2] Marinette and Peshtigo *Eagle* Sept. 23. [3] Stevens Point *Gazette* Sept. 20.

1883

In October, a "partridge" was found perched on a window sill in Augusta.[1]

On September 28, a grouse struck the window of a residence in Oconto, "scattering the glass a distance of 22 feet."[2]

Early in October, partridges were found in the shade trees in Grand Rapids.[3]

[1] Eau Claire *Free Press* Oct. 25. [2] Oconto *Reporter* Sept. 29. [3] Grand Rapids *Tribune* Oct. 6.

1884

In the fall several birds appeared in the business section of Neillsville, and two of them flew through windows.[1] On November 9, one broke a window, and its neck, in a shop at Neillsville.[2]

The end of September, one was caught in a barn at Elkhorn.[3]

On April 18, one broke a window in an office in Menomonie.[4]

[1] Neillsville *Times* Nov. 11. [2] Neillsville *True Republican* Nov. 13. [3] Elkhorn *Independent* Oct. 2. [4] Menomonie *News* April 19.

1885

In September, one was shot from a tree in the yard of a residence in Plover.[1]

At dusk on the evening of October 22, a partridge was discovered in a cellar in Green Bay.[2]

On September 20, one broke the window of a residence in Portage and fell at the feet of the owner as he sat reading.[3]

On October 8, a "full grown partridge" broke a window in a residence in Fort Atkinson.[4]

[1] Stevens Point *Gazette* Sept. 23. [2] Green Bay *Gazette* Oct. 24. [3] Portage *Democrat* Sept. 25. [4] Fort Atkinson *Union* Oct. 16.

1886

The end of September, a "pheasant" was found sitting on a sign on High Street, Mineral Point.[1]

On October 14, one flew through a "double-plate pane of glass" in a residence in Menasha.[2]

On October 25, one broke a window in a residence in Green Bay: "This is not the first one we have heard of in town this season."[3]

No less than five partridges, early in October, were killed or captured by flying against or into residences in Elkhorn.[4]

[1] Mineral Point *Tribune* Sept. 30. [2] Green Bay *Advocate* Oct. 21. [3] *Ibid* Oct. 28. [4] Elkhorn *Independent* Oct. 14.

1887

Early in October there were four cases of grouse striking or entering buildings in New Richmond.[1]

The middle of October, one was killed by striking a window in Portage.[2] It is recorded that on November 16 a "wild partridge," in attempting to dodge a man in the yard of the court house at Portage, struck a tree and was killed.[3] This is an exceptionally late date.

On October 20, one was captured alive in a structure on the square of the court house at Kewaunee.[4]

Early in October, one struck a window and was killed in Oshkosh.[5]

During the second week in October, several grouse appeared within the city limits of De Pere.[6]

The latter part of October two struck houses in Elkhorn.[7]

[1] New Richmond *Republican* Oct. 12. [2] Portage *State Register.* [3] Portage *Advertizer* Nov. 16. [4] Kewaunee *Enterprise* Oct. 21. [5] Oshkosh (w) *Northwestern* Oct. 13. [6] De Pere *News* Oct. 15. [7] Delevan *Enterprise* Oct. 26.

1890

The end of September, one flew through the window of a school house at Little Suamico.[1]

[1] Oconto *Reporter* Sept. 27.

1891

On October 3, a "partridge" broke a window in a residence in Angelo, then escaped.[1]

Early in October, one broke a window in De Pere.[2]

The window in a store at Seymour was broken by a partridge in the first half of October.[3]

[1] Sparta *Herald* Oct. 6. [2] De Pere *Democrat.* In Green Bay *Gazette* Oct. 14. [3] Appleton *Crescent* Oct. 17.

1893

"The fires in the woods have driven considerable small game into the city [Chippewa Falls] of late. . . . Squirrels and partridges are quite numerous in different parts of the city."[1]

[1] Chippewa Falls *Herald* Sept. 22.

1894

On November 5, a partridge was shot in the First Ward, Oshkosh.[1]

On September 19, one struck the screen door of a house in Sheboygan, then escaped.[2]

Early on the morning of September 20, one was killed with a club in the First Ward, Marinette.[3]

[1] Oshkosh *Times* Nov. 10. [2] Sheboygan Falls *News* Sept. 19. [3] Marinette *Eagle* Sept. 22.

1895

The latter part of September, a partridge struck a greenhouse at Mauston.[1]

[1] Mauston *Chronicle* Sept. 25.

1896

The end of September, one struck a plate glass window in Kilbourn and was killed.[1]

Snyder[2] records a similar instance at Beaver Dam.

On September 22, one flew through the window of a residence in Trempealeau.[3]

[1] Kilbourn *Gazette* Oct. 3. [2] W. E. Snyder, *Osprey* 1, No. 5 (Jan., 1897) 67. [3] Trempealeau *Herald* Sept. 25.

1897

On October 17, one flew through the window of the depot at Nye.[1]

At Rhinelander a partridge flew into a cigar shop on September 23, and another flew through the window of a store on October 6.[2]

The end of September, a "prairie chicken" broke a window in a house in Appleton.[3]

[1] St. Croix Falls *Standard* Oct. 21. [2] Rhinelander *Herald* Sept. 25; *Vindicator* Oct. 12. [3] Appleton *Crescent* Oct. 2.

1898

At dusk on September 18, a partridge flew into a barber shop at Chetek; and on the morning of the 20th, one remained for twenty minutes on the porch of a residence.[1]

The end of September, one was caught in an abandoned home at New London.[2]

On October 15, a partridge flew through one of the south windows of the court house at Mauston and, before falling, departed through a north window.[3]

On October 1, a partridge flew through a street-car at Marinette, then alighted on the window sill of a house nearby.[4]

[1] Chetek *Alert* Sept. 23. [2] New London *Press* Sept. 29. [3] Mauston *Star* Oct. 20. [4] Marinette *Eagle* Oct. 1.

1899

A partridge spent the night of October 6 on a fence-post within a block of the main street of Rhinelander and departed in the morning.[1]

[1]Rhinelander *Vindicator* Oct. 11.

1900

One broke two windows in the Warren home, about four miles from Fox Lake, Dodge County, on April 22.[1]

[1] W. E. Warren. *Forest and Stream* 54 (May 5, 1900) 347.

1901

About 10:00 A. M., September 28, a partridge struck a plate glass window in Stevens Point, and on October 6, a stunned bird was picked up from the street.[1]

Early in October, partridges appeared in number in Menominee, and several were killed by striking windows. "The birds seem to be about as numerous in town this year as they are in the woods."[2]

On October 1, a partridge broke a wing by striking a wire in Marshfield. Four birds were found in an apple tree in a front yard.[3] Five other cases are mentioned, including one brought in alive by a bird dog, for the same community.[4]

One flew through a window at Plymouth in summer,[5] and on October 6, one alighted on a wood shed in Pittsville.[6]

[1] Stevens Point *Journal* Oct. 5; *Gazette* Oct. 9. [2] Menominee (Michigan) *Herald.* In Marinette *Eagle* Oct. 11. [3] Marshfield *Times* Oct. 4. [4] Marshfield *News;* In Pittsville *Pilot* Oct. 10. [5] Plymouth *Review* Jan. 29, 1902. [6] Pittsville *Pilot* Oct. 10.

1902

On October 18, a partridge broke a window in a store at Lake Mills.[1] It weighed 18 ounces.

The end of September one broke a window in Rice Lake, and early in October another flew into a residence.[2]

[1] Lake Mills *Leader* Oct. 23. [2] Rice Lake *Chronotype* Oct. 10.

1903

One evening the forepart of October, two partridges alighted in a garden in Osceola and began pecking at the ripe tomatoes. Both were killed at one shot.[1]

On September 23, one was shot from a telephone wire at the corner of a store in Bloomer.[2]

[1] Osceola *Press* Oct. 15, p. 3. [2] Bloomer *Advance* Sept. 24.

1904

Early in November, one flew through the window of a cheese factory near Plymouth.[1]

In October, one alighted on the stove-pipe in a store in Marshfield.[2]

On September 30, a partridge entered a woodshed in Greenwood. A few days previously, one struck a house.[3]

On September 30, at 9:00 A. M., a partridge flew through a window at Medford.[4]

During the last week of September, two birds were caught in Phillips.[5]

One flew through the window of a residence in Wausau early on the morning of September 23.[6]

[1] Plymouth *Review* Nov. 9. [2] Marshfield *Times* Oct. 14. [3] Greenwood *Gleaner* Oct. 6. [4] Medford *Star and News* Sept. 30. [5] Phillips *Times* Oct. 1. [6] Wausau (w) *Record* Sept. 29.

1906

The end of September, a partridge broke a window in Sturgeon Bay, and another flew into a house in the town of Forestville.[1]

The middle of October, two birds broke glass in a conservatory in Florence and were captured.[2]

The end of September one flew through a kitchen window at Abrams and landed on the table.[3]

[1] Sturgeon Bay *Democrat* Sept. 29, Oct. 13. [2] Florence *Mining News* Oct. 13. [3] Oconto *Reporter* Sept. 26.

1907

On September 18, a partridge broke a window in Greenwood.[1]

During the third week of September, a bird took refuge in the main entrance to a hotel in Tomahawk.[2]

At 7:00 A. M. on September 17, one flew through the window of a residence in Florence.[3]

Similar instances are cited for two places in the Upper Peninsula of Michigan, Crystal Falls and Sault St. Marie.[4]

On the morning of October 17, a partridge was killed by striking a residence in New London, and on the following morning one flew through a window.[5]

The end of October, early in the morning, one was caught in a screened porch at Marinette.[6]

[1] Greenwood *Gleaner* Sept. 19. [2] Tomahawk *Tomahawk* Sept. 21. [3] Florence *Mining News* Sept. 21. [4] *Ibid.* Oct. 19. [5] New London *Press* Oct. 17. [6] Marinette *Eagle–Star* Oct. 31, p. 1.

1909

The end of September, one flew through the window of a residence in Medford.[1]

[1] Medford *Star–News* Oct. 1.

APPENDIX 2

RUFFED GROUSE ANNALS

1839

Partridges and other game were plentiful at Kenosha[1] and abundant in Milwaukee.[2]

[1] J. V. Quarles. *Wis. Mag. History* 16 (1933) 310. [2] Milwaukee (w) *Sentinel* Jan. 15.

1844

Killed at Racine in "considerable numbers."[1]

[1] Racine *Advocate* Jan. 23.

1845

They sold in the Chicago market at $1.25 per dozen.[1]

A Milwaukee sportsman found "a covey of partridges (ruffed grouse) and killed four with his two barrels." Having another chance, he killed five more, the gun this time being loaded with gravel.[2]

[1] Chicago (d) *Journal* Dec. 8. [2] Milwaukee *Sentinel* Sept. 23.

1846

Milwaukee sportsmen claimed that partridges, quails, etc. were never so abundant.[1]

[1] Milwaukee *Sentinel* Aug. 17.

1847

Abundant at Watertown.[1]

[1] Watertown *Chronicle* Aug. 18.

1852

Anderson,[1] who came to Manitowoc County in 1852, stated: "Partridges were abundant everywhere. I have stood on the Neshoto River bottoms in the years 1852 and 1853 and had coveys of partridges run around me thicker than the fowls in a farmer's barnyard and nearly as tame."

[1] J. S. Anderson. *Proc. Wis. Hist. Soc. for 1911* (1912) p. 161.

1853

Joseph Clason, of Beaver Dam, brought 100 partridges among other game to the Milwaukee market.[1]

There was good partridge shooting at Green Bay.[2] It was stated for Manitowoc County: "The woods are filled with bears and partridges. They are attracted to the beech groves, where they find a plentiful supply of nuts."[3]

[1] Milwaukee *Sentinel* Feb. 2. [2] Green Bay *Advocate* Sept 8. [3] Manitowoc *Herald;* In Milwaukee *Sentinel* Oct. 19.

1854

"A load of partridges and prairie hens" was sold in Watertown[1] and shipped to Milwaukee. The game dealers in Milwaukee had "any quantity" of partridges and other game.[2] Partridges and other game in abundance were offered for sale on the streets of Janesville[3] and Green Bay.[4] In December, they sold in Beloit for 12.5 to 18 cents apiece.[5]

[1] Watertown *Democrat* Dec. 21. [2] Milwaukee *Sentinel* Dec. 20. [3] Janesville *Standard;* In Madison *Argus and Democrat* Dec. 29. [4] Green Bay *Advocate* March 23. [5] Beloit *Journal;* In Madison *Argus and Democrat* Dec .29.

1855

Reported numerous at Superior.[1] Partridges and other game were obtainable in "unlimited numbers" at Hudson.[2] In January large numbers were sold in the markets of Watertown[3] and in October were taken in "great numbers" at Waukesha.[4] There was excellent shooting at Jefferson.[5] During the winter of 1855–6 tons of game birds, including partridges, were hanging in the yard of the Capitol House at Madison.[6]

[1] Superior *Chronicle* Oct. 5. [2] Hudson *North Star* Aug. 8. [3] Watertown *Democrat* Jan. 4 and 18. [4] Waukesha *Plain Dealer* Oct. 16. [5] Jefferson *Jeffersonian* Oct. 25. [6] Madison *State Journal* June 12, 1856.

1856

They were reported very plentiful at Prescott[1] in April, and at Watertown[2] in May. Large quantities of partridges and other game were marketed in Watertown[3] in January, November, and December. In January they were offered abundantly in the markets of Milwaukee,[4] and at Lancaster[5] the price was $1.00 to $1.25 per dozen. Cooke[6] settled at Gilmanton during this year and stated that partridges were obtained easily.

[1] Prescott *Transcript* April 12. [2] Watertown *Democrat* May 1. [3] *Ibid.* Jan. 31, Nov. 13, and Dec. 25. [4] Milwaukee *Sentinel* Jan. 25. [5] Lancaster *Herald;* In Milwaukee *Sentinel* Jan. 10. [6] W. W. Cooke. *Wis. Mag. History* 23 (March, 1940) 285.

1857

Reported plentiful at Janesville.[1] In December, they were offered for sale "cheap" in Milwaukee.[2] Cartwright[3] hunted in the fall on the Red Cedar River. While gone from camp a companion shot "a big pile of prairie chickens and partridges, enough to last a good sized family for a week." Davis,[4] while surveying for a railway, saw "many partridges and pigeons" between Portage and Chippewa Falls.

[1] Janesville *Gazette* Aug. 10. [2] Milwaukee *Sentinel* Dec. 17. [3] David Cartwright. *Natural History of Western Wild Animals.* Toledo (1875) p. 240. [4] A. M. Davis. *Proc. Wis. Hist. Soc. for 1910* (1911) p. 170.

1858

In February, the following statement appeared in a Milwaukee paper: "Patridges, on the other hand, which were not disturbed last year, have been abundant, excellent and cheap this year."[1] They were "very numerous" at Prairie du Chien in September.[3] The prices in Milwaukee in early winter ranged from 14 to 15 cents apiece, and $1.00 per dozen.[4]

Since partridges were also "abundant" in the market at Madison[2] in January, they must have been numerous in the fall of 1857.

[1] Milwaukee *Sentinel* Feb. 1. [2] Madison *Argus and Democrat* Jan. 16. [3] Prairie du Chien *Courier* Sept. 16. [4] Milwaukee *Sentinel* Dec. 1; La Crosse *Independent Republican* Dec. 1.

1859

Partridges sold in Milwaukee[1] on January 1 at 10 cents apiece and on January 17 at $1.50 per dozen. In November, large quantities of game, including partridges, were brought into Milwaukee.[2] Hunters in September came into Superior[3] "well supplied with partridges" and other game. In December, 20 cents a pair was paid for them in Sauk City.[4] Fox Lake claimed that they were plentiful in autumn.[5]

[1] Milwaukee *Sentinel* Jan. 1 and 17. [2] Milwaukee *News* Nov. 19. [3] Superior *Chronicle* Oct. 1. [4] Baraboo *Republic* Jan. 5, 1860. [5] Fox Lake *Gazette* March 22.

1860

Partridges were "abundant" to a "good many" at Horicon.[1] They, with other upland game birds, were "unusually plenty" at Burlington.[2] David Finn settled between Merrill and Wausau in 1860, at which time 20 to 30 partridges could be killed within an hour.[3]

[1] Horicon *Argus* Oct. 19, Nov. 16. [2] Burlington *Gazette* Aug. 14. [3] Merrill *Herald* Feb. 22, 1921.

1861

The woods at Watertown[1] were filled with partridges and other game.

[1] Watertown *Democrat* Aug. 1.

1862

They were very plentiful at La Crosse.[1] "Snap Shot," writing from Oregon, stated that quail and ruffed grouse "lurk under every hedge."[2]

[1] La Crosse *Democrat* Nov. 14. [2] *Wilkes' Spirit of the Times,* N. S. 7 (Sept. 27, 1862) 55.

1863

"Wil-mer-el" stated that partridges could be found everywhere in Wisconsin.[1] They were to be found in August "without much trouble" near La Crosse.[2] A party of 17 men left La Crosse on October 12 and hunted 15 miles north of the city. In the list of game killed were 53 "pheasants" and 11 prairie chickens.[3]

[1] *Wilkes' Spirit of the Times,* N. S. 7 (Jan. 10, 1863) 295. [2] La Crosse (w) *Democrat* Aug. 11. [3] Milwaukee *Sentinel* Oct. 21.

1864

"Snap Shot" stated that quail swarmed in the stubbles in Dane County, then added: "Grouse are proportionally plenty (I speak of ruffed). . . ."[1] They were "never so plenty" at Osceola.[2] The following statement appeared at Superior: "Partridges are very thick in the woods this fall; a party of gentlemen in going to the Copper Creek mine and back, killed some forty along the road."[3]

[1] *Wilkes' Spirit of the Times* 11 (Sept. 17, 1864) 35. [2] Osceola *Press;* In Milwaukee (d) *Wisconsin* Aug. 5. [3] Superior *Gazette* Nov. 5.

1865

They were reported plentiful in April at Sturgeon Bay[1] and in August they abounded "without number" at Osceola.[2] Wautoma reported: "Partridges and squirrels have never been as plenty during our acquaintance with the country as they are now."[3]

[1] Sturgeon Bay *Advocate* April 27. [2] Osceola *Press* Aug. 19. [3] Wautoma *Argus* Oct. 27.

1866

Partridges were "by no means scarce" at Appleton.[1] They were very plentiful in Dane County. One writer stated that they were more numerous than quail,[2] and another that they abounded in certain localities.[3] The following statement appeared at Madison: "An uncommonly large number of pheasants, or partridges, whichever you please to call them, have been brought into town for sale this fall."[4] They were very plentiful at Alma[5] and Osceola.[6] In January, 1867, thousands of quails and partridges were being shipped from the state contrary to law.[7]

[1] Appleton *Crescent* Sept. 22. [2] "Snap Shot" *Wilkes' Spirit of the Times* 15 (Oct. 20, 1866) 129. [3] *Ibid.* p. 82. [4] Madison *State Journal* Nov. 3. [5] Alma *Journal;* In Milwaukee *Sentinel* Oct. 17. [6] Osceola *Press* Sept. 22. [7] Milwaukee (d) *Wisconsin* Jan. 21, 1867.

1867

Pease and Baker, of Richland Center, ran the following advertisement: "Wanted 1000 Pheasants and Quails."[1]

[1] Richland Center *Republican* Dec. 12.

1868

C. H. Cooke made a canoe trip on the Chippewa River above Eau Claire in April. He wrote in his diary: "Partridges were not so plentiful as we had been told."[1] They were quite plentiful at Wausau,[2] and plentiful near Lake Pepin.[3] Richland Center reported: ". . . squirrels, partridges, quails, etc. have not been so abundant as now since the country was first settled."[4]

[1] Eau Claire *Telegram* Dec. 16, 1917. [2] Wausau *Pilot* Nov. 14. [3] Oliver Gibbs. *Lake Pepin Fish-Chowder.* N. Y. (1869) p. 52. [4] Richland Center *Sentinel;* In Madison *State Journal* Oct. 17.

1869

The following advertisement appeared at Lancaster: "10,000 quails, prairie chickens and pheasants are wanted by Nathan Schreiner & Co., for which a good price will be paid."[1]

The woods at Brodhead[2] were reported full of partridges and other game, but Janesville[3] had the following lament: "Sportsmen complain that the partridge which have hitherto been so common in the woodlands hereabout, have almost entirely disappeared."[3]

[1] Lancaster *Herald* Dec. 7. [2] Brodhead *Independent;* In Milwaukee (d) *Sentinel* Nov. 25, p. 1. [3] Janesville *Gazette* Oct. 18.

1870

The reports for this year are decidedly mixed. Prairie du Chien stated that quail and partridges were never more numerous[1] and that they were being shot in large numbers.[2] At Oshkosh[3] they were reported abundant throughout the state. Eau Claire[4] found them quite plentiful.

On the other hand "partridges have become almost extinct" at Watertown[5] and "scarce as hen's teeth" at Kaukauna.[6]

[1] Prairie du Chien *Courier;* In Madison *State Journal* Oct. 14. [2] Prairie du Chien *Union;* In Madison *State Journal* Oct. 19. [3] Oshkosh *Northwestern* Oct. 27. [4] Eau Claire *Free Press* Oct. 20. [5] Watertown *Republican* Nov. 9. [6] Appleton *Crescent* Sept. 3, Oct. 1.

1871

This year partridges showed a decided increase. The young were quite plentiful in July at Mauston.[1] There was good shooting at La Crosse[2] and Richland Center.[3] Black River Falls[4] reported them "plenty in every direction," Osceola[5] "numerous," and Neillsville[6] "in great numbers."

[1] Mauston *Star* July 20. [2] La Crosse *Democrat;* In Madison *State Journal* Nov. 2. [3] Richland Center *Republican* Dec. 7. [4] Black River Falls *Banner* Nov. 4. [5] Osceola *Press* Aug. 25. [6] Neillsville *Republican* Oct. 4.

1872

Partridges were reported abundant in May at Friendship,[1] and in October there was good shooting at Ellsworth.[2]

[1] Friendship *Press* May 4. [2] Ellsworth *Herald* Oct. 23.

1873

Partridges were reported plentiful at Madison[1] and La Crosse,[2] and very abundant at Prairie du Chien[3] and Menomonie.[4] Ashland[5] stated that there were "thousands" along the Central Railway. They were not "very abundant" at Lancaster.[6] A few were brought in at Clinton,[7] while at Watertown[8] they were not nearly as common as formerly. During a side hunt at Oshkosh,[9] in which a total of 28 men participated, 8 partridges were in the list of game killed.

[1] Madison *Democrat* Oct. 10. [2] La Crosse *Liberal Democrat;* In Milwaukee *News* Oct. 11. [3] Prairie du Chien *Courier* Sept. 16. [4] Menomonie *News* Oct. 4. [5] Ashland *Press* Oct. 11. [6] Lancaster *Herald* Nov. 6. [7] Janesville *Gazette* Nov. 19. [8] Watertown *Democrat* Aug. 21. [9] Oshkosh *Times* Oct. 15.

1874

They were reported plentiful to very plentiful at Yorkville,[1] Sheboygan,[2] Oconto,[3] Ashland,[4] Osceola,[5] River Falls,[6] and Montello.[7]

The price was 30 cents apiece in Madison[8] and 25 cents at Watertown,[9] in which market they were "pretty plenty."

[1] Racine *Argus* Sept. 17. [2] Sheboygan *Herald* Oct. 30. [3] Oconto *Reporter* Oct. 31. [4] Ashland *Press* Sept. 26. [5] Osceola *Press* April 11. [6] River Falls *Press* Oct. 8 and 29. [7] Fred Pond. *Forest and Stream* 2, No. 26 (1874) 410. [8] Madison *State Journal* Oct. 20. [9] Watertown *Democrat* Aug. 27.

1875

This year all the reports were very favorable. At Red Cedar, Barron County, the birds "are so thick at times the sun cannot be seen."[1] They were "unusually numerous" at De Pere[2] and were found "in greater numbers than ever before" at Sturgeon Bay.[3] They were reported plentiful to very numerous at Marinette,[4] New London,[5] Wausau,[6] and Chippewa Falls.[7]

Many were brought into Oconto[8] the end of December. Tiffany, Dunn County, reported: "Hundreds of partridges have been killed in this town and vicinity, and marketed at twelve to twenty cents apiece."[9] Approximately 3,000 pounds of birds were shipped from New Richmond[10] the end of the year.

Three men returned to Baldwin[11] with 100 birds. A hunter at Merrill,[12] in August, killed 11 partridges out of a flock of 12, while at Escanaba,[13] Michigan, a sportsman shot 36 partridges in a forenoon.

[1] Rice Lake *Chronotype* Aug. 28. [2] De Pere *News* Oct. 16. [3] Sturgeon Bay *Expositor* Oct. 22. [4] Marinette and Peshtigo *Eagle* Oct. 16. [5] New London *News* Sept. 15. [6] Wausau *Pilot* Aug. 21. [7] Chippewa Falls *Herald* Oct. 15; Oconto *Reporter* Jan. 1, 1876. [9] Menominee *News* Jan. 1, 1876. [10] New Richmond *Republican* Jan. 12, 1876. [11] Baldwin *Bulletin* Nov. 11. [12] Merrill *Advocate* Aug. 21. [13] Milwaukee Commercial *Times* Sept. 18.

1876

There were very few statements for this year. Green Bay[1] reported the woods filled with "partridge and small game," and the Madison[2] markets were "well stocked" with them. On the other hand, they were "quite scarce" at Prairie du Chien.[3] During a side hunt at Edgerton,[4] in which 11 men participated, 10 partridges were shot.

[1] Green Bay *Advocate* Oct. 19. [2] Madison *Patriot* Dec. 19. [3] Prairie du Chien *Union* Dec. 1. [4] Edgerton *Independent* Dec. 22.

1877

There was good shooting at Tiffany,[1] Dunn County. Partridges were numerous to very plentiful at Iola,[2] Waupaca County, Green Bay,[3] Sturgeon Bay,[4] Oconto,[5] Marinette,[6] Appleton,[7] Chippewa Falls,[8] and Westboro,[9] Taylor County. They were "quite numerous" at Milton,[10] where they sold for 15 cents apiece.

During a side hunt at Easton,[11] Adams County, on November 10, one man shot 4 birds. They were "few and far between" at Esdaile,[12] Pierce County.

[1] Menomonie *News* Jan. 5, 1878. [2] Waupaca *Republican* Sept. 13. [3] Madison *State Journal* Sept. 21, p. 2. [4] Sturgeon Bay *Expositor* Aug. 10. [5] Oconto *Reporter* Sept. 1. [6] Marinette and Peshtigo *Eagle* Oct. 27. [7] Appleton *Crescent* Aug. 25, Dec. 8. [8] Chippewa Falls *Herald* Oct. 26. [9] S. D. C. *Forest and Stream* 9 (Sept. 6, 1877) 94. [10] Janesville *Gazette* Oct 23. [11] Friendship *Press* Nov. 24. [12] Ellsworth *Herald* Sept. 5.

1878

Col. F. J. Bowman wrote from Bayfield on September 4 that "woodcock, pheasant and spruce-partridge are abundant."[1] Partridges were numerous to abundant at Prairie du Chien,[2] Chippewa Falls,[3] Oconto,[4] and Sturgeon Bay.[5] They were unusually scarce at Clear Lake.[6]

During a side hunt at Darlington,[7] 11 partridges were killed. A hunting party from Madison[8] spent a day in the Baraboo Valley and returned with a mixed bag containing 11 partridges.

[1] Bayfield *Press* Oct. 2. [2] Prairie du Chien *Courier* Sept. 10, Oct. 15. [3] Chippewa Falls *Herald* July 19, Nov. 1. [4] Oconto *Reporter* Sept. 7, Nov. 1. [5] Sturgeon Bay *Expositor* Oct. 11, Nov. 8. [6] Clear Lake *News* Aug. 30. [7] Darlington *Republican* Nov. 1. [8] Madison *State Journal* Oct. 14.

1879

They were numerous at Phillips[1] in May and plentiful near La Crosse[2] in July. Merrill[3] considered them quite plentiful near Waukesha, while L'Eclair,[4] writing from Milwaukee, states that the ruffed grouse, formerly common, is now exterminated. They were scarce at Clear Lake[5] and Boscobel.[6]

Partridges were "drumming vigorously" in November near Eau Claire.[7]

[1] Phillips *Times* May 17. [2] "Banshee." *Chicago Field* 11 (July 26, 1879) 378. [3] H. W. Merrill. *Forest and Stream* 13 (Nov. 20, 1879) 827. [4] L'Eclair, *Ibid.*, p. 714. [5] Clear Lake *News* Sept. 5. [6] Boscobel *Dial* Oct. 31. [7] Eau Claire *Free Press* Nov. 27.

1880

Partridges seem to have been numerous only in the extreme northeastern portion of the state. They were reported plentiful at Marinette,[1] Oconto,[2] and Sturgeon Bay.[3] An "immense load of rabbits and partridges," secured near Delavan, was brought into Whitewater.[4]

They were scarce at Lafayette,[5] Chippewa County, and at Eau Galle,[6] Dunn County. The report for the Milwaukee market was: "No partridges nor grouse have been offered during the week. They seem to be very scarce."[7]

[1] Marinette and Peshtigo *Eagle* Oct. 2. [2] Oconto *Reporter* Oct. 9. [3] Sturgeon Bay *Expositor* Oct. 1 and *Advocate* Nov. 4. [4] Whitewater *Register* Dec. 2. [5] Chippewa Falls *Herald* Oct. 1. [6] Menomonie *Times* Sept. 17. [7] Milwaukee *Sentinel* Oct. 18.

1881

They were quite plentiful at Racine[1] and New Richmond.[2] A hunter at Green Bay[3] shot 7 partridges and 8 pigeons in about fifteen minutes.

There were a few partridges at Waukesha.[4] They were scarce at Pepin,[5] and the same report was made for the entire state.[6]

[1] Racine *Journal* Oct. 26. [2] New Richmond *Republican* Oct. 12. [3] Green Bay *Gazette* Aug. 27. [4] L. G. *Chicago Field* 15 (May 7, 1881) 202. [5] A. T. *American Field* 16 (Oct. 22, 1881) 265. [6] "Scaup." *Turf, Field and Farm* 33 (Nov. 18, 1881) 322.

1882

Grundtvig[1] reported ruffed grouse "extremely abundant" at Shiocton the summers of 1882 and 1883. They were "quite numerous" at Florence.[2] During a side hunt at Beloit,[3] in which 34 men participated, 8 birds were shot. Five men hunting rabbits at Waldick,[4] Iowa County, brought in 17 partridges along with 184 rabbits in a day's hunt. Eleven men, engaged in a side hunt at Elroy,[5] had 4 birds in a mixed bag. They were scarce at Phillips[6] and Boscobel.[7]

[1] F. L. Grundtvig. *Trans. Wisconsin Acad. Sci.* 10 (1895) 105. [2] Florence *Mining News* Nov. 11. [3] Beloit *Free Press* Dec. 1. [4] Mineral Point *Democrat* Dec. 29. [5] Elroy *Tribune* Nov. 17. [6] Phillips *Badger* Sept. 27. [7] Boscobel *Dial* Nov. 3.

1883

There was a decided increase in numbers. Partridges were plentiful at Popple Lake,[1] Chippewa County, Green Bay,[2] and Marinette;[3] and abundant to "unusually abundant" at Appleton,[4] Westfield,[5] Noquebay Lake,[6] Shiocton,[7] Oconto,[8] Sevastopol,[9] Door County, and Marinette.[10] A hunter at Peshtigo killed 76 birds in an afternoon.[11]

[1] Chippewa Falls *Independent* Oct. 11. [2] Green Bay *Gazette* Nov. 3. [3] Marinette *Star* Oct. 5. [4] F. R. *Forest and Stream* 21 (Jan. 3, 1884) 456. [5] Harry Hunter. *American Field* 20 (Sept. 22, 1883) 270. [6] *Ibid.*, p. 174. [7] F. L. Grundtvig, *l.c.* [8] Oconto *Reporter* Sept. 22, Oct. 27. [9] Sturgeon Bay *Advocate* Jan. 3, 1884. [10] Marinette and Peshtigo *Eagle* Oct. 27. [11] *Ibid.* Nov. 3.

1884

Partridges were reported unusually numerous at Neillsville.[1] They were plentiful at Bailey's Harbor,[2] Door County, Marshfield,[3] and Peshtigo,[4] and "quite thick" at Hayward.[5] B. A. E.[6] wrote from Menomonie that "it is a hard fact that ruffed grouse are perceptibly less abundant than they were two years ago." A La Crosse sportsman hunted two days and killed 3 birds each day.[7] They sold for 20 cents apiece at Soldiers Grove.[8]

[1] Neillsville *Times* Nov. 11. [2] Sturgeon Bay *Advocate* Sept. 25 and *Expositor* Sept. 26. [3] Marshfield *Times* Aug. 30. [4] Marinette and Peshtigo *Eagle* Nov. 22. [5] Hayward *News* Oct. 11. [6] B. A. E. *Forest and Stream* 23 (Oct. 2, 1884) 186. [7] H. E. W. *Ibid.* 23 (Jan. 22, 1885) 507. [8] Soldiers Grove *Journal* Dec. 15.

1885

The reports for this year are very favorable. Partridges were plentiful to abundant at De Pere,[1] Green Bay,[2] Marinette,[3] Florence,[4] Waupaca,[5] Viroqua,[6] Chippewa Falls,[7] Chetek,[8] Neillsville,[9] Superior,[10] and Black River Falls.[11] Two hunters "bagged a large number of partridges and quail" at La Fayette,[12] Walworth County.

Market hunters were active. One man is stated to have "cleared $60 in two weeks" in Pierce County.[13] Due to the warm weather "hundreds of pheasants" spoiled before they could be shipped from Wilson,[14] St. Croix County. Large numbers were shipped from Lessor,[15] Shawano County, and from Grantsburg,[16] where the hunters received 10 to 12 cents per bird.

[1] De Pere *News* Oct. 24. [2] Green Bay *Gazette* Nov. 14 and *Advocate* Oct. 8. [3] Marinette *Eagle* Oct. 3, 17, 24, 31. [4] Florence *Mining News* Oct. 24. [5] Waupaca *Republican* Sept. 4. [6] Viroqua *Leader* Oct. 16. [7] Chippewa Falls *Herald* Oct. 9. [8] Chetek *Alert* Aug. 29. [9] Neillsville *Times* Oct. 6. [10] Superior *Times* Sept. 26. [11] Black River Falls *Independent* Dec. 2. [12] Elkhorn *Independent* Nov. 26. [13] River Falls *Journal* Nov. 19. [14] Baldwin *Bulletin* Oct. 2 and 9; *cf.* Eau Claire (d) *Leader* Oct. 31. [15] Shawano *Advocate* Dec. 3, 1886. [16] Grantsburg *Sentinel* Oct. 30.

1886

Partridges were very numerous this year. They "wintered well" at Egg Harbor.[1] La Crosse[2] reported that "there never was known such a year for partridges." One hunter brought 80 birds to the market. Another hunter shipped over one hundred dozen to the Chicago market from the Beef River district, Buffalo County.[3] They were very plentiful in Clark[4] and Jackson[5] counties, at Colby,[6] Wausau,[7] Florence,[8] Marinette,[9] Oconto,[10] and Sturgeon Bay.[11] A hunting party arrived in Fond du Lac[12] with a large number of birds, while two Beloit[13] hunters returned from the Lake Superior region with "five deer and about 50 partridges." The shooting was very good at Glidden,[14] Phillips,[15] De Pere,[16] and Tomah.[17] The number of birds at Sparta[18] was "first class," and they were quite numerous at Alma.[19] Ruffed grouse were considered more numerous than pinnated at Montello.[20]

In the southern part of the state partridges were plentiful at Darlington,[21] Mineral Point,[22] and Prairie du Chien.[23] They were shot in "considerable numbers" near Portage[24] and Beloit.[25]

The price paid to market hunters at Hersey,[26] St. Croix County, was 20 cents apiece.

Two market hunters at Elm Hall, Gratiot County, Michigan, are stated to have killed 2,000 birds during the season.[27]

[1] *Forest and Stream* 26 (April 8, 1886) 207. [2] La Crosse *Chronicle* Nov. 18, p. 8. [3] Richland Center *Rustic* Nov. 20, p. 6. [4] Neillsville *Times* Sept. 7, Nov. 16; *True Republican* Oct. 14; Milwaukee *Journal* Sept. 25. [5] Black River Falls *Banner* Oct. 8; *Independent* Oct. 6; Eau Claire *Free Press* Oct. 14. [6] Colby *Phonograph* Sept. 30. [7] Wausau *Pilot and Review* Aug. 31, Sept. 21, Oct. 5. [8] Florence *Mining News* Aug. 21. [9] Marinette *Eagle* Nov. 6. [10] Oconto *Reporter* July 31, Sept. 11, Oct. 9, 23. [11] Sturgeon Bay *Expositor* Oct. 22. [12] Fond du Lac *Commonwealth* Nov. 26. [13] Beloit *Free Press* Dec. 4. [14] Glidden *Pioneer* Sept. 23. [15] Phillips *Times* Oct. 2. [16] De Pere *News* Nov. 27. [17] Tomah *Journal* Sept. 18; Oct. 23. [18] Sparta *Herald* Aug. 10. [19] Alma *Journal* Sept. 9. [20] Montello *Express* Aug. 7, p. 2. [21] Darlington *Democrat* Aug. 26; *Republican* Oct. 15. [22] Mineral Point *Tribune* Aug. 26. [23] Prairie du Chien *Courier* Sept. 21. [24] Milwaukee *Journal* Oct. 23. [25] Beloit *Free Press* Oct. 22. [26] Baldwin *Bulletin* Sept. 17. [27] Shullsburg *Pick and Gad* Feb. 3, 1887.

1887

The birds were plentiful throughout the state. At Colby[1] they were "uncommonly thick" and at Phillips[2] "unusually abundant." Very favorable reports came from Neillsville,[3] Alma,[4] Hurley,[5] Crandon,[6] Ashland,[7] Barron,[8] Oshkosh,[9] Wausau,[10] Florence,[11] Oconto,[12] Green Bay,[13] Appleton,[14] Sparta,[15] Oxford,[16] Reedsburg,[17] Friendship,[18] Kilbourn,[19] Mineral Point,[20] and Darlington.[21] At Black River Falls[22] hunters did not have "much success" with either partridges or prairie chickens.

The following advertisement appeared in a Reedsburg[17] paper: "5000 Patridges wanted at Harris and Hosler's." There was a complaint from New Richmond[23] of illegal shipments of partridges to Chicago, and at Rice Lake[24] a consignment of 100 birds was seized by a game warden.

[1] Colby *Phonograph* Aug. 25, Sept. 29. [2] Phillips *Times* Oct. 1 and 8. [3] Neillsville *Times* Sept. 27. [4] Alma *Journal* Sept. 20. [5] Hurley *Miner* Oct. 27. [6] Crandon *Forest Leaves* Aug. 25. [7] Ashland *Press* Aug. 20, Oct. 8. [8] Barron *Shield* Sept. 30. [9] Oshkosh (w) *Northwestern* Oct. 13. [10] Wausau *Pilot and Review* Sept. 20. [11] Florence *Mining News* Sept. 17. [12] Oconto *Reporter* Oct. 22, Nov. 5. [13] Green Bay *Gazette* Oct. 12. [14] Appleton *Post* Oct. 13. [15] Sparta *Herald* Aug. 30; *Democrat* Sept. 10. [16] Montello *Express* Sept. 10. [17] Reedsburg *Free Press* Sept. 1, Oct. 27. [18] Friendship *Press* Nov. 5. [19] Kilbourn *Mirror–Gazette* Oct. 13. [20] Mineral Point *Tribune* Sept. 29. [21] Darlington *Democrat* Oct. 6; *Republican* Sept. 30. [22] Black River Falls *Independent* Sept. 7. [23] New Richmond *Republican* Oct. 26. [24] Chippewa Falls *Times* Nov. 1.

1888

This year the decline began in certain areas. At Neillsville[1] they had become scarce: "Last year there were thousands shipped, but the shipments so far have been only a few hundred." The birds were scarce near Oconto,[2] but reported plentiful in the western part of the county. The shooting was poor at Kilbourn,[3] Viroqua,[4] Dodgeville,[5] and Mineral Point.[6]

Partridges were plentiful at Green Bay,[7] De Pere,[8] Appleton,[9] Florence,[10] Crandon,[11] Bayfield,[12] Phillips,[13] and Wausau.[14] Two Wausau hunters are stated to have killed 26 birds in one day, while another pair killed 106. Marinette[15] reported that a party of four hunters, two of whom hunted two weeks, and two one week, killed a bear, 2 deer, and 112 partridges. A hunting party is stated to have killed 200 birds in 10 days in Bear Valley, Richland County.[16] A La Crosse[17] hunter killed 55 birds in 10 days in the Chippewa Valley.

An Appleton hunter[18] wrote that in a certain section there were "thousands" of birds. New Richmond[19] reported: "One thing our amateur sports seem to be agreed upon, and that is the measurement of partridges. They uniformly remark that you can go out and shoot a wagon load!"

At Crandon[11] \$2.00 per dozen were offered for partridges, while in La Crosse County[20] they sold from 15 cents apiece to \$3.00 per dozen.

[1] Neillsville *Republican and Press* Sept. 6 and 20, Oct. 18. [2] Oconto *Reporter* Sept. 1, Oct. 6. [3] Kilbourn *Mirror–Gazette* Sept. 8. [4] Viroqua *Leader* Sept. 7. [5] Dodgeville *Chronicle* Sept. 28. [6] Mineral Point *Tribune* Nov. 20. [7] Green Bay *Gazette* Oct. 17. [8] De Pere *News* Sept. 29, Oct. 13. [9] Appleton *Post* Oct. 4; C. V. Y. *Forest and Stream* 31 (Nov. 15, 1888) 326. [10] Florence *Mining News* Aug. 25, Sept. 29, Oct. 20. [11] Crandon *Forest Leaves* Oct. 11, Nov. 1; *Republican* Oct. 16 and 23. [12] Bayfield *Press* Oct. 6. [13] Phillips *Times* Aug. 18. [14] Wausau *Pilot and Review* Sept. 11, Oct. 2; *Torch of Liberty* Oct. 11. [15] Marinette *Eagle* Oct. 20. [16] Richland Center *Rustic* Nov. 24, Dec. 8. [17] La Crosse (w) *Republican and Leader* Oct. 20. [18] C. V. Y. *Forest and Stream* 35 (Nov. 20, 1890) 351. [19] New Richmond *Republican* Oct. 17. [20] La Crosse (w) *Republican and Leader* Nov. 17, Dec. 1.

1889

There were few reports for this year, indicating that the birds were not plentiful. They were "very scarce" at Milton[1] and "unusually scarce" at Algoma.[2] The hunters at Oconto[3] had "indifferent success," while the shooting at Florence[4] was fairly good. The birds were quite numerous near Neillsville,[5] where they brought 20 to 25 cents apiece in the market. At Chippewa Falls[6] two hunters returned from a day's hunt "loaded with partridges." Two hunters, in three days, killed 62 birds near Richland Center.[7] At Menominee, Michigan, two men "made a short trip up the state road on Wednesday and bagged 26 birds. . . ."[8]

[1] Milton *Telephone* Nov. 28. [2] Algoma *Record* Sept. 26. [3] Oconto *Reporter* Oct. 26. [4] Florence *Mining News* Aug. 31, Sept. 7, Oct. 19. [5] Neillsville *Republican and Press* Sept. 28, Oct. 19. [6] Chippewa Falls *Times* Nov. 6. [7] E. H. Parfrey. *Am. Field* 32 (Nov. 23, 1889) 485. [8] Green Bay *Advocate* Oct. 17.

1890

This year is clearly a "low." C. V. Y.[1] wrote from Appleton that he could not find an average of three birds in a day where there were thousands in 1888. He thought that the decrease was due to shooting for the market. The birds had "almost entirely disappeared" at Oxford,[2] and the shooting at Marinette[3] was "very poor." Florence[4] reported: "Partridges are 'all-fired' scarce this year. The reason for the prevailing scarcity is not apparent." The hunting at Barron[5] was poor.

Good shooting was reported at Lena, Oconto County.[6] At De Pere[7] a hunter killed 7 partridges, 11 rabbits, and a wildcat between 7:00 A. M. and 4.00 P. M.; and at Sparta[8] a hunter killed 13 partridges and 8 squirrels in "a couple of hours."

Partridges brought $3.00 a dozen at Merrillan,[9] La Crosse,[10] and Barneveld.[11]

[1] C. V. Y. *Forest and Stream* 35 (Nov. 20, 1890) 351. [2] Montello *Express* Aug. 23. [3] Marinette *Eagle* Oct. 4. [4] Florence *Mining News* Oct. 11. [5] Barron *Shield* Sept. 26. [6] Oconto *Reporter* Oct. 11. [7] De Pere *News* Nov. 1. [8] Sparta *Independent* Nov. 1. [9] Merillan *Leader* Oct. 31. [10] La Crosse (w) *Republican and Leader* Nov. 8. [11] Dodgeville *Chronicle* Dec. 26.

1891

The partridge population continued to be low. They were reported plentiful at Arcadia[1] and Durand;[2] and a letter from Drywood, Chippewa County, stated: "The partridge has been slain by the hundred owing to the 25 cents apiece they bring in the local market."[3] The birds were "quite plenty" at Shawano,[4] "rather scarce" at Crandon,[5] and "very scarce" at Appleton.[6] There was considerable hunting at Wausau[7] but no indication of the results. The individual bags reported by hunters at Viroqua[8] and Barron[9] show that partridges were far from plentiful.

[1] Arcadia *Leader* Oct. 22. [2] Durand *Courier* Oct. 31. [3] Baraboo *Republic* Nov. 26. [4] Shawano *Journal* Oct. 1, Nov. 5. [5] Crandon *Republican* Oct. 28. [6] Appleton *Crescent* Oct. 10. [7] Wausau *Pilot–Review* Oct. 20. [8] Viroqua *Censor* Nov. 4. [9] Barron *Shield* Oct. 2 and 9.

1892

The few reports for this year show that the population remained low. At Prairie du Chien[1] "dead loads of squirrels and pheasant" were brought in. A report of great scarcity at Marinette[2] was followed by one stating that partridges were "very plenty." Florence[3] and Wausau[4] reported that the birds were very scarce.

[1] Prairie du Chien *Courier* Nov. 1. [2] Marinette *Eagle* Sept. 10, Oct. 1. [3] Florence *Mining News* Sept. 17, Oct. 8. [4] Wausau *Pilot–Review* Oct. 4.

1893

The few reports available indicate that the number of partridges had increased slightly. The birds were quite numerous at Steuben,[1] Crawford County, Merrillan,[2] and Marinette.[3] They were reported numerous on the Indian reservation near De Pere,[4] while at Colby[5] two hunters killed "too many to speak of." Partridges were quite numerous in the city of Chippewa Falls,[6] due supposedly to having been driven in by forest fires. During a side hunt at West Salem,[7] 150 squirrels, 20 partridges, 20 rabbits, and 3 ducks were secured. Sheboygan Falls[8] reported that the partridge was no longer to be found in the vicinity.

[1] La Crosse (w) *Republican and Leader* Oct. 14 and 28. [2] Merillan *Leader* Sept. 22, Oct. 20. [3] Marinette *Eagle* Sept. 9. [4] De Pere *News* Oct. 14. [5] Colby *Phonograph* Dec. 7. [6] Chippewa Falls *Herald* Sept. 22. [7] La Crosse (w) *Republican and Leader* Nov. 11. [8] Sheboygan Falls *News* Sept. 6.

1894

At Jacksonport,[1] Door County, "partridges were never before as plentiful," and at Marinette[2] they were "unusually numerous." They were reported plentiful at Green Bay[3] and De Pere.[4] There was good shooting at Flambeau,[5] Rusk County, Arpin,[6] Wood County, and Prairie du Chien.[7]

[1] Sturgeon Bay *Advocate* Oct. 6. [2] Marinette *Eagle* Sept. 22. [3] Green Bay *Gazette* Aug. 29. [4] De Pere *News* Sept. 15. [5] Chippewa Falls *Herald* Oct. 26. [6] Centralia *Enterprise* Sept. 29. [7] Prairie du Chien *Courier* Oct. 23.

1895

Partridges were reported to be unusually plentiful in the northern part of Door County,[1] and plentiful at De Pere,[2] Marinette,[3] Trempealeau,[4] and Grantsburg.[5] The birds were very scarce at Florence,[6] and the shooting was poor at Merrill.[7] Six men hunted a day in Iron County[8] and secured only 2 birds. Other one-day bags were: one man shot 26 birds near Ashland;[9] a Marinette[10] hunter secured 13; and two men near Barron[11] shot 9.

[1] Sturgeon Bay *Democrat* Sept. 14. [2] De Pere *News* Sept. 14. [3] Marinette *Eagle* Oct. 12. [4] Trempealeau *Herald* Sept. 27. [5] Grantsburg *Sentinel* July 25. [6] Florence *Mining News* Oct. 5. [7] Merrill *Advocate* Sept. 10. [8] Hurley *Republican* Oct. 25. [9] Ashland (w) *Press* Oct. 12. [10] Peshtigo *Times* Sept. 28. [11] Barron *Shield* Oct. 11.

1896

The birds were plentiful this year at River Falls,[1] Cable,[2] Arcadia,[3] Richland Center,[4] Stanley,[5] Chippewa County, Dancy,[6] Marathon County, Marshfield,[7] Tomahawk,[8] Minocqua,[9] Florence,[10] Peshtigo,[11] and Kewaunee.[12] At De Pere[13] they were "much scarcer than last year."

"Observer,"[14] at Spooner, stated that the local express agent had purchased and shipped 25,000 "pheasants and grouse" during the season. Two men returned from Wood County with about 50 birds.[15] At Shawano[16] six men in a day's hunt killed 22 rabbits and 17 partridges. Bauer Bros. shipped nearly 2,000 birds from Marshfield[17] during the season. Three men hunted three days at Mellen and returned with 62 birds.[18] Two men killed 169 partridges near Ashland,[19] the length of the hunt not being stated.

[1] River Falls *Journal* Aug. 27. [2] J. S. I. *Forest and Stream* 47 (Dec. 12, 1896) 469. [3] Arcadia *Herald* Sept. 25. [4] Richland Center *Rustic* Nov. 21. [5] Stanley *Republican* Sept. 26. [6] Stevens Point *Journal* Oct. 10. [7] Marshfield *Times* Sept. 25. [8] Tomahawk *Tomahawk* Sept. 5. [9] Minocqua *Times* Sept. 3, 17, and 24. [10] Florence *Mining News* Aug. 29. [11] Marinette *Eagle* Oct. 3. [12] Kewaunee *Enterprise* Sept. 4. [13] De Pere *News* Dec. 5. [14] "Observer." *Forest and Stream* 48 (Feb. 27, 1897) 167. [15] Oshkosh (d) *Northwestern* Nov. 9, 1896, p. 2. [16] Shawano *Journal* Oct. 1. [17] Marshfield *Times* Dec. 18. [18] Ashland (d) *News* Oct. 13. [19] *Ibid.* Oct. 17.

1897

The birds were reported plentiful at Merrill,[1] Tomahawk,[2] Marinette,[3] Marshfield,[4] and Wausau.[5] There was much hunting at Claywood,[6] and Ogema,[7] Price County. The shooting at Sparta[8] was fair. At Florence[9] and Wausau[9] the early reports were favorable, but in October the shooting became poor. A statement from Wausau[10] reads: "Where a bag of 20 or 25 could easily be killed early in the season, hunters must now generally be content with three or four." Though the hunting was considered poor, two men at Wausau[11] killed 39 birds in one day. At Minocqua[12] two men returned with only 2 birds. A hunter at Bayfield[13] killed 7 partridges in an hour. Two men hunting along the Eau Claire near Wausau[14] killed 26 birds in one day and 12 the following morning. Two men who hunted in Taylor County[15] returned with "a large amount of pheasants." In Price County,[16] a man, in travelling from Pike Lake to Fifield, a distance of 26 miles, killed 20 partridges.

Partridges were "unusually scarce" at Kewaunee,[17] and scarce at Minong,[18] Washburn County, Stanley,[19] and at Spooner.[20] A report from the latter place states: As we have it, Wm. Busch shipped 2,300 in one week last year; this is more than the entire harvest this season."

[1] Merrill *Advocate* Oct. 5, Nov. 2. [2] Tomahawk *Tomahawk* Oct. 30. [3] Marinette *Eagle* Oct. 30. [4] Marshfield *Times* Sept. 3. [5] Wausau *Pilot* Aug. 24, Oct. 5; *Central Wisconsin* Aug. 28, Oct. 16. [6] Oconto *Reporter* Nov. 5; Shawano *Advocate* Nov. 4. [7] Prentice *Calumet* Sept. 17. [8] Sparta *Herald* Oct. 26. [9] Florence *Mining News* Sept. 4 and 18, Oct. 9 and 23. [10] Wausau *Central Wisconsin* Oct. 23. [11] Wausau *News* Sept. 30. [12] Minocqua *Times* Sept. 23. [13] Ashland (w) *Press* Sept. 11. [14] Wausau *Pilot* Oct. 12. [15] La Crosse (w) *Republican and Leader* Nov. 12. [16] Green Bay *Advocate* Nov. 4. [17] Kewaunee *Enterprise* Oct. 29. [18] Shell Lake *Register* Sept. 18. [19] Stanley *Republican* Oct. 9. [20] Shell Lake *Register* Oct. 16 and 30.

1898

In spite of the apparent decrease in partridges last year, this year was unquestionably a high in the cycle. They were reported unusually numerous at Antigo,[1] Wausau,[2] Minocqua,[3] Hurley,[4] New London,[5] Mellen,[6] Peshtigo,[7] Marinette,[8] Florence,[9] and Marshfield.[10] In Barron County, two men shot 78 birds in one day, and "hundreds" were shipped from Silver Lake.[11] Three men returned from a hunt at Bruce,[12] Rusk County, with 75 birds. At West Sweden,[13] Burnette County, a hunter killed 30 in one day. The shooting was good at Rice Lake, where partridges brought 20 cents apiece. One hunter "averaged eleven and twelve a day" for a week. The shipments from Rice Lake[15] were "surprisingly large." Hough[16] reported them numerous at Conover, Vilas County, and at Twin Lakes. A hunter at Butternut,[17] Ashland County, killed 20 partridges in four hours. They were "quite numerous" at Arpin,[18] Wood County. The "crop" was "very good" at Prentice.[19]

Hough[20] was told by John Stevans, of Neenah, that "the number of partridges that were being shipped from Ogema [Price Co.] was something almost past beief. He said that time and again he saw heaps of partridges piled up at the station platform in piles reaching almost as high as his head. Shipments of 400 and 500 a day from that one point alone were the ordinary thing during the open season. . . . The local shooters are paid 40 cents for each bird they kill, sometimes as high as 50 cents. The bags run from twenty to forty birds a day to each man. . . . One man said he had shipped 1,500 birds last fall up to date, and he was still shooting, and had 75 ready to ship. This man said that he had paid off the mortgage on his farm by means of his market shooting."

The citizens of Neillsville, according to Hough,[21] were indignant at the buyers who were shipping 500 to 600 partridges daily. Elsewhere[22] it is stated that the shipments comprised "partridges and grouse," and that 30 cents apiece was paid. Thomas[23] reported that thousands of partridges were shipped from Chippewa County. "An agent on the Soo road in the northern part of the county has written me that 3,000 were shipped from his station alone and this is hardly one fifth of the total killed."

The following statement appeared at Marshfield:[24] "Levin and Son are not what would be considered extensive buyers, yet during the hunting season they have bought and shipped to Milwaukee parties, 2,000 birds. For these they paid to hunters on an average 20 cents apiece, a total of $400. Other concerns in this city did an equal and possibly a better business. From the hundreds of towns along the different lines of railroad in this part of the state, thousands of these birds were shipped. . . ."

Partridges were quite scarce at Merrill,[25] Shawano,[26] and Kewaunee,[27] and very scarce at Green Bay[28] and De Pere.[29] A hunter at Glidden[30] was considered "well rewarded" with a dozen.

[1] Antigo *News Item* Oct. 1; *Republican* Sept. 22. [2] Wausau *Central Wisconsin* Sept. 3 and 10. [3] Minocqua *Times* Sept. 1, Oct. 13. [4] Hurley *Miner* Oct. 4. [5] New London *Republican* Sept. 1 and 8. [6] Ashland (w) *Press* Oct. 8. [7] Peshtigo *Times* Oct. 1; Marinette *Eagle* Oct. 15. [8] Marinette *Eagle* Oct. 15. [9] Florence *Mining News* Sept. 17, Oct. 1 and 15. [10] Marshfield *Times* Oct. 14. [11] Cumberland *Advocate* Sept. 15 and 22. [12] Barron *Shield* Oct. 21. [43] Grantsburg *Sentinel* Sept. 29. [14] Rice Lake *Chronotype* Sept. 23 and 30, Nov. 4. [15] Rice Lake *Leader* Sept. 29. [16] E. Hough, *Forest and Stream* 51 (Oct. 8, 1898) 288. [17] Ashland (w) *Press* Sept. 24. [18] Grand Rapids *Reporter* Oct. 20. [19] Prentice *Calumet* Sept. 16. [20] E. Hough, *Forest and Stream* 52 (Jan. 14, 1899) 30. [21] E. Hough. *Ibid.* 51 (Oct. 29, 1898) 348. [22] Viroqua *Censor* Oct. 26, p. 1. [23] Milwaukee *Sentinel* Jan. 22, 1899, p. 10. [24] Marshfield *Times* Nov. 19. [25] Merrill *Advocate* Sept. 6 and 13. [26] Shawano *Journal* Sept. 15. [27] Kewaunee *Enterprise* Oct. 28. [28] Green Bay *Gazette* Nov. 30. [29] De Pere *Democrat* Oct. 21. [30] Ashland (d) *News* Sept. 29.

1899

There was a decided drop in the population, judging from the few reports available. These birds were reported plentiful at Marshfield,[1] Merrill,[2] and "upper Wisconsin."[3] They were fairly plentiful at Florence,[4] Coomer,[5] Spirit Falls,[6] Lincoln County, and Minocqua,[7] where a man bagged 15 in one day. They were reported plentiful at Koepinick,[8] Langlade County, but at Antigo[9] "all the hunters claim that partridges are very scarce this year." The scarcity at Marinette[10] was attributed to the late, wet spring. A man hunting at Dudley,[11] Lincoln County, killed only 6 partridges in two days. During a side hunt at Sparta,[12] in which nine men took part, only 3 partridges were listed in the game killed. Hunters at Superior[13] found only a few birds. Prentice[14] buyers were paying 20 cents apiece.

[1] Marshfield *Times* Sept. 2. [2] Merrill *Advocate* Oct. 3. [3] E. Hough. *Forest and Stream* 53 (Sept. 30, 1899) 267. [4] Florence *Mining News* Oct. 14. [5] Grantsburg *Sentinel* Oct. 12. [6] Tomahawk *Tomahawk* Sept. 30. [7] Minocqua *Times* Oct. 19. [8] Antigo *Republican* Sept. 7 and 14. [9] Antigo *News–Item*

Oct. 7. [10] Marinette *Eagle* Sept. 2, Nov. 4. [11] Tomahawk *Tomahawk* Oct. 14. [12] Sparta *Herald* Oct. 24. [13] Superior (d) *Telegram* Oct. 7, p. 7. [14] Prentice *Calumet* Oct. 13.

1900

The reports were more favorable than for 1899. The birds were stated to be abundant at Longwood,[1] Clark County, Rhinelander,[2] and Florence;[3] and quite plentiful at Minocqua,[4] Hurley,[5] Antigo,[6] Marshfield,[7] Wausau,[8] and Waupaca.[9] Two men at Marshfield[10] killed over 500 birds during the season. A timber cruiser, working in the northern part of Clark County, reported that he had never seen deer and partridges more plentiful.[11] Two men hunting near Melrose,[12] Jackson County, killed 46 birds. Though more plentiful at Merrill[13] than the preceding year, no large bags were made. A hunter at Glen Flora,[14] Rusk County, bagged 13 birds in "short order."

They were scarce at Green Bay.[15] At Sparta,[16] 18 men engaged in a side hunt and reported only 3 partridges amongst the game killed.

Game wardens seized several illegal consignments. A shipment of 41 birds from Glen Flora was seized en route to St. Paul.[17] Near Stevens Point,[18] mixed shipments of ruffed grouse and prairie chickens amounting to 500, 150, and 300 birds were seized. Hough[19] mentions that 700 partridges were confiscated in Milwaukee. There is doubt if all of these birds were ruffed grouse. A shipment of 596 partridges from Mather, Juneau County, was seized in Milwaukee early in September.[20]

[1] Greenwood *Gleaner* Sept. 29. [2] Rhinelander *Herald* Sept. 1; *Vindicator* Oct. 17. [3] Florence *Mining News* Sept. 8, Oct. 6 and 13. [4] Minocqua *Times* Oct. 18. [5] Hurley *Vindicator* Oct. 17. [6] Antigo *News–Item* Oct. 27. [7] Marshfield *Times* Aug. 3. [8] Wausau *Central Wisconsin* Sept. 1, Oct. 20. [9] E. Hough. *Forest and Stream* 55 (Oct. 6, 1900) 268. [10] Marshfield *Times* Nov. 9. [11] *Ibid.* Aug. 17. [12] Black River Falls *Banner* Sept. 13. [13] Merrill *Advocate* Sept. 18, Oct. 23. [14] Prentice *Calumet* Oct. 4. [15] *Forest and Stream* 55 (Dec. 29, 1900) 508. [16] Sparta *Herald* Oct. 16. [17] Barron *Shield* Nov. 30. [18] Stevens Point *Journal* Oct. 6, 20, and 27; *Gazette* Sept. 26, Oct. 17 and 24. [19] E. Hough. *Forest and Stream* 55 (Oct. 13, 1900) 288; Eau Claire (d) *Telegram* Oct. 2. [20] Eau Claire (d) *Telegram* Sept. 5, p. 5.

1901

Partridges seem to have been fewer than last year. They were reported very plentiful at Florence,[1] and Marshfield,[2] and "quite" numerous at Cumberland,[3] Greenwood,[4] Clark County, Coomer,[5] Burnett County, Rhinelander,[6] Antigo,[7] Wausau,[8] and Hurley.[9] They were scarce at Arcadia[10] and Galesville.[11] Some

Indians passed through Shell Lake[12] with about 300 partridges and other grouse to be sold in the Spooner market.

Game wardens seized shipments of partridges at Antigo,[13] Marshfield,[14] and Stevens Point.[15] A barrel of birds seized at Ladysmith[16] appears to have been the largest consignment.

[1] Florence *Mining News* Aug. 10 and 31, Oct. 12. [2] Marshfield *Times* Aug. 16, Oct. 4. [3] Cumberland *Advocate* Oct. 3. [4] Greenwood *Gleaner* Sept. 13, Oct. 11. [5] Grantsburg *Journal* Oct. 25. [6] Rhinelander *Herald* Aug. 31; *Vindicator* Sept. 11, Oct. 9. [7] Antigo *News–Item* Sept. 21; *Republican* Sept. 5, Oct. 10. [8] Wausau *Pilot* Sept. 24, Oct. 8. [9] Hurley *Miner* Sept. 3 and 24. [10] Arcadia *Leader* Sept. 13. [11] Galesville *Republican;* from Independence *News–Wave* Sept. 28. [12] Shell Lake *Watchman* Oct. 10. [13] Antigo *Republican* Oct. 24. [14] Marshfield *Times* Nov. 1 and 8. [15] Stevens Point *Journal* Oct. 26; *Gazette* Nov. 6. [16] Ladysmith *Journal* Oct. 19.

1902

Large numbers of birds were reported at Green Bay,[1] Sturgeon Bay,[2] Florence,[3] Marshfield,[4] Minocqua,[5] Cumberland,[6] and Superior.[7] The woods at Antigo[8] were "full" of birds, but they were decimated rapidly as a result of the $9.00 per dozen offered in Milwaukee; however, only 30 cents apiece was offered at Prentice.[9] A party of three men returned from Rice Lake with "plenty of partridges."[10] A game warden at Stevens Point[11] stated that "more birds are being killed this fall than ever before in his memory." An Appleton[12] hunter killed 14 partridges in a day's hunt at Marshfield.

The birds were "quite scarce" at Ladysmith,[13] daily bags running from 5 to 10; but in various parts of Rusk County the shooting was very good. At Shell Lake[14] they were "quite numerous." Hunters at Hurley[15] and Grantsburg[16] obtained only a few birds. While they were reported very plentiful at Florence[17] in September, in October two men obtained only 9 birds in a hunt of two days. At Wausau[18] they were scarce and fewer than in 1901.

Small shipments, up to 72 birds, were seized at Marshfield.[19]

[1] A. G. H. *Forest and Stream* 59 (Oct. 11, 1902) 292. [2] Sturgeon Bay *Democrat* Sept. 20. [3] Florence *Mining News* Aug. 30, Sept. 27. [4] Marshfield *Times* Aug. 29. [5] Minocqua *Times* Sept. 18, Oct. 9. [6] Cumberland *Advocate* Sept. 25. [7] Superior (d) *Telegram* Sept. 4, p. 3. [8] Antigo *News–Item* Oct. 4. [9] Prentice *Calumet* Oct. 30. [10] Merrill *Advocate* Oct. 14. [11] Stevens Point *Gazette* Oct. 1. [12] Appleton *Post* Sept. 25. [13] Ladysmith *Journal* Sept. 13 and 20, Oct. 4 and 11. [14] Shell Lake *Register* Sept. 13, Oct. 4. [15] Hurley *Miner* Sept. 17. [16] Grantsburg *Journal* Sept. 5. [17] Florence *Mining News* Oct. 6. [18] Wausau *Central Wisconsin* Aug. 30, Sept. 6; *Record* Sept. 18. [19] Marshfield *Times* Oct. 3 and 24.

1903

In most areas the population remained low. The birds were "unusually numerous" at Ladysmith,[1] and plentiful at Shell Lake,[2] Washburn County. Good bags were made at Rice Lake[3] and Cumberland[4] in Barron County. Three men hunted five days in the southern part of Ashland County[5] and killed 72 "grouse and partridge." Two men hunted several days at the mouth of the Brule River and reported that it was more difficult "finding partridge this year than usual."[6] At Ashland[7] the hunting was very uneven: "Many of the sportsmen have been very successful, securing as many as a dozen or more birds in a day while others have not even had an opportunity of seeing any. In some portions of the woods, where partridge were in years past very plentiful, none can be found."

The birds were very scarce at Hurley,[8] Florence,[9] and Wausau,[10] due, supposedly, to the "continued rains." Two hunters at Stanley[11] killed 14 birds in a hunt of two days. Greenwood[12] lamented that partridges and prairie chickens could no longer be sold, thus destroying "quite an industry for the northern part of the state."

[1] Ladysmith *Journal* Sept. 5. [2] Shell Lake *Watchman* Aug. 27, Sept. 3. [3] Rice Lake *Chronotype* Sept. 25, Oct. 16, Dec. 4; *Leader* Oct. 22. [4] Cumberland *Advocate* Sept. 17, Oct. 15. [5] Ashland (w) *Press* Oct. 17. [6] Superior (d) *Telegram* Sept. 24, p. 3. [7] Ashland (d) *News* Sept. 4. [8] Hurley *Miner* Oct. 21. [9] Florence *Mining News* Sept. 12. [10] Wausau *Central Wisconsin* Sept. 5; *Record* Sept. 17. [11] Stanley *Republican* Nov. 14. [12] Greenwood *Gleaner* Aug. 27.

1904

The reports were more favorable than the year previous. Sturgeon Bay[1] stated: "Reports from Marinette County state that partridges are scarcer this fall than they have ever been before. Just the opposite is the case in this county. Hunters report that partridges were never so plentiful. . . ." Overbeck,[2] writing from Madison, stated that they were very plentiful. They were reported plentiful also at Spencer,[3] Wood County, Withee,[4] Clark County, Medford,[5] and unusually plentiful at Ashland.[6] Game Warden P. H. Waterbury[7] stated that partridges were quite plentiful at Solon Springs, but that "grouse" were scarce.

The shooting was poor at Florence,[8] Phillips,[9] and Hurley.[10] At Rice Lake[11] there were fewer birds than the previous autumn, covies having only three or four birds; however, they were "reported to be found in profusion in the woods about Longlake, Birchwood, and Radisson." They were "extremely scarce" at Wausau.[12] There was fair shooting at Ladysmith.[13]

A warden seized, at Eau Claire, 16 dozen partridges that had been shipped from Sawyer County.[14]

[1] Sturgeon Bay *Democrat* Oct. 15 and 22. [2] H. Overbeck. *Forest and Stream* 63 (Oct. 8, 1904) 305. [3] Marshfield *Times* Nov. 11. [4] Greenwood *Gleaner* Sept. 22. [5] Medford *Star and News* Aug. 26, Oct. 14. [6] Ashland (w) *Press* Sept. 3. [7] *Ibid.* Oct. 8. [8] Florence *Mining News* Oct. 15. [9] Phillips *Times* Sept. 17. [10] Hurley *Miner* Sept. 2. [11] Rice Lake *Chronotype* Oct. 28. [12] Wausau *Pilot* Sept. 27. [13] Ladysmith *Journal* Oct. 22. [14] *Ibid.* Oct. 8.

1905

The population continued to increase, the hunting in Price County was excellent.[1] The birds were very plentiful at Fifield.[2] At Prentice[3] a man secured 19 birds in a day's hunt, while at Phillips a man "started up the Coolidge road and was gone nearly the whole day. When he returned he had in his buggy 74 partridges." Deputy Game Warden A. W. Gratz, Madison, stated on August 29: "Reports from the northern counties say that partridges are plentiful, but that prairie chickens suffered somewhat from wet weather."[5] They were reported abundant at Chippewa Falls.[6] There was good shooting at Ladysmith.[7] At Rhinelander[8] a huntress killed 11 birds in a forenoon, and at Florence[9] a man shot 36 in three days, 15 of which were secured in one forenoon. Two other hunters at Florence[10] obtained 11 birds in a day's hunt. The shooting at Marshfield[11] was good.

There were few birds at Superior,[12] Heller,[13] Lincoln County, and Hurley.[14] They were scarce at Ashland,[15] where "the partridge now being shot are all old birds which shows that the young birds this spring did not grow to maturity." Wausau[16] reported: "It is a fortunate and persistent hunter who bags more than one or two birds in a half day's hunting and almost all of those brought in so far have been old and tough."

[1] Phillips *Bee* Oct. 12. [2] Fifield *Tribune* Oct. 19. [3] Prentice *Calumet* Oct. 26. [4] Phillips *Times* Sept. 23. [5] Chetek *Alert* Sept. 1, p. 2. [6] Chippewa Falls *Independent;* In Ladysmith *Journal* Sept. 2. [7] Ladysmith *Journal* Sept. 9. [8] Rhinelander *Vindicator* Sept. 20. [9] Florence *Mining News* Oct. 21. [10] *Ibid.* Sept. 11. [11] Marshfield *Times* Nov. 3 and 17. [12] Superior *Telegram* Sept. 23, p. 7. [13] Merrill *Advocate* Oct. 24. [14] Hurley *Miner* Sept. 15. [15] Ashland (d) *News* Oct. 3. [16] Wausau *Record* Oct. 5.

1906

This year was a high in the cycle. The birds were reported as very numerous at two localities in Door County,[1] and at Medford.[2] They were very plentiful near Superior and at the mouth of the Brule River,[3] while "hundreds" were killed near Hayward.[4] At Cable,[5] Bayfield County, they were "more plentiful than ever before." Ralph Mitchell, of Rhinelander,[6] reported: "It is many years since birds were as plentiful as this fall. The woods are literally filled with grouse and partridges." They were numerous at Ashland[7] in comparison with the year previous. Here most hunters secured good bags, some as high as 18 birds in a single day. They were reported plentiful at Flambeau,[8] Vilas County, and quite plentiful at Rhinelander.[9] An optimistic report at Florence[10] was reversed a week later. Partridges were "very numerous" at Greenwood,[11] Clark County. Near Fifield[12] a man killed 13 birds on October 30, while returning from Pike Lake. Wausau[13] reported them "plentiful," and Marshfield[14] numerous. They were quite plentiful at Antigo.[15]

There was much hunting at Phillips,[16] but the bags were small. At Couderay,[17] Sawyer County, the shooting was not as good as the year previous, and only a few birds were secured early in the season. Two men driving on the roads west of Cumberland,[18] Barron County, secured 14 birds in a day's hunt. They were not plentiful at Stanley.[19]

Partridges were "quite plentiful" at Oconto.[20] At Peshtigo[21] hunters were "all more or less successful," one man securing 16 birds in three hours. A Marinette[22] woodsman reported that "he had never seen partridges as numerous as they are now."

[1] Sturgeon Bay *Democrat* Oct. 6 and 24. [2] Medford *Star–News* Oct. 5 and 19. [3] Superior (d) *Telegram* Sept. 12 and 29, Oct. 13. [4] *Ibid.* Oct. 6. [5] Washburn *News and Itemizer* April 12, 1907. [6] Milwaukee *Sentinel* Oct. 21, p. 4. [7] Ashland (d) *News* Oct. 2. [8] Rhinelander *Vindicator* Oct. 17. [9] Rhinelander *Herald* Oct. 13. [10] Florence *Mining News* Sept. 8 and 15, Oct. 13. [11] Greenwood *Gleaner* Sept. 6. [12] Fifield *Tribune* Nov. 1. [13] Wausau *Pilot* Sept. 4. [14] Marshfield *Times* Sept. 5, Oct. 10. [15] Antigo *News–Item* Sept. 28, Nov. 8. [16] Phillips *Bee* Sept. 6; *Times* Oct. 6. [17] Rice Lake *Leader* Sept. 14. [18] *Ibid.* Oct. 5. [19] Stanley *Republican* Sept. 29. [20] Oconto *Reporter* Sept. 6. [21] Peshtigo *Times* Oct. 25, Nov. 1. [22] Marinette *Eagle–Star* Sept. 22.

1907

There was a sharp drop this year. Amherst,[1] Portage County, reported partridges "more plentiful than useful." Hunters at Ladysmith[2] returned "with quite a bunch." They were, however, reported scarce to extremely scarce at Minocqua,[3] Phillips,[4] Florence,[5] and Wausau.[6] It was stated at Phillips:[7] "It is to be regretted that something can't be done immediately to restore the usual number of partridge in this part of the country, because some unknown cause has made this splendid fowl extremely scarce this season. . . ."

[1] Stevens Point *Journal* Sept. 14. [2] Ladysmith *Journal* Oct. 5. [3] Minocqua *Times* Sept. 26. [4] Phillips *Bee* Oct. 10. [5] Florence *Mining News* Sept. 7, Oct. 19, Nov. 16. [6] Wausau *Pilot* Oct. 8; *Central Wisconsin* Oct. 12. [7] Phillips *Bee* Oct. 24.

1908

Partridges were reported "quite plentiful" at Florence[1] and Antigo,[2] but at neither place was the hunting good. They were reported scarce at Phillips[3] and scarce for the state as a whole.[4] No "extraordinarily large" bags were obtained at Osceola.[5]

[1] Florence *Mining News* Sept. 19, Oct. 3. [2] Antigo *Republican* Sept. 10. [3] Phillips *Bee* Oct. 8; *Times* Oct. 24. [4] *National Sportsman.* In Nekoosa *Times* Oct. 8. [5] Osceola *Sun* Sept. 10.

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STUDIES IN ORNITHOLOGY AT LAKE KOSHKONONG AND VICINITY BY THURE KUMLIEN FROM 1843 TO JULY, 1850

ANGIE KUMLIEN MAIN

This paper is based chiefly on the Swedish Journal kept by Thure Kumlien from February 14, 1844, to January 5, 1850, and other papers in his handwriting.

I have in my possession a paper dated May 15, 1843, which is written in Swedish by him before he left Sweden and contains a list of his Upsala University laboratory equipment and some mounted birds among which are mentioned swan, partridge, eider duck, eagle, lark, etc. It also lists books and the furniture of his room. The pieces named are one chair, a back cupboard, a case, etc. The price is listed after each article, so they are apparently being offered for sale to help raise money to come to America.

The next signed paper by Thure Kumlien is a note dated May 29, 1843, to a nobleman friend, Carl Gustaf Lowenkjelm, which shows Thure borrowed a sum of money for his passage to America. At the bottom of the note is a notation by Lowenkjelm on February 11, 1859, stating that the money had all been paid by Thure Kumlien by his sending collections of birds and other objects of natural history.

A passport before me is number 1397 and is made out for maiden Christine Wallberg, born in Upland, Sweden, with residence in Stockholm; another numbered 1398 is made out to maiden Sophia Wallberg with same birthplace and residence as her sister Christine. The last one, numbered 1399, is made out for student Thure Kumlien, born in Westergothland, Sweden, from Upsala. They are all dated May 31, 1843, and the passengers are all bound for New York. From a photostatic copy of the original passenger list of the log of the sailing vessel, the "Brig Swea,"[1] on which the above three sailed, I find that the ship landed in New York Harbor on August 16, 1843.

[1] Original list found in the archives at Washington, D. C.

In comparing the passenger list which I received after the publication of the biography[2] of Thure Kumlien, I find that James Worm, an instrument maker from Denmark, and Charles E. Westring, Lars and Andrus Wahlin from Sweden and Alice Benneworth, aged 71, mother of James Benneworth from England, were also passengers on the "Brig Swea" and settled near Lake Koshkonong. (The above names were not mentioned in my biography of Thure Kumlien.) In later years, James Worm hunted birds for Kumlien. James Benneworth came to bring his mother to the home of Samuel Kirby on the northwest shore of Lake Koshkonong where he had settled in 1841.[2] Mr. Benneworth acted as interpreter for the Swedes on board ship and in New York City. I mention this because I think it had a bearing on the place of settlement of these Swedes at Lake Koshkonong.

These passengers traveled by way of the Erie Canal and the Great Lakes to Milwaukee and while at Buffalo, New York, Kumlien probably met a Mr. Dole with whom he corresponded soon after arriving in Wisconsin. He was either interested in ornithology or was connected with shipping, for I find in Kumlien's journal under date of August 4, 1844: "Got a letter from Mr. Dole from Buffalo." Other records show that birds were shipped to him.

On August 28, 1843, Kumlien signed his intention of becoming a citizen of the United States in Milwaukee, Territory of Wisconsin. At the same place on September 5, 1843, Thure Kumlien and Christine Wallberg were married.

During a part of September and October the men of the party walked to Lake Koshkonong, staked their claims, and probably all except Thure Kumlien built temporary shacks until they could get their warmer log cabins built. I have a letter in which Kumlien states that he was on the lake every day for the first six months. His deep interest in ornithology and his being unused to manual labor of any kind is what probably prompted him to take possession of an old deserted hunter's cabin which had an open fireplace with a large outside stone chimney. This cabin was situated about fifteen rods southeast of the Elias Downing log house, which had been built in 1842, near what is now the Carcajou Club House. This Downing farm is now a

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[2] In "Thure Kumlien, Koshkonong Naturalist," *Wis. Mag. History*, 27 (1943) 17–39, 194–220; 27 (1944) 321–43, the dates of the settlement of Samuel Kirby and Elias Downing are changed around.

part of the late H. L. Skavlem farm. The present frame farm house was built around Downing's log house.

Thure and his bride, Christine, and her older sister, Sophia Wallberg, lived in this old cabin until the weather became too severe, when they moved in with Mr. Downing's people. They remained with the Downings until toward spring, when they went back to the cabin. They stayed here until the following January 20, 1845, when they moved to a new log cabin on their own claim, which was near Lake Koshkonong and about a mile northwest of Mr. Downing's.

This past summer, on May 20, 1944, I saw for the first time the site of this old hunter's cabin, which is only a few steps from the Noland cottage. It is a beautiful location with a grove of large ancient bur oaks near by. One of them is so near that it must have shaded the old cottage in those early days. Two springs near the lake shore are within sight, one of them having furnished water for these early settlers. The old cabin stood on a rather high piece of land which slopes gently to the lake shore. Mr. Charles Hammerquist, who is nearly ninety-five years old, tells me he lived in the Downing log house for a few years when he was a boy and played with the children who were then living in this old hunter's cabin.

From here one has a fine view of the lake. To the right is Willow Point, a long, narrow, wooded peninsula that extends out into the water from the mouth of Koshkonong Creek, which enters the lake here. The land has been built up through long years of deposition of the debris brought down by the current of the stream, and by floating canebrake.

It is now a wilderness of white and black ash, willows and soft maples. Along the edges of the trees the red osier and panicle dogwood, the button bush, the six-foot rushes and then the lower patches of blue flag and the big glossy arrow-shaped leaves of the arrow-head crowd the shore to the very water's edge, making the place a veritable jungle.

Between the peninsula and where we stood was a small marshy bay which was literally covered with large herring gulls. Occasionally one would leave the others and gracefully fly out over the lake, then return to feed on the dead fish which the waves had washed into the tiny bay.

Purple martins flew in and out of their house and sallied out over the marshy shore for their insect fare. When Thure Kumlien first came here, these swallows were nesting in holes in trees and did until 1869. The pewees sang their plaintive song from the old oaks, while the yellow-bellied and least flycatchers watched in the same trees.

The hairy, downy and red-headed woodpeckers were busy on the trunks of the trees. The black terns skimmed over the water and the barn and bank swallows also hunted there for their food.

Blue jays, house wrens, goldfinches, yellow warblers, flickers, Baltimore orioles, bluebirds, white-breasted nuthatches, song sparrows and a whole army of red-winged blackbirds claimed my attention as I walked among the oaks and followed the old path to the spring down by the lake shore.

Many changes have taken place here in the bird world during the past 100 years since Thure Kumlien's first appearance at Lake Koshkonong and the lake itself is not the same. It lies mostly in Jefferson County with a small part of its western edge in Dane County and the southern extremity in Rock County; it is nine miles long and four miles wide. This lake has many broad shallow bays, most of which are bordered by marshy or swamp areas, so it has a very irregular shore line. Before the advent of the white man it was for centuries the home of the aborigines. In the Winnebago language, it means "the lake we live on." Mute evidence of this is told by the nearly 500 Indian mounds, most of which still dot the shores and adjacent land.

Lake Koshkonong is a widening of Rock River and is fed by numerous springs. In the territorial and early days of this state, the lake as a whole was not as deep as it is now. Wild rice and wild celery grew abundantly in the bays and shallow parts of the lake. This change in the depth of Lake Koshkonong was brought about by the construction of a dam at Indian Ford which is about four miles below the outlet of the lake. "The Indian Ford dam is located in sections 16 and 21, township 24 north, range 12 East, Rock County. It appears to have been authorized by the Territorial Legislature of Wisconsin, approved April 7, 1843, and by Chapter 339, Laws of 1851. Since said time a dam has been continuously maintained at the present site by the grantees and their assigns under said legislative acts."[3]

[3] Public Service Commission of Wisconsin, from docket No. 2–WP–461.

When this dam was changed from a height of four feet to six or seven feet, the depth of the lake was greater. This killed the wild rice, except that which grew in the shallow bays.

When Dr. Increase A. Lapham visited Lake Koshkonong in 1850, he wrote: "The water is from 4 to 12 feet deep. At the time of our visit in July, wild rice was growing abundantly over almost its entire surface, giving it more the appearance of a meadow than a lake."[4]

In a letter written August 15, 1886, by Frithiof Kumlien to his father, Thure Kumlien, he says, "Thursday I took the Slagg boys out sailing. You would laugh to have seen the lake, grasshoppers and birds can walk clear across on the weeds."[5]

Governor Hoard told me that once in the fall of the early 1870's, Thure Kumlien invited him to go to the lake with him before daylight to watch the migration of the famous canvasback ducks. He said, "We lay flat in the boats on the shore and did not have long to wait before a roaring of wings was heard in the distance. As they flew over us, the noise became greater. On and on they came, great hosts of them. When morning broke, the water was covered with these beautiful ducks as far as the eye could see."

They had come here to feed on the wild celery buds (*Vallisneria spiralis*) and on the nutlets from the pond weeds, one of them belonging to the family *naiadaceae.*[6]

The redheads came here too in the fall and spring to feed on the same plant food as the canvasbacks. After a month or more of this plant food, the flesh of these two kinds of ducks was considered a great delicacy.[7]

In the forties Thure Kumlien didn't seem to be sure about the canvasbacks and the redheads for, on a list of birds seen at Lake Koshkonong, signed by him and dated 1850,[8] he mentions only the redhead. The early hunters at this lake were confused for quite some time because they called them the big and little

[4] *Wisconsin Antiquities*, p. 35.

[5] Letter in possession of the writer.

[6] See *Birds of Wisconsin* by Kumlien and Hollister, pp. 21–22.

[7] There were several springs in the marshes directly south of the home of Thure Kumlien where this wild celery grew in the water around them. The early settlers used to come to these springs to gather the celery for use on their tables. Information given to writer by Chas. Hammarquist in 1945.

[8] List of birds in possession of writer which will be given to the Wisconsin State Historical Society.

redheads. Eastern hunters had told our hunters that "there were no true canvasbacks in the West."[9]

In 1881 carp were introduced into Lake Koshkonong, unfortunately successfully, for they cleaned out the wild celery and pond weed and drove out the most of the native fish. Consequently the myriads of water fowl which once haunted its waters are now becoming a memory.

Thure Kumlien began his work as a naturalist at Lake Koshkonong before the hand of man had had a chance to destroy its rich treasures of plant and bird life. Old Koshkonong was then in the full tide of its glory as a lake for waterfowl.

The first dated record I have of Thure Kumlien's bird work is in his old Swedish Journal[10] under date of February 23, 1844. This and other bird records will follow in the order given.

> "Feb. 23, 1844, Cut 10 foot rails. Stuffed a blue jay. Carrick came here with new ale.
> "Feb. 26, Helped Carrick all afternoon. Janson saw six ducks.
> "Feb. 29, Saw two wild geese. Built at a hen house.
> "March 7, Shot 4 blackbirds. Cut down 2 large trees. Burned some grass.
> "March 8, Rainy and misty weather. Shot four blackbirds, and prepared two squirrel skins.
> "March 12, Rain. Did nothing but a little wood chopping. Shot more blackbirds."

Next day he mounted some birds.

> "March 14, at Downing's in the morning. Got some specimens at lake."

Next day Thure shot some more blackbirds and three squirrels.

> "March 16, Skinned two blackbirds and three squirrels.
> "March 17, Hard storm in night. Finished two blackbirds and looked over others.
> "March 26, Caught 19 fish; shot three ducks. Two of the fish weighed five pounds. None under 1½ pounds.
> "March 30, Nothing. Hunted. Worm here. Shot a crane [probably a sandhill[11]] and a tern."

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[9] Statement of Ira Bingham, famous early duck hunter of Lake Koshkonong, but who hunted several years later than 1843.

[10] This Swedish Journal was translated by A. O. Barton of Madison, Wisconsin, and is in the State Historical Society of Wisconsin.

[11] From a practice copy of a letter written by Thure Kumlien, I quote, "I have lived on the same place for nearly eight years and every spring there has been a pair of cranes on the marsh below my house; they have had their nest

The next day he hunted and worked at skins. Worm was there.

"April 9, Prepared bird skins.
"April 10, Shot two prairie chickens. Chopped some wood." [The common prairie chicken at this time was the prairie sharp-tailed grouse (*Pedioecetes phasianellus campestris*) and was very abundant in the forties. Later, it was gradually replaced by the prairie hen *(Tympanuchus cupido americanus)* as the country became more settled.]
"April 9, Prepared bird skins.
"April 10, Shot two prairie chickens. Chopped some wood.
"April 21, Caught two redhorses and shot six pigeons." [Wild pigeons or passenger pigeons.]

On April 23 and 24, he shot some birds but did not mention what kind. On May 2, Thure shot some birds and records that on May 4, he helped Mellberg a while in forenoon and shot nine fine birds. On May 11, he located a pair of cranes, undoubtedly sandhill.

"May 12, Shot some birds with handmade shot.
"May 19, To Fort Atkinson with a letter to Buffalo."[12]

The next day he found a couple of cranes near the end of the marsh.

"May 25, Rain all day. Shipped birds.
"June 2, Hunted in woods but got only two pigeons.
"June 8, Rainy weather. Stuffed one bird."

The next few days he mentions shooting some birds.

"June 18, At Fort to see about letter from Buffalo.
"June 24, Shot nine birds, midsummer day.
"Aug. 4, Got letter from Buffalo, Mr. Dole.
"Jan. 9, Puttered with the mounting of a prairie chicken.
"Feb. 16, At Reuterskiold's a while. Shot a woodcock and a gray squirrel. Rained and snowed in the night.
"Feb. 19, Heard some small birds today.
"Feb. 20, Heard the gray goose a couple of days ago. Neighbor thinks it will soon be green down in the swale. Repaired my boots.

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there and one spring they had it placed so I could see her sitting on her eggs from my window. I did not disturb her, as I loved to have the stately bird sitting on the marsh unmolested, but one of my neighbors had a different taste—set his dogs on them and fired at them without any other effect than that they have been rather shy since and keep on another side of the marsh. I will endeavor to get you a good skin of one next spring. If I cannot shoot any myself, having no rifle, I will hire one shot."

[12] His correspondent at Buffalo was a Mr. Dole.

"Feb. 21, Helped Carrick from 10 to 4 cutting logs for his bridge. Piled up some brush where I am thinking of breaking. Saw a flock of small gray birds in the black oaks next to the breaking. They seemed to be on flight, but I could not tell their variety. Norwegian Johnny came to borrow tools.

"Feb. 22, In forenoon cut stuff for about fifty rails and at eleven hauled stuff for about twelve rails and a load of wood. In the evening called at Carrick's to see about his sickness. Heard trana [crane] and blackbird singing today. Water rising. To Carrick's with some potatoes.

"Feb. 23, Nothing in particular. Fine weather. Fixed a prairie chicken.

"Mar. 2, Stuffed some small birds and was out looking for birds and squirrels. Mellberg here.

"March 27, Yesterday I shot a muskrat on the lake and one prairie chicken.

"March 28, Shot a prairie chicken with rifle and hauled two loads of stone. Shot a lark. [Horned lark or prairie horned lark.]

"March 30, Labeled and packed thirty birds for Dole of Buffalo and six for Norway's museum.

"April 1, Stuffed a pair of birds.

"April 6, I walked to Fort Atkinson[13] and bought 1¼ lbs. of shot for a muskrat skin and took eleven pounds of shot on credit. One dollar for the shot."

In the next few days Thure speaks of shooting prairie chickens.

"April 13, Sunday. Mounted birds."

The next week Thure shot ten ducks and several prairie chickens and mounted birds. The 28th and 29th he hunted and fixed birds, shot and skinned a blue jay and shot a sparrow hawk. Rain and hail fell as large as eggs.

"April 30, Stuffed birds and fixed two boxes of them. I now have birds fixed for $12, if I can sell them.

"May 4, Shot a nighthawk.

"May 5, Stuffed birds and shot a notskeriker, night crier.[14]

"May 6 & 7, At Whitewater for Ole Lind who is to pay me four shillings or 25 lbs. of meal for my oxen and work for me two days. I bought fifty lbs. of fresh meal flour for 75¢ and one bu. shorts for fifty cents. Sold birds for $2.50 cash.

"May 25, Stuffed a pair of sylvia. [Old scientific name for warbler.]

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[13] A distance of twelve miles.

[14] Might be nighthawk or night heron.

"June 2, Hunted in woods but only got two pigeons.
"June 13, Planted corn at Mellberg's, shot a specimen.
"June 18, At Fort to see about a letter from Buffalo."

Birds are not mentioned again for six months. Everyone in the family and many in the settlement are ill with fever and ague, and have a very hard time to get along and attend to their crops and threshing.

1846

"Jan. 1, Severe weather. I accomplish nothing. Looked up a place for cleaning wheat in the wind. Farbro put things in order for it. I moved my birds and deer skins to Farbro's.
"Feb. 10, Chopped wood. Shot a prairie chicken and prepared for a trip to Pine Lake.[15]
"March 22, Out hunting and fishing but got nothing except a prairie chicken and a pigeon.
"March 23, One prairie chicken.
"March 25, Nothing more than to skin a penelope.[16] Shot a blackbird and a pair of bommer [meaning not known]. In evening skinned a pair of ducks, 1 penelope and a high [illegible] Fuligula.
"March 29, In afternoon I went hunting at Downing's point. Shot two Fuligula ferina [redhead] and another Fuligala [probably canvasback].
"March 31, I stuffed a pair of ducks. Laid up fence and cut new rails. Shot a pair of geese and a pigeon.
"April 3, Continued Mellberg's houseraising in forenoon. I'm not well. Stuffed some birds. Received of Dr. Head pay for prairie chickens, mudhens and [illegible] at 50¢ each.
"April 5, Never saw more bommer.
"April 11, Nice weather after storm. Cold. B. J. gets a prairie chicken.
"April 12, Easter. Fixed some birds.
"April 13, Stuffed a prairie chicken.
"April 17, Did nothing but stuff a prairie chicken.
"April 23, Upon the prairie to see about wheat at Slaters. Shot three prairie chickens. Split twenty rails in the evening.
"April 27, I split 25 rails. Hindered by Carrick's visit. Shot a trana. [Swedish name for crane.]
"April 28, Rained all day. At Carrick's. Skinned the trana.
"May 3, Out to see if I could find any snakes or fish. Shot a teal duck, one quail and one prairie chicken.
"Nov. 11, Cleaned a cat [wild cat]. Fixed a hawk skin.
"Dec. 8, In forenoon puttered with some new birds.

[15] To visit Rev. Unonius, a Swedish Episcopal minister.

[16] Penelope is the specific name of the European wigeon, but he undoubtedly had the American wigeon in mind.

1847

"Jan. 5, Butchered a large gobbler and a hog. [Undoubtedly a wild turkey.]
"Jan. 30, In the afternoon fixed two bird skins.
"March 13, Fixed a pair of birds.
"April 9, Laid up a fence and fixed a pair of Strix [owls].
"April 20, Ran around to borrow salt, did not succeed. In afternoon fixed a vitvea. [Not decipherable.]
"May 2, Fixed Dr. Head's birds for which he paid me four new dollars.
"May 3, Shot three snapyroil." [Meaning not known.]

The first week in May Kumlien worked quite steadily at his birds.

"May 9, Fixed some birds and one woodchuck. To Green's with two trana for $1.00.
"May 18, Fixed a glass box with birds and took it to Catfish [now Fulton].
"May 21, Rained. Stuffed Tra. etc.
"May 22, At Catfish after 4½ bu. grist for myself and for five others. Sold birds for $1.75.
"May 23, Fixed a little on Dr. Head's birds. With Hammerquist at Blackhawk Island but did not shoot anything.
"May 27, Planted 7 small pails of potatoes. Fixed four bird skins for an Englishman.
"June 18, In forenoon sold bird skins for $4.00 and worked at fixing four others for $1.00.
"July 4, America's high festival day. In afternoon to store with five pounds butter. Shot one duck. Fia home.
"Aug. 9, Shot three fine white ardeidae. [Probably American egret.]
"Aug. 22, Shot seven ducks Saturday and fixed three today.
"Oct. 2, Made a mounting.
"Oct. 3, Shot four shitepokes and a blue crane.
"Nov. 6, Cleaned manure out of the stable. Rain and cold with thick weather and strong storm. Wrote and sent Friday (yesterday) a letter to J. G. Bell, New York, about birds.
"Dec. 11, Butchered a pig in forenoon, went after an eagle in the afternoon.

1848

"Feb. 18, Translated for Dr. Dass [Dr. Dundass] on his accounts. Took gray goose.
"Feb. 26, At Fort Atkinson, letter from Bell. Got word from Willard, selling a box of birds to Pelton for $2.00.
"Feb. 27, Shot two [illegible] and one lark.

"March 21, At Dietrichson's for Wilson's Ornithology.
"March 29, Have sore throat. Split 16 rails. Got of Mrs. Reuterskiold $1.50 for 6 bu. potatoes and $1.50 on fees [Thure Kumlien appraised the Reuterskiold estate when Mr. Reuterskiold died] which equals $3.00 which I sent with Preston Downing to Unonious and birdboxes from Milwaukee to pay for Wilson's Ornithology."

In a letter to Thure Kumlien from Rev. Gustaf Unonius, Pine Lake, Wisconsin, dated March 14, 1848, and which was sent to him through Pastor Dietrichson (pastor at one of the Koshkonong Lutheran churches) at the Christiania Post Office, Dane County, is a reference to Wilson's Ornithology as follows: "You have received, I believe, the book from Pastor Dietrichson. It cost $3.00, which little sum I have paid out. When you send it to me, send the letter with the money to Delafield Post Office as until further notice this will be my address. The other book which you asked me to buy costs $30. So I thought it best not to buy it. Write soon to me. God be with us all. Your indebted friend, G. Unonius."

This book was the first bird book he ever had on American birds. The $30 book Kumlien wanted was one by Audubon, who was living at this time.

"April 2, I shot four ducks and Tetrao umbellus [ruffed grouse] on a visit at Mellberg's.
"April 11, Yesterday arranged to stuff a pelican for Mr. Harden in Catfish. Chopped a little near the woods.
"May 3, Planted six pails of early potatoes and onions. Had visit in tamaracks of Pelicanus erythroryhnchus [American white pelican].
"May 5, I laid up a fence. Shot a sialia sialis [bluebird], a Baltimore Oriole and a Tetrao. Dass here on medical errand.
"May 9, In the Norwegian Settlement after Fjargallare. [Probably Swedish name for butterflies.]
"May 21, Hunted down by the lake. Phalaropus lobatus [Northern phalarope].
"May 22, Rained the greater part of the day. I was lucky enough to shoot four Phalaropus lobatus.
"June 1, Sold a prairie hen to H. Hull for 50¢.[17]
"June 4, Rained in night. Pelican visitors.
"June 8, Hoed. Planted potatoes. Finished a bird cabinet.
"June 12, Second day of Pentecost. Out on the lake sailing and hunting. Christine along.

[17] This might be his first *Tympanuchus americanus* which, in after years, nearly replaced the prairie sharp-tailed grouse in southern Wisconsin.

"June 19, Hoed in forenoon. Fixed a bird box.

"June 28, At Clinton and Cambridge. Sold a bird box for a pair of boots, $2.50.

"July 4, America's holiday. Rained all day. In the evening a big flock of bird visitors arrive.

"July 30, Shot a white gull, one gray blue large ---------- one Totanus [probably yellow-legs] and two Charadrii [plovers].

"Sept. 14, Nothing. Shot three wood ducks.

"Sept. 22, Fia cocked up a little hay. I shot five ducks.

"Oct. 14, Gubben plowed and I fixed my bow and made three arrows for hunting hens.

"Nov. 9, My birthday, 29 years old. A considerable age.

1849

"March 1, Yesterday Hammarquist saw and heard a gray goose.

"March 10, Swen cut two new logs for the house and trimmed a pair of others. I worked on the house. Yesterday I saw crow-blackbirds [bronzed grackle].

"March 11, Spring seems near. Bluebirds.

"March 12, After the grist at Clinton.[18] Saw a flock of Bl. Migratora [bluebirds].

"March 13, Turdus migratorius [robin]. Chopped for house.

"March 16, Saw Wood ducks. Hammarquist in. Heard Trana. Beautiful day. Strong frost in night. Have seen Trana.

"March 25, Cold night. Snowed yesterday. Some fish appear to be running. Not many small birds yet. *Fringilla hyemalis* [slate-colored junco] and *Fringilla arborea,* [Wilson, is the tree sparrow], *Emb. lapp.* [lapland longspur] and *Al. Alpestris* [*Alauda Alpestris,* northern horned lark]. Blackbirds have been here in large flocks.

"March 29, Shot a pair of hens.

"April 9, Rained nearly all day. Fixed some birds for Sweden.

"April 11, Heard *Totanus Bartramius.* [Bartram's sandpiper.]

"April 18, Shaved shingles. Stuffing a *pelicanus Americanus* [American white pelican].

"April 19, Sowed and dragged about an acre. In afternoon worked on pelican. Bjorkander and Henry Carrick buy the old sawmill.

"May 7, Carrick brought a red bird to stuff. Rainy. Mr. James Clarke, an Englishman brought four birds to stuff.

"May 13, Sunday. Lots of visitors. Mr. Clarke brought six birds to stuff. Stuffed two of them and shot four.

[18] Now Rockdale.

"May 21, Planted corn. Stuffed a highholder [flicker] for Mr. Clarke.

"May 22, At Rice's with 3 pounds 5 oz. butter for which I got 3# sugar. Got of Clarke's boys 2½ bu. corn for fixing birds, $4. Grubbed a little.

"May 26, At store with 3# butter with which I bought a jug of tack [vinegar] 25¢. Received of Randall 4 bu. corn for a pair of *Tetrao cupido* [pinnated grouse, prairie chicken] $1.00.

"May 29, Chinked and mudded at stable. Grubbed a little in afternoon. Shot a scarlet Tanager.

"May 30, Stuffed a scarlet bird for Jenken's boy.

"May 31, Stuffed a *fulig. rubida* [old name for ruddy duck].

"June 2, Cut and split 80 shingles. Moved the fence by the stable. Put eyes in several birds.

"Nov. 4, Music of *Totanus* [one of the species of yellow-legs] in afternoon.

"Nov. 23, Busy, heard *Totanus* all day.

"Nov. 28, Got of Dr. Head 94¢ on payment of pelican. Worked a little on house.

"Dec. 8, Skinned a *Grus Americanus* [whooping crane].

"Dec. 12, Wrote letter to Sweden and fixed a Crane."

The last date in the journal concerns a bird and is under date of

"Jan. 5, Worked on a swan."

As Thure Kumlien did not always give the species of a bird mentioned in the old journal, but would write, "I saw six ducks," "heard music of the *Totanus*," etc., I cannot give the exact number of different birds seen by him at Lake Koshkonong in the 1840's. Many translations are missed because the words were not decipherable.

The blue jay was the first bird mentioned in the journal; the most common birds were red-winged blackbirds, prairie chickens and quails. The robin, *Turdus migratorius,* was not mentioned until March, 1849, and the bluebird was first mentioned two days earlier.

I have in my possession a list of birds, dated June 14, 1850, and signed by Thure Kumlien, that he had met with in Wisconsin on the west side of Koshkonong Lake in Jefferson County. This list contains several birds not mentioned in the journal and the journal contains a few birds not found on this list. This list is written with the old scientific names which have been translated into the present-day common names.

1. Falco leucocephalus ______	Bald Eagle
2. Falco sparverius _________	Sparrow Hawk
3. Accipiter pennsylvanicus (Swainson) __________	Sharp-shinned Hawk
4. Falco cyaneus ___________	Marsh Hawk
5. Falco leverianus _________	Eastern Red-tailed Hawk
6. Strix nyctea ____________	Snowy Owl
7. Strix tengmalmi _________	Richardson's Owl [might be confused with Strix asio —screech owl]
8. Strix nebulosa __________	Barred Owl
9. Strix virginiana _________	Great Horned Owl
10. Caprimulgus vociferus ___	Whip-poor-will
11. Caprimulgus virginianus__	Nighthawk
12. Cypselus pelasgius ______	Chimney Swift
13. Hirundo riparia _________	Bank Swallow
14. Alcedo alcyon ___________	Kingfisher
15. Muscicapa tryannus _____	Kingbird
16. Muscicapa crinita ________	Crested Flycatcher
17. Muscicapa fusca _________	Phoebe
18. Lanius borealis _________	Great Northern Shrike
19. L. excubitoroides ________	Migrant [or Loggerhead] Shrike
20. Turdus migratorius ______	Robin
21. Turdus minor (Bonap) __	Hermit Thrush
22. Turdus felivox (Bonap)__	Catbird
23. Turdus rufus ___________	Brown Thrasher
24. Sylvia coronata _________	Myrtle Warbler
25. Sylvia aestiva ___________	Yellow Warbler
26. Sylvia canadensis _______	Black-throated Blue Warbler
27. Sylvia trichas ___________	Maryland Yellow-throat
28. Troglodytes palustris ____	Marsh Wren
29. Troglodytes aedon _______	House Wren
30. Troglodytes americanus __	Audubon Wood Wren [confused with House Wren in fall plumage]
31. Regulus satrapa _________	Golden-crowned Kinglet
32. Regulus calendula _______	Ruby-crowned Kinglet
33. Sialia wilsonii (Swainson)	Eastern Bluebird
34. Certhia familiaris _______	Brown Creeper
35. Parus atricapillus _______	Black-capped Chickadee
36. Alauda alpestris _________	Northern Horned Lark
37. Fringilla pennsylvanica __	White-throated Sparrow
38. Fringilla gramina _______	Vesper Sparrow
39. Fringilla canadensis _____	Tree Sparrow
40. Fringilla hyemalis _______	Slate-colored Junco

41. Fringilla linaria ---------- Redpoll
42. Emberiza lapponica ------ Lapland Longspur
43. Emberia nivalis ---------- Snow Bunting
44. Cyanospiza cyanea ------ Indigo Bunting
45. Carduelis tristis ---------- Goldfinch
46. Pipilo erythrophthalmus -- Red-eyed Towhee
47. Coccothraustes ludoviciana Rose-breasted Grosbeak
48. Pyranga rubra ----------- Scarlet Tanager
49. Icterus baltimore --------- Baltimore Oriole
50. Icterus spurius ----------- Orchard Oriole
51. Icterus agripennis -------- Bobolink
52. Icterus pecoris ----------- Cowbird
53. Icterus xanthocephalus --- Yellow-headed Blackbird
54. Icterus phoeniceus -------- Red-winged Blackbird
55. Quiscalus major ---------- Boat-tailed Grackle [mistake; not here]
56. Quiscalus versicolor ------ Bronzed Grackle
57. Quiscalus ferrugineus ---- Rusty Blackbird
58. Sturnella ludoviciana ---- Meadowlark
59. Corvus corax ------------- Raven
60. Corvus americanus ------ Crow
61. Garrulus cristatus ------- Blue Jay
62. Sitta carolinensis --------- White-breasted Nuthatch
63. Quote: "There is a humming bird here, which one I don't know."
64. Picus pileatus ------------ Pileated Woodpecker
65. Picus villosus ------------ Hairy Woodpecker
66. Picus pubescens ---------- Downy Woodpecker
67. Picus varius -------------- Yellow-bellied Sapsucker
68. Picus carolinus ----------- Red-bellied Woodpecker
69. Picus erythrocephalus ---- Red-headed Woodpecker
70. Picus auratus ------------ Flicker
71. Coccyzus erythrophthalmus Black-billed Cuckoo
72. Ectopistes migratoria ---- Passenger Pigeon
73. Ectopistes carolinensis --- Mourning Dove
74. Ortyx virginianus -------- Quail—Bobwhite
75. Tetrao umbellus ---------- Ruffed Grouse
76. Tetrao cupido ------------ Pinnated Grouse—Prairie Chicken
77. Tetrao phasianellus ------ Sharp-tailed Grouse
78. Gallinula chloropus ------ Florida Gallinule
79. Fulica americana --------- American Coot
    Quote: "Three species of *Rallus* I think I have had but had no ornithology then."
80. Grus americanus --------- Whooping Crane
81. Ardea nycticorax --------- Black-crowned Night Heron
82. Ardea lentiginosa -------- American Bittern
83. Ardea exilis -------------- Least Bittern
84. Ardea herodias ----------- Great Blue Heron

85.	Ardea candidissima ------	Snowy Heron
86.	Ardea egretta -----------	American Egret
87.	Charadrius vociferus ----	Killdeer
	Quote: "and I think one smaller Charadrius."	
88.	Tringa alpina -----------	Red-backed Sandpiper
89.	Totanus Bartramius -----	Upland Plover
	Quote: "Two or three more species" not identified	
90.	Limosa (I think) hudsonica	Hudsonian Godwit
91.	Scolopax wilsonii --------	Wilson's Snipe
92.	Scolopax noveboracensis --	Eastern Dowitcher
93.	Microptera americana ---	American Woodcock
94.	Numenius longirostris ---	Long-billed Curlew
95.	Phalaropus wilsonii -----	Wilson's Phalarope
96.	Anser canadensis --------	Canada Goose
97.	Anser bernicla ----------	American Brant
98.	Cygnus buccinator ------	Trumpeter Swan
99.	Anas boschas -----------	Mallard
100.	Anas americana ---------	Baldpate
101.	Anas acuta -------------	Pintail
102.	Anas sponsa ------------	Wood Duck
103.	Anas carolinensis --------	Green-winged Teal
104.	Anas discors ------------	Blue-winged Teal
105.	Anus clypeata ----------	Shoveller
106.	Fuligula ferina ----------	Red-head
107.	Fuligula marila ---------	Scaup
108.	Fuligula rufitorques ------	Ring-necked Duck
109.	Fuligula rubida ---------	Ruddy Duck
110.	Fuligula albeola ---------	Buffle-head
111.	Mergus merganser -------	American Merganser
112.	Mergus cucullatus -------	Hooded Merganser
113.	Pelecanus americanus ----	American White Pelican
114.	Sterna hirundo ----------	Common Tern
115.	Sterna nigra ------------	Black Tern
	Quote: "Two or three species of *Larus*—Gulls"	
116.	Colymbus glacialis -------	Loon
	Quote: "One species of *Grebe* or *Podiceps*"	

At the end of the list Thure Kumlien writes, "This list, of course, is very imperfect, but having not until late been able to get a book on the subject and but little time to spend on hunting, it is very likely that I have not mentioned half of the birds we have here."

By the will of Thure Kumlien, his natural history collection, bird books and his bird notes were left to his son, Ludwig, who was also a naturalist.

These bird notes were used by Ludwig Kumlien and Ned Hollister in their "Birds of Wisconsin," which was published in

1903. I will quote the bird notes mentioned as of the 1840's from "Birds of Wisconsin."

Trumpeter Swan, *Olor buccinator,* p. 31. "Thure Kumlien had a juvenile specimen, obtained somewhere between 1842–45 in Jefferson County, with down on the head and primaries still soft, color a dingy ash."

Cory's Least Bittern,* *Ardetta neoxena,* p. 34. "In June, 1845, Thure Kumlien found some Indian children playing with a small headless heron, using it as a target for bow and arrow practice. This was at an Indian encampment on Black Hawk Island, Lake Koshkonong. The bird was new to him and he secured it and later sent a color sketch to Dr. T. M. Brewer. Brewer pronounced it probably some southern species or a different plumage of the least bittern. A copy, or in fact the original sketch, is still in our possession, and it plainly shows the specimen to have been a typical *Ardetta neoxena.* No others were found and the matter was lost sight of by both Dr. Brewer and Kumlien. Neither was the bird ever found by L. Kumlien during many years of careful marsh collecting in the same locality. Its claim to a place in the present list, therefore, rests principally on the capture of a full plumaged male by Mr. C. E. Akeley on Lake Koshkonong, May 22, 1893, and preserved in the Field Columbian Museum, Chicago. (Cherrie, Auk, XIII, p. 79)"

American Avocet, *Recurvirostra americana,* p. 42. "Specimens of this peculiar wader were taken by Thure Kumlien at different times from 1844 to 1875. Three were shot on Lake Koshkonong September, 1873. Those taken by Thure Kumlien were more often taken in September and October and were principally young birds."

American Woodcock, *Philohela minor,* p. 42. "On the evidence of Thure Kumlien and Dr. Hoy, and others, this species increased from the early forties up to say about 1870. From that time on to the present its numbers have decreased, from too close shooting, settlement of the country, and the draining and drying up of its natural resorts."

Buff-breasted Sandpiper, *Tryngites subruficollis,* p. 51. "Rare migrant. During a residence of fifty years in southern Wiscon-

* Now considered a color phase of the Least Bittern.—Editor.

sin, Thure Kumlien procured but a single specimen, killed on a prairie in Dane County late in September, 1845."

Hudsonian Curlew, *Numenius hudsonicus*, p. 52. "From 1845 to about 1865 this species was fairly common during migrations in the prairie regions. Dr. Hoy writes of finding a few nesting at Fox Lake, June 15, 1848, and Thure Kumlien found the birds in summer in Dane County and, from their actions, supposed them to be nesting. We have no *positive* evidence, however, that the species ever bred in the state."

Great Gray Owl, *Scotiaptex cinerea*, p. 70. "Rare winter visitant. This great owl seldom reaches southern Wisconsin, especially of late years. Before the heavy timber was cut down specimens were sometimes known to reach even the southern tier of counties. Recorded by Dr. Hoy from Racine in 1848. Two specimens were sent to Thure Kumlien from Bark River woods, Jefferson County, at about the same time."

Snowy Owl, *Nyctea nyctea*, p. 72. "Winter visitant, of irregular occurrence." Thure Kumlien knew of two cases of this owl remaining through the summer, but the birds proved to be cripples. "Perfectly sound specimens were secured, however, in April on several occasions, and one as late as May 5 (1847)."

Carolina Paroquet, *Conurus carolinensis*, p. 73. "Many years ago the paroquet occasionally wandered to southern Wisconsin. Thure Kumlien saw a considerable flock near Lake Koshkonong in 1844 or 1845. One specimen which he secured at this place at an early day was sent to John G. Bell, of New York."

Prairie Warbler, *Dendroica discolor*, p. 116. "A rare straggler to Wisconsin. Dr. Hoy procured but one specimen at Racine, and Thure Kumlien but one at Lake Koshkonong. Unfortunately the dates of capture of both specimens are gone, but both were taken at a very early day, between 1845 and 1860."

Bell's Vireo, *Vireo belli*, p. 133. "In the early forties Thure Kumlien procured specimens of a vireo which he called *belli*, of which he had no description, simply to distinguish it from *gilvus*. This led to some confusion with Lawrence, Baird, and others who had not seen the specimens. The bird referred to was later described by Cassin as *V. philadelphicus*."

On a paper written by Thure Kumlien at an early date, he writes, "The yellow-billed Cuckoo I have not seen here, but the black-billed Cuckoo is not uncommon and I may get their eggs. I have found its nest three times but only one nest within the last three or four years."

Considering the fact that Thure Kumlien had to learn the English language, that he had no knowledge nor experience of manual labor and that he had to work so hard to eke out a bare existence in this new country with no railroads, no American books on the subject of natural history, no one else anywhere around him interested in the subject, without the proper equipment for his work and with ill health stalking the family, he did very well indeed with his bird study the first seven years from 1843 to 1850.

The early pioneers suffered many hardships during the long Wisconsin winters, so the arrival of spring was very welcome. It was especially so to Thure Kumlien, as the following lines which were found in his own handwriting among his old papers will show:

"At last spring has come—the bluebirds, robins, and meadow larks singing near my house and the prairie hens tooting in the lowlands below it with an occasional screaming of the Sandhill cranes, long strings of geese cackling and the constant whirring of duck wings over my head is delightful to me now. To me spring has something inexpressibly pleasing."

The writer is indebted to A. W. Schorger of Madison, Wisconsin, for helping in unravelling some of the old scientific bird names.

EDWARD KREMERS (1865–1941)

REFORMER OF AMERICAN PHARMACEUTICAL EDUCATION

George Urdang
American Institute of the History of Pharmacy, Madison, Wis.

I. The Preliminary Stage

The word "reformer" has, objectively as well as subjectively, a disquieting connotation. It presupposes an individual dissatisfied with the *status quo,* who takes issue with conveniences and tacit allowances, who is moving faster than the majority of his contemporaries and sees realities which to them still seem to be dreams, fanciful or even dangerous.

To be a "reformer" means to ask for a fight. There are those who know this fact and try to circumvent it or at least to diminish its tempo and temper. To these born statesmen a compromise is a desirable success which may be used as a stepping stone for further accomplishment. To bribe people into their fold by flattery or persuasion is to them perfectly legitimate. There are others who, knowingly or otherwise, take pleasure in fighting. To these born fighters combat is wonderful and almost an end in itself and compromise, however promising, a despicable disgrace. Hesitant people are not to be persuaded but driven into the fold by thunderous reproach.

The statesmen present suggestions taking as little personal risk as possible. The fighters set an example taking every risk possible. The reformer Edward Kremers belonged to the second, the fighter category.

The last third of the nineteenth century saw a remarkable change in the educational ideas and methods in the United States of America. It was political (and politico-ideological) not intellectual independence from Great Britain that had been achieved as the fruit of the Revolutionary War at the end of the eighteenth century. There had been some sprinkling of French influence in letters as well as in science. On the whole, however, for more than a century the educational system, spirit and results, had been definitely Anglo-Saxon in character.

But now the great-grandchildren of the men of Bunker Hill and the grandchildren of the French refugees from 1789 to 1815 had been joined in great numbers by the children of the German liberals coming to this country about 1848 and after. Moreover. one of the miraculous constellations for which historians heap up reasons without ever finding a patent explanation had just now made Germany the leader in scientific education and research. Thus it was German trends and influence that played an important part in the educational renaissance taking place in the United States after the Civil War. "The leaders of American education in the post-Civil War period were for the most part German-trained; the universities of Göttingen, Jena and Berlin were particularly influential."[1]

Edward Kremers was as "German-trained" as a native American possibly could be. He was born on February 23, 1865 in the most German community within the United States, Milwaukee, as the scion of a German immigrant family that clung to the cultural traditions of the "fatherland" with all the tenacity of this idealistic generation of refuges who emphatically tried to create and set an example for a synthesis of what they esteemed most, both in the countries of their birth and their choice. About his Milwaukee schooltime Kremers reports: "there were in my class two or at the most three children who did not participate in the instruction in German, *i.e.*, were of English descent."[2] His high-school training he received in the "Missionhouse" in Herman township, Wisconsin, a German theological institution devoted especially to the education of ministers of the Reformed faith.

Thus prepared, the young man entered in his home town a professional activity which in its specific form even in the old country has always belonged to the most typical German institutions, a pharmacy "equipped and conducted exclusively according to German concept"[3] and even called by its German-born

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[1] S. E. Morrison and H. S. Commager, 1942. The Growth of the American Republic. New York. 2:311.

[2] *Badger Pharmacist,* 1936. No. 8, 10.

[3] Louis Lotz (1843–1923). Autobiographical notes in the manuscript files of the American Institute of the History of Pharmacy.

This picture of Dr. Edward Kremers was taken on the occasion of the Convention of the American Medical Association, held at Milwaukee in June, 1933. It shows him amidst an exhibition of pharmacopeias. The pictures on the wall, from left to right, represent Thomas F. Wood (1833–1892), C. Lewis Diehl (1840–1917), and Lyman Spalding (1775–1821).

owner, Louis Lotz,[4] with its German name *Apotheke.* A former student of Liebig (chemistry), Jolly (physics), Radlkofer (botany) and Buchner (pharmacognosy), Lotz had passed his pharmaceutical examination at the University of Munich with the best possible marks. Besides, he was a man of high general culture quoting in his instructions to his apprentices not only scientific authors but also the great German poets.

The idea of pharmacy as applied science and not as a business requiring the more or less disconnected knowledge of some scientific details, was inculcated on young Edward by Louis Lotz. The aging German apothecary imbued the young American furthermore with the doctrine that there has to be an educational balance between science proper and the humanities which, without interfering with the necessary specialization in the one field or the other, marks the well-educated man and maintains the unity of the world of culture. The certificate which the apothecary Lotz in the city of Milwaukee handed Edward Kremers at the end of the latter's apprenticeship (reduced from three to two years because of the special merits of the unusual apprentice) is written in German. It could have been a copy of the certificate which Lotz himself received in 1862 from the apothecary August Halberstadt in Camberg in the grandduchy Nassau.

It is significant that the only attempt ever made by Edward Kremers at staying for a longer period of time in another part of the United States than in the Middle West, in particular Wisconsin, proved to be a failure. After having attended the junior course in the Philadelphia College of Pharmacy during the fall and winter 1884–85, he returned to Wisconsin in order to continue his studies at the university of his home state where a Department of Pharmacy had been established scarcely two years previously.

There were three men who in the formative period of his life gave Edward Kremers the incentives and the opportunities which he needed. The one was the apothecary Louis Lotz mentioned above. The second was the Anglo-American Frederick B. Power,[5] one of the great American scientists who came from

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[4] Owner of a professional pharmacy in Milwaukee for half a century, archeologist, and mineralogist.

[5] Frederick B. Power (1853–1927), organizer and first head of the Department of Pharmacy of the University of Wisconsin, member of the National Academy of Science. He attained international renown as director of the Wellcome Research Laboratories in London, especially by his studies of chaulmoogric and hydnocarpic acids which proved to be of scientific as well as therapeutic importance.

the ranks of pharmacy and Kremers' teacher as well as predecessor in the capacity as head of the Department of Pharmacy of the University of Wisconsin. The third was the pharmaceutical scientist, author and journalist Frederick Hoffmann[6] who, like Lotz German-born and educated, not only was an excellent analytical chemist but wielded one of the most analytical pens ever employed in American pharmaceutical journalism. All three men had studied at German universities, at Munich (Lotz), at Strassburg—German from 1871–1918—(Power) and Berlin (Hoffmann).

Lotz was a German romanticist to whom, irrespective of his strong scientific ambitions, general cultural ideas and ideals were of first importance. Power was an Anglo-American pragmatical classicist to whom, irrespective of his strong cultural ambitions, science and scientific achievements were of first importance. Hoffmann was a German intellectualist of the militant preceptor type using as his yardstick the cultural German situation as it was when he left his home country in 1862, guilded by distance and his need of justification for his assumed role of *praeceptor pharmaciae Americanae.* It was in Hoffmann's *Pharmaceutische Rundschau* that Kremers, in 1887, published his first scientific report to appear in a periodical. Although it was a German-language paper and Kremers mastered German with the same perfection as English, the article was written in the latter in spite of or perhaps even because of the editor's persuasive invitation to write in German. To whatever extent the young man may have felt proud of his descent and what he may have thought to be its cultural advantages, he apparently refused to be regarded (and to regard himself) as anything else but American.

Already one year earlier, in 1886, the name Edward Kremers had appeared before the pharmaceutical world. It was in the *Contributions from the Department of Pharmacy of the University of Wisconsin No. II* that Kremers' Pharmaceutical Graduate (Ph. G.) thesis on *Fraxinus Americanus* was published. After his graduation the young man continued work at the School and acted as Professor Power's assistant during the col-

[6] Frederick Hoffmann (1832–1904), owner of a New York pharmacy, editor of a New York pharmaceutical German-language journal, analytical chemist. His "Manual of Chemical Analysis as Applied to the Examination of Medical Chemicals" lived to see several editions.

legiate year 1886–87. In this year he published the results of not less than four different investigations. With two of them he entered the field in which he was to become an internationally recognized authority, that of the examination of volatile oils. They brought him simultaneously his first public distinction, the Ebert prize of the American Pharmaceutical Association for the year 1887.

In the fall of 1887 Kremers matriculated again as an undergraduate, this time in the General Science Course of the University of Wisconsin, and in 1888 he graduated as Bachelor of Science. As he states in one of his many autobiographical notes, it was his "self esteem" which caused the young pharmacist to make himself "the equal" of the non-pharmaceutical students on the campus who looked down on the "pharmics" with practically no entrance requirements and with only four terms out of twelve of the undergraduate quadrennium. This confession is of highest psychological importance. It offers the cue to the special direction of the later activities of the reformer Kremers, to the missionary zeal with which he tried to make pharmacy, first and above all, the "equal" of the other professions requiring an academic study.

In the late summer of 1888 the young man made his great trip over the ocean, and in the fall of that year he matriculated at the University of Bonn, Germany. It was, however, not a certain university, it was a certain man to whom his pilgrimage was directed. This man was Otto Wallach,[7] the so-called "Messiah of the Terpenes." "I was drawn to the master," writes Kremers, "by his earliest contributions in the *Annalen* [Liebig's *Annalen der Chemie*] of the early eighties while I was working in the laboratory of Professor Power on the volatile oils of pennyroyal and citronella. Though a mere tyro in the field, I recognized instinctively the accomplishments of the master."[8] Naturally, Kremers also took advantage of the presence of other famous scientists on the teaching staff of the University of Bonn and attended with special pleasure and profit the lectures of the theoretical chemist Kekulé.[9] When, however, his master Wallach in 1889 accepted a call to Göttingen as successor to Victor

[7] Otto Wallach (1847–1931). His experimental work and the theoretical conclusions drawn from it opened a new era in the chemistry of terpenes and essential oils and influenced general structural chemistry.

[8] E. Kremers. Otto Wallach. 1933. *Register of Phi Lambda Upsilon,* 18:91.

[9] F. A. Kekulé von Stradonitz (1829–1896), creator of the benzene ring theory.

Meyer,[10] Kremers followed him. He was rewarded not only by his unusually successful work with Wallach, but by the unexpected opportunity of being introduced into a then new branch of science, physical chemistry, by a young man who was to become one of the great physicists of our time, Walter Nernst.[11]

It is a remarkable proof of the ability of the young American student, as well as of the knowledge acquired by him previous to his study in Europe, that after scarcely two years of work with Wallach, Kremers, in 1890, took the degree of Doctor of Philosophy at the University of Göttingen. His dissertation dealt with "The Isomerism within the Terpene Group" and laid the ground for many later investigations. Kremers' work was based on limonene nitrosochloride, limonene monhydrochloride and limonene hydrochloro-nitrosochloride and their derivatives from both dextro and laevo limonene. According to Kremers' own statement "out of some forty odd compounds fully two-thirds were new."

When the young American returned to his home country in the late summer of 1890, he came back with the holy zeal of a missionary. He had been an active and efficient part of a well-organized and highly esteemed world of science in which his own profession, pharmacy, had its place and was given its opportunity, and he had seen professional pharmacy practiced as a rule and not as an exception. Even there he had found much that, in his opinion, was in need of reform. All the more reason to change the chaotic situation in American pharmaceutical education fundamentally, using the German pattern but by no means adopting it.

A quite unusual stroke of luck gave the young man his opportunity when all his irons still were hot. In the fall of 1890 he had become an instructor of pharmacy at the University of Wisconsin (and Assistant to Professor Power) with an annual salary of $600.00. Soon the laboratory instruction, the experimental as well as the theoretical, was turned over completely to Kremers—the University Catalogue for 1890–1891 lists him as "Instructor in Pharmacy and Director of the Pharmaceutical Laboratory"—and his salary was doubled. Hardly another year

[10] Victor Meyer (1848–1897), known especially for his researches leading to the thiopene series.

[11] Walter Nernst (1864–____) became especially known for his studies on electricity (Nernst's electric lamp).

later, in spring 1892, the unexpected happened. Professor Power decided to leave Madison in particular and teaching pharmacy in general for a position in industry, and it was with almost automatic self-evidence that Kremers succeeded him. At the age of twenty-seven years a young idealist found himself in a position offering unusual, almost dazzling potentialities. If he should decide to go farther than Professor Prescott at Ann Arbor,[12] the man who had served in a considerable degree as a model to Professor Power, there was no precedent to be followed. His was the full sensation of the decision, the full sweetness of satisfaction if he succeeded, the full bitterness of disappointment if he failed. Sure, there was the administration of the University of Wisconsin, the President and the Regents whose permission had to be asked for. There were the druggists of Wisconsin on whose initiative the Department of Pharmacy was created and who, through their association, patronized as well as supervised it. But he, young Edward Kremers, was after all the only one on the campus and in the State and, may be, even in the nation, who had some definite idea about a reform in pharmaceutical education, its ways and aims. There was no doubt in his mind, he would be allowed to make a start for there was nobody except himself who really knew what he was after and what it would lead to. As a matter of fact, Kremers had already begun his work of reform during his instructorship.

II. A Reformer at Work

a. The Background

What was the situation in American pharmaceutical education about 1890? It has to be borne in mind that it was not until 1904 that one state, New York, made graduation from a School of Pharmacy the legal prerequisite for the State Board examination which had to be passed by all applicants for registration as licensed pharmacists, and that this example was followed only very slowly.[13] Until 1890 there were still fifteen states without a pharmacy law, hence without a pharmaceutical

[12] Alfred B. Prescott (1832–1905). Without any drug store experience the physician Prescott became closely connected with American pharmacy and as the Dean of the University of Michigan School of Pharmacy one of the most progressive pharmaceutical teachers in this country. He was author of several textbooks.

[13] At the time being there are still two states, Nevada and Vermont, and one Territory, Alaska, without the requirement of college graduation for pharmaceutical licensure.

licensing board and examination. It is understood that under such conditions the number of students of pharmacy was bound to be small. Of the 34,886 American drugstore owners counted in 1892 only about ten percent had attended a School of Pharmacy, and even of this number "only a few were prepared for a profound study of the sciences of pharmacy."[14] The apprentice system still dominated the pharmaceutical scene and the older colleges, all of them private institutions established mostly by local druggists or druggist associations, were intended to supplement the training and experience received in "the store" rather than to furnish scientifically educated pharmacists. There were no educational prerequisite requirements, or at best very modest ones, until the beginning of the twentieth century. A person with only a grammar school education or even less could enter most of the colleges of pharmacy in the United States. Evening courses were the rule, and laboratory work was offered only in exceptional cases.

Kremers was by no means the first one to attempt a change of this situation and the idea underlying it. The first step forward was taken, when an American state university, Michigan, in 1867, made the academic education of pharmacists a part of its tasks, and the Dean of this new School of Pharmacy, Albert B. Prescott, ignored the traditional apprenticeship as an obligatory preliminary to pharmaceutical college education not only for admission but even for graduation. It was but natural that he was outlawed for this sacrilege by the leaders of what was then official American pharmacy.[15] Prescott furthermore replaced at Ann Arbor the evening courses of the old-line colleges by a balanced combination of laboratory work and lectures during the day demanding practically the entire time of the student for two academic years. When the second American State University School of Pharmacy, that of Wisconsin, was established in 1883, the man who was to become its leader, Professor Power,

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[14] E. Kremers. 1893. *Pharm. Rundschau,* 11:76.

[15] At the St. Louis meeting of the American Pharmaceutical Association in 1871 the (School of Pharmacy of the) University of Michigan was denied the recognition of being "within the proper meaning of our [the association's] Constitution and By-laws, a College of Pharmacy: it being neither an organization controlled by pharmacists, nor an institution of learning which, by its rules and requirements, insures to its graduates the proper practical training, to place them on a par with the graduates of the several colleges of pharmacy represented in this Association." *Proc. Amer. Pharm. Assoc.,* 19:1871, 47.

visited at Ann Arbor and "received much encouragement and valuable suggestions from Professor Prescott.[16]

There was, however, one fundamental difference between the origin of the Michigan and the Wisconsin School of Pharmacy. The former was started without the cooperation of the local pharmacists, hence was not obligated to any kind of compromise, while the latter, being the child of the druggists of the State, was to a great extent responsible to them. Kremers describes the course in pharmacy offered by Professor Power at the University of Wisconsin in 1883 as "a compromise between the old and new with strong leanings to the old," and states that "it was not until ten years later," *i.e.*, under his, Kremers', leadership "that changes were made which placed the Wisconsin course on a footing similar to that of Michigan."[17] In one respect, however, Power from the very beginning of his activity at the University of Wisconsin vied successfully with Michigan: in the spirit of research, work which at that time was scarcely in existence at other American Schools of Pharmacy and even very rare in the other departments of American universities.

"In this," says Kremers, "he [Power] was far ahead of most of his colleagues in other departments of the University. Long before graduation theses were required in the College of Letters and Science, they were insisted upon in Pharmacy. What is more, these theses were not essays copied from encyclopedias and textbooks, but were based on laboratory experimentation."[18] This statement found an authoritative confirmation when, on the occasion of the conferring of the honorary degree of Doctor of Laws upon Frederick B. Power by the University of Wisconsin on June 17, 1908, President Van Hise said: "The value of your services here were greatly enhanced by scientific research at a time when this aspect of university activity was in its infancy."[19]

The question may well be asked, what, after such beginnings and examples, were the reformations due to Kremers which made him the foremost figure in the fight for adequate pharmaceutical education in the United States of America. The answer

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[16] *The Badger Pharmacist,* 1900. 113.

[17] E. Kremers, The Old Northwest Territory and Pharmaceutical Education. Lafayette, Ind. 1934. 12.

[18] *Ibid.*

[19] *Pharm. Review,* 26:1908, 192a.

is that of the three men in question, Prescott, Power and Kremers, only the latter felt himself actually a pharmacist and was prepared for fight by inclination as well as by professional pride. He alone saw in the leadership of a School of Pharmacy not only a locally restricted task to be taken care of to the best of his ability, but a mission in the service of American pharmacy and, through it, of American society on the whole. Prescott, after his rebuke by American pharmacists in 1871, withdrew for a while, until a changed time asked for his cooperation, from the public pharmaceutical arena devoting himself to his School and the pharmaceutical affairs of his home state only. Power, after nine years at Madison and just when the development had reached a critical point, left educational pharmacy for scientific work in the pharmaceutical industry. Kremers did not make any attempt to evade the issue in the one or the other way. On the contrary, he invited fight by fearless and sometimes even aggressive presentation of his views.

b. The Four Years' Course in Pharmacy

As pointed out above, Kremers had already begun his work of reform while still an instructor. During the winter term he gave a preparatory "review of pharmaceutical chemistry" of three lectures weekly. The outline of this course as published in the Catalogue of the University of Wisconsin for 1890–1891 reads as follows: "The subjects may be taken from inorganic or organic chemistry. Facts of pharmaceutical interest will be chiefly dwelt upon. These, however, will be viewed in the light of general and theoretical history. The end to be attained is to lead the student to think and reason for himself in order to better prepare him for the original investigations connected with his thesis work."

Here the entire educational program of Edward Kremers is given in a nutshell. Understanding instead of memorizing was the goal. Everything else was only a more or less elaborate means of achieving this aim. That the end was to be attained in employing historical views was another novelty not only in American pharmaceutical education but in scientific education in this country at large.

The young instructor was especially proud of the fact that a number of students had remained at the University during the spring term of 1892 and continued to work with him voluntarily. This encouraged him, when he had taken the chair of Professor Power, to lengthen the Course in Pharmacy from two years of two terms to two full academic years of three terms each. While the title of his predecessor had been "Professor of Pharmacy and Materia Medica," Kremers' title as given in the University Catalogue 1891–1892 reads "Professor of Pharmaceutical and Pharmacognostical Chemistry." This change was a very deliberate one. It meant a program, a new departure in American pharmaceutical education following resolutely and even expanding the pattern set by Professor Prescott at Ann Arbor.

It was evidently when Kremers still acted *ad interim,* during the spring term of the academic year 1892, that the changes referred to were decided upon, and it was still before he definitely started his new office in the fall of 1892 that he let the American pharmaceutical world know who and what was coming. On June 6 of this memorable year Edward Kremers married Laura Haase of Milwaukee and in July he attended with her the annual meeting of the American Pharmaceutical Association held at the Profile House, in the White Mountains, New Hampshire. It was the first time that the young man had appeared before this forum. But he certainly made his debut impressive. He presented one paper entitled "The Menthol Group," reporting highly successful scientific (phytochemical) research, another one dealing with queries published in earlier volumes of the *Proceedings* of the Association and not yet answered, and finally "Notes on Pharmaceutical Education" which, in tone and contents, was a challenge to the generally accepted concepts and was recognized as such. The three papers together cover twenty-eight printed pages in the *Proceedings* of the Association for 1892 (vol. 40). Not less than six pages in small type are devoted to the discussion of Kremers' views on education.

In his "Notes on Queries" Kremers criticized severely the American pharmaceutical journals. Stating that "the very existence of the customary queries is a confession of poverty of thought and observation in the ranks of the pharmaceutical profession," he assured his audience that, to use his own words, "I shall do as much as is in my power to oppose them, at least in their present form."[20] In his "Notes on Pharmaceutical Educa-

[20] *Proc. Amer. Pharm. Assoc.* 1892. 40:288.

tion" the young debutant wholly discarded the customary way of subdividing the subject-matter to be taught at the American colleges of pharmacy and stressed something hitherto unheard of in American pharmaceutical education, the necessity of humanizing the technical sciences. "The professional student," he said, "should at least have a fair knowledge of the history of his profession. If philosophy makes the natural sciences interesting, history lends them a peculiar charm. Both, I dare say, are equally important in the symmetric development of a scholar."[21] Finally he ventured the opinion that "medical materia medica receives an undue share of attention in the pharmaceutical schools" due to the fact that a majority of the then teachers at these schools were M. D's.[22]

No less a person than Henry H. Rusby[23] called Kremers' Notes on Pharmaceutical Education "a very learned paper, and one which will rank among the historical brochures of this Association."[24] But he was opposed to the statements as well as to the conclusions of the speaker and so were most of the others taking part in the discussion. Joseph P. Remington,[25] the foremost representative of the private schools and then President of the American Pharmaceutical Association, expressed certainly the opinion of the majority of the pharmacy teachers present, when he charged that "Professor Kremers has considered the subject of materia medica without also thoroughly taking into consideration the needs of the institution."[26] The head of the Wisconsin delegation to the 1892 meeting of the American Pharmaceutical Association, Mr. John A. Dadd,[27] was undoubtedly right in stating in his report that the paper on pharmaceutical education read by Professor Kremers had caused

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[21] *Ibid.* 316.

[22] *Ibid.* 310.

[23] Henry H. Rusby (1855–1940), M. D., botanist and pharmacognosist, botanical explorer and author, professor at the New York College of Pharmacy.

[24] *Proc. Amer. Pharm. Assoc.* 1892. 40:318.

[25] Joseph P. Remington (1847–1918), professor in the Philadelphia College of Pharmacy (1874) and its Dean (1893), author of a most successful American pharmaceutical textbook, one of the most influential men in American contemporary pharmacy.

[26] *Proc. Amer. Pharm. Assoc.* 1892. 40:321.

[27] John A. Dadd (1829–1895), English-born Milwaukee druggist, first president of the Wisconsin Pharmaceutical Association, one term vice-president of the American Pharmaceutical Association, one of the fathers of early Wisconsin pharmaceutical legislation and education.

"much comment and discussion, the views expressed being much at variance with existing conditions."[28]

This experience of seeing his ideas refused and misunderstood, and as he was inclined to think partly even deliberately, had by no means a discouraging effect on the young reformer. He had seen that the same people who had answered his suggestions with a more or less disguised *"crucifige!"* had welcomed with *"hosannah!"* and as an extremely progressive step the suggestion of Professor W. Simon[29] of a "three-years' course in colleges of pharmacy." Supposed to consist of "three sessions (of six months each),"[30] Simon's course was to cover exactly the same time of study, *i.e.,* eighteen months, as the two full academic years which Kremers just had introduced as the pharmaceutical minimum course at the University of Wisconsin. Furthermore, the only practical argument advanced against his suggestions had been the allusion by Professor R. G. Eccles[31] to "the brevity of time that is allotted" for the study of pharmacy. "It is simply the fable of Aesop of the boy and the nuts," Eccles had said. "The boy putting his hand into the narrow necked jar to pull out the nuts, fills his hands too full and gets none at all."[32]

As Kremers apparently saw it, there were two steps to be taken: 1. The eighteen months' course, welcomed as an aim to be approached by the recognized leaders in pharmaceutical education and just realized at Wisconsin, had to be built up as a more or less strictly pharmaceutical course, complete and satisfactory as possible; 2. In order to counteract the idea that this eighteen months' course was the ultimate educational end of American pharmacy, another course had to be offered, aiming at a general education with pharmacy as its main but by no means only objective. Kremers took both steps immediately. He had hardly returned from his trip to the East, his honeymoon and his first crossing of swords in his lifelong fight for progress in education, when he initiated what proved to be the second milestone in American pharmaceutical education after Prescott's emanci-

[28] *Proc. Wis. Pharm. Assoc.* 1892. 13:15.

[29] William Simon (1844–1916), German-born pharmacist, professor of chemistry at the Maryland College of Pharmacy and the Baltimore Colleges of Physicians and Surgeons and of Dental Surgery, author of a well-known textbook.

[30] *Proc. Amer. Pharm. Assoc.* 1892. 40:299.

[31] Robert G. Eccles (1847–1934), Scotch-born M. D. and Ph. G., research and sometime government chemist, professor in the Brooklyn College of Pharmacy, author, editor of Merck's *Archives.*

[32] *Proc. Amer. Pharm. Assoc.* 1892. 40:319.

pation of the academic teaching in pharmacy from "the store" program: the first academic four-years' course in pharmacy on American soil, and the first course of this kind in the whole world.

In announcing the extension of the University of Wisconsin Course in Pharmacy to two full academic years, Kremers in a "general statement" in the Catalogue of the University 1891–1892 says that "the addition of two terms admits of remodeling of the fundamental studies and of *a closer adjustment of the studies to those of the General Science Course.* (The italics here and in the paragraphs that follow are the writer's.) In the Catalogue of 1893–1894 he triumphantly tells of a "decided improvement" in this eighteen-months' course which was to meet the first goal of his program. "The object of this course," he says, "has been and still is to lay *as thorough a scientific foundation as time and means will permit for the pursuit of the profession of pharmacy.* The elements of chemistry, botany and physics must be studied before their application to pharmacy can rationally be considered. This is as true for pharmacy as for any other applied science or art. Any other process must tend toward superficiality."

It was in the University Catalogue issued between the two quoted above, *i.e.*, that for 1892–1893, that the establishment of a four-years' course in pharmacy was announced giving the pharmacy students the possibility of a complete instead of merely "a closer" adjustment to the General Science Course. "This longer course," reads the Catalogue, "was created in order to accommodate those students who desire to obtain *a general scientific education* and to include in their course the pharmaceutical studies; and with the hope of stimulating a broader pharmaceutical education." In later years Kremers frequently stated that to him in 1892 the contents of the four-years' course in pharmacy, although he took them very seriously, were of little significance as compared with the fundamental idea of placing the pharmaceutical course on a par with the other courses on the University campus. It was for the same reason that from the very beginning the course was open to high-school graduates only. When the President of the University, Dr. Chamberlin, before giving his consent to the planned innovation, asked Kremers how many students he expected in the proposed four-years' course, the young reformer proudly replied: "Mr. President, I am not concerned with numbers, but with an ideal."[33]

Like everyone fighting for an ideal, Kremers did not immediately find complete understanding and appreciation. On the contrary, he encountered plenty of difficulties within Wisconsin as well as without. At times the opposition among the Wisconsin druggists against his emphasis on scientific achievements and teaching methods was so strong that his position was in danger, and his colleagues at the other American schools of pharmacy viewed his reformatory zeal and actions with much reserve and suspicion, if not even fear and indignation, and resented heartily his continuous criticism and admonitions. At this place details would lead too far. They may be reserved for a biography of Kremers and/or a History of Pharmaceutical Education in the United States of America. Kremers himself, in an address delivered at the dedication ceremonies of the University of Maryland School of Pharmacy in 1930, describes the reaction to the establishment of a four-years' course in Pharmacy as follows:[34]

"The new step, so far as it did not remain unnoticed, received little else than ridicule. Thus the Dean of Northwestern Oscar Oldberg[35] who, in the name of efficiency, had concentrated the former so-called two-year course into one calendar year, suggested that someone might be crazy enough—though he did not use this word—to offer an eight-year course. This criticism amused. But it did hurt when Professor Prescott replied to a question as to what he thought of the step: 'it will do no harm.' The young innovator had looked up to his venerable colleague for encouragement and had received a shrug of the shoulder. This was in 1893. Soon thereafter,[36] President James, then of Northwestern, left his Evanston Campus to address the pharmacy students in Chicago. He told them that every boy and girl aspiring to become a pharmacist should take a four-year course at college. It was also a few years later that Professor Prescott wrote: 'We are contemplating giving a four-year course. Upon looking over the catalogues, we find that you are already giving such a course. What has been your experience?' "

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[33] *Journ. Amer. Pharm. Assoc.* 1930. 19:603.

[34] *Ibid.*

[35] Oscar Oldberg (1846–1913), Swedish-born pharmacist, teacher, editor, author.

[36] In fact it was nine years later, in 1902. *Bull. Pharmacy,* 1902. 16:242.

What then had been Kremers' experience? In 1896 he states that "no school or college of pharmacy in this country or in Europe can boast of such an organization" as it existed at this time at the University of Wisconsin.[37] In 1897 he reports that "more than two thirds of the Wisconsin pharmacy students were taking courses longer than the two-years' course,"[38] and in 1897 "the school graduated five students from the four-years' course, six from the three-years' course and but two from the two-years' course."[39]

Still more, the young reformer's bold experiment found the highest recognition possible, that of imitation, after an almost incredibly short incubation period. Kremers' reply to Prescott's inquiry caused the introduction at Ann Arbor of an analogous elective "college course of four years, leading to the Degree of Bachelor of Science in Pharmacy" in 1895 (School of Pharmacy of the University of Michigan, Announcement for 1895–96). In the same year the University of Purdue School of Pharmacy followed suit, and two other schools, established in 1895 as departments of educational state institutions, of the Alabama Polytechnic Institute and of the Maine State College of Agriculture (later University of Maine), introduced the elective four-years' course in pharmacy from the very beginning of their existence. One year later, in 1896, Louis E. Sayre,[40] who was given the new title of a Michigan Bachelor of Science in Pharmacy as an honorary degree by Prescott, introduced the four-years' course at the School of Pharmacy of the University of Kansas.

One of the new schools, that of Maine, made the four-years' course even a kind of drawing card for itself and for the University Schools of Pharmacy in general. In its Catalogue for 1898–99 it contended incorrectly that "only three other courses of the same length and kind exist in the United States"; and in 1901 the Bulletin of the University of Maine, after having outlined the all-round education offered by the four-years' course in pharmacy, went on to say that "such opportunities are found, in their entity, only in University Schools of Pharmacy."[41]

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[37] *Proc. Wis. Pharm. Assoc.* 1896. 16:42.
[38] *Ibid.* 1897. 17:66.
[39] *Ibid.* 1899. 19:30.
[40] Louis E. Sayre (1848–1925), retail druggist in Philadelphia, then Dean of the School of Pharmacy of the University of Kansas from its founding in 1885, author of a well-known text on pharmacognosy.
[41] *The Maine Bulletin,* 1901, 3, No. 6:2.

This latter statement was undoubtedly correct, and it was the idea behind it which Kremers expressed much more definitely before a meeting of the American Pharmaceutical Association in 1895, only three years after his dramatic debut on the same platform. Having triumphantly announced that his ideas had "this year received the endorsement of three large state universities," he gives an outline of the studies to be recommended for a four-years' university course in pharmacy and admits cold-bloodedly that the development which he advocates was to undermine the old private schools. His recommendation to these schools is to give up their fragmentary independence and to become affiliated with state universities in order to make available for their students "all education and training in general sciences and letters which they may demand."[42] It does not need to be proved that this suggestion did not enhance Kremers' popularity with those, teachers as well as druggists, interested in the maintenance of the private schools of pharmacy, then still outnumbering by far the few university schools already in existence.

Time has confirmed Kremers' foresight step by step. With the beginning of the twentieth century one school (or department or college) of pharmacy after the other offered an elective four-years' course, and this course was made the only official (minimum) course at the Ohio State University College of Pharmacy in 1925, at Georgia in 1926, and at Minnesota in 1927. In 1932, finally, it became the obligatory minimum course at all accredited schools of pharmacy in the United States of America on the basis of a resolution adopted by the American Association of Colleges of Pharmacy as early as 1928 and accepted by the National Association of Boards of Pharmacy. This development was paralleled by another one presaged likewise by Kremers which has been summarized in the Kremers–Urdang–History of Pharmacy as follows:[43]

"More and more private colleges of pharmacy sought and secured affiliation with universities and in this way offered to students and teachers an open door to broader intellectual opportunities. Even those colleges which were so proud of their traditional independence that they did not want any affiliation, followed the general trend, although in another way. The Phila-

[42] *Proc. Amer. Pharm. Assoc.* 1895. 43:447.

[43] E. Kremers and G. Urdang, History of Pharmacy. Philadelphia, 1940. 218.

delphia College of Pharmacy, for example, responded to the challenge by remodelling the structure of the school, adding courses of purely scientific character and developing into 'a great specialized scientific school. In token of the extension of its activities, a new charter was secured, and the name of the corporation was changed to the Philadelphia College of Pharmacy and Science.' "

At the present time, all but seven of the sixty-five accredited schools of pharmacy in the United States of America are either parts of or more or less closely affiliated with general institutions of higher learning (Universities, Polytechnic or Technologic Institutes, State Colleges, Agricultural or Medical Colleges).

c. Graduate Study in Pharmacy

It has not been recognized sufficiently that in introducing the full academic four-years' course in Pharmacy, Kremers opened the way for the realization of another aim of pharmaceutical education to which the adoption of the general academic undergraduate requirements by pharmacy was only the necessary prerequisite: The degree of Doctor of Philosophy or Science to be granted by acknowledged institutions of higher learning to pharmacists doing graduate work in their own schools on scientific problems.

The emancipation of the academic teachers in pharmacy from the necessity of obtaining their advanced training and degrees in fields outside of pharmacy or, like Kremers himself, abroad, by opening to them an opportunity of such training and degrees in their own country was at least as important as the emancipation of the academic teaching in pharmacy from "the store" concept by Prescott in 1868. From now on the self-taught teachers gradually disappeared from the pharmaceutical faculties, and it became increasingly less frequent that pharmacists with teaching talent and intention acquired the M. D. degree or that M. D.'s without pharmaceutical training or experience were entrusted with professorships and deanships at Colleges of Pharmacy. There had been so-called graduate courses in Schools of Pharmacy before Kremers. They represented, however, essentially a prolongation of the usual twelve or eighteen-months' courses adding one more year of study and leading to titles like Master of Pharmacy, Pharmaceutical Chemist and Doctor of

Pharmacy which carried little weight outside of pharmacy and not even very much within.[44]

In 1899 and in 1900 the first Master of Science degrees acquired under regular academic conditions were earned in the School of Pharmacy of the University of Wisconsin, and in 1902 the first Ph. D. degree was given to a student of Dr. Kremers, Oswald Schreiner.[45] In his report submitted to the Wisconsin Pharmaceutical Association in the same year, Kremers proudly states that according to his knowledge "this is the first time that an American university has given its highest degree to a graduate student who pursued his major work in a pharmaceutical department."[46] In an article written exactly thirty years later, in 1932, Oswald Schreiner preserved for posterity the significant remark of another "admiring alumnus" which he quotes as follows: "Many have come to him [Kremers] to learn the art of making pills and have departed as doctors of philosophy."[47] Surveying in 1930 the development of pharmaceutical graduate study at the University of Wisconsin Kremers himself wrote this:

"At first we were permitted to give the degree of Doctor of Philosophy with Pharmaceutical Chemistry as major. Pharmaceutical Botany under Dr. True,[48] a recent disciple of Pfeffer,[49] the noted plant physiologist at Leipzig, followed. When, however, we offered Pharmacy as major, a battle was on. . . . Pharmaceutical chemistry, after all, was chemistry, and pharma-

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[44] Such a three-years' course leading to the degree of Master of Pharmacy was announced at the University of Wisconsin for the first time in the Catalogue 1890–91 and for the last time in the Catalogue 1916–17. According to W. L. Scoville the title of Doctor of Pharmacy was still given in 1905 by six schools after two years and by nine after three years of study. The title of Pharmaceutical Chemist could be earned at sixteen schools after pursuing a two-year course and at one institution even after only one year. Although for the Master of Pharmacy a three-year course was the rule, it could be obtained at two schools after only two years.

[45] Oswald Schreiner (1875–   ), German-born pharmacist, joined the U. S. Department of Agriculture, Bureau of Plant Industry, shortly after having received his Ph. D. and advanced to Chief, Division of Soil Fertility. A recognized authority in the field, Schreiner represented the United States at the First International Congress of Soil Science in 1928.

[46] *Proc. Wis. Pharm. Assoc.* 1902. 22:49.

[47] *Industrial and Engineering Chemistry,* 1932. 24:115.

[48] Rodney H. True (1866–1940), pharmacognosist in the School of Pharmacy of the University of Wisconsin (1895–98), physiologist in charge of physiological investigations in the Bureau of Plant Industry, U. S. Dept. Agr., professor of botany in the University of Pennsylvania (1920–37).

[49] Wilhelm Pfeffer (1845–1920), author of a fundamental book on plant physiology.

ceutical botany was botany, but pharmacy, God forbid! If his colleagues of the Philosophical Faculty at Giessen had accused Liebig of introducing the methods of the kitchen into academic procedure, we were accused of doing something equally abhorrent or even worse. Well, strange things have happened educationally since the days of Liebig[50] a hundred years ago. Not only did we win the fight, but in 1926 the Department of Pharmacy had six successful candidates for the doctorate, five of whom took it with pharmacy as major."[51]

More than fifty Ph. D.'s have earned their degree under the personal guidance of Edward Kremers and they have proved the value, scope and special meaning of pharmaceutical research all over the United States and even beyond the borders of this country. Kremers' men have excelled in government positions and in industry as well as in academic work, in research and in teaching. They have carried Kremers' ideas and methods into the staffs of many continental American Colleges of Pharmacy as well as to Puerto Rico, the Philippines and even Beirut in Syria, and it is certainly not accidental that most of those Schools of Pharmacy in this country in which at present research is regarded as an indispensable part of the school activities and given special attention are headed by or staffed with former students of Kremers. Of the fifty members of the Committee of Revision of the United States Pharmacopoeia Convention elected in 1940 ten were men who received their doctor's degree at Wisconsin. "Considered from the point of view of geographical distribution," says Kremers, "Wisconsin would have been entitled to one representative."[52] The significance of this recognition of the scientific capacity warranted by a doctor's degree acquired under Kremers becomes still more evident from the fact that only thirty-two of the fifty members of the Committee of Revision were representatives of pharmacy (schools, associations, retail and manufacturing business), while the rest represented medicine or, in one case, dentistry. Hence almost one third of the pharmaceutical group within this most important Committee concerned with the utilization of medical and pharmaceutical

[50] Justus von Liebig (1803–1873), German chemist known especially for his pioneer work in agricultural and physiological chemistry. With pharmacy he was connected by ten months of apprenticeship and lifelong collaboration with the leading men in German scientific and industrial pharmacy.

[51] *J. Amer. Pharm. Assoc.* 1930. 19:604.

[52] *Wisconsin Druggist.* 1940. 8:6.

science and experience for the sake of the people consisted of former students of Kremers.

d. Cooperation Between Schools and State Boards of Pharmacy

There has always been one danger in the educational set-up of American pharmacy: Lack of understanding between the schools of pharmacy supposed to warrant the scientific capacity of the applicants for a pharmaceutical license and the boards of pharmacy supposed to guarantee the practical ability and reliability of the licentiates. In earlier times this danger was still aggravated by the fact that the practitioners acting as State Board examiners often did not have any or but little scientific education, hence were inclined to underestimate its meaning and importance. There has been factual overlapping and personal suspicion resulting from lack of sufficient cooperation.

It was on Kremers' instigation that a common platform was established on which Schools and Boards of Pharmacy have met regularly and presented their views to each other since 1904. He initiated this innovation in his capacity as the third president of the Conference of Pharmaceutical Faculties (now American Association of Colleges of Pharmacy) in 1903. "His only recommendation was that the colleges invite the boards to effect a similar organization [as the schools had founded in 1900] and to hold one joint meeting of the two bodies annually. In 1904, the boards organized as a national body . . . which is not only carrying out his [Kremers'] suggestion of an annual conference with the college faculties but also joint district conferences throughout the year."[53]

It testifies to the gradually growing appreciation of the work and person of Kremers by the representatives of pharmaceutical retail practice that in 1939, two years before his death, he found himself Honorary President of the National Association of Boards of Pharmacy.

e. The Pharmaceutical Experiment Station at the University of Wisconsin

The main distinction between the reformer by nature and by mere accident is that the first will find some reform to be made or initiated everywhere, while the latter restricts himself to the

[53] National Association of Boards of Pharmacy, *Bull.* 1939. 3, No. 7.

one problem he accidentally happens to stumble upon. Having made plant chemistry his special field and knowing about the prominent part taken by European pharmacists in the cultivation of medicinal plants through the ages, it was to be expected that some day Kremers would also turn his energies to this task as an educational and research problem of American pharmacy. In his report submitted to the Wisconsin Pharmaceutical Association in 1909, Kremers makes the following announcement:

"For fifteen years your reporter had hoped that his botanical or agricultural colleagues might take up the cultivation of medicinal plants. In this he was disappointed, but not discouraged. So during the summer of 1908 he, with the cooperation of the pharmacy students, made an attempt in his own garden. The results were such that when Dr. True, in charge of medicinal and poisonous plants at Washington, visited Madison last fall, a plan of cooperation between the Department of Agriculture at Washington and the University was agreed upon. We now have an acre of University ground seeded and planted. . . . With this step, the University has gone back to first principles in pharmacy."[54]

This statement disproves the claim of the University of Minnesota College of Pharmacy of having been the first American School of Pharmacy to add a plant garden to its educational facilities. Anyway, a mere plant garden would not have satisfied the vision of this born reformer. What he conceived was a State-supported "Pharmaceutical Experiment Station." On June 21, 1912 the Wisconsin Pharmaceutical Association following Kremers' suggestion resolved unanimously to prepare a draft of a bill "to be presented to the next legislature."[55] On June 2, 1913 the bill became law, and for the first time there came into existence on American soil a State-supported Pharmaceutical Experiment Station in connection with the Department of Pharmacy of a State University supposed to cooperate with the Federal Department of Agriculture and to disseminate information on the basis of research. The work done by the new Station met all justified expectations of a practical as well as of a scientific nature. With an appropriation of originally $2,500 which was doubled in 1917, it carried through a series of investigations

[54] *Proc. Wis. Pharm. Assoc.* 1909. 29:19.
[55] *Ibid.* 1912. 32:43.

yielding valuable results. It was due to the research done at the Station that the indigenous horsemint (*Monarda punctata L.*) became a source of thymol in the United States of America, and a new method for purifying digitalis was put to general use during the first world war. The *Pharmaceutical Journal*, the official organ of the British Pharmaceutical Society, called the Wisconsin innovation, "a model,"[56] and the renowned English pharmacognosist, H. G. Greenish, in referring to the Wisconsin Pharmaceutical Experiment Station expressed his regret "that no experimental station exists in this country [Great Britain] in connection with the Pharmaceutical Society."[57]

A new method of extraction of thymol which proved to be of economic interest was worked out at the Station. An especially remarkable amount of successful study was devoted to the various species of Monarda. It is due to the work done by and in connection with the Pharmaceutical Experiment Station of the University of Wisconsin that we possibly know more at present about the chemical constituents of these plants and the role they play in the life processes than of any other genus of plants. Finally, the Station paralleled its analytical work by synthetic ones. It prepared synthetics, such as guajacol derivatives.

It was at the height of the period of depression, in 1933, that the Wisconsin legislature discontinued the appropriation which had made possible the work of the Pharmaceutical Experiment Station and thus put an unjustified end to it that, if merit and usefulness are decisive, can be but transitory.

III. Conclusion

It would be wrong to consider the reformer Kremers as a lonely figure in the American pharmacy of his time. If that would have been the case, the period of incubation which his ideas had to go through, would have lasted much longer. His merit was that he not only grasped what had to be done but did it without even thinking of compromise at a time when the steps he took required a considerable amount of courage and defiance of what is commonly regarded as collegial courtesy. In starting his reformatory action at a turning point in American education in general, Kremers delivered once and forever American pharmaceutical education from its traditional isolation.

[56] *Pharm. Journ. and Pharmacist.* 1919. 102:424.
[57] Year Book of Pharmacy (London), 1912. 361.

Kremers' reform activities were due undoubtedly to his vision and the strength of his conviction. It was, however, his being a high-grade scientist and historian that made his fight a success. If the young man had not proved very early his capacity as a teacher and a research worker and established his scientific reputation on the campus by his learned paper on *"The Limonene Group of Terpenes"* read before the Wisconsin Academy of Sciences, Arts and Letters on December 30, 1891,[58] the President of the University of Wisconsin would scarcely have permitted him to establish the first American full academic course in pharmacy. If his historical sense and knowledge would not have enabled him to use the experience of the past for his plans for the future, he would have lacked the adequate arguments and power of inspiration.

It must remain for a more comprehensive biography of Kremers to record in detail his scientific achievements and to list his publications.[59] At this place it must suffice to say that phytochemistry, especially the knowledge of the essential oils, owes him much, that he furnished fruitful ideas to theoretical chemistry, and that his numerous articles on pharmaceutico-historical and cultural subjects placed this branch of the history of civilization on a level which in this country it had not had before. As an editor he became the guardian of pharmaceutical ethics, and his many and profound book reviews created a new standard in this field of American pharmaceutical journalism. As early as 1901 Henry B. Mason, a well-versed pharmaceutical journalist, wrote about the then thirty-six-year-old Wisconsin professor as follows:

"Edward Kremers . . . is one of the best-equipped and ablest men in American Pharmacy . . . , a specialist who has read widely and thought deeply; whose interests range over a wide field of observation, and whose activities are directed into several channels. . . . What he believes, he believes earnestly, and he is as sincere in his devotion to pharmacy as any man in this broad land of ours."[60]

And yet, the record testifying to the merits of Edward Kremers is not without its other side. Working so intensively in so many fields, Kremers was an inspiring and even impetuous

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[58] *Trans. Wisconsin Acad. Sci.* 1892. 8:312–62.

[59] Such a biography is in the process of preparation.

[60] *Bulletin of Pharmacy.* 1901. 15:150.

initiator rather than a man finishing meticulously one job after the other. The Kremers–Urdang History of Pharmacy published by J. B. Lippincott Company, Philadelphia in 1940, not quite one year before Kremers' death, would never have appeared had it not been for the fact that his co-author took over the actual writing. The "detailed classification of all constituents isolated from volatile oils," promised by Kremers in 1900[61] has never been published, and the only hope that the standard work on phytochemistry expected from Kremers will ever be presented to the world, rests on the fact that in the last years of his life he delivered the preliminary work done by him to one student of his in whose scientific ability and human reliability he put confidence. "As a matter of fact, I have been too busy collecting material to find time to edit it," he himself once confessed.[62]

Edward Kremers closed a biographical sketch devoted to another reformer, the founder of the Russian Pharmaceutical Society, Alexander N. von Scherer (1771–1824), with a quotation from the *Neuer Nekrolog der Deutschen* which, in some measure, may well be applied to himself. This quotation reads in translation as follows: "He had learned much but finished less because of his lack of consistency and perseverance [meaning here concentration on one task]. He knew the highest aims of his science and had them in mind. He did, however, never reach them entirely because there was so much that attracted his curiosity and led him astray. He had worked much and fought much. But although he weathered storms and waves, he never really entered the port, and peace came to him only with his death."[63]

In all probability that is as it has to be. Although peace may be the reformer's aim, fight is his lot. What the world expects of him, is the opening of new ways rather than the completior of some special work; perfectioning rather than perfection.

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[61] *Amer. Drugg. and Pharm. Rec.* 1900. 36:172.
[62] *Isis.* 1925. 7:110.
[63] *Journ. Amer. Pharm. Assoc.* 1930. 19:1246.

THE LABRAL SENSE ORGANS OF THE RED-LEGGED GRASSHOPPER, *MELANOPLUS FEMUR-RUBRUM* (DEGEER)

Wm. S. Marshall

Emeritus Professor of Entomology, University of Wisconsin

Nagel's (1894) figure of the inner surface of the labrum of *Acridium caerulescens* (Pl. V, Fig. 86) is similar to what we found in *Melanoplus femur-rubrum*. He depicted the furcula and the large setae surrounding it, those back of and at either side of the anterior marginal notch and others scattered over the surface, also the groups of cuticular setae. He figured the labrum of *Locusta viridissima* (Pl. V, Fig. 85) which is quite different from his other view and unlike our specimens.

McIndoo (1920) figured the dorsal surface of a grasshopper's labrum (Fig. 5) and described a group of four pores on the median line of the ventral surface a little posterior to the notch. On the labrum of the red-legged grasshopper he noted three pores (Fig. 75) resembling our sensilla without setae. He described on the ventral surface many hypodermal gland pores differing from those on the dorsal; the ones he figured were not setiferous thus differing from what we found in our specimens. Röhler (1906) has a figure showing the ventral surface of the labrum of *Tryxalis nasuta;* on it are setae in groups or scattered similar to those shown in our view (Fig. 1). Slifer (1936) listed the scoloparia on the body and appendages of *Melanoplus differentialis;* he fails to menuon the labrum.

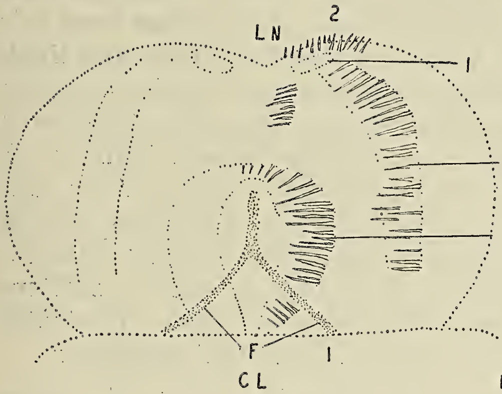
A view of the internal surface of the labrum of *Melanoplus femur-rubrum* (Fig. 1) shows sense organs and spaces upon it there are no traces of setae or pits. A study of sections shows two main types of sensilla, those with setae, scattered and more numerous, others without setae which are restricted in their distribution. Where setae protrude above the surface they appear quite similar, but sections show that these can be divided into two groups: first, each seta is part of a sensillum; second, cuticular setae without any underlying sense organ. Each kind is well scattered over the surface or is restricted to certain areas.

Explanation of Plate

1. View of internal surface of labrum, 1, 2, 3, and 4 the sensilla and cuticular setae restricted to certain areas. A few of the setae have been drawn on one side only. Diagram.
2. Sensillum without seta on the internal surface showing a nerve entering at its base. ×940.
3. Sensillum on internal surface, this is very similar to all the others on both surfaces. ×940.
4. A sensillum on the external surface, this differs from the others in its narrow pore canal and smaller body. ×940.
5. Tip of labrum showing sensillum oblique to its surface. ×210.
6. Showing attachment of a seta to its tubercle. ×940.
7. Peculiar binucleate cell from external surface. ×940.

Abbreviations

AB	Apical body
AM	Articular membrane
CL	Clypeus
CN	Circular nucleus
CT	Cuticula
D	Dorsal
F	Furcula
FI	Fibrils
H	Hypodermis
LN	Median notch of labrum
N	Nuclei
NS	Nuclei of sensillum
NV	Nerve
S	Seta
SB	Striated border
TS	Terminal strand
V	Ventral
VA	Vacuole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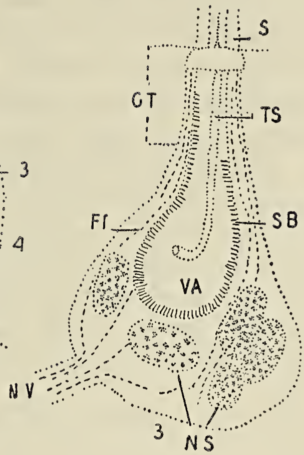
S
GT
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FI
SB
VA
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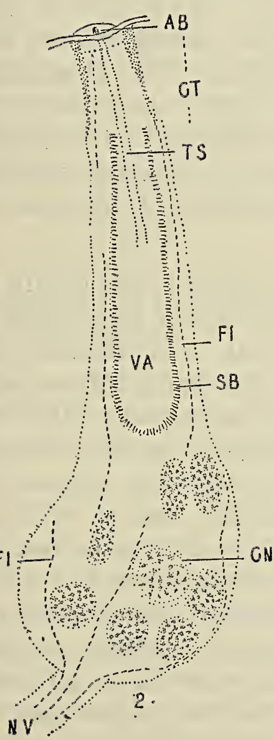
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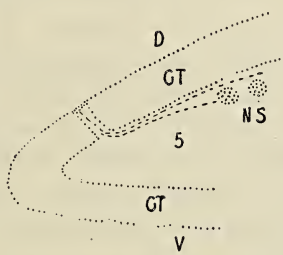
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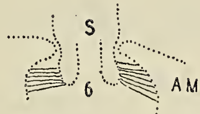
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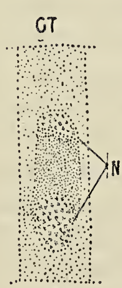
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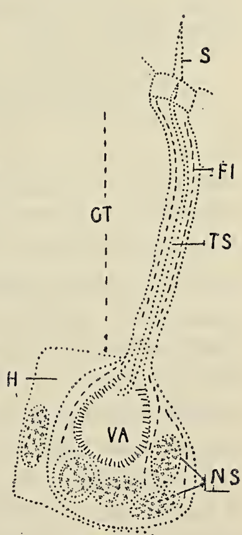
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As far as practical these groups are shown (Fig. 1) and each one numbered: (1) here are found a small number of sense organs without setae; (2) these short, curved setae have thick pore canal and tubercle; (3) these slightly curved and lightly colored setae are set directly upon the cuticula, they are oriented towards the median axis of the labrum. The setae of this group are smaller on the anterior part of the labrum than are the central or posterior ones; (4) here are the largest of the setae, they have darker and heavier pore canal and tubercle than the others, are slightly curved and all are oriented towards the furcula. The setae not included in these four groups are scattered over the surface; they show differences in length, are straight or slightly curved, and are oriented in different directions.

The sense organs without setae (Fig. 2) are the only ones on either surface not protruding above the cuticula. There are two groups of these, one each side of the median notch of the labrum and close to its anterior margin. A line drawn around either group would form a long, irregular outline having two or three sensilla in its transverse and about fifteen in its longitudinal diameter. Two groups of similar sense organs are found at the base of the labrum but most of these belong to the clypeus. Packard (1889) noticed similar sensilla in *Cannula pellucida* between the clypeus and the labrum; he referred to them as two fields of taste pits.

Each of these sense organs is of two parts, one within the cuticular layer, the other in the hypodermis and surrounded by its cells. The former part, the pore canal, is a distinct, dark tube, its wall of greater sclerotization and easily differentiated from the surrounding cuticula. Over the outer end of this tube the cuticula shows a slight, circular depression at the bottom of which is a thin cap or disk, perforated in its center. Above this opening is a short peg, apical body, to the base of which is attached the distal end of the terminal strand; its proximal end did not connect with nuclei or fibrils but often ended in a loop within the body of the sensillum. When cut transversely this strand showed, as in longitudinal section, a distinct, colored wall, probably the neurilemma. Within the canal are a number of longitudinal fibrils of varying lengths, a few ended upon the inner surface of the disk, others extended into the body of the sensillum.

The body of the sensillum is long and narrow, its basal part widest, especially if it extends beyond the hypodermis where it is free from compression by other cells. Some of these bodies are perpendicular, others oblique to the surface of the labrum towards the posterior end of which they are directed. Each contains a vacuole extending from within the pore canal to the group of nuclei in the basal part of the body. This vacuole is best seen in the wider sense organs in which it may leave but little space between it and the lateral boundary of the sensillum, the general contour of which it follows. Some of the wider vacuoles show a peculiar inner lining having a ciliate appearance, so referred to by others, but it more nearly resembles the striated border of the mid-intestine; it has been mentioned and figured by others but, as far as we have ascertained, nothing is known as to its function except its acting as a reservoir for the secretion from the trichogen.

No cell boundaries were seen in the sensillum but several nuclei are crowded together in its basal part. These nuclei are of various shapes, circular or elongated, the latter lie parallel to the longitudinal axis of the hypodermal cells the nuclei of which they resemble. At least one of these nuclei is circular and a little larger than the others; often it is surrounded by a clear circle as if enclosed in a vacuole of a slightly greater diameter; in some this outer circle is not clear. The chromatin bodies of this nucleus are further apart than in the others and give it a lighter appearance.

Noyes (1931) figured the labrum of a termite, *Termopsis angusticollis*, and showed the distribution of the nerves on both its inner and external surfaces. Two nerves are shown, one each side, entering the base of the labrum and branching into all its parts. Not having examined the entrance of nerves into the labrum of *Melanoplus femur-rubrum* we assume it to be similar to what has been described for this termite. Our longitudinal sections through the labrum show many branching nerves which subdivide to finally contact the inner surface of the hypodermis. Examining a number of sections a small branch can be found to enter the base of a sensillum into which its fibrils can be followed for varying distances; they pass around the nuclei and the vacuole.

The setiferous sense organs on the inner surface differ more in size than in structure. Their setae vary in length and thickness, some are straight, others curved, some restricted to certain areas, others scattered; nearly all are yellow and their orientation is in different directions. One kind is cuticular; the others are part of a sensillum and all of these have their body fundamentally alike in structure, a description of one (Fig. 3) will suffice for all.

The pore canal extends through the cuticula covering the inner surface of the labrum; it, the tubercle and the setae vary in thickness, attaining their maximum in the heavy setae surrounding the furcula. The alveolus, at the distal end of the pore canal, sinks for a short distance below the surface of the cuticula and its rim, the tubercle, is but slightly elevated. Within the pore canal are a number of longitudinal fibrils some of which can be seen to enter the body of the sensillum and a few can be traced to their insertion on the inner surface of the cap. The terminal strand connects with the central part of the cap and extends into the hollow seta. Its proximal end could not be traced further than the bottom of the vacuole or to the group of nuclei in the basal part of the sensillum.

The body of the sensillum varies in size and shape, elongated and narrow or shorter and broad. This difference depends upon its position within the hypodermis, the oblique ones near the tip of the labrum are directed towards its base (Fig. 5). It is impossible to differentiate cells as no boundaries were seen separating the nuclei from each other. Within the body, as in the pore canal, a number of longitudinal fibrils are present; some are seen to enter the pore canal, others can be traced to near the base of the body. The terminal strand can be followed from the base of the seta towards and into the body of the sensillum where it often ends in a loop near the center of the vacuole. This strand has a tubular appearance due to its thin, stained wall, the neurilemma. The principal nucleus in the largest sensilla is circular or elliptical; if the latter, it lies across the body at its base. Most of the other nuclei are elongated and follow the position of those in the hypodermal cells. In the widest sensilla a vacuole is seen to extend from within the pore canal to the nuclei of the body, and this vacuole has an inner lining resembling a striated border.

Cuticular setae are present only upon the internal surface where some are restricted to certain areas (Fig. 1, 3), others are scattered. All are pointed and hollow to near the closed tip, not fitting upon a tubercle but directly upon the surface of the labrum. In studying the largest of these setae it was noticed that where they were attached to the cuticula this layer showed a hollow connecting with that in the seta and reaching to the surface of the hypodermis. This opening does not have a definite wall but is an elongated hollow equal to the width of the cuticula. A few sections showed places where the underlying hypodermis had been withdrawn from the cuticula; here, occasionally, were seen stained strands leading from the surface of the hypodermis through the open space in the cuticula and into the hollow of the seta. Other slides showed similar strands passing through the cuticula when the hypodermis was close against its inner wall. An unsuccessful search was made for hypodermal cells from which these strands originated. Such could not be found, and we conclude that these strands are the last of the secretion given out by the trichogen forming the seta.

The connection of a seta to its tubercle is best seen in one of the largest ones which, probably, represents the condition in all sizes. The rim of the tubercle, often more elevated than in the one figured (Fig. 6), fits into a notch around the outer wall of the seta near its proximal end. This is best seen in a longitudinal section as a surface view shows the basal part of the seta encircled by a narrow collar formed by the free end of the pore canal (Fig. 4). The base of the seta is connected to the cuticula by a finely striated articular membrane. This striated appearance has been noticed and figured by others; it is best shown in a surface view of the labrum at some place where a seta has been cut off.

The cuticula on the external surface is thicker than on the inner, its setae are not so numerous nor are they arranged in such regular groups. Many have been broken off and, from a surface view, their tubercles appear as pits or some form of sense organ; this view is dispelled by a study of sections where their true nature as part of a sensillum is disclosed. The setae are of different lengths, straight or curved, and many are more erect than those upon the opposite surface. No cuticular setae were observed on this surface and each one formed part of a sensillum.

A description of the pore canal and body of the sensilla on the external surface would be similar to what has been described in the sense organs upon the internal surface. A drawing of one of these (Fig. 3) shows what they are like, also their similarity to the others already described. There is one exception, a description of which follows.

The one sense organ (Fig. 4) on the external surface differing from the others has a short seta and a small but well-marked body. These sensilla are restricted to the posterior half of the labrum and their most striking difference to the others is their pore canal. This is a canal through the cuticula; its sides are parallel until near its distal end where it enlarges and bends, generally, towards the tip of the labrum, Hauser (1880), Erhardt (1916) and Sihler (1924). The seta is shorter than the others but is similar in its structure and its attachment to the tubercle. The body of the sensillum is small, has fewer nuclei and these are crowded together. A vacuole can be seen in the body of the sensillum extending into the pore canal, but the narrowness of this made it impossible to follow the vacuole to the distal end of the canal. The wall of the canal is not sclerotized but appears as a tunnel through the cuticular layer. The terminal strand can be traced through the canal from the base of the setae to the anterior part of the body, and fibrils are present in the pore canal and in the body of the sensillum.

So much similarity is apparent in all the labral sense organs that it might be well to give a general and comparative account, to point out a few differences as well as certain parts common to all. There also occurs the comparison with what other workers have described about the sensilla in insects of different orders. This literature is a large one. We can mention but a few of the many papers, and select some of those having certain similarities to what we have found in our work on the red-legged grasshopper.

The greatest difference in the setae of the sense organs is in their size and curvature; all are yellow, the darkest being the numerous small ones near the tip of the labrum and those at or near the margin. All are hollow and closed at their tip, and all are widest at their base. In the largest ones the groove around their base, into which the rim of the tubercle fits, can be seen in longitudinal sections.

The tubercle, fitting into a shallow alveolus, may be flush with the surface or slightly elevated, never far above it. There are differences in thickness and size which, to a large degree, depend upon the size of the seta fitting into the tubercle. In surface view the articular membrane shows fine striae, in sections a lamellated structure often is present. The membrane is lightly colored by methelene or Lyon's blue.

The width of the pore canal depends upon the size of the seta and tubercle; its length corresponds to the thickness of the cuticular layer surrounding it. There is a variation in the amount of sclerotization of its wall which is thickest and darkest at or near its distal end. Many specimens showed a darker exocuticula near the tip of the labrum and, in this region, was found the darkest of the pore canals. The pore canal contained the distal part of the terminal strand, many fibrils and a portion of the vacuole.

The terminal strand narrows as it enters the base of the seta but does not clearly show sense rods nor apical bodies. Some specimens did show a dark end to the strand but not enough of these were seen to give to it any definite special part. The strand has a border corresponding to the neurilemma of others and, as the strand narrowed at its tip, this might converge to form a small inverted v. In some specimens one could trace the proximal end of the strand to near the group of basal nuclei, in others not so far. It often ended in a loop [Hsu (1938)] apparently within the vacuole but, no doubt, external to it. One naturally might expect to see its proximal or inner end connected with one or more of the nuclei, or that it consisted of a number of fibrils joined together; it never was seen to have any such connection. The strand and its apical end can best be seen in specimens stained with Heidenhein's iron-hematoxylin, or with methelene blue followed by aqueous safranin.

The sensilla contained many nuclei one of which differed from the others; it was circular or elliptical, and the position of the latter generally was transversely across the base of the sensillum. The slightly greater size of these nuclei has been mentioned, also that the circular ones often were surrounded by a narrow circle, generally clear. Their chromatin granules were further separated than in the other nuclei thus giving them a lighter appearance. The relation of these slightly different nuclei to the others, to the terminal strand or to the fibrils, could not be ascertained; we concluded that the sensilla in the labrum of the red-legged grasshopper are without a special sense cell or nucleus, but that the cells, the nuclei and the fibrils, combine to form a sense organ. Similar insect sensilla have been described; v. Rath (1888), Eggers (1924), Wacker (1925) and Hüfner (1939).

The body of the sensillum varies in size and shape, generally pyriform. The group of nuclei in its basal part forms the most noticeable content of the body; they generally are crowded together and not separated by cell boundaries. The body contains the major part of the vacuole, the proximal portion of the terminal strand with its free end, and many fibrils of different lengths. The boundary of the sensillum in many sections was difficult to define, in others clearly marked. Some specimens had not been depigmented and in these the cells of the hypodermis contained pigment granules. These were not present in the sensilla.

A number of papers figure and describe the vacuole as belonging to the trichogen, Snodgrass (1926, 1935), Sihler (1924); in our specimens, in which cell boundaries could not be seen, it was impossible to place the vacuole in any one cell. The inner ciliate-like lining, striated border, has been found in this vacuole in different insects and a granular content has been described by Freiling (1909). Most of our specimens were mature and the seta fully formed, but one can imagine the necessity of a large trichogen to secrete the largest of the setae.

Some of the cited references show the fibrils similar to those we have described. Eggers (1924) figures them as coming from the nerve and extending to near the tip of the sensillum. In the sensilla of our specimens the fibrils were seen for distances of different lengths, a few were observed coming from the nerve to enter the base of the sensillum, some to end on the base of the setae, but no single one could be traced for a long distance; what one sees in sections is only a part of a fibril. A careful examination was made in an endeavor to find a connection between a fibril and a nucleus; at first glance such was evident, but under the highest power of the microscope such a fibril was seen to go around its edge, over or under it, not to show any distinct connection.

In a number of our specimens dark, thick and irregular strands were seen to extend from near or at the base of the hypodermis to the inner surface of the cuticula; these were irregular in position, changed their diameter, some were straight their entire length, others bent and crooked. Many appeared as if originating from the nucleus of a hypodermal cell but, upon closer observation, this was found to be incorrect. These strands appeared in the hypodermis and in the sensilla, were more abundant on the inner surface of the labrum, and were seen in greatest numbers in its distal half. Many had a dark blue color as if stained with Heidenhein's iron-hematoxylin; they also were colored by aqueous safranin. In examining the literature on the sense organs of insects it was found that Guenther (1901) had figured strands similar to those just described. His text did not give an account of these except to say they were, "die schwarzen geschlungenen Plasmafortsätze der Hypodermiszellen".

No endeavor, other than a microscopic one, was made to determine what these strands signified and their relationship, if any, to the hypodermal cells and sensilla. Randow (1924) has two figures (6 and 16) of the wall of the fore- and hind-intestine of a myriapod, *Julus fallax;* these show, especially the former, that the strands he figures are quite similar to those in our specimens. These two parts of the alimentary tract of this myriapod consist of a single row of cells covered by a chitinous layer. Randow labelled these strands glycogen. Our sections showing these strands, also from mature specimens after the setae and cuticular layer had been secreted, might represent some residue after the formation of the chitinous parts. "It (chitin) is believed to be formed partly from glycogen and partly from protein," Wigglesworth (p. 327).

In a number of our specimens the hypodermis of the external surface has binucleate cells and a body, without any apparent structure between them (Fig. 7). These cells were similar in size and shape to the regular ones and gave no sign of special use which could be microscopically determined. The internuclear body showed, in some specimens, a lighter center, this without any apparent structure. Generally the nucleus nearest the cuticular layer was the smaller of the two, and fitted like a cap upon the end of the internuclear body.

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THE RECTAL GLANDS OF MOSQUITOES

WM. S. MARSHALL
Emeritus Professor of Entomology, University of Wisconsin

During the summer of 1944 Dane County, Wisconsin, appropriated money for a mosquito survey, one object of which was to determine the species within that area and their breeding habitats. Dr. L. G. Gumbreck, at that time assistant in zoology at the State University, had experience in this line of work and was assigned the task of collecting larvae and pupae, and the breeding and identification of the adults. An interest in the rectal glands, papillae, of insects led to an examination, both sexes, of the different species of these mosquitoes since Engel (1924) had discovered that in the Culicidae the males had four and the females six rectal glands. His paper figured the rectal sac with its papillae of both male and female *Culex pipiens* L. (p. 510), and he described the same variation (p. 509) in *Anopheles maculipennis* Mg. and *Culex annulatus* Schrk. We examined both male and female specimens of twelve species and found that in all of these the number of glands had the same ratio 4 : 6. We appreciate the generous assistance of Dr. Gumbreck in naming the specimens and his help in other ways.

Obtaining the mosquitoes soon after they were killed and before feeding and ovulation, the abdomen was cut off near its base and placed in water on a slide. Under a binocular dissecting microscope one could, by using fine forceps, hold the tip and the base of the abdomen and, gently pulling, sever it near its tip, and the intestine would be released through the basal segments. It was easier with the males because their genital claspers could be held and a single pull would free the rectal sac for examination under the microscope. The females were more difficult; two or three of the segments remained attached to the apical end and had to be removed with fine needles before the rectal sac could be seen. After both sexes of each species, later enumerated, had been examined, no further attention was given to that species. Whole mounts and sections were made for a detailed study. These specimens were prepared in the same way except a small amount of the fixative was placed on the slide instead of water. After removing the rectal sac, to which a small portion of the intestine adhered, it was placed in a vial of the fixative and then transferred to alcohol. Sections were made in the usual paraffin method, haematoxylin stains were used, and several of the slides counter stained.

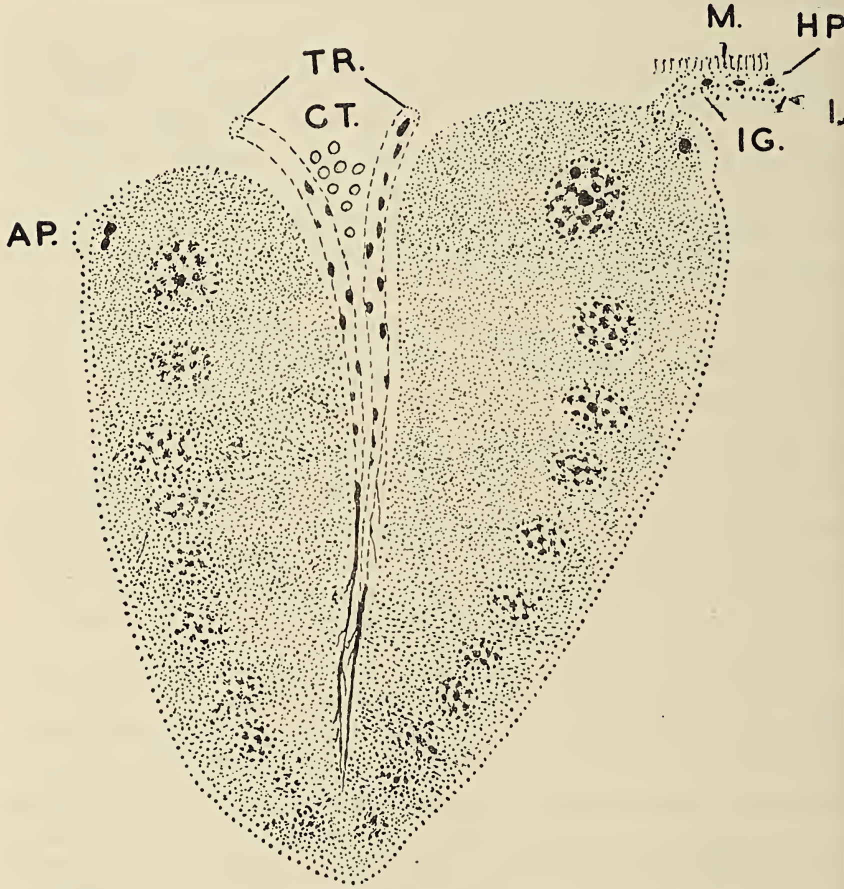

FIG. I.

FIG. 1.—A partially diagrammatic longitudinal section of a rectal gland of a mosquito. To make them more easily seen, certain parts, interglandular wall and the attachment-plate, have a greater enlargement than the other parts. AP., attachment-plate; CT., connective tissue; HP., hypodermis; I., intima; M., muscles; TR., tracheae. Sections were made through the rectal sac, with its enclosed glands, of several different species of mosquitoes, both male and female. These were so similar that differences could not be observed, and this figure represents a gland seen in any of the sections.

The structure of the rectal glands of mosquitoes can best be understood by an examination of a longitudinal section (Fig. 1). This is very similar to that of other Diptera as figured by Chun (1876) and Tonkov (1925) for *Musca vomitoria* L., and by Engel (1924) for *Tipula oleraceae* L. Where the tracheae enter the gland there is a small amount of connective tissue and similar cells are scattered in the wider part of the lumen. The epithelial cells are arranged in a single layer around the lumen and constitute the greatest part of the gland. The cells forming the basal row are larger than the others and all cells and their nuclei decrease in size towards the apex. The shape of the nuclei depends upon that of the cells; they are narrowest in the thinner cells, more circular in others.

The tracheal supply to each rectal gland has been described for several Diptera; in mosquitoes we find that it is best shown in whole mounts of the rectal sac. Those examined had two tracheae entering each gland through the opening at its base, not proof that this number is constant. In longitudinal sections the tracheae are seen to give off branches which decrease in diameter until they reach the apex of the gland, although they were not seen to enter the epithelial layer; probably such are present in a limited number. In Diptera and other insects tracheae and tracheoles have been found to penetrate the epithelium of the gland; in our sections a few tracheoles, difficult to find, were seen to enter between the cells. Nuclei of the tracheae are present in the lumen of the gland.

The much-reduced interglandular portion of the wall of the rectal sac consists of three layers (Fig. 1, IG); externally the longitudinal and circular muscles, next the small hypodermal cells with their nuclei, and the intima, often in small folds, form the inner layer. The thin layer of interglandular muscles could not be traced into the lumen of the gland but is seen to extend over its basal part between its opening and the margin. Where the interglandular wall joins the gland it abruptly enlarges to form the basal row of cells. The intima covers the gland and, near its base, bulges outward to form a loop (Fig. 1, AP) encircling the gland and, under this loop, there are one or two nuclei, generally a single one. This loop of the intima forms the attachment-plate, "Chitinring," "Kreiswulst" of some authors. It is difficult to assign any use to this structure in the mosquitoes.

Two specimens, counter stained with aqueous safranin, showed many small, red granules between the margin of the gland and the intima.

Literature on mosquitoes has greatly increased in the last few years; most of this is taxonomic with but little work on internal structure. The following is a summary of much of the work on the rectal glands in an endeavor to ascertain what, if anything, is known about this difference in the number of these glands in the male and female mosquitoes. The writings of early authors were not examined although Dufour (1851) has drawings of the alimentary tract of several Diptera, and his figure of a *Culex annulatus* Schrk., shows two pairs of rectal glands. Christophers (1901), without giving the species, says of a female mosquito, "into the rectum project six solid growths the so-called rectal glands" (p. 7). He figures a section through the rectal sac containing two glands. Giles (1902) shows the rectal sac of a female *Culex* with four glands and makes this curious statement: "connected with the intestine by short ducts" (p. 103). Nuttall and Shipley (1903) show a longitudinal diagrammatic section of *Anopheles maculipennis* Mg., with three papillae. In a view of a dissection of a female they show six rectal papillae and mention the same number in the text. Thompson (1905) shows the rectal sac of a female mosquito with six glands and mentions this number in the text. Patton and Cragg (1913) figure the alimentary tract of a *Culex* with three papillae, sex not mentioned. Hindle (1914) has a diagrammatic longitudinal section of *A. maculipennis* Mg., copied from Nuttall and Shipley (1903). This shows two glands, but in the text Hindle says the rectum contains six large ovoid papillae. Neumann and Mayer (1914) show the alimentary tract of *C. pipiens* L., with six rectal papillae. In the text (p. 196) they mention six glands for the female, four for the male. Engel (1924) has been mentioned. Patton and Evans (1929) show the alimentary tract of a female *C. pipiens* L., with six glands.

It might be of interest to see if the works on blood sucking and predatory Diptera refer to anything similar to the 4 : 6 ratio of the rectal glands of mosquitoes. The older workers are not listed. Stuhlmann (1905) writes of *Glossina*, "treten in das Lumen der Analblase vier grosse hohle Papillen ein" (p. 389). Later (1907) he says that the rectal sac of the male has four glands. Minchin (1905) records the same of *Glossina palpalis* Rob.–Desv. In the text (p. 538) he mentions four rectal glands, sex not given, and figures this number of papillae in the male. Patton and Cragg (1913) figure the alimentary tract of *Tabanus* with three rectal papillae, in their text they mention six. They show four glands in *Hippobosca maculata,* sex not given. Engel (1924) in his study of the rectal sac and glands of the Diptera examined more species than any other worker. A complete list of these would be out of place but we give the results he obtained from some blood sucking and predatory flies. Tabanidae: *Haematopoda fluvialis* Mg., *Tabanus bromius* L., and *T. montanus* Mg., each has six glands in both sexes, the males are not blood sucking. Rhagionidae: *Arterix ibis* L., male and female have the same number and ratio as the Culicidae. *Leptis scolopacea* L., has four glands, sex not given. Hippoboscidae: *Hippobosca equina* L., *Crataerrhina palliola* Ltr., *Lopoptena cervi* L. and *Melophagus ovinus* L., were examined and four glands were found in each sex. Lester and Lloyd (1928) writing of the tsetse fly: "In the wall of the metarectum are the usual four rectal papillae of Diptera." Perfiljew (1928) describing *Phlebotomus minutus Rondani* shows that both sexes have two glands. Patton and Evans (1929) show the female of *Haematopoda fluvialis* Mg., with six glands. *Glossina palpalis* Rob.–Desv., the male has four glands (p. 226). *Simulium ornatum,* the female is figured with four glands. *Phlebotomus chinensis* R. and H., figured with two glands, the text gives six. *Culicoides varius,* the female figured with two glands. Smart (1935) says the female of *Simulium ornatum* Mg., has six rectal papillae. No mention of the male except it is not blood sucking.

If we consider the mosquitoes and not the other Diptera, what meaning, if any, has this greater number of glands in the female as compared to the smaller number in the male? It is known that these insects can produce viable ova without a blood meal although blood is the principal, if not the exclusive, food of many females, rarely of the males. This difference in highly nutritious food might have something to do with the presence of the larger number of glands in the female as this sex has to produce much more, ova and egg coverings, than the male. The greater number of rectal glands in the female might be of use in the production of a larger amount of secretion, or, if the glands are not secretory, there must be some other reason. We have shown that in twelve species of mosquitoes this ratio of four glands in the male to six in the female is common to all.

The mosquitoes we examined for this work:

Aedes vexans Meig.,
A. trivittatus Coq.,
Anopheles punctipennis Say,
A. quadrimaculatus Say,
A. walkeri Theo.,
Culex apicalis Adams,
Culex pipiens L.,
C. tarsalis Coq.,
C. territans Walker,
Theobaldia inornata Will.,
T. morsitans Theo.,
Uranotaenia sapphirina O. Sacken,

To this list can be added two other species examined by Engel (1924), *Anopheles maculipennis* Mg., and *Culex annulatus* Schrk.; specimens of these species we did not have a chance to examine.

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PARASITES OF NORTHWEST WISCONSIN FISHES

I. THE 1944 SURVEY

JACOB H. FISCHTHAL

Biologist, Wisconsin Conservation Department, Spooner

During recent years the general public has taken more notice of and interest in the encysted parasites in the skin and flesh of some of Wisconsin's game and pan fishes. As a result of the many inquiries on parasites made of the Wisconsin Conservation Department, and the need for more knowledge on the distribution of the bass tapeworm, *Proteocephalus ambloplites,* in securing a brood stock and in planting of fingerling bass, a program was formulated for a complete survey of the parasites of Wisconsin fishes.

Northwest Wisconsin has been little investigated for fish parasites in the past and in this regard is relatively virgin territory. Bangham (in press) spent about one week in this region during the summer of 1943 investigating a few of the lakes and streams for fish parasites. However, due to the shortness of his stay too few fishes and waters were surveyed. The majority of the parasite surveys for Wisconsin were accomplished in other sections of the state by Marshall and Gilbert (1905), Pearse (1924), Cross (1938), and Bangham (in press and unpublished research).

The present paper is the first in a series of annual reports on a parasite survey of northwest Wisconsin fishes. The survey started December 22, 1943 and for the purpose of this report was terminated December 6, 1944. During this period fresh fishes were examined from 54 different lakes, streams, and natural and artificial bass rearing ponds as shown in Table 1. These fishes were collected for the most part by the use of fyke nets in lakes, and a common sense minnow seine in streams. Other means used for collecting fishes were electric shocking, line fishing, and poisoning with rotenone.

A total of 2,059 fishes, representing 44 different species, were examined for parasites. Nineteen hundred and eighty-four or approximately 96.4 percent of these fishes harbored at least one species of parasite (data summarized in Table 2). This figure is quite high when compared to other surveys elsewhere.

Bangham (in press) found parasites in 93.2 percent of the 1,329 fishes examined in northern Wisconsin during 1943. Essex and Hunter (1926) obtained parasites from 39 percent of 652 fishes from lakes and streams of the Central States. In a survey of Lake Erie, Bangham and Hunter (1939) found 58.3 percent of 2,156 fishes infected with parasites. Bangham (1940) found 88 percent of 1,380 fresh-water fishes from southern Florida infected. Fishes from Algonquin Park lakes (Ontario) studied by Bangham (1941) showed 84.3 percent of 560 fishes parasitized. Hunter (1941) found parasites in 72.5 percent of 598 Connecticut fishes examined.

In Table 1 the locations given for streams are those points at which collections were made. In collecting from lakes, fyke nets were set in varying aquatic environments in order to obtain as representative a sample of fishes as possible and under varied ecological conditions. The information on water condition, also shown in Table 1, was obtained mainly from lake surveys by Bordner (1942); the figures for total alkalinity were secured from water analyses by Mr. N. H. Boortz (unpublished research). In the other tables, no mark preceding the names of the parasite indicates an adult stage; an inverted T (⊥) before the parasite denotes the presence of both adult and immature stages in the same fish; two asterisks (**) preceding the parasite indicates an immature stage; a single asterisk (*) preceding the parasite indicates a larval stage; the superimposed number one (^{1}) following the number of infected fish indicates an infection with one to ten specimens of that species; the superimposed number two (^{2}) denotes an infection with 11–50 specimens; the superimposed number three (^{3}) indicates an infection with 51 or more specimens. The use of sp. or spp. after a generic name or a broader classification than the genus indicates that the specimens could not be identified more completely. The notation (B.) following the Yellow River indicates the stream is in Barron County; the notation (W.) indicates Washburn County.

Appreciation is due Dr. R. V. Bangham, College of Wooster, Ohio, for aid in verifying certain identifications, in identifying certain other specimens, and for his many helpful suggestions; Mr. D. John O'Donnell for his many helpful suggestions during the course of this work; Mr. Warren Churchill, and many of the Fisheries personnel at Spooner for their aid in collecting the fishes.

TABLE 1

LAKES AND STREAMS SURVEYED FOR PARASITES

Lake or Stream	County	Location	Water Conditions	1944 Collection Dates
Balsam Lake	Washburn	Town 37 North, Range 10 West, Sections 26, 35	Very hard, clear	1/30
Bean Brook	Washburn	T40N, R11W, S28, 35	Hard, clear	3/20
Bear Creek	Barron	T36N, R11W, S18 T35N, R11W, S5	Hard	1/14, 2/4
Bear Lake	Barron	T36N, R12W, S1, 12	Hard	4/15
Boos Lake	Sawyer	T42N, R5W, S28	Medium, brown	7/15
Brill River	Washburn	T37N, R11W, S25	Very hard, clear	
Brule River	Douglas	T46N, R10W, S3, 30 T47N, R10W, S34	Total alkalinity 61.05 p.p.m.—medium	7/13, 7/26, 8/1 11/22, 12/6
Cable Lake	Washburn	T39N, R12W, S18	Medium hard, very clear	6/28, 10/24
Casey Lake	Washburn	T40N, R13W, S15, 16, 21	Medium, clear	7/27
Cedar Lake	Polk & St. Croix	T32N, R18W, S24, 27, 35 T31N, R18W, S2, 3	Very hard, green	4/30
Chetac Lake	Sawyer	T38N, R9W, S27, 33, 34	Hard, green	6/8
Clam Lake	Burnett	T39N, R16W, S34, 35	Very hard, clear	4/17
Clam River Flowage	Burnett	T40N, R13W, S24	Very hard	7/18
Crooked Lake	Burnett	T38N, R16W, S4, 5, 8	Very soft, clear	11/13
Crystal Brook	Washburn	T39N, R11W, S31	Very hard, clear	1/14
Cyclone Lake	Washburn	T39N, R13W, S26, 35	Medium, clear	9/29
Devils Lake	Burnett	T40N, R16W, S34, 35	Medium hard, clear	7/22
Eau Claire County Bass Pond	Eau Claire	City of Eau Claire	Total alkalinity 32.5 p.p.m.—soft	7/18
Ellsworth Lake	Washburn	T39N, R13W, S17, 18	....	11/15
Hay River	Barron	T34N, R13W, S29	....	3/14
Horseshoe Lake	Barron	T36N, R14W, S3, 4, 10	Soft	8/24
Island Lake Hatchery Pond	Rusk	T33N, R8W, S21	Total alkalinity 57.5 p.p.m.—medium	7/17
La Crosse Federal Hatchery	La Crosse	City of La Crosse	....	8/16
Lightning Creek	Barron	T34N, R13W, S30	....	3/14
Little Long Lake (Pauquettes)	Burnett	T38N, R14W, S2, 3	Medium, clear	7/26

TABLE 1—*(Continued)*

LAKES AND STREAMS SURVEYED FOR PARASITES

Lake or Stream	County	Location	Water Conditions	1944 Collection Dates
Long Lake	Burnett	T40N, R16W, S4, 5	Hard, clear	7/19
Lost Land Lake	Sawyer	T42N, R6W, S20, 29	Hard, green	5/10, 9/20
Marshmiller Pond	Chippewa	T31N, R8W, S17, 20, 29	Medium hard, clear	6/4
Mathews Lake	Washburn	T41N, R13W, S14, 23	Hard, clear	7/29
Meadow Creek	Barron	T34N, R11W, S4	....	2/4
Namekagon River–Hayward Flowage	Sawyer	T41N, R9W, S26, 27	Medium hard, brown	8/19
Polk County Bass Pond #3	Polk	T34N, R16W, S27	Total alkalinity 35.0 p.p.m.—soft	7/26
Potato Creek	Washburn	T40N, R12W, S34 T39N, R11W, S20, 21	....	3/20, 4/10
Red Cedar River	Barron	T34N, R11W, S30	....	2/4
Rocky Ridge Lake	Washburn	T39N, R13W, S5, 8	Very hard, clear	11/15
Round Lake	Chippewa	T32N, R9W, S14, 23	Very soft	10/13
St. Croix County Bass Pond #18	St. Croix	T30N, R18W, S34	Total alkalinity 21.2 p.p.m.—soft	8/1
St. Croix County Bass Pond #19	St. Croix	T30N, R19W, S10	Total alkalinity 2.0 p.p.m.—very soft	8/1
St. Croix County Bass Pond #20	St. Croix	T31N, R16W, S18	Total alkalinity 22.5 p.p.m.—soft	8/1
Silver Lake	Barron	T36N, R13W, S24, 25	Soft, clear	8/9
Spooner Hatchery Pond	Washburn	T39N, R12W, S31	Total alkalinity 72.5 p.p.m.—hard	8/2
Spooner Lake	Washburn	T39N, R12W, S22, 26, 27	Very hard, clear	9/2
Staples Lake	Barron & Polk	T35N, R14W, S19, 30 T35N, R15W, S24, 25	Total alkalinity 22.5 p.p.m.—soft	5/1, 8/11, 9/28
Teal Lake	Sawyer	T42N, R6W, S26, 27	Hard, green	5/9, 7/13
Tozer Lake	Washburn	T38N, R13W, S1, 2	Very hard, clear	10/24
Upper Turtle Lake	Barron	T34N, R14W, S16, 21, 22	....	3/14, 8/25
Vermillion Lake	Barron	T35N, R13W, S15	Hard	8/10
Vermillion River	Barron	T34N, R13W, S22, 26	....	2/4

TABLE 1—*(Concluded)*

LAKES AND STREAMS SURVEYED FOR PARASITES

Lake or Stream	County	Location	Water Conditions	1944 Collection Dates
Washburn County Bass Pond #5...	Washburn	T38N, R12W, S21	Total alkalinity 12.5 p.p.m.—very soft	7/22
Washburn County Bass Pond #6...	Washburn	T38N, R13W, S19	Total alkalinity 10.0 p.p.m.—very soft	7/22
Whalen Creek....................	Washburn	T40N, R12W, S25, 36	Hard, clear	1/15, 3/20
Windigo Lake....................	Sawyer	T40N, R9W, S22, 27	Very soft, clear	7/8
Yellow River....................	Barron	T34N, R12W, S27	....	2/4
Yellow River....................	Washburn	T39N, R12W, S31	Total alkalinity 72.5 p.p.m.—hard	12/22/43, 1/9, 1/10, 3/28, 9/12

TABLE 2

SUMMARY OF PARASITE SURVEY DATA

Fish	No. Exam.	No. Inf.	% Inf.	No. Waters Exam.	No. Spp. Parasites Found
1. *Amia calva*	5	5	100	3	9
2. *Salmo trutta fario*	14	7	50	3	6
3. *Salmo gairdnerii irideus*	18	14	78	1	6
4. *Salvelinus f. fontinalis*	6	5	83	2	4
5. *Moxostoma aureolum*	1	1	100	1	1
6. *Moxostoma rubreques*	6	5	83	2	5
7. *Moxostoma erythrurum*	8	8	100	2	3
8. *Hypentelium nigricans*	11	8	73	4	6
9. *Catostomus c. commersonnii*	151	144	95	20	31
10. *Campostoma anomalum pullum*	43	41	95	7	11
11. *Rhinichthys c. cataractae*	5	5	100	2	8
12, *Rhinichthys atratulus meleagris*	4	3	75	3	2
13. *Nocomis biguttatus*	29	29	100	5	14
14. *Semotilus a. atromaculatus*	25	25	100	6	15
15. *Notemigonus crysoleucas auratus*	16	15	93	2	5
16. *Hyborhynchus notatus*	19	13	68	6	8
17. *Notropis cornutus frontalis*	61	61	100	8	20
18. *Notropis rubellus*	12	8	67	1	4
19. *Notropis heterodon*	1	1	100	1	1
20. *Ameiurus n. natalis*	34	34	100	13	19
21. *Ameiurus n. nebulosus*	68	68	100	10	21
22. *Ameiurus m. melas*	13	13	100	4	15
23. *Noturus flavus*	13	13	100	2	9
24. *Schilbeodes mollis*	10	10	100	4	8
25. *Umbra limi*	26	26	100	4	14
26. *Esox lucius*	125	125	100	21	20
27. *Esox m. masquinongy*	4	4	100	2	10
28. *Perca flavescens*	144	142	99	24	31
29. *Stizostedion v. vitreum*	118	118	100	15	26
30. *Hadropterus maculatus*	4	4	100	2	3
31. *Percina caprodes semifasciata*	5	5	100	3	10
32. *Boleosoma n. nigrum*	82	82	100	10	22
33. *Poecilichthys exilis*	10	6	60	2	8
34. *Poecilichthys c. caeruleus*	9	9	100	6	8
35. *Catonotus flabellaris lineolatus*	38	37	97	6	14
36. *Micropterus d. dolomieu*	8	8	100	4	23
37. *Huro salmoides*	156	152	97	21	27
38. *Lepomis cyanellus*	4	4	100	2	11
39. *Lepomis gibbosus*	139	139	100	17	29
40. *Lepomis m. macrochirus*	217	217	100	20	28
41. *Ambloplites r. rupestris*	132	132	100	22	29
42. *Pomoxis nigro-maculatus*	216	207	96	20	25
43. *Cottus b. bairdii*	16	16	100	3	9
44. *Eucalia inconstans*	33	15	45	5	12
TOTALS	2,059	1,984	96.4		

TABLE 3

Amia calva Linnaeus – BOWFIN

	Casey Lake	Rocky Ridge Lake	Yellow River (W.)
Examined 5 Infected 5	3 3	1 1	1 1
Azygia augusticauda	....	1^{1}	....
***Camallanus oxycephalus*	1^{1}	....	....
***Contracaecum* sp.	1^{1}	....	....
Illinobdella sp.	1^{1}	....	....
Leptorhynchoides thecatus	....	1^{1}	1^{2}
Macroderoides parvus	3^{3}	1^{2}	....
Neoechinorhynchus cylindratus	1^{1}	....	....
Pomphorhynchus bulbocolli	....	....	1^{1}
***Proteocephalus pearsei*	1^{1}	....	....

Bowfin

All five bowfin were infected. Parasitic infections were relatively light. The immature *Contracaecum* sp. was recovered from the intestine.

TABLE 4

Salmo trutta fario Linnaeus – BROWN TROUT

	Bean Brook	Brule River	Crystal Brook
Examined 14 Infected 7	1 1	12 6	1 0
***Camallanus oxycephalus*	....	1^{1}	....
Crepidostomum farionis	....	2^{1}	....
Cystidicoloides harwoodi	....	3^{1}	....
**Glochidia*	1^{3}	....	....
**Neascus* sp.	....	2^{1}	....
***Proteocephalus* sp.	....	3^{1}	....

Brown trout

Only seven (50 percent) of the 14 brown trout were infected. The *Proteocephalus* sp. from the Brule River was too immature for species identification. The glochidia on the trout from Bean Brook were extremely numerous, over 100 being on all fins, the operculum, and the gills.

TABLE 5

Salmo gairdnerii irideus Gibbons – COAST RAINBOW TROUT

	Brule River
Examined 18 Infected 14	18 14
Cystidicoloides harwoodi	10[1]
**Neascus* sp.	1[1]
Phyllodistomum sp.	2[1]
Pomphorhynchus bulbocolli	1[1]
Rhabdochona cascadilla	1[1]
Spinitectus gracilis	4[1]

TABLE 6

Salvelinus f. fontinalis (Mitchill) – COMMON BROOK TROUT

	Brill River	Brule River
Examined 6 Infected 5	1 0	5 5
Cystidicoloides harwoodi	....	4[1]
**Neascus* sp.	....	1[2]
Oxyuridae	....	1[1]
Rhabdochona cascadilla	....	4[1]

Common brook trout

Five (approximately 83 percent) of the six brook trout were infected. A single specimen belonging to the nematode family Oxyuridae was found in the intestine of one trout. Bangham (personal communication) has "seen a similar form in frogs," and it is possible that the one from the trout may have been accidently ingested with the frog.

TABLE 7

Moxostoma aureolum (LeSueur) – Northern Redhorse

	Bean Brook
Examined 1	1
Infected 1	1
***Contracaecum* sp.	1[1]

TABLE 8

Moxostoma rubreques Hubbs – Greater Redhorse

	Bear Lake	Namekagon River
Examined 6	1	5
Infected 5	0	5
Biacetabulum infrequens		1[1]
***Biacetabulum infrequens*		1[1]
Gyrodactyloidea		3[2]
**Leptorhynchoides thecatus*		1[1]
Neoechinorhynchus crassus		2[1]
Pomphorhynchus bulbocolli		2[1]

TABLE 9

Moxostoma erythrurum (Rafinesque) – Golden Redhorse

	Clam Lake	Yellow River (W.)
Examined 8	7	1
Infected 8	7	1
**Clinostomum marginatum*	7[1]	
Myxosporidia	1[1]	
Neoechinorhynchus crassus	1[1]	1[1]
**Neoechinorhynchus crassus*		1[2]

Golden redhorse

All golden redhorse were infected. The Myxosporidia was found in a cyst on the roof of the mouth; the larval *Neoechinorhynchus crassus* was encysted in the mesenteries.

TABLE 10

Hypentelium nigricans (LeSueur) – HOG SUCKER

	Bean Brook	Bear Creek	Hay River	Meadow Creek
Examined 11 Infected 8	1 1	4 1	4 4	2 2
**Clinostomum marginatum*	....	....	....	2[1]
***Contracaecum* sp.	....	1[1]	....	....
Glaridacris catostomi	1[1]	....	3[1] 1[2]	1[1] 1[2]
Gyrodactyloidea	1[1]	....	3[1] 1[2]	1[2] 1[3]
**Neascus* sp.	....	1[1]	2[1]	1[1]
**Philometra* sp.	....	....	1[1]	....

Hog sucker

Eight (approximately 73 percent) of the 11 hog suckers were infected. The larval *Philometra* sp. was found encysted in the mesenteries.

Common white sucker

Only 144 (approximately 95 percent) of the 151 suckers were infected. The larval *Diplostomulum* sp. occurred in the lens of the eye. The Myxosporidia was found in cysts in the gills. The larval *Bucephalus elegans, Philometra* sp., *Pomphorhynchus bulbocolli, Proteocephalus* sp., and *Spiroxys* sp. were encysted in the mesenteries. *Sanguinicola* sp. from Potato Creek was taken from the mesenteric blood vessels and apparently is a new species of blood fluke. Bangham (in press) found only the adult *Pomphorhynchus bulbocolli* in two Yellow River suckers examined by him. In his examination of 18 Brule River suckers similar parasites were found as indicated in this report, and in addition he recorded *Triganodistomum attenuatum* from three of these 18 fish.

TABLE 11

Catostomus c. commersonnii (Lacépède) – COMMON WHITE SUCKER

	Bean Brook	Bear Lake	Boos Lake	Brill River	Brule River	Cable Lake	Cedar Lake	Clam Lake	Crystal Brook	Lost Land Lake	Meadow Creek	Namekagon River	Potato Creek	Spooner Lake	Staples Lake	Teal Lake	Tozer Lake	Upper Turtle Lake	Whalen Creek	Yellow River (W.)
Examined 151 Infected 144	2 2	2 2	1 1	12 12	28 27	3 1	7 7	2 2	9 8	1 1	6 6	4 4	15 14	1 1	6 6	10 10	12 12	4 4	15 14	11 10
Acolpenteron catostomi	....	....	....	....	....	....	....	....	1^1	....	....	....	....	....	....	....	....	....	....	....
Allocreadium lobatum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....	....
Anonchohaptor anomalum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....	....
Argulus catostomi	....	....	....	....	....	....	....	....	....	1^1	....	....	....	....	....	....	....	....	....	....
**Bucephalus elegans*	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....	....	....	....	....
***Camallanus oxycephalus*	....	....	1^1	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....	....
Chloromyxum sp.	....	....	....	....	....	....	....	....	....	....	....	....	2^3	....	....	....	....	....	1^3	....
**Clinostomun marginatum*	....	....	....	1^1	....	....	....	....	....	1^1	....	....	....	1^1	....	1^1	1^1	....	....	....
***Contracaecum* sp.	....	....	....	1^1	....	....	....	....	2^1	....	....	....	3^1	....	....	....	....	....	....	1^1
**Diplostomulum* sp.	....	....	....	....	....	....	7^1	....	1^1	....	....	....	....	....	....	....	9^1	3^1	....	....
Glaridacris catostomi	....	....	....	3^1	....	1^1	3^1	....	1^1	....	....	....	....	....	....	4^1 3^2	....	....	....	6^1 2^2
⊥*Glaridacris catostomi*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1
***Glaridacris catostomi*	....	2^1	1^1	2^1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....
Glaridacris confusus	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2^1	....	....
⊥*Glaridacris confusus*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....
***Glaridacris confusus*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....
Glaridacris intermedius	....	....	....	....	2^1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
⊥*Glaridacris intermedius*	....	....	....	....	6^1 2^2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
***Glaridacris intermedius*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5^1 5^2 2^3	....	....	....
**Glochidia*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	1^1
Gyrodactyloidea	....	....	....	1^2	....	....	....	....	....	....	....	2^2	....	....	....	....	....	....	....	....
Hepaticola bakeri	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....

TABLE 11—*(Continued)*

Catostomus c. commersonnii (Lacépède) – COMMON WHITE SUCKER

	Bean Brook	Bear Lake	Boos Lake	Brill River	Brule River	Cable Lake	Cedar Lake	Clam Lake	Crystal Brook	Lost Land Lake	Meadow Creek	Namekagon River	Potato Creek	Spooner Lake	Staples Lake	Teal Lake	Tozer Lake	Upper Turtle Lake	Whalen Creek	Yellow River (W.)
Leptorhynchoides thecatus							3[1]	1[1]					1[1]							
Myxosporidia				1[1]									1[1]			1[1]			1[1]	1[1]
**Neascus* sp.	1[1]			6[1]	1[1]				1[1]	1[1]			7[1]			3[1]	1[1]		5[1]	1[1]
				5[2]									4[2]							
				1[3]	26[3]															
Neoechinorhynchus crassus	1[1]	1[1]		3[1]	12[1]		1[1]	1[1]			3[1]		8[1]		3[1]	4[1]		3[1]	5[1]	4[1]
				9[2]	2[2]					1[2]	1[2]					6[2]	3[2]	1[2]	2[2]	4[2]
Octospinifer macilentus					14[1]															
					1[2]															
**Philometra* sp.	1[1]								3[1]				4[1]						5[1]	
***Plagioporus sinitsini*																			1[1]	
Phyllodistomum lysteri															2[1]	1[1]		2[1]		1[1]
***Phyllodistomum lysteri*													2[1]						1[2]	
Pomphorhynchus bulbocolli		1[1]		6[1]	3[1]			1[1]			4[1]	4[1]	4[1]		5[1]	7[1]		3[1]	5[1]	5[1]
											2[2]				1[2]	2[2]		1[2]		3[2]
**Pomphorhynchus bulbocolli*																1[1]				
**Proteocephalus* sp.													9[1]							
Sanguinicola sp.													5[1]							
**Tetracotyle* sp.						1[2]							1[1]			1[2]			1[1]	
**Spiroxys* sp.			1[1]								1[1]		1[1]				1[1]		2[1]	1[1]
**Triaenophorus nodulosus*			1[2]				1[1]									7[1]				
																2[2]				
[1]*Triganodistomum attenuatum*									1[1]											1[1]
***Triganodistomum attenuatum*	2[1]			1[1]					4[1]				6[1]			1[1]			9[1]	
																2[2]				

TABLE 12

Campostoma anomalum pullum (Agassiz) – CENTRAL STONEROLLER

	Bear Creek	Brill River	Hay River	Lightning Creek	Meadow Creek	Vermilion River	Whalen Creek
Examined 43	10	2	7	10	4	9	1
Infected 41	9	2	7	10	3	9	1
**Clinostomum marginatum*	....	....	....	....	....	....	1[2]
***Contracaecum* sp.	....	....	....	....	....	1[1]	....
**Glochidia*	6[1]	....	3[1]	9[1] 1[2]	....	1[1] 1[1]	....
Myxosporidia	....	....	....	....	....	1[2]	....
**Neascus* sp.	4[1]	1[1] 1[2]	2[1] 5[2]	.... 1[2] 9[3]	3[1]	8[1] 1[2]	....
**Posthodiplostomum minimum*	4[1]	.... 1[2] 1[3]	4[1] 2[2]	3[1]	.... 1[2] 2[3]	6[1]	.... 1[2]
Proteocephalus sp.	....	....	1[1]	3[1]	....	....	....
***Proteocephalus* sp.	....	....	....	1[1]	....	....	....
***Proteocephalus pearsei*	....	....	....	....	....	1[1]	....
Rhabdochona cascadilla	....	....	1[1]	....	....	....	....
**Tetracotyle* sp.	....	....	1[1]	1[1]	....	....	....
Trichodina sp.	....	2[3]	....	....	....	....	....

Central stoneroller

Forty-one (approximately 95 percent) of the 43 examined harbored parasites. The adult and immature *Proteocephalus* sp. from Hay River and Lightning Creek is apparently a new species, according to Bangham (personal communication), and a similar form had been taken by him in Lake Erie. *Trichodina* sp. was recovered from the ureters of a stoneroller from Brill River. The Myxosporidia was found in cysts on the gills.

TABLE 13

Rhinichthys c. cataractae (Valenciennes) – Great Lakes Longnose Dace

	Bean Brook	Bear Creek
Examined 5	3	2
Infected 5	3	2
**Clinostomum marginatum*	1[1]	....
***Contracaecum* sp.	1[1]	1[1]
**Glochidia*	1[1]	....
Myxosporidia	1[3]	....
**Neascus* sp.	1[1]	1[1]
**Posthodiplostomum minimum*	1[1]	1[1]
***Proteocephalus* sp	....	1[1]
Rhabdochona cascadilla	3[1]	....

Great Lakes longnose dace

All longnose dace were infected. The Myxosporidia from Bean Brook was found in the liver. The immature *Proteocephalus* sp. from Bear Creek was too young to be identified; no apical sucker was seen on the scolex.

TABLE 14

Rhinichthys atratulus meleagris Agassiz – Western Blacknose Dace

	Bean Brook	Hay River	Whalen Creek
Examined 4	2	1	1
Infected 3	1	1	1
**Neascus* sp.	....	1[1]	1[1]
**Posthodiplostomum minimum*	1[1]	....	....

TABLE 15

Nocomis biguttatus (Kirtland) – HORNYHEAD CHUB

	Bean Brook	Brill River	Meadow Creek	Vermillion River	Whalen Creek
Examined 29	1	1	17	8	2
Infected 29	1	1	17	8	2
**Bucephalus elegans*	1[1]				
Cestodaria			1[1]		
Chloromyxum sp.					1[3]
**Clinostomum marginatum*			7[1]	6[1]	
				1[2]	
***Contracaecum* sp.		1[1]			
Gyrodactyloidea			7[1]		1[1]
			5[2]	1[2]	
Leptorhynchoides thecatus				1[1]	
Myxosporidia	1[3]				1[1]
**Neascus* sp.			9[1]	6[2]	1[2]
	1[2]		6[2]	2[3]	1[3]
Phyllodistomum nocomis			1[2]		
***Phyllodistomum nocomis*			1[1]		
Pomphorhynchus bulbocolli				1[1]	
**Pomphorhynchus bulbocolli*					2[1]
**Posthodiplostomum minimum*	1[1]	1[1]	12[1]	4[1]	
				1[2]	
**Spiroxys sp.*				1[1]	
**Tetracotyle* sp.			7[1]		

Hornyhead chub

The 29 hornyhead chubs examined were all infected. The larval *Bucephalus elegans, Pomphorhynchus bulbocolli,* and *Spiroxys* sp. were encysted in the mesenteries. *Chloromyxum* sp. was recovered from the gall bladder. The Myxosporidia from Bean Brook was from the gall bladder, while the Whalen Creek species was from two large cysts on the gills.

TABLE 16

Semotilus a. atromaculatus (Mitchill) – NORTHERN CREEK CHUB

	Bear Creek	Crystal Brook	Meadow Creek	Potato Creek	Vermillion River	Whalen Creek
Examined 25	1	2	3	7	10	2
Infected 25	1	2	3	7	10	2
Allocreadium lobatum	....	....	....	2^1	3^1	1^1
***Allocreadium lobatum*	....	....	....	....	1^1	1^1
Bothriocephalus formosus	....	....	....	1^1	....	....
***Camallanus oxycephalus*	....	....	1^1	....	....	....
**Clinostomum marginatum*	....	....	3^1	....	4^1	....
***Contracaecum* sp.	....	1^1	....	1^1	....	1^1
**Glochidia*	....	....	....	3^1 1^2	....	....
Gyrodactyloidea	1^1	....	1^1 1^2	7^1	2^1 1^1	....
Leptorhynchoides thecatus	....	....	1^1	....	....	....
**Leptorhynchoides thecatus*	....	....	1^1	....	....	....
Myxosporidia	....	....	....	....	1^3	....
**Neascus* sp.	1^1	....	3^2	2^1	5^1 5^2	.... 1^2
**Posthodiplostomum minimum*	1^1	1^1	1^2 2^3	3^2	7^1	1^1 1^2
Proteocephalus sp.	....	....	....	2^1	....	....
**Proteocephalus* sp.	....	1^1	....	....	....	....
Rhabdochona cascadilla	....	....	....	1^1	....	....
Trichodina sp.	....	....	....	2^2 1^3	....	....

Northern creek chub

All 25 creek chubs were infected with parasites. The larval *Leptorhynchoides thecatus* and *Proteocephalus* sp. were encysted in the mesenteries. The mature *Proteocephalus* sp. from Potato Creek is probably a new species according to Bangham (personal communication) as he does "not think this fits in with any described species." *Trichodina* sp. was found on the gills. The recovery of *Bothriocephalus formosus* from this fish appears to be a new host record.

TABLE 17

Notemigonus crysoleucas auratus (Rafinesque) – WESTERN GOLDEN SHINER

	Crooked Lake	Potato Creek
Examined 16	15	1
Infected 15	14	1
***Contracaecum* sp.	...	1[1]
Gyrodactyloidea	4[1]	...
**Hymenolepis* sp.	3[1]	...
**Neascus* sp.	13[1]	...
**Tetracotyle* sp.	1[2]	...

Western golden shiner

Fifteen (approximately 94 percent) of the 16 fish harbored a parasite. The larval *Hymenolepis* sp. was found in the intestine of Crooked Lake golden shiners. Van Cleave and Mueller (1934), in their survey of Oneida Lake (New York) fish, found a larval *Hymenolepis* sp. in the intestine of the largemouth bass (*Huro salmoides*) and stated that "all evidence seems to point to this as an abnormal host and location. It is highly probable that the larva is carried normally by some crustacean through whose agency the tapeworm enters a natural bird host."

TABLE 18

Hyborhynchus notatus (Rafinesque) – BLUNTNOSE MINNOW

	Crystal Brook	Potato Creek	Red Cedar River	Upper Turtle Lake	Ver-million River	Whalen Creek
Examined 19	2	4	1	10	1	1
Infected 13	0	4	1	6	1	1
**Bucephalus elegans*	...	1[1]	...	...	...	...
Chloromyxum sp.	...	1[3]	...	...	...	...
***Contracaecum* sp.	...	1[1]	1[1]	...	1[1]	...
**Glochidia*	...	...	1[1]	2[1]	...	1[1]
Myxosporidia	...	...	...	3[1]	...	...
**Neascus* sp.	...	2[1]	...	3[1]	1[1]	...
**Posthodiplostomum minimum*	...	2[1]	...	2[1]	1[1]	1[1]
Rhabdochona cascadilla	...	1[1]	...	...	...	...

Bluntnose minnow

Thirteen (approximately 68 percent) of the 19 bluntnose minnows examined were infected. The protozoan, *Chloromyxum* sp., was found in the gall bladder. The Myxosporidia was found on the gills.

TABLE 19

Notropis cornutus frontalis (Agassiz) – NORTHERN COMMON SHINER

	Bear Creek	Cedar Lake	Meadow Creek	Potato Creek	Red Cedar River	Upper Turtle Lake	Ver-million River	Whalen Creek
Examined 61	2	1	17	16	1	3	7	14
Infected 61	2	1	17	16	1	3	7	14
Allocreadium lobatum			2^{1}	1^{1}				
***Allocreadium lobatum*			2^{1}	6^{1}			3^{1}	8^{1}
***Bothriocephalus* sp.								1^{1}
**Bucephalus elegans*	2^{1}			1^{1}		1^{1}		3^{1}
Chloromyxum sp.				1^{3}				6^{3}
**Clinostomum marginatum*			2^{1}	1^{1}			1^{1}	
**Glochidia*	1^{1}		1^{1}	6^{1}		1^{1}	1^{1}	
Gyrodactyloidea			6^{1}	9^{1}				
			9^{2}	2^{2}	1^{1}	2^{1}	3^{1}	9^{1}
			1^{3}				3^{2}	3^{2}
Microsporidia				1^{1}				1^{1}
Myxosporidia							1^{1}	
				3^{3}			1^{3}	
**Neascus* sp.	1^{1}		4^{1}	6^{1}	1^{1}	3^{1}	4^{1}	7^{1}
							2^{2}	
Octomacrum lanceatum							2^{1}	
Phyllodistomum notropidus				1^{2}				1^{1}
***Phyllodistomum notropidus*				1^{1}				3^{1}
Plagioporus sinitsini			2^{1}	1^{1}				2^{1}
⊥*Plagioporus sinitsini*								1^{1}
Pomphorhynchus bulbocolli	5^{1}		5^{1}	1^{1}				
**Pomphorhynchus bulbocolli*	5^{1}		5^{1}		1^{1}			
**Posthodiplostomum minimum*	1^{1}	1^{3}	12^{1}	5^{1}		1^{1}	3^{1}	9^{1}
			5^{2}					2^{2}
***Proteocephalus* sp.			1^{1}					
Rhabdochona cascadilla	1^{1}	1^{1}	15^{2}	7^{1}	1^{2}	1^{1}	4^{1}	9^{1}
			2^{3}				3^{2}	1^{2}
Sanguinicola sp.				1^{1}				
**Spiroxys* sp.				3^{1}				1^{1}
**Tetracotyle* sp.		1^{1}	1^{1}	1^{1}				

Northern common shiner

All 61 common shiners were infected. *Chloromyxum* sp., and the heavy infections with Myxosporidia from Potato Creek and Vermillion River occurred in the gall bladder. The Myxosporidia in the light infection from Vermillion River was found within two cysts in the flesh. The Microsporidia occurred as very large cysts in the flesh of the back. The larval *Bucephalus elegans* and *Pomphorhynchus bulbocolli* were encysted in the mesenteries. The blood fluke *Sanguinicola* sp. was found in the mesenteric blood vessels and apparently is a new species.

TABLE 20

Notropus rubellus (Agassiz) – ROSYFACE SHINER

	Bear Creek
Examined 12	12
Infected 8	8
**Bucephlaus elegans*	3 [1] 1 [2]
**Diplostomulum scheuringi*	3 [1]
**Posthodiplostomum minimum*	3 [1]
**Spiroxys* sp.	1 [1]

TABLE 21

Notropis heterodon (Cope) – BLACKCHIN SHINER

	Crystal Brook
Examined 1	1
Infected 1	1
***Contracaecum* sp.	1 [1]

Northern yellow bullhead

All 34 yellow bullheads were infected. The larval *Contracaecum* sp., *Leptorhynchoides thecatus, Pomphorhynchus bulbocolli,* and *Spiroxys* sp. were encysted in the mesenteries. The larval *Diplostomulum* sp. was found in the lens of the eye. The Myxosporidia was found in many cysts on the gills.

TABLE 22

Ameiurus n. natalis (LeSueur) – NORTHERN YELLOW BULLHEAD

	Bear Creek	Cable Lake	Casey Lake	Cedar Lake	Clam Lake	Ellsworth Lake	Meadow Creek	Namekagon River	Red Cedar River	Spooner Lake	Staples Lake	Tozer Lake	Yellow River (W.)
Examined 34 Infected 34	1 1	1 1	1 1	1 1	2 2	1 1	1 1	1 1	2 2	9 9	2 2	11 11	1 1
Alloglossidium corti	......	1^{1}	......	......	......	......	......	......	......	......	......	......	......
Alloglossidium geminus	......	......	......	......	......	......	......	1^{1}	......	4^{1}	1^{1}	......	......
⊥*Alloglossidium geminus*	......	......	......	......	......	......	......	......	......	......	......	1^{3}	......
***Alloglossidium geminus*	......	1^{1}	......	......	......	......	......	......	......	......	......	1^{1} 1^{2}	......
***Camallanus oxycephalus*	......	......	......	......	1^{1}	......	......	......	......	......	1^{1}	7^{1}	......
**Clinostomum marginatum*	......	1^{1}	1^{1}	1^{1}	1^{1}	......	......	......	......	5^{1}	1^{1}	......	......
***Contracaecum* sp.	......	......	......	......	......	1^{1}	......	......	......	1^{1}	......	......	......
**Contracaecum* sp.	......	......	......	......	1^{1}	......	......	......	1^{1}	......	......	3^{1}	......
Corallobothrium fimbriatum	......	......	......	......	......	......	......	......	......	4^{1}	......	......	......
⊥*Corrallobothrium fimbriatum*	......	......	......	......	......	......	......	......	......	......	......	1^{1}	......
***Corallobothrium fimbriatum*	......	......	......	1^{1}	......	......	......	......	......	......	......	9^{1}	1^{1}
***Dichelyne robusta*	......	1^{1}	......	......	......	......	......	......	......	......	......	......	......
**Diplostomulum* sp.	......	......	......	......	......	......	......	1^{1}	1^{1}	......	1^{1}	11^{1}	......
**Glochidia*	1^{1}	......	......	......	......	......	......	......	2^{1}	......	......	......	......
Gyrodactyloidea	1^{1}	......	1^{2}	1^{1}	......	......	1^{1}	1^{3}	......	3^{1} 3^{2}	2^{1}	......	......

TABLE 22—*(Continued)*

Ameiurus n. natalis (LeSueur) – NORTHERN YELLOW BULLHEAD

	Bear Creek	Cable Lake	Casey Lake	Cedar Lake	Clam Lake	Ells-worth Lake	Mead-ow Creek	Name-kagon River	Red Cedar River	Spoon-er Lake	Staples Lake	Tozer Lake	Yellow River (W.)
Leptorhynchoides thecatus	......	......	1^{1}	......	1^{1}	......	......	......	1^{1}	6^{1}	......	......	1^{1}
**Leptorhynchoides thecatus*	......	......	......	......	......	......	1^{1}	......	2^{1}	1^{1} 4^{2}	......	......	1^{2}
Myxosporidia	......	......	......	......	......	......	......	......	......	......	1^{3}	......	......
Phyllodistomum staffordi	......	......	......	......	......	......	......	1^{1}	......	......	......	6^{1}	......
Pomphorhynchus bulbocolli	......	......	......	......	......	......	......	......	1^{1}	4^{1}	......	......	1^{1}
**Pomphorhynchus bulbocolli*	......	......	1^{2}	......	......	......	......	......	1^{1}	9^{1}	......	......	......
**Posthodiplostomum minimum*	......	......	......	......	1^{1}	......	......	......	......	......	......	......	......
**Proteocephalus ambloplites*	......	......	......	......	......	......	......	......	......	......	1^{1}	9^{1}	......
***Proteocephalus pearsei*	......	......	......	......	......	......	......	......	......	1^{1}	......	......	......
Spinitectus carolini	......	......	......	......	......	......	......	......	......	......	......	5^{1}	......
**Spiroxys* sp.	......	......	1^{1}	1^{1}	1^{2}	1^{1}	......	......	1^{1}	1^{1}	1^{1}	1^{1}	1^{1}

TABLE 23

Ameiurus n. nebulosus (LeSueur) – NORTHERN BROWN BULLHEAD

	Cedar Lake	Ellsworth Lake	Lost Land Lake	Namekagon River	Round Lake	Silver Lake	Spooner Lake	Staples Lake	Windigo Lake	Yellow River (W.)
Examined 68	2	14	2	4	13	12	2	12	6	1
Infected 68	2	14	2	4	13	12	2	12	6	1
Alloglossidium corti			2¹							
Alloglossidium geminus	2¹			3¹ 1²		5¹ 7²	2¹	3¹ 6² 1³	5¹	
Azygia augusticauda			1¹					1¹		
***Bothriocephalus cuspidatus*								1¹		
***Camallanus oxycephalus*	1¹									
**Clinostomum marginatum*	1¹			1¹			1¹			
***Contracaecum* sp.						5¹	1¹	1¹		
**Contracaecum* sp.								2¹	3¹	
Corallobothrium fimbriatum	1¹		1¹			1¹	2¹		3¹ 1²	
⊥*Corallobothrium fimbriatum*						1¹			1²	
***Corallobothrium fimbriatum*		8¹				6¹				
Dichelyne robusta			1¹ 1²			7¹		7¹	2¹	
**Diplostomulum* sp.	1¹			3¹ 1²				6¹		
**Glochidia*								1³		
Gyrodactyloidea			1¹	1¹ 2² 1³	12¹ 1²	12³	2²	3¹ 7²	4² 2³	
Leptorhynchoides thecatus						3¹				1¹
**Leptorhynchoides thecatus*							1³			1²
Phyllodistomum staffordi		14¹	1¹	4¹	4¹	8¹		9¹	4¹	1¹

TABLE 23—*(Continued)*

Ameiurus n. nebulosus (LeSueur) – NORTHERN BROWN BULLHEAD

	Cedar Lake	Ellsworth Lake	Lost Land Lake	Namekagon River	Round Lake	Silver Lake	Spooner Lake	Staples Lake	Windigo Lake	Yellow River (W.)
Pomphorhynchus bulbocolli	....	....	1[1]	1[1]	....	....	2[1]	7[1]	....	1[2]
**Pomphorhynchus bulbocolli*	....	....	1[1]	2[1]	....	....	2[2]	1[1]	....	....
**Proteocephalus ambloplites*	1[2]	....	1[1]	2[1]	....	....	....	5[1]	....	....
			1[2]	....	....	....	....	....	....	....
***Proteocephalus pearsei*	....	....	....	....	....	....	....	....	1[1]	1[1]
**Proteocephalus* sp.	....	....	....	....	2[1]	....	....	....	....	....
Spinitectus carolini	....	....	....	....	....	....	....	....	1[1]	....
**Spiroxys* sp.	....	6[1]	1[1]	....	3[1]	3[1]	2[2]	2[1]	....	1[1]
		4[2]	....	....	....	....	....	....	....	....
**Tetracotyle* sp.	1[3]	....	....	....	....	....	....	1[1]	....	....

Northern brown bullhead

All 68 brown bullheads were infected. The larval *Diplostomulum* sp. occurred in the lens of the eye. The larval Acanthocephala, *Contracaecum* sp., *Proteocephalus* sp., and *Spiroxys* sp. were encysted in the mesenteries. One brown bullhead was examined from Spooner Lake by Bangham (in press) and infections of one to nine specimens each of *Alloglossidium geminus, Ergasilus versicolor,* Gyrodactylidae, and *Phyllodistomum staffordi* were found. From the Yellow River he examined 14 brown bullheads, but found neither *Proteocephalus pearsei* nor larval *Spiroxys* sp. recorded in this report. However, in addition to the other parasites recorded, he found *Alloglossidium geminus,* larval *Clinostomum marginatum, Corallobothrium fimbriatum,* immature *Crepidostomum* sp., *Dichelyne robusta,* Gyrodactylidae, *Myxobolus* sp., and larval *Proteocephalus ambloplites.*

TABLE 24

Ameiurus m. melas (Rafinesque) – NORTHERN BLACK BULLHEAD

	Brule River	Namekagon River	Potato Creek	Vermillion River
Examined 13	1	8	1	3
Infected 13	1	8	1	3
***Alloglossidium corti*				2[1]
Alloglossidium geminus		6[1]		
**Clinostomum marginatum*		2[1]		
Corallobothrium fimbriatum		2[1]		
**Crepidostomum cooperi*				2[1]
Dichelyne robusta		2[1]		
**Diplostomulum* sp.		6[1]		
		2[2]		
Gyrodactyloidea		2[1]	1[1]	1[1]
		6[2]		2[2]
Leptorhynchoides thecatus		1[1]		
Phyllodistomum staffordi		3[1]		
Pomphorhynchus bulbocolli		3[1]		
**Pomphorhynchus bulbocolli*	1[1]	8[1]	1[1]	
***Proteocephalus* sp.	1[1]			
**Proteocephalus* sp.				1[1]
Spinitectus gracilis	1[1]			
**Spiroxys* sp.	1[1]			3[1]

Northern black bullhead

All the black bullheads were infected with at least one species of parasite. The larval *Diplostomulum* sp. was in the lens of the eye. The larval *Pomphorhynchus bulbocolli, Proteocephalus* sp., and *Spiroxys* sp. were found in cysts in the mesenteries.

TABLE 25

Noturus flavus (Rafinesque) – Stonecat

	Vermillion River	Yellow River (W.)
Examined 13	1	12
Infected 13	1	12
Alloglossidium corti	1[1]	9[1] 1[2]
**Clinostomum marginatum*	1[1]	...
***Corallobothrium fimbriatum*	...	1[1]
**Diplostomulum* sp.	...	10[1]
Gyrodactyloidea	...	1[1]
Leptorhynchoides thecatus	...	2[1]
**Leptorhynchoides thecatus*	...	1[1]
Pomphorhynchus bulbocolli	...	2[1]
**Proteocephalus* sp.	...	1[1]
**Spiroxys* sp.	...	1[1]

Stonecat

All 13 stonecats were infected with at least one species of parasite. The larval *Diplostomulum* sp. were taken from the lens of the eye; the larval *Proteocephalus* sp. were encysted in the mesenteries.

TABLE 26

Schilbeodes mollis (Hermann) – Tadpole Madtom

	Bear Creek	Vermillion River	Whalen Creek	Yellow River (W.)
Examined 10	1	1	7	1
Infected 10	1	1	7	1
Alloglossidium corti	1[1]	1[1]	1[1]	1[1]
***Crepidostomum cooperi*	...	...	...	1[1]
Gyrodactyloidea	...	...	5[1]	1[1]
Leptorhynchoides thecatus	...	...	...	1[1]
**Leptorhynchoides thecatus*	...	...	1[1]	...
Pomphorhynchus bulbocolli	...	...	4[1]	...
**Proteocephalus* sp.	...	...	3[1]	...
**Spiroxys* sp.	...	...	2[1]	...
Trichodina sp.	...	...	...	1[2]

Tadpole madtom

All 10 madtoms were infected with at least one species of parasite. The larval *Leptorhynchoides thecatus* and *Proteocephalus* sp. were encysted in the mesenteries. *Trichodina* sp. was found on the gills.

TABLE 27

Umbra limi (Kirtland) – Western Mudminnow

	Potato Creek	Round Lake	Vermillion River	Whalen Creek
Examined 26	7	2	3	14
Infected 26	7	2	3	14
Bunoderina eucaliae	2[1]		1[1]	5[1]
***Bunoderina eucaliae*	1[1]			2[1]
**Clinostomum marginatum*	1[1]			1[1] 2[2]
***Contracaecum* sp.				2[1]
**Diplostomulum* sp.	1[1]			
Hepaticola bakeri			1[1]	
***Hepaticola bakeri*		2[1]		
**Leptorhynchus thecatus*				2[1]
Myxosporidia		1[1]		
**Neascus* sp.			1[1]	
**Neoechinorhynchus* sp.				1[1]
Phyllodistomum brevicecum			1[1]	
Pomphorhynchus bulbocolli				1[1]
**Pomphorhynchus bulbocolli*	1[1]			4[2]
**Proteocephalus* sp.	5[1]		1[1]	
Sprioxys sp.			1[1]	14[1]
***Tetracotyle* sp.			1[1]	

Western mudminnow

All 26 mudminnows were infected. The larval *Diplostomulum* sp. was in the humor of the eye. The larval Acanthocephala and larval *Proteocephalus* sp. were encysted in the mesenteries. The Myxosporidia occurred on the gills.

TABLE 28

Esox lucius Linnaeus – NORTHERN PIKE

	Bear Creek	Bear Lake	Casey Lake	Cedar Lake	Clam Lake	Crooked Lake	Cyclone Lake	Devils Lake	Little Long Lake	Mathews Lake
Examined 125 Infected 125	12 12	9 9	3 3	3 3	2 2	1 1	3 3	3 3	3 3	4 4
Azygia augusticauda	6^1	2^1	2^1	3^1	2^1	....	2^1	1^1	1^1	3^1
ᴸ*Azygia augusticauda*	2^1	....	....	....	....	....	....	....	....	....
***Azygia augusticauda*	3^1	....	....	....	....	....	....	1^1	....	....
Camallanus oxycephalus	....	2^1	....	....	....	....	....	....	....	....
***Camallanus oxycephalus*	3^1	3^1	....	....	....	....	1^1	....	....	....
**Clinostomum marginatum*	1^1	....	....	1^1	....	....	....	....	....	....
Contracaecum brachyurum	4^1 6^2	....	1^1	....	....	....	....	....	....	....
***Contracaecum brachyurum*	....	....	2^1	....	....	....	1^2 1^3	3^1	1^1	1^1
**Contracaecum* sp.	....	....	....	1^1	....	....	....	....	....	....
***Cryptogonimus chyli*	....	....	1^1	....	....	....	....	....	....	....
**Diplostomulum scheuringi*	2^1	7^1	1^1	1^1 1^2	1^1	1^2	2^1	2^1	3^1	1^1
**Glochidia*	9^1	....	....	....	....	....	....	....	....	....
Gyrodactyloidea	2^1 10^2	1^1 6^2 2^3	3^2	1^1 1^2 1^3	....	....	2^2 1^3	3^3	1^1 2^2	4^2
Illinobdella sp.	....	....	1^1	....	....	....	....	....	....	....
Leptorhynchoides thecatus	5^1	....	....	....	....	....	2^1	1^1	....	....
Macroderoides flavus	....	....	....	....	....	....	....	1^1	3^1	....
Myxosporidia	....	....	....	....	1^1	....	....	....	....	....
**Neascus* sp.	8^1 4^2	3^2 6^3	2^1	3^3	2^1	1^2	2^1 1^3	1^1 1^2 1^3	3^1	4^3

TABLE 28—*(Continued)*

Esox lucius Linnaeus – Northern Pike

	Bear Creek	Bear Lake	Casey Lake	Cedar Lake	Clam Lake	Crooked Lake	Cyclone Lake	Devils Lake	Little Long Lake	Mathews Lake
Neoechinorhynchus tenellus	6^1	3^1	3^1	...	...	...	1^1	...	...	1^1
	1^2	...	...	...	...	...	1^2	...	...	...
Phyllodistomum sp.	...	...	...	...	...	...	...	1^1	...	...
***Phyllodistomum* sp.	...	2^1	...	...	...	...	...	...	...	...
Proteocephalus pinguis	8^2	...	...	1^2	...	...	...	...	...	...
	1^3	...	...	2^3	...	...	...	...	...	...
[1]*Proteocephalus pinguis*	2^2	...	1^1	...	1^2	...	1^1	...	1^2	...
	1^3	...	...	...	...	...	1^2	...	...	...
***Proteocephalus pinguis*	...	1^1	1^1	...	1^1	1^3	1^2	2^1	2^2	1^1
		4^2	1^3	...	...	...	...	1^2	...	...
		3^3	...	...	...	...	...	...	...	...
Spinitectus carolini	...	...	...	...	...	...	...	...	...	1^1

TABLE 28—*(Continued)*

Esox lucius Linnaeus – Northern Pike

	Namekagon River	Rocky Ridge Lake	Silver Lake	Spooner Lake	Staples Lake	Upper Turtle Lake	Vermillion Lake	Vermillion River	Whalen Creek	Windigo Lake	Yellow River (W.)
Azygia augusticauda	1^1	...	5^1	3^1	3^1	8^1	...	...	...	...	7^1
					2^2						
***Azygia augusticauda*	...	...	...	...	...	1^1	...	...	...	...	...
***Camallanus oxycephalus*	1^1	...	...	...	...	...	...	1^1	1^1	...	...
**Clinostomum marginatum*	...	1^1	1^1	...	2^1	1^1	...	1^1	...	...	...
Contracaecum brachyurum	...	...	1^1	1^1	1^1	...	...	...	1^1	1^1	7^1
											2^2
***Contracaecum brachyurum*	...	3^1	3^1	1^1	...	...	...	...	...	2^1	...
		1^2	...	1^2	...	...	...	...	...	1^2	...
**Diplostomulum scheuringi*	2^1	4^1	1^1	3^1	8^1	8^1	2^1	...	...	...	1^1
Gyrodactyloidea	2^1	3^2	6^2	2^2	7^1	1^1	...	...	2^2	1^1	5^1
		1^3	3^3	2^3	7^2	18^2	...	...	...	...	6^2
					3^3	1^3	...	...	...	...	...
Leptorhynchoides thecatus	...	1^1	2^1	1^1	...	1^1	...	...	...	...	3^1
Macroderoides flavus	...	1^1	4^1	1^1	...	7^1	...	...	...	...	1^1
		2^2	3^2	...	...	2^2	...	...	...	...	...
***Macroderoides flavus*	...	...	...	2^1	...	...	...	...	...	...	...
**Neascus* sp.	...	2^1	3^1	1^1	2^1	3^1	5^1	1^1	1^1	1^1	1^1
	2^2	...	4^2	2^2	3^2	10^2	...	...	1^2	3^2	5^2
	1^3	1^3	2^3	1^3	12^3	7^3	...	...	...	...	5^3
Neoechinorhynchus tenellus	1^1	...	...	...	...	...	...	...	1^1	...	4^1
	2^2	...	...	...	...	...	...	...	...	...	...
Phyllodistomum sp.	2^1	...	...	...	...	...	...	...	1^1	...	6^2
									1^2	...	2^3
***Phyllodistomum* sp.	...	...	...	...	2^1	...	...	...	...	...	...

TABLE 28—*(Continued)*

Esox lucius **Linnaeus – Northern Pike**

	Name-kagon River	Rocky Ridge Lake	Silver Lake	Spooner Lake	Staples Lake	Upper Turtle Lake	Ver-million Lake	Ver-million River	Whalen Creek	Windi-go Lake	Yellow River (W.)
**Proteocephalus ambloplites*	....	....	....	1^{1}	....	....	....	....	....	....	....
Proteocephalus pinguis....	....	1^{2}	....	....	1^{1} 2^{2}	9^{1} 2^{2}	....	....	1^{2}	2^{1}	1^{3} ....
⊥*Proteocephalus pinguis*....	....	....	4^{2}	....	1^{1}	1^{1} 3^{2}	....	1^{2}	....	2^{2}	9^{3}
***Proteocephalus pinguis*....	1^{1}	1^{1} 2^{2}	1^{1} 4^{2}	4^{1}	11^{1} 1^{2}	2^{1}	4^{1} 1^{2}	....	1^{2}	....	1^{2} ....
Spinitectus gracilis.......	....	....	3^{1}	....	....	....	....	....	....	....	....
Trichodina sp............	....	....	....	....	....	....	....	....	....	....	1^{3}

Northern pike

All 125 northern pike were infected. The Myxosporidia was in a very large cyst in the upper portion of the mouth. *Trichodina* sp. occurred on the gills. Four northern pike were examined by Bangham (in press) from Spooner Lake; however, he did not find *Leptorhynchoides thecatus, Macroderoides flavus,* and larval *Proteocephalus ambloplites.* In addition to the other parasites recorded in this report from this lake he found immature *Haplonema* sp., and larval *Triaenophorus nodulosus.* Bangham (in press) also examined four fish from the Yellow River; however, *Contracaecum brachyurum, Leptorhynchoides thecatus, Macroderoides flavus, Neoechinorhynchus tenellus, Phyllodistomum* sp. and *Trichodina* sp. were not recorded by him. In addition to the other parasites mentioned from this Yellow River fish, excluding those listed immediately above, he found *Crepidostomum cooperi* and *Spinitectus* sp.

TABLE 29

Esox m. masquinongy (Mitchill) – GREAT LAKES MUSKELLUNGE

	Lost Land Lake	Teal Lake
Examined 4	2	2
Infected 4	2	2
***Camallanus oxycephalus*	1 [1]	....
Gyrodactyloidea	....	1 [1]
Myxosporidia	1 [3]	2 [1]
**Neascus* sp.	1 [2]	2 [1]
Neoechinorphynchus tenellus	1 [1]	2 [1]
**Proteocephalus ambloplites*	1 [2]	....
Proteocephalus pinguis	....	1 [1]
***Proteocephalus pinguis*	1 [2]	1 [1]
**Triaenophorus nodulosus*	1 [2]	2 [1]
***Triaenophorus nodulosus*	1 [1]	....
Trichodina renicola	2 [3]	....
Trichodina sp.	1 [3]	....

Great Lakes muskellunge

All four muskellunge bore a parasitic infection. The Myxosporidia was recovered from cysts on the gills. *Trichodina renicola* was observed in the ureters and urinary bladder, while another species of *Trichodina* was seen on the gills.

TABLE 30

Perca flavescens (Mitchill) – Yellow Perch

	Balsam Lake	Bear Creek	Bear Lake	Boos Lake	Brill River	Cable Lake	Cedar Lake	Chetac Lake	Clam Lake	Crook-ed Lake	Cy-clone Lake	Eau Claire County Bass Pond
Examined 144	6	4	1	2	1	14	2	4	1	14	13	1
Infected 142	6	4	1	2	1	14	2	4	1	14	13	0
Azygia augusticauda							1[1]					
***Azygia augusticauda*		1[1]										
***Bothriocephalus cuspidatus*	3[1]					9[1]						
Bunodera leuciopercae	4[1]											
***Bunodera leuciopercae*						9[1] 5[2]					6[1] 6[2] 1[3]	
Bunodera sacculata						7[1]						
Camallanus oxycephalus								2[1]				
***Camallanus oxycephalus*	1[1]	1[1]				9[1]	1[1]		1[1]		3[1]	
**Clinostomum marginatum*	5[1]	1[1]		1[2]		10[1] 3[2]	1[1]	2[1] 1[2]	1[3]		9[1] 3[2]	
***Contracaecum* sp.	6[1]	1[1]			1[2]							
**Contracaecum* sp.			1[1]								11[2] 2[3]	
Crepidostomum cooperi	3[1] 1[2]	1[1]										
***Crepidostomum cooperi*				1[1]								
**Cryptogonimus chyli*		1[1]										
Dichelyne cotylophora			1[1]			2[1]	1[2]		1[1]			
⊥*Dichelyne cotylophora*						3[1]						
***Dichelyne cotylophora*						2[1]						

TABLE 30—*(Continued)*

Perca flavescens (Mitchill) – Yellow Perch

	Balsam Lake	Bear Creek	Bear Lake	Boos Lake	Brill River	Cable Lake	Cedar Lake	Chetac Lake	Clam Lake	Crooked Lake	Cyclone Lake
**Diplostomulum scheuringi*		2[1]		2[1]		12[1] 2[2]	2[1]	4[1]			4[1] 9[2]
**Diplostomulum* sp.	1[1] 3[2]	3[1]	1[1]	1[1]	1[2]		1[1]	1[1]	1[2]	14[2]	
**Glochidia*		2[1] 2[2]									
Gyrodactyloidea	5[1] 1[2]		1[1]	1[2] 1[1]	1[2]			3[1] 1[2]	1[2]	7[1] 7[2]	9[1] 1[2]
Leptorhynchoides thecatus				1[1]							8[1] 2[2]
**Neascus* sp.	2[1] 2[2] 2[3]	3[1] 1[2]	1[1]	1[2]	1[2]	7[1] 7[2]	1[1] 1[2]	1[1] 2[2]	1[3]	5[1] 2[2]	7[1]
Neoechinorhynchus cylindratus							1				
**Posthodiplostomum minimum*	1[1]										
**Proteocephalus ambloplites*	3[1] 1[2]	2[1]	1[1]			1[1]	1[1]			4[1]	7[1]
⊥*Proteocephalus pearsei*	2[2]										
***Proteocephalus pearsei*		2[1] 1[2]		1[1]	1[2]			2[1]		3[1] 2[2]	4[1]
**Proteocephalus* sp.		2[1]									
Spinitectus gracilis				1[1]							
**Spiroxys* sp.											4[1]
**Tetracotyle* sp.		1[1]									
**Triaenophorus nodulosus*				1[1]							
Trichodina sp.		1[2]						2[3]			

TABLE 30—*(Continued)*

Perca flavescens (Mitchill) – YELLOW PERCH

	Ellsworth Lake	Lost Land Lake	Marshmiller Pond	Meadow Creek	Namekagon River	Red Cedar River	Spooner Lake	Staples Lake	Teal Lake	Upper Turtle Lake	Windigo Lake	Yellow River (W.)
Azygia augusticauda												2[1]
***Azygia augusticauda*					2[1]					1[1]		
⊥*Bothriocephalus cuspidatus*			2[1]					1[2]				
***Bothriocephalus cuspidatus*		1[1]						7[1]	1[1]	8[1]		
Bucephalus elegans								1[1]				
Bunodera leuciopercae												5[1] 4[2] 1[3]
***Bunodera leuciopercae*							3[1]					
Bunodera sacculata					2[1] 1[2]					3[1]		
⊥*Bunodera sacculata*					2[2]							
***Bunodera sacculata*					9[1]					4[1]		
Camallanus oxycephalus									1[1]			
***Camallanus oxycephalus*			2[1]		2[1]						1[1]	
Capillaria catenata											3[1] 1[2]	
**Clinostomum marginatum*	3[1]	2[1]	1[1]	1[1]	14[1] 1[2]		3[1]	4[1] 2[2]	6[1] 2[2]	13[1] 1[2]	2[1]	5[1]
***Contracaecum* sp.												4[1] 3[2]
**Contracaecum* sp.											1[1] 3[2]	2[1]
Crepidostomum cooperi				1[1]		1[1]		4[1] 1[2]				3[1] 1[2]
Dichelyne cotylophora		1[2]							7[1] 1[2]	8[1]	3[1] 1[2]	

TABLE 30—*(Continued)*

Perca flavescens (Mitchill) – YELLOW PERCH

	Ellsworth Lake	Lost Land Lake	Marshmiller Pond	Meadow Creek	Namekagon River	Red Cedar River	Spooner Lake	Staples Lake	Teal Lake	Upper Turtle Lake	Windigo Lake	Yellow River (W.)
**Diplostomulum scheuringi*........	1^{1}	1^{1} 1^{2}	2^{1}	....	13^{1} 1^{2}	1^{1}	3^{1}	7^{1} 1^{2}	6^{1} 1^{2}	1^{1}	....	2^{1} 4^{2}
**Diplostomulum* sp...	....	2^{1}	....	....	.... 15^{2}	1^{1}	....	7^{1}	3^{1} 5^{2}	2^{1} 13^{2}	3^{1}	1^{1} 6^{2} 1^{3}
*Glochidia	....	....	....	....	1^{1}	.... 1^{2}	....	1^{1} 1^{2}	....	....	....	.... 1^{3}
Gyrodactyloidea ...	....	1^{1} 1^{2}	.... 2^{2}	....	2^{1}	....	1^{1} 2^{2}	3^{1}	5^{1} 6^{2}	1^{1}	3^{1} 1^{2}	3^{1} 2^{2}
Leptorhynchoides thecatus..........	....	....	....	....	1^{1}	....	....	1^{1}	....	....	....	4^{1} 3^{2}
**Leptorhynchoides thecatus*..........	....	....	....	1^{2}	....	1^{2}	....	....	....	....	....	4^{1} 5^{2} 2^{3}
**Neascus* sp.........	3^{1} 1^{2}	1^{1} 1^{2}	.... 1^{2} 1^{3}	1^{1}	11^{1} 4^{2}	1^{1}	1^{1} 1^{2} 1^{3}	6^{1} 2^{2} 2^{3}	2^{1} 4^{2} 4^{3}	.... 7^{2} 8^{3}	1^{1} 1^{2} 2^{3}	2^{1} 4^{2} 4^{3}
Neoechinorhynchus cylindratus.......	....	....	2^{1}	....	1^{1}	....	....	2^{1}	2^{1}	....	....	1^{1}
Pomphorhynchus bulbocolli........	....	....	....	....	....	....	....	....	....	....	....	2^{1}
**Proteocephalus ambloplites*.......	....	2^{1}	....	....	....	....	3^{1}	2^{1}	2^{1}	9^{1} 2^{2}	....	....
***Proteocephalus pearsei*..........	....	....	.... 2^{2}	....	1^{1}	....	....	1^{1} 1^{2} 1^{3}	7^{1} 3^{2}	6^{1}	1^{1}	3^{1} 1^{2} 1^{3}
Sanguinicola occidentalis.......	....	....	....	....	....	1^{1}	....	....	....	....	....	....
Spinitectus carolini..	....	....	....	....	....	....	....	....	1^{1}	....	....	....
**Spiroxys* sp.........	....	....	....	....	....	....	....	....	....	....	....	5^{1}
**Triaenophorus nodulosus*........	....	1^{1}	....	....	....	....	....	....	5^{1}	....	....	....
Trichodina sp.......	....	....	1^{1} 1^{3}	....	....	....	....	....	.... 1^{2}	....	....	.... 1^{3}

Yellow perch

Of the 144 perch examined, 142 (approximately 99 percent) were infected. The larval *Contracaecum* sp., *Cryptogonimus chyli, Leptorhynchoides thecatus, Proteocephalus* sp., and *Spiroxys* sp. were encysted in the mesenteries. The larval *Diplostomulum* sp. (probably *D. huronense*) occurred in the humor of the eye. The larval *Triaenophorus nodulosus* was encysted in the liver. *Trichodina* sp. occurred on the gills. Bangham (in press) in his examination of nine fingerling perch from Spooner Lake found only Gyrodactyloidea and larval *Neascus* sp. in common with that recorded in this report from the three adult fish. In addition to these two parasites in common he found *Azygia augusticauda,* immature *Bothriocephalus cuspidatus, Bunodera sacculata, Leptorhynchoides thecatus,* and *Neoechinorhynchus cylindratus.* One perch was also examined from the Yellow River by Bangham, and only larval *Clinostomum marginatum, Crepidostomum cooperi,* larval *Diplostomulum* sp. (1), Gyrodactylidae, *Leptorhynchoides thecatus,* and larval *Neascus* sp. were found. In the one perch examined from Cable Lake, Bangham found larval *Clinostomum marginatum, Dichelyne cotylophora,* larval *Diplostomulum* sp. (1), Gyrodactylidae, *Leptorhynchoides thecatus,* and larval *Neascus* sp.

Walleye pike

All 118 walleye pike were infected. The larval *Triaenophorus nodulosus* occurred in cysts in the liver and mesenteries. *Trichodina* sp. was found on the gills. Bangham (in press) examined four pike from Cable Lake, finding *Azygia augusticauda, Bothriocephalus cuspidatus, Bucephalopsis pusilla,* larval *Diplostomulum scheuringi,* Gyrodactylidae, *Proteocephalus stizostethi,* and larval *Neascus* sp.

TABLE 31

Stizostedion v. vitreum (Mitchill) – Walleye Pike

	Bear Lake	Boos Lake	Brill River	Cable Lake	Cedar Lake	Chetac Lake	Horseshoe Lake	Lost Land Lake	Silver Lake	Spooner Lake	Staples Lake	Teal Lake	Tozer Lake	Upper Turtle Lake	Yellow River (W.)
Examined 118	9	13	2	17	6	1	3	5	4	1	19	18	4	5	11
Infected 118	9	13	2	17	6	1	3	5	4	1	19	18	4	5	11
Azygia augusticauda					1^{1}										
***Azygia augusticauda*				1^{1}											
Bothriocephalus cuspidatus		10^{1} 2^{2}		1^{1}			1^{1} 1^{2}		1^{1}	1^{1}	3^{1}		1^{1}	3^{1}	
¹*Bothriocephalus cuspidatus*	1^{2}			12^{2}	3^{2}			1^{2} 3^{3}	1^{1}		4^{2} 1^{3}	1^{2} 11^{3}	2^{1}	1^{1}	
***Bothriocephalus cuspidatus*	8^{2}			4^{2}	1^{1} 2^{2}	1^{2}		1^{1}	2^{1}		6^{1} 5^{2}	1^{2} 5^{3}	1^{1}	1^{1}	
Bucephalopsis pusilla	4^{1}		2^{2}					1^{2} 3^{3}	1^{1}		3^{1}	1^{1} 1^{2} 9^{3}			2^{1} 6^{2} 1^{3}
Camallanus oxycephalus	3^{1} 3^{2} 1^{3}	1^{2}		1^{2}	3^{1}	1^{3}		1^{1} 1^{2}			1^{1}	4^{1} 3^{2} 3^{3}			
¹*Camallanus oxycephalus*	1^{2}	2^{2} 2^{3}			1^{1}			2^{1}				2^{3}			
***Camallanus oxycephalus*		1^{1} 6^{2}	2^{1} 1^{2}	7^{1} 4^{2}											
Capillaria catenata											1^{1}				
**Clinostomum marginatum*	3^{1}			1^{1}				2^{1}				3^{1}			
***Contracaecum* sp.											1^{1}				7^{1} 3^{2}

TABLE 31—*(Continued)*

Stizostedion v. vitreum (Mitchill) – Walleye Pike

	Bear Lake	Boos Lake	Brill River	Cable Lake	Cedar Lake	Chetac Lake	Horseshoe Lake	Lost Land Lake	Silver Lake	Spooner Lake	Staples Lake	Teal Lake	Tozer Lake	Upper Turtle Lake	Yellow River (W.)
**Contracaecum* sp.	1^{1}	....	2^{1}	....	1^{1}	....	....	1^{1}	....	....	....	....	....	....	....
Dichelyne cotylophora	....	....	....	....	....	....	....	....	....	....	....	2^{1}	....	....	....
**Diplostomulum scheuringi*	3^{1}	....	....	12^{1} 1^{3}	....	....	2^{1} 1^{2}	1^{3} 1^{1}	....	1^{1}	....	2^{1}	....	....	....
*Glochidia	....	....	....	....	....	....	....	....	....	....	4^{1}	....	....	....	....
Gyrodactyloidea	.... 8^{2} 1^{3}	4^{1} 9^{2}	....	....	....	....	....	.... 1^{2} 4^{3}	....	....	3^{1} 2^{2}	1^{1} 2^{2} 15^{3}	....	2^{1} 2^{2} 1^{3}	....
Leptorhynchoides thecatus	....	....	....	1^{1}	....	....	....	2^{1}	1^{1}	.... 1^{2}	....	1^{1}	....	....	5^{1}
Lymphocystis	....	....	....	....	....	....	....	....	....	....	....	1^{2}	....	2^{2}	....
**Neascus* sp.	7^{1}	8^{1} 2^{2}	2^{1}	3^{1} 11^{2} 3^{3}	1^{1}	.... 1^{2}	3^{1}	1^{1} 4^{2}	3^{1} 1^{2}	.... 1^{2}	2^{3} 10^{1} 4^{2}	7^{1} 5^{2} 1^{3}	3^{1}	1^{1} 2^{2} 2^{3}	4^{1} 2^{2}
Neoechinorhynchus tenellus	.... 3^{2} 6^{3}	4^{1}	....	....	....	.... 1^{2}	....	1^{1} 1^{2} 3^{3}	....	....	....	6^{1} 10^{2} 1^{3}	....	....	6^{1}
Philometra cylindracea	....	1^{1}	....	....	....	....	....	....	....	....	....	....	....	....	....
Pomphorhynchus bulbocolli	1^{1}	....	....	....	....	....	....	....	....	....	1^{1}	....	....	....	....
**Pomphorhynchus bulbocolli*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^{1}
**Posthodiplostomum minimum*	....	....	....	....	1^{1}	....	....	....	....	....	....	....	1^{1}	....	....
**Proteocephalus ambloplites*	....	....	....	1^{1}	....	....	....	....	....	....	....	....	1^{1}	....	....

TABLE 31—*(Continued)*

Stizostedion v. vitreum (Mitchill) – WALLEYE PIKE

	Bear Lake	Boos Lake	Brill River	Cable Lake	Cedar Lake	Chetac Lake	Horseshoe Lake	Lost Land Lake	Silver Lake	Spooner Lake	Staples Lake	Teal Lak	Tozer Lake	Upper Turtle Lake	Yellow River (W.)
***Proteocephalus pearsei*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1¹
Proteocephalus stizostethi	.....	2¹	.....	.....	.....	.....	.....	1¹	.....	.....	.....	2¹ 4²	.....	.....	.....
***Proteocephalus stizostethi*	.....	1¹	.....	.....	.....	1¹	.....	.....	.....	.....	.....	5¹	.....	.....	.....
Sanguinicola occidentalis	4¹	4¹	1¹	.....	.....	1¹	.....	4¹	1¹	.....	1¹	9¹	.....	2¹	4¹
Spinitectus carolini	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3¹	.....	.....	.....
Spinitectus gracilis	.....	1¹	.....	.....	.....	.....	.....	.....	2¹	.....	.....	.....	.....	.....	.....
***Triaenophorus nodulosus*	.....	5¹ 1²	.....	.....	.....	.....	.....	2¹	.....	.....	.....	.....	.....	.....	.....
**Triaenophorus nodulosus*	.....	1¹	.....	.....	.....	1¹	.....	1¹	.....	.....	.....	.....	.....	.....	.....
Trichodina sp.	.....	.....	1³	.....	.....	1³	.....	.....	.....	.....	.....	2² 8³	.....	.....	.....

TABLE 32

Hadropterus maculatus (Girard) – BLACKSIDE DARTER

	Hay River	Yellow River (B.)
Examined 4	1	3
Infected 4	1	3
***Contracaecum* sp.	....	1[1]
**Contracaecum* sp.	....	2[1]
Leptorhynchoides thecatus	....	1[1]
**Neascus* sp.	1[1]	3[1]

Blackside darter

All four blackside darters were infected. The larval *Contracaecum* sp. was encysted in the mesenteries; the immature *Contracaecum* sp. was found in the liver.

TABLE 33

Percina caprodes semifasciata (De Kay) – NORTHERN LOGPERCH

	Bean Brook	Bear Creek	Eau Claire County Bass Pond
Examined 5	3	1	1
Infected 5	3	1	1
***Contracaecum* sp.	2[1]	....	....
Crepidostomum isostomum	3[1]	....	....
**Diplostomulum scheuringi*	1[1]	....	....
**Diplostomulum* sp.	2[1]	1[2]	....
**Neascus* sp.	3[1]	1[2]	....
**Neoechinorhynchus cylindratus*	1[1]	....	....
Phyllodistomum etheostomae	....	1[1]	....
Spinitectus gracilis	....	....	1[1]
**Tetracotyle* sp.	2[1]	1[1]	....
Trichodina sp.	....	1[3]	....

Northern logperch

All logperch were infected. The larval *Diplostomulum* sp. was found in the humor of the eye. The larval *Neoechinorhynchus cylindratus* was encysted in the mesenteries. Trichodina sp. was on the gills.

TABLE 34

Boleosoma n. nigrum (Rafinesque) – CENTRAL JOHNNY DARTER

	Bean Brook	Bear Creek	Brill River	Brule River	Hay River	Lightning Creek	Red Cedar River	Whalen Creek	Yellow River (B.)	Yellow River (W.)
Examined 82	12	13	1	14	9	1	4	14	7	7
Infected 82	12	13	1	14	9	1	4	14	7	7
Azygia augusticauda	1^1	....	....	1^1	....	....	....	....	....	....
Bothriocephalus formosus	....	2^1	....	9^1	1^1	1^1	....	3^1	2^1	2^1
**Clinostomum marginatum*	2^1	1^1	1^1	....	....	....	....	6^1 1^2	5^1	1^1
***Contracaecum* sp.	7^1	6^1	1^1	....	....	....	....	7^1	1^1	2^1
**Contracaecum* sp.	5^1	5^1 1^2	....	....	3^1	....	....	6^1	....	....
Crepidostomum cooperi	....	1^1	....	....	....	....	....	....	....	....
Crepidostomum isostomum	1^1	....	....	1^1	....	....	....	....	....	....
**Cryptogonimus chyli*	3^1	....	....	....	5^1 2^2	1^1	....	....	....	....
**Diplostomulum scheuringi*	....	....	....	....	....	....	....	....	....	2^1
**Diplostomulum* sp.	6^1	....	....	....	....	....	....	....	....	....
*Glochidia	....	5^1	....	8^1	....	....	3^1 1^2	....	5^1 2^2	....
Gyrodactyloidea	1^1	....	....	....	....	....	1^1	....	....	....
Leptorhynchoides thecatus	....	1^1	....	....	....	....	....	2^1	2^1	3^1
**Leptorhynchoides thecatus*	....	....	....	....	....	....	4^1	6^1	2^1	1^1
Myxosporidia	1^1	5^1	....	5^1	1^1	.... 1^2	1^1	....	2^1	....
**Neascus* sp.	2^1	8^1 2^2	1^1	5^1	8^1 1^2	.... 1^2	....	6^1 1^2	1^1 2^2	6^1
Neoechinorhynchus cylindratus	1^1	....	....	....	....	....	....	....	....	....
**Neoechinorhynchus cylindratus*	....	1^1	....	....	....	....	....	....	....	....
Phyllodistomum etheostomae	2^1	....	....	2^1	....	....	....	1^1	....	1^1
Pomphorhynchus bulbocolli	2^1	2^1	....	....	....	....	3^1	9^1	....	3^1 1^2
**Posthodiplostomum minimum*	....	....	....	....	9^1	....	....	....	....	....
**Proteocephalus* sp.	4^1	....	....	....	....	....	....	6^1	....	2^1
Rhabdochona cascadilla	1^1	....	....	....	....	....	....	....	....	....
**Tetracotyle* sp.	9^1	....	....	2^1 1^2	....	....	....	1^1	....	....
Trichodina sp.	1^2	....	....	....	....	....	....	....	....	....

Central Johnny darter

All 82 Johnny darters were infected. The larval *Contracaecum* sp., *Cryptogonimus chyli*, *Leptorhynchoides thecatus*, *Neoechinorhynchus cylindratus*, and *Proteocephalus* sp. were all encysted in the mesenteries. The larval *Diplostomulum* sp. was found in the humor of the eye. *Trichodina* sp. occurred on the gills. The Myxosporidia were recovered from cysts in the musculature, liver and mesenteries.

TABLE 35

Poecilichthys exilis (Girard) – IOWA DARTER

	Bear Creek	Yellow River (W.)
Examined 10 Infected 6	4 3	6 3
***Camallanus oxycephalus*	1[1]	
***Contracaecum* sp.		1[1]
**Diplostomulum scheuringi*		1[1]
*Glochidia	1[1]	
Leptorhynchus thecatus		2[1]
**Neascus* sp.	2[1]	1[1]
Pomphorhynchus bulbocolli		1[1]
**Spiroxys* sp.		1[1]

Iowa darter

Six (60 percent) of the 10 Iowa darters examined harbored at least one species of parasite. The immature *Contracaecum* sp. were recovered from the liver of the fish; the Glochidia were on the gills and fins.

TABLE 36

Poecilichthys c. caeruleus (Storer) – NORTHERN RAINBOW DARTER

	Bear Creek	Brill River	Hay River	Meadow Creek	Red Cedar River	Yellow River (B.)
Examined 9 Infected 9	2 2	1 1	2 2	1 1	2 2	1 1
**Clinostomum marginatum*				1[1]	1[1]	
**Contracaecum* sp.				1[1]	1[1]	
**Cryptogonimus chyli*			1[1]			
			1[2]			
**Diplostomulum* sp.		1[1]			2[1]	
*Glochidia				1[1]	2[2]	1[1]
**Leptorhynchoides thecatus*				1[1]	1[1]	
**Neascus* sp.	1[1]		1[1]	1[1]	2[1]	1[1]
**Posthodiplostomum minimum*	1[1]					

Northern rainbow darter

All rainbow darters were infected. The larval *Cryptogonimus chyli*, *Contracaecum* sp., and *Leptorhynchoides thecatus* were all encysted in the mesenteries. The larval *Diplostomulum* sp. was recovered from the humor of the eye.

TABLE 37

Catonotus flabellaris lineolatus Agassiz – STRIPED FANTAIL

	Bear Creek	Brill River	Hay River	Lightning Creek	Vermilion River	Yellow River (B.)
Examined 38 Infected 37	13 13	4 4	4 3	1 1	13 13	3 3
***Camallanus oxycephalus*	5^{1}	....	....	....	....	....
**Clinostomum marginatum*	....	....	1^{1}	....	2^{1}	....
***Contracaecum* sp.	7^{1}	3^{1}	....	....	....	1^{1}
**Contracaecum* sp.	1^{1}	....	1^{1}	1^{1}	1^{1}	....
**Cryptogonimus chyli*	....	....	3^{1}	....	....	....
**Diplostomulum scheuringi*	2^{1}	1^{1}	....	....	....	....
**Diplostomulum* sp.	....	1^{1}	....	....	....	....
*Glochidia	1^{1}	....	....	1^{1}	1^{1}	1^{1}
Gyrodactyloidea	2^{1}	....	....	....	8^{1} 2^{2}	....
Leptorhynchoides thecatus	1^{1}	....	....	....	....	1^{1}
**Leptorhynchoides thecatus*	3^{1}	....	....	....	....	2^{1}
**Neascus* sp.	5^{1} 5^{2} 1^{3}	1^{1}	2^{1} 1^{2}	1^{1}	2^{1} 10^{2} 1^{3}	1^{1} 2^{2} ....
**Neoechinorhynchus cylindratus*	1^{1}	....	....	....	....	....
Phyllodistomum etheostomae	....	1^{1}	....	....	5^{1}	....
Plagiocirrus primus	....	....	1^{1}	....	....	....
**Proteocephalus ambloplites*	1^{1}	1^{1}	....	....	....	....

Striped fantail

Thirty-seven (approximately 97 percent) of the 38 fantails were infected. The larval *Contracaecum* sp., *Cryptogonimus chyli, Leptorhynchoides thecatus,* and *Neoechinorhynchus cylindratus* were encysted in the mesenteries. The larval *Diplostomulum* sp. was found in the humor of the eye.

Northern smallmouth bass

All eight smallmouth bass were infected. The Whalen Creek bass was a two-inch fingerling. The larval *Contracaecum* sp., *Leptorhynchoides thecatus, Proteocephalus* sp., and *Rhipidocotyle papillosum* were encysted in the mesenteries. The species of *Sanguinicola* was recovered from the mesenteric blood vessels and is a new species as it differs morphologically from the only known North American species *S. occidentalis* from *Stizostedion vitreum*. This new species also occurs in the largemouth bass. *Trichodina* sp. was found on the gills.

TABLE 38

Micropterus d. dolomieu Lacépède – Northern Smallmouth Bass

	Lost Land Lake	Teal Lake	Whalen Creek	Windi-go Lake
Examined 8	2	3	1	2
Infected 8	2	3	1	2
Achtheres micropteri	1^{1}	2^{1}		2^{1}
Caecincola parvulus	1^{2} 1^{3}			
Camallanus oxycephalus		1^{1}		
⊥*Camallanus oxycephalus*		1^{2}		
***Camallanus oxycephalus*	2^{1}	1^{1}		
Capillaria catenata				1^{1} 1^{2}
**Clinostomum marginatum*	1^{1}			1^{1}
**Contracaecum* sp.	1^{1}			
Cryptogonimus chyli			1^{2}	
***Cryptogonimus chyli*		1^{2}		
Dichelyne cotylophora		2^{1}		
**Diplostomulum scheuringi*	2^{1}			
Ergasilus caeruleus	2^{3}	3^{3}		
*Glochidia			1^{1}	
Gyrodactyloidea				1^{1}
Leptorhynchoides thecatus	1^{1}	2^{1} 1^{2}		
**Leptorhynchoides thecatus*			1^{1}	
**Neascus* sp.	2^{2}	1^{1} 2^{2}		1^{2}
Neoechinorhynchus cylindratus	2^{1}	1^{1}	1^{1}	
Pomphorhynchus bulbocolli		1^{1}		
Proteocephalus ambloplites		2^{2}		
***Proteocephalus ambloplites*	1^{1}	1^{1}		
**Proteocephalus ambloplites*	2^{3}	1^{2} 2^{3}		2^{1}
***Proteocephalus pearsei*		1^{1}		1^{2}
**Proteocephalus* sp.			1^{1}	
***Rhipidocotyle papillosum*		1^{1}		
**Rhipidocotyle papillosum*			1^{1}	
Sanguinicola sp.	1^{1}			
Spinitectus carolini		2^{2} 1^{3}		
Trichodina sp.		1^{3}		

TABLE 39

Huro salmoides (Lacépède) – LARGEMOUTH BASS

	Bear Lake	Casey Lake	Cedar Lake	Clam Lake	Devils Lake	Eau Claire Co. Bass Pond	Island Lake Hatchery Pond	La Crosse Federal Hatchery	Lost Land Lake	Mathews Lake	Polk Co. Bass Pond #3	Rocky Ridge Lake	Round Lake	St. Croix Co. Bass Pond #20	St. Croix Co. Bass Pond #19	St. Croix Co. Bass Pond #20	Spooner Hatchery Pond	Staples Lake	Washburn Co. Bass Pond #5	Washburn Co. Bass Pond #6	Windigo Lake
Examined 156	11	8	1	1	6	5	9	10	12	2	11	2	6	5	8	9	14	8	8	12	8
Infected 152	11	8	1	1	6	3	7	10	12	2	11	2	6	5	8	9	14	8	8	12	8
Achtheres micropteri	....	6^1	....	....	....	....	....	....	3^1	1^1	....	....	1^1	....	....	....	....	....	....	....	8^1
Azygia augusticauda	....	....	....	....	....	....	....	....	7^1	....	....	....	....	....	....	....	....	1^1	....	....	....
***Azygia augusticauda*	....	6^1	....	....	1^1	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	1^1
***Bothriocephalus cuspidatus*	....	....	....	....	1^1	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....
Caecincola parvulus	3^1	1^1	....	....	2^1	....	....	....	....	....	....	....	....	....	....	....	2^1	....	....	....	....
	4^2	2^2			2^2				6^2	1^2							4^2				
	1^3	3^3	1^3		2^3				6^3												
Camallanus oxycephalus	1^2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
⊥*Camallanus oxycephalus*	1^2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
***Camallanus oxycephalus*	2^1	4^1	....	....	2^1	....	....	....	2^1	....	....	....	1^1	....	....	....	....	....	....	....	4^1
	2^2																				
**Clinostomum marginatum*	6^1	1^1	....	....	3^1	....	....	....	6^1	1^1	....	2^1	....	....	....	....	....	1^1	....	....	1^1
***Contracaecum* sp.	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....	....	....	....	....	....	2^1
**Contracaecum* sp.	1^1	....	1^1	....	1^1	1^1	....	....	1^1	1^1	....	1^1	....	....	....	....	....	1^1	....	....	1^1
***Crepidostomum cooperi*	1^1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Dichelyne cotylophora	....	1^1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
**Diplostomulum scheuringi*	5^1	5^1	....	....	....	1^1	....	....	2^1	1^1	1^1	....	....	....	....	....	2^1	....	....	....	....
Ergasilus caeruleus	7^1	3^1	....	....	....	....	....	....	2^1	....	....	....	....	....	....	....	....	3^1	....	....	....
		4^2							7^2												
		1^3																			

TABLE 39—*(Continued)*

Huro salmoides (Lacépède) – Largemouth Bass

	Bear Lake	Casey Lake	Cedar Lake	Clam Lake	Devils Lake	Eau Claire Co. Bass Pond	Island Lake Hatchery Pond	La Crosse Federal Hatchery	Lost Land Lake	Mathews Lake	Polk Co. Bass Pond #3	Rocky Ridge Lake	Round Lake	St. Croix Co. Bass Pond #20	St. Croix Co. Bass Pond #19	St. Croix Co. Bass Pond #20	Spooner Hatchery Pond	Staples Lake	Washburn Co. Bass Pond #5	Washb rn Co. Bass Pond #6	Windiog Lake
Gyrodactyloidea	.... 7[2] 4[3]	1[1] 6[2] 1[3]	.... 1[2]	....	.... 4[2] 2[3]	....	....	7[1] 3[2]	4[1] 7[2] 1[3]	1[1] 1[2]	8[1] 3[2]	.... 2[2]	.... 1[2] 5	5[1]	8[1]	9[1]	12[1] 2[2]	.... 6[2] 2[3]	2[1] 6[2]	7[1] 5[2]	.... 8[2]
Illinobdella sp.	....	....	....	....	....	....	....	....	1[1]	1[1]	....	....	....	....	....	....	....	1[1]	....	....	....
Leptorhynchoides thecatus	5[1] 2[2]	7[1]	1[1]	....	1[1] 5[2]	....	....	....	2[1]	1[1]	....	....	....	....	....	....	....	1[1]	....	....	....
**Leptorhynchoides thecatus*	1[1]	1[1]	....	....	....	....	....	....	....	2[1]	....	....	....	....	....	....	....	....	....	....	....
Myxosporidia	1[1]	3[1] 1[2]	....	....	....	....	....	....	1[1]	....	....	....	....	....	....	....	1[1]	....	....	....	4[1] 1[2]
**Neascus* sp.	.... 11[2]	1[3] 7[1]	1[1]	.... 1[2]	1[3] 1[1] 5[2]	....	2[1]	....	1[3] 1[1] 11[2]	1[1] 1[3]	....	1[1] 1[2]	....	....	....	2[1]	8[1] 1[2]	5[1] 2[2] 1[3]	....	....	1[1] 7[2]
Neoechinorhynchus cylindratus	4[1] 7[2]	4[1] 4[2]	1[1]	.... 1[2]	2[1]	....	....	2[1]	4[1]	.... 1[2] 1[3]	....	2[1]	....	....	....	....	1[1]	4[1] 2[2]	....	....	....
Philometra cylindracea	....	....	....	....	....	....	....	....	....	1[1]	....	....	....	....	....	....	....	....	....	....	....
Pomphorhynchus bulbocolli	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1[1]	....	....	....
**Pomphorhynchus bulbocolli*	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1[1]	....	....	....

TABLE 39—*(Continued)*

Huro salmoides (Lacépède) – LARGEMOUTH BASS

	Bear Lake	Casey Lake	Cedar Lake	Clam Lake	Devils Lake	Eau Claire Co. Bass Pond	Island Lake Hatchery Pond	La Crosse Federal Hatchery	Lost Land Lake	Mathews Lake	Polk Co. Bass Pond #3	Rocky Ridge Lake	Round Lake	St. Croix Co. Bass Pond #20	St. Croix Co. Bass Pond #19	St. Croix Co. Bass Pond #20	Spooner Hatchery Pond	Staples Lake	Washburn Co. Bass Pond #5	Washburn Co. Bass Pond #6	Windogi Lake
**Posthodiplostomum minimum*	1^{1}	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Proteocephalus ambloplites	....	....	....	....	....	....	....	....	1^{1}	....	....	....	....	....	....	....	....	....	....	....	....
**Proteocephalus ambloplites*	2^{1} 5^{2} 4^{3}	8^{1}	.... 1^{3}	....	1^{1} 3^{2} 2^{3}	....	5^{1} 2^{2}	8^{1} 2^{2}	.... 11^{2} 1^{3}	.... 2^{2}	....	....	5^{1} 1^{2}	....	....	....	....	4^{1} 4^{2}	....	....	1^{1} 7^{2}
***Proteocephalus pearsei*	....	....	....	....	....	....	....	....	....	....	....	....	3^{1}	....	....	....	6^{1}	....	....	....	....
***Rhipidocotyle papillosum*	....	....	....	1^{1}	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sanguinicola sp.	1^{1}	....	....	....	....	....	....	....	7^{1}	....	....	....	....	....	....	....	....	....	....	....	....
Spinitectus carolini	10^{1}	6^{1}	.... 1^{3}	....	....	....	....	....	....	1^{1}	....	....	....	....	....	....	....	....	....	....	1^{1}
Spinitectus gracilis	....	....	....	....	2^{1}	.... 2^{2}	....	....	....	....	....	....	....	....	....	....	....	1^{1}	....	....	....
**Spiroxys* sp.	....	....	....	1^{1}	....	....	2^{1}	8^{1}	1^{1}	....	1^{1}	....	....	....	....	....	2^{1}	1^{1}	....	....	....

Largemouth bass

Of the 156 largemouth bass examined, 152 (approximately 97 percent) were infected. The bass examined from the bass rearing ponds were all fingerlings from two to four inches in length. The larval *Contracaecum* sp., Acanthocephala, and *Spiroxys* sp. were encysted in the mesenteries. *Sanguinicola* sp., occurring in the mesenteric blood vessels, is a new species of blood fluke, and is similar to the one recovered from the smallmouth bass. The Myxosporidia occurred in cysts in the mouth region.

TABLE 40

Lepomis cyanellus Rafinesque – GREEN SUNFISH

	Cedar Lake	Long Lake
Examined 4 Infected 4	3 3	1 1
***Camallanus oxycephalus*	1[1]	....
**Contracaecum* sp.	1[1]	....
Crepidostomum cooperi	1[1]	....
***Cryptogonimus chyli*	1[1]	....
**Diplostomulum scheuringi*	2[1]	....
Gyrodactyloidea	....	1[1]
**Neascus* sp.	1[1] 2[2]	1[1]
**Posthodiplostomum minimum*	1[1] 1[2] 1[3]	....
**Proteocephalus ambloplites*	1[1]	....
Spinitectus carolini	1[1] 1[2]	....
**Spiroxys* sp.	1[1]	

TABLE 41

Lepomis gibbosus (Linnaeus) – PUMPKINSEED

	Bear Lake	Boos Lake	Cable Lake	Casey Lake	Clam Lake	Crooked Lake	Cyclone Lake	Devils Lake	Ellsworth Lake	Lost Land Lake	Mathews Lake	Namekagon River	Round Lake	Spooner Lake	Staples Lake	Teal Lake	Yellow River (W.)
Examined 139	6	2	1	13	3	14	13	8	17	8	9	19	1	2	14	1	8
Infected 139	6	2	1	13	3	14	13	8	17	8	9	19	1	2	14	1	8
Azygia augusticauda	....	....	....	....	....	....	....	1[1]	....	....	....	1[1]	....	....	....	....	....
***Azygia augusticauda*	....	....	....	3[1]	....	....	....	....	....	....	2[1]	2[1]	....	....	1[1]	....	1[1]
Bothriocephalus claviceps	....	....	....	1[1]	....	1[1]	....	3[1]	....	....	....	....	....	....	....	....	1[1]
Camallanus oxycephalus	1[1]	....	....	1[1]	....	....	....	....	....	....	....	....	....	....	....	....	....
⊥*Camallanus oxycephalus*	....	....	....	1[1]	....	....	....	....	....	....	....	....	....	....	....	....	....
***Camallanus oxycephalus*	....	1[1]	....	1[1]	3[1]	....	7[1]	....	....	1[1]	1[1]	....	....	....	....	....	....
Capillari ı catenata	....	....	....	5[1]	....	....	....	....	....	....	1[1]	....	....	....	3[1]	....	....
**Clinostomum marginatum*	5[1]	1[1]	....	6[1]	2[1]	....	6[1]	3[1]	6[1]	4[1]	6[1]	11[1]	....	1[1]	5[1]	....	2[1]
			1[2]		1[2]							3[2]			2[2]		
***Contracaecum* sp.	5[1]	....	....	....	1[1]	....	3[1]	3[1]	....	....	....	....	....	....	1[1]	....	7[1]
**Contracaecum* sp.	....	....	....	1[1]	....	....	2[1]	....	....	1[1]	....	....	1[1]	....	....	....	1[1]
Crepidostomum cooperi	5[1]	....	....	1[1]	....	....	....	....	....	....	....	....	....	....	4[1]	....	2[1]
			1[2]												1[2]		1[2]
																	2[3]
⊥*Crepidostomum cooperi*	....	....	....	1[1]	....	....	....	....	....	....	....	....	....	....	....	....	....
***Crepidostomum cooperi*	1[1]	2[1]	....	....	....	....	....	....	....	....	....	10[1]	....	....	2[1]	....	1[1]
												2[2]					
Crepidostomum cornutum	....	....	....	....	1[1]	....	....	....	....	....	....	....	....	....	....	....	....
***Crepidostomum cornutum*	....	....	....	....	....	....	1[1]	....	....	....	....	1[2]	....	....	....	....	....
**Diplostomulum scheuringi*	6[1]	....	1[1]	7[1]	1[1]	3[1]	11[1]	8[1]	10[1]	2[1]	5[1]	18[1]	....	1[1]	11[1]	....	2[1]
				1[2]		11[2]											1[2]
**Diplostomulum* sp.	....	....	....	....	....	....	....	....	....	....	....	1[1]	....	....	....	....	....

TABLE 41—*(Continued)*

Lepomis gibbosus (Linnaeus) – PUMPKINSEED

	Bear Lake	Boos Lake	Cable Lake	Casey Lake	Clam Lake	Crooked Lake	Cyclone Lake	Devils Lake	Ellsworth Lake	Lost Land Lake	Mathews Lake	Namekagon River	Round Lake	Spooner Lake	Staples Lake	Teal Lake	Yellow River (W.)
Ergasilus caeruleus	....	....	....	.... 9^2 3^3	....	....	....	....	....	1^1	....	9^1 4^2 1^3	....	....	.... 1^2	....	....
*Glochidia	1^1	....	....	....	....	....	....	....	4^1	....	....	5^1	....	....	1^1	....	1^1
Gyrodactyloidea	.... 4^2 2^3	1^1 1^2	1^1	10^1 2^2	1^1 2^2	5^1 6^2 3^3	3^1 8^2 1^3	.... 8^2	10^1 6^2	1^1 6^2	7^1 2^2	1^1 15^2 3^3	....	.... 2^2	.... 11^2 3^3	1^1	.... 3^2 3^3
Illinobdella sp.	....	....	....	4^1	....	....	9^1	1^1	....	1^1	1^1	....	....	....	....	....	....
Leptorhynchoides thecatus	4^1	2^1	....	6^1	....	....	8^1 3^2	....	....	2^1	6^1	10^1	....	1^1 1^2	3^1	1^1	5^1
**Leptorhynchoides thecatus*	....	....	....	....	....	....	....	2^1 1^2	....	....	2^1	....	....	....	....	....	5^1
Myxosporidia	....	....	....	3^1 4^2	....	1^1	1^1	.... 2^2 1^3	3^1 11^2	.... 1^2 1^3	2^1	1^1 9^2	....	....	1^1 2^2	....	....
**Neascus* sp.	1^1 4^2 1^3	.... 2^2	.... 1^3	7^1 4^2 1^3	.... 2^2 1^3	10^1	12^1 1^2	1^1 6^2 1^3	7^1 6^2 2^3	6^1 2^2	.... 5^2 4^3	4^1 10^2 5^3	....	1^1 1^2	5^1 7^2 2^3	.... 1^3	2^1 5^2 1^3
Neoechinorhynchus cylindratus	....	....	....	....	1^1	....	....	2^1	....	....	....	....	....	....	....	....	....
Phyllodistomum pearsei	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1 1^3

TABLE 41—*(Continued)*

Lepomis gibbosus (Linnaeus) – PUMPKINSEED

	Bear Lake	Boos Lake	Cable Lake	Casey Lake	Clam Lake	Crooked Lake	Cyclone Lake	Devils Lake	Ellsworth Lake	Lost Land Lake	Mathews Lake	Namekagon River	Round Lake	Spooner Lake	Staples Lake	Teal Lake	Yellow River (W.)
[1]*Phyllodistomum* sp.	...	...	1^{3}	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Pomphorhynchus bulbocolli	...	...	...	1^{1}	...	...	1^{1}	...	...	...	...	...	...	...	...	...	1^{1}
**Pomphorhynchus bulbocolli*	1^{1}	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
**Posthodiplostomum minimum*	... 6^{3}	... 1^{2} 1^{3}	... 1^{3}	... 8^{2} 5^{3}	... 1^{2} 2^{3}	...	... 9^{2} 3^{3}	1^{1} 6^{2} 1^{3}	15^{1} 2^{2}	2^{1} 4^{2} 1^{3}	1^{1} 6^{2} 1^{3}	1^{1} 18^{2}	...	... 1^{2} 1^{3}	2^{1} 6^{2} 6^{3}	... 1^{2}	... 8^{3}
**Proteocephalus ambloplites*	...	2^{1}	...	1^{1}	...	2^{1}	12^{1}	5^{1} 3^{2}	...	2^{1}	2^{1}	...	...	...	...	...	...
***Proteocephalus pearsei*	...	...	...	...	...	1^{1}	...	...	...	...	...	...	...	...	...	...	4^{1}
Spinitectus carolini	3^{1}	1^{1}	...	6^{1}	1^{1}	...	...	3^{1}	...	...	4^{1}	6^{1}	...	...	5^{1} 1^{2}	...	... 1^{2}
Spinitectus gracilis	...	...	...	5^{1}	...	...	...	...	...	...	...	1^{1}	...	...	...	...	...
**Spiroxys* sp.	3^{1}	...	1^{1}	...	...	...	3^{1}	2^{1}	4^{1}	...	...	...	...	...	...	...	2^{1}
**Triaenophorus nodulosus*	...	...	...	...	...	...	...	...	...	3^{1}	...	...	...	...	...	...	...
Trichodina sp.	...	...	...	...	...	...	...	...	1^{2}	...	...	...	...	...	...	...	...

Pumpkinseed

All 139 pumpkinseeds were infected. The larval *Contracaecum* sp., Acanthocephala, and *Spiroxys* sp. were encysted in the mesenteries. The larval *Diplostomulum* sp. occurred in the humor of the eye. The larval *Triaenophorus nodulosus* was encysted in the liver. *Trichodina* sp. occurred on the gills. The Myxosporidia was in cysts in the mesenteries, and more numerous on the conus of the heart. Bangham (in press) examined one pumpkinseed from Spooner Lake, finding all but Gyrodactyloidea and *Leptorhynchoides thecatus* as recorded in the report. He also examined nine fish from the Yellow River, finding similar parasites with the exceptions of *Bothriocephalus claviceps,* larval and immature *Contracaecum* sp., Glochidia, larval *Leptorhynchoides thecatus, Phyllodistomum pearsei,* and *Pomphorhynchus bulbocolli* which he did not record.

Common bluegill

All 217 bluegills were infected. The larval *Contracaecum* sp., *Proteocephalus* sp., *Rhipidocotyle papillosum,* and *Spiroxys* sp. were encysted in the mesenteries, while the larval *Triaenophorus nodulosus* was encysted in the liver. The Myxosporidia occurred in cysts in the mesenteries. *Trichodina* sp. was found on the gills. Bangham (in press) in one bluegill from Cable Lake found all but the larval *Clinostomum marginatum, Crepidostomum cooperi,* and *Leptorhynchoides thecatus* recorded in this report. Ten fish were examined by Bangham from Chetac Lake, however, he did not find the larval *Clinostomum marginatum,* or Myxosporidia. Besides the parasites found in common in both reports on this lake, he found *Azygia augusticauda,* immature *Camallanus* sp., *Crepidostomum cooperi,* larval *Diplostomulum scheuringi,* larval *Proteocephalus ambloplites,* and larval *Triaenophorus nodulosus.* Also examined by Bangham were six fish from Spooner Lake in which he recorded all but *Ergasilus caerleus* and larval *Proteocephalus ambloplites* listed in the present report. In addition to the parasites in common he found *Bothriocephalus claviceps,* immature *Camallanus* sp., and larval *Clinostomum marginatum.* Seven bluegills from Tozer Lake were examined by Bangham. He failed to find *Crepi-*

dostomum cornutum; however, in addition to those species in common listed in this report he found the larval *Clinostomum marginatum, Crepidostomum cooperi,* and *Myxobolus* sp.

TABLE 42

Lepomis m. macrochirus Rafinesque – COMMON BLUEGILL

	Bear Creek	Bear Lake	Boos Lake	Cable Lake	Casey Lake	Cedar Lake	Chetac Lake	Clam Lake	Crooked Lake	Cyclone Lake
Examined 217	4	7	3	17	16	3	2	3	13	17
Infected 217	4	7	3	17	16	3	2	3	13	17
Achtheres micropteri..........	....	....	....	....	1^1	....	....	....	....	....
Camallanus oxycephalus......	....	....	....	....	1^1	....	....	....	....	1^1
***Camallanus oxycephalus*......	....	2^1	....	....	5^1	2^1	....	1^1	....	6^1
Capillaria catenata...........	....	....	....	....	9^1	....	....	....	....	1^1
**Clinostomum marginatum*....	....	1^1	....	2^1	1^1	....	1^1	....	....	1^1
***Contracaecum* sp.	....	2^1	....	....	....	....	....	1^1	....	1^1
Crepidostomum cooperi........	1^1	2^1	....	4^1	....	....	....	....	....	....
⊥*Crepidostomum cooperi*........	....	....	....	3^2	....	....	....	....	....	....
***Crepidostomum cooperi*........	....	....	1^1	8^1	2^1	....	....	....	....	....
				1^2						
⊥*Crepidostomum cornutum*.....	....	....	....	....	....	....	....	....	....	1^1
***Crepidostomum cornutum*.....	....	....	....	....	....	....	....	....	....	3^1
**Diplostomulum scheuringi*....	2^1	7^1	....	14^1	9^1	2^1	....	1^1	5^1	10^1
				1^2	1^2				8^2	
Ergasilus caeruleus...........	....	1^1	....	....	6^1	....	....	....	....	....
					4^2			1^2		
Gyrodactyloidea.	....	1^1	3^1	4^1	13^1	....	....	....	5^1	15^1
	2^2	5^2		2^2	1^2	3^2	2^2	1^2	8^2	1^2
	2^3	1^3						2^3		
Illinobdella sp................	....	....	....	....	1^1	....	....	2^1	....	1^1
Leptorhynchoides thecatus.....	1^1	5^1	1^1	1^1	....	....	1^1	4^1	....	11^1
										5^2
Myxosporidia...............	....	....	....	....	....	....	1^3			
**Neascus* sp.................	3^1	3^1	1^1	2^1	13^1	....	....	....	5^1	13^1
	1^2	4^2	....	14^2	....	2^2	2^2	1^2	6^2	1^2
				1^3		1^3		2^3		1^3
Pomphorhynchus bulbocolli...	....	....	....	....	1^1	....	....	....	....	....
**Posthodiplostomum minimum*.	....	....	....	....	....	....	....	....	....	2^1
	4^2			16^2	16^2		1^2	1^2		12^2
		7^3		1^3		3^3	1^3	2^3		2^3
**Proteocephalus ambloplites* ...	....	1^1	2^1	3^1	1^1	....	....	....	1^1	6^1
Spinitectus carolini..........	4^1	4^1	3^1	17^1	12^1	1^1	1^1	1^1	1^1	6^1
		2^2				2^2				
		1^3								
Spinitectus gracilis..........	....	....	2^1	....	6^1	....	....	....	....	....

TABLE 42—*(Continued)*

Lepomis m. macrochirus Rafinesque – COMMON BLUEGILL

	Devils Lake	Lost Land Lake	Namekagon River	Round Lake	Silver Lake	Spooner Lake	Staples Lake	Teal Lake	Tozer Lake	Windigo Lake
Achtheres micropteri	....	....	....	2^{1}	....	....	....	....	....	....
***Azygia augusticauda*	....	....	2^{1}	....	....	....	....	....	....	....
***Bothriocephalus cuspidatus*	....	1^{1}	....	....	....	....	....	....	....	....
Camallanus oxycephalus	1^{1}	....	....	....	....	....	....	....	....	3^{1}
***Camallanus oxycephalus*	1^{1}	....	....	5^{1}	....	....	....	....	2^{1}	8^{1}
Capillaria catenata	....	1^{1}	....	....	....	....	1^{1}	....	....	8^{1} 2^{2}
**Clinostomum marginatum*	....	1^{1}	3^{1}	....	....	....	3^{1}	7^{1}	....	....
***Contracaecum* sp.	1^{1}	....	....	....	....	....	2^{1}	....	....	....
**Contracaecum* sp.	1^{1}	....	....	....	....	....	....	....	....	2^{1}
Crepidostomum cooperi	....	....	....	....	1^{1}	....	5^{1} 1^{2}	1^{1} 1^{2}	....	....
***Crepidostomum cooperi*	....	....	8^{1}	....	9^{1} 3^{2}	....	....	3^{1}	....	....
Crepidostomum cornutum	....	8^{1} 2^{2}	....	....	....	....	....	4^{1} 3^{2}	3^{1}	5^{1}
***Crepidostomum cornutum*	....	....	....	....	....	....	....	....	1^{1} 1^{2} 1^{3}	1^{1}
**Diplostomulum scheuringi*	12^{1} 1^{2}	4^{1}	11^{1}	5^{1}	6^{1}	5^{1}	11^{1}	1^{1}	2^{1}	4^{1}
Ergasilus caeruleus	....	1^{1}	7^{1} 2^{2}	....	....	2^{1} 1^{2} 2^{3}	2^{1}	2^{1}	....	....
*Glochidia	....	....	5^{1}	....	....	....	2^{1}	1^{1}	....	....
Gyrodactyloidea	13^{1} 2^{2}	5^{1} 9^{2} 1^{3}	9^{1} 5^{2} 1^{3}	12^{1}	5^{1} 9^{2}	3^{1} 4^{2} 2^{3}	5^{1} 8^{2} 1^{3}	3^{1} 7^{2} 3^{3}	6^{1}	5^{1} 7^{2} 1^{3}
Illinobdella sp.	3^{1}	....	....	....	....	....	....	....	....	....
Leptorhynchoides thecatus	....	3^{1}	11^{1}	....	8^{1}	7^{1} 1^{2}	4^{1}	4^{1}	....	....
Myxosporidia	....	1^{1}	....	....	....	....	....	....	....	....
**Neascus* sp.	.... 6^{2} 9^{3}	8^{1} 3^{2}	11^{1} 4^{2} 1^{3}	1^{1}	9^{1} 4^{2}	1^{1} 8^{2} 1^{3}	5^{1} 9^{2}	6^{1} 9^{2} 1^{3}	2^{1} 3^{2} 1^{3}	4^{1} 9^{2}
Neoechinorhynchus cylindratus	1^{1}	....	....	....	....	....	....	....	....	....
Pomphorhynchus bulbocolli	....	....	1^{1}	....	....	....	5^{1}	....	....	....
**Posthodiplostomum minimum*	9^{1} 1^{2} 2^{3}	6^{1} 7^{2} 1^{3}	.... 15^{2} 1^{3}	2^{1}	4^{1} 10^{2}	.... 6^{2} 4^{3}	.... 9^{2} 5^{3}	4^{1} 7^{2} 5^{3}	.... 6^{2}	4^{1} 4^{2}
**Proteocephalus ambloplites*	4^{1}	....	....	2^{1}	3^{1}	2^{1}	3^{1}	4^{1} 1^{2}	3^{1}	8^{1}
**Proteocephalus* sp.	....	....	....	1^{1}	....	....	....	....	....	....
**Rhipidoctoyle papillosum*	....	1^{1}	....	....	....	....	....	....	....	....
Spinitectus carolini	10^{1} 2^{2}	2^{1}	7^{1} 1^{2}	5^{1}	1^{1}	2^{1}	12^{1}	7^{1} 1^{2}	4^{1} 2^{2}	12^{1} 1^{2}
Spinitectus gracilis	....	....	....	....	8^{1} 6^{2}	....	....	4^{1} 3^{2}	....	....
**Spiroxys* sp.	....	2^{1}	....	1^{1}	....	....	1^{1}	2^{1}	....	....
**Triaenophorus nodulosus*	....	3^{1}	....	....	....	....	....	7^{1}	....	....
Trichodina sp.	....	....	....	....	....	....	.... 2^{3}	2^{2}	....	....

TABLE 43

Ambloplites r. rupestris (Rafinesque) – NORTHERN ROCK BASS

	Bean Brook	Bear Creek	Bear Lake	Boos Lake	Casey Lake	Cedar Lake	Crystal Brook	Cyclone Lake	Devils Lake	Lost Land Lake	Mathews Lake
Examined 132	7	1	4	8	4	5	1	3	9	7	3
Infected 132	7	1	4	8	4	5	1	3	9	7	3
Azygia augusticauda.....	....	....	....	....	1^{1}	....	....	....	....	....	1^{1}
**Azygia augusticauda.....	....	....	....	....	2^{1}	....	....	....	....	....	2^{1}
*Bucephalus elegans.......	1^{1}	....	....	....	....	....	....	....	....	....	....
Camallanus oxycephalus..	....	1^{1}	....	7^{1}	1^{1}	1^{1}	....	....	....	2^{1}	....
⊥Camallanus oxychephalus	....	....	2^{1} 1^{2}	....	....	1^{1}	....	....	....	....	....
**Camallanus oxycephalus .	1^{1}	1^{1}	....	....	2^{1}	2^{1}	....	2^{1}	1^{1}	3^{1}	....
Capillaria catenata.......	....	....	....	....	....	....	....	....	....	1^{1}	2^{1}
*Clinostomum marginatum	6^{1}	....	1^{1}	2^{1}	....	5^{1}	....	1^{1}	1^{1}	....	1^{1}
Contracaecum brachyurum	..	....	....	1^{1}	1^{1}	....	....	....	....	....	....
**Contracaecum brachyurum	4^{1}	....	2^{1}	1^{1}	....	....	1^{1}	....	1^{1}	....	....
Crepidostomum cooperi...	1^{1} 1^{2}	....	....	1^{1}	1^{1}	....	....	....	....	....	....
Cryptogonimus chyli.....	.... 4^{2} 2^{3}	....	1^{1} 3^{2}	....	3^{1} 1^{2}	3^{1} 1^{2}	....	2^{1}	....	.... 4^{2} 3^{3}	2^{1} 1^{2}
**Cryptogonimus chyli.....	1^{2}	....	....	....	....	....	....	....	....	....	....
Dichelyne cotylophora....	....	....	....	....	2^{1}	....	....	....	....	....	....
*Diplostomulum scheuringi	....	.... 1^{2}	2^{1} 2^{2}	4^{1}	1^{1} 3^{2}	4^{1}	....	2^{1}	3^{1} 6^{2}	4^{1} 2^{2}	3^{1}
Ergasilus caeruleus......	....	....	.... 4^{2}	2^{1} 4^{2} 1^{3}	.... 2^{2} 2^{3}	....	....	....	....	.... 7^{2}	2^{1}
*Glochidia.............	.... 2^{2} 5^{3}	1^{1}	.... 1^{2}	....	....	....	....	....	....	....	....
Gyrodactyloidea	5^{1} 1^{2}	1^{1}	2^{1} 1^{2}	6^{1} 2^{2}	....	1^{1} 1^{2}	1^{1}	2^{1} 1^{2}	....	3^{1} 4^{2}	2^{1}
Illinobdella sp...........	....	....	....	....	....	....	....	....	3^{1}	....	....
Leptorhynchoides thecatus	1^{1}	....	2^{1} 1^{2}	4^{1} 3^{2}	4^{1}	....	....	2^{1} 1^{2}	4^{1} 3^{2}	5^{1}	3^{1}
Myxosporidia..........	1^{1}	....	1^{1}	....	....	....	....	....	....	....	....
*Neascus sp............	5^{1} 2^{2}	1^{1}	.... 4^{2}	3^{1} 1^{2}	2^{1} 1^{2}	3^{1} 2^{2}	1^{1}	1^{1} 1^{2} 1^{3}	7^{1} 2^{2}	1^{1} 5^{2} 1^{3}	.... 2^{2} 1^{3}
Neoechinorhynchus cylindratus..........	5^{1}	....	1^{1}	....	....	....	....	1^{1}	5^{1}	1^{1}	2^{1}
Pomphorhynchus bulbocolli............	2^{1}	....	....	....	....	....	....	....	....	....	....
*Posthodiplostomum minimum............	3^{1}	....	.... 4^{3}	1^{1} 1^{2}	1^{1} 1^{2} 1^{3}	1^{1} 3^{2}	....	.... 2^{2} 1^{3}	1^{1} 3^{2}	2^{1} 2^{2} 3^{3}	.... 1^{3}
*Proteocephalus ambloplites..........	....	....	4^{1}	....	3^{1}	2^{1}	....	1^{1}	4^{1}	3^{1}	2^{1}
**Proteocephalus pearsei...	3^{1} 3^{2}	1^{1}	....	1^{1}	....	....	....	....	3^{1}	1^{1}	....
Spinitectus carolini......	2^{1}	....	....	4^{1}	....	1^{1}	....	....	1^{1}	1^{1}	....
Spinitectus gracilis......	....	....	....	2^{1}	....	....	....	....	....	....	....
*Spiroxys sp............	3^{1}	....	2^{1}	1^{1}	....	3^{1}	....	1^{1}	....	3^{1}	....

TABLE 43—*(Continued)*

Ambloplites r. rupestris (Rafinesque) – NORTHERN ROCK BASS

	Namekagon River	Red Cedar River	Silver Lake	Spooner Lake	Staples Lake	Teal Lake	Tozer Lake	Upper Turtle Lake	Vermillion River	Windigo Lake	Yellow River (W.)
Achtheres micropteri	....	....	....	....	....	2^{1}	....	....	....	....	....
Azygia augusticauda	....	....	....	....	....	....	....	....	....	....	1^{1}
***Azygia augusticauda*	....	....	2^{1}	....	....	....	....	3^{1}	....	2^{1}	....
***Bothriocephalus cuspidatus*	....	....	....	....	....	1^{1}	....	....	....	....	....
Camallanus oxycephalus	....	....	....	....	....	5^{1} 1^{2}	....	....	....	5^{1}	....
⊥*Camallanus oxycephalus*	....	....	....	....	....	1^{1}	....	....	....	....	....
***Camallanus oxycephalus*	....	....	....	....	....	2^{1} 1^{2}	1^{1}	....	....	4^{1}	....
Capillaria catenata	....	....	....	....	....	....	....	....	....	11^{1} 1^{2}	....
**Clinostomum marginatum*	....	....	....	....	....	2^{1}	....	....	....	1^{1}	1^{1}
Contracaecum brachyurum	....	....	1^{1}	....	....	2^{1}	....	....	....	....	....
**Contracaecum* sp.	....	....	....	....	....	2^{1}	....	....	....	....	....
Crepidostomum cooperi	1^{1}	....	....	....	....	2^{1}	....	....	....	....	5^{1} 3^{2}
***Crepidostomum cooperi*	1^{1}	....	7^{1}	....	....	....	....	....	....	....	....
***Crepidostomum cornutum*	....	....	....	....	....	4^{1}	....	....	....	....	....
Cryptogonimus chyli	4^{1} 1^{2}	....	....	1^{1}	....	4^{1}	....	1^{1} 5^{2} 9^{3}	....	....	5^{1} 2^{2} 3^{3}
***Cryptogonimus chyli*	....	....	....	....	....	1^{1}	....	....	....	....	....
**Diplostomulum scheuringi*	4^{1} 1^{2}	....	7^{1}	1^{1}	2^{1}	11^{1}	1^{1}	4^{1}	....	6^{1}	3^{1} 3^{2} 2^{3}
Ergasilus caeruleus	4^{1}	....	1^{1} 7^{2}	1^{1}	....	2^{1} 7^{2} 9^{3}	....	13^{1} 1^{2}	....	....	....
*Glochidia	....	....	....	....	....	1^{1}	....	1^{1}	....	....	3^{1}
Gyrodactyloidea	3^{1} ^{2}	1^{1}	.... 9^{2} 2^{3}	1^{1}	2^{1}	1^{1} 8^{2} 8^{3}	....	8^{1} 2^{2}	.... 2^{2}	2^{1} 10^{2}	4^{1}
Illinobdella sp.	....	....	....	....	....	....	....	....	1^{1}	....	....
Leptorhynchoides thecatus	3^{1} 2^{2}	....	6^{1}	.... 1^{2}	....	13^{1} 2^{2}	....	12^{1}	1^{1}	....	8^{1} 2^{2}
**Leptorhynchoides thecatus*	1^{1}	1^{1}	1^{1}	....	....	....	....	....	....	....	4^{1} 1^{2}
Myxosporidia	....	....	....	....	....	....	....	....	....	....	2^{1} 1^{2}
**Neascus* sp.	.... 4^{2} 1^{3}	....	5^{1} 6^{2}	.... 1^{2}	1^{1} 1^{2}	10^{1} 5^{2} 1^{3}	.... 1^{2}	1^{1} 6^{2} 8^{3}	2^{1}	9^{1} 4^{2}	1^{1} 6^{2} 4^{3}
Neoechinorhynchus cylindratus	1^{1}	....	....	1^{1}	1^{1}	6^{1}	....	....	....	....	2^{1}
Pomphorhynchus bulbocolli	1^{1}	....	....	....	....	1^{1}	....	....	....	....	6^{1}

TABLE 43—*(Continued)*

Ambloplites r. rupestris (Rafinesque) – NORTHERN ROCK BASS

	Namekagon River	Red Cedar River	Silver Lake	Spooner Lake	Staples Lake	Teal Lake	Tozer Lake	Upper Turtle Lake	Vermillion River	Windigo Lake	Yellow River (W.)
**Pomphorhynchus bulbocolli*	....	....	....	....	....	....	....	....	....	....	1¹
**Posthodiplostomum minimum*	....	....	3¹ 2²	....	.... 1² 1³	1¹ 8² 2³	....	3¹ 5² 1³	1¹	....	4¹ 2²
**Proteocephalus ambloplites*	....	....	4¹	....	....	3¹	1¹	12¹ 1²	....	1¹	....
***Proteocephalus pearsei*	....	....	1¹	1¹	....	....	....	....	....	1¹	5¹
Spinitectus carolini	....	....	....	....	....	4¹ 2²	1¹	....	....	1² 6¹	....
Spinitectus gracilis	....	....	5¹ 1²	....	....	4¹ 5²	....	....	....	....	....
**Spiroxys* sp.	....	....	1¹	....	....	4¹	....	....	....	....	....
Trichodina sp.	....	....	....	....	....	1¹ 8³	....	....	....	....	.... 1³

Northern rock bass

All 132 rock bass were infected. The larval *Bucephalus elegans, Contracaecum* sp., Acanthocephala, *Spiroxys* sp. were encysted in the mesenteries. The Myxosporidia occurred in cysts in the mouth region. *Trichodina* sp. was found on the gills. Bangham (in press) examined six rock bass from the Yellow River, and many parasites were found in common with those recorded in this report. In addition he recorded *Illinobdella* sp., and larval and immature *Proteocephalus ambloplites*. He did not find any *Azygia augusticauda,* Glochidia, larval *Leptorhynchoides thecatus,* Myxosporidia, *Neoechinorhynchus cylindratus,* larval and adult *Pomphorhynchus bulbocolli,* and *Trichodina* sp.

TABLE 44

Pomoxis nigro-maculatus (LeSueur) – Black Crappie

	Bear Lake	Boos Lake	Cable Lake	Casey Lake	Cedar Lake	Chetac Lake	Clam Lake	Cyclone Lake	Devils Lake	Lost Land Lake	Marshmiller Pond	Mathews Lake	Namekagon River	Red Cedar River	Silver Lake	Spooner Lake	Staples Lake	Teal Lake	Upper Turtle Lake	Windigo Lake
Examined 216	5	15	16	14	2	3	3	15	9	12	12	12	14	1	12	11	13	18	16	13
Infected 207	5	15	16	11	2	3	3	15	7	12	12	11	13	1	12	11	13	18	16	11
Argulus versicolor															1^{1}					
***Azygia augusticauda*											1^{1}	1^{1}			1^{1}					
Camallanus oxycephalus	1^{1} 4^{2}				1^{2}	3^{1}					5^{1}		1^{1}					2^{1} 3^{2}		
⊥*Camallanus oxycephalus*				1^{1}														1^{1} 2^{2}		
***Camallanus oxycephalus*		2^{2} 4^{1} 9^{2}	8^{1} 7^{2}	5^{1}						9^{1}	1^{1}		2^{1}					3^{2} 2^{3}		
Capillaria catenata																				3^{1}
***Contracaecum* sp.				1^{1}								1^{1}								
**Contracaecum* sp.	1^{1}		1^{1}	1^{1}	1^{1} 1^{2}		2^{1}				9^{1} 2^{2}	1^{1}								
Crepidostomum cooperi																		2^{1} 1^{2}		
Crepidostomum cornutum																		2^{1}		
**Diplostomulum scheuringi*	4^{1}	1^{1}	14^{1}	9^{1}			2^{1}	7^{1}	7^{1}	1^{1}	12^{1}	6^{1}	13^{1}	1^{1}	6^{1}	6^{1}	12^{1}	2^{1}	2^{1}	1^{1}
**Diplostomulum* sp.													1^{1}							
Ergasilus caeruleus													1^{1}							
*Glochidia														1^{2}						
Gyrodactyloidea	2^{1} 1^{2}	10^{1} 2^{2}	6^{1}		1^{2}	1^{1} 2^{2}	1^{1} 1^{3}			5^{1} 2^{3}	1^{1} 8^{2} 3^{3}	1^{1}	3^{1} 1^{2}				1^{1} 9^{2} 3^{3}	8^{1} 8^{2} 2^{3}		9^{1} 1^{2}

TABLE 44—*(Continued)*

Pomoxis nigro-maculatus (LeSueur) – BLACK CRAPPIE

	Bear Lake	Boos Lake	Cable Lake	Casey Lake	Cedar Lake	Chetac Lake	Clam Lake	Cyclone Lake	Devils Lake	Lost Land Lake	Marshmiller Pond	Mathews Lake	Namekagon River	Red Cedar River	Silver Lake	Spooner Lake	Staples Lake	Teal Lake	Upper Turtle Lake	Windigo Lake
Leptorhynchoides thecatus	3^1	3^1	....	1^1	....	1^1	2^1	14^1 1^2	1^1	4^1	....	1^1	8^1 1^2	1^1	11^1	9^1	1^1	4^1	12^1	....
**Leptorhynchoides thecatus*	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....	....	....	....
Myxosporidia	2^1 1^2 1^3	....	....	1^2	....	....	....	....	....	....	....	5^1 1^2 1^3	3^1 2^2	1^3	....	6^1 3^2	2^1 8^2	1^1 1^2	....	....
**Neascus* sp.	4^1	1^1	1^1	....	....	....	....	....	....	3^1 1^2	2^1 3^2	3^1	....	....	1^1	....	....	8^1	12^1 2^2	2^1
Neoechinorhynchus cylindratus	....	....	....	....	....	....	....	....	1^1	....	....	....	....	....	....	....	....	2^1	....	....
Pomphorhynchus bulbocolli	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....	....
**Proteocephalus ambloplites*	1^1	....	1^1	....	1^2	....	....	....	....	....	....	2^1	....	....	....	2^1	....	....	6^1	1^1
***Proteocephalus pearsei*	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	1^1	1^1	....	1^1 1^2	1^1	....
**Proteocephalus* sp.	....	....	....	....	....	....	....	....	2^1	....	....	....	....	....	....	....	....	....	....	....
Spinitectus carolini	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2^1	....	....
Spinitectus gracilis	2^1	3^1	....	....	....	....	....	....	....	3^1 1^2	....	1^1	....	....	8^1 4^2	....	1^1	2^1 2^2	....	....
**Spiroxys* sp.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	1^1	....	....
**Tetracotyle* sp.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1^1	....	....
Trichodind sp.	....	....	....	....	....	....	....	....	....	....	10^2 1^3	....	....	....	....	....	....	....	....	....

Black crappie

Of the 216 crappies examined, 207 (approximately 96 percent) were infected. Of all the game and pan fish examined the black crappie shows the lightest incidence and intensity of infection. *Argulus versicolor* was taken from the underside of the operculum. The larval *Diplostomulum* sp. occurred in the lens of the eye. The Myxosporidia were in cysts in several locations, viz., on the conus arteriosus in one fish from Bear Lake, in three from the Namekagon River, in eight from Spooner Lake, and in the 10 from Staples Lake; on the conus and in the mesenteries in one from the Namekagon River; in the gills in the seven from Mathews Lake; in the stomach wall in one from the Namekagon River; in the intestinal wall in three from Bear Lake, in one from Casey Lake, in one from Spooner Lake, and the two from Teal Lake; in the gall bladder in the one from the Red Cedar River. *Trichodina* sp. occurred on the gills. Bangham (in press), in examining seven crappies from Chetac Lake, found in addition to those parasites listed in this report the following larval parasites: *Diplostomulum scheuringi, Leptorhynchoides thecatus, Neascus* sp., *Posthodiplostomum minimum,* and *Proteocephalus ambloplites;* also the adult *Spinitectus* sp.

TABLE 45

Cottus b. bairdii Girard – Northern Muddler

	Bean Brook	Brule River	Potato Creek
Examined 16	3	12	1
Infected 16	3	12	1
Crepidostomum cooperi	2^1	2^1	...
†*Crepidostomum cooperi*	...	1^2	...
***Crepidostomum cooperi*	...	1^1	...
**Diplostomulum* sp (1)	3^1	...	...
**Diplostomulum* sp. (2)	1^1	...	...
*Glochidia	1^2 2^3	...	...
**Neascus* sp.	1^1 2^2	... 9^2 3^3	...
Phyllodistomum undulans	...	1^1	1^1
Pomphorhynchus bulbocolli	...	1^1	...
***Proteocephalus pearsei*	3^1	4^1	...
Rhabdochona cascadilla	...	11^1 1^2	...

Northern muddler

All 16 muddlers were infected with at least one species of parasite. Two species of larval *Diplostomulum* were recovered from the humor of the eyes of Bean Brook fish.

TABLE 46

Eucalia inconstans (Kirtland) – BROOK STICKLEBACK

	Bean Brook	Brule River	Crystal Brook	Hay River	Potato Creek
Examined 3	1	16	14	1	1
Infected 15	1	6	6	1	1
Bunoderina eucaliae	....	6[1]	3[1]	....	....
***Bunoderina eucaliae*	....	....	1[1]	....	....
***Contracaecum* sp.	....	1[1]	3[1]	....	....
*Glochidia	1[1]	....	....	1[1]	....
Illinobdella sp.	....	....	1[1]	....	....
**Neascus* sp.	....	....	....	1[1]	....
*Nematoda	....	....	1[1]	....	....
Neoechinorhynchus sp.	....	1[1]	....	....	....
**Pomphorhynchus bulbocolli*	....	1[1]	....	....	....
**Proteocephalus* sp.	....	....	1[1]	....	....
Spinitectus gracilis	....	1[1]	....	....	....
**Tetracotyle* sp.	1[1]	....	....	....	1[1]
Trichodina sp.	....	....	....	1[3]	1[2]

Brook stickleback

Only 15 (approximately 45 percent) of the 33 sticklebacks were infected. The larval nematode, *Proteocephalus* sp., and *Pomphorhynchus bulbocolli* were encysted in the mesenteries. Specimens of *Neoechinorhynchus* sp. from the Brule River sent to Dr. R. V. Bangham and Dr. H. J. Van Cleave were placed by both (personal communications) in the above genus. Van Cleave, in addition, stated "the worms seemed to be definitely stunted in size due to their occurrence in such a miniature host." He also stated "the worm looks very much like an undescribed species Professor Pearse sent me from various Wisconsin fishes and which was also included in the old Marshall and Gilbert collections of their pioneer survey. I have had the species in question from perch, from rock bass and from Esox." *Trichodina* sp. from Hay River and Potato Creek fish occurred on the gills.

CHECK LIST OF PARASITES

Parasite	*No. spp. fish infected*
Trematoda	
Acolpenteron catostomi (Fischthal and Allison, 1942)	1
Allocreadium lobatum (Wallin)	3
Alloglossidium corti (Lamont, 1921)	5
Alloglossidium geminus (Mueller, 1930)	3
Anonchohaptor anomalum (Mueller, 1938)	1
Azygia augusticauda (Stafford, 1904)	11
Bunodera leuciopercae (Mueller, 1776)	1
Bunodera sacculata (Van Cleave and Mueller, 1932)	1
Bunoderina eucaliae (Miller, 1938)	2
Bucephalopsis pusilla (Stafford, 1904)	1
Bucephalus elegans (Woodhead, 1930)	7
Caecincola parvulus (Marshall and Gilbert, 1905)	2
Clinostomum marginatum (Rudolphi, 1819)	24
Crepidostomum cooperi (Hopkins, 1931)	11
Crepidostomum cornutum (Osborn, 1903)	4
Crepidostomum farionis (Mueller, 1788)	1
Crepidostomum isostomum (Hopkins, 1931)	2
Cryptogonimus chyli (Osborn, 1903)	8
Diplostomulum scheuringi (Hughes, 1929)	15
Diplostomulum spp.	14
Gyrodactyloidea	24
Macroderoides flavus (Van Cleave and Mueller, 1932)	1
Macroderoides parvus (Hunter, 1932)	1
Neascus spp.	33
Octomacrum lanceatum (Mueller, 1934)	1
Phyllodistomum brevicecum (Steen, 1938)	1
Phyllodistomum etheostomae (Fischthal, 1942)	3
Phyllodistomum lysteri (Miller, 1940)	1
Phyllodistomum nocomis (Fischthal, 1942)	1
Phyllodistomum notropidus (Fischthal, 1942)	1
Phyllodistomum pearsei (Holl, 1929)	1
Phyllodistomum spp.	3
Phyllodistomum staffordi (Pearse, 1924)	3
Phyllodistomum undulans (Steen, 1938)	1
Plagiocirrus primus (Van Cleave and Mueller, 1932)	1
Plagioporus sinitsini (Mueller, 1934)	2
Posthodiplostomum minimum (MacCallum, 1921)	18
Rhipidocotyle papillosum (Woodhead, 1929)	3
Sanguinicola occidentalis (Van Cleave and Mueller, 1932)	2
Sanguinicola spp.	4
Tetracotyle spp.	12
Triganodistomum attenuatum (Mueller and Van Cleave, 1932)	1
Cestoda	
Biacetabulum infrequens (Hunter, 1927)	1
Bothriocephalus claviceps (Goeze, 1782)	1
Bothriocephalus cuspidatus (Cooper, 1917)	5
Bothriocephalus formosus (Mueller and Van Cleave, 1932)	2
Bothriocephalus sp.	2
Cestodaria	1
Corallobothrium fimbriatum (Essex, 1928)	4
Glaridacris catostomi (Cooper, 1920)	2
Glaridacris confusus (Hunter, 1929)	1
Glaridacris intermedius (Lyster, 1940)	1
Hymenolepis sp.	1

CHECK LIST OF PARASITES *(Continued)*

Parasite	*No. spp. fish infected*
Proteocephalus ambloplites (Leidy, 1887)	14
Proteocephalus pearsei (La Rue, 1919)	12
Proteocephalus pinguis (La Rue, 1911)	2
Proteocephalus spp.	16
Proteocephalus stizostethi (Hunter and Bangham, 1933)	1
Triaenophorus nodulosus (Pallas, 1781)	5
NEMATODA	
Camallanus oxycephalus (Ward and Magath, 1917)	19
Capillaria catenata (Van Cleave and Mueller, 1932)	7
Contracaecum brachyurum (Ward and Magath, 1917)	2
Contracaecum spp.	31
Cystidicoloides harwoodi (Chandler, 1931)	3
Dichelyne cotylophora (Ward and Magath, 1917)	5
Dichelyne robusta (Van Cleave and Mueller, 1932)	3
Hepaticola bakeri (Mueller and Van Cleave, 1932)	2
Nematode—larva	1
Philometra cylindracea (Ward and Magath, 1917)	2
Philometra sp.	2
Oxyuridae	1
Rhabdochona cascadilla (Wigdor, 1918)	9
Spinitectus carolini (Holl, 1928)	12
Spinitectus gracilis (Ward and Magath, 1917)	12
Spiroxys sp.	19
ACANTHOCEPHALA	
Leptorhynchoides thecatus (Linton, 1891)	25
Neoechinorhynchus crassus (Van Cleave, 1919)	3
Neoechinorhynchus cylindratus (Van Cleave, 1913)	11
Neoechinorhynchus tenellus (Van Cleave, 1913)	3
Neoechinorhynchus sp.	2
Octospinifer macilentus (Van Cleave, 1919)	1
Pomphorhynchus bulbocolli (Linkins, 1919)	24
PROTOZOA	
Chloromyxum spp.	4
Microsporidia	1
Myxosporidia	17
Trichodina renicola (Mueller, 1931)	1
Trichodina spp.	15
COPEPODA	
Achtheres micropteri (Wright, 1882)	4
Argulus catostomi (Dana and Herrick, 1837)	1
Argulus versicolor (Wilson, 1902)	1
Ergasilus caeruleus (Wilson, 1911)	6
MOLLUSCA	
Glochidia	23
VIRUS	
Lymphocystis	1
HIRUDINEA	
Illinobdella spp.	7

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THE *CARTOSYRPHUS* FLIES OF NORTH AMERICA (*SYRPHIDAE*)

C. L. Fluke
University of Wisconsin

F. M. Hull
University of Mississippi

This revision is Part III of a study of the genus *Cheilosia* S. L. which was started jointly several years ago. Part I deals with the genus *Cheilosia* sensu stricto and is published elsewhere. A discussion of generic synonomy is included in Part I. The second part appeared in the last volume of these Transactions and covered the subgenus *Chilomyia* Shannon which Goffe proposes for *Cheilosia* Meigen 1822 nec Panser, 1809. A discussion of this paper is not necessary as the topic is covered fully by Goffe.

The authors treat only of *Cartosyrphus* Bigot sensu stricto in this paper, excluding the group with plumose arista, which was designated *Hiatomyia* Shannon, genotype *willistoni* Snow by Shannon, 1922. We are not particularly concerned whether *Cartosyrphus* is considered a genus or sub-genus but for consistency in our series of papers it is recognized here with sub-generic rank.

We have had access to numerous collections for our revision but have had relatively few specimens from Mexico, thus our studies deal mostly with representatives from the United States and Canada. Many of the types have been seen and we wish to take this opportunity to thank all who have been of assistance. Special thanks are due to Dr. C. H. Curran of the American Museum, Dr. R. H. Beamer of the University of Kansas, Dr. Nathan Banks of the Museum of Comparative Zoology, Dr. S. A. Scullen of the Oregon Agricultural College, Mr. Kenneth MacArthur of the Milwaukee Public Museum, and Mr. R. R. Dreisbach of Midland, Michigan.

Cartosyrphus Bigot sensu stricto

Ann. Soc. Ent. France (6) 3:230, 1883.
Shannon, 1922, Insec. Insci. Mens. 10:127.
Goffe, 1944, Ent. Mont. Mag. 80:238.

Figures 1 and 2

Eyes bare; face with a prominent tubercle; face usually bare of long pile, as distinct from the short pubescence, although pile is present in a few forms; antennal pits usually confluent, but separated by a distinct chitinous extension of the frontal lunule in three known American species; arista bare or very short pubescent; scutellum may or may not have apical bristles but with abundant ventral fringe; anterior cross-vein placed well before the middle of the discal cell; abdomen black, the sides curled under. Genotype *Syrphus paganus* Meig., 1822.

This characterization eliminates species of *Cheilosia* with hairy eyes and those bare-eyed species with a long plumose arista.

Unlike the other sub-genera of *Cheilosia,* this one is well represented in the eastern states. About a dozen species occur east of the Mississippi River and seven or eight of these are restricted to the east.

The flies of *Cartosyrphus* fall into five groups based upon the principal characters used in the keys. They are as follows:

(1) **Antennal pits separated by a chitinous ridge**
pulchripes, platycera, wisconsinensis

(2) **Slopes of face pilose**
sialia, sialia var. *argentipila* n. var.,
sialia var. *alpinensis* n. var.

(3) **Legs and antennae entirely black**
lucta, laevis

(4) **Black bristles on the scutellum**
sialia, laevis, lucta, shannoni, wisconsinensis, pulchripes, platycera, sororcula, tristis, leucoparea, pallipes, megatarsa

(5) **With enlarged hind metatarsi**
shannoni, megatarsa

The flies of this sub-genus are small, ranging from 5 or 6 mm. to 10 mm. in length. They offer very few distinguishing characters, thus considerable reliance must be placed upon the color of the pile in placing them in the keys. The facial tubercle is a good character but difficult to express in words. The beginning student should have his determinations verified and then study carefully the shape and size of the tubercle. In this way he will be able to recognize the species more readily. The color of the legs is quite variable within species and teneral specimens will often lead one astray. Soft, poorly matured material is of very little value and any determinations of such forms are unreliable.

The authors have been working on these flies for several years and even yet are not fully satisfied in every respect regarding their conclusions. More study is needed but only after abundant collecting and proper association of sexes. Early spring collecting is the best time to find them although a few occur later in the season. They are most numerous near wooded areas and along streams where spring flowers, especially willow catkins, plum blossoms, and dandelions are in bloom.

KEY TO THE MALES OF *Cartosyrphus*

1. Slopes of face pilose.. 2
   Face without long pile except on side strips...................... 4
2. Pleural pile black, squamae brownish (Western)..................
   .... *sialia* var. *alpinensis* n. var.
   Pleural pile pale, at most only a few hairs black; squamae yellow 3
3. Smaller species 5.5 to 6.5 mm. (Wisconsin)
   .... *sialia*, var. *argentipila* n. var.
   Larger species 7 to 8 mm. (Canada, Michigan, New York)
   .... *sialia* Shan.
4. Legs and antennae wholly black.................................. 5
   At least the base of the tibiae yellowish or reddish................ 6
5. Squamae white ciliate (Northwestern)............... *laevis* Bigot
   Squamae blackish ciliate (Colorado, New Mexico)...... *lucta* Snow
6. Margin of scutellum with evident bristles with or without long hairs, bristles usually black..................................... 7
   Margin of scutellum with only delicate long hairs, although they may be black.. 15
7. Hind metatarsi unusually thickened, greater than girth of hind tibiae (side view); arista pubescent; upper mesopleural pile golden or brassy, squamal fringe brownish (Eastern)
   .... *shannoni* Curran
   Hind metatarsi slender, no larger than hind tibiae; arista pubescent or bare, squamal fringe usually pale yellow..................... 8
8. Antennal pits separated by a chitinous extension of the frontal lunule, arista nearly bare..................................... 9
   Antennal pits confluent, not completely separated................. 11

9. Third segment of antennae one and three-fourths as long as broad, four front tibiae yellow, separation of antennal pits longer than wide.................................*wisconsinensis* n. sp.

   Third segment of antennae little longer than broad, four front tibiae darkened, separation of pits as broad as long............. 10

10. Face evenly but deeply concave, pile of fourth tergite largely black (Western)..................................*pulchripes* Loew

    Face nearly straight from antennae to base of tubercle, pile of fourth tergite usually largely yellow (Alaska)....*platycera* Hine

11. Pteropleural and usually the mesopleural pile predominately black, anterior coxae dark brown to black, humeri nearly always black, mesonotal pile pale or black................................ 12

    Mesopleural and pteropleural pile usually pale in color except for the few black hairs on the upper edge, anterior coxae brownish yellow, pile in the center of the mesonotum pale yellow often mixed with black hairs.................................. 13

12. Blue black flies, mesonotal pile pale (Southwestern States) ....*sororcula* Will.

    Black flies, mesonotal pile mostly black (Canada, Northern States) ....*tristis* Loew

13. Hind tarsi black or dark brown, pile on the sides of the abdomen and under the scutellum white, dark blue-black species (Southwestern States)..............................*sororcula* Will.

    Second to fourth segments of hind tarsi yellow, pile on sides of abdomen and fringe of scutellum yellowish; black, aeneous, or brassy-black flies.. 14

14. Scutellar discal pile all pale yellow, upper oral edge and apex of tubercle equally distant from eye margins, hind femora usually wholly black (Southeastern States)............*leucoparea* Loew

    Scutellar discal pile usually black and yellow mixed, tubercle closer to eye margins than upper oral edge, hind femora frequently yellow basally..............................*pallipes* Loew

15. Front nearly bare (Nebraska)..................*laevifrons* Jones

    Front long pilose.. 16

16. Pile of front yellowish, white or silvery......................... 17

    Pile of front black.. 19

17. Basal edge of costa with conspicuous long black bristles, tibiae generally without a conspicuous dark ring (Southeastern States) ....*capillata* Loew

    Costa with the usual very short black or pale bristles, tibiae with definite black ring, smaller species............................ 18

18. Pile of tibiae and basal segments of tarsi white, tubercle of face inconspicuous (Eastern).........................*caltha* Shannon

    Pile of tibiae and tarsi largely black, facial tubercle more prominent (Colorado)..............................*brevichaeta* Shannon

19. Upper edge of the third antennal segment straight, occasionally slightly concave; fore tibiae entirely yellow; dorsal pile on the hind metatarsi black (Southeastern)..............*prima* Hunter
    Upper edge of third segment rounded, fore tibiae usually with a dark spot.. 20
20. Large species (10 mm.); shiny, brassy-haired; hind metatarsi entirely yellow haired, tibiae largely yellow with black ring (Northeastern States)................................*slossonae* Shan.
    Small species (7 mm.); shining black, pile more fulvous, hind metatarsi black haired above, tibiae largely black.................... 21
21. Thoracic and abdominal pile fulvous with a stripe of black pile from the humeri to the wings and a few black hairs on the post alar callosities, tarsal segments brownish (Ontario) ....*sensua* Curran
    Thoracic and abdominal pile pale whitish with only a few black hairs on the notopleura, tarsal segments usually reddish (Colorado)..*tarda* Snow

Chilosia frontosa Bigot from Mexico is not included.

Key to the Females of *Cartosyrphus*

1. Slopes of face pilose 2
   Slopes of face bare 4
2. Pile of front and occiput predominantly silvery, black only near the ocelli (Wisconsin).................*sialia* var. *argentipila* n. var.
   Pile of front and occiput predominantly black or brown........... 3
3. Eastern, front with a faint median sulcus.............*sialia* Shan.
   Western, front without a median sulcus (Western States) ....*sialia* var. *alpinensis* n. var.
4. Legs entirely black, antennae dark brown to black, wing veins brown 5
   Legs in part yellowish or reddish, antennae usually yellowish or reddish brown.. 6
5. Pile of the thorax short but erect, of the abdomen also generally erect, pile of the lower half of the front yellow and black mixed, mesopleura with one to three black bristle-like hairs above (Northwestern States)...........................*laevis* Bigot
   Pile of the thorax and posterior segments of the abdomen appressed, pile on lower front all pale, mesopleura pale pilose (Colorado) ....*lucta* Snow
6. Antennal pits separated by a chitinous extension of the frontal lunule, arista nearly bare.. 7
   Antennal pits confluent, not completely separated................. 9
7. Legs largely yellow, mesonotal pile appressed, third segment of antennae elongate.......................*wisconsinensis* n. sp.
   Femora black, tibiae with black ring, mesonotal pile partly erect, antennae oval.. 8

8. Face evenly but deeply concave, pile of fourth tergite partly black on the disc (Western) .... *pulchripes* Loew

   Face nearly straight from antennae to base of tubercle, pile of fourth tergite all pale (Alaska) .... *platycera* Hine

9. Scutellar rim with evident bristles, usually black 10

   Scutellar rim with only slender hairs, either short or long 15

10. Hind metatarsi enlarged, wider than adjacent portion of tibiae; greenish black or black flies 11

    Hind metatarsi slender, no wider in side view than adjacent portion of tibiae 12

11. Face on each side with a rounded yellowish spot; arista moderately pubescent; legs with very little yellow color; hind metatarsi grossly thickened, nearly twice as much as hind tibiae (Colorado) .... *megatarsa* n. sp.

    Face at most only reddish brown on the sides, arista conspicuously pubescent, hind metatarsi thickened but much less so, the four front tarsi except apical segment, yellow or reddish (Eastern) .... *shannoni* Curran

12. Femora and tibiae extensively pale yellow, the fore pair entirely so, scutellum largely yellow, mesonotal pile appressed. .*pallipes* Loew

    Femora extensively black, scutellum at most only narrowly yellow on the rim 13

13. Mesonotal pile white and generally erect, scutellar bristles often pale (Southwestern States) .... *sororcula* Will.

    Mesonotal pile yellow and appressed, scutellar bristles always black 14

14. Third segment of antenna yellow, large, reaching to apex of tubercle (Southeastern States) .... *leucoparea* Loew

    Third segment of antennae usually darkened apically, small, never reaching the apex of tubercle .... *tristis* Loew

15. Costa near base with long black bristle-like hairs, third segment of antenna large with a straight slit on the inner side (Southeastern States) .... *capillata* Loew

    Costa with the bristles either short and black or pale in color, antenna wthout seam 16

16. Third antennal segment very large, several times as large as usual, bright orange-yellow; large species (8 to 11 mm.) 17

    Third segment usual in size, orange colored, small species (6 to 7 mm.) 18

17. All the femora pale yellow, the hind femora occasionally with a small brown cloud near the middle (Southeastern States) .... *prima* Hunter

    Femora black, narrowly yellow at the tip (Northeastern States) .... *slossonae* Shannon

18. Front flattened, not trisulcate (Colorado, Canada) .... *comosa* Loew

    Front with a median fine furrow in addition to the usual side furrows 19

19. Pile on the outer sides of the hind tibiae largely black; pale areas of legs reddish (Colorado) .... *brevichaeta* Shan.
    Pile on the hind tibiae pale, pale areas of legs yellowish (Central States) .... *caltha* *Shannon*

Cheilosia (Cartosyrphus) sialia Shannon

Insec. Insci. Menst. 10:132, Oct. 1922.
Chilosia rita Curran, May 1922, Can. Ent. 54:71
(preoccupied, by *rita* Curran p. 70) ; Can. Ent. 59:74.

Figures 7, 20 and 21

Sides of the face pilose; squamae yellow; pile of the mesonotum black, of the pleura generally pale; Length 7 to 8 mm.

MALE:—Face and front shining black, lightly silvery pubescent with a heavier coating beneath the antennae; slopes of the face with white pile, occasionally a few black hairs present; pile of front, ocellar triangle, and upper occiput black; pile of the cheeks and lower occiput white. Facial tubercle prominent with a deep concavity above, strips of average width, shining, orange colored, somewhat darkened apically on some specimens; arista black, thickened basally, microscopically pubescent.

Thorax:—Shining black, the mesonotum with brownish pollen on the anterior half, pile all black, longer and somewhat bristly along the sides. Pile of the pleura and humeri white, a few black hairs on the upper edge of the mesopleura. Pile of the scutellum long and black, longer and bristle-like on the rim, the fringe long and white.

Legs:—Black; apex of the femora, basal third and narrower apex of the tibiae, and the basal two or three segments of the tarsi yellowish brown, the pile mostly pale on the femora and tibiae, black on the inner sides of the hind tibiae; a circlet of black bristles at the apex of the mid tibiae. Wings luteous, the veins yellow to light brown; squamae and plumule pale yellow; halteres yellow with darkened knob.

Abdomen:—Shining black, opaque on the disc of the first two tergites and on the posterior edge of the third. Pile all erect, pale with a few black hairs in the middle and on the posterior edges of the second and third tergites.

FEMALE:—Curran has given a full description of the female. The only points that need be added here are that the arista is microscopically pubescent, front often (usually?) with a faint median sulcus and dominantly black pile, pile of mesonotum appressed and pile of the mid and hind tibiae largely black.

Distribution:—NEW BRUNSWICK—type male (In U. S. N. Mus.) and ONTARIO, type female as *rita* Curran (in Ontario Museum, Toronto).

Material reviewed:—Type male; MICHIGAN—Jackson, 1 male May 2, 1925 (E. G. Anderson); Mecosta County, 1 female May 30, 1940 (Dreisbach); Oseola County, 1 pair May 11 and 25, 1940 and 1941 (Dreisbach); Otsego County, 1 male April 26, 1941 (Dreisbach). NEW YORK—Cayuga Lake, 1 male May 8, 1935 (Townes). WISCONSIN—Madison, 1 male May 11, 1926 (Fluke). ALBERTA—Wabamun, 1 female June 27, 1936 (Strickland). ONTARIO—Lake Abitibi, 1 female June 18, 1925 (Bigelow). QUEBEC—Hull, 1 female April 26, 1923 (Osburn); Megantic, 1 female June 20, 1923 (Curran).

This species would be very easy to place because of the hairy face if it were not for the variations that occur in other sections of the country. The eastern forms are generally paler, the high altitude western forms extremely dark including the squamae. Since there appears to be a gradual gradation of forms from east to west we are naming the two forms below as new varieties, both of which may prove to be distinct species.

Cheilosia (Cartosyrphus) sialia var. *alpinensis* n. var.

Figure 2

Mesonotal and pleural pile black and the squamae brownish fringed on the male; females practically indistinguishable from typical *sialia*. Length 7 to 8 mm.

MALE:—Head shining black the slopes of the face with sparse long white pile with several black ones below; the front sparsely pubescent and relatively long black pilose, with a median deep sulcus; facial strips very narrow with short white pile. Facial tubercle prominent. Vertical triangle shining with long black pile, cilia long and all black. First two segments of the antennae brown, the third orange with darker tip and upper edge, arista black, basally thickened; micropubescent.

Thorax:—Shining black, the pile long and all black, bristle-like along the sides and on the rim of the scutellum yellow.

Legs:—Dark brown to black; the apices of all the femora, basal two-fifths of all the tibiae and their narrow apices, and basal two segments of the four front tarsi yellowish brown, all rather diffuse. Hind femora ventrally black pilose except for a few pale hairs at the base, otherwise pale pilose except the apex which is black pilose; pile of the other femora quite similarly colored; pile of the tibiae black, pale on the inner surface.

Wings:—Pale brown, the stigma yellow; subapical cross-vein extremely long, joining the third vein at an acute angle. Squamae dull yellowish brown, the border and fringe darker; plumule yellowish, halteres black.

Abdomen:—Oval, shining black with a bluish cast, broadly opaque on the second tergite and on the middle of the third. Pile erect, pale basally, becoming mostly black posteriorly. Ventral pile pale.

FEMALE:—Similar to the male; facial pile sparse and all pale; third segment of antenna larger and generally more yellowish orange; front long, no definite median sulcus but with a prominent transverse depression above the antennae with a median depression reaching forward to the antennae; pile black with shorter white hairs towards the antennae; mesonotal pile extremely short and appressed, all black; pleural pile pale; scutellar pile pale and black intermixed, appressed, the rim with two pairs of short black bristles and two other pairs of still shorter lateral ones; squamae whitish. Abdominal pile is short, appressed except in the basal corners of the tergites, shining black with bluish cast.

Holotype:—Male, Granite Peaks Camp, Bayfield, Colorado, July 1928, 9,000 ft. elevation (J. Bequaert).

Allotype:—Female same data.

Paratypes:—One male Hood River, Oregon, May 19, 1917 (F. R. Cole); one male Electron, Wash., June 26, 1933 (J. Wilcox); one female same data as holotype. Holotype and allotype in Hull collection, paratypes in Oregon State and Fluke collections.

The female is very difficult to separate from *sialia*. The specimens before us have a narrowing front above and with no trace of a median sulcus, *sialia* has a very shallow median furrow and the front is also somewhat wider. The males are amply distinct, told principally by the black pile of the pleura and darkened squamae.

Cheilosia (Cartosyrphus) sialia var. *argentipila* n. var.

Figure 6

Smaller than typical *sialia* (5.5 to 6.5 mm.), pile of the mesonotum of the male more brownish with a few whitish hairs intermixed especially on the anterior disc.

FEMALE:—Pile of front largely pale, black only near the ocelli; on the mesonotum also yellowish but difficult to distinguish due to its extremely appressed condition; no black bristles on the mesopleura, pile of the hind tibiae and tarsi yellow. The front of the female is similar to the females of *sialia,* that is wider than variety *alpinensis* and with a faint median sulcus.

Holotype:—Female Madison, Wis. May 30, 1924, (Fluke).

Allotype:—Male same place May 10, 1926.

Paratypes:—One male same place May 17, 1926 and one female same place May 11, 1922.

Cheilosia (Cartosyrphus) pulchripes Loew*

Chilosia pulchripes Loew, 1857, Verh. Zool. Bot. Ges. 7:597.

Figure 22

Antennal pits separated, face strongly concave, facial strips narrow, pile on fourth tergite of female black on the disc. Length 6.5 to 7 mm.

FEMALE:—Face shining black, almost devoid of any pollen-like pubescence except beneath antennae, the tubercle prominent and sloping above into a deep concavity. Cheeks shining with white pile. Facial strips quite narrow, nearly bare with short fine white pile. Front shining with shallow side furrows, the pile black with a few yellowish hairs, the frontal lunule and a transverse depression above shining; the inner arms of the lunule extend between the antennae to separate the antennal pits, this separation is about twice as wide as on *wisconsinensis.* Antennae yellowish orange, the third segment enormous, reaching to the apex of the tubercle, longer than broad; arista brown, practically bare. Ocellar triangle black pilose, the occipital pile yellow with a few black cilia.

Thorax and *Scutellum:*—Shining black, the pile all short and yellow with black bristles on the upper edge of the mesopleura,

* Kertesz lists this species as a synonym of *pagana* Mg.

notopleura, calli, above wing base, and on the rim of the scutellum, although these latter are not many and they are relatively short.

Legs:—Yellow; the femora except the apex, an apical ring on the hind tibiae, the hind metatarsi, and the apical segment of all the tarsi dark brown.

Wings:—Yellowish, the plumule and halteres white.

Abdomen:—Shining black, the pile yellowish along the sides, black and somewhat appressed on the disc of the fourth tergite.

The above description made from a female from Welzheimer —Wald, Germany. Two females from Alberta, Canada are identical although the legs are slightly darker and in one the pile on the fourth tergite is mostly pale.

MALE:—The specimen before us also from Germany lacks the head and most of the dorsum of the thorax. The legs are quite similar to those of the female but there is evidence of black pile along the sides of the mesonotum. The pile down the middle of the abdomen is also black.

Coquillett recorded this species from Alaska but Shannon stated that this reference was to an undescribed species which he named *kincaidi*. The two are very similar but definitely different. We have however two females before us from Alberta that do not differ in any respects from the European forms.

Distribution:—EUROPE.

Material reviewed:—GERMANY—A pair. ALBERTA—Edmonton, 1 female June 1, 1934 and 1 female May 29, 1926 (Strickland).

Recorded by others:—Alberta, British Columbia (Osburn).

Cheilosia (Cartosyrphus) platycera Hine

Chilosia platycera Hine, 1922 (March), Ohio Jour. Sci. 22:143.

Cartosyrphus kincaidi Shannon 1922 (July), Insec. Insci. Menst. 10:142.

Figures 23 and 24

Closely related to *pulchripes* Lw. Distinguished principally by the shape of the face which is very little concave between the upper base of the tubercle and the antennae. The antennae are slightly rounder, the legs are darker, and the mesonotum is more shaggy haired with relatively few black hairs except along the sides. European specimens of *pulchripes* apparently vary considerably as to color of pile and color of legs and if it were not for the less concave face we would consider the two identical, especially in view of the Alberta specimens which we consider typical *pulchripes*. We have before us one of the Harriman Alaska specimens and we have also examined the types of both American species and can find no differences that appear to be specific.

Distribution:—ALASKA (Type in Ohio State Museum).

Material reviewed:—ALASKA—Type; Kukak Bay, 1 male July 1, 1899 (Kincaid); Mt. Taveloq, 1 male June 7, 1913 (Kuske); Seward, 2 males and 2 females June 21, 1937 (Phillip).

Cheilosia (Cartosyrphus) wisconsinensis n. sp.

Figures 12, 25, 26, 27 and 28

Antennae yellow, the third segment elongated, about one and three-quarters longer than wide. Pile of the front mostly white, of the mesonotum erect and yellowish-white, appressed on the female; bristles of the scutellum long and black. Length 8.5 mm.

MALE:—Face with a moderate tubercle gently excavated above and rather sharply excavated below; the oral angles slightly protruding below; white pubescent below the antennae and very lightly dusted over the rest of the face. Front whitish pubescent with predominately black pile, a few white hairs intermixed. Ocellar triangle semi-shining, the pile largely black, the cilia sparse, partly black and partly white; cheeks next to the eyes heavily white pollinose, the pile all white. Antennae yellow; the first segment slightly darker; third segment elongate; the arista reddish-brown and very short pubescent, thickened on the basal third. Antennal pits narrowly but distinctly separated; in this respect related to *platycera* Hine.

Thorax:—Mesonotum shining blue-black with erect white pile, a strong black bristle and four or five black hairs on the notopleura; about four black bristles just above the wing base and two on the callus; scutellar pile long and all white, the rim with about four pairs of black bristles; fringe yellowish-white. Scutellum slightly rugose near the apex. Pleura shining with pale pile and two black bristles on the upper mesopleura.

Legs:—Mostly yellow with the following black areas: coxae, all but the narrow base and apical third of the femora, a median ring on the hind tibiae, the hind metatarsi, and the apical segment of all tarsi. Pile of the legs rather sparse and mostly white, strong black setulae on the under sides of the hind femora, middle tarsi and a few on the outside of the hind tibiae.

Wings:—Hyaline, the veins and stigma yellow; squamae and plumule white, the halteres yellow.

Abdomen:—Shining black with long, erect white pile along the sides becoming darker and shorter down the middle.

FEMALE:—Dissimilar; face reddish over the tubercle and on the sides; front quite narrow, no median sulcus, the pile appressed and all pale; occipital pile pale; third segment of antennae slightly larger than on the male but similarly shaped and entirely yellow.

Thorax:—Shining black, the pile rather long but appressed and pale on the mesonotum and scutellum, the latter with marginal black bristles although they are all broken off except one; one strong black bristle on the mesopleura, one on the notopleura, two or three above the wing base and two on the calli.

Legs:—Generally yellow, the tibiae entirely so, the femora may be brownish on well-matured specimens but are only very little darkened on the allotype; hind metatarsi and the apical segment of the other tarsi brownish. Wings yellowish, the veins yellow.

Abdomen:—Entirely shining black with a brassy tint; the pile all white and generally appressed except along the sides.

Holotype:—Male, Madison, Wisconsin May 20, 1925 (Fluke).

Allotype:—Female, Milwaukee, Wisconsin June 20, 1908.

Paratypes:—One male Columbus, Wisconsin, May 27, 1926 (Fluke) and one crippled male (lacks head) Columbus, Wisconsin, June 15, 1924 (Fluke), one male Milwaukee, Wisconsin, May 31, 1909. Allotype female and last named paratype male in the Milwaukee Public Museum. Holotype in the American Museum.

This species is quite distinct with its elongate yellow antennae. The frontal and ocellar pile on the male from Columbus is all white except for a few black hairs, on the other two males it is dominantly black. We believe this female belongs with the males because of the similarity of the antennae and divided antennal pits, even though the facial tubercle is more prominent on the females.

Cheilosia (Cartosyrphus) laevis Bigot

Chilosia laevis Bigot, 1883, Ann. Soc. Ent. France, No. 32, part 23, p. 553.

Figures 8 and 29

Antennae and legs entirely black, squamae yellow, mesonotal pile of female short, mostly white and erect. Length 7 mm.

MALE:—Face shining black, with fine pollen-like grey pubescence, thicker below the antennae; pile of the strips short and pale. Front shining, lightly pubescent, the pile black. Ocellar and occipital pile long and black. Antennae small, dark brown to black, the third segment almost obtuse at the end; arista brown, noticeably pubescent.

Thorax:—Mesonotum shining black with rather strong black and white pile intermixed, longer and blacker on the sides; on the scutellum quite similar, the rim with many long bristly-like hairs. Pleura shining, the upper edge with black pile becoming pale below. Legs dark brown to black, the pile mostly black, paler at the bases of the femora. Wings infuscated dark brown, the pile at the base of the costa conspicuous and black. Squamae almost white, the fringe yellowish, halteres brown.

Abdomen:—Shining, semi-opaque down the middle; the pile yellow, shorter and often black down the middle.

FEMALE:—Similar. The frontal pile pale with a few intermixed black hairs; occipital pile largely pale. Mesonotal pile short, erect, and largely pale, with strong black bristles along the side; scutellar pile similar to mesonotum, the rim bristles fewer and shorter. Abdomen more oval, entirely shining.

Distribution:—WASHINGTON (Type in Brit. Museum).

Material reviewed:—Type; COLORADO—Ward, 1 male June 25, 1922 (9300 ft. alt.). OREGON—Bellfouatain, 1 male (Lovett); Alsea Mt., Benton Co., 1 male May 3, 1936 (Scullen). WASHINGTON—Electron, 5 males, 1 female May 7, 1935 (Wilcox); Olympia, 1 female May 3, 1932 (Martin); Puyallop, 1 female May 3, 1932 (Wilcox); Roy, 1 male May 4, 1930; Sumner, 2 males, 3 females April 30, 1930 and May 27, 1933 (Latta).

Recorded by others:—Colorado, Oregon, Washington.

This species is easily recognized by its dark legs and antennae. It resembles closest *lucta* which species however has black ciliate squamae on the male and appressed yellow pile on the mesonotum of the female. On the females of *lucta* before us there are no black bristles on the pteropleura, always present on *laevis*.

Cheilosia (Cartosyrphus) lucta Snow

Chilosia lucta Snow, 1895, Kansas Univ. Quart. 3:228.

Figure 30

Entirely black, including antennae and legs; pile on the mesonotum of the female appressed; squamal fringe of male blackish ciliate, on female yellowish. Length 6 mm.

FEMALE:—Head shining black with pale pile, black around the ocelli; face deeply concave below antennae, giving the tubercle an upturned appearance; facial strips broad with delicate white pile. Antennae velvety black, the third segment round, arista feebly pubescent.

Thorax:—Shining, with short appressed yellowish pile, two black bristles on the notopleura, one on the calli, and usually one or two above the wing. Scutellar edge with a pair of relatively short black bristles and three pairs of shorter pale bristles. Legs wholly black, not even yellowish on the knees. Wings with blackish veins. Halteres and squamae yellowish.

Abdomen:—Shining black, first tergite dulled in the middle, the pile short and pale, appressed on the third and fourth tergites.

Distribution:—COLORADO—Type female Manitou (In University Kansas Collection).

Material reviewed:—COLORADO—(Type), Custer Co., 1 female Aug. 1928, 10,000 ft. elev. (Painter); Lake City, 1 female Aug. 1938, 9,000 ft. elevation (Fluke); Masonville, 1 female July 10, 1938, 6,567 ft. elev. (James). NEW MEXICO—Jemez Springs, 1 female July 1, 1941 (Baemer).

*We have not seen the male but have used the character employed by Shannon of black ciliate squamae. In this respect it differs from *laevis* a very closely related species. Snow's original

* Since the above was written we have examined several males collected at Estes Park, Colo. (Aug. 1946—Fluke). They agree in having the squamae black ciliate.

description does not mention the black bristles on the rim of the scutellum but an examination of the type shows they have been broken off, thus they are characteristic of the species.

Cheilosia (Cartosyrphus) tristis Loew

Chilosia tristis Loew 1863, Centuria, 4:71.
Cartosyrphus longipilosa Wehr. 1922, Univ. Stu. Nebr. 22:25.

Figures 1, 9, 31 and 32

Shining aeneous black, scutellum with long black bristles on the rim, facial slopes without pile. Male: face black, mesonotal pile mostly black, squamal fringe brownish, abdomen semi-opaque. Female: slopes of face with yellowish red spot, pile of mesonotum whitish and appressed, abdomen mostly shining. Length 6 to 8 mm.

MALE:—Face shining black with a dark red cast below the well-rounded tubercle and below on the cheeks; the fine pubescence white and very sparse, thicker on the facial strips and just below the antennae; the fine short pile on the facial strips white, longer on the cheeks. Front and ocellar triangle shining black, the former with a deep median furrow, the pile long and black, the frontal lunule shining yellowish red; the cilia on the upper occiput black, the shorter pile behind and below white. Antennae small, first two segments blackish, the third variable but usually yellowish red or light orange, sometimes brown but never black, very little longer than broad; arista brown with pubescence as long as diameter of arista.

Thorax:—Semi-shining; the mesonotum quite dull with three poorly defined rusty pollinose vittae on the anterior half seen from the side and in front, the pile mostly black, posteriorly often with a few whitish hairs and the black ones may be tipped brownish, usually several longer prescutellar black bristle-like hairs. The humeri black with a rusty patch of pollen on their inner sides. Scutellum shining black with long black hairs and shorter white hairs intermixed, the rim with three or four pairs of long slender black bristles, the fringe long and yellow. Notopleura, calli, and an area just above the wing base with strong black bristles, usually two in each area. Pleura lightly dusted with white pollen, the pile pale below but black on the pteropleura and mesopleura with a few bristles on the hump.

Legs:—Dark brown to black; extreme tips of the femora and tibiae, basal third of the tibiae, and the extreme bases and tips of the tarsal segments reddish to yellowish; northeastern United States examples are usually lighter colored, the reddish areas more extensive and the tarsal segments except the last one often entirely yellow. Pile not conspicuous, usually black but with longer white hairs on the femora basally, the hind femora with many bristle-like hairs on the underside; pile of the front tibiae yellowish below. Wings dilutely tinged brownish, the veins brown. Squamae yellow, the fringe brown although an occasional specimen with yellowish fringe; plumule yellowish white; halteres yellow with darkened knob.

Abdomen:—Shining aeneous black on the first and fourth tergites and broadly on the anterior corners of the second and third tergites, otherwise opaque black; the pile rather long and yellowish to whitish on the shining areas, black and shorter down the middle and at the apex of the fourth tergite. Venter shining, pile on the first two sternites long and white; short, black and appressed on the apical sternites.

FEMALE:—Dissimilar. Facial slopes usually with a distinctive yellow spot between the oral opening and the eyes. Front shining with parallel sides, a pair of white side dust spots, the pile black above the frontal lunule, from there to the ocelli with white pile with black hairs intermixed, often predominately black; cilia usually white with an occasional black hair; third segment of antenna a little larger than on the male. Pile of the mesonotum short and yellowish white, appressed; humeri often reddish, the interhumeral pollinose spots white; without the brownish pollinose vittae on the anterior half. Pile of the scutellum short, appressed and white, the rim bristles long and black, the fringe short and white. The black bristles along the sides of the mesonotum similar to the male but more conspicuous in the background of white pile. Pleural pile white with two black bristles on the upper edge of the mesopleura. Legs usually more extensively yellow, wing veins yellowish toward the base, halteres and squamae yellow. Abdomen more shining, the pile shorter but colored similar to the male.

This description is based upon a long series of specimens from Pingree Park, Colorado which are considered typical. Loew described the species from specimens from the Red River of the

North. We therefore believe these high altitude specimens from Colorado are more typical than the Eastern representatives before us. Specimens of the males from Maine, Massachusetts, and Michigan are paler, often having yellowish hairs on the disc of the mesonotum and there are also some differences in the shape of the facial tubercle; in these respects they closely resemble the male of *pallipes* and even *leucoparea.* A series of six females, three from Red River, New Mexico and three from Lake Nipigon, Ontario have the rim of the scutellum extensively yellow agreeing in this respect with *pallipes* but the legs are dark. Another series of 25 females and nine males from Lake City, Colorado also vary from the others in the shape of the facial tubercle and darker color of the legs, but we do not believe they are sufficiently different to be distinct.

There will occasionally be some confusion in identifying slightly teneral specimens, and it may be possible that this species was originally described from such forms.

Wehr's species represents one of the several varieties that occur in the males. It is somewhat similar to the Eastern specimens mentioned below which have considerable yellowish pile on the disc of the mesonotum. We have examined two of the males of the original series described by Wehr. Unfortunately we have not had an opportunity in recent years to examine Loew's types.

Distribution:—CANADA—Red River of the North (Type, Female in the Museum of Comp. Zoology).

Material reviewed:—ONTARIO—Macdiarmid, Lake Nipigon, 3 females July 28, 1932 (Bigelow); Low Bush, Lake Abitibi, 1 female Aug. 14, 1925 (Bigelow). COLORADO—Cameron Pass, 3 males and 1 female Aug. 1932 and 1941 (Fluke); Cuchara, 9,000 ft. elev., 1 female Aug. 7, 1940 (Snyder); Estes Park, 1 female Aug. 22, 1936; Granite Peaks Camp, 9,000 ft. elev., July, 1928 (J. Bequaert); Lake City, 9,000 ft. elev., 9 males and 34 females Aug. 1936 and 1938 (Fluke); Pingree Park, 9,000 ft. elev., 9 males and 106 females Aug. 1923, 1925, 1932, 1935 (Fluke); Webster, Aug. 1, 1938. MAINE—Bar Harbor, 2 males and 2 females July 10 (C. W. Johnson); Great Pond, Mt. Desert, 1 male July 16, 1918 (C. W. Johnson); Mt. Desert, 3 males and 4 females July (C. W. Johnson); Orrs Island, 2 males July 24 (C. W. Johnson); S. W. Harbor, 1 male July 10, 1918. MASSA-

CHUSETTS—North Adams, 4 males June 20 (C. W. Johnson); Mt. Greylock, 1 male July 13 (C. W. Johnson); Reading, 1 male July 23, 1933 (Dow). MICHIGAN—Cheboygan Co., 1 pair Aug. 15, 1940 (Dreisbach). NEW HAMPSHIRE—Glen House, 11 males and 4 females July 17 to 20 (C. W. Johnson). NEW MEXICO—Red River, 2 females Aug. 14, 1940 (Snyder). OREGON—Breitenbus Hot Springs, 2,222 ft. elev., 1 male July 4, 1931 (Scullen). WASHINGTON—Mt. Rainier, 1 male July 7, 1926. WISCONSIN—Madison, 1 female Aug. 27, 1929 (Fluke); Maher, 1 female Sept. 20, 1930. WYOMING—Centennial, 1 pair July 27, 1935 (Blake) and August 20, 1936 (Fluke).

Recorded by others:—Alaska, British Columbia, New York, and Ohio.

Cheilosia (Cartosyrphus) shannoni Curran

Cartosyrphus similis Shannon, 1916, Proc. Biol. Sci. Wash. 29:196.

Cartosyrphus shannoni Curran, 1927, Can. Ent. 59:73.

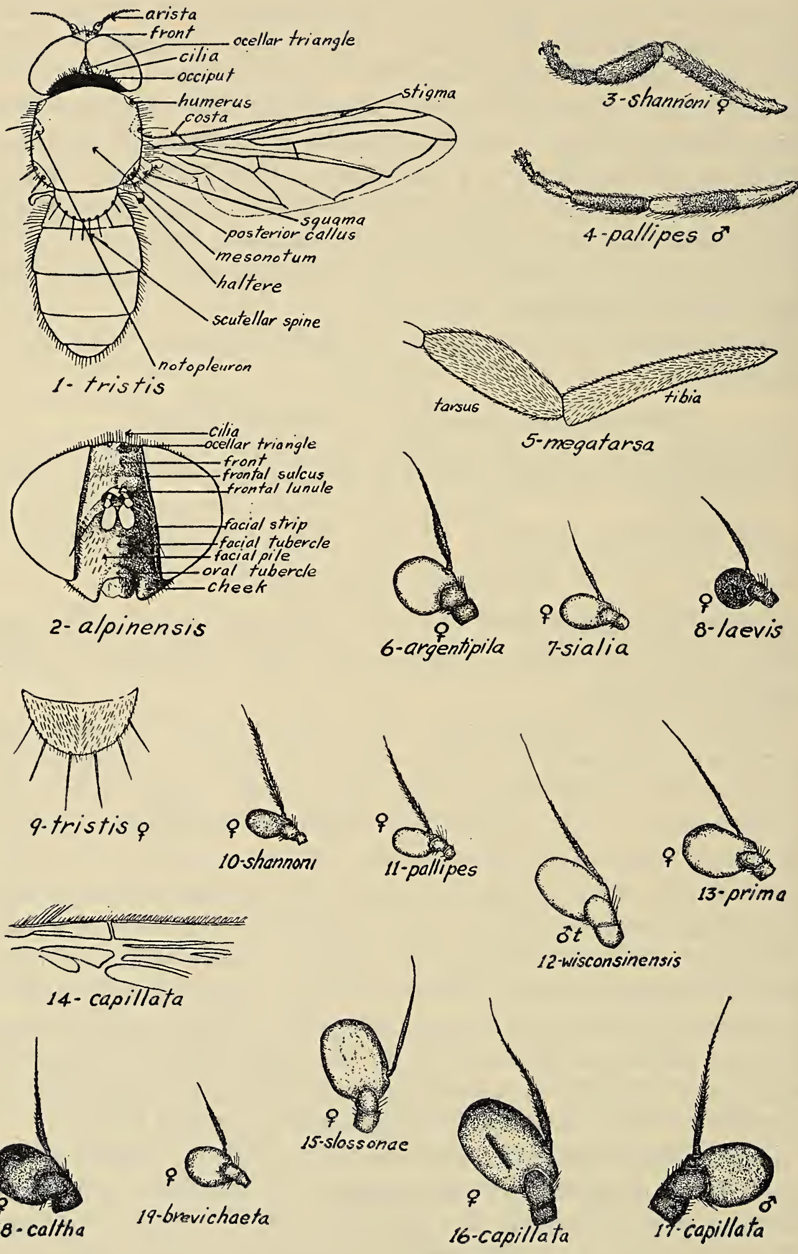
Figures 3, 10 and 35

Recognized principally by the enlarged hind metatarsi, weakly so on the male; squamae of male brownish fringed. Length 7 to 8 mm.

MALE:—Face shining black, the tubercle nasiform with the groove below extending to the side strips; lightly pubescent but not pilose, the pubescence white and much thicker below the antennae and on the side strips which are relatively narrow. Pile of the front and vertex black, on the cheeks yellow. Antennae small, third segment orange, arista black and prominently pubescent, the hairs nearly as long as diameter of arista.

Thorax:—Shining black, the disc of mesonotum in front lightly brownish pollinose; the pile black, somewhat yellowish in the middle of the mesonotum and all yellow on the pleura except for a few black bristle-like hairs on the upper edge of the pteropleura and mesopleura. Scutellum with black pile and shorter brownish hairs intermixed, the rim with long black bristles.

Legs:—Brownish to black; the basal half and narrower tips of the tibiae and basal two segments of the four front tarsi yellowish to reddish; pile mostly black, yellow hairs at the basal half of the femora and generally on the front tibiae. The hind metatarsus considerably enlarged, best seen from a side view.

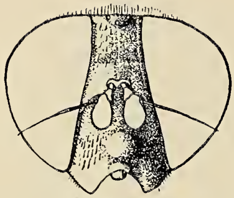

arista
front
ocellar triangle
cilia
occiput
humerus
stigma
costa
squama
posterior callus
mesonotum
haltere
scutellar spine
notopleuron
1- tristis
3-shannoni ♀
4-pallipes ♂
tarsus
tibia
5-megatarsa
cilia
ocellar triangle
front
frontal sulcus
frontal lunule
facial strip
facial tubercle
facial pile
oral tubercle
cheek
2- alpinensis
♀
6-argentipila
♀
7-sialia
♀
8-laevis
9-tristis ♀
♀
10-shannoni
♀
11-pallipes
♂t
12-wisconsinensis
♀
13-prima
14- capillata
♀
15-slossonae
♀
16-capillata
17-capillata ♂
♀
18-caltha
♀
19-brevichaeta

Explanation of Plates

All drawings were made with the aid of the camera lucida except numbers 5 and 34. All head sketches except 34 were made to the same scale. The antennae were made in two different scales: numbers 6, 12, 16, 17 and 18 to one scale and the rest to a slightly smaller scale. Front views of heads were each made at slightly different angles.

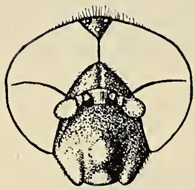
Plate I

Fig. 1. *C. tristis* Lw. dorsal view of male.
Fig. 2. *C. sialia* var. *alpinensis* n. var. front of female.
Fig. 3. *C. shannoni* Cur. hind leg of female.
Fig. 4. *C. pallipes* Lw. hind leg of male.
Fig. 5. *C. megatarsa* n. sp. tibia and meta tarsus of female.
Fig. 6. *C. sialia*, var. *argentipila* n. var. antennae of female.
Fig. 7. *C. sialia* Shan. antenna of female.
Fig. 8. *C. laevis* Big. antenna of female.
Fig. 9. *C. tristis* Lw. scutellum of female.
Fig. 10. *C. shannoni* Cur. antenna of female.
Fig. 11. *C. pallipes* Lw. antenna of female.
Fig. 12. *C. wisconsinensis* n. sp. antenna of male.
Fig. 13. *C. prima* Hunter antenna of female.
Fig. 14. *C. capillata* Lw. basal costal margin of wing.
Fig. 15. *C. slossonae* Shan. antenna of female.
Fig. 16. *C. capillata* Lw. antenna of female.
Fig. 17. *C. capillata* Lw. antenna of male.
Fig. 18. *C. caltha* Shan. antenna of female.
Fig. 19. *C. brevichaeta* Shan. antenna of female.


20-sialia

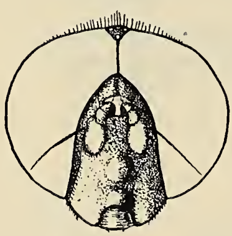

21- sialia

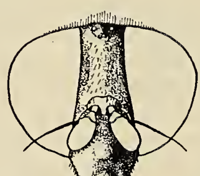

22-pulcripes


23-platycera


24-platycera


25- wisconsinensis

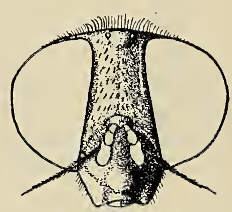

26-wisconsinensis


27-wisconsinensis

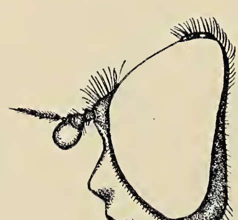

28-wisconsinensis


29-laevis


30-lucta


31-tristis

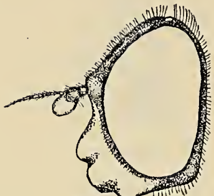

32-tristis


33-sororcula

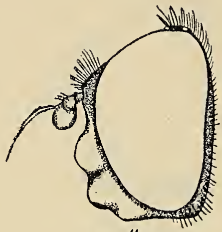

34-megatarsa

PLATE II

Fig. 20. *C. sialia* Shan. front view of head of female.
Fig. 21. *C. sialia* Shan. profile of head of male.
Fig. 22. *C. pulchripes* Lw. profile of head of female.
Fig. 23. *C. platycera* Hine front view of head of male.
Fig. 24. *C. platycera* Hine side view of head of female.
Fig. 25. *C. wisconsinensis* n. sp. profile of head of male.
Fig. 26. *C. wisconsinensis* n. sp. front view of head of male.
Fig. 27. *C. wisconsinensis* n. sp. front view of head of female.
Fig. 28. *C. wisconsinensis* n. sp. profile of head of female.
Fig. 29. *C. laevis* Bigot profile of head of male.
Fig. 30. *C. lucta* Snow profile of head of female.
Fig. 31. *C. tristis* Lw. front view of head of female.
Fig. 32. *C. tristis* Lw. profile of head of male.
Fig. 33. *C. sororcula* Will. profile of head of male.
Fig. 34. *C. megatarsa* n. sp. profile of head of female.



35-shannoni

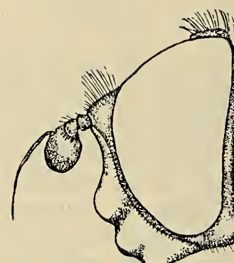


36-pallipes

37-pallipes

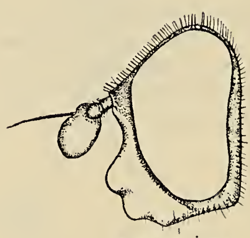
38-leucoparea

39-leucoparea



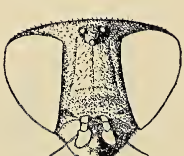
40-slossonae

41-capillata

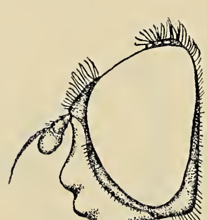


42- prima

43-caltha



44-caltha



45-brevichaeta

46-tarda

PLATE III

Fig. 35. *C. shannoni* Cur. profile of head of female.
Fig. 36. *C. pallipes* Lw. profile of head of male.
Fig. 37. *C. pallipes* Lw. profile of head of female.
Fig. 38. *C. leucoparea* Lw. profile of head of male.
Fig. 39. *C. leucoparea* Lw. profile of head of female.
Fig. 40. *C. slossonae* Shan. profile of head of male.
Fig. 41. *C. capillate* Lw. profile of head of male.
Fig. 42. *C. prima* Hunter profile of head of female.
Fig. 43. *C. caltha* Shan. profile of head of male.
Fig. 44. *C. caltha* Shan. front view of head of female.
Fig. 45. *C. brevichaeta* Shan. profile of head of male.
Fig. 46. *C. tarda* Snow profile of head of male.

In some specimens the enlargement is very little more than the girth of the adjacent tibia.

Wings:—Decidedly tinged with brown, squamae light brownish, the fringe darker, halteres yellowish brown.

Abdomen:—Semi-opaque black, the fourth tergite and anterior corners of the second and third shining; pile yellowish along the sides, black broadly down the middle and more broadly on the tips of the tergites.

FEMALE:—Much paler; pile of front white except near ocelli; on the mesonotum short and white, mostly erect; black bristles along the sides of the thorax. Legs much paler, the tibiae largely yellow. Wings less infuscated, squamae yellow. Abdominal pile shorter and generally pale. Hind metatarsus conspicuously thickened.

Distribution:—Eastern states (Type in the U. S. Natl. Museum).

Material reviewed:—Type; MARYLAND—College Park, 4 males Sept. and Oct. 1930 (J. H. Roberts); East Shore, 1 female Sept. 25, 1930 (Ditman); Prince George County, 2 females July 12, 1917 (Nicolay). MASSACHUSETTS—Holliston, 3 females August (Banks); Southboro, 1 female Sept. 24, 1922 (Frost). MAINE—Southwest Harbor, 1 female Aug. 1923 (C. W. Johnson). MICHIGAN—Livingston Co., 1 female Sept. 3, 1933 (Stykskal). VIRGINIA—Great Falls, 3 females October (Shannon). WISCONSIN—Madison, 1 male and 1 female, Sept. and Aug. (Fluke).

Recorded by others:—New Jersey, New York, Pennsylvania, North Carolina.

This species appears to be most common in the late summer and fall months. It occurs over the entire eastern section of the United States.

Cheilosia (Cartosyrphus) megatarsa n. sp.

Figures 5 and 34

Characterized by the greatly thickened hind metatarsus, small antennae, pubescent arista, appressed pile on the mesonotum, and black bristles on the rim of the scutellum. Length 8 mm.

FEMALE:—Face shining black with a faint brassy cast, the lower slopes with a brownish yellow spot, cheeks brown; pubescence white, rather thick on the lower half of face and cheeks, mid line of face bare; tubercle quite narrowly pointed and prominent, the slope from tubercle to antennae long, slanting, projecting considerably forward from the base of the antennae, concavity below tubercle short and deep. Front polished black with faint brassy reflections, a wedge-shaped sub-triangular yellowish grey pubescent patch along the eye margin, continuing more narrowly nearly to the ocelli; pile chiefly silvery with several black hairs above the antennae and others on the upper part. The vertical pile before and behind the ocelli is black; occipital pile very pale yellow, almost white. Antennae small dark brown, the third segment scarcely lighter colored below and basally; arista dark brown, thickened on the basal third, strongly pubescent.

Thorax:—Mesonotum thickly, quite short, appressed yellowish white pilose; ground color shining black with slight brassy cast. Black bristles on the following areas: Two or three on the notopleura, seven or eight short ones above the wing base, three long and one or two short ones on the post calli, two small ones on the upper edge of the mesopleura, none on the pteropleura. Pile of scutellum similar to mesonotum, the outer edge with two pairs of long stout tuberculate black bristles, the base with two shorter pairs.

Legs:—Dark brown; narrow apex of hind femora, apices of other femora a little more extensively, basal fourth of hind tibiae and narrow apex, basal half and narrow apex of middle tibiae are light brownish in color; all the tarsi are dark brown to black. Pile of the legs inconspicuous, mostly whitish on the hind femora, the usual short black bristles on the ventral apical half are sparse and scattered, reduced to six or seven; hind metatarsus black pilose above and enormously thickened, about twice as thick as the end of the tibiae and nearly two and one half times as thick as the middle of the tibiae. Wings long and slender, pale grey, hyaline, the stigma concolorous; the postical cross vein straight, with a spur; the subapical cross vein long, very gently sinuous, without spur and joining the third vein acutely.

Abdomen:—Black, but little shining, with a very faint coppery or brassy luster; the pile silvery and erect except on a median line; black pilose on posterior triangles of second to fifth tergites, small on second and fifth, larger on intervening tergites.

Holotype:—Female, Chambers Lake, Colorado, Sept. 3, 1922. Type in the Colorado State College Collection, Fort Collins. (Chambers Lake is about 60 miles west of Fort Collins and close to the continental divide, altitude about 9,500 feet.)

Cheilosia (Cartosyrphus) pallipes Loew

Chilosia pallipes Loew, 1863, Centuries. 4:70.
Chilosia pallipes Williston, 1886, Syn. N. Amer. Syrph. 41.
Cartosyrphus pallipes Shannon, 1916, Proc. Biol. Soc. Wash. 29:196.

Figures 4, 11, 36 and 37

MALE:—Face with a broad rounded tubercle forming a transverse depression below that reaches between the facial strips, pubescence of the face moderately well distributed but heavier on the lower slopes, rather heavy just below the antennae; facial strips narrow with white pollen and pile. Front small, particularly bare of pollen, a deep median sulcus, pile black. Ocellar triangle shining black, the pile all black and rather long. The upper occiput thin with black cilia, lower occiput with white pile; cheeks somewhat reddish with white pile. Antennae yellowish brown, the first two segments darker; arista dark with conspicuous pubescence, which is longer than the arista is wide.

Thorax:—Shining black with very little pollen anteriorly, a prominent patch of white pollen just interior from the yellowish humeri; pile all black along the sides becoming paler towards the middle; on the disc of the scutellum with long, black hairs and many shorter white hairs, on the rim of the scutellum at least four pairs of long, black bristles but frequently more slender bristles are also present; near the apex the scutellum with one or two shallow depressions; the fringe long and white. Pleura shining, the pile mostly white with some stronger black hairs on the upper edge of the meso and pteropleura.

Legs:—Reddish brown with the following yellow areas: tips of the femora, basal third to one half and the apex of the tibiae, the basal four segments of the four front tarsi and the middle three segments of the hind tarsi. Pile of the femora mostly black but becoming white basally, the hind femora with many bristle-like hairs on the under side; pile of the front tibiae entirely yellow, pile of the hind metatarsi mostly yellow below, black above.

Wings:—Slightly tinged with yellow, the veins brown; squamae white with golden fringe, the plumule white, halteres yellowish brown.

Abdomen:—Shining on the first and fourth tergites and broadly on the anterior corners of the second and third tergites, otherwise opaque black; the pile rather long and white on the shiny areas, black and shorter down the middle and at the apex of the fourth tergite.

FEMALE:—Readily recognized by its extremely pale legs, the four front pair almost entirely yellow; the yellow slopes of the face, yellow humeri, dominately yellow scutellum, and yellow wing veins. From *leucoparea* with which it is related it can be told by the yellow four front femora and smaller antennae. The female of *leucoparea* has very large antennae and the femora are mostly black.

Distribution:—DISTRICT OF COLUMBIA (Type in Museum Comp. Zoology).

Material reviewed:—MAINE—Bar Harbor, 2 males and 3 females July (CWJ); Mt. Desert, 2 males (CWJ). MASSACHUSETTS—Chester, 2 males and 1 female July and August (CWJ); Holliston, 1 female August 3 (H. E. Smith); Lexington, 1 male June 23; Melrose, 1 pair June 16 (H. E. Smith); Sharon, 1 female June 28; Southbridge, 1 female July 8 (CWJ); Stony Brook Res., 1 female June 21, 1925; Williamsburg, 1 female Aug. 7 (CWJ). MICHIGAN—Marquette, 1 male 1911 (W. T. Davis); Midland Co., 1 male Aug. 29, 1937 (Dreisbach). MISSISSIPPI—Tishomingo Co., 1 female June, 1940. NEW HAMPSHIRE—Glen House, 2 females July 15 (C. W. Johnson); Franconia, 1 female July 21; Jaffrey, 1 female July 25. NEW JERSEY—Hewitt, 1 male June 18, 1918; Riverton, 1 female Aug. 6, 1920. NEW YORK—Flushing, 1 male May 18, 1918; Keene Valley, Essex Co., 1 male June 14, 1916; Watchogue, 1 male July 21, 1920. NORTH CAROLINA—Franklin, 1 male Mar. 15, 1939 (Hardy); Highlands, 2 males June 29 (Fairchild). TENNESSEE—Smoky Mts., 1 female Sept. 1, 1933 (Fluke). VERMONT—Manchester, 1 pair July 8 (CWJ); Norwich, 2 males July 7 (CWJ); Woodstock, 1 female (A. P. Morse). WASHINGTON—Montesano, 1 female July 23, 1931 (Baemer). WISCONSIN—Madison, 5 males June and July (Fluke); Sturgeon Bay, 3 pairs June and Aug. (Fluke).

Ontario—Lake Nipigon, 1 female Aug. 26, 1923 (Bigelow). Quebec—Montreal, 1 female June 1, 1920; St Anne's, 1 male June 15, 1940.

Recorded by others:—New Hampshire, Washington, Oregon (Williston); New York (Leonard); Ohio (Metcalf); Oregon (Cole and Lovett); Colorado (Jones); British Columbia (Osburn).

The males of this species are difficult to separate from those of *leucoparea* and *tristis.* The pteropleura and mesopleura of *tristis* are mostly black haired, usually pale haired except for the upper edge on *leucoparea* and *pallipes.* The scutellar discal pile is all pale on the single male that we have identified as *leucoparea* and it is usually yellow and black mixed on *pallipes.* It is possible that we have misidentified the male of *leucoparea;* certainly the female, which we feel sure of, is amply distinct. Paler colored males of *pallipes* have the hind femora extensively yellow basally.

Cheilosia (Cartosyrphus) sororcula Williston

Chilosia sororcula Williston, 1891, Biol. Cent. Amer. 3:9.

Figure 33

Dark blue-black species with whitish mesonotal and abdominal pile. Related to *tristis.* Length 7.5 to 8.5 mm.

Male:—Face rather thickly coated with white pubescence, the strips with delicate white pile; tubercle low but broad; front shining, the pile black; vertex with black pile. Antennae orange to brown, third segment very little longer than broad, arista brown and pubescent.

Thorax:—Shining with long white pile, black along the sides and narrow bands anteriorly and in front of the scutellum; the latter with black pile and much shorter white pile intermixed; scutellar rim with long black bristles, the fringe white. Pleural pile white with a prominent patch of black hairs on the upper half of the pteropleura and sometimes on the mesopleura.

Legs:—Black; the basal third or half and narrower apex of the tibiae and the basal two or three segments of the four front tarsi yellow to reddish; the long pile largely white. Wings dilutely infuscated, the stigma yellowish brown; squamae white with yellow fringe; halteres yellow.

Abdomen:—Shining blue black, opaque on the disc of the second tergite and a broad hourglass-shaped spot on the third; the pile all white except on the apex of the fourth tergite where it is black and appressed.

FEMALE:—Paler; the front broad without a median sulcus, pile white, black near ocelli; mesonotal pile generally erect and all white except for a few black bristles along the sides; pleural pile all white; scutellar bristles may often be yellow, sometimes black. Legs more extensively pale; abdomen more shining and with shorter pile.

Distribution:—MEXICO (Type in British Museum).

Material reviewed:—ARIZONA—Mt. Lemon, Catalina Mts., 15 males and 6 females July 27 at 6,000 ft. (J. Bequaert) and Feb. 29, 1917 at 8,000 ft.; 1 male July 22, 1942 (Scullen); Post Creek Co., Pinalen Mts., Fort Grant, 1 female July 15, 1917 (J. Bequaert). COLORADO—Granite Peaks Camp, 9,000 ft., 2 males July 28 (J. Bequaert). NEW MEXICO—Magdalena Mts., 4 males August 1894 (Snow); Santa Fe, 9,200 ft., 1 female July 27, 1932.

Recorded by others:—Oregon (Lovett), Colorado (Jones), New Mexico (Snow), and Wisconsin (Graenicher—error).

The general blue-black color and white pile with the low tubercle will distinguish this species from its nearest relatives.

Cheilosia (Cartosyrphus) leucoparea Loew

Chilosia leucoparea Loew, 1863, Centuries, 4:69.

Figures 38 and 39

Scutellum with strong black bristles; lower slopes of face, the humeri and the rim of the scutellum yellowish on the female, only slightly so on the male. Length 7 to 8 mm.

MALE:—Head; face black, lower slopes usually reddish, lightly dusted with white pubescence which is prominent beneath the antennae; the tubercle large and very broad reaching the narrow side strips. Front small with long black pile so distributed that a central area is bare; the median sulcus distinct. Ocellar triangle black pilose; occiput very narrow, the upper cilia black. Cheeks reddish brown with sparse white pile. Antennae small; the third segment longer than broad, yellow, the basal segments somewhat darker; arista black, brownish pubescent. Thorax shining brassy, the notopleura, almost all the humeri, a confluent band across the anterior part of the mesonotum, and the posterior margin of mesonotum black pilose; rest of the pile yellowish brown. Notopleura with two or three strong black bristles, the posterior calli with two, and usually two more just above the wing base. Pleura with pale pile, a few black hairs on the upper edge of the mesopleura and pteropleura. Scutellum shining black with long pale yellow pile, a few fine black hairs intermixed; rim with four or five hairs of long black bristles with shorter pairs basally; fringe long and brassy. Legs black to dark brown with the following areas yellow: All the extreme bases of the femora, more widely apices of the femora, basal halves and apical fourth of the tibiae, all the tarsi except the apical segment and the hind metatarsus. Pile mostly yellow with black hairs intermixed; conspicuously short, stubby and black below on the hind femora. Wings hyaline, the veins brown, false vein and stigma yellow, squamae yellow to white, the fringe slightly brownish; halteres yellow.

Abdomen:—Opaque black, the first tergite, large basal spots, and the entire fourth shining with a brassy reflection. The pile yellow, long, with shorter somewhat appressed black pile on the disc of the third and fourth tergites and some longer black hairs at the apex of the fourth; pile mostly black on the genitalia.

FEMALE:—Dissimilar; the antennae much larger but of the same shape and color; lower slopes of the face yellow; pile of the front silvery with a few black hairs just above the antennae and around the ocelli. Arista briefly pubescent, less than on the male. Pile of the mesonotum short, pale, and appressed; one black bristle on the notopleura, one on the calli, and a patch just above the wing base. The humeri and broad rim of the scutellum yellow, apical two segments of all tarsi black. Abdomen mostly short pilose which is black and appressed except on the sides of the second segment where it is erect and brownish.

Distribution:—CAROLINA (Type in Museum Comp. Zoology).

Material reviewed:—GEORGIA—Yonah Mt., 1 male June 10, 1936 (P. W. Fattig). NORTH CAROLINA—Valley of Black Mts., 1 male July 17, 1906 (Beutenmuller). TENNESSEE—Smoky Mts., 1 female Sept. 1, 1933 (Fluke).

This species is not common and apparently has not been generally recognized except in the female. For this reason we present a rather detailed description of the male. The male will be told with difficulty from *pallipes* Lw.

Cheilosia (Cartosyrphus) capillata Loew

Chilosia capillata Loew, 1863, Centuries, 4:65.
Cartosyrphus lamprurus Bigot, 1884, Ann. Soc. Ent. France, 552.

Figures 14, 16, 17 and 41

A relatively large shining black species with rather abundant yellowish pile; pile of the front in both sexes white; scutellum without bristles although the female may have two slightly longer bristle-like hairs near the apex. Length 9 to 10 mm.

This species is easy to recognize by the long black setose hairs on the costa at the base and the longer hairs as far as the stigma. The abdomen of the male is brownish opaque on the posterior margins of tergites two and three, also somewhat dulled on the disc, otherwise shining with all yellow pile. Mesonotum shining, slightly punctate, pile long and abundant, yellow, with a few black bristles on the sides just above the wing base. Legs black, the tibiae and all but the apical two or three tarsal segments yellow, hind metatarsus and a ring on the hind tibiae of the male dark; pile of legs nearly all yellow. Third segment of the antennae of the female with a deep longitudinal seam on the inner surface.

Distribution:—DISTRICT OF COLUMBIA (Type, in Museum Comp. Zoology).

Material reviewed:—MARYLAND—Garrett Co., 1 female June 6, 1931 (Roberts). PENNSYLVANIA—Heckton Mills, 1 male May 5, 1911 (Kirk); Dauphin, 1 female May 25 (Champlain & Knull). VIRGINIA—1 male.

Recorded by others:—OHIO (Metcalf).

Cheilosia (Cartosyrphus) laevifrons Jones

Chilosia laevifrons Jones, 1907, Jour. N. Y. Ent. Soc. 15:90.

Front with very short, sparse, yellowish pile, arista finely pubescent, mesonotum covered with long yellowish pile, scutellum without bristles, abdomen yellowish pilose. Length 7.65 mm.

We have not seen this species. It was described from a single male taken at Roca, NEBRASKA. Apparently it is related to *brevichaeta* Shannon but that species has abundant long yellowish pile on the front.

Cheilosia (Cartosyrphus) slossonae Shannon

Insec. Insci. Menst. 10:144 (Oct. 1922).
Chilosia rita Curran (Printer's error) Can. Ent. 54:70 (May 1922).
Chilosia ontario Curran, Can. Ent. 54:191 (Nov. 1922).
Chilosia ontario Curran, Can. Ent. 59:73 (1927).

Figures 15 and 40

A large brassy-haired species closely related to *prima* Hunter. General color shining black with aeneous cast, tibiae yellow with indefinite dark streaks, third segment of antenna rounded on dorsal edge. Length 8.5 to 10 mm.

MALE:—Face shining black, very lightly dusted, heavier beneath the antennae; side strips shining dark brown with short white pile. Cheeks shining with pale sparse pile. Front sulcate, punctate except for a depressed smooth triangle just above the frontal lunule, pile black. Ocellar triangle shining with black pile, shorter and yellow behind, the cilia all black. Antennae large, the third segment longer than broad and well rounded apically above; yellowish red, darker on the apex and above; arista brown, bare.

Thorax and Scutellum:—Shining black with a slight aeneous cast, the pile long and yellow, with dominately black hairs on the notopleura and several above the wing base, on the calli, upper edge of the pteropleura and mesopleura. The scutellar pile is all yellow on all the specimens before us except for one male from Madison which has three pairs of slender black bristles on the rim. Legs black with following parts yellow: tips of the femora, the tibiae except for elongate spots on the outside, the hind metatarsi, and the apical segment of each tarsus. Wings hyaline, the stigma and veins yellowish. Squamae and plumule yellowish white, halteres darker.

Abdomen:—Shining with a greenish cast, sub-opaque on the second and third tergites except on the sides and down the middle of the latter; pile all yellowish, a few black hairs on the apex of the fourth tergite and genitalia.

FEMALE:—Similar, the antennae larger, the pile all yellow and shorter, yellow of legs more pronounced, no dark spot on the tibiae; pile on the front entirely yellow.

Distribution:—New Hampshire (Types in U. S. Natl. Museum).

Material reviewed:—Quebec—Newwago, 1 female June 25, 1916. New Brunswick—Fredericton, 1 female June 3, 1931 (Maxwell). Wisconsin—Madison, 6 males and 17 females April and May (Fluke).

Recorded by others:—Ontario (Curran's type), New York (Leonard).

We agree with Curran that the few black hairs on the scutellum that occur on some specimens are only a variation; we can see no other differences. This species, however, is very close to *prima,* differing only in the more rounded third antennal segment, shorter pile on the mesonotum of the male, and paler legs. There is a difference in the shape of the facial tubercle but difficult to describe. Typical representatives of *prima* occur in the Southeastern States, of *slossonae* in the Northeastern States.

We regret that it is necessary to use Shannon's name, but to use *rita* for either of Curran's species would cause confusion.

Cheilosia (Cartosyrphus) prima Hunter

Chilosia prima Hunter, 1896, Can. Ent. 28:92.

Figures 13 and 42

Very similar to *slossonae* Shannon. The males differ principally in the shape of the antennae, the third segment of which is straight on its dorsal edge, in fact almost concave in some specimens; the female is amply distinct with the legs all yellow except the hind metatarsi which are brown. In two female specimens before us from Florida and Georgia the hind femora are partly darkened, but typical specimens are all pale. The pile on the mesonotum of the male is slightly shorter than on *slossonae,* and the tibiae are entirely yellow.

Distribution:—Pennsylvania (Type, Location unknown).

Material reviewed:—Florida—Gainesville, 1 pair Feb. 22, 1919 (Fattig). Georgia—Atlanta, 3 females June, 1933, 1934, 1941 (Fattig); Stone Mt., 1 male Apr. 19, 1931 (Fattig). Maryland—Prince Frederick, 2 females Sept. 4, 1931 (Ditman). Mississippi—Oxford, 2 males and 5 females May, 1942 and 1944 (Hull).

Recorded by others:—Wisconsin (error, see *slossonae*).

Cheilosia (Cartosyrphus) caltha Shannon

Cartosyrphus caltha Shannon, 1922, Insec. Insci. Menst., 10:133.

Figures 18, 43 and 44

A small, shining, brassy black, white pilose species, no bristles on the rim of the scutellum. Length 6.5 to 7.5 mm.

MALE:—Head—Face shining, very lightly pubescent on the sides, the tubercle low, only gently concave below antennae; facial strips wide, shining, the pile pale and short. Front inflated with a median sulcus, pale pubescent, the pile long and all whitish. Pile of the ocellar triangle mostly white, a few black hairs intermixed. Antennae small, the third segment oval, reddish, darker at the apex and above; arista black, very faintly pubescent.

Thorax:—Shining brassy black, the pile everywhere white with a slight yellowish tinge on the mesonotum, grey pollinose on the mesonotum. Scutellum slightly rugose before the apex, the pile on the rim longer than on the disc, but all pale.

Legs:—Black, tibiae at the basal half and narrowly at the apex yellow, basal two or three segments of the tarsi yellowish brown; the pile all pale, a few black setulae at the apex of the tibiae and beneath the tarsi. Wings hyaline, the stigma yellow, hairs at base of costa pale in color. Squamae and plumule white, halteres yellow.

Abdomen:—Mostly shining black, the pile all white.

FEMALE:—Quite similar, the tubercle more prominent due to a deeper cavity above; the pile of the front and mesonotum shorter; the abdomen entirely shining. Front shining and trisulcate, the median sulcus a very shallow but definite furrow; antennae slightly larger and the inner surface of the third segment poriform. Pile on the hind tibiae all yellow.

Distribution:—INDIANA— (Type, Male from Lafayette, April 22, 1918 Aldrich, in the Natl. Museum).

Material reviewed:—ILLINOIS—Carlinville, 4 males and 4 females 1891 and 1892 (Robertson). KANSAS—Douglass Co., 1 female April 23, 1925 (Beamer). MICHIGAN—East Lansing, 1 female May 25, 1937 (Sabrosky). MISSOURI—Platte Co., 1 male and 3 females May 2, 1936 (Henderson). WISCONSIN—Gays Mills, 2 females May 11 and 13, 1934; Monroe, 1 male May 5, 1934 (Fluke).

The general appearance of this species is very similar to Shannon's species *brevichaeta* which was described from Colorado. The latter species, however, has short black hairs on the tibiae and tarsi, all pale except the setulae on *caltha*.

A splendid series of this species was located in the Robertson collection which is now in the Illinois Natural History Survey. The specimens were all collected at Carlinville, Illinois.

Cheilosia (Cartosyrphus) brevichaeta Shannon

Cartosyrphus brevichaeta Shannon, 1922, Insec. Insci. Menst. 10:133.

Figures 19 and 45

A white pilose species closely related to *caltha*, pile on inside of hind tibia black, facial tubercle more prominent. Length 7 to 8 mm.

MALE:—Head shining black with white pubescence lightly on the sides of the face, heavier beneath antennae and on the front; pile of front white, of the vertex black, cilia white; facial strips broad, entirely shining, the pile white. Antennae small, the third segment reddish yellow, slightly darker at the obtuse apex; arista dark, thickened almost on the basal half, practically bare.

Thorax:—Shining with a slight bluish green cast, the pile long and all silvery except for a single black hair on the notopleura and one just posterior to it; a paratype male lacks these two black hairs. Legs brown, the basal third or more and apex of the tibiae reddish yellow; the tarsi reddish brown. Pile of the legs whitish, black on the inner and upper sides of the tibiae and basal segments of the tarsi. Wings lightly yellowish, squamae white, halteres reddish.

Abdomen:—Shining, somewhat dulled on the basal tergites; the pile erect and all whitish.

FEMALE:—Very similar; the antennae larger, the third segment more rounded; front trisulcate with short whitish pile, a few black hairs around the ocelli; pile of thorax shorter; pile of abdomen shorter, all erect on the fourth tergite; abdomen, entirely shining.

Distribution:—COLORADO—(Type, in U. S. Natl. Museum).

Material reviewed:—COLORADO—Paratype male; 1 male Halfway House, Pikes Peak, at Salix, May 30 (Cockerell); 2 females near Ward June 2–9, 1933 (Rodeck); 1 female Boulder, May 27, 1922.

This species is slightly larger than *caltha,* the tubercle of the male more prominent, and the pile of the legs blacker; otherwise they are very similar. The female of *caltha* has paler legs and is particularly brassy in appearance.

Cheilosia (Cartosyrphus) tarda Snow

Chilosia tarda Snow, 1895, Kansas Univ. Quarterly 3:228.

Figure 46

Front of male large, inflated, scutellum without bristles; mesonotum pale pilose; squamae yellowish. Length 6 to 7 mm.

MALE:—Head shining, black; the face mahogany, nearly straight with the upper slope of the tubercle gentle, strips very wide with pale sparse pile; front large and inflated, with a median sulcus, lightly greyish pubescent, pile long and black. Ocellar triangle black pilose, the cilia black, occiput whitish pilose. Antennae small, the third segment dark red, brownish at the apex, arista thickened on the basal third, very short pubescent.

Thorax:—Shining metallic black, the pile long and white with a yellowish tinge along the sides, a few black hairs on the notopleura, upper edge of the mesopleura, and just above the wing base. Pile on the scutellum all yellowish. Legs black to dark brown; the tips of all the femora and tibiae, basal third to half of the tibiae and the basal two or three segments of the four front tarsi yellowish red. Hind tibiae somewhat arcuate, their pile mostly black. Wings dilutely tinged, the veins light brown; squamae yellow, halteres yellowish brown. Abdomen shining black, somewhat dulled in the middle of the first three segments, pile all yellowish.

FEMALE:—Unknown. When found it will probably resemble *brevichaeta* except for black hairs at the base of the costa.

Distribution:—COLORADO—(Type, Male from Fort Collins in the Kansas University Collection).

Material reviewed:—COLORADO—Ward, 1 male and 2 females June 2–9, 1933 (H. G. and H. E. Rodeck).

Cheilosia (Cartosyrphus) sensua Curran

Chilosia sensua Curran, 1922, Can. Ent. Vol. LIV, p. 19.

Face bare, frontal pile black, mesonotal pile yellow with black hairs along the sides, metatarsi blackish. Length 7 mm.

MALE:—Face and front shining black, the fine pubescence present in moderate amounts below the antennae; side strips lack pubescence but with short sparse white pile; pile of front black, of the ocellar triangle black in front and whitish behind. Antennae yellowish red, the first and second segments darker and the third darkened at the apex and above; arista brown and bare.

Mesonotum:—Shining black, the pile fulvous with stronger black hairs along the sides; scutellum with pre-apical depression, the pile all fulvous but longer on the rim, no black bristles; pleural pile yellowish, a few black hairs on the upper mesopleura.

Legs:—Generally black; narrow tips of femora, basal third or more of the tibiae, narrow apices of the four front tibiae and the middle three segments of their tarsi reddish yellow. Wings with yellow veins; squamae, plumule, and halteres yellow.

Abdomen:—Shining black, considerably opaque on the second and less so on the third tergites; pile wholly fulvous.

Distribution:—ONTARIO—(Type, Male in Canadian National Museum).

Material reviewed:—NEW JERSEY—Palisades, 1 male March 31, 1918 (A. Nicolay).

The description above was made from the New Jersey specimen which is slightly teneral; we believe, however, that it is Curran's species, although we have not seen the type. The almost entirely shining face and front and the fulvous pile on the thorax appear to distinguish this species from its relatives.

Cheilosia (Cartosyrphus) comosa Loew

Chilosia comosa Loew, 1863, Centuries, 4:66.

Chilosia comosa Williston, 1886, Bull. U. Natl. Mus. No. 31, p. 44.

Cartosyrphus comosa Shannon, 1922, Insec. Insci. Menst. 10:133, 135.

This species was described from the English River, Winnipeg, and recorded by numerous writers from Colorado, Idaho, Oregon, Nebraska, Wisconsin (?), and Washington. We have been unable to recognize it from the descriptions among the numerous specimens before us. There is a strong suspicion that Snow described it as *tarda* if we are to accept Williston's short description. Shannon, however, places the species in his keys, the male on the basis of white pile on the front and the female front as non-trisulcate. These identifications do not agree; and we therefore leave the species unidentified, although we have followed Shannon by placing the female in our key. It will be necessary to examine the type, a male, which we have been unable to do, in order to determine its status. We give below a direct quotation from Williston which is almost a direct translation of Loew's short Latin description:

"Habitat.—Colorado!, English River, Winnepeg (Lw.).

"MALE. Length, 6 mm. Shining metallic green, with rather long yellowish pile. Frontal triangle large, with blackish pile. Face shining black, lightly pollinose on the sides and above. Antennae rather small, first joint black, second and third joints obscurely red; arista black, bare. Eyes bare. Scutellum without black bristles. Abdomen wholly shining, but less so on the anterior segments. Legs black; tip of femora, base and tip of tibiae, yellowish red. Wings cinereous hyaline, stigma and veins yellowish, the latter on the outer part and the costa darker.

"FEMALE. The pile shorter, the third antennal joint larger and lighter-colored, the tibiae in larger part, and the tarsi in part, yellowish red.

"Two males and one female from Colorado."

Distribution:—CANADA — (Type, in the Museum Comp. Zoology).

Cheilosia (Cartosyrphus) latrans (Walker)

Syrphus latrans Walker 1849, Cat. Dipt. Ins. Part 3:575.

MALE:—Length 7.5 mm. Facial knob conspicuous, the cavity below the antennae deep with gradual slope, below the tubercle short and deep. Face dark brownish black, shining black below the antennae. Front short, shining, pile long and black; vertex shining and with long black pile; occipital pile white. Antennae brown, the third segment more orange; arista brown, basally swollen and long pubescent.

Thorax:—Mesonotum and scutellum brassy black; the pile delicate, long, erect, and everywhere black. Upper pleural pile black, white below. Legs dark brown; femora blackish, their tips reddish; tibiae brownish and darker on a wide median band. Pile of femora black anteriorly, pale ventrally and baso-posteriorly; tibiae pile black. Wings uniformly tinged smoky brown which is not more intense basally; stigma pale brownish yellow. Squamae and fringe light brown; halteres dark brown.

Abdomen:—Brassy black, especially on the sides and anterior parts of the segments. The abdomen is greasy, its pile decumbent upon the last two segments, pale yellow on the sides except at the extreme posterior corners of the segments. The pile on the posterior one half of the last segment and especially on the anterior halves of the segments, as well as upon the hypopyguim, is long, delicate, and black. (Redescription by Hull direct from the type in the British Museum.) The type is from Martin Falls, Canada.

Unfortunately we are unable to associate this species with any of the well-known forms described above. It appears to belong to the *tristis* complex and may be a dark form of that species. It was described in 1849, and if it proves to be *tristis,* then this name will have to be changed. The following species *(aescytes)* appears also to be closely related to *tristis.* These descriptions were made a number of years ago, and it wasn't possible at that time to make associations with present known forms.

Cheilosia (Cartosyrphus) aescytes Walker

Syrphus aescytes Walker, 1849, Cat. Dipt. Ins. Part 3:591.

Length 6.3 mm. Specimen teneral. *Head:*—Shining, light brown in color, facial strips moderately wide, but not visible in profile; pubescence (not pile) is thick along the facial strip and concentrated in a triangular spot near the eye margin below the antennae, continuing as a narrow median band that does not reach the tubercle; likewise, thicker on the lower part of the face. Pile of the front and vertex black, elsewhere white. Third segment of antennae missing, the first and second segments light brown.

Thorax:—Shining dark brown with some evidence of a violaceous tinge, probably brassy black in well-developed specimens. Pollen of the thorax white and dense; pile long, upright, and black but not dense, changing to long black bristles on the posterior half of the scutellum. There are a few black bristles above the base of the wing and on the posterior calli. Ventral fringe of the scutellum white. Upper pleural pile is black, stiff, tips delicate; lower pleural pile and pollen white.

Legs:—Uniformly pale brownish yellow and slightly teneral; the femora with posteriorly directed fringes of delicate blackish pile. The fore femora seem to be a little more than usually arcuate upon the anterior surface. The hind metatarsi are as long as the remaining segments. The mid tibiae are black-clawed and the mid tarsi black spinose. Fore tarsi and tibiae and hind tarsi and tibiae pale yellowish pilose.

Wings:—Pale brownish, the stigma only slightly darker; base of the wing not darkened. Squamae white and white-fringed; halteres brownish cream colored.

Abdomen:—Light brown, sub-shining, the very narrow posterior borders darker; sides of the segments brassy; the marginal pile is black bristly and on the greatly curled extreme edges, white; pile on the last two segments is largely appressed, black, very fine and bristly. (Description by Hull direct from type in British Museum.) The type, a male, was collected at Martin Falls, Canada.

Appendix

A recent opportunity by F. M. Hull to examine two of Loew's types in the Museum of Comparative Zoology at Cambridge enables us to make the following additional notes.

C. comosa Loew. We indicated a possibility that *tarda* is the same as *comosa* but a critical examination of the type of *comosa,* a male, shows that they are distinct. *Comosa,* male, runs in our key to *brevichaeta* Shan. The character used by Shannon will not apply to *comosa* since the mesonotal pile is long and not so short as he indicates in his key. The only differences we can note between a male *brevichaeta* compared with the type at Washington and the type of *comosa* is a slight difference in the apical shape of the antennae (somewhat flattened apically on *brevichaeta*) and the more whitish pile of the front and mesonotum of the latter. *Comosa* has a few black hairs on the front but the pile is dominantly whitish. We doubt if these differences are enough to be specific.

C. tristis Loew. An examination of the type female does not indicate any necessary additions to the description already given; however, some of our specimens may be distinct varieties, especially the midwestern and Lake City, Colorado representatives.

C. lucta Snow. A splendid series of both males and females of this species taken at Chamber's Lake, Colorado, August 14, 1946 (Fluke). The black ciliate character used in the key to the males is correct and will place the species readily.

THE USE OF PHEMEROL IN THE TREATMENT OF CERTAIN BACTERIAL FISH DISEASES

Barbara A. McLaren, Elmer F. Herman,
C. A. Elvehjem and Edward Schneberger

Department of Biochemistry, University of Wisconsin

and

*Biology Division, Wisconsin Conservation Department,
Madison, Wisconsin*

Introduction

For several years the Biology Division of the Wisconsin Conservation Department, in cooperation with the Biochemistry Department of the University of Wisconsin, has been interested in a fish nutritional program. The work has been carried on at the James Nevin State Fish Hatchery, located at Madison, Wisconsin. The purpose of the project is to ascertain the nutritional requirements of trout, so that healthy, sound fish may be produced more economically. During the course of these experiments with yearling rainbow trout, *(Salmo gairdnerii irideus)*, an outbreak of fin rot occurred which affected adversely these nutritional experiments. In order to insure accurate results, it was imperative to use normal individuals, since fish so afflicted would not furnish reliable evidence as to the merits of various dietary factors.

Fin rot is one of the most common diseases of hatchery and experimental fish. Jewell, Schneberger, and Ross (1933) mentioned the susceptibility to fin rot of catfish and goldfish on synthetic diets. Fish on rations containing fresh meat did not develop the disease. Wolf (1938) observed the condition of the fins of trout on adequate and restricted diets. The stunted trout had both the dorsal and pectoral fins badly diseased while those on the adequate diet were, for the most part, normal. Davis (1937) presented a detailed account of the manifestations of the disease, but did not isolate the causative organism. He pointed out that the bacterium found in the greatest numbers on the infected fins was a rod-shaped bacillus. Zobell (1938)[1] confirmed Davis' findings and characterized it as a non-sporulating, gram-negative, non-pigmented and non-motile bacillus. It measured from 2.0 to 3.8μ in length and 0.6 to 0.8μ in width. It grew readily on fresh-water nutrient agar but failed to be nourished on corresponding media prepared from sea water. Following some later nutritional studies in relation to ulcer disease, Wolf (1940) came to the conclusion that fin rot and ulcer disease were one and the same. A search of the literature revealed that no other workers have confirmed this relationship, although Davis (1937) is strongly inclined to believe that these two diseases are caused by the same organism. Solution of this question lies in the isolation of the organism or organisms which cause fin rot and the inoculation of the organism into healthy fish, thereby producing the disease.

It is the purpose of this paper to present a report of the studies which led to a cure of this infection by dipping the fish in a solution of Phemerol.

Pathology

Fin rot is characterized by the disintegration of the fins, which are often entirely destroyed. Usually the first indication is a more or less distinct white line along the outer margin of the fin. The white line gradually progresses toward the base of the fin, while at the same time the outer edges become frayed, owing to the disintegration of the interradial membrane (Figures 1 and 3). In the later stages, lesions, filled with a glistening white pus, develop at the base of the fin. These lesions are small, usually circular depressions, which extend for some distance into the underlying muscle.

The extent to which the lesions develop is largely dependent upon the age and size of the fish. In very young fish death usually occurs before the infection extends beyond the fins, the occurrence of lesions on the body being rare. Larger, more resistant fish may live for a time after some of the fins are entirely destroyed, affording more opportunity for the lesions to develop on the adjacent tissues.

Wright (1936) observed that the disease varied greatly in intensity with the mortality rates, extending from a very low

[1] Reported in Sumner, F. B. and Doudoroff, P. (1938).

to a very high percentage. Over a four-year period, she found losses ranging from 50 to 95 percent and believed this was due to a difference in the virulence of the bacteria.

Experimental Procedure and Data

The fish used for experimentation were (20–90 gm.) rainbow trout *(Salmo gairdnerii irideus)*. They were obtained from the raceways of the hatchery and all were infected with fin rot in varying degrees of severity.

Preliminary trials were made, using twenty-five yearling rainbow trout, maintained in hatchery tanks 13.5 feet long by 1.5 feet wide and 1 foot deep. These tanks contained approximately sixty-two gallons of water. The water supply was from one of the many springs used for trout propagation on the hatchery grounds.

Mortality and regeneration of the fins were taken as criteria for measuring the effectiveness of the treatment. Losses were recorded daily. Each fish was examined every other day for the presence of the white line of infection. Replacement of the white by a black line was used as a standard for declaring the fish cured. The black line is shown in Figure 2.

Phemerol is a quaternary ammonium salt and occurs in the form of colorless, odorless crystals containing one molecule of water of crystallization. These crystals are extremely soluble in water giving solutions which have a pH range of 5 to 6. Surface tension characteristics of a germicide are of importance because of the resulting increase in spreading and penetrating properties. This property is exhibited to a marked degree by Phemerol. A solution of Phemerol (1 part in 1,000 parts of water) has a surface tension of 36 dynes per cm. at 25° C. (water has a surface tension of 72 dynes per cm. at the same temperature). According to Joslyn, et al., (1941) who used the Shippen (1928) technique, the action of Phemerol is bactericidal. They tested this drug against ten pathogenic microorganisms and found it effective.

The desired amount of Phemerol was weighed, then ground in a mortar and added to seven gallons of water. It was stirred vigorously to insure proper mixing. At first, the solution was aerated, but oxygen tests (Winkler method) indicated that aeration was unnecessary if not used for more than six treatments.

The trout were placed in a deep dip net and completely immersed in the solution. The immersion period was measured by means of a stop watch. After the treatment, the fish were returned to their respective tanks.

Experimental Treatments

Series 1. Laboratory experiments.

A(1). A 1:26,000 solution of Phemerol was used. Groups of 25 fish each were dipped in the solution for 2, 5, 10, 15, 30, and 40 minutes. A(2). Since there were large losses in those groups which were treated for more than five minutes, four more groups were dipped for 1, 2, 3, and 4 minutes. The losses were greatly reduced, and it was evident that the fish should not be allowed to remain in contact with Phemerol for more than two minutes (Table 1).

B. The concentration of Phemerol was varied from 1:26,000 to 1:6,000. The duration of the immersions was extended from 30 to 120 seconds. The data are summarized in Table 2.

A control tank of trout was maintained under exactly the same conditions as the Phemerol-treated fish. At the same time another group was treated with malachite green according to the procedure outlined by Foster and Woodbury (1936). All fish were fed daily a ration composed of equal parts of fresh liver and canned carp, plus 5 percent brewer's yeast. The fish were given an amount equivalent to 5 percent of their body weight.

TABLE 1

Effect of Varying Time Intervals Using Concentration of 1:26,000 Solution of Phemerol

(Series 1, laboratory experiments)

Groups	Number of Fish	Time (Minutes)	Losses (Percent)
A (1)			
	25	2	4
	25	5	20
	25	10	28
	25	15	40
	25	30	56
	25	40	80
A (2)			
	25	1	0
	25	2	0
	25	3	12
	25	4	16

TABLE 2

THE EFFECT OF VARYING TIME AND CONCENTRATION ON THE MORTALITY AND CONDITION OF DISEASED TROUT

No. of Fish	Concentration	Time (Seconds)	Loss (Percent)	Condition (Percent Cured)
25	1:26,000	60	0	48
25	1:13,000	30	0	44
25	1:13,000	45	0	24
25	1:13,000	60	0	16
25	1:13,000	90	8	36
25	1:13,000	120	8	8
25	1:10,000	30	0	64
25	1:10,000	45	0	60
25	1:10,000	60	0	36
25	1: 9,000	30	0	16
25	1: 9,000	45	0	12
25	1: 9,000	60	0	8
25	1: 7,000	30	0	64
25	1: 7,000	45	0	60
25	1: 7,000	60	0	36
25	1: 6,000	30	88	..
25	control	..	8	24

C. The third series was set up with 100 fish to a tank. This number was selected as it approximated the number of fish usually held in the same quantity of water in the hatchery raceways. Seven tanks were used—one was maintained as a control—the second was treated with malachite green—and the five others were given a Phemerol treatment in graduated doses. Using a Phemerol solution (1:10,000), each group received treatment as follows:

a. One group received one dip;
b. One group received two dips in two days;
c. One group received three dips in three days;
d. Two groups received four dips in four days (Table 3).

On the fifth day the fish which had been given four dips did not eat all of their food, indicating that the maximum number of immersions the fish could tolerate was four.

It was observed that the fish which most frequently succumbed to the Phemerol treatment were those which weighed about 75–100 grams. Twenty-five fish of this size were dipped in a solution of Phemerol whose concentration was gradually increased from 1:26,000 to 1:10,000 over a period of four days.

TABLE 3

THE EFFECT OF INCREASING THE NUMBER OF DIPS

(Concentration 1:10,000—Time: 30 seconds)

No. of Fish	No. of Dips	Loss (Percent)	Condition (Percent Cured)
Phemerol			
100	1	0	40
100	2	2	52
100	3	4	80
100	4	4	80
100	4	6	84
Malachite green 1:10,000—Time: 2 minutes			
100	4	2	28
Control—			
100	....	2	22

There were no losses in the group. The fin rot disappeared after ten days. Thus, better results were obtained when the tolerance of the trout to this bactericidal agent was developed gradually.

Fifty large fish (20 inches in length) weighing approximately 1,000 grams developed fin rot. There were as many as three dying each day. A 0.3 percent solution of Phemerol was applied to the infected areas every other day. After three applications, the sores began to heal and the mortality was entirely eliminated.

Series 2. Hatchery raceway procedure.

A. When the preliminary trials in the biological laboratory were completed, Phemerol was tested under raceway conditions. For this experiment, 2,200 three-year old rainbow trout were selected. These fish averaged 13 inches in length and had an average weight of 540 grams. Many of the group were badly infected with fin rot. The procedure for this treatment was to seine the fish and hold them in a large net, dipping about 100 of them at a time, for 30 seconds. The initial concentration of Phemerol was 1:26,000. The lower concentration was used for two days to assure the survival of the weakest fish. On the third day the concentration was increased to 1:17,000, on the fourth

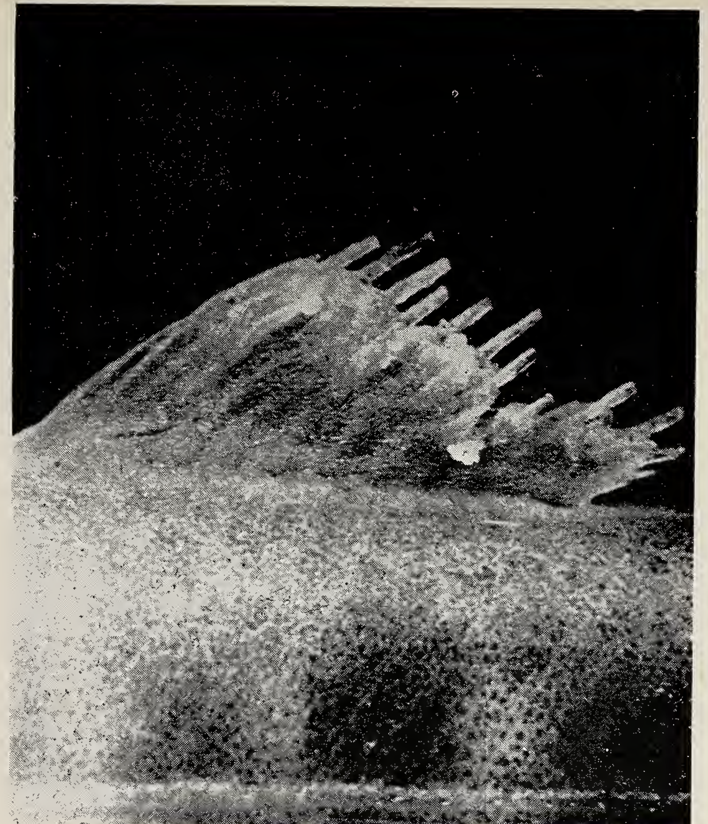


FIG. 1.—Dorsal fin showing denuded fin rays and accompanying fungus infection.

FIG. 2.—A regenerated dorsal fin showing the black line on the outer edge. The light color of the fin is due to lack of pigmentation in the newly formed tissue.

FIG. 3.—Caudal fin showing almost complete erosion of fin rays and intermedial membrane.

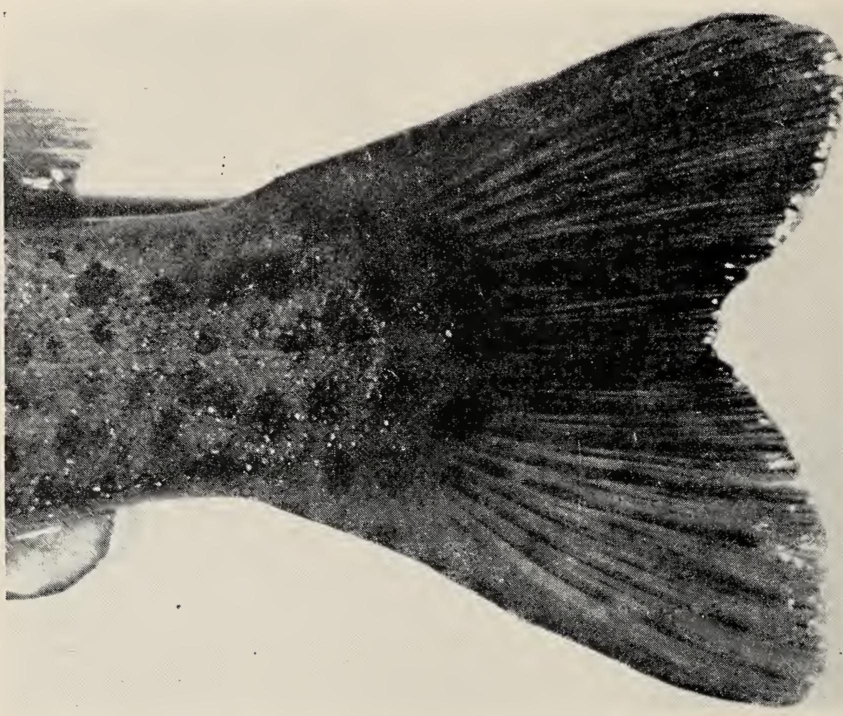


FIG. 4.—Caudal fin cured of fin rot showing almost complete regeneration. Several areas of incomplete regeneration of the interradial membrane are still apparent.

day to 1:13,000, and on the fifth to 1:10,000. Immediately after the dipping treatment, they were fed 22 pounds of canned carp, supplemented with 2 percent codliver oil. During the treatment and a three-week observation period, 26 fish succumbed, a mortality of 1.2 percent.

B. Another group of 1,100 yearlings was treated with Phemerol. This lot of fish was in better condition and, therefore, it was decided to give them only one dip in the 1:26,000 solution and increase the concentration to 1:17,000 for the second immersion, to 1:13,000 for the third, and to 1:10,000 for the fourth. There were no losses over a period of four weeks. Only those fish which had their dorsal fin almost completely eaten away still showed some white markings. On closer examination, the fin had regenerated to such an extent that there was no question in the minds of several experienced fish-culturists that the disease had been cured. The regeneration of the fin is shown in Figures 2 and 4.

The spent solutions of Phemerol were thrown away on the grass a few feet from the raceway without any deleterious effects on vegetation.

Discussion

Most chemicals have a toxic effect on fish when used in too high a concentration. The ideal curative range of Phemerol is very limited. There are two variable factors whose relation must be ascertained for effective treatment, namely, the duration and concentration of the immersion. Rice (1885) introduced the method of dipping the fish. He used a 3.0 percent solution of sodium chloride until they showed signs of distress, after which he removed them to fresh water. This procedure has been used extensively in Europe and the United States. Wright (1936), employing sodium chloride, obtained moderately successful results during four consecutive yearly epidemics of fin rot. She found that a 1:100,000 solution of copper sulfate, as proposed by Davis (1937), did not successfully combat the disease. Fish (1935) devised a method whereby a concentrated solution of copper sulfate was allowed to flow into a raceway at a uniform rate. This technique eliminates handling and causes less bodily harm to the fish. It was found that Phemerol could also be used in this manner.

Foster and Woodbury (1940) tested the effectiveness of many bactericidal agents for the control of fish diseases. They came to the conclusion that malachite green was superior to common salt, copper sulfate and potassium permanganate, in the treatment of Saprolegnia. When the epidemic of fin rot first occurred at the Nevin hatchery, the trout were dipped in malachite green according to the procedure outlined by these authors, but it was found ineffective. If an outbreak occurs in a hatchery, the usual procedure should be to thin out the fish and destroy those which are badly infected. It seems obvious that only 25 yearling trout in one of our hatchery tanks (13.5′ x 1.5′ x 1′) are not overcrowded. Moreover, it is evident that the meatless diets did not contribute to the weakened condition of the fish for there were comparable losses on the fresh meat rations. The meatless rations consist of a mixture of dry meals, supplemented with yeast, salt, codliver oil and liver powder. The fresh meat diet consists of fresh liver, canned carp and yeast.

From the data presented in Table 1, it may be concluded that Phemerol is toxic to the fish if they are left in contact with it for more than two minutes. Table 2 is a summary of many attempts to arrive at the most effective concentration—duration relationship. Two important observations were made during the course of these tests. First, if the dips of higher concentrations were given without sufficient time intervals, the fish lost their appetites. If their tolerance was developed by gradually increasing the concentration of the dips from day to day over a four- or five-day period, they appeared stronger and continued to eat. Second, a 1:17,000 solution was too weakening to the trout, for, although there were no losses with these groups, their appetite was diminished. From Table 3 it can be seen that trout will tolerate at least four baths, the concentration of which is 1:10,000. From the results of dipping operations in the raceway, it was found that the older trout could stand five immersions of increasing concentration.

Although the swabbing technique is tedious, it is effective in controlling the infection amongst the larger trout. It may be of value in treating fish on display, which are prone to develop skin diseases, due to handling.

A few words may not be amiss concerning the application of this method to other species of fish. O'Donnell (1941), using malachite green in extensive experiments with warm and cold water types of fish, found that trout would tolerate a higher concentration and a longer interval of immersion than bass, bluegills, sunfish, perch, black crappie, muskellunge, northern pike, bluntnose and fathead minnows. It should be pointed out that the technique for each species of fish must be determined individually.

Conclusions

The following assertions seem warranted with reference to the use of Phemerol in the treatment of bacterial diseases:

1. After the correct time interval of dipping and the most effective concentration of Phemerol were determined, fin rot was cured. The most effective concentration was shown to be 1:10,000 with a duration of immersion of 30 seconds. By using graduated doses of Phemerol, losses were reduced to such an extent that they were negligible.

2. Secondary fungus infections were also destroyed by this treatment.

3. Phemerol has been shown to be very effective in the control of fin rot in all ages of trout and probably has its application for other species of fish.

4. Phemerol, if it comes in contact with vegetation on the hatchery grounds, has no deleterious effects. Thus, a spent solution offers no disposal problem.

Acknowledgments

The authors wish to acknowledge the generous supply of Phemerol supplied to Mr. Lester Teply of the Biochemistry Department by Parke, Davis and Company and the help received from Mr. Wendel Anderson, fish-culturist at the James Nevin Hatchery, Madison, Wisconsin.

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PARASITES OF BRULE RIVER FISHES

*Brule River Survey: Report No. 6**

JACOB H. FISCHTHAL
Wisconsin Conservation Department, Spooner

As part of the project to survey northwest Wisconsin fishes for parasites, a total of 106 fishes representing eight species were examined from the Brule River in Douglas County during 1944. Eighty-five or approximately 80.2 percent were infected with at least one species of parasite. These fishes were collected on July 13 and 26, August 1, November 22 and December 6, 1944, from below Stone's bridge, in Big and Lucius lakes, and from the latter to Winneboujou bridge. Since the parasites from these different localities were somewhat similar, the results of the survey were grouped together regardless of the area from which the fishes were collected.

In the table following, an inverted T (⊥) before the parasite denotes the presence of both adult and immature stages in the same fish; two asterisks (**) preceding the parasite indicates an immature stage; a single asterisk (*) preceding the parasite indicates a larval stage; no mark before the parasite denotes an adult stage; a single pound mark (#) following the number of infected fish indicates an infection with one to ten specimens of that species; two pound marks (##) denote an infection with 11 to 50 specimens; three pound marks (###) denote an infection with 50 or more specimens. The use of sp. after a generic name, or a broader classification than the genus, indicates that the specimens could not be identified more completely.

Appreciation is due Messrs. D. John O'Donnell, J. R. Jacobson, and Warren S. Churchill for their aid in collecting the fishes herein examined; Dr. R. V. Bangham, College of Wooster, Ohio for aid in verifying certain parasite identifications.

* Brule Papers 1 to 5 appeared in Volume 36 (1944) of the *Transactions*, pages 1–76.

Discussion

From the table presented, it can be ascertained that Brule River fishes in general are lightly parasitized. The exceptions are in the extremely heavy infections of *Catostomus c. commersonnii* and *Cottus b. bairdii* with *Neascus* sp., the larval parasite causing black spot. These fishes were thickly peppered with hundreds of black spots. Fish-eating birds serve as the natural definite host for the black spot parasite. Bangham (in press), in his examinations of 18 *Catostomus c. commersonnii* from the Brule River during the summer of 1943, found parasitism in this species similar to that indicated in this report; in addition he recorded the trematode *Triganodistomum attenuatum* from three of these 18 fish.

TABLE 1

INCIDENCE OF PARASITISM IN BRULE RIVER FISHES

	Salmo Trutta Fario	Salmo Gairdnerii Irideus	Salvelinus F. Fontinalis	Catostomus C. Commersonnii	Ameiurus M. Melas	Boleosoma N. Nigrum	Cottus B. Bairdii	Eucalia Inconstans
No. Examined 106	12	18	5	28	1	14	12	16
No. Infected 85	6	14	5	27	1	14	12	6
% Infected 80.2	50	78	100	96	100	100	100	38
TREMATODA								
Azygia augusticauda						1 #		
Bunodertna eucaliae								6 #
Crepidosomum cooperi							2 #	
							1 # #	
⊥*Crepidostomum cooperi*							1 # #	
***Crepidostomum cooperi*							1 #	
Crepidostomum farionis	2 #							
Crepidostomum isostomum						1 #		
**Neascus* sp.	2 #	1 #	1 #	1 #		5 #	9 # #	
Phyllodistomum ethostomae				26 # # #		2 #	3 # # #	
Phyllodistomum sp.		2 #						
Phyllodistomum undulans							1 #	
**Tetracotyle* sp.						2 #		
						1 # #		
CESTODA								
Bothriocephalus formosus						9 #		
Glaridacris intermedius				2 #				
⊥*Glaridacris intermedius*				6 #				
				2 # #				
***Proteocephalus pearsei*							4 #	
***Proteocephalus* sp.	3 #				1 #			

TABLE 1—(*Continued*)

INCIDENCE OF PARASITISM IN BRULE RIVER FISHES

	Salmo Trutta Fario	*Salmo Gairdnerii Irideus*	*Salvelinus F. Fontinalis*	*Catostomus C. Commersonnii*	*Ameiurus M. Melas*	*Boleosoma N. Nigrum*	*Cottus B. Bairdii*	*Eucalia Inconstans*
NEMATODA								
***Camallanus oxycephalus*	1 #							
***Contracaecum* sp.								1 #
Cystidicoloides harwoodi	3 #	10 #	4 #					
Oxyuridae			1 #					
Rhabdochona cascadilla		1 #	4 #				11 #	
							1 # #	
Spinitectus gracilis		4 #			1 #			1 #
**Spiroxys* sp.					1 #			
ACANTHOCEPHALA								
Neoechinorhynchus crassus				12 #				
				2 # #				
Neoechinorhynchus sp.								1 #
Octospinifer macilentus				14 #				
				1 # #				
Pomphorhynchus bulbocolli		1 #		3 #			1 #	
**Pomphorhynchus bulbocolli*					1 #			1 #
MOLLUSCA								
*Glochidia						8 #		
PROTOZOA								
Myxosporidia						5 #		

A FOUR-YEAR CREEL CENSUS ON THE BRULE RIVER, DOUGLAS COUNTY, WISCONSIN[1]

Brule River Survey Report No. 7

D. JOHN O'DONNELL
Wisconsin Conservation Department, Madison

ABSTRACT

Creel censuses were conducted during the trout seasons of 1936, 1940, 1943 and 1944 to determine fishing intensity or concentration of anglers, catch, rate of catch, and effectiveness of 1943 and 1944 plantings of marked (tagged and fin-clipped) legal-sized trout in the Brule River. The brook trout catch has continued to decline since 1936 while the brown trout have entered the creel in increasing numbers during the same period, even though plantings of the latter species have always been light. Stocking of brown trout was stopped entirely three years ago. In 1936 the catch of resident (unmarked) brook trout was 57.5 percent, brown trout 10.2 percent, and rainbow trout 32.3 percent, as compared with the 1944 catch of brook trout 34.3 percent, brown trout 35.2 percent and rainbow trout 30.5 percent. Returns from a spring plant of 2,000 marked legal-sized brook trout in 1943 amounted to 28.7 percent. The captures from a spring plant of 6,500 legal brook trout in 1944 amounted to 27.7 percent of the plant, but made up 50.5 percent of the total catch of all species of trout for the year. Very few of the trout stocked in 1943 were caught in 1944 since only one brook trout from a plant of 2,000, and only 11 rainbow trout from a plant of 1,665, were noted by census clerks. The catch per fisherman-day of resident trout has declined steadily since 1936; the numbers of trout per fisherman were 4.4, 2.8, 2.8, and 2.4 for the years 1936, 1940, 1943 and 1944 respectively. When the tagged legal-sized trout are included, the catch per fisherman-day for the last two years has amounted to 4.7 and 4.8 trout. It is concluded that the stocking of legal-sized trout during the spring and early season provides a return to the angler in fishing satisfaction which the previous extremely heavy plants of fingerling trout did not provide.

Introduction

As part of the biological survey of the Brule River in Douglas County, an intensive creel census was conducted during 1943 and 1944. These data were compared with data for the seasons of 1936 and 1940 in order to determine changes in fishing pressure, catch by species, rate of catch, and the effectiveness of 1943 and 1944 plantings of legal-sized trout. Such data are reliable indices to the annual trend in fishing and provide a measure of the results of stocking, management practices, and legal restrictions. These censuses also provide a personal contact between state employees and the fisherman and stimulate the general interest of sportsmen in conservation matters.

During the past few years, considerable evidence has been reported to show that greater returns to the angler are obtained when trout of legal size are stocked in the spring or during the open season than when the fish are released in the fall. Cobb (1934) recovered 5,403 (33 percent) of 15,875 marked legal brown and brook trout released in Connecticut streams. The trout were marked by internal tags. He found that brown trout provided fishing for several weeks after planting while brook trout, planted during the open season, were usually depleted within one week. Nesbit and Kitson (1937), in Massachusetts, concluded that spring planting gave a return to the angler by an average ratio of five to one over fall stocking. Hoover and Johnson (1938) found that 76 percent of a plant of 2,000 legal-sized brook trout, stocked during the season, were caught within three weeks. They also found that the greatest migration from the point of planting was 3,900 feet upstream (by the end of twenty days) and 3,700 feet downstream (end of eight days). In checking the efficiency of stocking methods, they found that spot plantings provided good fishing for a maximum of three weeks, while scatter plants throughout the stream produced good fishing for five weeks or longer.

Williamson and Schneberger (1943) obtained a check of recapture of 37.5 percent of 2,623 marked legal-sized rainbow trout stocked in a Wisconsin stream. The stocked legals amounted to 29.0 percent of the total yield.

Shetter and Hazzard (1942) made experimental plantings of 36,000 trout in 51 experiments. Brook trout were planted in six streams and brown and rainbow in four. They found a return to the creel of 4.4 to 5.8 percent for fall stocking, 11.3 to 25.5 percent for spring stockings, and 13.0 to 25.4 percent for open-season plantings. A very few brown and rainbow trout were found to carry over to a second season, but brook trout were never found during the second season. Brook trout contributed to the catch for approximately four weeks after planting and the brown and rainbow trout were usually caught out in eight weeks.

Needham and Slater (1944), in five years' study on 63 trout plants, found a summer mortality of planted fingerlings of 45 to 70 percent and an additional first winter mortality of 56 to 71 percent, and they conclude that few, if any, planted fingerlings ever survive to the creel. Natural propagation provides practically all of the angler's catch, and the most efficient use of hatchery fish is by planting for the creel in heavily fished waters.

Smith (1940) conducted a creel census on the Salmon Trout River in northern Michigan, a stream with relatively light fishing pressure, and also checked the yield from fall- and spring-planted, marked, legal brook trout. Fall planting yielded a maximum of 1.0 percent, while spring-planted produced a maximum return of 19.6 percent. The contribution of hatchery fish of legal size to the entire season's catch amounted to 44.0 percent, 38.6 percent and 24.9 percent respectively in three successive seasons.

Methods

The 1936 creel census was made with the assistance of personnel of the Works Progress Administration, while the census clerks for 1940 were members of the Civilian Conservation Corps who had been especially instructed, and who worked under the supervision of a biologist. The censuses of 1943 and 1944 were made with Survey employees.

Since the first plant in the Brule in 1890, some 3,935,295 trout of all species have been stocked. Up to 1918 the plants were limited almost entirely to fry, and from 1919 to 1942 to fingerlings. During the course of the survey in 1943 and 1944, the planting was restricted to marked legal-sized trout. The marking was either by fin-clipping or jaw-tagging.

The number in the census crew varied from six to twelve persons at selected stations, with additional personnel on a "roving" assignment. As a result of "spot checks" and other investigations, it was concluded that the census was 50 percent complete.

Past Plantings

Records of state plantings of all species of fish in the river since the first stocking in 1890 are shown in Table 1. The plant of 1890 consisted of 160,000 walleye pike fry in Big Lake, an expansion of the river. Brook trout were native and present in abundance. In 1892 an introduction of 30,000 rainbow trout fry was made; the first state stocking of brook trout in 1894 consisted of 10,000 fry.

TABLE 1

Stocking of Fish in Brule River and Tributaries, 1890–1945

(Total plant, all species: 3,935,295; largest plant in one year, all species: 542,822.)

Year	Species			
	Brook	Rainbow	Brown	Others
1890–1894	10,000	55,000	....	160,000[1]
1895–1899	61,000	94,500	....	....
1900–1904	52,000	45,250	....	....
1905–1909	64,000	47,500	....	2,500[2]
1910–1914	153,200	126,000	....	....
1915–1919	110,700	232,200	....	....
1920–1924	126,850	77,400	10,800	....
1925–1929	87,315	205	94	....
1930–1934	171,192	13,455	124	....
1935–1939	775,324	214,476	36,555	....
1940	170,200	322,642	50,000	....
1941	71,569	181,000	100,000	....
1942	73,400	38,865	178,469	....
1943	4,350[3]	1,665[3]	....	....
1944	6,500[3]	....	....	....
1945	10,000[3]	....	....	....
Totals	1,946,800	1,449,953	376,042	162,500

[1] Walleye Pike.
[2] Black Bass.
[3] Legal—7 inches and over.

The stocking of brook and rainbow trout fry continued sporadically until 1902 when yearly plants were inaugurated. Black bass (2,500), species unknown, were introduced into Big Lake in 1906. Practically all of the brook and rainbow trout planted up to 1918 consisted of fry. Beginning at that time production of fingerlings increased steadily, and the number of fish planted increased accordingly. Brown trout fry were introduced in 1920 with a plant of 10,800 fish. After the initial plant only 218 brown trout were planted during the next 14 years. From 1934 to 1942 a total of 376,042 brown trout were planted, and further plantings were discontinued in 1942. Subsequent to 1942, only legal-sized brook and rainbow trout have been planted. Since the first plant in 1890, a total of 1,944,800 brook trout, 1,449,953 rainbow trout, 376,042 brown trout, 160,000 walleye pike and 2,500 black bass (species unknown) have been planted—a grand total of all species of 3,935,295. The largest plant made in any one year consisted of 542,842 trout of all species and sizes.

Summary of Total Catch

As census data were compiled for each of the four years, a cumulative summary table was prepared (Table 2) showing the annual catch and percentage of the total for all species of trout, both marked and unmarked.

The censuses of 1936 and 1940 were made during the period of very heavy plants of fingerling, which were made because of many complaints that trout fishing was continuing to decline. The actual contributions of these fingerlings to the stock of legal-sized fish could not, of course, be determined. During 1943 and 1944, however, several plants of marked legal trout were present, and comparisons could be made between the contributions of the planted and native fish to the total catch.

An examination of Table 2 shows that resident (unmarked) brook trout have declined greatly since 1936, with a very sharp reduction between 1936 and 1940. The period from 1936 to 1940 was one of intense "stream improvement" on the river. Many devices were built, logs and "down" trees removed, some bank clearing and other work carried on which tended to improve the river for canoe travel. Some of these operations, however, may very well have helped bring about the sharp reduction of brook trout.

Much of the fluctuation in the percentage of each species of trout caught during the four years is due to the wide variations in the take of rainbow trout. The availability of rainbow trout is regulated by environmental conditions which determine the relationship between the time of migration back to Lake Supe-

TABLE 2

SUMMARY RECORD OF ALL TROUT REPORTED CAUGHT IN BRULE RIVER, 1936, 1940, 1943, 1944

The creel census on which these figures are based are estimated to have been about 50 percent efficient.

SPECIES OF TROUT	1936		1940		1943		1944	
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
(Unmarked)								
Brook Trout	927	57.5	264	17.4	309	11.9	607	17.1
Brown Trout	165	10.2	194	12.8	252	9.7	623	17.4
Rainbow Trout	521	32.3	1,058	69.8	914	34.8	539	15.1
(Tagged)								
Brook Trout	......	......	......	......	574	22.1 [1]	1,806	50.5 [2]
Rainbow Trout	......	......	......	......	478	18.4 [3]	......	......
(Fin-Clipped)								
Brook Trout	......	......	......	......	68	2.6 [4]	......	......
Total Catch								
Brook Trout	927	57.5	264	17.4	951	36.6	2,413	67.5
Brown Trout	165	10.2	194	12.8	252	9.7	623	17.4
Rainbow Trout	521	32.3	1,058	69.8	1,392	54.6	539	15.1
GRAND TOTAL	1,613	......	1,51[6]	......	2,595 [5]	......	3,575 [6]	......

[1] Return of 28.7 percent on total plant of 2,000 legal trout.
[2] Return of 27.7 percent on total plant of 6,000 legal trout.
[3] Return of 28.7 percent on total plant of 1,665 legal trout.
[4] Return of 2.9 percent on total plant of 2,350 legal trout.
[5] 1,120 tagged and clipped (43.1 percent); 1,475 unmarked (56.9 percent).
[6] 1,806 marked (50.5 percent); 1,769 unmarked (49.5 percent).

rior and the date of the opening of the season. The year 1936 was very poor for rainbow trout, while in 1940 this species made up almost 70 percent of all trout taken from the river.

The catch of brown trout has continued to increase year after year even with little or no stocking. The first plant of brown trout which was made in 1920 consisted of 10,800 fry. During the following fourteen years, only 218 brown trout (adults) were planted. In the fall of 1935, the stream was stocked with 36,380 fingerlings, but it is most improbable that any of these entered the 1936 catch, since insufficient time had elapsed for them to reach legal size. The brown trout contributed 10.2 percent of the total catch of all species in 1936. It is known definitely that the brown trout has become established in the shore waters of Lake Superior and that, each fall, these large breeders migrate up the streams tributary to Lake Superior for the purpose of spawning. These migrations have actually been observed in the Brule River.

The legal brook and rainbow trout, marked with jaw-tags, made substantial contributions to the total catch of all species in 1943, 22.1 percent and 18.4 percent respectively. An additional lot of fin-clipped legal brook trout was planted, but the returns amounted to only 2.9 percent of the plant. This low figure can be attributed only to oversight by census clerks when we consider that a return of 28.7 percent was obtained on the total plants of both brook and rainbow trout that had been jaw-tagged.

In 1944 a larger plant was made of jaw-tagged, legal-sized brook trout. In that year the total return on the plant amounted to 27.7 percent. However, the percentage contribution to the total catch (50.5 percent) was much greater than that from the 1943 plant (22.1 percent). The 1943 introductions of legal trout were made before the season and during the early season as "spot" plantings (at bridges), while in 1944 all introductions were "scatter" plantings (well distributed by boat).

Since, as previously explained, the annual catch of rainbow trout varied widely according to conditions affecting migrations, the trends of the populations of brook and brown trout are shown more advantageously in Table 3, in which the data on rainbow trout have been omitted.

TABLE 3

SUMMARY OF ALL BROOK AND BROWN TROUT REPORTED CAUGHT IN THE BRULE RIVER, 1936, 1940, 1943, 1944

Species	1936		1940		1943		1944	
	No.	%	No.	%	No.	%	No.	%
Brook Trout..........	927	84.9	264	57.6	309	55.1	607	49.3
Brown Trout.........	165	15.1	194	42.4	252	44.9	623	50.7

The highest percentage of brook trout in the combined catches of brook and brown trout occurred in 1936 when the former species made up 84.9 percent of the total as compared with 15.1 percent for the latter. During the period between 1936 and 1940 the brook trout declined at a rapid rate (percentage) while the brown trout increased at exactly the same rate. From the percentages of brook trout (marked legals not included) in the catch for the four years, 84.9 percent, 57.6 percent, 55.1 percent, 49.3 percent, a sudden decline followed by a slower, but continuing, decline is to be noted. The percentages for brown trout obviously show precisely the reverse trend. It should also be noted at this point that the last plant of brown trout (made in 1942) consisted of 62,022 fingerlings. These fish, in combination with the considerable numbers known to be produced naturally, undoubtedly accounted for the rapidity with which the brown trout is becoming the dominant trout of the river.

FISHING SUCCESS

The test of whether a stream will continue to receive the attention of the angler depends almost entirely on whether or not the fisherman can expect a reasonable creel for the amount of effort expended. Angler satisfaction has been defined in the past as an average of one fish per hour of effort.

The success of fishermen on the Brule River is shown in Table 4 for each of the census years. The number of fishermen increased from 1936 through 1940 and has decreased only slightly during the past few years. The fishing success (fishermen catching trout) decreased somewhat from 1936 through 1940, but has increased during the past two years. The percentage of successful fishermen has amounted to 67.7 percent, 58.7 percent, 77.8 percent and 92.4 percent, during each of the four years.

TABLE 4

TOTAL NUMBERS OF FISHERMEN, NUMBERS AND PERCENTAGES THAT DID AND DID NOT TAKE TROUT, AND NUMBERS OF TROUT TAKEN PER FISHERMAN-DAY IN THE BRULE RIVER IN 1936, 1940, 1943, AND 1944

Data are given for sections of the river in 1936 and 1943. Estimated efficiency of census was 50 percent.

YEAR	UPPER SECTION [1]	MIDDLE SECTION [2]	LOWER SECTION [3]	TOTALS	PERCENTAGES	AVERAGES
			Number of Fishermen			
1936......	202	70	211	483	....	....
1940......	....	....	....	921	....	....
1943......	185	324	195	704	....	....
1944......	....	....	....	745	....	....
			Fishermen Catching Trout			
1936......	152	36	139	327	67.7	....
1940......	....	....	....	541	58.7	....
1943......	133	272	143	548	77.8	....
1944......	....	....	....	692	92.4	....
			Fishermen Without Trout			
1936......	....	....	....	156	32.3	....
1940......	....	....	....	380	41.3	....
1943......	....	....	....	156	22.2	....
1944......	....	....	....	53	7.6	....
			Number of Trout Per Fisherman-Day			
1936......	7.50	3.00	2.70	....	....	4.4
1940......	....	....	....	....	....	2.8
1943......	7.04	4.94	3.28	....	....	4.7 [4]
1944......	....	....	....	....	....	4.8 [5]

[1] Upper Section—Headwater downstream to and including Stone's bridge.
[2] Middle Section—Stone's downstream to and including Highway 2 bridge.
[3] Lower Section—Highway 2 bridge downstream to Lake Superior.
[4] Average of 1.9 (tagged); 2.8 (untagged).
[5] Average of 2.4 (tagged); 2.4 (untagged).

Much of the increase during 1943 and 1944 can be attributed to the catch of tagged legal trout which were planted. This is verified by the fact that a number of fishermen (approximately 35) who were checked had caught only tagged trout. There has been a corresponding decrease in the percentage of anglers catching no trout (32.3 percent, 41.3 percent, 22.2 percent, and 7.6 percent).

The average number of trout per fisherman-day was at a level of 4.4 in 1936 and had dropped to 2.8 in 1940. In 1943, the average had again increased, being 4.7; however, this is composed of 1.9 tagged trout and 2.8 untagged trout (resident). Therefore, the average catch per fisherman-day of resident (untagged) trout remained approximately the same as for 1940. During 1944, the average catch again increased, however, the catch consisted of 2.4 tagged trout and 2.4 untagged trout (native). These averages indicate a continual decrease in the return to the creel of native trout (4.4, 2.8, 2.8, and 2.4) although fishing satisfaction was maintained by the plant of tagged legal-sized trout during 1943 and 1944 which brought the average up to 4.7 and 4.8 respectively. The carryover of tagged legal-sized trout from the 1943 plant was negligible, consisting of one brook trout and eleven rainbow trout; however, on the opening day of the season in 1945, four returns were examined of tagged brook trout from the 1944 plant.

A complete resume was prepared of the 1943 census by seven-day periods and for a number of categories (Table 5). It will be noted that of 704 fishermen, 215 or 30.5 percent were concentrated in the first seven days of the season. These fishermen caught 23.4 percent of the total season's catch and 47.4 percent of the total pounds of trout caught. Although the average fisherman-day amounted to 5.54 hours and the average creel amounted to 2.8 trout per day, the average pounds of trout per fisherman consisted of 4.19 pounds.

The largest single creel for one fisherman, caught during the same period, weighed 16 pounds and 15 ounces. The record trout for the entire season was a rainbow caught on the second day which weighed 10 pounds and 10 ounces. These unusually high figures for the early season catch are due to the fact that most fishermen are concentrating on the large Lake Superior run rainbow trout.

As the season advances the fishing pressure is reduced to what could only be considered as a very light pressure for the amount of fishing water available (46.9 stream miles; 199 acres). Although the hours per fisherman-day remains up to very near average and during some weeks is even increased, the average catch per day is reduced, and the average weight of trout per fisherman-day decreases to 2.00 pounds or less from July 10 to the end of the season.

TABLE 5

DETAILED INFORMATION ON THE 1943 CREEL CENSUS ON THE BRULE RIVER
(Length of season—130 days. Record trout for season: 10 lbs.-10 oz., rainbow, May 2.)

Date	Number of Fishermen	Total Number of Trout, All Species	Average Number of Trout per Fisherman	Weight of Total Catch (Pounds)	Average Weight of Trout per Fisherman (Lbs.)	Total Hours of Fishing	Average Hours per Day per Fisherman	Largest Single Creel In One Fisherman-Day
May								*Lbs. Oz.*
1– 7......	215	607	2.82	901	4.19	1,191	5.54	16–15
8–14......	51	226	4.43	232	4.55	245	4.80	20– 6
15–21......	14	57	4.06	57	4.07	67	4.78	13– 0
22–28......	18	104	5.77	45	2.50	142	7.88	10– 8
June								
29– 4......	26	107	4.11	55	2.11	134	5.15	9– 0
5–11......	11	44	4.00	39	3.55	51	4.64	8–13
12–18......	29	258	8.90	96	3.31	123	4.24	4–15
19–25......	23	74	3.21	36	1.56	82	3.56	4– 1
July								
26– 2......	43	236	5.49	97	2.25	158	3.67	9– 6
3– 9......	29	186	6.41	70	2.41	107	3.70	8– 2
10–16......	14	130	9.28	28	2.00	71	5.00	3–12
17–23......	13	66	5.07	15	1.15	83	6.38	1– 5
23–30......	6	33	5.50	12	2.00	37	6.16	3– 0
August								
31– 6......	22	119	5.41	42	1.91	101	4.59	4– 4
7–13......	10	46	4.60	16	1.60	44	4.40	3–10
14–20......	21	46	2.19	18	0.86	106	5.04	10– 2
21–27......	29	37	1.27	14	0.48	130	4.48	5– 8
Sept.								
28– 3......	25	47	1.88	26	1.04	90	3.60	6–12
4– 7......	45	80	1.77	38	0.84	206	4.57	8–12
Misc.......	60	92	1.53	63	1.05	169	2.81	8– 9
TOTALS AND AVERAGES..	704	2,595	3.68	1,900	2.70	3,337	4.74	20– 6

Even though the total harvest of trout amounted to 1,900 pounds, the removal was at a rate of 9.5 pounds per acre. Much of the crop weight was due to the migratory rainbow trout and does not represent the actual removal of resident trout.

In addition to the trout, several other species of fish were caught. These included 3 rock bass *(Ambloplites rupestris)*, 8 northern pike *(Esox lucius)* (19 to 27 inches), 300 walleye pike *(Stizostedion vitreum)* (14 to 22 inches), 40 silver redhorse

(Moxostoma anisurum) (14 to 18 inches), and several hundred suckers—in the upper reaches of the river the common sucker *(Catostomus commersonnii commersonnii)*, and in the lower parts the Eastern sturgeon sucker *(Catostomus catostomus catostomus)*.

The 1943 census has been tabulated in Table 6 to indicate the success of those fishermen catching trout, and arranged by stream section from the headwaters to Lake Superior.

The distribution of fishermen by sections has always been very uneven due to success in previous years, parking and other facilities. The two headwater sections have been popular for the brook trout fisherman, while those areas known as Winneboujou, Ranger Station, Co-op Park and Johnson's Bridge have attracted those interested in rainbow and brown trout.

TABLE 6

FISHING SUCCESS BY STREAM SECTION IN THE BRULE RIVER, 1943

(Of 704 fishermen, 548 or 77.8 percent caught trout while 156 or 22.2 percent did not catch trout.)

Section	Number of Fishermen	Number of Trout	Average Number per Fisherman
Highway P	36	216	6.00[1]
Stone's	82	663	8.08[1]
Cedar Island	15	109	7.27
Big Lake	9	41	4.55
Winneboujou	97	522	5.38[1]
Ranger Station	141	365	2.59
Highway 2	7	23	3.29
Co-op	42	118	2.81
Johnson's	71	330	4.64[1]
Highway 13	0	0	....
McNeil's	8	19	2.37
Scott	0	0	....
Lake Superior	0	0	....
Miscellaneous	40	189	4.72
TOTALS	548	2,595	4.72

[1] Tagged trout planted here.

The Winneboujou bridge and Ranger Station areas consistently draw most of the fishermen. The facilities for parking are excellent and these areas can be quite easily fished by wading.

The average number of trout per fisherman-day is greatest in the headwater areas and gradually decreases in the downstream areas. However, the catch in the upper waters consists almost entirely of brook trout while brown and rainbow trout, in fewer numbers but of larger sizes, enter the catch in the middle and lower reaches of the river. These statements are clearly supported by the data presented in Table 6. However, the averages which are numbered are abnormally high due to the fact that legal-sized brook and rainbow trout were "spot" planted in these sections.

In 1943 part of the legal tagged trout were planted two to four weeks before the season opened and part were planted during the season (Table 7). One thousand brook trout were "spot" planted two weeks before the season opened, and apparently had distributed themselves sufficiently that only 12.0 and 19.2 percent respectively were caught during the season. However, these furnished fishing for approximately ten weeks. Another one thousand were "spot" planted six weeks after the season opened and most of those recaptured were taken within three weeks, although a fair catch was made for an additional three weeks. The total recorded catch amounted to 41.8 percent or two to three times the percent caught from the before-season plant. Averaging the total return from the three plants, the recorded return to the fisherman amounted to 28.7 percent. The results from two before-season "spot" plants and one in-season plant of tagged legal-sized rainbow trout gave exactly the same total recorded return, 28.7 percent, and the contribution to the creel was in practically the same proportion, and over the same period of time, as that for brook trout.

During 1943 the co-operation of an expert trout fisherman was secured, and we obtained a record of trout caught by species and hours fished. His record has been tabulated in Table 8 and presents several interesting facts with reference to fishing in the upper Brule above Big Lake.

The percent of total catch of brook, brown and rainbow trout amounted to 38.7, 37.1 and 24.2 percent respectively; however, it should be noted that the brook trout catch of 38.7 percent is a combination of 16.1 percent tagged brook trout and 22.6 percent untagged or resident brook trout. A one-day catch of ten tagged legal-sized brook trout made a substantial contribution to his catch of this species. He fished a total of 42 hours and had a total catch of 62 trout, or an average catch of 1.5 trout per hour,

TABLE 7

SUMMARY OF RECAPTURES OF TAGGED TROUT PLANTED IN THE BRULE RIVER, 1943

Species	Planted		Caught During					Total Catch	Percentage of Recapture
	Number	Date	May	June	July	Aug.	Sept.		
Brook	500	4–14	37	14	9	....	....	60	12.0
Brook	500	4–14	47	22	12	6	9	96	19.2
Brook	1,000	6–11	....	341	68	5	4	418	41.8
Totals	2,000	....	84	377	89	11	13	574	28.7
Rainbow	626	4–3	141	6	5	1	1	154	24.6
Rainbow	456	4–6	80	10	4	3	1	98	21.5
Rainbow	583	6–30	....	....	210	13	3	226	47.3
Totals	1,665	....	221	16	219	17	5	478	28.7

TABLE 8

CATCH OF TROUT BY ONE FISHERMAN, 1943

(62 trout were caught in 42 hours or an average of 1.5 trout per hour. Of the total trout 16.1 percent were tagged brook trout and 22.6 percent were untagged brook trout.)

Date	Brook	Brown	Rainbow	Hours Fished	Hours Before 5:00 P. M.	Hours After 5:00 P. M.
July 14	10[1]	2	3	8	7	1
Aug. 2	....	4	2	6	1	5
Aug. 5	....	7	2	7	3	4
Aug. 18	7	4	3	8	7	1
Aug. 25	7	2	3	6	3	3
Sept. 27	....	4	2	7	6	1
TOTALS . . .	24	23	15	42	27	15
PERCENT	38.7	37.1	24.2	....	64.3	35.7

[1] Tagged trout.

which is well over the "one fish per hour" considered necessary for fishing satisfaction. Approximately two thirds (64.3 percent) of the fishing effort was before 5 P.M. while one third (35.7 percent) was during the early and late evening. The evening fishing accounts for the fact that 37.1 percent of the trout catch were brown trout as compared to an average of 17.4 percent for the full length of the stream during the entire season.

During the season of 1944 another expert fisherman cooperated with the survey by keeping accurate records of his catch. All trout were caught in the middle section of the Brule, from Big Lake to U. S. 2 bridge, and all fishing was between the hours of 9 A.M. and 6 P.M. Approximately two thirds of the fish were taken on wet flies and one third on dry flies. A tabulation of his season catch is given in Table 9.

Since the section of stream was fished for 54 days and a total of 237.5 hours, the average fisherman-day consisted of 4.4 hours and the average catch per day amounted to 7.8 trout, which is somewhat higher than the average of 4.8 trout for the entire stream. The average number of trout caught per hour was 1.78, which is almost double the one fish per hour considered necessary for fishing satisfaction. The catch of brook trout (61.9 percent) is slightly less than the average for the entire stream (67.5 percent), the catch of brown trout (24.4 percent) some-

TABLE 9

CATCH OF TROUT BY ONE FISHERMAN, 1944

Month	Total Hours Fished	Total Trout	Average Number of Trout Per Hour	Total Trout			Resident Brook Trout	Tagged Legal Brook Trout	Days Fished
				Brook	Brown	Rainbow			
May	9	22	2.44	16	3	3	7	9	2
June	62½	144	2.30	99	27	18	51	48	17
July	94	146	1.55	87	38	21	41	46	19
August	67	103	1.54	56	31	16	36	20	15
September	5	8	1.60	4	4	0	3	1	1
Totals	237½	423	1.78	262	103	58	138	124	54
Percent	....	....	....	61.9	24.4	13.7	52.7	47.3	....

what higher than the stream average (17.4 percent), while the catch of rainbow trout (13.7 percent) agrees quite well with the stream average of 15.1 percent. The total catch of brook trout has been further divided into resident and tagged legal. The resident brook trout accounted for 52.7 percent while the balance, or 47.3 percent, were tagged legal-sized brook trout as compared to 49.5 percent and 50.5 percent respectively for the same groups on a streamwide average.

Analysis of the 1940 Catch

The catch for 1940 in the Brule River has been analyzed and presented graphically in a number of figures (1 to 6) to show the length distribution of the various species caught and the areas in which each was taken.

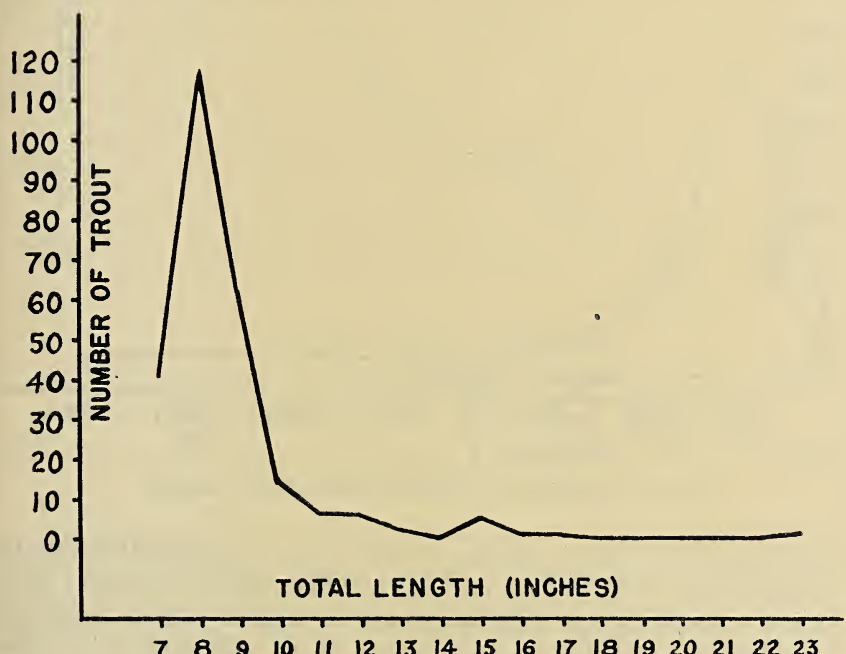

Fig. 1.—Length distribution of all brook trout caught in the Brule River, 1940. (Legal length—7 inches)

The size of brook trout and the number of each size is shown in Figure 1. Although one brook trout 23 inches in length was caught, the vast majority were in the 7–10-inch range, the 8-inch group predominating. There is a sharp rise from the

7-inch to the 8-inch group indicating that many fishermen must return to the water quite a few trout which are barely 7 inches in length. The same sharp increase from 7 to 8 inches is noted on the graphs for brown trout and rainbow trout which will follow later.

The distribution of the brook trout catch by the number caught in various sections of the stream is shown in Figure 2. The section labeled Stone is the Stone's bridge area at the upper end of the stream, and the McNeil section is at the extreme lower end near Lake Superior. The majority of the brook trout are caught in the upper one-third of the Brule, from the headwaters down to Winneboujou bridge. Comparatively few brook

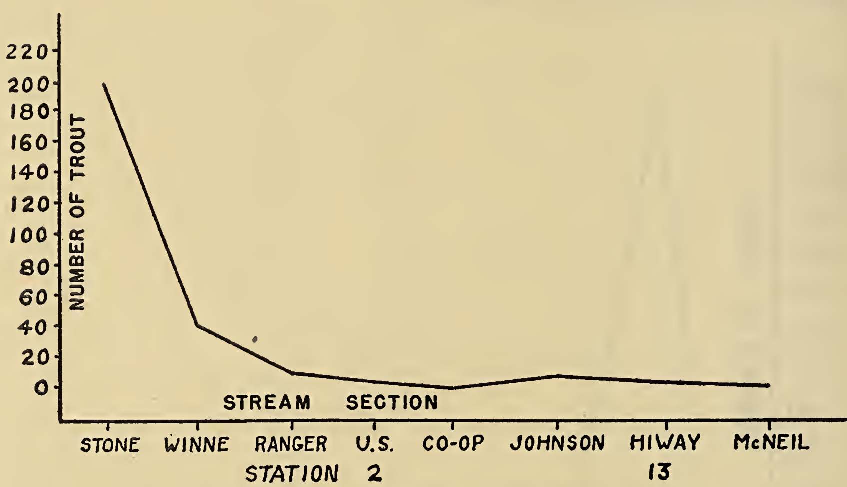

FIG. 2.—Number of brook trout by stream section.

trout are taken in the balance of the river, very probably due to the fact that many environmental conditions are no longer conducive to good brook trout production. Higher water temperatures prevail, and there occurs very serious soil erosion into the stream.

The brown trout is rapidly becoming the dominant trout in the Brule River. The evidence for this fact will be presented in a forthcoming report on an analysis of the fish populations of the river. Figure 3 indicates that there is a much wider range of catch sizes in the brown trout than was found in the brook trout.

The size-range of the principal catch extends from 7 inches to 17 inches, however, the majority were in the 7-inch to 12-inch group.

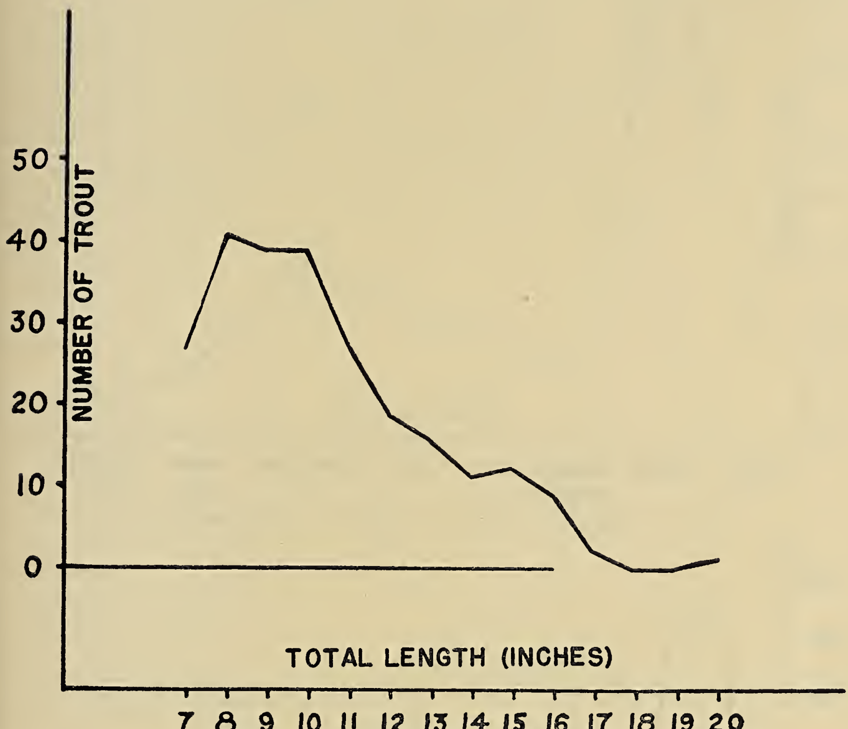

FIG. 3.—Length distribution of all brown trout caught in the Brule River, 1940. (Legal length—7 inches)

Whereas the peak catch of brook trout was in the Stone's bridge area, the peak catch of brown trout occurred in the Winneboujou area (upper end of middle section of river), with a smaller peak in the Johnson's bridge area (lower end of middle section). This is shown graphically in Figure 4.

Practically the same type of curve as was obtained for brook and brown trout results when the rainbow trout data are plotted. Table 5 shows the number of rainbow trout according to total length. Although the principal attraction of the Brule River during the early season is the presence, and the possibility of catching one or more, of the large rainbow trout which migrate

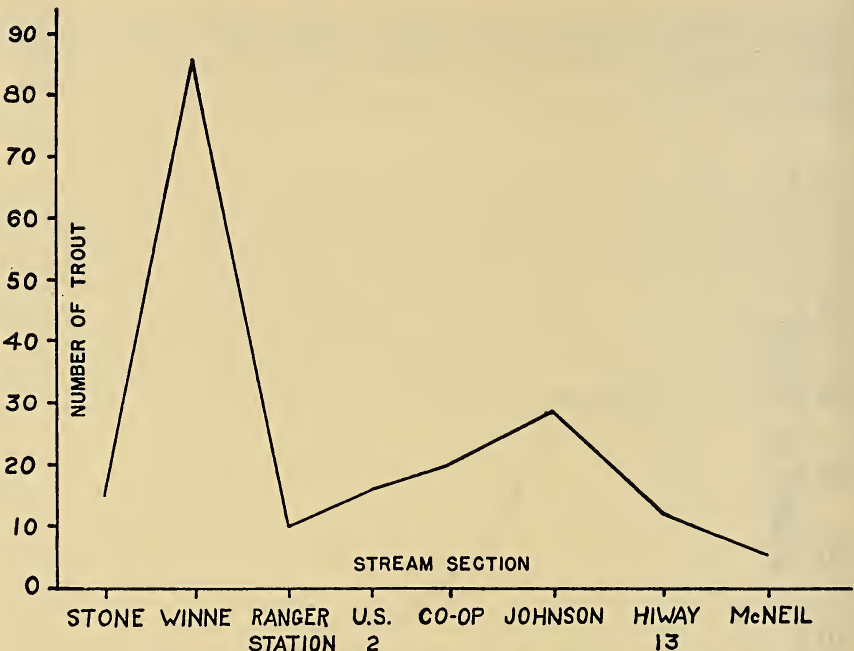

FIG. 4.—Number of brown trout by stream section.

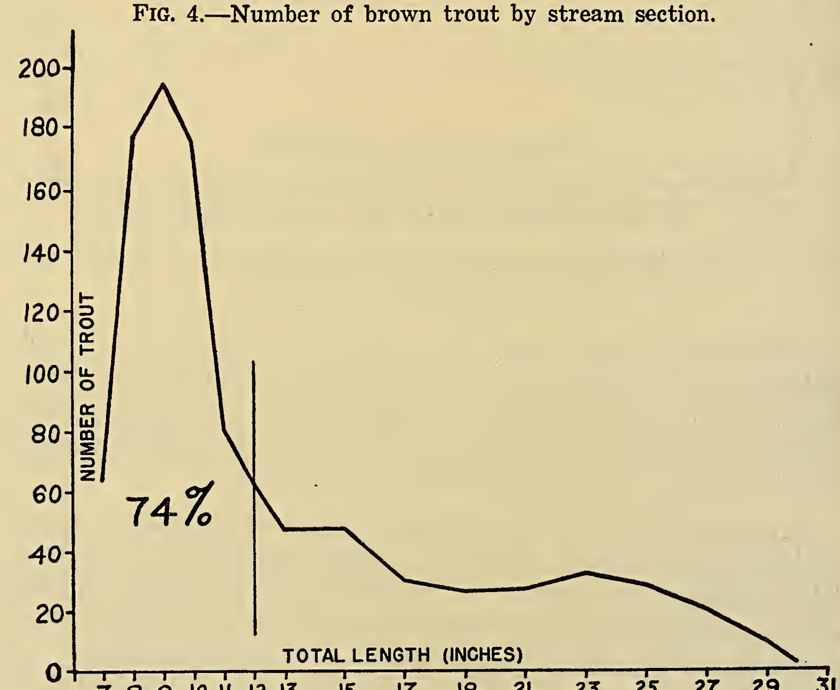

FIG. 5.—Length distribution of all rainbow trout (1,022) caught in the Brule River, 1940. (Legal length—7 inches)

from Lake Superior, 74 percent of the actual catch consists of rainbow trout 7 to 12 inches in length.

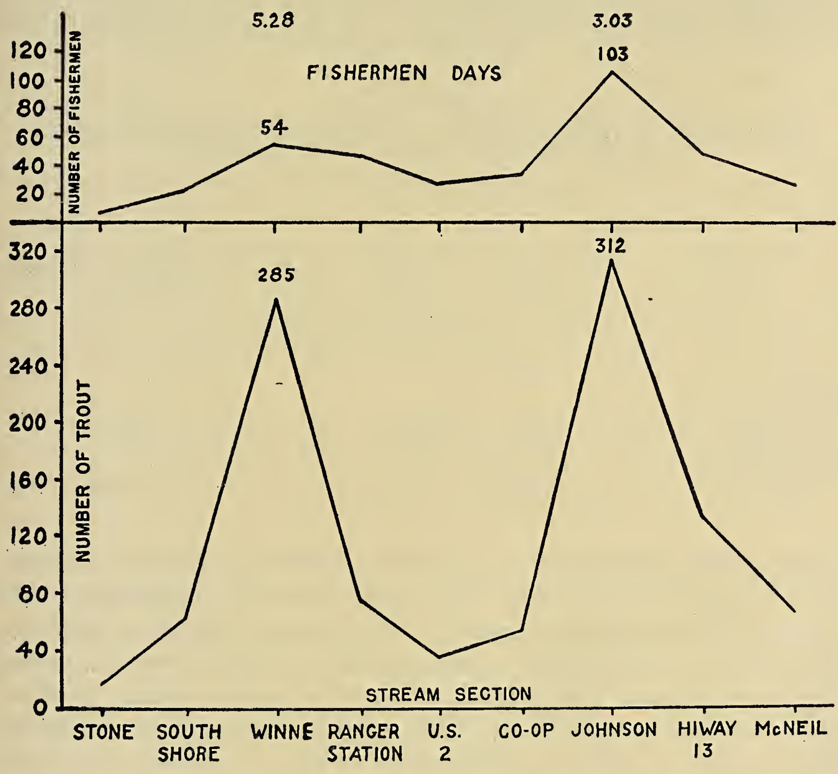

FIG. 6.—Upper: Number of fisherman-days by stream section with average catch per fisherman-day indicated for Winneboujou bridge and Johnson bridge areas, 5.28 and 3.03 respectively. Lower: Number of rainbow trout caught by stream section.

Several types of data have been graphed on Figure 6. The total rainbow trout catch is shown by stream section indicating two areas of heavy catch, the Winneboujou area and Johnson's bridge area, respectively. Almost the same number of trout was caught in each area. However, approximately twice as many fisherman-days were required in the Johnson's bridge area as in the Winneboujou area. Consequently the fishing satisfaction, as reflected in trout per fisherman-day, was greater in the Winneboujou area (5.28 trout) than in the Johnson's bridge area (3.03 trout).

During the 1944 investigational work on the river, approximately 125 quantitative samples of the fish population were made with the use of electric shocking equipment which allowed the fish to be collected easily; length and weight measurements and other data were then taken, and the fish returned to the water without damage. A report will follow later on an analysis of fish populations in the river based upon all of the above collections. However, since much of the creel census data indicates the decline of the brook trout and the growing importance of the brown trout, Table 10 is presented in this report to show that the brown trout is, in fact, well established in the Brule River, and to make a comparison with populations of other streams. The Flag and Iron rivers were selected for convenience of contact and because they are both considered good streams, although not as highly advertised as the Brule. In addition, they did not receive the extensive "stream improvement" such as was done on the Brule. The stations selected on the Brule were two of the best trout areas on the river. These data indicate that the brown trout is well established in the Brule, and also that there is a comparatively low standing crop of trout in pounds-per-acre in the Brule when compared to the Flag and Iron rivers.

TABLE 10

COMPARISON OF TROUT POPULATION COLLECTED BY ELECTRIC SHOCKER IN BLOCKED SECTIONS OF THREE STREAMS

Station	Area Sq. Ft.	Brown	Brook	Rainbow	Total Trout	
					Grams/ Sq. Ft.	Pounds/ Acre
		Grams	Grams	Grams		
Flag River (Jct. of Forks)	5,900	1,926	126	958	0.51	48
Iron River (Road Crossing)............	2,400	2,872	....	134	1.26	117
Brule River May's Rip . .	7,500	1,080	150	8	0.29	25
Cedar Island (½ mi. below)........	9,600	1,526	105	1,059	0.27	23

SUMMARY

1. Trout were first planted in the Brule River in 1890 and, since the first introductions, a total of 3,935,295 fish of all species

have been stocked. This includes 160,000 walleye pike fry and 2,500 black bass (species unknown).

2. Brook trout were native to the river and the first introductions, by the state of various species, were made as follows: walleye pike in 1890, rainbow trout in 1892, brook trout in 1894, black bass in 1906 and brown trout in 1920. The largest plant in one year of all species consisted of 542,842 trout stocked in 1940.

3. The catch of brook trout declined markedly between 1936 and 1940, the period of intense "stream improvement."

4. The return to the creel of marked legal-sized trout amounted to 28.7 percent in 1943 and 27.7 percent in 1944. The stocking consisted of 2,000 tagged trout in 1943 and 6,000 in 1944. However, the marked legal-sized trout contributed 43.1 percent in 1943 and 50.5 percent in 1944 to the total creel of all species.

5. "Scatter" planting of legal-sized trout allows a return to the creel over a longer period of time than does "spot planting." "Spot" planted trout (at bridges) are rapidly removed from the stream.

6. The catch of brown trout has increased since 1936 at the same rate as that for the decrease in brook trout.

7. The average catch of trout per fisherman-day has declined each year for 1936, 1940, 1943, and 1944, being 4.4, 2.8, 2.8, and 2.4. The plant of tagged legal-sized trout in 1943 and 1944 increased the average for these two years to 4.7 and 4.8 respectively.

8. The over-winter carryover of legal trout was negligible.

9. In 1943, the first seven days of the season provided fishing for 30.5 percent of the season's total fishermen, and they caught 23.4 percent of the total season's catch and 47.4 percent of the total pounds of trout.

10. The total harvest checked (minimum) amounted to 1,900 pounds in 1943 or 9.5 pounds per surface acre (199 acres, 46.9 stream miles). Much of this crop weight was due to the migratory rainbow trout.

11. In addition to trout, the following species of fish were taken in varying numbers: rock bass, northern pike, walleye pike, silver redhorse, common sucker and Eastern sturgeon sucker.

12. The catch in the extreme upper waters consists almost entirely of brook trout, while brown and rainbow trout in fewer number, but of larger sizes, enter the catch in the middle and lower reaches of the river.

13. Early season stocking of legal-sized trout provide two to three times the return to the creel as before-season planting.

14. The total season catch of two fishermen, one in 1943 and one in 1944, is analyzed.

15. The catch for 1940 is analyzed and presented graphically to show the length distribution of the various species caught, and the areas in which each was taken.

16. The trout population of two areas on the Brule River was compared with areas on the Flag and Iron rivers. All samples were quantitative, in seine-blocked areas, and fish were collected with the electric shocker. The results indicate that the brown trout is dominant in that section of the Brule, and also that there is a low standing crop of trout in pounds-per-acre when compared to the Flag and Iron rivers.

17. Recommendations for stocking of trout. Plant only brook trout of legal size, south of Cedar Island, to provide reasonable success for anglers. Give consideration to legal-sized brown trout in lower portion of river. Rainbow trout are not to be stocked.

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AN ANALYSIS OF THE VEGETATIVE COVER OF THE BRULE RIVER (WISCONSIN) WATERSHED

Brule River Survey Report No. 8

JOHN W. THOMSON, JR.
Department of Botany, University of Wisconsin

INTRODUCTION

In order to obtain an accurate estimate of the present-day vegetative cover of the Brule River (Wisconsin) watershed, for use in gauging its possible influence upon the stream and the life in it, the present study was undertaken.

Funds making possible the necessary field work and making available the aerial photographs and reproduction of the cover map were supplied by the Wisconsin Conservation Commission from the budget allotted to the Brule River Survey in cooperation with the University of Wisconsin. Grateful acknowledgment is made to Dr. N. C. Fassett and to my wife, Olive S. Thomson, for help and suggestions in the preparation of this paper.

The basis of the map included in this paper are aerial photographs made of this region for the A.A.A. program by the Abrams Aerial Survey Corp., Lansing, Michigan in August, 1938. Enlargements showing the area on a scale of approximately three inches to the mile were used in plotting the cover. A small Zeiss stereoscope provided by the Forestry Division of the Conservation Department was used in examining the photographs. The borders of the cover types were traced in pencil and then plotted on the cover map, which is on the scale of an inch to the mile, by means of a transparent grid placed over the photograph and compared with a proportionately smaller grid drawn on the working map. Reference was made constantly to the conditions in the field to be certain that the interpretation of the photographs was correct. The photographs were for the most part satisfactory for plotting cover, although certain types could not be distinguished and therefore have been lumped together.

TABLE 1

AREAS IN VEGETATIONAL COVER TYPES ON THE BRULE RIVER WATERSHED AND ITS SECTIONS OF PARTICULAR INTEREST

	Cover Type	Red Clay Soils		Barrens Area		Sections Touching the River		Lake Nebagamon Drainage Area		Total Area of Brule River Watershed	
		Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
	Conifer Bog	1,010	9.4	1,339	4.3	3,521	16.0	4,285	11.3	8,411	6.8
Aspen Association	Popple–birch	838	7.8	1,297	4.1	5,961	27.0	18,382	48.4	38,036	31.0
	Popple–birch and conifers	1,092	10.1	....	....	436	1.9	....	....	1,400	1.1
	Popple–pine	....	....	845	2.7	1,227	5.6	362	0.9	4,399	3.6
	Popple and alders	2,071	19.2	....	....	978	4.4	158	0.4	5,055	4.1
Jack Pine Association	Pine	....	....	3,239	10.4	1,094	4.9	204	0.5	4,235	3.4
	Scattered Pine	....	....	10,633	34.1	1,646	7.4	267	0.7	12,420	10.1
	Grass Upland	....	....	8,738	28.0	....	....	....	....	9,035	7.3
	Oak Scrub	....	....	3,288	10.5	877	3.9	....	....	3,943	3.2
	Hazel Brush	....	....	224	0.72	243	1.1	....	....	461	0.3
Lowland Hardwoods Association	Lowland Hardwoods	....	....	25	0.08	278	1.2	999	2.6	1,361	1.1
	Lowland Hardwoods and Conifers	474	4.4	....	....	530	2.4	3,435	9.0	5,473	4.4
	Lowland Hardwoods and Alder	....	....	329	1.05	207	0.9	145	0.3	1,500	1.2

Maple–Basswood–Yellow Birch........	....	....	....	....	826	3.7	40	0.1	2,228	1.8
Alder Swamp........	1,906	17.7	73	0.23	1,941	8.7	1,342	3.5	6,203	5.0
Grass Marsh........	72	0.7	52	0.17	132	0.6	7	0.02	143	0.1
Leatherleaf Bog........	....	....	55	0.17	30	0.1	397	1.0	864	0.7
Cultivated or Pastured........	3,285	30.6	939	3.01	2,073	9.3	6,073	16.0	15,210	12.4
Lake........	....	....	105	0.34	71	0.3	1,828	4.8	2,064	1.6

Pasture and cultivated land could not be satisfactorily separated without visiting each area in the field and have therefore been grouped together in this analysis. For the same reason black spruce *(Picea mariana)*, balsam *(Abies balsamea)*, and white cedar *(Thuja occidentalis)* have been grouped together under the general term, conifer bog.

The areas marked off on the photographs were measured with a planimeter and the readings translated into acreages for Table 1 by simple proportion:

$$\text{Acres} = \frac{640 \times \text{planimeter reading of cover area}}{\text{planimeter reading of the square mile}}$$

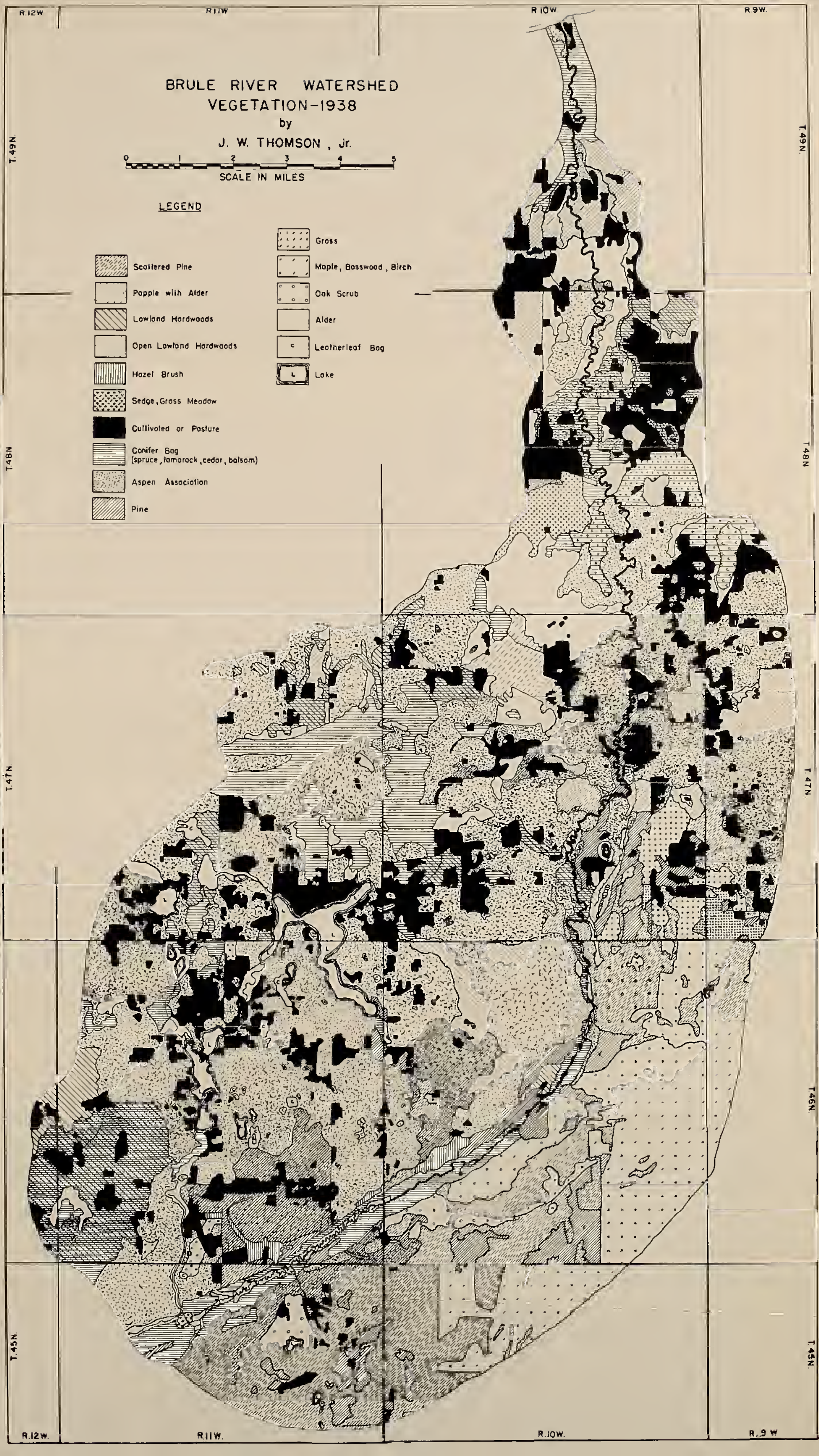
As the enlargements varied somewhat from mile to mile, the planimeter reading was taken for each square mile as well as for the areas of the various cover types within the square mile. Only one reading was taken for each measurement, because to make several readings and to take the average would have required more time than was available for this work and would not have appreciably affected the results. It was felt that an accuracy well within 7% was obtained from the readings. Calculations of proportions were made by use of a slide rule, but this possible source of error may be minimized for the purposes of this study.

The lists of plants characteristic of the various communities are by no means complete for the region but represent samples listed in various parts of the watershed. Aquatic and semi-aquatic communities have been omitted as they have been discussed in a previous paper. A complete set of voucher specimens has been deposited in the Herbarium of the University of Wisconsin; a second set is at the Superior State Teachers College.

CONIFER BOG COMMUNITIES

Gates makes three associations of the coniferous bog communities: the *Larix* or tamarack, the *Picea mariana* or black spruce, and the *Thuja* or white cedar associations. The *Thuja* association is the climax association for boggy areas in the Brule watershed as well as in northern lower Michigan. Whether the seres leading to this association are the grass marsh community, the alder swamp association or the leatherleaf bog association, the final stand would be of the white cedar or *Thuja* association whose species are listed below.


T.45N.
R.9W.
R.9W.
R.10W.
R.10W.
R.11W.
R.11W.
R.12W.
R.12W.
T.45N.



BRULE RIVER WATERSHED
VEGETATION-1938
by
J. W. THOMSON, Jr.
0 1 2 3 4 5
SCALE IN MILES
LEGEND
Scattered Pine
Popple with Alder
Lowland Hardwoods
Open Lowland Hardwoods
Hazel Brush
Sedge, Grass Meadow
Cultivated or Pasture
Conifer Bog (spruce, tamarack, cedar, balsam)
Aspen Association
Pine
Grass
Maple, Basswood, Birch
Oak Scrub
Alder
Leatherleaf Bog
Lake
R.12W.
R.11W.
R.10W.
R.9W.
T.49N.
T.48N.
T.47N.
T.46N.
T.45N.

PLANTS OF CONIFER BOGS

Dominant

Abies balsamea (balsam fir), *Larix laricina* (tamarack), *Picea mariana* (black spruce), *Sphagnum* (peat moss), *Thuja occidentalis* (white cedar).

Subdominant

Chamaedaphne calyculata (leatherleaf), *Ledum groenlandicum* (Labrador tea).

Associated Species

Acer rubrum (red maple), *Alnus incana* (tag alder), *Aster puniceus* (aster), *Botrychium virginianum* (rattlesnake fern), *Calla palustris* (water arum), *Carex intumescens* var. *fernaldii* (sedge), *Carex laxiflora* (sedge), *Carex tenella* (sedge), *Carex trisperma* (sedge), *Chiogenes hispidula* (snowberry), *Circaea alpina* (enchanter's nightshade), *Clintonia borealis* (Clintonia), *Coptis trifolia* (goldthread), *Cornus canadensis* (bunchberry), *Cypripedium pubescens* (yellow lady's slipper), *Dryopteris cristata* (crested fern), *Dryopteris thelypteris* var. *pubescens* (marsh fern), *Equisetum fluviatile* (marsh horsetail), *Eriophorum viridi-carinatum* (cotton grass), *Fraxinus nigra* (black ash), *Galium triflorum* (bedstraw), *Geum canadense* (white avens), *Glyceria canadensis* (rattlesnake manna grass), *Goodyera repens* var. *ophoides* (rattlesnake plantain), *Habenaria dilatata* var. *media* (wood orchis), *Habenaria obtusata* (wood orchis), *Ilex verticillata* (black alder), *Impatiens biflora* (jewel weed), *Linnaea borealis* var. *americana* (twinflower), *Lonicera canadensis* (honeysuckle), *Lonicera oblongifolia* (honeysuckle), *Lycopodium annotinum* (clubmoss), *Mitella nuda* (naked mitrewort), *Moneses uniflora* (one-flowered pyrola), *Nemopanthus mucronata* (mountain holly), *Osmunda cinnamomea* (cinnamon fern), *Polygala paucifolia* (fringed polygala), *Pteretis nodulosa* (ostrich fern), *Pyrola chlorantha* (pyrola), *Pyrola secunda* var. *obtusata* (pyrola), *Rhamnus alnifolia* (alder-leaved buckthorn), *Ribes prostratum* (skunk currant), *Rubus triflorus* (dwarf raspberry), *Senecio aureus* (golden ragwort), *Smilacina trifolia* (three-leaved solomon's seal), *Solidago uliginosa* (bog goldenrod), *Symplocarpus foetidus* (skunk cabbage), *Trientalis ameri-*

cana (star flower), *Vaccinium oxycoccus* var. *ovalifolium* (cranberry), *Veronica americana* (American brooklime), *Viburnum trilobum* (highbush cranberry), *Viola pallens* (white violet).

Although only 6.8% of the area of the entire watershed and 16% of the area of the sections touching the river are covered by the conifer bog communities, the conifer bog is of utmost importance in the management of the stream. This is due to the peculiar geological setting of the stream and the consequent effect upon the water supplies. As pointed out by E. F. Bean and J. W. Thomson, Jr., the Brule River occupies the former valley of a stream which once drained Glacial Lake Duluth to the southwestward. This stream eroded the broad valley of the upper Brule in which the conifer bog communities have become the dominant vegetation. The *Thuja,* or white cedar association, is the principal community in the floor of the valley. Under it a deposit of five to six feet of woody peat has been laid down. This organic material is the result of the slow accumulation since the Glacial Period of the remains of the bog plants—an accumulation of some 25,000 to 30,000 years. As pointed out by Gates and other students of bogs, the white cedar association is dependent upon the maintenance of wet ground and also upon the continued accumulation of the woody peat. Changes which destroy the delicate moisture balance destroy the bog. The upper Brule River obtains its water supplies in part from the precipitation, rain or snow and ice, which falls upon the bog and seeps slowly through the bog to enter the stream. The major part of the water supply, however, comes from the sand barrens. Water falling on the large barrens to the east of the Brule, or the smaller barrens to the west (see the maps) seeps vertically down through the sand to become part of the ground water supply. Eventually the water emerges on the broad valley floor through the springs and seepages which supply the upper Brule. Protected from warm sunlight by the bog association, and supplied by water seeping slowly through the cold peat deposits, the upper Brule is kept fairly constant in temperature and well within the range of satisfactory conditions for brook trout throughout the summer. The coniferous bog on the upper Brule must thus be protected not only to assure satisfactory shade over the stream but also to continue to deposit the woody peat which is a controlling factor in the upper valley. Pulpwood or other cutting, and placing of roads and trails through the bog, will undoubtedly cause deterioration of the cover, loss of the organic soil through oxidation and run-off, and disintegration of the upper Brule, the portion of the stream which is at present the least disturbed and in the most satisfactory condition. As seen in Table 1, large portions of the clay soil area and the Lake Nebagamon drainage area are in conifer bog communities, 9.4% and 11.3% respectively. These bogs act as buffers in preventing deposition of erosion materials in the Brule via Nebagamon Creek. While these bog communities may be cut under selective logging procedures, care should be taken not to destroy these buffers either by overlogging, fires, or other destructive practices.

THE ASPEN ASSOCIATION

The principal plant community of the watershed area, covering 39.8 percent of the entire area is the aspen association. Several phases of this association were distinguished on the watershed, depending upon the admixture of other trees. Over the greater part of the watershed the typical phase is one in which various species of *Populus* (aspen) and *Betula papyrifera* (white birch) dominate. This is called the popple–birch cover type in Table 1 and Aspen Association on the map. Along the Brule River and in the Nebagamon Creek drainage area are the main areas covered by this phase. On the red clay soil area in the north portion of the watershed, below the Copper Range, this cover type becomes largely supplemented with an admixture of conifers. Balsam, *Abies balsamea,* arbor vitae, *Thuja occidentalis,* and white spruce, *Picea canadensis,* are the principal conifers coming up among the poplars and white birch. Economically this sub-sere or phase is of greater value than the popple–birch type. On the uplands along the river and in some parts of the barrens, the poplars are intermixed with pine, largely jack pine, *Pinus banksiana,* and red pine, *Pinus resinosa.* On the red clay area large stands of the aspen association are mixed with alder on the poorly drained parts of the area. Cutting of the better stands of poplar, birch, and conifers for pulpwood tends to produce, on the red clay soils, the successional stages largely dominated by alders, *Alnus incana.* On the areas examined in the field there does not seem to be much recovery of the poplars, and still less of the conifers, following the clear cutting on the red clay. Succession following fires is the reason generally given by most authors for the presence of the aspen association in the lake states, and the Brule River watershed is no exception. All through the aspen association are great stumps, charred and blackened by the fires following the lumbering on the watershed. Where unbroken by roads, cultivation, pulpwood logging, or other activities of man, adequate protection of the watershed soils is given by the aspen association. An abundance of herbaceous plants as well as woody plants is found in the aspen association. Except along the banks of the lower Brule, where the undercutting of the red clay soils produces landsliding and slumping, little evidence of erosion was noted in this association. Where the aspen association on the red clay soils is cut for pulpwood, care should be taken to avoid the succession toward the alder swamp association which has become dominant over 17 percent of that area.

Plants of the Aspen Association

Dominant

Betula papyrifera (white birch), *Populus grandidentata* (large-toothed aspen), *Populus tremuloides* (trembling aspen), *Prunus pennsylvanica* (pin cherry).

Subdominant

Aster macrophyllus (large-leaved aster), *Diervilla lonicera* (bush honeysuckle), *Pteridium latiusculum* (bracken fern).

Associated Species

Abies balsamea (balsam fir), *Acer rubrum* (red maple), *Acer saccharum* (sugar maple), *Actaea rubra* (red baneberry), *Agrostis scabra* (hair grass), *Amelanchier wiegandii* (june-berry), *Amphicarpa monoica* (hog peanut), *Anemone canadensis* canada anemone), *Anemone quinquefolia* (wood anemone), *Antennaria neodioica* (pussy-toes), *Apocynum androsaemifolium* (dogbane), *Aquilegia canadensis* (columbine), *Aralia nudicaulis* (wild sarsaparilla), *Aralia racemosa* (spikenard), *Aster lindleyanus* (aster), *Athyrium angustum* (lady fern), *Botrychium multifidum* (grape fern), *Botrychium virginianum* (rattlesnake fern), *Carex gracillima* (sedge), *Caulophyllum thalictroides* (cohosh), *Chimaphila umbellata* (pipisissewa), *Clintonia borealis* (clintonia), *Cornus canadensis* (bunchberry), *Cornus paniculata* (gray dogwood), *Cornus rugosa* (round-leaved cornel), *Corylus rostrata* (beaked hazelnut), *Dryopteris spinulosa* (spinulose shield fern), *Epigaea repens* (rattlesnake plantain), *Epilobium angustifolium* (fire-weed), *Equisteum sylvaticum* (horsetail), *Erigeron ramosus* (daisy fleabane), *Fragaria virginiana* (strawberry), *Hepatica americana* (hepatica), *Hystrix patula* (bottlebrush grass), *Lactuca canadensis* (wild lettuce), *Lathyrus ochroleucus* (white wild pea), *Lathyrus venosus* var. *intonsus* (wild pea), *Luzula saltuensis* (wood rush), *Lycopodium clavatum* (club moss), *Lycopodium obscurum* (club moss), *Maianthemum canadense* (canada mayflower), *Melampyrum lineare* (cow wheat), *Mitchella repens* (partridge-berry), *Osmunda claytoniana* (interrupted fern), *Ostrya virginiana* (ironwood), *Panicum xanthophyscum* (panic grass), *Pedicularis canadensis* (wood betony), *Petasites palmatus* (sweet coltsfoot), *Picea canadensis* (white spruce), *Pinus banksiana* (jack pine), *Pinus resinosa* (red pine), *Pinus strobus* (white pine), *Poa pratensis* (june grass), *Populus tacamahacca* (balsam poplar), *Prenanthes alba* (white lettuce), *Pyrola asarifolia* var. *incarnata* (pyrola), *Quercus borealis* (red oak), *Rhus toxicodendron* (poison ivy), *Rosa blanda* (pasture rose), *Rubus nigrobaccus* (blackberry), *Rubus parviflorus* (thimbleberry), *Rubus villosus* (dewberry), *Salix discolor* (pussy willow), *Salix humilis* (prairie willow), *Sanicula marilandica* (black snakeroot), *Senecio pauperculus* (ragwort), *Streptopus roseus* var. *longipes* (twisted-stalk), *Steironema ciliatum* (fringed loosestrife), *Thalictrum dioicum* (meadow rue), *Tilia americana* (basswood), *Vaccinium pennsylvanicum* (blueberry), *Viburnum dentatum* (arrow-wood), *Vicia americana* (vetch), *Viola pubescens* (yellow violet).

THE JACK PINE COMMUNITY

Two subdivisions have been made of the jack pine community *(Pinus banksiana)* for the purpose of distinguishing between the amounts of standing timber on each. The "pine" cover type represents a dense growth of jack pine with the tops confluent in the aerial photographs. The "scattered pine" cover type is the same community but with the tops discrete, and even widely spaced, on the aerial photographs. The jack pine community is characteristic of the sandy soils of the Brule Barrens, mainly to the east of the river. As already pointed out in papers by Thomson and Fassett, drainage in the barrens area is almost entirely vertical. Little or no effect on the river is likely to occur from changes in this vegetational cover. The jack pine barrens are the result of fires as well as climate and soils. Periodic fires set the succession back. Early seres or stages in the succession toward the jack pine community are the grass upland, the oak scrub, the hazel brush, and the scattered pine cover types. The probable successional stages are indicated in Figure 1.

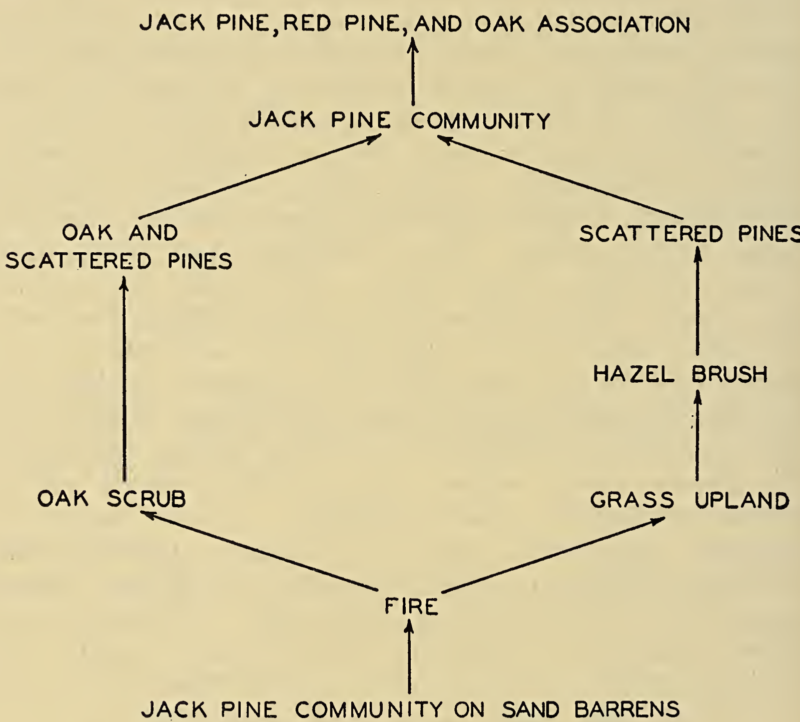


FIG. 1.—Probable plant succession on the Brule barrens.

When the burning is severe as in the fire of 1936, large areas of the "barrens" are converted into grass barrens. When the pines are eliminated by burning the Hill's oak, *Quercus ellipsoidalis*, underground parts may survive and by sending up shoots, produce a community apparently dominated by this oak. However, young jack pines soon spring up among the oaks and the community reverts to the jack pine community with oak interspersion. The forbs and grasses are similar in these seres leading to the climax jack and red pine and Hill's and bur oak association.

In this analysis it was not worthwhile separating the other pine communities from the jack pine because the areas in which these are dominant represent such an insignificant part of the watershed. A fine stand of red pine existed on the Pierce estate at the time of the field work but was being logged in 1945. Small stands of white pine also exist, but do not grealy influence the river.

Plants of the Jack Pine Community and Seres Leading to It

Dominant

Pinus banksiana (jack pine), *Quercus ellipsoidalis* (Hill's oak).

Subdominants

Corylus americana (hazelnut), *Danthonia spicata* (wild oats grass), *Myrica asplenifolia* (sweetfern), *Pteridium latiusculum* (bracken fern), *Quercus macrocarpa* (bur oak), *Salix humilis* (prairie willow), *Vaccinium pennsylvanicum* (blueberry).

Associated Species

Acer rubrum (red maple), *Agrostis gigantea* (red-top), *Agrostis scabra* (hair grass), *Alnus crispa* (green alder), *Amelanchier humilis* (juneberry), *Andropogon furcatus* (big bluestem), *Andropogon scoparius* (little bluestem), *Anemone quinquefolia* (wood anemone), *Antennaria fallax* (pussy-toes), *Antennaria plantaginifolia* (pussy-toes), *Apocynum androsaemifolium* (dogbane), *Arabis laevigata* (tower mustard), *Arctostaphylos uva-ursi* (bearberry), *Aster azureus* (aster), *Aster laevis* (smooth aster), *Aster lindleyanus* (aster), *Aster macrophyllus* (large-leaved aster), *Aster ptarmicoides* (aster), *Campanula rotundifolia* (bluebells), *Ceanothus ovatus* (New Jersey tea), *Cladonia chlorophaea* (pyxie cups), *Cladonia cristatella* (scarlet-crested cladonia), *Cladonia gracilis* (slender cup lichen), *Cladonia nemoxyna, Cladonia verticillata* (organ pipes lichen), *Comandra umbellata* (bastard toadflax), *Convolvulus spithamaeus* var. *stans* (bindweed), *Cypripedum acaule* (common lady's slipper), *Diervilla lonicera* (bush honeysuckle), *Erigeron glabellus* (fleabane), *Fragaria virginiana* (strawberry), *Gaultheria procumbens* (wintergreen), *Helianthemum canadense* (frostweed), *Helianthus occidentalis* (sunflower), *Helianthus rigidus* (sunflower), *Heuchera richardsonii* var. *hispidior* (alum root), *Houstonia longifolia* (bluets), *Koeleria cristata* (prairie junegrass), *Lactuca canadensis* (wild lettuce), *Liatris ligulistylus* (blazing star), *Lilium philadelphicum* (wood lily), *Lithospermum canescens* (puccoon), *Lithospermum carolinense* (puccoon), *Lysimachia quadrifolia* (whorled loosestrife), *Maianthemum canadense* (Canada mayflower), *Mollugo verticillata* (carpetweed), *Monarda fistulosa* (wild bergamot), *Oryzopsis asperifolia* (mountain rice), *Panicum depauperatum* (panic-grass), *Panicum meridionale* (panic-grass), *Pinus resinosa* (red pine), *Polygala polygama* (fringed polygala), *Polytrichum piliferum* (awled hair-cap moss), *Populus tremuloides* (trembling aspen), *Prunus pumila* (sand cherry), *Rubus villosus* (dewberry), *Selaginella rupestris* (creeping club moss), *Senecio pauperculus* (ragwort), *Solidago canadensis* (Canada goldenrod), *Sorghastrum nutans* (indian grass), *Symphoricarpos occidentalis* (wolfberry), *Viola conspersa* (violet), *Waldsteinia fragarioides* (barren strawberry).

THE SWAMP HARDWOODS ASSOCIATION

The swamp or lowland hardwoods association is of minor importance in the watershed as a whole. In its various phases it occupies 6.7 percent of the entire watershed. On poorly drained portions of the Lake Nebagamon watershed it assumes more importance and covers 11.9 percent of that area. Two subphases are distinguishable in the Brule watershed: one with a heavy mixture of balsam fir and white cedar, and one with a heavy proportion of alder. These are easily separable on the aerial photographs and have, therefore, also been separated in Table 1.

Plants of the Swamp Hardwoods Association

Dominant

Acer rubrum (red maple), *Fraxinus nigra* (black ash), *Ulmus americana* (elm).

Subdominant

Abies balsamea (balsam fir), *Alnus incana* (tag alder), *Betula papyrifera* (white birch), *Populus tacamahacca* (balsam poplar).

Associated Species

Acer spicatum (mountain maple), *Actaea alba* (white baneberry), *Actaea rubra* (red baneberry), *Apocynum androsaemifolium* (dogbane), *Aralia nudicaulis* (wild sarsaparilla), *Asarum canadense* (wild ginger), *Aster macrophyllus* (large-leaved aster), *Athyrium angustum* (lady fern), *Botrychium virginianum* (rattlesnake fern), *Campanula aparinoides* (marsh bellflower), *Carex retrorsa* (sedge), *Carex tuckermani* (sedge),

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Cornus stolonifera (red-osier dogwood), *Corylus americana* (hazelnut), *Dryopteris spinulosa* (spinulose shield fern), *Echinocystis lobata* (bur-cucumber), *Equisetum arvense* (horsetail), *Eupatorium purpureum* (joe-pye-weed), *Geum canadense* (white avens), *Humulus lupulus* (hops), *Impatiens biflora* (jewelweed), *Laportea canadensis* (wood nettle), *Lilium michiganense* (yellow meadow lily), *Maianthemum canadense* (Canada mayflower), *Onoclea sensibilis* (sensitive fern), *Osmunda claytoniana* (interrupted fern), *Pteretis nodulosa* (ostrich fern), *Pteridium latiusculum* (bracken fern), *Ribes cynosbati* (wild currant), *Rubus idaeus* (raspberry), *Rudbeckia laciniata* (coneflower), *Sanicula marilandica* (black snakeroot), *Scutellaria lateriflora* (mad-dog skullcap), *Senecio aureus* (golden ragwort), *Stachys palustris* (woundwort), *Steironema ciliatum* (fringed loosestrife), *Streptopus roseus* (twisted stalk), *Thalictrum dioicum* (meadow rue), *Thuja occidentalis* (white cedar), *Trillium cernuum* (trillium), *Urtica procera* (nettle), *Viburnum lentago* (nannyberry), *Viburnum opulus* var. *americanum* (high-bush cranberry), *Waldsteinia fragarioides* (barren strawberry).

MAPLE–BASSWOOD–YELLOW BIRCH COMMUNITY

This community, with a dominance of hardwood trees is of small importance on the watershed, the main stands being on the north side of Lake Minnisuing and to the east of the Brule River near the Copper Range and on it. Less than 2 percent of the watershed is covered by this type. Formerly a sugar camp for obtaining maple sugar was located on the hill to the west of the N. P. Johnson's Bridge, but with lumbering and fires, the old trees have gone and the sugaring has ceased. A scrub growth of the same species covers the rock hill today, but recovery will be slow as much of the soil is gone from the hillslopes.

PLANTS OF THE MAPLE–BASSWOOD–YELLOW BIRCH COMMUNITY

Dominant

Acer rubrum (red maple), *Acer saccharum* (sugar maple), *Betula lutea* (yellow birch), *Betula papyrifera* (white birch), *Ostrya virginiana* (ironwood), *Pinus strobus* (white pine), *Tilia americana* (basswood).

Associated Species

Abies balsamea (balsam fir), *Acer spicatum* (mountain maple), *Allium tricoccum* (wild leek), *Aralia nudicaulis* (wild sarsaparilla), *Aralia racemosa* (spikenard), *Arisaema triphyllum* (jack-in-the-pulpit), *Asarum canadense* (wild ginger), *Athyrium angustum* (lady fern), *Botrychium matricariaefolium* (grape fern), *Botrychium virginianum* (rattlesnake fern), *Carex intumescens* (sedge), *Clintonia borealis* (clintonia), *Corallorhiza maculata* (coral-root orchis), *Cornus stolonifera* (red-osier dogwood), *Dryopteris linnaeana* (oak fern), *Dryopteris phegopteris* (long beech fern), *Galium aparine* (bedstraw), *Hepatica americana* (hepatica), *Maianthemum canadense* (Canada mayflower), *Milium effusum* (wild millet), *Osmorrhiza claytoni* (sweet cicely), *Osmorrhiza longistylis* (sweet cicely), *Osmunda claytoniana* (interrupted fern), *Petasites palmatus* (sweet coltsfoot), *Ranunculus abortivus* (abortive buttercup), *Ribes prostratum* (skunk currant), *Rubus villosus* (dewberry), *Sanicula marilandica* (black snakeroot), *Streptopus roseus* var. *longipes* (twisted stalk), *Trientalis americana* (star flower), *Trillium cernuum* (trillium), *Veronica serpyllifolia* (thyme-leaved speedwell).

ALDER SWAMP ASSOCIATION

Although a small percentage of the area next to the river is in this cover type, the influence upon the river is very strong. Only 8.7 percent of the sections touching the river is in this type, but the alder swamp association borders the stream and is especially important in the upper section above Big Lake where the Brule River flows through the Brule bog. Here the sediments, as shown by R. I. Evans, are principally contributed by this plant association. The non-aquatic invertebrates supplying fish foods and the terrestrial and aerial stages of the aquatic insects must all be strongly influenced by this stream border association.

Along the upper Brule, the association provides much needed cover to protect the stream. The dark waters and bottom readily absorb the heat rays in the sunlight and these must be intercepted by appropriate stream cover to prevent warming of the water. The alder swamp association, eminently satisfactory for this purpose, should be maintained, not cleared, along the upper Brule. The narrow fringe of alders along the lower Brule also should be left undisturbed to provide cover and erosion prevention.

Fires and continued pulpwood cutting of the aspen association on the red clay soils area have led to a large percentage of this area, 17.7 percent, being covered with an alder thicket.

Plants of the Alder Swamp Association

Dominant

Alnus incana (tag alder).

Subdominant

Cornus stolonifera (red-osier dogwood), *Rhamnus alnifolia* (alder-leaved buckthorn), *Salix pedicellaris* (bog willow), *Viburnum opulus* var. *americanum* (high-bush cranberry).

Associated Species

Aster puniceus (aster), *Aster umbellatus* (aster), *Athyrium angustum* var. *rubellum* (lady fern), *Calamagrostis canadensis* (bluejoint), *Calla palustris* (water arum), *Chrysosplenium americanum* (golden saxifrage), *Cicuta bulbifera* (water hemlock), *Cirsium muticum* (swamp thistle), *Dryopteris cristata* (crested fern), *Equisetum sylvaticum* (horsetail), *Fragaria virginiana* (strawberry), *Galium asprellum* (bedstraw), *Galium claytoni* (bedstraw), *Helianthus giganteus* (sunflower), *Impatiens biflora* (jewelweed), *Iris versicolor* (iris), *Lycopus americanus* (water horehound), *Mentha arvensis* var. *lanata* (mint), *Myosotis scorpioides* (forget-me-not), *Myrica gale* (sweet gale), *Prenanthes alba* (white lettuce), *Ribes americanus* (gooseberry), *Rumex britannica* (great water dock), *Solidago uliginosa* (bog goldenrod), *Spiraea salicifolia* (meadowsweet), *Steironema ciliatum* (fringed loosestrife), *Thalictrum dasycarpum* (meadow rue), *Viola* sp. (violet).

GRASS MARSH COMMUNITIES

It would appear that the grass marsh communities, comprising only a fraction of 1 percent, are of very little importance to the entire watershed. Here, as in the case of the conifer bogs and the alder swamp association, the importance is that of position. Examination of the maps will show that the grass marshes are along the river, particularly the upper Brule. Removal of the trees from a wooded bog, particularly when followed by fires, brings about the establishment of the *Calamagrostis* association of wet-meadow grasses according to Gates. The stream then winds through an open marsh with the black bottom exposed to insolation which can raise the bottom temperatures considerably. In addition, the streamside alder cover is reduced along such meadows on the upper Brule, and conditions for fish seem less satisfactory than in undisturbed sections of the stream. Protection from fires and from removal of the timber is necessary to prevent further encroachment of the grass marsh communities.

Plants of the Grass Marsh Communities

Dominants

Calamagrostis canadensis (bluejoint), *Poa palustris* (fowl bluegrass).

Associated Species

Asclepias incarnata (swamp milkweed), *Aster lateriflorus* (aster), *Campanula aparinoides* (marsh bellflower), *Carex stricta* (sedge), *Gentiana flavida* (yellow gentian), *Glyceria grandis* (manna grass), *Hypericum ascyron* (great St. John's-wort), *Hypericum virginicum* var. *fraseri* (marsh St. John's wort), *Lycopus americanus* (water horehound), *Lycopus virginicus* (water horehound), *Lysimachia thyrsiflora* (tufted loosestrife), *Mentha arvensis* var. *lanata* (mint), *Polygonum sagittatum* (arrow-leaved tear-thumb), *Stellaria longifolia* (marsh chickweed).

LEATHERLEAF BOG ASSOCIATION

The leatherleaf bog or *Chamaedaphne* association is of practically no importance in the watershed management. It occupies mainly the kettleholes of the morainic topography of the Lake

Nebagamon watershed area and the Barrens, and occupies but a fraction of 1 percent of the entire area. The leatherleaf bog association, if given protection, especially from fires, leads eventually through tamarack and black spruce communities to the white cedar association.

Plants of the Leatherleaf Bog Association

Dominant

Chamaedaphne calyculata (leatherleaf), *Sphagnum* sp. (peat moss).

Subdominant

Ledum groenlandicum (labrador tea), *Vaccinium pennsylvanicum* (blueberry).

Associated Species

Andromeda glaucophylla (bog rosemary), *Betula papyrifera* (white birch), *Calla palustris* (water arum), *Calopogon pulchellus* (grass pink), *Drosera rotundifolia* (sundew), *Dryopteris thelpyteris* var. *pubescens* (marsh fern), *Dulichium arundinaceum* (three-way sedge) *Epilobium angustifolium* (fireweed), *Eriophorum spissum* (cotton grass), *Eriophorum viridi-carinatum* (cotton grass), *Kalmia polifolia* (pale laurel), *Larix laricina* (tamarack), *Lysimachia terrestris* (swamp-candle), *Menyanthes trifoliata* (buck bean), *Picea mariana* (black spruce), *Pinus banksiana* (jack pine), *Sarracenia purpurea* (pitcher plant), *Scirpus atrocinctus* (wool grass), *Utricularia vulgaris* var. *americana* (bladderwort), *Vaccinium oxycoccus* (cranberry), *Vaccinium pennsylvanicum* var. *nigrum* (blueberry).

PASTURE AND CROP LAND

The most extensively cultivated and pastured part of the watershed is on the red clay soil area north of the Copper Range. Here 30.6 percent of the area is under pasture or is cultivated. The Lake Nebagamon drainage area is second with 16 percent under cultivation and pastured. The average for the entire area is but 12.4 percent. The barrens with only 3 percent in such cover pulls down the average. A preliminary study of the crop practices by O. R. Zeasman and M. F. Schweers showed that cropping practices were such that the cultivated areas were contributing little silt to the river. The crop lands are largely on level ground and are used for raising close-grown crops which do not cause great erosion. Taking the figures for T.49N., R.10W. and T.48N., R.10W. from J. S. Bordner's study of the county, we find that 2,347 acres are in open, pastured or abandoned land and 4,831 acres are in crop land. If the portion of these red clay soil townships which is in the Brule River watershed maintains the same proportion of crop to pastured and similar land, then about 10 percent of the red clay soil is pastured and 20 percent is under cultivation. Small grains, peas and similar crops, are the principal crops on the red clay soils, and the increasing tendency is to place more and more in pasture, thus keeping the soils rather well protected. As pointed out in earlier reports, the highways, access roads to farms and cottages, and eroding river banks are the principal sources of silt in the river. There are some clean tilled crops in the Lake Nebagamon area, but between them and the river are the bogs and kettleholes of that area and the settling basins of Lakes Nebagamon and Minnisuing.

SUMMARY

1. The Brule River drainage pattern is atypical of most trout streams of northern Wisconsin in that its valley is a broad valley eroded by a former, much larger, stream which flowed in the opposite direction. The water supplies come partly from a coniferous bog occupying this valley, and partly from springs issuing from the floor of the valley. The ground water emerging from the springs comes via vertical drainage from the sandy barrens to either side of the Brule. With this peculiar drainage pattern, the vegetation of the parts of the watershed in the barrens has little effect on the river; and on the other hand the vegetation of the headwaters bog, although it occupies but a small percentage of the watershed area, has a very great influence.

2. The principal plant communities of the Brule River watershed are the conifer bog communities, the aspen association, the jack pine barrens community, the swamp or lowlands hardwoods association, the maple–basswood–yellow birch association, the alder association, the grass marsh communities, the grass upland community, the leatherleaf bog association, and cultivated and pastured land.

3. The conifer bog communities include the tamarack, black spruce, and white cedar–balsam fir associations.

4. Seres or successional stages, caused by fires, on the Brule barrens are the grass uplands, hazel brush, oak scrub, and jack pine communities, leading to the jack pine– red pine–Hill's and bur oak association.

5. The dominant, subdominant and associated species of each community are listed.

6. The analysis of the watershed area vegetational cover in toto and for various parts is given in terms of acreages and percentages.

7. A map of the watershed area, showing the vegetational cover, is provided.

8. Some watershed management recommendations are made.

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BOTTOM DEPOSITS OF THE BRULE RIVER

Brule River Survey Report No. 9

RICHARD EVANS
Department of Botany, University of Wisconsin

Recent studies made upon the Brule River have shown that the general character of the stream varies considerably throughout its length. Such differences, of course, make for equally different conditions for the growth of trout. Conditions in the lower Brule are fairly obvious: the stream cuts through banks of red clay and as a consequence the water is heavily charged with red sediment. In the upper Brule the stream flows through a sphagnum bog which acts as a filter and as a reservoir from which water eventually seeps into the river. This bog is bordered by jack pine barrens; papers now in press in the Transactions of the Wisconsin Academy (N. C. Fassett, J. W. Thomson) present the theory that, although these barrens are largely deforested by burning, there is little or no surface drainage reaching the Brule River because precipitation water soaks into the sand and thence reaches the river largely through springs in the bog. However, the upper river has a heavy bottom deposit, sometimes several feet deep, of material which is superficially amorphous and unidentifiable to the naked eye.

Identification of the constituents of these deposits (both from qualitative and from quantitative standpoints) has been undertaken for the purpose of determining their origin. The bearing which the presence or absence of these bottom deposits may have upon trout, whose environment they probably affect both directly and indirectly, and upon suckers which derive food from some of these bottom substances can, of course, best be evaluated by fish experts.

All the first collections made by Dr. N. C. Fassett were taken directly from the exposed upper layer of detritus during the fall of 1943. One collection made by Dr. John Thomson on April 30, 1944 was from flotsam in an eddy at Stone's Bridge following the extraordinarily high water of that year. The remaining collections were made by the writer on the 21st of May, 1944 at various points in the upper river above Stone's Bridge. These latter collections were taken as follows: a sample was removed from the surface and one from six inches below the surface at the same point in the river bottom with a tubular brass trap fitted with a seated conical valve. This valve could be manipulated from above by means of a brass rod which extended up through the trap and through the extendable pipe-handle threaded onto the trap.

At the outset, in making determinations, a few cc. of a well-mixed sample were thoroughly shaken in distilled water; this mixture was then allowed to stand for an hour and the liquid was pipetted off and centrifuged. A second washing was made followed by a half-hour settling period and the liquid was treated as in the first washing. Likewise several other washings which were followed respectively by three fifteen-minute settling periods, a ten-minute period, and a five-minute period were made—the liquid in each case being pipetted and centrifuged. However, in examining the centrifuged residues from the supernatant liquid following the longer settling periods it was found that there was little of an identifiable nature present. Following even the five-minute period, nothing that could be certainly identified remained in suspension excepting some of the smaller diatoms, extremely fine silt, individual parenchymatous cells of higher plants or small groups of such cells, cork cells, individual wood fibers, bits of xylem vessels or tracheids, an occasional fragment of a filamentous alga, and a few sponge spicules. Much of this material could not be specifically identified beyond these categories. Most of the filamentous algal fragments appeared to be *Ulothrix* sp. A very few desmids, *Cosmarium* sp., were found. Beyond these forms, no algae were encountered which could be recognized as such. A very few gymnosperm pollen grains were found, but they were only occasional. Since such pollen grains are provided with hollow appendages and hence will float for a long time before becoming water-logged, it is small wonder, perhaps, that only a very few were found in the bottom deposits in the upper reaches of the river.

The following procedure was then settled upon: two or three cc. of a sample were well shaken in distilled water and the whole was allowed to stand for a minute or two until everything of a possibly identifiable size had settled. The water was then carefully decanted. This same procedure was repeated until the water came off clear. All the washing water was filtered and the residue was saved. Using a dissecting binocular microscope, the washed detritus was sorted into identifiable and unidentifiable fractions. The identifiable fraction was then further sorted into wood fragments, leaf fragments and bark fragments. All the fractions of the total sample were dried in an oven and weight computations were made.

Results obtained from the analyses of these samples show that most of the deciduous leaf material that could be identified was alder, although some member of the *Ericaceae* also was represented—probably leatherleaf. The bulk of the gymnosperm leaf material was white cedar, with some balsam, white pine, and tamarack leaf fragments also present. Gymnosperm leaves were found to maintain their identities remarkably consistently as long as portions of them remained which were large enough to be selected and examined. Bark was in most cases unidentifiable as to species, although groups of cork cells as such could be recognized under the microscope. Fragments of bark large enough to show recognizable characteristics proved to be alder bark.

With respect to the identification of the wood fractions of the various samples, the following may be said: alder, leatherleaf, and aspen could be recognized with certainty. Angiosperm wood in which disintegration was too far advanced to permit the finding of characteristic vessel segments could, even so, be distinguished from gymnosperm wood and was cataloged simply as "angiosperm wood." In working with gymnosperm wood, most of the fragments were too small or too far advanced toward disintegration to employ the usual means for further specific diagnoses (such as those based, for example, upon ray characteristics). Consequently gymnosperm wood was of necessity simply classified as such. In all identifications of wood, the phloroglucinol-hydrochloric acid treatment was used. It may be noted that in general, gymnosperm wood, as long as it could be recognized by bordered pits and no matter how far it had proceeded toward disintegration, gave the characteristic bright red of the phloroglucinol lignin test, whereas only the most recent angiosperm wood samples stained brilliantly. However, gymnosperm wood was never recorded as such unless bordered pits could be distinguished. When there was doubt with respect to identity, fragments were simply classified as "wood."

As has been suggested, calculations were based upon oven-dry weights of sorted detritus. Although the proportions vary somewhat with the samples, the following figures are representative for the surface bottom collections:

TABLE 1

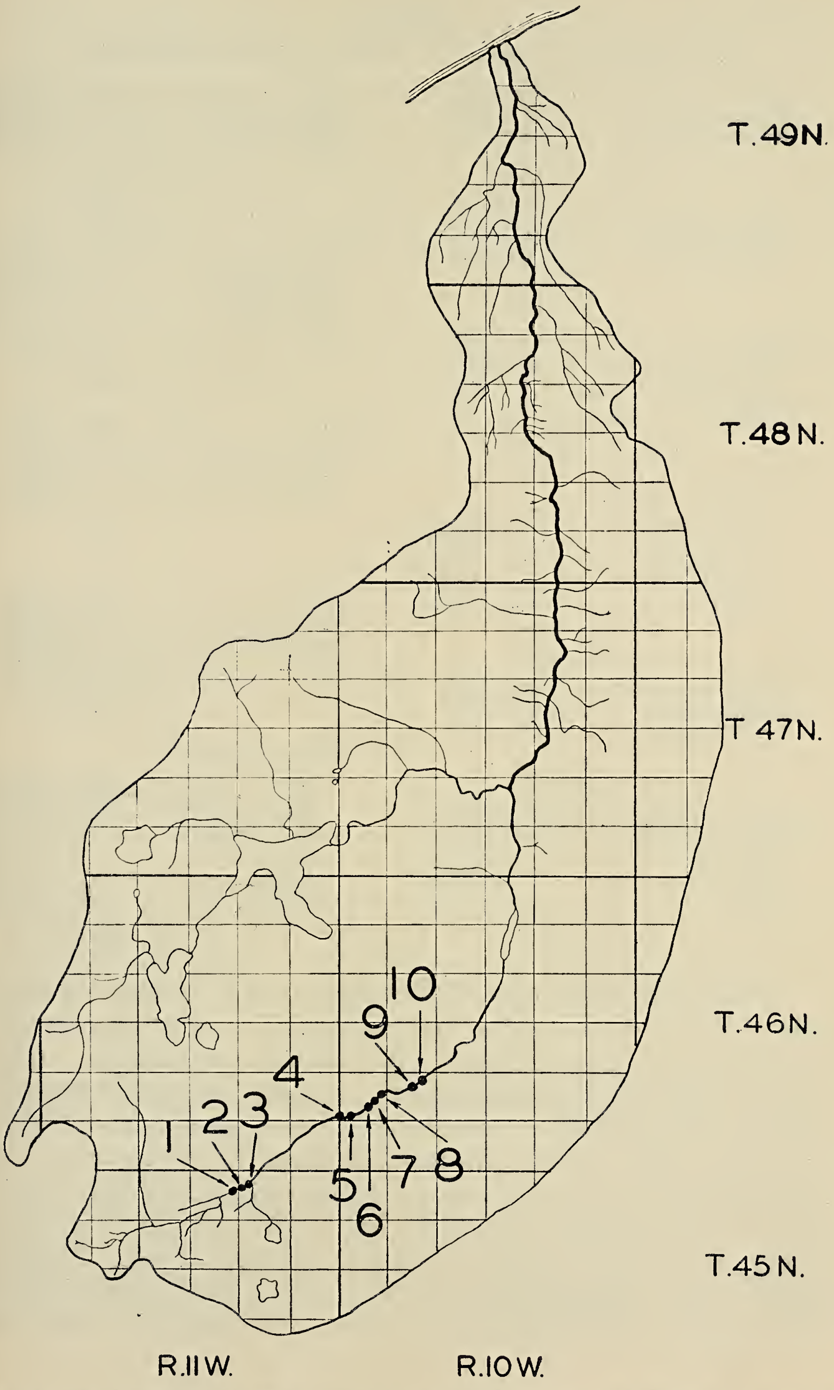
(Location 2 on the map)

Recognizable residue	87.3 mg.	29.5%	Percentages of total sample.
Unrecognizable residue	78.1 mg.	26.3%	
Flotable residue	131.0 mg.	44.1%	
	296.4 mg.		

Recognizable residue	Wood	47.2 mg.	54.0%	Percentages of identifiable fraction.
	Bark	20.3 mg.	23.2%	
	Leaf	19.8 mg.	22.7%	
		87.3 mg.		

What is referred to in the above table as "flotable residue" is that material which was carried off with the washing water in the first fractionating procedure—colloidal soil particles, individual cells or very small groups of cells, etc. A composite quantity of flotable residue taken from six surface samples was oven-dried. Of this sample, .8809 gr. was ignited for twelve hours at 1200° F. The ignition loss was 61.5%. Prof. M. L. Jackson of the Soils Department of the University determined by means of the chromic acid method that the organic matter in this same sample was 59.5%. The "recognizable" and "unrecognizable" residues make up those materials which were left after washing. These figures would indicate (1) that almost half the bottom sediment was made up of extremely finely divided organic and mineral matter, of which approximately 60% was organic; (2) that 75% or more of the bulk (by weight) of the identifiable material was wood and bark.

The figures given below with the recapitulation at the end present the wood analyses for representative surface collections in the upper Brule and for the flotsam collection made by Dr. Thomson. The first column of figures in each case gives the numbers of fragments concerned.



Location of collections. The numbers correspond to those used in the tables.

TABLE 2

(See map for locations of the following ten collections.)

1.	Alder	25—50%
	Gymnosperm	24—48%
	Aspen	1— 2%
		50
2.	Alder	26—52%
	Gymnosperm	17—34%
	Angiosperm	7—14%
		50
3.	Alder	23—46%
	Gymnosperm	24—48%
	Leatherleaf	1— 2%
	Aspen	2— 4%
		50
4.	Flotsam collection	
	Alder	70—55.5%
	Gymnosperm	49—38.8%
	Leatherleaf	1— 0.8%
	Aspen	2— 1.6%
	Wood	4— 3.2%
		126
5.	Alder	63—67%
	Gymnosperm	26—27%
	Leatherleaf	6— 6%
		95
6.	Alder	43—56.5%
	Gymnosperm	21—27.6%
	Leatherleaf	3— 3.9%
	Angiosperm	8—10.5%
	Wood	1— 1.3%
		76
7.	Alder	19—47.5%
	Gymnosperm	13—32.5%
	Angiosperm	6—15.0%
	Wood	2— 5.0%
		40
8.	Alder	23—37.8%
	Gymnosperm	29—46.8%
	Leatherleaf	3— 4.8%
	Angiosperm	4— 6.4%
	Wood	3— 4.8%
		62
9.	Alder	20—40%
	Gymnosperm	25—50%
	Angiosperm	3— 6%
	Wood	2— 4%
		50
10.	Alder	29—58%
	Gymnosperm	16—32%
	Leatherleaf	4— 8%
	Aspen	1— 2%
		50
Recapitulation:		
	Alder	341—52.5%
	Gymnosperm	244—37.6%
	Leatherleaf	18— 2.8%
	Aspen	6— 0.9%
	Angiosperm	28— 4.3%
	Wood	12— 1.8%
		649

It is possible that these figures do not give an entirely accurate estimate of the original proportions of the various constituents of the bottom deposits. Since alder, for example, disintegrates much more rapidly than gymnosperm wood, there is extant very probably a considerably lower proportion of alder fragments than would have been observed if all the wood had disintegrated at the same rate. An interesting side-light might well be presented at this point. Up to 95% of the wood fragments were more or less completely permeated with fungous hyphae. The percentages of fungous infestations varied from 30% to 95%, but in general they were well over 50%. Many of the wood fragments in which hyphae could not be found showed fungous erosion, but these latter were excluded in calculating the percentages given above. Practically all the hyphae which were observed possessed cross-walls; clamp connections were frequent. This evidence points to the fact that the fungi concerned were Basidiomycetes and hence were present in the wood before it settled to the stream bottom. It may be concluded from the high incidence of basidiomycetous hyphae that disintegration in most instances was well advanced before the wood reached the river.

In Table 3 weight data are presented for two representative collections—one taken at the surface, the other taken at six inches below the surface at the same spot in the river bottom of the upper Brule. The figures for the surface collection have already been given in Table 1, but they are repeated here for purposes of comparison.

TABLE 3

(Location 2 on the map)

Surface Sample:

Recognizable residue	87.3 mg.		29.5%	Percentages of total sample.
Unrecognizable residue	78.1 mg.	26.3%	70.4%	
Flotable residue	131.0 mg.	44.1%		
	296.4 mg.			

Recognizable residue	Wood	47.2 mg.	54.0%	Percentages of identifiable fraction.
	Bark	20.3 mg.	23.2%	
	Leaf	19.8 mg.	22.7%	
		87.3 mg.		

Sub-surface sample—6 inches below the surface:

Recognizable residue	4.1 mg.		2.7%	Percentages of total sample.
Unrecognizable residue	35.3 mg.	23.3%	97.2%	
Flotable residue	111.8 mg.	73.9%		
	151.2 mg.			

Recognizable residue	Wood	1.3 mg.	31.7%	Percentages of identifiable fraction.
	Bark	1.0 mg.	24.4%	
	Leaf	1.8 mg.	43.9%	
		4.1 mg.		

It may be noted in studying Table 3 that the recognizable residue from the surface collection comprised 29.5% of the total sample, whereas that from the sub-surface collection made up only 2.7% of the total bulk. Accordingly, 70.4% of the surface sample was unrecognizable as compared with 97.2% of unrecognizable material in the sub-surface sample. It may also be observed in comparing surface "recognizable residue" with sub-surface "recognizable residue" that the wood fraction decreased sharply: from surface 54.0% to sub-surface 31.7% whereas the bark and leaf fractions increased in amounts: bark, surface 23.2% to sub-surface 24.4%; leaf, surface 22.7% to sub-surface 43.9%. The leaf material in the sub-surface sample was in large part made up of badly decomposed fragments of gymnosperm leaves; little in the way of angiosperm leaf material was present and that little was extremely fragmentary. Figures presented in Table 4 itemize the wood counts for this same pair of collections (surface and sub-surface). The figures in Table 5 give a resumé of percentages of the woods found in 300 fragments from comparable pairs of surface and sub-surface collections.

TABLE 4

(Location 2 on the map)

Surface		*Sub-surface*	
Alder	26—52%	Alder	5—10%
Gymnosperm	17—34%	Gymnosperm	23—46%
Angiosperm	7—14%	Angiosperm	6—12%
		Wood	16—32%

TABLE 5

(Locations 1, 2, and 3 on the map)

Surface		*Sub-surface*	
Alder	49.3%	Alder	4.0%
Gymnosperm	43.3%	Gymnosperm	73.3%
Leatherleaf	0.6%	Leatherleaf	1.3%
Aspen	2.0%	Unidentified wood (includes angiosperm)	21.4%
Unidentified wood (includes angiosperm)	4.6%		

From the data presented in Tables 3, 4, and 5, it may be concluded that the differences in constitution of bottom surface detritus and sub-surface detritus are to a considerable degree contingent upon the comparative ages of these two layers. The data in Table 3 suggest these probabilities: since there is so much more unidentifiable material in the sub-surface layer than in the surface layer, (1) it is highly probable that the sub-surface layer is much older than the surface layer and as a corollary, (2) there has been over the years very little disturbance in the river bottom as each year's deposit of detritus is added to those which preceded. In other words, it would appear that the entire body of detritus in the river bottom is not a mass of material which is constantly being churned and mixed, but is an orderly accumulation of annual deposits of debris which find their way into the stream.

With respect to these probabilities, the following comments may be made. In Tables 4 and 5 the figures demonstrate for the surface collections the high incidence of alder—a wood which decays relatively quickly—and the low incidence of alder at the sub-surface levels. Likewise the proportion of gymnosperm wood which is considerably more durable than alder is far higher at the lower than at the surface levels. In addition, in the sub-surface collections as compared with the surface collections it is apparent that there has accumulated five times as much wood which has decayed to such a point that it can no longer be specifically identified. This fact, in addition to the fact that the more durable gymnosperm leaf fragments and the corky bark fragments are in greater abundance at the lower levels, lends support to those probabilities which have been suggested above—namely, a greater age of sub-surface layers as compared with surface layers, this probability hinging upon the lack of disturbance and mixing of these layers following even extraordinarily high water such as that of the month preceding the one in which certain of the collections were made.

Often a considerable proportion of the unidentifiable bottom material, especially that of the spring holes, was in the form of more or less spherical or ovoid masses which ranged in size from approximately 100 to 500 microns in diameter. These bodies were often firm enough so that they could be manipulated or separated from the other materials with a pair of finely pointed needles. Microscopic examination demonstrated their composition to include individual cells or small groups of cells of higher plants, diatom shells, extremely finely divided inorganic material, sponge spicules, occasional pollen grains, and fragments of algae and fungous hyphae.

Some of the bottom material from one of the springs which included practically nothing but these bodies was put through a homogenizer so that the individual constituents were completely separated and a smooth suspension was obtained. This liquid was put into a low container about three inches in diameter with a sheet-cork lid into which were inserted rows of common pins at one-eighth inch intervals each way. The pins reached from the lid to the bottom of the container and acted as baffles in the liquid when the apparatus was put onto a shaking device. The shaker platform moved back and forth at the approximate rate of twenty strokes to the minute so that the liquid moved through the pin baffles rather slowly and was only gently agitated. At the end of 48 hours, bodies comparable in form, texture, and constitution to the original ones were again present. The result of this experiment may indicate that the method of origin of these bodies, often present in great quantity in the bottom deposits, is a matter of flocculation accomplished through relatively gentle stream action. It would seem that these bodies form in particular abundance in the springs in which there is a constant boiling action and accumulate elsewhere in the stream by a process of differential sedimentation. There is no reason to believe, however, that such bodies could not form in places in the stream other than the springs.

Conclusions

In the light of the data presented above, certain facts stand out clearly:

(1) But a very small fraction of the accumulated debris in the river bottom of the upper Brule is made up of plants or parts of plants which originate in the river itself. Diatoms, of course, are present along with fragments of filamentous algae, but the actual bulk of such remains is relatively negligible.

(2) The great bulk of material in the bottom comes from plants growing in the immediate vicinity of the river. More than one half of the wood is alder, obviously coming from the shrubs bordering the stream.

(3) The material originating in the bog is remarkably small in amount when we consider the fact that the stream is flowing through this bog. To be sure, leaf and wood fragments of leatherleaf are found, but there are numerous places along the upper river where these plants are close enough to the river so that their parts could drop directly into the water. The scarcity of Sphagnum remains in the detritus is perhaps one of the most conspicuous departures from what might be expected. Leaves of Sphagnum are durable and are so characteristic in appearance

that their presence in any abundance would most certainly have been observed even without the use of the compound microscope.

(4) As for the barrens, there is no evidence of plant material reaching the river from this source. It is impossible to say that the wood of red pine or of jack pine was not present in the conifer wood fractions of the various collections, for the reason given above—i.e., inability to distinguish one gymnosperm wood from another. However, fragments of the leaves of all the conifers can readily be distinguished and no fragments of red pine or of jack pine needles were found in this entire study. Likewise, the incidence of aspen wood is extremely low in comparison to all the other woods. Aspen, of course, is abundant in the barrens, but some aspens also grow close enough to the river so that portions of these trees could reach the stream directly.

All these observations definitely corroborate the idea that the water seeps through the bog but carries on practically no erosion; likewise they indicate that the river does not cut into the bog to any appreciable extent. This is of some practical significance in that undamaged bog, which acts as a reservoir and as a regulator of the flow of water into the stream, allows essentially nothing in the way of the products of erosion from surrounding areas to reach the stream. What is in the stream bottom in the way of plant detritus is there because of the proximity to the stream of the plants from which this detritus came. All of these findings point toward the wisdom of the Conservation Commission in its present policy of buying and protecting the bogs as a basic measure for protecting the physical characters of the Brule itself.

The appreciation of the writer is due Prof. N. C. Fassett and Prof. J. W. Thomson for suggestions and for aid in making collections, and to the Wisconsin Alumni Research Foundation for financial aid which made possible a portion of this work.

THE BROOK LAMPREY IN THE BRULE RIVER

Brule River Survey Report No. 10

WARREN S. CHURCHILL
Wisconsin Conservation Department, Woodruff

INTRODUCTION

During a survey of the Brule River in Douglas County, Wisconsin, it was found that ammocoetes of the northern brook lamprey, *Ichthyomyzon fossor,* were extremely abundant throughout the lower part of the stream. A study of these was undertaken to determine something of their life history and particularly their role in the ecology of the Brule River. This is the second record of this species from Wisconsin; the first from the Lake Superior drainage of Wisconsin.

METHODS

Lampreys were collected from the river by means of an electric shocker. This is a device for passing an alternating current of variable voltage through the water or bottom between two electrodes. At high voltages this stuns any fish in the electric field thus created; at lower voltages it causes convulsive movements which usually take the fish out of the field. Even at paralyzing voltages, lampreys make a few such movements before succumbing, and these usually cause them to emerge from the mud in which they were buried. They are then easily captured with a dip net.*

For lamprey collections, a field of 110 volts is used and the electrodes are held on the river bottom about six feet apart and moved slowly upstream. Many of the lampreys emerge completely from the mud before they are paralyzed and drift downstream; others are overcome when still partly buried and may be dug out with the corner of the net. Either end may emerge first.

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* During the summer of 1945, use of the shocker has revealed the presence of brook lampreys in a large number of streams in Northern Wisconsin.

Still others are paralyzed while still buried and are passed over by the collector; a second sweep usually brings out a considerable number that were missed the first time. While in the electric field they are quite rigid and often contorted, but they recover almost instantaneously when removed and are fully restored by the time they are placed in the collecting pail.

Since this method depends on seeing the lampreys in the water or on the bottom, it is obvious that the smallest individuals will be most frequently overlooked. In any quantitative collection the smallest and youngest individuals should be the most numerous, but in these the larvae of the latest two seasons are quite scarce. Okkelberg found the same thing when using another method of collecting, and also attributes it to the difficulty of detecting the smallest larvae. He also suggests the possibility that younger ammocoetes remain nearer the spawning grounds at first.

Measurements were made to the nearest millimeter, using an ordinary fish-measuring board. With the exception of the November collection, all lampreys were preserved in the field with 5 percent formaldehyde and measured after preservation. On one occasion, eighty lampreys from a collection were allowed to die of asphyxiation in air and measured while fresh. They were then preserved and measured after two months in formaldehyde. The average shrinkage was about 3 percent. The November collection was brought to the laboratory alive and measured under ether anaesthesia. A 1.5 percent aqueous solution of ether was used; all lampreys recovered and showed no ill effects.

Life History

Spawning has not been observed in the Brule River. On June 18 and 19, 1945, 17 adults which had not yet spawned were collected from three locations where conditions were suitable for spawning. Since no congregations were observed on the riffles, and no nests were identified, it is believed that spawning activities had not yet begun. The spring of 1945 was unusually cold, and spawning was probably later than usual. This would place the average spawning season sometime around the middle of June. Hubbs reports that *I. fossor* spawns in June in northern Michigan.

Judging from the abundance of ammocoetes, spawning activities must be very extensive. Leach states that hatching takes place about twelve days after fertilization in the laboratory, the larvae swimming freely for a short time, and beginning to burrow about fourteen days after fertilization. This would mean that the new larvae appear in the Brule in late June or early July. The earliest collection of ammocoetes from the Brule was on July 6 and did not include any ammocoetes considered to be the young of the year. A collection on July 7 contained one larva of 27 mm., probably hatched that year since it was 10 mm. shorter than the next smallest and about 20 mm. shorter than the average of the presumptive year-old group. Subsequent collections usually included one or more very small individuals considered to be the young of the year. As mentioned above, these smallest larvae were very scarce in all collections. The smallest measured 20 mm.

The ammocoetes require a fairly soft bottom in which to make their burrows. They are not, as a rule, found in firm sand or in the extremely soft mud of the backwaters. The best location is a mixture of a sand and silt. In a given area with suitable bottom they are most numerous in water six to twenty-four inches deep, among the vegetation. They have been dislodged from burrows in water as deep as three feet.

Food of the ammocoetes in the burrowing period consists of microscopic organisms. All of the alimentary canals examined contained diatoms and unicellular algae which were not identified. Creaser and Hahn have given a detailed account of the stomach contents of Entosphenus. They found all of the organisms taken to be present in the water and especially abundant in the thin surface layer of debris on the bottom. They were not present below this layer, indicating that the food of the ammocoetes comes from the surface of the bottom. Leach reports that larvae frequently extend the head and pharynx out of the burrow while feeding.

The length of this larval life is not definitely known. It ends with the transformation of the larva into the adult, at which time the alimentary canal degenerates and no more food is taken. Detailed descriptions of the changes that take place are given by Gage and Leach. The first obvious changes are the appearance of the eye and alteration in the snout occurring in late summer or early fall. Ammocoetes showing these changes have been found in the Brule as early as August 9; Leach reports transformation beginning as late as September 15. On September 15, ten individuals were found in the Brule in which transformation was still incomplete, while on November 22, four individuals were found in which the external changes appeared complete but none in a partially transformed state. Internal changes continue until maturation of the gonads the following spring. Since degeneration of the alimentary canal occurs at the beginning of transformation, there is a period of eight or nine months during which no food is taken.

Both Gage and Leach have concluded that transformation does not occur until a year after full growth is reached, although Leach has found internal changes occurring during this resting period. In all collections from the Brule which contained transforming individuals, there were larger numbers of larvae of the same size that showed no evidence of transformation and had functional alimentary canals. Larvae in this size range were found all through the summer and there is no indication of growth through the year in this group.

All investigators agree that the brook lamprey dies very shortly after the spawning season.

Distribution in the Brule River

For the first third of its course, the Brule River is a region of deep slow water with a thick muck bottom and heavy weed growth. The first riffle occurs about one third of the way down. From this point on, rapids and riffles are frequent and the proportion of slow water steadily diminishes toward the mouth.

During the summer of 1944, collections were made with the shocker throughout the length of the river. No lampreys were found in any of the collections above the first riffle, but one or more occurred in every collection below this point.

They are most numerous in fairly shallow pools having a suitable bottom and some rooted vegetation. However, even in the most swift and rocky parts of the stream there are mudbanks along the shore and pockets between the rocks where the ammocoetes can and do make their burrows. The test areas were purposely selected to include all types of bottom and current, and all contained at least a few lampreys.

Where conditions are optimum, the concentration is very high. At one station, on a delta below a strong rapid, 153 lampreys were taken from an area 13 feet square. Undoubtedly enough were missed to raise the total to more than one per square foot. At another station, 73 were taken from a mudbank covering about 220 square feet in an otherwise swift and rocky part of the stream. Lampreys were found to be more abundant than any species of fish.

Community Relations

Brook lampreys play a very minor role in the life of the stream community. Their activities are restricted to a single type of habitat where their principal neighbors are burrowing mayfly nymphs and small mussels. All three of these forms feed directly on the microscopic organisms of the bottom and have no effect on each other except possibly in the competition for food. The abundance of all three in the same area indicates that such competition is not an important factor.

As forage for fish they are also unimportant, since their burrowing habits make them inaccessible throughout larval life. Out of 300 trout stomachs from the Brule examined in the course of the survey, only five contained remains of lampreys. These were all rainbow trout, taken early in July from a part of the stream where lampreys are very abundant. While the remains were too well digested to make sure, it is thought that they were adults taken during or just after the spawning period. None of 200 sucker stomachs examined contained lampreys.

It is worth noting in this connection that lampreys are highly prized as bait by trout fishermen in certain parts of the country. The sale of "mud eels" is a profitable business on the west coast.

Population Studies

A number of attempts have been made to estimate the length of the larval life of this and other species by analysis of the size distribution in collections. Since there is only one spawning season each year, the ages of ammocoetes in any one collection must vary by one-year steps. Hence, if the larvae fall into definite size classes, these may be taken as year groups. There is a difference of opinion as to whether such size groups exist.

Okkelberg found seven such size groups in two collections for Thunder Bay River in Michigan, and concluded that the larval life was seven years. Schultz, working with much larger collections of Lampetra, concluded that this method is not satisfactory for determination of the length of life and indicated that Okkelberg's groups were not distinct enough to justify his conclusions. Leach cites measurements of one collection from the Tippecanoe River in Indiana which fall into five very distinct groups, and concludes that growth of the larva takes five years, followed by a year's resting period before transformation.

In drawing their conclusions, none of the above-mentioned authors makes any mention of a difference in size between the sexes. Collections from the Brule show that, at least in this stream, there is such a difference in this species. Of 68 transforming lampreys examined, 37 males ranged from 97 to 130 mm. in length, after preservation, with the average length 110 mm. Thirty-one females ranged from 112 to 141* mm., with an average length of 125 mm.

Of 17 adults, 10 males ranged from 100 to 128 mm. with an average length of 108 mm. Seven females ranged from 112 to 147 mm. with an average length of 123 mm.

This difference results in overlapping of the size ranges of the year classes, so that no well-marked modes appear on the distribution curve except at the ends. If the sexes could be plotted separately, it is probable that the year classes would be indicated by distinct humps on the curve.

Attempts to separate the sexes have thus far been unsuccessful, since lamprey larvae are hermaphroditic in early life. Okkelberg found that the gonads of larvae of *Entosphenus wilderi* have both oocytes and cysts of male cells at the same time. He was able to distinguish sex in these larvae only by ratio of male to female cells as determined by actual count.

All of the larger larvae of one collection from the Brule were opened and a bit of the gonad removed and examined briefly under the microscope. All gonads found contained large numbers of oocytes and all were similar in appearance. No gonad was found on macroscopic examination in about one fourth of the larger ammocoetes. The lengths of these individuals were evenly distributed and no conclusions could be drawn.

In Chart 2 are shown the length distribution curves of ammocoetes in eight collections from the Brule River. These curves

* 145 mm. when alive; preserved length estimated as 3 percent less.

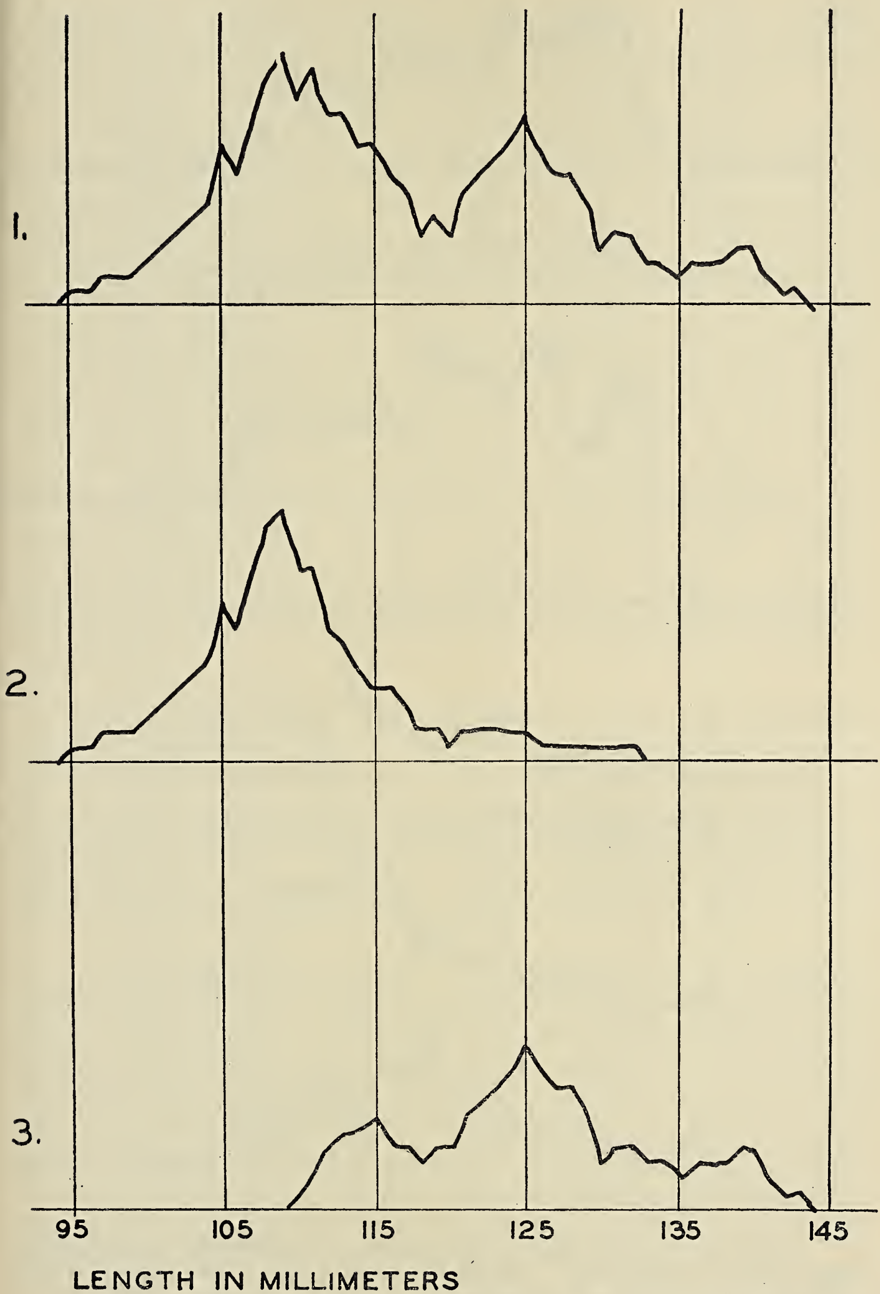

CHART 1. Length frequency distribution of 68 metamorphosing lampreys taken from the Brule River. Moving average of five 1 mm. classes. 1. All individuals; 2. 37 males; 3. 31 females.

CHART 2. Length frequency distributions of ammocoetes in eight collections from the Brule River. Moving average of five 1 mm. classes. Transforming individuals are indicated by circles at the corresponding length on the scale. Open circles represent males, solid circles females.

1. July 7, 1944; 2. July 6, 1944; 3. August 16, 1944; 4. July 28, 1943; 5. August 29, 1944; 6. August 28, 1944; 7. September 15, 1944; 8. November 22, 1944.

represent a moving average of five adjacent 1 mm. classes. Open circles under the curves represent transforming males of the indicated length, solid circles transforming females.

It will be noted from the graphs that most of the Brule River collections contain one or more larvae of such small size as to be clearly the young of the year. There is a very definite separation between this size group and the next larger. Okkelberg also found a very pronounced size group in this range, which was considered valid by Schultz. The small number in each case is due to the difficulties in collection mentioned above. Likewise, most of the collections show another distinct hump in the curve representing the yearlings. It is safe to assume in each case that the larvae captured were the larger members of the group, and that the average size for this time and place would be somewhat smaller than that indicated by the graph. Beyond this point, the size groups overlap so that no definite modes appear, indicating that a difference in growth rate has set in between the sexes. This agrees with Okkelberg's conclusion that the future sex of the hermaphroditic larva is determined during the second year.

Fig. 1, Chart 1, shows the distribution curve of all transforming lampreys taken from the Brule. Figs. 2 and 3 show how this group breaks down into males and females. The extra hump at the extreme right is due to the larger females. The characteristic curve of Fig. 1 can be identified, with slight variations, at the right end of the collection graphs; it represents the fully grown ammocoetes that will transform within the year.

It is worth noting that the two curves presented by Okkelberg show this same peculiarity at the right end. Okkelberg found seven modes in the curve which he identified as year classes, plus these few larger larvae which he regarded as atypical. The seventh mode of the two curves centered at 105 and 110 mm. respectively, is the size range of the fully grown males in the Brule River collections. Of the five size groups mentioned by Leach in one collection from the Tippecanoe River, the two largest averaged 105 and 125 mm. respectively, corresponding to the males and the females of the same year in these collections.

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THE FIRST YEAR OF THE WISCONSIN JUNIOR ACADEMY OF SCIENCE, 1944–1945

JOHN W. THOMSON, JR., *Chairman, Junior Academy Committee*

The Inception—Credit for the founding of the Wisconsin Junior Academy of Science should go to a committee composed of members of the Wisconsin Academy of Sciences, Arts and Letters and members of the faculty and staff of the University of Wisconsin. Instrumental in the inception of this project were: President E. B. Fred of the University of Wisconsin, C. J. Anderson, E. F. Bean, C. A. Dykstra, E. M. Gilbert, Frank O. Holt, M. H. Ingraham, A. W. Schorger, and H. A. Schuette. Much help was given in organization by Dr. Howard E. Enders of the Indiana Junior Academy of Science and Miss Alta S. McEvoy of the Illinois Junior Academy of Science.

The Start—In order to acquaint the science teachers and principals with the aims and proposed activities of the Wisconsin Junior Academy of Science several means were utilized. A letter from President Schuette was sent to each of the science teachers listed by Science Clubs of America as having a club or as being interested in science club work. In schools where no such teacher was listed, the same letter was sent to the principal. A listing of the names of the teachers and principals was obtained from the State Department of Public Instruction through the courtesy of Superintendent John A. Callahan. The letter, a statement of the general aims of the Junior Academy and an introduction to the appointment of J. W. Thomson, Jr. as Chairman of the Junior Academy Committee, follows:

"That it may serve and stimulate the development of scientific activities on the part of youth the Wisconsin Academy of Sciences, Arts and Letters has expanded its activities by setting up the Junior Academy of Science for which it assumes sponsorship. This sponsorship presupposes a cooperative arrangement with Science Service, Inc., which administers Science Clubs of America.

"Because of the suggestion which was made that participation in an activity of this type would constitute another off-campus service to the citizens of our State, the University of Wisconsin, not unmindful of the possibilities of being a factor in the discovery and development of scientific abilities and interests among the youth of Wisconsin, has cooperated in this program and generously given us its aid. This aid has found expression in the appointment of Dr. John W. Thomson, Jr., formerly of State Teachers College at Superior, as assistant professor of botany, who will devote his time not only to the supervision and management of the Junior Academy but also to the encouragement of scientific work at the pre-college level. The council of the Academy, in turn, has appointed Dr. Thomson chairman of its Committee on the Junior Academy of Science. In his hands has been placed the guidance of the Junior Academy. Steps have already been taken to recruit the personnel of this committee from among the high school science teachers with due consideration to their past or present key positions in the several district educational associations of our State.

"Perhaps you have already had the opportunity of personally hearing Dr. Thomson discuss his plans. In any event, you may expect to hear from him by letter.

"May I bespeak for Dr. Thomson, and the Wisconsin Academy of Sciences, Arts and Letters, your cordial cooperation?

"I am, with much respect,

Very truly yours,"

(Signed) H. A. SCHUETTE

President

A second letter was sent as a follow-up. This letter, issued by the Chairman of the Junior Academy Committee, stated some of the specific objectives and proposed activities of the Junior Academy and invited the teachers or principals to return an enclosed questionnaire on science clubs. Inasmuch as this letter and questionnaire went to every high school in the state it was of material assistance in locating the active science clubs in this state. Replies were received from 188 schools. Some 60 out of the 487 high schools in Wisconsin are listed as having active science clubs at the present time. In comparison with some of the other states this reflects a serious neglect in the schools of a useful phase of development of science talent. Virginia, for example, has 115 science clubs in their Junior Academy alone.

While the questionnaire was being sent out, and while awaiting the replies in the mail, in the winter, the chairman of the Junior Academy Committee visited schools in southeastern Wisconsin, using the mailing list provided by Science Clubs of America. High schools in the following communities were visited at that time: Milwaukee, 27 schools; Jefferson; Albany; Janesville; Beloit; South Milwaukee; Racine, two schools; Burlington; Waterford; Union Grove; Sturtevant; Kenosha; Lake Geneva; Wilmot; Walworth; Columbus; Watertown; Hartland; Oconomowoc; Burnett; Waupun; Fond du Lac; North Fond du Lac; Lomira; Campbellsport; Kewaskum; Port Washington; Oostberg; Sheboygan, two schools; and North Sheboygan. The teachers were interviewed in these schools to determine the actual club situation in the field and to determine the needs of the club sponsors in encouraging scientific work at the secondary school level. In schools which have clubs the number varies from one to seven clubs operating in various fields of science. Reflecting present-day interests, the greatest number are general science clubs, and the others are biology, physics, or chemistry clubs in decreasing number.

Arrangement of a District Meeting in Milwaukee—By the time many of these schools had been visited it was apparent that enough schools were interested to warrant holding a district meeting in the Milwaukee area during the spring of 1945. Therefore, a preliminary meeting of sponsors of clubs in the Milwaukee area was called on March 10. Through the courtesy of Prof. Ross H. Bardell, the preliminary meeting was held at the

Milwaukee Extension Center of the University of Wisconsin. Representatives from twelve schools attended this meeting and arranged for a tentative date and program for the middle of May. Estimates showed that so many club delegates would come that the large hall of Marquette University would be the only room with the necessary facilities able to accommodate the group. Through the kindness of Prof. John R. Koch, Head of the Department of Chemistry at Marquette University, and Father Keegan, the lecture room in the science building was made available for the Junior Academy meeting. The program of the meeting on May 20 follows:

Address of Welcome, Professor H. A. Schuette, President, Wisconsin Academy of Sciences, Arts and Letters, 5 minutes.

Red Blood Preferred, Catherine Backe, Dolores Deniski and Patricia Kasper, Mercy Science Club, Mercy High School, 15 minutes.

Butterfly Collecting, Wanda Provencher, Science and Camera Club, Messmer High School, 10 minutes.

Black Magic with Ultra-Violet, Dan Rasmussen and David Dalyrimple, Tesla-Marconi Club, West Allis Central High School, 20 minutes.

Tesla-Coil Demonstration, Fritz Dudi and Karl Dudi, Science Club, Rufus King High School, 20 minutes.

Automatic Crossing Switch, Carl King, Science and Camera Club, Messmer High School, 10 minutes.

Relationship of the Atomic Number to Conductivity, James Ringenoldis, Chemistry Club, Custer High School, 6 minutes.

Pharmacy in Colonial America, James Tingstadt, Chemistry Club, Custer High School, 6 minutes.

Wisconsin Limestone and Minerals Found With It, Robert Zusy, St. John Cathedral High School, 10 minutes.

Volcanism, Alfred Newmann, Jr., Steuben Junior High Science Club, Steuben Junior High School, 20 minutes.

Exhibits

Butterflies, Wanda Provencher, Science and Camera Club, Messmer High School.

The Futer of Magnesium, a mural by Betty Woelm, Chemistry Club, Custer High School.

Attendance at the meeting was 180 with delegates from clubs as far away as Madison, Lake Geneva, Port Washington, and Kenosha attending to observe the proceedings.

Awards—The papers and demonstrations presented at the Milwaukee district meeting were of such high quality that it was difficult to choose the recipients of the honorary awards. By vote of the Science Club sponsors present at the meeting the following awards were made: one year honorary memberships in the American Association for the Advancement of Science went to Wanda Provencher, Messmer High School, and Dan Rasmussen and David Dalyrimple of West Allis High School. One year honorary memberships in the Wisconsin Academy of Sciences, Arts and Letters were voted for Catherine Backe, Dolores Deniski, and Patricia

Kasper, representing Mercy High School Science Club; Fritz and Karl Dudi, from Rufus King High School Science Club; Robert Zusy of St. John Cathedral High School; and Alfred Newmann, Jr., of Steuben Junior High School. Honorary mention was accorded James Tingstadt and James Ringenoldis of Custer High School and Carl King of Messmer High School.

The Honorary Junior Memberships in the American Association for the Advancement of Science entitle the recipients to the Association *Bulletin* and to *Science News Letter* for a year in addition to copies of reports of meetings of the association. The recipients of the one year memberships in the Wisconsin Academy of Sciences, Arts and Letters are entitled to the *Transactions* of the Academy and to any other material issued by the Academy for general distribution to the members as well as being privileged to attend the meetings.

Newsletters—Three newsletters were issued during the spring semester. The first, in response to the requests of the sponsors present at the preliminary meeting to arrange for the Milwaukee district meeting, consisted of sample programs of the annual meets of the Junior Academies of Science of other states. The programs were obtained from various programs and publications issued by the academies.

The second newsletter was a circular announcing the date of the Milwaukee meeting and mainly consisted of blanks to be filled in and concerned the registration for the Milwaukee meeting and joining the Junior Academy of Science.

The third newsletter announced the program of the Milwaukee meeting, the awards offered, a preliminary announcement of a news bulletin to be put out by the clubs next year, and two cooperative projects with state scientists on tree distribution and wildflower phenology.

Publicity—Through the help of the University Press Bureau several articles about the Junior Academy of Science appeared in the newspapers. Articles appeared in the *Daily Cardinal* for November 30, 1944; the *Milwaukee Journal* for November 26, 1944, May 17, May 20 and May 21, 1945; the *Milwaukee Sentinel* for May 21, 1945; *Science* for December 8, 1944 and June 1, 1945; the *Chicago Tribune* for May 14, 1945; and the *University Press Bulletin* for May 16, 1945. Articles prepared by the chairman of the Junior Academy Committee appeared in the *Wisconsin Journal of Education* for February and May, 1945. A longer article, "The Wisconsin Junior Academy of Science," appeared in the *Bulletin of the Wisconsin Association of Secondary School Principals* for March, 1945. This issue was distributed by the association to all of the Wisconsin principals.

Talks to Clubs—During the spring semester, scheduled trips were made to central, northern, and eastern Wisconsin to talk with the science club members about the activities of the Junior Academy of Science. The schools in which these talks were given are located in Black River Falls, Rhinelander, Goodman, Marinette, Florence, Wonewoc, Eau Claire, Oshkosh (three schools), Berlin, Wisconsin Rapids, Pittsville, Stevens Point, and Wausau. In addition club sponsors were visited in a few communities in which the clubs were not meeting in time for scheduled talks. These were in Bloomer, Medford, Dorchester, and Plainfield.

As part of the assignment of encouraging pre-college level scientific activity, nature study talks were given in several conferences for the Regional Recreational Laboratories in Whitewater and Antigo and at the 4H Club Leadership Camps at Green Lake, Hudson, and Pigeon Lake near Drummond. Talks at the Lincoln County Achievement Days at Tomahawk and Merrill and to the Edgerton Rotary Club and Methodist Men's Club were given in the same vein. In addition to a talk on wildflower conservation, a conference on the Junior Academy possibilities interested the biology society, the Zeta Chapter of Sigma Zeta, of Central State Teachers College, Stevens Point, in being hosts to the high school science clubs at a district meeting in the future.

A talk on the Junior Academy was given at the Lake Superior Education Association convention on October 12, 1944. A similar talk was scheduled for the Southern Wisconsin Education Association convention to have been held in March, 1945. The ban on conventions by the Office of Defence Transportation cancelled this. Barring similar difficulties this fall, arrangements have been made to speak at the Milwaukee convention of the Wisconsin Education Association and at the convention of the Northwestern Wisconsin Education Association.

Services to the Clubs—In addition to the news bulletins issued to help the clubs three other important projects were prepared. In response to requests from several clubs a list of plays on science and scientists was made available. These were reviewed and briefly annotated in the listing. The greatest immediate need felt on the part of the club sponsors, it was found on visiting the schools, was a list of sources to which the teachers and students could turn for ideas for club projects and experiments. By writing the publishers for the loan of books and by scanning every available source, a list of books and pamphlets covering this field was compiled. The contents were noted on the listing in order that the club sponsor would know what materials the book covered.

Directions were prepared for two projects for the clubs which are interested in cooperating with state scientists. The projects are on the distribution of Wisconsin forest trees, and on the phenology, or blooming and fruiting dates, of the common wildflowers and trees. Data of considerable value is expected to accrue from these projects.

Further materials resulting from club requests is a list of the clubs in the state with their interests and activities mentioned as well as the sponsor names and other data of assistance to the clubs in keeping in touch with each other.

Membership—Charter member clubs started joining the Junior Academy in April, the Science Club of Rufus King High School, Milwaukee being the first. By June, fifteen clubs with a total membership of 433 pupils were enrolled in the Wisconsin Junior Academy of Science. This, compared with the initial years of the junior academies of some of the other states, seems very satisfactory. Indiana started with eight, Kansas with six, Alabama with seventeen, Iowa with thirteen, Minnesota with seven, Pennsylvania with fourteen and Oklahoma and West Virginia with sixteen.

First Year Charter Members

Science Club, Rufus King High School, Milwaukee
Science Experiment Club, South Milwaukee High School, South Milwaukee
Tesla-Marconi Club, West Allis High School, West Allis
.............., St. John Cathedral High School, Milwaukee
Mercy Science Club, Mercy High School, Milwaukee
Stan-Sci Club, St. Stanislaus High School, Milwaukee
Chemistry Club, Custer High School, Milwaukee
Science and Camera Club, Messmer High School, Milwaukee
Phi-Bi-Chem Club, Steuben Junior High School, Milwaukee
Albertus Magnus Math-Science Club, St. Mary's Academy, Milwaukee
The Searchers, Girl's Trades and Technical High School, Milwaukee
.............., Port Washington High School, Port Washington
C Y Science Club, Peckham Junior High School, Milwaukee
Albertus Magnus Club, St. Robert School, Shorewood
Seminar, Kenosha High School, Kenosha

Looking Ahead—Some of the services which the Junior Academy would like to offer to the clubs of Wisconsin are listed below. Some of these are already maturing. The presentation of the very fine lantern slide collection of the late Prof. E. R. Downing to the Junior Academy by his widow will make possible a circulating loan collection for the clubs. Dr. Downing was a former member of the Wisconsin Academy of Sciences, Arts and Letters and this gift will enable us to render a very useful service to the clubs.

1. A news bulletin edited by the clubs.
2. A circulating lantern slide collection.
3. Lectures to the clubs.
4. Can we obtain help to offer scholarships for excellent work?
5. More cooperative projects.
6. Organization of a central Wisconsin district.
7. Selection of student officers.
8. Circulating loan collections of booklets on projects and of materials useful for club exhibits on plastics, etc.
9. An advertising folder.
10. Radio programs.

PROCEEDINGS OF THE ACADEMY

Seventy-fifth Annual Meeting

In view of the request by the War Mobilization Director for a ban on conventions, the Council of the Academy voted 13 to 1 for postponement of the 75th anniversary meeting.

However, the table of contents of this volume was previewed February 15, 1946, in the Wisconsin Academy News Letter. This was considered as a meeting "in print". All papers published in Volume 37 of the TRANSACTIONS are dedicated to the 1945 meeting as our 75th anniversary.

As a regular meeting was not held, all of the officers of the Academy retained their office for the next Academy year.

Treasurer's Report

April 1, 1945

Receipts

Carried forward in Treasury, April 12, 1944	$1,944.30
Receipts from dues, April 15, 1944–April 1, 1945	1,152.65
Sale of publications	98.90
Interest on endowment	98.25
Grant-in-aid for research from A.A.A.S.	96.00
Home Owners Loan Coupon Bonds called in by U. S. Government	1,050.00
Total receipts	$4,440.10

Disbursements

Purchase of U. S. Savings Bonds Series G	$ 300.00
Purchase of U. S. Savings Bond Series F	1,110.00
Cost of Bond transfer	.70
Allowance to Secretary-Treasurer Banner Bill Morgan	100.00
Grant-in-aid for research to E. S. McDonough	96.00
Rental of film for annual meeting	2.30
Rubber stamps	1.20
Transfer of cash from checking account to savings account	1,000.00
Printing for Junior Academy	44.75
Stamps, envelopes, express charges, materials for Newsletter	59.03
Check in process of collection	100.00
Total disbursements	$2,813.98

Balance, April 1, 1945	$1,626.12
Check in process	100.00
	$1,726.12 Balance March 31, 1945, Bank Statement.

Banner Bill Morgan
Secretary-Treasurer

The accounts of the Academy were found to be in order and as reported above for the date March 31, 1945.

Auditing Committee
RAYMOND J. ROARK
R. J. MUCKENHIRN

ENDOWMENTS AND ASSETS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

1.	U. S. Treasury Coupon Bond 1692B	$1,000.00
2.	" " " " 12894D	500.00
3.	U. S. Savings Bond Registered Series G—M1696059G	1,000.00
4.	" " " " " G—C1563347G	100.00
5.	" " " " " G—C1563348G	100.00
6.	U. S. Savings Bond Series F—D494206F	500.00
7.	" " " " F—M989457F	1,000.00
8.	" " " " G—C3389339G	100.00
9.	" " " " G—C3457898G	100.00
10.	" " " " G—C3512841G	100.00
	Total Amount of Endowment	$4,500.00
11.	U. S. Savings Bond Series G—C2386504G	100.00
12.	" " " " G—C2386505G	100.00
13.	" " " " G—C2386506G	100.00
14.	" " " " G—C2386507G	100.00
	Current Assets Invested in U. S. Bonds	$ 400.00
15.	Savings Account No. 3263, 12/13/44	1,000.00
	Total	$5,900.00

The contents of the safety deposit box and the savings account were found in order and as reported above for the date March 31, 1945.

Auditing Committee
RAYMOND J. ROARK
R. J. MUCKENHIRN

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

LIST OF ACTIVE MEMBERS

Corrected to December 31, 1945

1. Aberg, Wm. J. P. .... 3401 Lake Mendota Drive, Madison, Wis.
2. Abrams, Allen .... Rothschild, Wis.
3. Adkins, Homer .... 369 Chemistry Bldg., Madison 6, Wis.
4. Alcorn, Paul .... Univ. of Conn., Storrs, Conn.
5. Alexander, Edward P. .... 208 Historical Library, Madison, Wis.
6. Allen, Charles E. .... 104 Biology Bldg., Madison, Wis.
7. Allison, Leonard L. .... Pittsburgh Road, Poland, Ohio
8. Anderson, Donald .... 801 Magdeline Drive, Madison, Wis.
9. Aurner, R. R. .... 418 Sterling Hall, Madison, Wis.
10. Badalik, Elizabeth A.. St. Xavier Coll., 4900 Cottage Grove, Chicago, Ill.
11. Bagg, Rufus M. .... P. O. Box 386, Appleton, Wis.
12. Baier, Joseph, Jr. .... 623 W. State St., Milwaukee, Wis.
13. Baldwin, Ira L. .... 150 Bascom Hall, Madison, Wis.
14. Bangham, R. V. .... 1004 N. Bever St., Wooster, Ohio
15. Barber, W. H. .... Dept. of Physics, Ripon Coll., Ripon, Wis.
16. Barta, E. F., Dr. .... 425 E. Wis. Ave., Milwaukee, Wis.
17. Barton, A. O. .... 1914 Madison St., Madison, Wis.
18. Bartsch, A. P. .... 623 W. State St., Milwaukee, Wis.
19. Bass, Turner C. .... 233 Alden Drive, Madison, Wis.
20. Bassett, N. D. .... Maple Bluff, Madison, Wis.
21. Baumann, Carl A. .... Biochemistry Bldg., U. W., Madison, Wis.
22. Bean, Ernest F. .... 115 Science Hall, Madison, Wis.
23. Becker, George Charles .... Port Edwards, Wis.
24. Beckman, Wm. C. .... Univ. Museums Bldg., Ann Arbor, Mich.
25. Bennett, Edward .... 208 Elec. Engr. Bldg., Madison, Wis.
26. Benninghoven, R. N. .... 1110 H St., N. E., Washington, D. C.
27. Berger, Kermit C. .... 6 Soils Bldg., Madison, Wis.
28. Bertrand, Kenneth
 .... Apt. C–657, 3520—39th St., N. W., Washington, D. C.
29. Black, J. D. .... Dept. Biol., Anderson Coll., Anderson, Ind.
30. Bloodgood, F. J., Rev. .... 1102 Lincoln St., Madison, Wis.
31. Bolender, E. L. .... 92 Maple Ave., Superior, Wis.
32. Boutwell, Paul W. .... Dept. Chem., Beloit Coll., Beloit, Wis.
33. Bradley, H. C., Dr. .... Serv. Mem. Inst. Bldg., Madison, Wis.
34. Brauns, Fritz E. .... 306 E. South River St., Appleton, Wis.
35. Briggs, Lucia R.
 .... Holton Hall, Milwaukee-Downer Coll., Milwaukee, Wis.
36. Brink, Royal A. .... 105 Genetics Bldg., Madison, Wis.
37. Brown, Bruce K. .... 910 S. Mich. Ave., Chicago, Ill.
38. Brown, Charles E. .... State Hist. Museum, Univ. Lib., Madison, Wis.
39. Browne, Frederick L. .... U. S. Forest Prod. Lab., Madison, Wis.
40. Browning, Harold W. .... R. I. State Coll., Kingston, R. I.
41. Bryan, G. S. .... 203 Biology Bldg., Madison, Wis.
42. Bubbert, Walter .... 1516 N. 37th St., Milwaukee, Wis.
43. Buchen, Walther .... 605 Arbor Vitae Rd., Winnetka, Ill.
44. Buck, Philo M., Jr. .... 77 Bascom Hall, Madison, Wis.
45. Buckstaff, Ralph N. .... 1122 S. Main St., Oshkosh, Wis.
46. Bunting, Charles H. .... 504 Serv. Mem. Inst., Madison, Wis.

47. Buss, Irven O........................Wis. Cons. Dept., Madison, Wis.
48. Cameron, Donald H.........% B. D. Eisendrath Tanning Co., Racine
49. Campbell, R. S..........................Univ. of Mo., Columbus, Mo.
50. Carbine, W. F.........203 Museums Annex Bldg., Ann Arbor, Mich.
51. Carbye, J. O......................135 W. Wells St., Milwaukee, Wis.
52. Carrol College.....................................Waukesha, Wis.
53. Carroll, Paul, Rev.
St. Louis Univ. School of Med., 1402 S. Grand Blvd., St. Louis, Mo.
54. Catenhusen, John...
55. Chase, Samuel H....................905 Univ. Ave., Madison, Wis.
56. Chase, Wayland J.................1727 Summit Ave., Madison, Wis.
57. Chidester, Gardner H.........U. S. Forest Prod. Lab., Madison, Wis.
58. Churchill, W. S.............................Box 168, Minocqua, Wis.
59. Clark, Harry H....................356 Bascom Hall, Madison, Wis.
60. Clark, O. H.................Univ. Museums Bldg., Ann Arbor, Mich.
61. Clark, Paul F.................421 Serv. Mem. Inst., Madison, Wis.
62. Cole, Leon J......................108 Genetics Bldg., Madison, Wis.
63. Coleman, Thomas E.....................Maple Bluff, Madison, Wis.
64. Coleman, Wm. W.............1101 N. Marshall St., Milwaukee, Wis.
65. Colien, Francis E..............2010 N. 54th St., Omaha 4, Nebraska
66. Colmer, Arthur R.....Coll. of Agr., West Va. Univ., Morgentown, Va.
67. Conant, Geo. R..........................719 Watson St., Ripon, Wis.
68. Cooper, Berenice...................1219 N. 21st St., Superior, Wis.
69. Cooper, Delmer C.................103 Genetics Bldg., Madison, Wis.
70. Cox, Eleanor H..........................Stout Inst., Menomonie, Wis.
71. Curry, John S..........................432 Lorch St., Madison, Wis.
72. Curtis, John T.......................58 Biology Bldg., Madison, Wis.
73. Daniels, Farrington...................1301 E. 60th St., Chicago, Ill.
74. Davies, Ithel B.........................325 Racine St., Delavan, Wis.
75. Deason, Hilary J..Fish and Wildlife Serv., U.S.D.I., Washington, D. C.
76. De Cleene, L. A. V., Rev........920 Christian St, Philadelphia 47, Pa.
77. De Esbjorn, Gustavus......Gen. Del., Winnipeg, Manitoba, CANADA
78. Denniston, Rollin H...............409 Biology Bldg., Madison, Wis.
79. Derleth, August W.....................................Sauk City, Wis.
80. Deutsch, Harold F..............202 Mem. Inst. Bldg., Madison, Wis.
81. de Weerdt, Ole N..............Beloit Coll., 405 E. Grand Ave., Beloit
82. Dillon, Myles.......................108 Bascom Hall, Madison, Wis.
83. Doane, Gilbert H..................220 Univ. Library, Madison, Wis.
84. Dobblesteen, L. A..........................R. #2, Luxemburg, Wis.
85. Dodge, B. O......................N. Y. Bot. Garden, New York, N. Y.
86. Domogalla, Bernhard P.
.................Bd. of Health, 110 N. Hamilton St., Madison, Wis.
87. Doolittle, Sears P.............1519 44th St., N. W., Washington, D. C.
88. Dornfeld, Ernst J...........Zool. Dept., Ore. St. Coll., Corvallis, Ore.
89. Doudna, E. G..........................2017 Monroe, Madison, Wis.
90. Drechsler, Charles...............Bur. Plant Ind., Sta. Beltsville, Md.
91. Du Mez, Andrew G.
School of Pharmacy, U. of Md., Lombard & Green Sts., Baltimore, Md.
92. Durand, Loyal, Jr.......Dept. of Geog., U. of Tenn., Knoxville, Tenn.
93. Dykstra, Clarence A...........Provost, U. C. L. A., Los Angeles, Cal.
94. Dyson, Helen C........................1815 King St., La Crosse, Wis.
95. Eggleton, F. E.........Dept. of Zool., U. of Mich., Ann Arbor, Mich.
96. Eigen, David F............3141 N. Green Bay Ave., Milwaukee, Wis.
97. Ellis, C. W.......................122 Lakewood Blvd., Madison, Wis.
98. Elvehjem, Conrad A.......Biochemistry Bldg., U. W., Madison, Wis.
99. Englerth, Geo. H...............Forest Products Lab., Madison, Wis.
100. Englerth, Mrs. Harriet W............601 Baltzell St., Madison, Wis.
101. Errington, Paul...............Zool. Dept., Ia. State Coll., Ames, Iowa
102. Evans, Clarence T...........2626 Lefeber Ave., Wauwatosa 13, Wis.
103. Evans, Lucille.............2129 E. Kenwood Blvd., Milwaukee, Wis.

104. Evans, Richard....................110 Biology Bldg., Madison, Wis.
105. Everest, D. C....................................Rothschild, Wis.
106. Farner, Donald S...4332 N. 32nd St., % Mrs. C. S. Copps, Omaha, Neb.
107. Fassett, Norman C..................261 Biology Bldg., Madison, Wis.
108. Feeney, Wm. S..............Menasha Ave., Ladysmith, Box 132, Wis.
109. Finch, Vernor C......................301 Science Hall, Madison, Wis.
110. Fischer, Richard.......................1 Langdon St., Madison, Wis.
111. Fischthal, J. H............Biol. Lab., Wis. Cons. Dept., Spooner, Wis.
112. Fisk, Emma L.....................205 Biology Bldg., Madison, Wis.
113. Fluke, Charles L., Jr...................105 King Hall, Madison, Wis.
114. Fowlkes, John Guy...............88 Cambridge Road, Madison, Wis.
115. Fox, Philip G......................403 Sterling Hall, Madison, Wis.
116. Frasche, Dean F.........1830 Plymouth St., N. W., Washington, D. C.
117. Frautschi, Walter A..................33 Fuller Drive, Madison, Wis.
118. Fred, Edwin B.....................158 Bascom Hall, Madison, Wis.
119. Frey, Charles N................45 Cambridge Road, Scarsdale, N. Y.
120. Friesner, R. C..........Dept. of Bot., Butler Univ., Indianapolis, Ind.
121. Fuller, Albert M..........Milwaukee Pub. Museum, Milwaukee, Wis.
122. Funk, John L.......................State Stream Pollution Comm., Daniel Bagley Hall, U. of Wash., Seattle, Wash.
123. Gajewski, J. E. ......Dept. of Pharmacology, 315 Mem. Inst. Bldg., Madison, Wis.
124. Gates, Charles B............2501 E. Stratford Court, Milwaukee, Wis.
125. Gehrke, Willis T........................16 Park Ave., Mayville, Wis.
126. Gerry, Eloise......................Forest Prod. Lab., Madison, Wis.
127. Gilbert, Edward M..................307 Biology Bldg., Madison, Wis.
128. Gilbert, Wm. P......Dept. of Physics, Lawrence Coll., Appleton, Wis.
129. Gloyer, Walter O................N. Y. Agr. Expt. Sta., Geneva, N. Y.
130. Graber, L. F..........................111 Moore Hall, Madison, Wis.
131. Grace, Harriett M.................613 Howard Place, Madison, Wis.
132. Greacen, Katherine....................Hunt Oil Co., Midland, Texas
133. Greco, Jennie.........................5519—25th Ave., Kenosha, Wis.
134. Greene, H. C.......................210 Biology Bldg., Madison, Wis.
135. Greene, Howard T...............................Genesee Depot, Wis.
136. Greene, John M.................................Genesee Depot, Wis.
137. Greve, H. C..Hayward, Wis.
138. Grill, John, Dr..............4145 W. McKinley Ave., Milwaukee, Wis.
139. Groves, James F..............Biology Dept., Ripon Coll., Ripon, Wis.
140. Guyer, Michael F...................253 Biology Bldg., Madison, Wis.
141. Halbert, Charles A..................Shorewood Hills, Madison, Wis.
142. Hall, Norris F......................205 Chem. Bldg., Madison, Wis.
143. Hanawalt, Ella M.........Milwaukee-Downer Coll., Milwaukee, Wis.
144. Hanley, Wilber.................107 Ext. Bldg., U. W., Madison, Wis.
145. Hansen, Arthur C................2565 N. 84th St., Wauwatosa, Wis.
146. Hanson, Harold C.......Nat. Hist. Surv. Resource Bldg., Urbana, Ill.
147. Harper, Robert A..................................R. #5, Bedford, Va.
148. Harrington, C. L.....................136 Lathrop St., Madison, Wis.
149. Hasler, Arthur D...............Biology Bldg., U. W., Madison, Wis.
150. Hawley, John C...............The Evergreens, R. #4, Madison, Wis.
151. Hayes, Merlin L..% James Fox, 789 N. Jefferson St., Milwaukee, Wis.
152. Hays, Orville E...................Cons. Expt. Sta., La Crosse, Wis.
153. Heffner, R. M. S..........Dept. of German, 84 Bascom Hall, Madison
154. Henmon, V. A. C.....................20 Bascom Hall, Madison, Wis.
155. Heun, Alphonse L................1611 N. 33rd St., Milwaukee, Wis.
156. Heuser, Emil.........................304 River Drive, Appleton, Wis.
157. Hiestand, Wm. A........Dept. of Biol., Purdue Univ., Lafayette, Ind.
158. Higgs, Charles D............................Box 86, Fontana, Wis.
159. Hile, Ralph................Univ. Museums Bldg., Ann Arbor, Mich.
160. Hoffman, Carl E....................1127 W. 8th St., Appleton, Wis.
161. Hollister, H. L.......................11 E. 75th St., New York, N. Y.

162. Honey, E. E.............................Box 474, Milwaukee, Wis.
163. Hotchkiss, W. O............Rensselaer Polytechnic Inst., Troy, N. Y.
164. Hougen, O. A.......................2247 Rowley Ave., Madison, Wis.
165. Howells, W. W................2432 Tracy Place, Washington, D. C.
166. Hrubesky, C. E...................Forest Prod. Lab., Madison, Wis.
167. Hughes, Merritt Y................352 Bascom Hall, Madison, Wis.
168. Huntzicker, V. E..........2857 N. Stoverel Ave., Milwaukee 11, Wis.
169. Huskins, C. L..................Biology Bldg., U. W., Madison, Wis.
170. Icke, Paul...................407 Rosemary Lane, Fall Church, Va.
171. Ihde, A. J..........................132 Chem. Bldg., Madison, Wis.
172. Ingraham, Mark H............102 South Hall, U. W., Madison, Wis.
173. Ireland, Edward J.
...........Dept. of Pharmacology, Loyola Univ., New Orleans, La.
174. Jackson, Hartley H. T.......Fish & Wildlife Serv., Washington, D. C.
175. Jahnke, Paul J......................1970 B St., Lincoln, Nebraska
176. Jasper, Thomas M.
.....Union League Clb. of Chicago, 65 W. Jackson St., Chicago, Ill.
177. Johnson, Raymond E..................53 E. Main St., Mystic, Conn.
178. Jones, Fred Revel............214 Hort. Bldg., U. W., Madison, Wis.
179. Jones, S. Paul........................509 W. Ave., Waukesha, Wis.
180. Jung, Clarence S...........6383 N. Port Wash. Rd., Milwaukee, Wis.
181. Kant, Fritz.......................1300 Univ. Ave., Madison, Wis.
182. Kaufman, Theo. N.....295 Pleasant Valley Way, West Orange, N. J.
183. Keitt, Geo. W.................207 Hort. Bldg., U. W., Madison, Wis.
184. Keller, Sr. Mary Anthony
..................Marian Coll., 390 E. Div. St., Fond du Lac, Wis.
185. Kesselman, Wm..................3061 N. Downer, Milwaukee, Wis.
186. Kiekhofer, Wm. H................308 Sterling Hall, Madison, Wis.
187. Kilmer, Victor J..................Mayo Gen. Hosp., Galesburg, Ill.
188. King, Ralph...................1056 Lancaster Ave., Syracuse, N. Y.
189. Kirchhoff, Roger C.............1908 Arlington Place, Madison, Wis.
190. Klak, Geo. E.........................8101 Diggs Road, Norfolk, Va.
191. Kliefoth, Max.....................Woodward Grove, Madison, Wis.
192. Koehler, Arthur..................Forest Prod. Lab., Madison, Wis.
193. Kohl, E. J...............................Ripon Coll., Ripon, Wis.
194. Kopf, Kenneth......Hawaiian Pineapple Co., Ltd., Honolulu, Hawaii
195. Kowalke, Otto L..............104 Chem. Engr. Bldg., Madison, Wis.
196. Krause, H., Dr.....................510 Fort St., Pensacola, Florida
197. Krohn, Charles H...........3728 W. Sheridan Ave., Milwaukee, Wis.
198. Krumholz, Louis A.........Dept. Zool., Ind. Univ., Bloomington, Ind.
199. Kruschke, Emil P..............Milw. Pub. Museum, Milwaukee, Wis.
200. LaFleur, Angelus, Rev.........................Mt. St. Francis, Ind.
201. Laird, Melvin R.................208 S. Cherry St., Marshfield, Wis.
202. Lamers, Wm...................7832 Warren Ave., Wauwatosa, Wis.
203. Leonard, Clifford S., Dr.
................Dept. of Pharmacology, U. of Vt., Burlington, Vt.
204. Leopold, Aldo...................102 Old Ent. Bldg., Madison, Wis.
205. Liesch, W. H....................207 N. Spooner St., Madison, Wis.
206. Lilly, John H...................Biology Bldg., U. W., Madison, Wis.
207. Lindsay, Ruth H...Hallowell House, Wellesley Coll., Wellesley, Mass.
208. Link, Karl Paul............Dept. of Biochem., U. W., Madison, Wis.
209. Lorenz, Robert H.........4825 N. Cumberland Ave., Milwaukee, Wis.
210. Loughborough, W. Karl............Forest Prod. Lab., Madison, Wis.
211. McCalmont, Mary M................Stout Institute, Menomonie, Wis.
212. McCoy, Elizabeth F....................21 Agr. Hall, Madison, Wis.
213. McDonough, Eugene S.....Dept. of Biol., Marquette Univ., Milwaukee
214. McElvain, S. M......................309 Chem. Bldg., Madison, Wis.
215. McKern, W. C................818 W. Wis. Ave., Milwaukee 3, Wis.
216. McNeel, W.......................3610 Nakoma Road, Madison, Wis.
217. MacLean, J. D.....................Forest Prod. Lab., Madison, Wis.

218. Main, Angie Kumlien....................R. #1, Fort Atkinson, Wis.
219. March, Herman W................1825 Summit Ave., Madison, Wis.
220. Marquette, Wm. G................59 Broadway, Pleasantville, N. Y.
221. Marschall, A. J......................14 Proudfit St., Madison, Wis.
222. Marshall, Ruth............................Wisconsin Dells, Wis.
223. Marshall, Wm. S..................139 E. Gilman St., Madison, Wis.
224. Marvin, Philip R................3726 N. Booth St., Milwaukee, Wis.
225. Mason, Arnold C.................Ill. Geological Survey, Urbana, Ill.
226. Mathews, Joseph H..................111 Chem. Bldg., Madison, Wis.
227. Mathiesen, John..................1111 Ruley Ave., Houghton, Mich.
228. Maurer, Edward R.............167 N. Prospect Ave., Madison, Wis.
229. Mead, Daniel W..................120 W. Gorham St., Madison, Wis.
230. Mead, Warren J.................77 Mass. Ave., Cambridge 39, Mass.
231. Meloche, Villiers W.................269 Chem. Bldg., Madison, Wis.
232. Merrell, Martha B.....................1438 Main St., Racine, Wis.
233. Middleton, W. S.....................Wis. Gen. Hosp., Madison, Wis.
234. Miles, Philip E.................1900 Arlington Place, Madison, Wis.
235. Miller, Eric R.......................Box 536, Winter Park, Florida
236. Moeck, Arthur H..............301 E. Armour Ave., Milwaukee, Wis.
237. Moffett, James W.
North Rotunda, Museum Bldg., Stanford Univ., Palo Alto, California
238. Morgan, Banner Bill..............101 Stock Pavilion, Madison, Wis.
239. Mossman, Harland W...............417 Science Hall, Madison, Wis.
240. Mowry, Wm. A..................119 Wis. Gen. Hosp., Madison, Wis.
241. Muckenhirn, Robert J.................303 Soils Bldg., Madison, Wis.
242. Neff, E. E., Dr.........................Maple Bluff, Madison, Wis.
243. Neidhoefer, J. R..................2443 N. 68th St., Milwaukee, Wis.
244. Nelson, Glenn H...................2807 E. Lee Street, Tucson, Ariz.
245. Nesbitt, Paul H............................Beloit Coll., Beloit, Wis.
246. Nevins, Beatrice I.............Ga. State Women's Coll., Valdosta, Ga.
247. Nichols, M. Starr..............423 Serv. Mem. Inst., Madison, Wis.
248. Noland, Lowell E....................455 Biol. Bldg., Madison, Wis.
249. Norris, R. F.................2024 Chadbourne Ave., Madison, Wis.
250. Oberholser, Harry C.
Cleveland Museum of Nat. Hist., 2717 Euclid Ave., Cleveland, Ohio
251. O'Donnell, D. John. Wis. Cons. Dept., State Office Bldg., Madison, Wis.
252. Oehlenschlaeger, Eliz. A...R. #6, Fairy Chasm Rd., Milwaukee, Wis.
253. Ordway, John G...Crane Mfg. Co., Broadway at Fifth, St. Paul, Minn.
254. Palmer, Lewis C..................131 W. Gilman St., Madison, Wis.
255. Parsons, Helen T..............219 Home Econ. Bldg., Madison, Wis.
256. Paul, Benson H..................Forest Prod. Lab., Madison, Wis.
257. Perry, James C.............Dept. Zool., Marquette Univ., Milwaukee
258. Perry, L. E...................605 Volunteer Bldg., Atlanta, Georgia
259. Peterman, Mary L.................911 Clymer Place, Madison, Wis.
260. Pfefferkorn, K. B.
.......Oshkosh Clinic Bldg., Inc., 19 Jefferson Ave., Oshkosh, Wis.
261. Pinney, Mary E.
.........Johnston Hall, Milwaukee-Downer Coll., Milwaukee, Wis.
262. Pohl, Richard.......................Box 374, Colorado City, Texas
263. Potzger, J. E...Dept. of Botany, Butler University, Indianapolis, Ind.
264. Pratt, Clarence H.......................727 Thorne St., Ripon, Wis.
265. Pritzl, Peter P.................St. Norbert Coll., West DePere, Wis.
266. Reed, Geo. M..............Brooklyn Botanic Garden, Brooklyn, N. Y.
267. Reese, Hans H......................Wis. Gen. Hosp., Madison, Wis.
268. Rehwaldt, Aug. C..................615 N. 11th St., Milwaukee, Wis.
269. Reis, Raymond, Rev...............Marquette Univ., Milwaukee, Wis.
270. Reith, Allan F.............924 E. Sylvan Ave., Whitefish Bay, Wis.
271. Retzer, John P.................4973 N. Larkin, Whitefish Bay, Wis.
272. Reyer, H. B..................7525 Oak Hill Ave., Wauwatosa, Wis.
273. Reynolds, B. S...................1015 E. Wash. Ave., Madison, Wis.

274. Richards, C. Audrey..............Forest Prod. Lab., Madison, Wis.
275. Richardson, Robert K..................829 Church St., Beloit, Wis.
276. Richtmann, W. O....................453 Chem. Bldg., Madison, Wis.
277. Riker, Mrs. A. J.....................212 Hort. Bldg., Madison, Wis.
278. Ritter, Geo. J.......................310 Vista Road, Madison, Wis.
279. Roark, Raymond J.............115 Educ.-Engr. Bldg., Madison, Wis.
280. Robinson, W. Merle......................Box 146, Montezuma, Iowa
281. Roebuck, John R..................128 Sterling Hall, Madison, Wis.
282. Rogers, Walter E...........Dept. Botany, Lawrence Coll., Appleton
283. Rohde, H. W................3927 N. Stowell Ave., Milwaukee, Wis.
284. Rosenberry, Marvin B., Hon.......81 Cambridge Road, Madison, Wis.
285. Ross, Frank A.......................Shorewood Hills, Madison, Wis.
286. Ruegger, Geo...Radisson, Wis.
287. Sarles, Wm. B.......................310 Agr. Hall, Madison, Wis.
288. Schmidt, Erwin R..................Wis. Gen. Hosp., Madison, Wis.
289. Schneberger, Edward
..............Wis. Const. Dept., State Office Bldg., Madison, Wis.
290. Schubring, E. J. B...............122 W. Wash. Ave., Madison, Wis.
291. Schubring, Selma L., Dr.........410 N. Pinckney St., Madison, Wis.
292. Schuette, H. A......................253 Chem. Bldg., Madison, Wis.
293. Schulte, Walter B.................1551 W. Logan St., Freeport, Ill.
294. Schwartz, Sidney L................Forest Prod. Lab., Madison, Wis.
295. Scott, Walter E.............Mendota Beach Heights, Madison, Wis.
296. Searles, Clarence A........................Wisconsin Rapids, Wis.
297. Seguin, Hazel A.................State Teach. Coll., Superior, Wis.
298. Sevringhaus, Elmer L...............Wis. Gen. Hosp., Madison, Wis.
299. Shackelford, R. Max.............202 Genetics Bldg., Madison, Wis.
300. Shoemaker, Milton J.............3433 Sunset Drive, Madison, Wis.
301. Simon, Arthur.....828 First Wis. Nat'l. Bnk. Bldg., Milwaukee, Wis.
302. Sr. Mary Roberdetta.......1218 W. Kilbourn Ave., Milwaukee, Wis.
303. Sr. Mary St. Victor........1218 W. Kilbourn Ave., Milwaukee, Wis.
304. Slidell, Kemper..................1811 Kendall Ave., Madison, Wis.
305. Slotkin, J. S.......................Howard Univ., Washington, D. C.
306. Smith, Lloyd L..Div. of Fish and Game, Dept. of Cons., St. Paul, Minn.
307. Smith, W. N......................121 Bayley Ave., Platteville, Wis.
308. Snell, Walter H...................21 Laurel Court, Providence, R. I.
309. Sorum, C. H...................938 Univ. Bay Drive, Madison, Wis.
310. Sperry, Theo. M....................648 Oakland Court, Decatur, Ill.
311. Spohn, Wm. H..................221 Lakewood Blvd., Madison, Wis.
312. Squier, Theo. L..................425 E. Wis. Ave., Milwaukee, Wis.
313. Stauffer, John F...................55 Biology Bldg., Madison, Wis.
314. Stebbins, Joel................Washburn Observatory, Madison, Wis.
315. Steenbock, Harry................258 Biochem. Bldg., Madison, Wis.
316. Steil, Wm. N....................1926 N. 53rd St., Milwaukee, Wis.
317. Steiner, Gotthold.......................4117—29th, Mt. Rainier, Md.
318. Stevens, Myron..................2317 W. Lawn Ave., Madison, Wis.
319. Stevens, Neil E..............Dept. of Botany, U. of Ill., Urbana, Ill.
320. Stickney, Malcolm E......Botany Dept., Denison Univ., Granville, O.
321. Stock, Kurt..Fish Creek, Wis.
322. Stoddard, Herbert L.........................R. #5, Thomasville, Ga.
323. Storey, O. W......................180 N. Wabash Ave., Chicago, Ill.
324. Stout, Arlow B................N. Y. Bot. Gardens, New York, N. Y.
325. Stovall, Wm. D.................438 Mem. Inst. Bldg., Madison, Wis.
326. Struve, Otto...............Yerkes Observatory, Williams Bay, Wis.
327. Studer, Sr. M. Mira.......1413 South Layton Blvd., Milwaukee, Wis.
328. Supernaw, Jack S................818 Prospect Place, Madison, Wis.
329. Sweet, Carroll V.....................115 Ely Place, Madison, Wis.
330. Swift, Ernest.....................2716 Gregory St., Madison, Wis.
331. Teisberg, Halvor O...................120 Univ. Lib., Madison, Wis.
332. Tenney, Horace K., Jr.........2110 Chadbourne Ave., Madison, Wis.

333. Thomsen, Hans Peter........% Louis Larsen, R. #3, Box 406, Beloit
334. Thomson, J. W., Jr.............Dept. Botany, U. W., Madison, Wis.
335. Thorkelson, H. J. B....................% Kohler Co., Kohler, Wis.
336. Throne, Alvin L.................State Teach. Coll., Milwaukee, Wis.
337. Thwaites, Fredrik T................207 Science Hall, Madison, Wis.
338. Trautmann, W. J....................1743 Emerson St., Beloit, Wis.
339. Trewartha, Glenn T................313 Science Hall, Madison, Wis.
340. Truog, Emil........................204 Soils Bldg., Madison, Wis.
341. Turneaure, Frederick E.........166 N. Prospect Ave., Madison, Wis.
342. Twenhofel, Wm. H.................208 Science Hall, Madison, Wis.
343. Tyler, Stanley...................Science Hall, U. W., Madison, Wis.
344. Urdang, Geo.......................1635 Monroe St., Madison, Wis.
345. Van Biesbroeck, Geo.........Yerkes Observatory, Williams Bay, Wis.
346. Vanderwall, E. J...Wis. Cons. Dept., State Office Bldg., Madison, Wis.
347. Van Vleck, J. H..............55 Fayerweather St., Cambridge, Mass.
348. Von Jarchow, B. L...................1601 Wash. Ave., Racine, Wis.
349. Wadmond, Samuel C.........3859 Columbus Ave., Minneapolis, Minn.
350. Wagner, Geo...................546 Wash. Ave., Palo Alto, California
351. Wales, Julia G.....................320 Bascom Hall, Madison, Wis.
352. Walker, J. Chas.....................206 Hort. Bldg., Madison, Wis.
353. Walker, Ruth I...U. W. Ext. Bldg., 623 W. State St., Milwaukee, Wis.
354. Washburn, Robert G.............425 E. Wis. Ave., Milwaukee, Wis.
355. Waters, Ralph M...................730 Senica Place, Madison, Wis.
356. Watson, Kenneth M...........3501 Blackhawk Drive, Madison, Wis.
357. Weishar, Wm. J........513 E. Kenwood Ave., Menomonee Falls, Wis.
358. Wellman, Frederick L.
..............% U. S. Embassy, San Salvador, El Salvador, C. A.
359. Wells, Sidney D......................Box 1, Combined Locks, Wis.
360. Welty, Carl............................819 College St., Beloit, Wis.
361. Wenstrand, David E. W..........720 E. Wis. Ave., Milwaukee, Wis.
362. Westenberger, E. J., Rev.........128 S. Monroe St., Green Bay, Wis.
363. Wettengel, Mrs. Geo. R.............317 E. Coll. Ave., Appleton, Wis.
364. White, Helen C......................321 Bascom Hall, Madison, Wis.
365. Wickhem, John D., Hon..........716 Edgewood Ave., Madison, Wis.
366. Wilde, Sergius A......................202 Soils Bldg., Madison, Wis.
367. Williams, Clement C............129 N. Prospect Ave., Madison, Wis.
368. Wilson, H. F........................105 King Hall, Madison, Wis.
369. Wing, M. E............................Beloit College, Beloit, Wis.
370. Wingert, E. L.................117 N. Prospect Ave., Madison, Wis.
371. Winslow, Carlile P...............Forest Prod. Lab., Madison, Wis.
372. Wise, Louis E................Inst. of Paper Chem., Appleton, Wis.
373. Witzemann, Edgar J................Serv. Mem. Inst., Madison, Wis.
374. Wolfe, Harold R...................68 Biology Bldg., Madison, Wis.
375. Wright, Stillman..U. S. Bur. of Fisheries, Utah Agr. Coll., Logan, Utah
376. Zdanowicz, Casimir................207 Bascom Hall, Madison, Wis.
377. Zellmer, Luther.................State Teach. Coll., Platteville, Wis.
378. Zens, Rev. Claude P.......St. Francis Major Sem., St. Francis, Wis.
379. Zimmerman, Fred R.................4110 Birch Ave., Madison, Wis.
380. Zirrer, Francis..................................R. #3, Hayward, Wis.
381. Tressler, W. L........Dept. Zool. Univ. Maryland, College Park, Md.

New Members for 1945

1. Aberg, Wm. J. P...........3401 Lake Mendota Drive, Madison, Wis.
2. Aurner, R. R........................418 Sterling Hall, Madison, Wis.
3. Baier, Joseph, Jr..................623 W. State St., Milwaukee, Wis.
4. Barton, A. O.......................1914 Madison St., Madison, Wis.
5. Bartsch, A. F......................623 W. State St., Milwaukee, Wis.
6. Bass, T. C...........................233 Alden Drive, Madison, Wis.
7. Black, John D.......Dept. Biology, Anderson College, Anderson, Ind.

8. Brown, Bruce K.................910 S. Michigan Ave., Chicago, Ill.
9. Buchen, Walther................605 Arbor Vitae Rd., Winnetka, Ill.
10. Campbell, R. S.........Dept. Zoology, Univ. Missouri, Columbia, Mo.
11. Churchill, W. S..........................Box 168, Minocqua, Wis.
12. Doudna, E. G..........................2017 Monroe, Madison, Wis.
13. Ellis, E. W......................122 Lakewood Blvd., Madison, Wis.
14. Englerth, George H............Forest Products Lab., Madison, Wis.
15. Englerth, (Mrs.) Harriet W..........601 Baltzell St., Madison, Wis.
16. Fischthal, J. H.....Biol. Lab., Wis. Conservation Dept., Spooner, Wis.
17. Gilbert, W. P........Dept. Physics, Lawrence College, Appleton, Wis.
18. Greco, Jennie........................5519 25th Ave., Kenosha, Wis.
19. Greve, H. C.....................................Hayward, Wis.
20. Hanley, W. M..................441 Virginia Terrace, Madison, Wis.
21. Hansen, Arthur C...............2565 N. 84th St., Wauwatosa, Wis.
22. Hougen, O. A.....................2247 Rowley Ave., Madison, Wis.
23. Huskins, C. L....................1938 Rowley Ave., Madison, Wis.
24. Ihde, A. J.................132 Chemistry, Univ. Wis., Madison, Wis.
25. Kesselmann, Wm..................3061 N. Downer, Milwaukee, Wis.
26. King, Ralph..................1056 Lancaster Ave., Syracuse, N. Y.
27. Kliefoth, Max H..................Woodward Grove, Madison, Wis.
28. Kopf, Kenneth.........Hawaii Pineapple Co., Ltd., Honolulu, Hawaii
29. Liesch, W. H.....................207 N. Spooner St., Madison, Wis.
30. Marvin, Philip R................3726 N. Booth St., Milwaukee, Wis.
31. McKern, W. C...................818 W. Wis. Ave., Milwaukee, Wis.
32. McNeel, W......................3610 Nakoma Rd., Madison, Wis.
33. O'Donnell, D. John
.........Wis. Conservation Dept., State Office Bldg., Madison, Wis.
34. Ordway, John G.....Crane Mfg. Co., Broadway at 5th, St. Paul, Minn.
35. Paul, Benson H................Forest Products Lab., Madison, Wis.
36. Reyer, Harold B...............7525 Oak Hill Ave., Wauwatosa, Wis.
37. Reynolds, B. S.............1015 E. Washington Ave., Madison, Wis.
38. Robinson, W. Merle................P. O. Box 146, Montezuma, Iowa
39. Slidell, Kemper..................1811 Kendall Ave., Madison, Wis.
40. Sorum, C. H...................938 Univ. Bay Drive, Madison, Wis.
41. Watson, Kenneth M.................3501 Blackhawk, Madison, Wis.
42. Wingert, E. L.................117 N. Prospect Ave., Madison, Wis.
43. Zimmerman, F. R. (Reinstated) ......4110 Birch Ave., Madison, Wis.

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1933–1944

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* Continuation of the compilation by L. E. Noland, Trans. Wisconsin Acad. Sci. 1932. 27:573–606.

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