FACTORS INFLUENCING THE EXTENSION OF THE NORTHERN RANGE OF THE CARDINAL (RICHMONDENA CARDINALIS CARDINALIS) IN MICHIGAN

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FACTORS INFLUENCING THE EXTENSION OF THE NORTHERN RANGE OF THE CARDINAL (*RICHMONDENA CARDINALIS CARDINALIS*) IN MICHIGAN

By

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A THESIS

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INTRODUCTION

During the early period of settlement in Michigan the Eastern Cardinal, Richmondena cardinalis cardinalis (L.), was present in the state as a cage bird imported from the south. Today it is a common nesting bird in the southern half of the Lower Peninsula and occurs sparingly further north. This change in status indicates an obvious northward extension of the Cardinal's range in this area. Similar expansion is indicated in other areas along the margin of the "normal" range of the subspecies. This expansion has apparently been accompanied by an increase in the Cardinal population in other areas, such as Ohio, Indiana and southern Illinois, adjacent to the expansion zones.

In southern Michigan the Cardinal is present at all seasons of the year. Consequently, information with respect to this bird is noticeably lacking from spring and fall migration records for this area. In contrast to this, when the Cardinal appears in a new area, it is usually reported. Because of this its northward expansion is well documented in the literature and a fairly accurate year to year location of range boundaries can be mapped from the published data.

The object of this investigation was two-fold: to learn more about the present distribution of the Eastern Cardinal, and to determine the factors which contributed to the relatively recent expansion of its range.

The study consists of an analysis of the Cardinal's status in Michigan with references to the history of the northward movement throughout the whole range of the species. Special attention is given to Long Island, New York, and Massachusetts, two areas which illustrate important principles involved in the extension of range.

Field investigations were carried out from the spring term of 1952 to the winter term of 1954, except for the summer months, on the campus of Michigan State College and in the adjoining woodlots. Winter courtship and the establishment of territories were investigated on the Campus, and nestlings were banded there. Winter flocking was studied in the Red Cedar Woodlot where, during the fall and winter of both years, a banding station was operated. At this time field observations with regard to feeding and movements were also made. The field observations were supplemented by a survey of the literature, and an analysis of available banding data.

HISTORICAL BACKGROUND

Taxonomy and Geographical Distribution of the Cardinal

The genus Richmondena belongs to the family Fringillidae. The Fringillidae are subdivided (Mayr, 1946:7) into the following subfamilies: (1) Carduelinae -- the cardueline finches; (2) Emberizinae -- certain buntings and American sparrows; and (3) Richmondeninae -- the cardinals or South American finches.

Although 15 subspecies of the Cardinal, Richmondena cardinalis (L.) Ridgway, have been described (Hellmayr, 1938: 67-13), this particular study is concerned only with the eastern form (R. c. cardinalis). The subspecies listed by Hellmayr, together with the distributional ranges (see map, Fig.1) which he indicates, are:

1) R. c. cardinalis (Linnaeus). Range -- the upper and lower Austral zones of eastern North America east of the great plains, from south-eastern South Dakota, southern Iowa, northern Indiana, northern Ohio, southern Ontario, Pennsylvania and the southern Hudson Valley, south to the northern parts of the Gulf States and Georgia; casual in Colorado, Minnesota, Wisconsin, Michigan, New Brunswick, Massachusetts and Connecticut. The Cardinals in southern California and the Bermuda Islands were introduced from undetermined stock.

2) R. c. floridana (Bangs). Range -- restricted to peninsular Florida.

3) R. c. canicauda (Chapman). Range -- central western Texas, south through eastern Mexico to Puebla and Michoacan.

4) R. c. coccinea (Ridgway). Range -- Caribbean slope of southeastern Mexico, in the states of Vera Cruz and Oaxaca.

5) R. c. yucatanica (Ridgway). Range -- Peninsula of Yucatan.

6) R. c. flammigera (Peters). Range -- Southern Quintana Roo (Xcopen) and British Honduras (Corosal, Belize).

7) R. c. magnirostris (Bangs). Range -- Eastern Texas and southern Louisiana.

8) R. c. saturata (Ridgway). Range -- Cozumel Island, Yucatan.

9) R. c. superba (Ridgway). Range -- Southern Arizona, southwestern New Mexico and the adjacent parts of northwestern Sonora (south to Pesqueira).

10) R. c. ignea (Baird). Range -- Arid tropical and lower Austral zones of the Cape district of Baja California, north to about lat. 27°.

11) R. c. townsendi van Rossem. Range -- Tiburon Islands, Gulf of California and on the coast of Sonora in northeastern Mexico.

12) R. c. affinis (Nelson). East and south Sonora and adjacent parts of southwestern Chihuahua (Batopillas, La Trompa, etc.).

13) R. c. sinaloensis (Nelson). Range -- Pacific lowlands and foothills of southern Sinaloa, Mexico.

14) R. c. mariae (Nelson). Range -- Tres Maria Islands of Western Mexico.

15) R. c. carnea (Lesson). Range -- Pacific Coast district of southwestern Mexico, from Colima to Oaxaca (Huamelula).

Presumed South American Origin of Richmondena Stock

Mayr (1946:25) considers the genus Richmondena to be of South American origin because the cardinal group (Richmondeninae) is so richly developed in all parts of South America, and is relatively scarce in Central and North America.

This study is concerned with three of the seven elements of origin set up by Mayr (1946:11-13): the North American, the Pan-American and the South American elements. The North American element comprises the fauna which developed here during the Tertiary while this continent was separated from South America, and connected with Asia only by the Bering Strait bridge. The Pan-American element includes those families that are rich in endemic genera and species in both North and South America. The South American element consists of certain families which are richly developed in all parts of South America.

During the greater part of the Tertiary, the North American continent had a subtropical climate; thus, some tropical families have representatives established in North America.

It should be noted that no final decision can be reached on the Richmondeninae until it has been determined whether certain South American genera belong to that subfamily or to the Emberizinae. There is a possibility that the Richmondeninae may have to be transferred from the South American element to the Pan-American (Mayr, 1946:27). Regardless in which of these groups -- Emberizinae or Richmondeninae--the cardinals may be placed, their origin was apparently in a region with a tropical climate since North America was much warmer during the Tertiary.

The Cardinal (R. cardinalis) is a species which has rapidly adapted itself to a cool temperate climate. It was noted by Randall (1951:117) that the Cardinal wintered as far north as Bismarck, North Dakota, in 1950. The average temperature during January of that year was -10.2°F, with a minimum of -44°F. Snow at the end of January, when the Cardinals were observed, was 14 inches deep. Although such extreme northern records occur, it should be noted that the Cardinal increases in density from north to south. This is suggestive of a more equatorial origin for the group.

In Michigan nesting records are completely lacking in habitats which are indicative of the Canadian zone. Also, in the jack-pine country of the Lower Peninsula the Cardinal is absent, but is found around the periphery of this area even to the north. Where soil conditions are fertile enough to maintain farms, orchards and other agricultural industries, the Cardinal is able to establish itself if the original habitat has been altered in such a way as to provide suitable food and cover.

History of the Northward Movement of the Cardinal

Northward Movement in Michigan

Early records. - The earliest record of the Cardinal in Michigan was a mere listing in the State Natural History Survey in 1837 (Wood, N. A. 1926:555), with no details as to season, date, or location. More than likely such an early report was of an escaped cage bird. According to Swales and Taverner (1907:146) there is some evidence that the Cardinal was present in some towns as early as 1850. Many old residents spoke of the "Red-birds" that they used to see, and also mentioned their whistling powers. These authors proposed that the Cardinal exhibited "a large cycle", and was merely reoccupying territory it once did years ago. From the study of

the bird's habitat requirements, and valid observations in other areas, such a hypothesis is highly doubtful. For example, in Iowa, Sherman (1913:78-80) stated that Cardinals had never been observed during the fifty years prior to 1913.

Strays from the south no doubt entered Michigan from time to time before 1880, but it was after this date that reports of the Cardinal are listed in the literature. From the "tone" of the reports it was a new bird in the area, never seen before in southern Michigan by ornithologists.

Wood (1926:555) first mentioned specimens taken in Michigan from the southern part of the State in 1879. The following reports of the Cardinal in the 1880's suggest it was about this period when it began to move into the State.

It is surprising to note that the next records in 1883, include specimens taken as far north as Kent County in the west and Port Sanilac in the east (Cook, 1893:117). Although these specimens were taken this far north, the Cardinal was <u>not</u> found generally throughout the southern four tiers of counties It seems probable that if the Cardinal occurred in Lansing and Ann Arbor at that time, it would have been recorded since ornithologists were located at both places. Swales (1907:146) states that the Cardinal remained on the Washtenaw County list from 1892 to 1894 on the basis of an old sight record. The Cardinal, however, had been definitely recorded in Ann

Arbor on June 14, 1884 (Wood, 1910:134).

The first nesting record for Detroit was of a set of eggs taken on June 19, 1892 (Cook, 1893:117). In the same year W. A. Oldfield reported to Cook that a few Cardinals were now seen in Monroe County every spring.

By 1897 the Cardinal was still a rare "find" in Detroit. Wood (1900:391) said, "During the 10 years of careful work I have seen the Cardinal Grosbeak but twice, and have secured both specimens . . ." These specimens were a female taken November 1, 1897, and a male on December 3, 1899.

In 1899, the Cardinal was first recorded from Ingham County at East Lansing. From then until 1912 it was found regularly on the campus each year. Sometimes four or five individuals wintered there (Barrows, 1912:530).

At the end of the century the Cardinal occurred sparingly in the State. The distribution was spotty with only a few reports of individuals taken at various points in the southern four tiers of counties (Figure 2).

Records from 1900 to 1910. - During the first ten years of the century, the Cardinal established itself as a breeding resident in those areas where it formerly had been reported as a stray. There were no reports of it progressing to the undeveloped areas in the northern part of the State. Although a nest with one egg was located near Ann Arbor on May 24, 1899

Data for Figure 1

1. Kent County, Michigan, a female was taken on August 10, 1883, and a male on Ocober 24, 1883 (Cook, 1893:117).
2. Port Sanilac, Michigan, a male was taken in town (Cook, 1893:117).
3. Springfield, Massachusetts, a few were seen in the 1880's (Chadbourne, 1882:4).
4. Wellesley, Massachusetts, an adult male was shot on November 4, 1888 (Denton, 1889:28).
5. Central Park, New York City, New York, during the spring of 1882 the Cardinal was reported as a permanent resident (Zerga, 1884:117).
6. Worburn, Massachusetts, a Cardinal was taken on November 14, 1880, and did not exhibit the characteristics of a caged bird (Richards, 1883:59).
7. Minneapolis, Minnesota, a male taken on October 23, 1875, and a specimen taken in October, 1878, were the first records for the area (Roberts, 1932:335).
8. Southern Michigan, a few specimens were taken from the area about 1879 (Wood, N. A., 1926:555).
9. Washtenaw County, Michigan, a first occurrence record was on June 14, 1884 (Wood, N. A., 1910:134).
10. Erie, Pennsylvania, a pair raised a brood of young during the summer of 1892 (Todd, 1904).

(Wood, 1910:134), since that year the species gradually increased until by 1909 it was referred to as a permanent resident of Washtenaw County. Other breeding records listed for Ann Arbor were May, 1905 and May 8, 1909.

The first nesting record for the campus at East Lansing was June 6, 1903 (Barrows, 1912:530). The second record of a nesting bird was for June, 1911.

During this same period, from 1904 to 1907, the Cardinal was noted to be definitely on the increase in the Detroit area (Swales, 1907:146). In the fall of 1904 a brood of young birds accompanied by both parents was seen on the mainland near the St. Clair Flats. In May, 1905, two birds were observed at Flat Rock on the Huron River, and on January 6, 1907, six scattered individuals were seen along the river between Flat Rock and Rockwood. Single individuals were seen during most of the spring, fall and winter months between Detroit and the mouth of the Huron River. The valley of this stream seemed to be the main artery of their distribution in this section, and they were rather common as far north as Ann Arbor by 1907 (Swales, 1907:146).

In Wayne County on January 20, 1909, a male Cardinal was seen in Woodmere Cemetery, Detroit, where it probably wintered (Wood, J. C., 1910:41). Wood also stated that there was a decided increase in the numbers of individuals

at about that time. It was possible to see one to four Cardinals on each of his field excursions during December and January. The Cardinal was found commonly on Belle Isle in the winter of 1908.

By 1910 it was established as a permanent resident in southern Michigan where it had been reported as a stray ten years previously. It can be seen that the Cardinal was able to establish itself about ten years after its first arrival in the Detroit area (Fig. 3).

Records from 1910 to 1930. - During this period the Cardinal continued to increase in the southern part of the state until it became a fairly common resident everywhere in that region (Fig. 4). In 1910 the Cardinal was listed on the Christmas bird count in New Buffalo. At about this time it began to appear on the counts in other southern Michigan cities and towns. In 1912 Barrows (1912:530) stated that apparently the species was not common anywhere in the State, but that a pair or two had been reported from St. Clair and Jackson Counties; Kalamazoo; Olivet; Battle Creek; Petersburg; Monroe ounty; Hillsdale County; Ann Arbor; Bangor, Van Buren County; Detroit; Grand Rapids; Forestdale, Sanilac County Beulah, Benzie County. Reports from the Upper Peninsula were thought to relate to the Scarlet Tanager.

Data for Figure 3

1. Burlington, Iowa, some islands in the Mississippi River supported some Cardinals, and first occurrences in town were reported about 1900 (Ross, 1938:27).
2. Clayton County, Iowa, at the mouth of the Sny Magill Creek, both a male and female were singing on April 17, 1908 (Sherman, 1913:78-80).
3. Sioux City, Iowa, a group of 12 birds made up of young and adults was seen in September 1901 (Talbot, 1902:86-7).
4. Chicago, Illinois, pairs were observed during the winter of 1905-6 (Ferry, 1907:128).
5. Belle Isle, Michigan, two individuals were observed on January 1, 1903 Swales, 1904:84).
6. St. Thomas, Ontario, a male was shot during the spring of 1890. A male was taken in a cedar swamp a mile from London on November 30, 1896 (Keay, 1902:202).
7. East Lansing, Michigan, a nest containing two eggs was found on June 6, 1903 (Barrows, 1912:530).
8. Ann Arbor, Michigan, a nest with one egg was found on May 24, 1903. Other breeding records for the area were secured in May, 1905, and on May 8, 1909 (Wood, N.A. 1910:134).
9. Amesbury, Essex County, Ontario, a Cardinal was shot on September 27, 1889, and a pair was seen on May 19, 1901 (Allen, 1913:27).

Data for Figure 3 Continued

10. Flat Rock, Michigan, a brood of young with both parents was found near the Huron River in the fall of 1904. A flock of six was seen in the same area along the Huron River on January 6, 1907 (Swales, 1907:146).
11. Manhatten, New York, five individuals were seen on the Christmas bird count in December 1909 (Anonymous, 1910).
12. Guelph, Ontario, a Cardinal was reported in the area during the winter of 1899-1900 (Keay, 1902:202).
13. Ames, Iowa, a group of five was seen only once on April 20, 1909 (Anonymous, 1910:100).
14. Cambridge, Massachusetts, a male was seen in the area on November 27, 1901 (Comey, 1902:86).

Data for Figure 4

1. Vermillion, South Dakota, a Cardinal was reported on the Christmas bird count in December 1916 (Anonymous, 1917:34).
2. Sioux City, Iowa, six individuals were seen in December, 1916 (Anonymous, 1917:34).
3. Omaha, Nebraska, eight individuals were reported on the Christmas bird count in December, 1916 (Anonymous, 1917:34).
4. South English, Iowa, the Cardinal was reported on the Christmas bird count in December, 1916 (Anonymous, 1917:34).
5. Charlevoix, Michigan, the first record for a Cardinal in the area was on August 18, 1922 (Wood, 1951:447).
6. Whitefish Point, Chippewa County, Michigan, a female was collected on November 3, 1929 (Tyrrell, 1931:131).
7. La Crosse, Wisconsin, a Cardinal was banded on April 23, 1926, and was found wounded at the same place January 23, 1935 (Lincoln, 1939:138).
8. Warren, Rhode Island, a female was seen on January 23, 1916, and was believed to be the first Cardinal record for the State (Madison, 1917:94).
9. Rockaway, Long Island, New York, a Cardinal was heard calling on March 31, 1926 (Anonymous, 1926:337). Staten Island, New York, a male was seen on December 26, 1925, on the Christmas bird count (Anonymous, 1926:26).

Data for Figure 4 Continued

10. Minneapolis, Minnesota, a female was banded on November 12, 1929, and was believed to be the first individual to be banded in the area (Commons, 1928:206).
11. Scranton, Pennsylvania, a pair was seen on four different occasions. This was believed to be the first record for Lackawanna County (Coffin, 1928:223).
12. Littleton, Colorado, a pair was reported nesting for three seasons (Bergtold, 1927:108).
13. Pratt, Pratt County, Kansas, several were seen in the area, and there is one nesting record (Linsdale, 1927:56).

By 1919 the Cardinal was classed as a fairly common resident in the southern counties (Wood, N. A., 1926:555). During the following decade the Cardinal made its way to the Upper Peninsula. Wood (1926:555) reported the Cardinal in Charlevoix, near the northern end of the Lower Peninsula, in 1922. Tyrrell (1931:131) speaks of a female taken in the Upper Peninsula at Whitefish Point near Sault Ste. Marie on November 3, 1929.

Northward Movement in Other Areas

There are areas other than Michigan where the Cardinal has made notable extensions in its northern range. Among these, the Long Island region of southeastern New York and the Mississippi Valley region are good examples. In still other regions the movement has been restricted to essentially the same areas for about 70 years; Massachusetts is an example of this. Comparison between regions of restriction and expansion in movement are made in the following paragraphs.

Massachusetts. - In the 1880's the Cardinal was reported as a stray in various population centers of this state, (Fig. 2). During this period it was a popular cage bird and, no doubt, some of the early reports pertain to escaped individuals. In those instances where the recorder believed the birds seen were wild, the reports are included in Figure 2

and some of them are discussed below. These reports include an early record of a Cardinal taken in Woburn on November 14, 1880 (Richards, 1883:59). A male was shot in Wellesley, November 4, 1888, (Denton, 1889:28). In Springfield it was thought to be too common for all of the individuals to be cage birds (Chadbourne, 1882:4). The above mentioned specimens were in good condition, and did not exhibit worn tail feathers or long claws typical of cage birds.

Although restricted areas of suitable Cardinal habitat occur in New England, it is believed that if these areas were of greater extent, food and cover would be available to support Cardinals. It can be seen that as early as the 1880's the bird had made its way into Massachusetts as far as the northeastern section. These early visitors no doubt came from the areas to the southwest, i.e., New Jersey and eastern Pennsylvania.

On November 27, 1901, a male was seen in Cambridge. It was reported to be the same individual which had been seen a quarter of a mile away on the 19th of the same month (Comey, 1902:86). During the period from 1880 to the present time the habitat for the most part has not undergone the drastic changes which took place in Michigan.

The area surrounding Boston has been thickly settled and is probably less suitable for the Cardinal today than it was 50 years ago. In any event recent reports are more

frequent from the Springfield area of central Massachusetts and from Berkshire County in the western part of the state (Fig. 5). Since the Cardinal has become more common in eastern New York, these individuals in the Berkshires may have come in from the west. A singing male was seen near Great Barrington in July, 1953, by the author. Two were reported on the 1951 Christmas bird count from Pittsfield (Anonymous, 1952), another in Lynn, and a male in Northhampton, Hampshire County, during November, 1950 (Anonymous, 1951).

Although the range of the Cardinal has extended as much as 500 miles to the north in some areas, its status has remained fairly constant in Massachusetts with the possible exception of Berkshire County where it appears to be a more recent invader. It is interesting to note that, although it is apparently lacking from New Hampshire, Vermont and Maine, the Cardinal occasionally is seen in New Brunswick. It was reported from there as early as 1900 (More, 1901:201) and is listed as casual there by Hellmayr (1938:67).

Long Island and Southeastern New York. - For many years much of Long Island remained undeveloped. In this respect it was similar to Massachusetts, and the Cardinal was restricted from the area due to the unfavorable habitat. Long Island has recently become the site of a

Data for Figure 5

1. Bismarck, North Dakota, two males spent the month of January, 1950. Other individuals were reported eight miles north by a farmer (Randall, 1951:117).

2. Fargo, North Dakota, strays occur from this area rather frequently, and they are also reported from the adjacent areas in Minnesota.

3. Marquette County, a male was seen in a jack-pine forest at the mouth of the Pine River 200 yards from Lake Superior on July 26, 1939 (Christy, 1942).

4. Fort William, Ontario, the first record of a stray in this area was during mid-December 1950 (Anonymous, 1951).

5. Sturgeon Falls, Ontario, a male was seen in December, 1950 (Anonymous, 1951).

6. Adirondacks, New York, the Cardinal has been absent from this area. The first record for Lake Placid of the occurrence of a Cardinal was on October 30, 1951. In Schenectady to the west a few are seen during the winter (Anonymous, 1952).

Data for Figure 5 (Continued)

7. Pittsfield, Massachusetts, two Cardinals were reported on the 1951 Christmas bird count (Anonymous, 1952:188).

8. Aberdeen, South Dakota, an individual was reported from the area during the winter of 1938-9 (Anonymous, 1940:118).

tremendous building boom, and has consequently become more suitable for Cardinals in a comparatively short time. This is reflected by the recent records from Long Island (Fig. 5).

The Cardinal's range had progressed beyond New York City as early as the 1900's. However, it was noticeably absent from Long Island. About 1880 (Paine, 1885:60) in Central Park, in the heart of New York City, the bird was evidently present in fair numbers. It was reported as a permanent nesting resident in Central Park on the basis of data from May 11, 1882 (Zerga, 1884:117). Since at that time the more or less continuous range of the bird extended only to central New Jersey (Fig. 2), it seems obvious that the Cardinal was able to exist in an outlying locality such as Central Park because of the presence of suitable habitats. Today the Park supports nesting Cardinals even though it is completely surrounded by buildings.

Although the Cardinal has been established in the center of New York City since 1880, it has not generally appeared in areas surrounding the city until quite recently. As the population of the city increased, vast residential districts were developed to the north in Westchester County and, somewhat later, to the east on Long Island. With such residential development, suitable Cardinal habitats were created and the bird moved in from adjacent areas. The most striking

example of rapid occupation of the newly available habitats is the Long Island region.

Some of the earliest records for Long Island were at Orient Park in December, 1909 (Anonymous, 1910) and at Sheepshead Bay on January 1, 1912 (Nichols et al, 1917:443). The latter record was discussed as follows: "Of late years very rare. A male in the cedar grove . . . is the only recent occurrence of which we are cognizant." At the present time the Sheepshead Bay area is completely residential or commercial and a cement wharf borders the bay. The district is too congested to support Cardinals.

Even as late as 1925 the Cardinal was virtually absent from Long Island. Following the extensive residential developments begun about 1940 and continuing today, it has become increasingly frequent. Records from the Christmas counts indicate specimens seen in western Long Island, South Nassau County, and as far east as Smithtown (Anonymous, 1950, 1951, 1952, 1953). Although reported as a stray from outlying area, the bulk of the population of Cardinals is on the western half of the island. However, it is apparently absent from the thickly settled parts of Brooklyn.

Mississippi Valley and Westward. - West of Michigan the Cardinal has made an even more striking increase in range. The prairies and the plains were lacking in suitable cover

before the period of settlement. Upon the advent of white man, the entire region was put into cultivation almost at once. Trees were planted along many of the rivers and streams, and as towns were settled, similar plantings around dwellings provided the necessary cover for the bird. A greater expanse of similar land was available for the bird here than in Michigan.

In the 1900's the Cardinal was a relatively rare find as far south as Burlington, Iowa (Fig. 2). At that time the people of that town had to row up the Mississippi River eight miles to a group of islands where there were a few pairs (Ross, 1938:27). On the western side of the state a dozen birds, young and adults, were seen at Riverside Park near Sioux City, Iowa (Talbot, 1902:86-7). The park superintendent stated that they had only been in that area during the past two or three years.

In northeastern Iowa both a male and female were reported singing at the mouth of Sny Magill Creek, Clayton County, on April 17, 1908. A male was seen in December, 1908, and remained for three months at a feeding station in McGregor, Clayton County (Fig. 3), and across the Mississippi River in Wisconsin two Cardinals spent the winter in Roscobel (Sherman, 1913:80).

The above reports indicate that the Cardinal evidently preferred the large river valleys as it moved northward; both

along the Mississippi and the Missouri Rivers there was considerable timber and many tangles affording good cover. In the central part of Iowa the northward movement was apparently slower. At Ames the Cardinal was reported as rare, with a single sight record on December 28, 1908, and a group of five recorded on April 20, 1909 (Anonymous, 1910:100). During the next twenty years the Cardinal increased in numbers throughout the state.

Even before the bird was well established in Iowa, there were some rather early records for Minnesota. The first records for Minneapolis were a male taken October 23, 1875, and another specimen October, 1878 (Roberts, 1932:335). There were some earlier indefinite sight records for the same area. There is a record of a male at Red Lake Falls, Red Lake County, in the Red River Valley some 300 miles north of any previous record prior to 1929. It remained throughout the winter of 1929-30, feeding on dried wild grapes and other berries. There is an early Duluth record for the winter of 1931-32 (Roberts, 1932:335). It was also reported here on the 1950 Christmas bird count (Anonymous, 1951).

To the northwest a male was seen at Fort Yates, Sioux County, North Dakota, on November 7, 1948. It was last seen March 7, 1949 (Kyllingstad, 1951:515). A dozen Cardinals spent the winter on the campus of the North Dakota Teacher's

College at Valley City (Ibid). During the winter of 1949-50 at least two males were seen repeatedly near Bismarck, North Dakota (Randall, 63:117). These records are indicated on the map in Figure 5.

Northernmost records. - The most northern record for the Cardinal is from Fort William, Ontario, on the north shore of Lake Superior, during mid-December 1950 (Anonymous, 1951:). Other northern records across the range of the species are indicated on the map in Figure 5 and included in Table III.

Current Status of the Cardinal in Michigan

The Cardinal is fairly common as far north as Mt. Pleasant, Isabella County, in the central part of the state, and Bay City to the east (see map, Fig. 6). Everywhere south of latitude 44.5° N. the Cardinal may be classed as a common permanent resident.

Although it has been reported as far north as Boyne City, it is generally absent in the north-central part of the Lower Peninsula. Zimmermann (1952:283) reported the Cardinal singing on July 13, 1952 in Cadillac, Wexford County. This is on the western border of the jack-pine plains. Toward the southern edge of the jack-pine country, a group of five was seen at Houghton Lake, Roscommon County on November 6, 1938

(Wood, 1951:448). In the northern part of the Lower Peninsula the Cardinal exhibits a preference for an open habitat with deciduous trees and shrubs. Consequently it is absent, except for occasional strays, from the extensive jack-pine plains. In contrast to this, a few Cardinals occur in the pine barrens of New Jersey. There the surrounding deciduous forest areas have a relatively high Cardinal population, while in northern Michigan the population is quite low.

Although there are no nesting records for the Upper Peninsula, the occurrences are frequent enough to indicate there are more records than logically can be attributed to strays. There are sight records for St. Ignace, Blaney Park, Sault Ste. Marie, and a remarkable one on July 26, 1939, of a male under observation at close range for five minutes in an open jack-pine forest within two hundred yards of the shore of Lake Superior, in Marquette County (Christy, 1942:181). Two were reported on Drummond Island, Chippewa County, during the winter of 1938-39 and on Mackinac Island on January 4, 1939 (Wood, 1951:448).

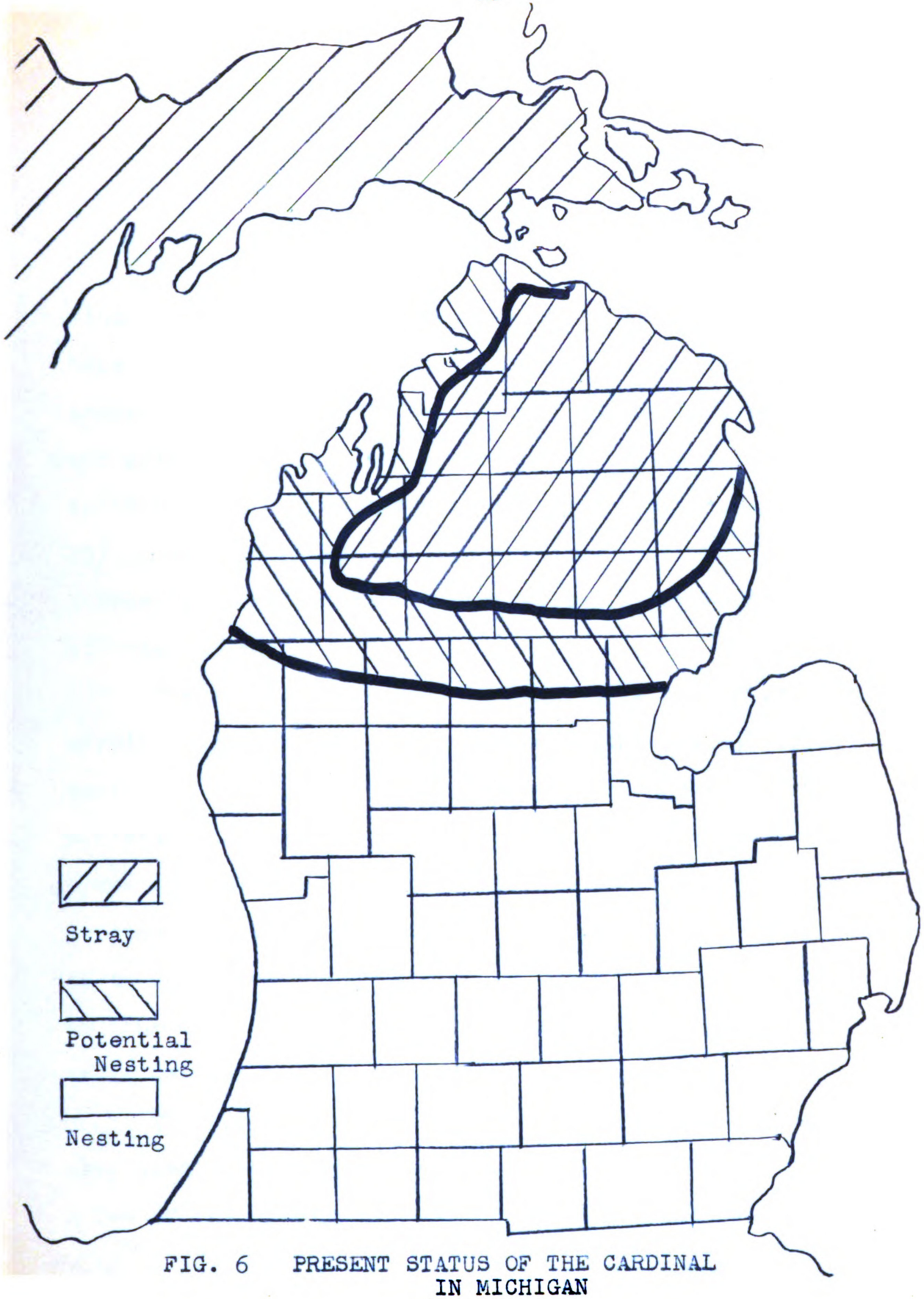

FIG. 6 PRESENT STATUS OF THE CARDINAL IN MICHIGAN

METHODS OF STUDY

Field Procedures

The banding program was carried out in the Red Cedar Woodlot (Fig. 7) by trapping Cardinals with the government-type sparrow trap (Fig. 8). This method was satisfactory for trapping males but not for females. Shoop (1936:313), using the same method in winter, captured 31 males at one station to 14 females. By using a spring-door-type trap Bacon (1953: 29) banded 264 males and 263 females. Thus, traps of the latter type are apparently more suitable for banding programs of this nature.

The bait used in the Red Cedar area consisted of commercial wild bird seed supplemented with an equal amount of sunflower seeds. This was placed in areas where Cardinals wintered, and when flocks came to feed on the seeds, the traps were placed over the food. If the traps were allowed to remain in the area constantly, the Cardinals quickly learned to go in and out at will. By removing the traps for three or four days, and then resetting them in the morning, Cardinals would generally enter the traps by the end of the day.

The No. 2 bands issued by the Fish and Wildlife Service were used in conjunction with painted color-bands of aluminum. A few of the wrap-around celluloid color-bands were used and

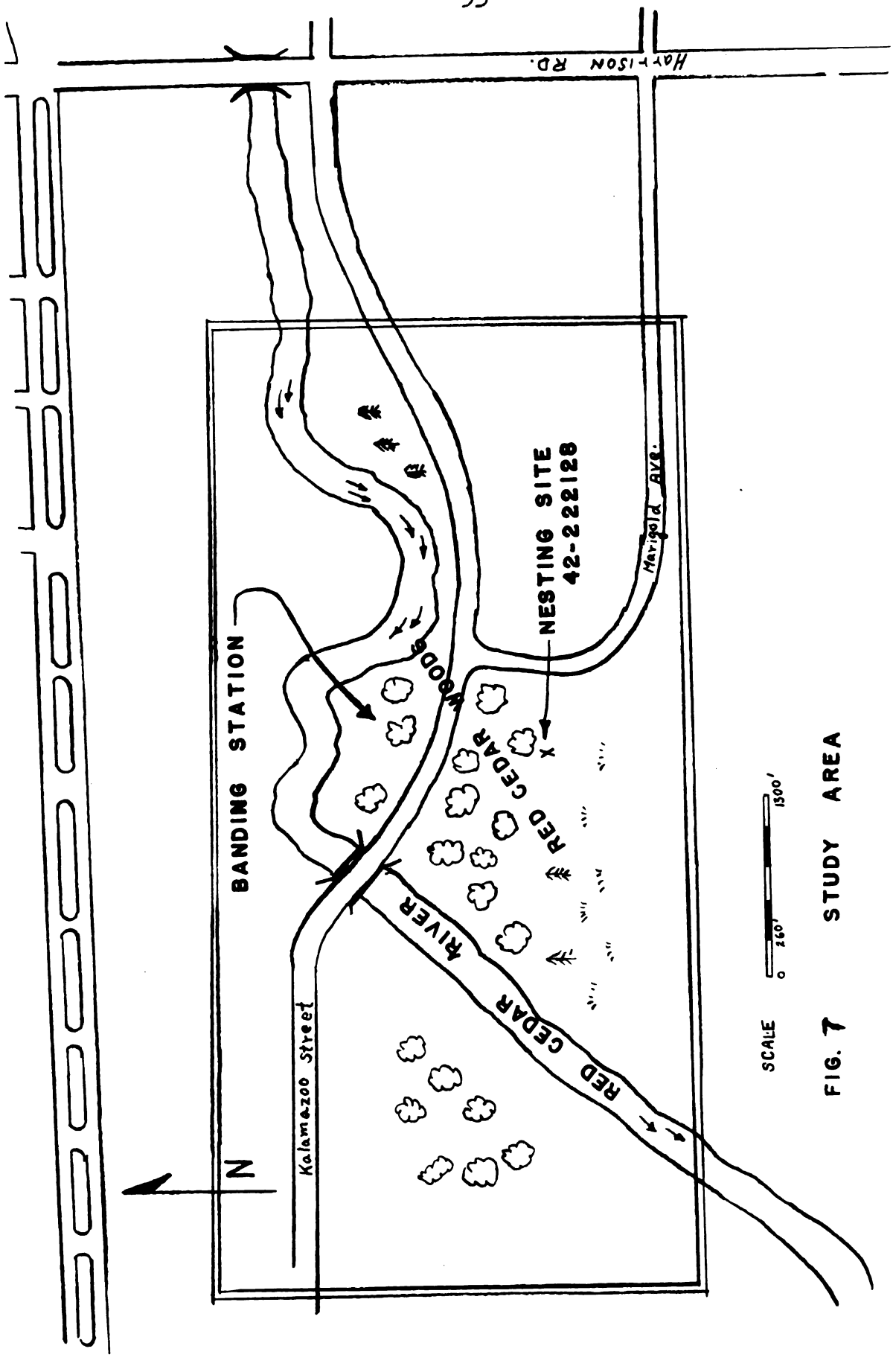

FIG. 7 STUDY AREA

found to be more satisfactory than those of painted aluminum. When the latter were used on the same leg with the Fish and Wildlife bands, the adjacent edges would flare.

A 20X spotting scope mounted on a tripod was used to identify banded individuals in the field. This method was awkward and unsatisfactory. The following year the tips of the primaries were painted with a high grade of white airplane dope (Fig. 9). The two individuals thus painted were never seen again, but other workers have found this method satisfactory.

During the spring nests were kept under observation and the young banded. Some of the nests were parasitized by the Cowbird (Molothrus ater). In an attempt to increase the number of juvenile Cardinals, old Cowbird eggs were substituted for the parasitic eggs in a nest. After keeping the confiscated eggs cool for a few days, they were used for substitution in other parasitized nests. The female gave no evidence that the nest had been tampered with when Cowbird's eggs were exchanged.

Correlative Investigations

All of the 6000 banding returns for Cardinals recorded at the Patuxent Research Refuge, Laurel, Maryland, were personally examined for movements of the Cardinal. All of the returns for Michigan, as well as those for Columbus and

Fig. 8. Banding station in the Red Cedar Woodlot.

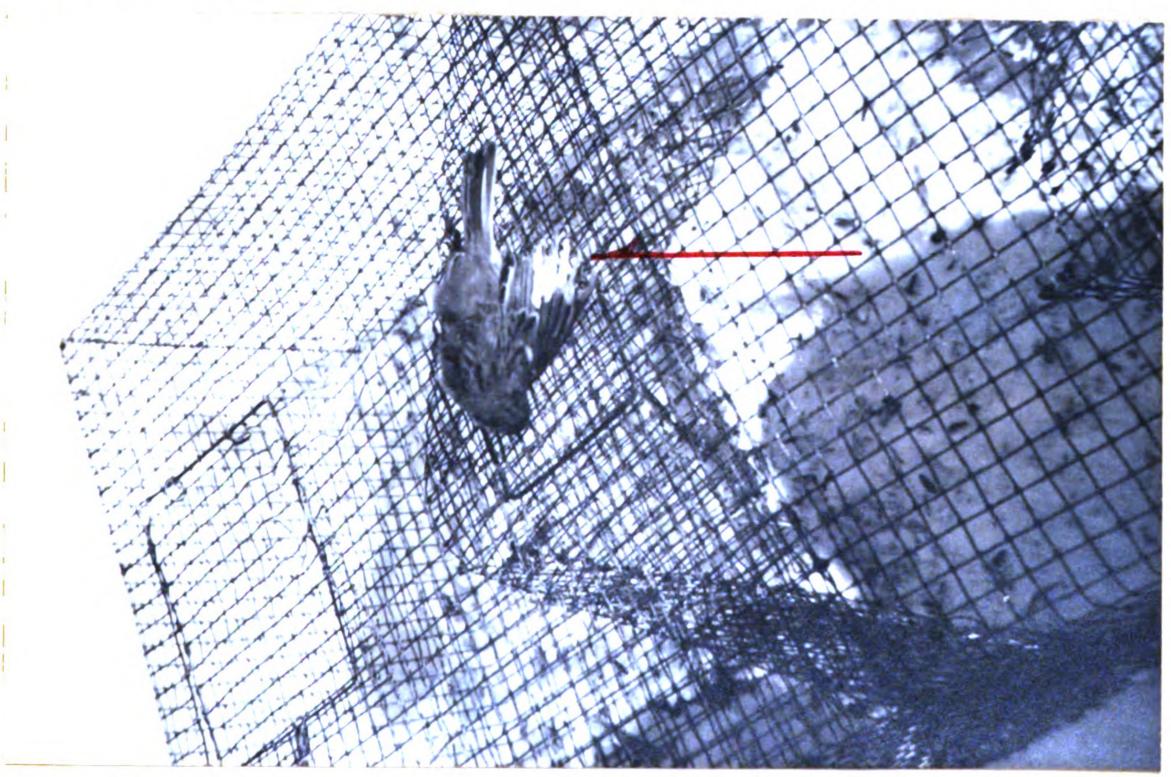

Fig. 9. Painted primaries of a Tree Sparrow (Spizella aborea).

Cincinnati, Ohio, were recorded as to date and place of banding and date and place of recovery. All other such records indicating movements of individuals were also tabulated. Following study of these records, information pertinent to this particular problem was extracted for inclusion in the thesis.

All of the 53 Audubon Christmas censuses to date were examined for distributional data on Cardinals over the past 53 years. References to the Cardinal in Bird-Lore, Audubon Field Notes, The Auk, Wilson Bulletin and Bird-Banding were also checked. State ornithological journals provided much additional information about the status of this species in the various states mentioned elsewhere. Correspondence with other ornithologists concerning recent records in the north was of great help in the study.

ECOLOGY OF THE CARDINAL

Pertinent Cardinal Songs

The vocal powers of the Cardinal are as striking as its bright plumage. It has numerous variations to its songs. Laskey (1944:27) states she was able to record 28 different songs or variations of two to six syllables each. No attempt is made to list all of these here. The purpose of the descriptions which follow is to list the "basic" call and songs which are mentioned in subsequent parts of this thesis.

1) "Chip" call note -- is one of the most common utterances and consists of a single sharp chip. The frequency of chips increases when the bird is distressed.

2) "Up-and-down" song -- is named for its rapid up and down the scale notes approximately one octave in range, and ending in a series of musical chip-notes given in rapid succession. This is sung so rapidly at times that some observers say the bird sings two songs at once.

3) "What-cheer" song -- is probably the most common song. It is a variation of the "up-and-down" song having only a short up-inflected whistle followed with the down slur portion of the "up-and-down" song. This song is sometimes followed by rapid musical chipping.

4) "Chew" song -- this is the most frequent single-syllabled song. It consists of only the down slur portion of the "up-and-down" song with no introductory note as in the "what-cheer" song. It is generally repeated two or three times with several very musical chip notes following. The song is sometimes followed by chipping after each down slur. An imitation of this song will attract Cardinals more quickly than any of the others.

5) "Dog-whistle" song -- sounds like someone calling a dog. It is the up-the-scale portion of the "up-and-down" song. It begins slowly and the slurs up the scale are repeated with increasing rapidity and diminishing intensity. This song sometimes has a variation in early spring. At that time the up-slurs are followed by chipping.

Establishment and Defense of Territories

The establishment of territories begins with the commencement of full song in February and early March. As the season progresses, more males are heard to sing from various high perches. By the first week or two in March, Cardinals are singing from distances averaging 400 yards apart on the Campus. Laskey (1944:29) noted that male Cardinals in Tennessee sing from perches only 100 yards apart. This fact, plus the larger winter flock sizes in the south, probably indicates the relative abundance of Cardinals in Michigan compared to Tennessee.

When the establishment of territories is taking place, Cardinals are not often found in actual combat. When territories are being claimed, the singing displays are the most conspicuous behavior patterns. Males are also seen in low level flights. When intruders invade a territory, it is the individuals of like sex which exhibit the most belligerence; the members of the opposite sex seem quite unconcerned over the matter. In general males will chase males, and females chase females. This is also illustrated during reflection fighting. The Cardinal, perhaps more than any other North American species, will fight its reflection during the spring courtship period. The surprising thing about these battles is the apparent unconcern of one mate when the other is fighting. Regardless of whether it is the male or female fighting its reflection, its mate will often sit in the same bush, and watch unconcernedly.

The Cardinal may be considered relatively passive, and many times pays no attention to intruders. Even when the number of breeding pairs increased on the Campus, no battles were observed. The territories of established males tended to remain almost the same when later territories were formed, i.e., a new territory was established between those already occupied (Fig. 10). In the study areas there seemed to be more ground which could be claimed (by more Cardinals)if needed.

Although a male may defend a larger area than is actually needed at first, he readily gives up part of it. Thus, it should be noted that by late winter many males in a given area have established their territories. If more territories are formed, they will be dispersed among those already present. Banding returns also suggest that no regional movements occur in the late winter and early spring periods. If such movements take place, they follow the breeding season. Therefore, the individuals which winter in an area may be expected to nest nearby.

Once nesting has begun, singing from high perches by males still occurs, but not as frequently. Males of adjacent territories were never observed to exhibit belligerence toward one another. In the Red Cedar Woodlot there was evidence of recognition points. When the birds were alarmed, males of two adjoining territories would fly to a small maple and perch within three feet of each other. When a minute or less had elapsed, each would return to his respective territory. After this behavior was noted at intervals during the spring, a similar instance was recalled from the previous year's notes: At Park Lake, Ingham County, June 13, 1952, two males flew to a tree along the side of the road when the "what cheer" song was imitated. Neither male exhibited any sign of belligerence. They appeared as a team to drive the intruder away. The males remained about a minute, then flew in different directions.

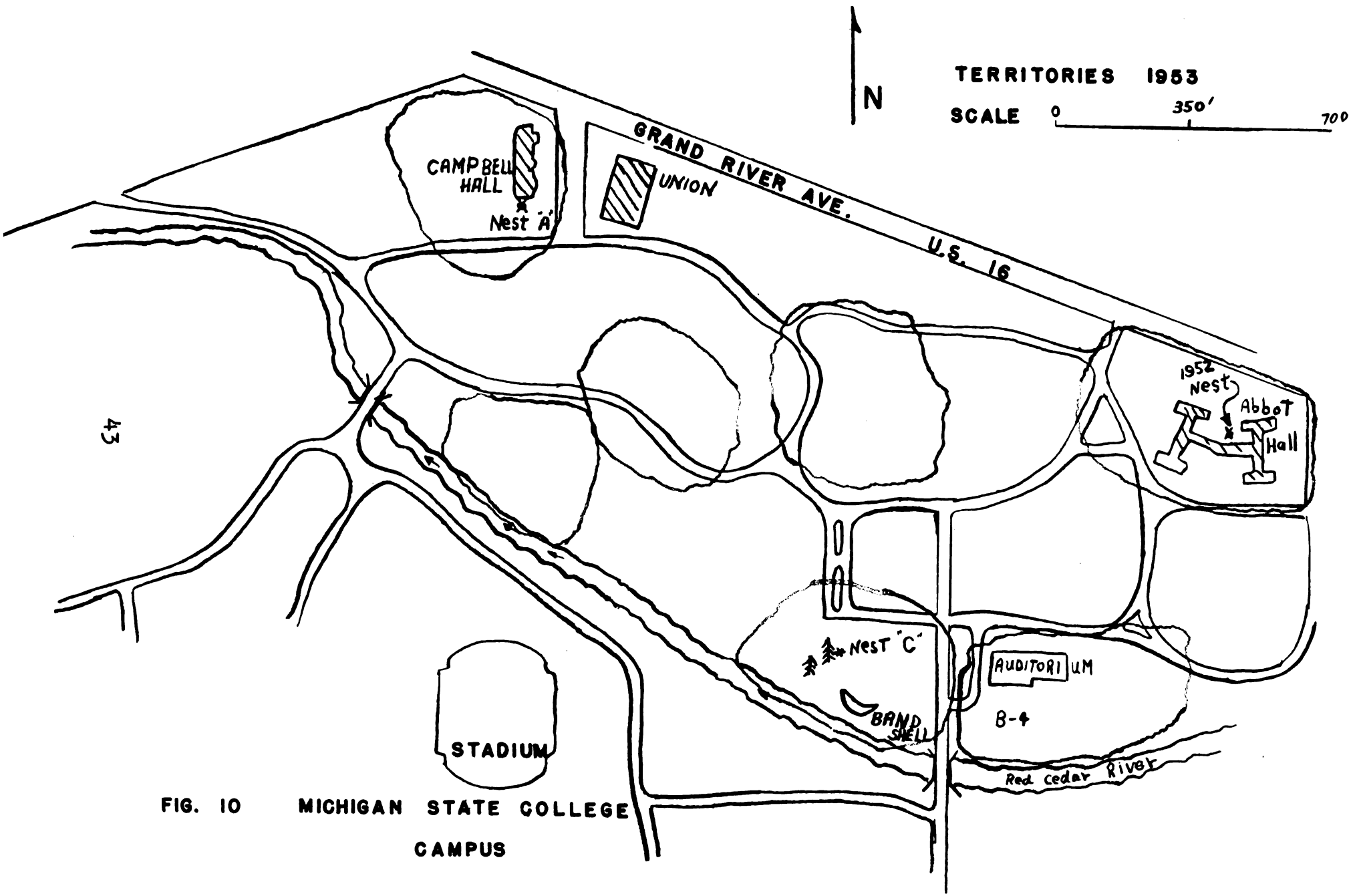

FIG. 10 MICHIGAN STATE COLLEGE CAMPUS

One male continued to sing from a tree about 200 yards distant. This incident was the first behavior of this type to be observed.

An imitation of the "chew" song was given in the Red Cedar Woodlot. Almost immediately the males flew to the same recognition point. It was found on subsequent days that as long as the imitated call was given in an area between the two males, both would fly to the same tree. After this had taken place once, it was not possible to make them repeat the above act until a day or two later. Thus, it appears that breeding males respect a neighbor's territories, but overlap their territories if a recognition tree is on the border. The Cardinal exhibits little tendency to drive a surplus of potential breeding birds from an area. There are even some cases of double nestings, as discussed in the subsequent section on "Sociability," which illustrate the extreme tolerance exhibited by some individuals.

Nesting

Nesting Time

Actual nesting begins in mid-April and reaches a peak in May and early June. Nesting continues all summer; if repeated interruptions occur there may be young in the nest as late as October 19 (Christy, 1942:186). Young have been found in the nest as late as September 24 in Ingham County. With

this exceptionally long breeding period, the Cardinal has greater possibilities for ultimate nesting success.

The cold Michigan climate does retard nesting somewhat. First attempts usually occur about mid-April. However, this often proves disastrous, for the sometimes flimsy nest of the Cardinal does not give ample protection during the frequent cold wet weather of a Michigan spring. Although this habit of early nesting is frequently unproductive, the Cardinal readily renests.

Nesting Habitats

In parks, residential districts and on campuses the Cardinal will often utilize coniferous trees for early nestings. However, nesting just as frequently takes place in shrubs which are very much exposed. The surprising thing is the apparent success of these exposed nests. Although the coniferous forests do not provide a suitable habitat, conifers are readily utilized for nesting provided open grasslands and fruit-bearing shrubs are in the area.

Nesting sites of the Cardinal are various. In residential districts shrubs around houses, evergreens, thick vines and tangles are used. In the country the Cardinal is found nesting in sparsely wooded zones where streams and swamps occur near open areas. It is not a bird of the deep woods. Small wood-lots, and borders with thick shrubs make up the best

nesting areas. Pasture land which has been allowed to grow over with hawthorn (Crataegus) provides an abundance of breeding sites.

The above mentioned conditions are all generally a result of man's settlements. In areas where forests did not exist, man promptly planted trees and shrubs to beautify his surroundings. Thus wherever man congregates in large numbers, the Cardinal will be able to establish itself. The further north the range is extended the larger the suitable areas must be for nesting and survival through the winter.

Nesting Materials

The nest of the Cardinal is a loosely constructed affair lined with fine grasses or rootlets. In the 17 nests studied there was a great deal of variability. The materials used in the construction were generally those which were suitable and could be found in the immediate area.

Nests built in residential districts illustrated the frequent use of paper. Nest A in Figure 11 contained 15 inside wrappers of gum, a cellophane wrapper from a package of cigarettes, paper cleansing tissue and several leaves in the outside portion of the nest.

Another nest (C in Fig. 11) on the Campus built in a Norway spruce (Picea abies) near the bandshell contained one gum wrapper and another piece of paper. The rest of the nest

consisted of small twigs, leaves and a lining of fine grasses.

A nest from a farm near Belding, Michigan (B in Fig. 11), consisted entirely of grasses. No twigs or bits of paper were used in the construction. The lining was of fine grasses. Each of these three selected nests exhibited a similar lining, except Nest A which contained two or three small rootlets.

Thus, the Cardinal uses materials conveniently at hand for the outside construction of the nest, and is consistent in using grasses for a lining. The wide variety of materials and sites selected has enabled it to adjust to several different habitats.

Wintering

Wintering Habitats

The Cardinal may leave its summer nesting territory if there is not enough food and cover on it during the winter. Pough (1946:215) relates, "This bird is at home in any habitat that includes dense thickets, shrubs and tangles near open areas -- field edges, woodland borders, stream banks, open swamps, parks and residential districts." Wintering areas, however, are predominately along stream banks and open swamps where wooded areas are near at hand. The wood-stream habitat of the Red Cedar woodlot (Fig. 12) provided food and shelter for a flock of Cardinals during the winters of 1952-53 and 1953-54.

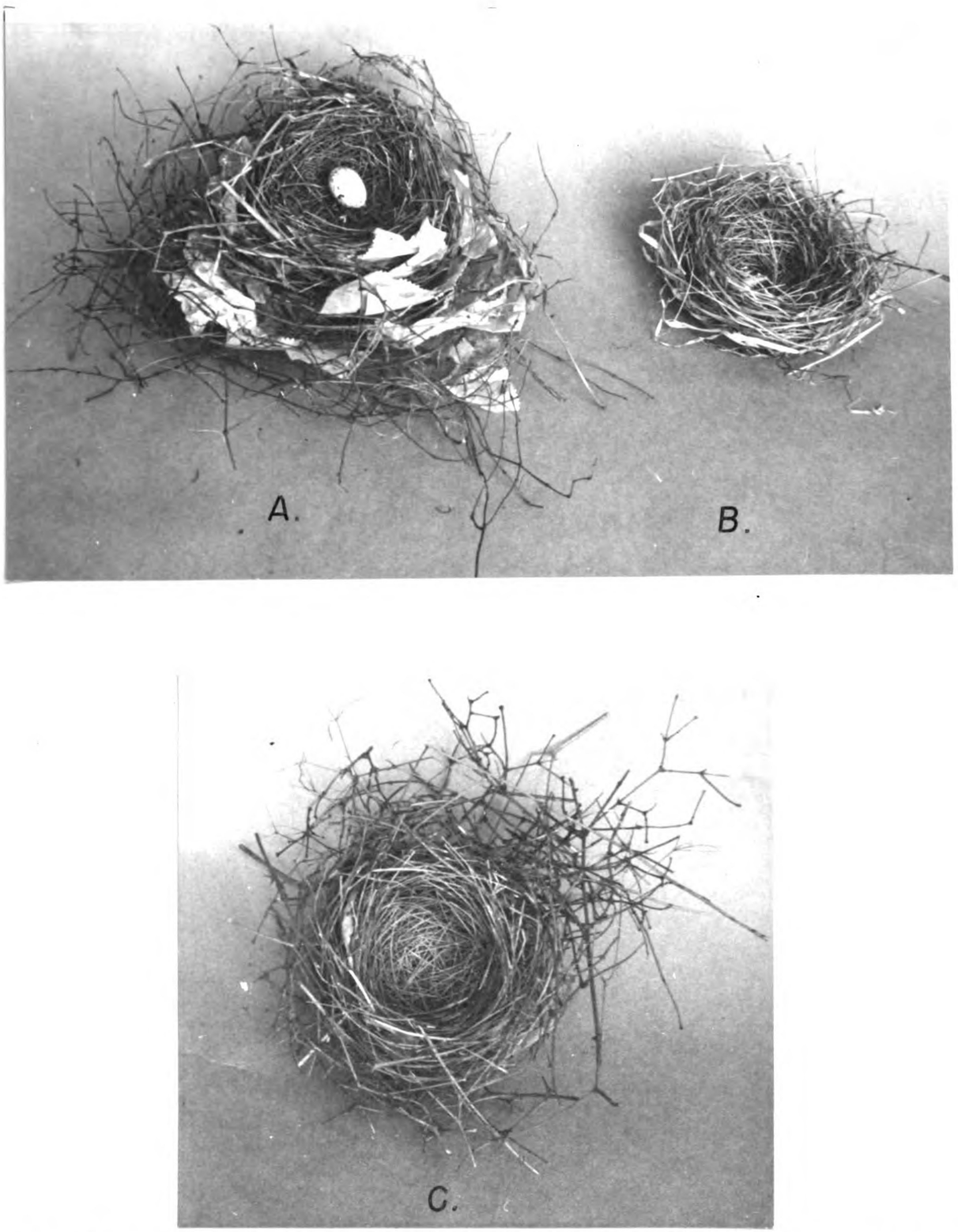

Fig. 11. Various materials which are used in nest construction.

Fig. 12. The wood-stream habitat of the Red Cedar Woodlot.

Early reports of the Cardinal in Michigan mentioned the valley of the Huron River as the main artery of distribution of the bird in the southeastern part of the state (Swales and Taverner 1907:146). Although Cardinals favor streams and swamps flocks do occur regularly in other areas, especially where corn and seeds are available. Grain elevators, and railroad right-of-ways where grains have spilled are often winter feeding sites for groups of Cardinals.

In Michigan the Cardinal is found wherever the above named habitats exist. In the northern half of the state these habitats are widely dispersed and favorable conditions for the species are not as common.

Winter flocks of Cardinals inhabit the wilder areas rather than the residential districts. If quantities of grain or bird-seed are available, flocks may be induced to remain for awhile in the vicinity of dwellings. Lack of ample cover for a large roaming flock is probably responsible for their absence in such areas. Generally only pairs or single individuals occur in parks, and residential areas during the winter.

Wintering Habits

The Cardinal is more conspicuous in winter than in any other season. Singing begins in January, and by February the singing males can be heard from many perches. During the winter it is found on its territory or in flocks near the area where nesting will take place.

The Cardinals, which exhibit territorial behavior, are generally found in the residential districts, parks and areas such as a well planted campus, rather than the more primitive habitats. These birds spend most of the year on or near their breeding territories, but on rare occasions may join a flock for short periods.

During the three years for which records were kept, the earliest date on which a male was heard to sing a complete song was January 15, 1954. An individual (B -4) had been in the area of the Auditorium on the Michigan State College Campus since the first week of December (Fig. 10). Although it was not banded, it is believed that the same bird remained on the area all winter. Ordinarily early singing takes place on clear mornings; however, on this day the first song occured when it was warm and hazy. The song consisted of a few up and down notes, and stopped as suddenly as it started.

In 1952, the first song was heard on January 23 from a male on a clear day when the temperature was below freezing (28°F.). It sang the "dog whistle" song with several rapid chipping notes at the end of each slur. These chipping notes are similar to the "chip" call notes. However, there is a distinct musical quality to them when they are given in conjunction with a song.

On February 1, 1953, the Cardinal was not heard until a female sang a whispering song just outside a window. Other

workers have referred to this type of singing as part of the courtship behavior from January to April (Shaver and Roberts, 1933:118). Adult birds may sing an almost inaudible song during the months of courtship and mating (Laskey, 1944:28). After hearing the whispering song, an imitation of the "what cheer" song was given to try to induce the female to sing aloud. When the imitation was given, the female flew down into some low shrubbery and gave several "chip" notes. A male 100 yards away responded to the imitated "what cheer" song by singing the "up-and-down"song.

By mid-February singing is of regular occurrence from many perches on the campus. These first songs are not always sung from the tops of trees. As the season progresses, Cardinal songs become more frequent and during March the highest trees in the territories are used. Singing continues with great vigor until April. During the first part of this month, the singing tapers off, but may be heard at almost any hour of the day. Thus, the singing during the winter is considered to be almost entirely for the purpose of establishing territories.

Flocking

One of the most notable habits of the Cardinal in the more southern states is the large flock-size attained in areas where it is common. Flocking occurs in Michigan, but flock-size does not reach the proportions exhibited in the south.

During the fall and winter the Cardinal may form groups provided the summer territory is void of food and cover. In Michigan flocks rarely exceed 15 or 20 individuals. In Ohio flocks of 50 to 75 are not uncommon in the favorite wintering grounds (Land, 1952). Christy (1944:186) states that he once saw a flock of Cardinals numbering at least 150 individuals along the Buckhannon River in West Virginia.

In the fall flocks of four to six individuals are common. As the season progresses these flocks, believed to be made up of family groups, merge with other small groups in the area. Laskey (1944:38) found that early fall returns of banded Cardinals included several individuals banded in the nest the previous summer. She states (1944:37): "Among Cardinals one plausible explanation of the fall grouping and wandering of a large part of the local population, while certain individuals and pairs remain on their nesting grounds, is that these groups are composed mostly of young birds hatched during the year (though the flocks doubtless also include adult birds that have left their breeding territories for various reasons such as lack of food and shelter)."

Due to late nestings, immatures still under parental care may be found as late as October. In these cases there can be no doubt that the small group consists of a family.

Flock Dispersal

Flocks in the more primitive areas remain intact after many individuals on the Campus and in the residential areas have already selected territories. Although the areas supporting a flock in winter may have nesting pairs during the spring and summer, there is no indication of belligerence or territorial behavior when these groups are together.

Over the winter the flock in the Red Cedar area always contained more males than females. During most of the flocking season the group was made up of three males and one female. Although new individuals continued to join the flock all winter, each male repeated at least once. (See Table I). The female never repeated, but was recovered the following year, April 11, 1954, 100 feet southwest of where it was banded.

The Red Cedar flock was still intact on February 18, 1953. Three males and one female were observed on the north shore of the Red Cedar River in the study area. Male 42-222128, also marked with a yellow color band, was the only one of the group which could be identified. The other two males and female were apparently not banded. These four individuals joined a group of two females and a male on the south bank, and the merged group went together about 150 yards down stream (Fig. 7). This phenomenon of merging groups was also noted by Land (1952). This group altogether must have contained

11 individuals although, because of obstructions, it was difficult to count them exactly. This was the largest congregation of Cardinals ever observed in the study area. There was no indication of courtship. The males and females, while in the flock, did not show any favoritism that might indicate pairing had taken place.

TABLE I

BANDING DATA FROM STATION IN RED CEDAR WOODLOT

Band No.	Sex	Age	Date Banded	Date Repeated	Date Returned
42-222128	M	Ad.	2-8-53	2-23-53 3-5-53 3-11-53	20-30-53
42-222129	M	Ad.	2-12-53		3-9-53 dead
42-222130	M	Ad.	2-14-53	3-5-53	
42-222131	M	Ad.	3-5-53	3-9-53	
42-222132	F	Ad.	3-9-53		4-11-54 Found dead 100 feet from traps.

The Cardinals in the study area remained in groups until mid-March, but during the period March 10-15, the flock began to break up. The first real indication that the area was claimed by a male was on March 9. At 1:00 P.M., when the

temperature was about 32°F., the traps contained three Cardinals, and others were heard nearby. The flock this day gave no indication of dispersing. On the following day a male was heard to sing from the top of a tree to the west of the trap-area. It was not possible to determine if this singing male was one of the banded birds. A search of the area disclosed no other Cardinals in the immediate vicinity. The woodlot was checked again at 6:30 P.M. for some indication of a flock. On both occasions Cardinals were apparently absent from the area with the exception of the singing male at noon.

On March 11, 1953, male 42-222128 was trapped at the base of the tree from which it was heard to sing the day before. This individual had been observed here more frequently than any other Cardinal, and eventually nested within the study area to the south of Kalamazoo street (Fig. 7).

On March 12, 1953, two Cardinals flushed from the trapping area as it was approached. A male was singing from the top of a tree 200 feet east of the tree in which a Cardinal was heard to sing March 10. It could not be determined if this was another territory, or if the same male was merely singing from a different perch. The flock had evidently dispersed with the exception of one or two strays remaining in the area. If the two Cardinals which flushed from the traps were in the possibly newly established territory, there was no sign of belligerence from the singing male.

Thus, Cardinals in this area are found in flocks from late November to the middle of March. In favorable wintering areas, individuals which do not nest there will congregate. The resident birds which winter and nest in the same place, show no antagonism toward these winter visitors.

Movements

From information available in the literature, as well as from personal observations, it was apparent that several degrees of movement are shown by the Cardinal. For convenience of the discussion below these may be defined as follows:

1) Local wandering -- normal movements about the nesting and wintering areas; these seldom exceed a distance of two miles.

2) Short-range movements -- less frequent movements involving distances of less that 25 miles.

3) Major movements -- occasional journeys involving distances greater than 25 miles.

To get a better picture of the entire situation, the banding returns in the files of the Fish and Wildlife Service were examined. Records of movements were scarce because of the essentially sedentary habits of the Cardinal. Of the approximately 6000 returns culled from these files, no more than 14 were from a distance greater than 25 miles from the

place of banding. As might be expected records of short-range movements were more abundant. Some evidence of local wanderings was found, but better information on this phase of the problem can be obtained from the literature (e.g., Land, 1952; Hundley, 1952).

Local Wandering

Every winter flock thus far studied has included individuals which join the flock for short periods and then disappear. This phenomenon has been mentioned in other studies (Laskey, 1944; Land, 1952; Hundley, 1952), and was also noticed among the banded birds in the Red Cedar Woodlot. Of the birds listed in Table I male 42-222128 was the resident male, while the other three males apparently were transient individuals. As indicated in the table, such birds appeared to remain in the area for a few days and then returned about a month later. The study carried out by Land (1952), indicated that individuals nested near their wintering grounds. A more detailed work by Hundley (1952), using over 230 marked individuals, suggested that the Cardinal remains within a mile of the place of banding. The greatest observed radius for a painted bird was that of a female which traveled 2.8 miles from the point of marking (Hundley, 1952:81).

It has been repeatedly mentioned in the literature that new birds are continually found to enter banding traps. This

suggests that there are some individuals which are not attached to an area, but spend a large part of the late fall and winter wandering.

Food availability will apparently influence a flock to remain in an area. The flock in the Red Cedar Woodlot would stay in the trapping area for three to four days before moving down stream 400 yards. From this area down stream the Cardinals would disappear for one to two days, and then return to the trapping area. Flocks observed in other localities exhibited a similar roaming disposition, and did not spend the entire time in one area.

Hundley (1952) attributes the sporadic appearance of new individuals in a flock to roving transients. Land (1952) found that although a group was present in an area, its composition changed continually through the winter. There are two possible explanations for the occurrence of apparently new individuals in a given area:

1) The No. 2 band, formerly recommended for the Cardinal by the Fish and Wildlife Service, can be removed by the birds. There is only one record of this in the Red Cedar Woodlot flock. A male returned with only a color band; the Fish and Wildlife band previously attached was missing. Lovell (1948:71-72) marked Cardinals by notching the tail. About eight per cent were found to remove bands. Hundley

(1952:35) found through field observations that five birds had removed either colored or federal bands. Of the 100 individuals banded by him, 50 repeated. This also indicates that about 10 per cent of the returns were able to remove the No. 2 Fish and Wildlife bands.

2) Land (1952) found that when a flock in Ohio moved into an area, some of the individuals would join the group for distances up to one-half mile before returning to their main wintering territory. Thus, it can be seen that these strays can be accounted for by other individuals in nearby territories joining such moving flocks, or single birds moving into an area which might provide better food and cover. In any event it is quite certain that an individual appearing in a banding trap for the first time came from an area not more than a few miles distant.

Short-range Movements

The only location in the United States in which it was possible to find satisfactory records of short-range movements was along Lake Michigan in the Chicago area. Because most Cardinals remain close to where they were hatched, it is only in an area where banding stations are spaced at intervals of four or five miles that these movements can be detected (Fig. 13). Since Lake Michigan is a barrier to the east, and since the banding stations were located only along the lake,

it would appear that movements took place only in a north-south direction. However, other records of movements indicate that the Cardinal goes in all directions (Fig. 14).

Hundley (1952:9) suggested that the records from the Chicago area showed that the Cardinal was not as restricted in its movements there as in an area like that near Morgantown, West Virginia, where the Cardinal population is greater. However, in southern Illinois the Cardinal appears to be even more common than in West Virginia. In central Illinois the bird exhibits the same type of short-range movements (Table II). Thus, it appears that this sedentary habit is fairly consistent for the entire subspecies and that there is no apparent tendency for the individuals in the north to move more than those in the south.

In contrast to the situation in the Chicago area, the 293 returns at Columbus, Ohio, have not yielded a single record of a Cardinal leaving the area. Although the data suggest that no movements took place, it must be understood that a journey of less than 100 miles would likely go undetected since the nearest banding stations from Columbus are located in Cincinnati. Therefore, when several unbanded Cardinals appear in traps during the latter part of fall, this is probably due to the shuffling of individuals in new flock combinations (see the previous section on "Local Wandering") rather than to short-range movement.

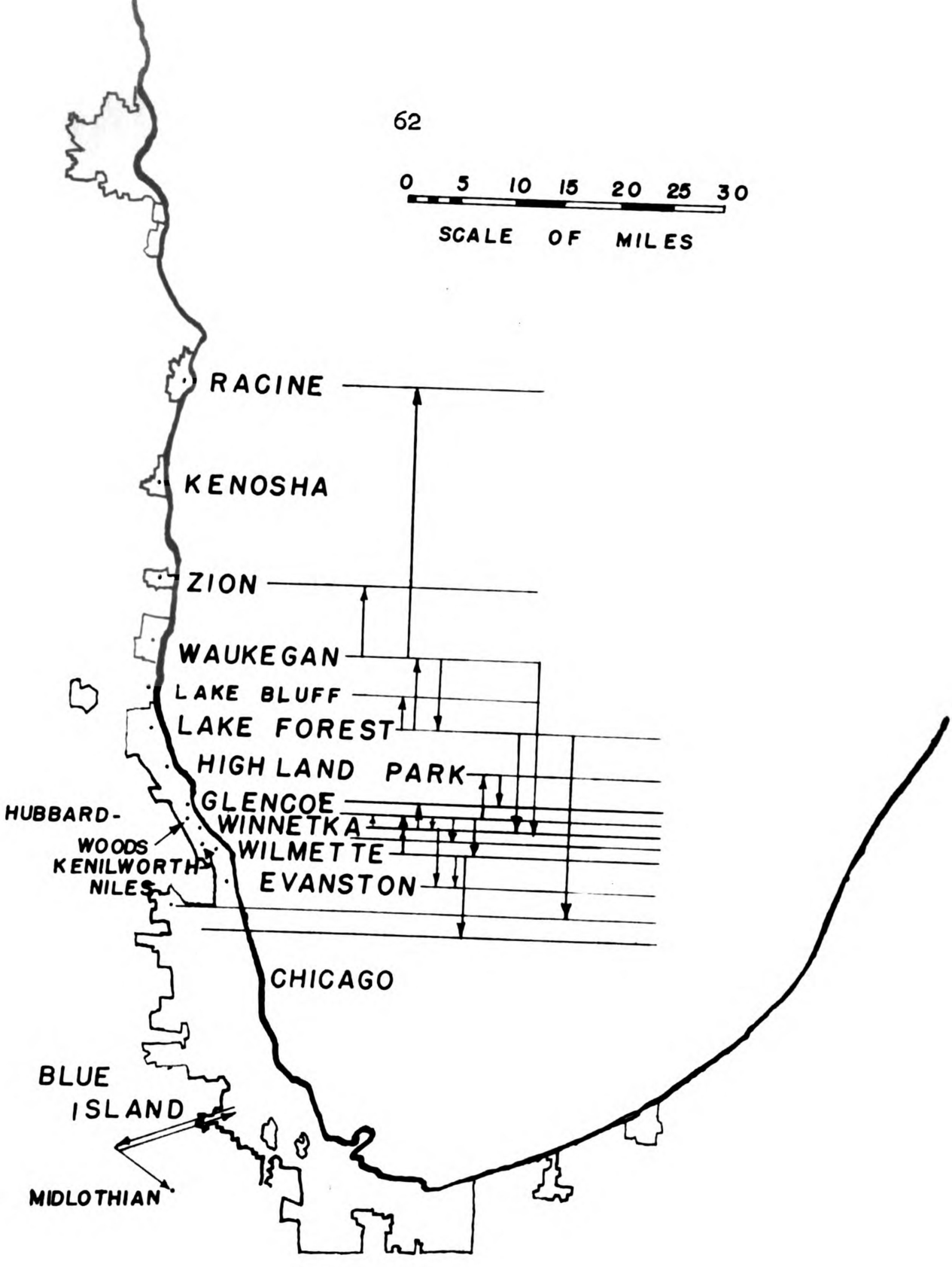

FIG. 13 SHORT-RANGE MOVEMENTS

TABLE II

ILLINOIS RECOVERIES

		Banded		Recovered	
Number	Sex	Date	Place	Date	Place
Recoveries from 1 to 2 Miles					
A-265546	M	4-27-33	Hubbard Woods	5-10-33	Winnetka
34-252677	F	12-8-34	Hubbard Woods	3-25-35	Winnetka
38-209818	?	7-22-38	Hubbard Woods	12-6-38	Winnetka
35-219234	M	2-17-38	Hubbard Woods	5-14-39	Winnetka
36-234823	F	3-19-37	Hubbard Woods	4-12-41	Winnetka
35-219598	F	10-10-37	Winnetka	11-20-39	Hubbard Woods
38-242406	?	10-10-38	Winnetka	3-15-39	Glencoe
46-219932	?	10-10-47	Urbana	5-15-51	Champaign
36-234445	F	9-2-47	Champaign	10-24-48	Urbana
37-210105	M	5-14-40	Champaign	5-16-42	Urbana
37-210166	M	10-16-43	Champaign	7-21-50	Urbana
Recoveries from 3 to 4 Miles					
38-209965	?	10-18-39	Wilmette	10-19-39	Hubbard Woods
37-226794	im.?	8-1-39	Wilmette	2-1-40	Evanston
A-293953	M	12-19-31	Wilmette	9-9-34	Evanston
36-219289	M	6-24-38	Wilmette	11-23-39	Evanston
37-209684	F	9-29-39	Hubbard Woods	3-4-40	Wilmette

TABLE II -- Continued

Number	Sex	Banded		Recovered	
		Date	Place	Date	Place
34-252677	F	12-8-34	Hubbard Woods	3-25-35	Kenilworth
37-23140	F	4-20-37	Highland Park	2-3-40	Glencoe
F-133576	M	5-13-35	Lake Forest	5-20-36	Lake Bluff
		Recoveries from 5 to 7 Miles			
B-202321	F	8-8-30	Lake Forest	5-17-33	Waukegan
35-204820	F	11-29-37	Lake Forest	4-6-38	Waukegan
B-258427	M	10-10-34	Waukegan	6-22-35	Zion
39-251212	M	9-10-39	Winnetka	1-2-40	Evanston
B-205311	M	10-15-35	Hubbard Woods	3-12-36	Highland Park
34-206528	M	12-10-33	Chicago	9-6-35	Blue Island
34-246783	?	12-13-36	Chicago	12-18-37	Blue Island
34-208977	M	2-22-34	Chicago	12-19-34	Blue Island
37-206409	?	3-5-40	Blue Island	6-27-40	Chicago
40-214841	F	12-1-40	Blue Island	6-2-47	Chicago,76 St.
48-208160	M	5-3-49	Blue Island	9-1-49	Midlothian
		Recoveries from 8 to 10 Miles			
38-209956	F	4-2-38	Wilmette	12-15-38	Chicago

TABLE II -- Continued

Number	Sex	Banded Date	Banded Place	Recovered Date	Recovered Place
Recoveries 15 to 20 Miles					
A-259735	im.F	8-25-30	Lake Forest	2-23-34	Niles
_-390300	M	1-18-27	Waukegan	11-4-28	Winnetka
Recoveries over 25 Miles					
34-248983	?	7-23-37	Waukegan	12-17-39	Racine,Wis.

Major Movements

Since the Cardinal may appear as a stray many miles outside the normal range, there is always the question of where such birds came from, and which individuals tend to make such record flights. Banding returns indicate that only 14 out of 6,000 were taken more than 25 miles from the point of banding. This constitutes only 0.23 per cent of the total number of returns and, of this small percentage, the possibilities of the bird venturing to the north are apparently no greater than for any other direction.

The following records, taken from the files of the Fish and Wildlife Service, are the only records of major movements of more than 25 miles (See Fig. 14):

1) Female (41-106333), banded on Long Island City, New York, April 7, 1942, was taken in Summit, New Jersey, June 19, 1947, about 25 miles west of the point of banding.

2) Immature male (37-237826), banded in Takoma Park, Maryland, March 10, 1939, was taken in New Kensington, Pennsylvania, July 20, 1940, about 185 miles north-northwest of the place of banding.

3) Bird of unknown sex (39-247157), banded in Chevy Chase, Maryland, August 20, 1943, was taken in Ronks, Lancaster County, Pennsylvania, November 2, 1943, about 45 miles north.

4) Bird of unknown sex (A-280993), banded in Harrisonburg, Virginia, March 13, 1936, was taken in Mitchello, Culpeper County, Virginia, January 15, 1940, 45 miles east.

5) Female (38-249175), banded in Roanoke, Virginia, September 8, 1943, was found dead near Princeton, Johnson County, North Carolina, March 3, 1944, a distance of 165 miles southeast.

6) Male (36-120378), banded in Raleigh, North Carolina, May 29, 1938, was taken in Winston-Salem, North Carolina, December 26, 1939, 95 miles west.

7) Female (35-208878), banded in Memphis, Tennessee, February 18, 1936, was taken three miles north of Russellville, Alabama, November 25, 1936, a distance of 145 miles east-southeast.

8) Female (37-340864), banded in Nashville, Tennessee, January 1, 1938, was taken in Buffalo, Alabama, April 1, 1939, a distance of 200 miles south.

9) Immature female (39-267598), banded at the Cranbrook Institute of Science, Bloomfield Hills, Michigan, August 8, 1948, was found dead on a farm near Vassar, Tuscola County, Michigan, about November 26, 1949, 60 miles due north of the point of banding.

10) Immature male (B-270818), banded in Battle Creek, Calhoun County, Michigan, October 23, 1933, was captured by hand in Ann Arbor, Michigan and released a few hours later on December 15, 1933, a distance of 85 miles east.

11) Nestling male? (37-231951), banded in Augusta, Kalamazoo County, Michigan, May 30, 1938, was found dead at Harbor Springs, Emmet County, Michigan, April 18, 1939, a distance of 200 miles due north.

However there is no record of the banding of this bird in the files of Dr. Jickling who banded the bird. The following letter reporting the recovery indicates there is little doubt that this bird was a Cardinal:

April 24, 1939

Dear Sirs:

Enclosed is the tag which was on a bird found in our garden April 18, #37-231951.
This is the first year they have ever been here in Harbor Springs. They have been here all winter, they seem to stick in groups, and have held the interest of many people. Some say, they are Kentucky Redbirds others say Kentucky Cardinals. Would be very interested to learn of this certain bird. Would it be possible to reply. Thank you.

Mr. James Davis
Harbor Springs, Michigan

12) Bird of unknown sex (34-248983), banded at Waukegan, Illinois, July 23, 1937, was captured just south of Milwaukee County line near Racine, Wisconsin, December 17, 1939, about 30 miles due north.

13) Male? (A-293311), banded in Sioux City, Iowa, November or December 24, 1931, was taken along the Missouri River at Santee, Nebraska, May 11, 1932, a distance of about 85 miles northwest. This record seems reasonable in that the bird probably followed the river; however, there is no record of the letter stating the recovery in the banding files.

14) Male (35-204712), banded in Sutherland, O'Brien County, Iowa, September 26, 1935, was found dead in Newell, Buena Vista County, Iowa, November 1, 1935, a distance of 35 miles southwest.

Sociability

During the summer months the Cardinal is rather inconspicuous and wary which, at least in part, accounts for more reports of the bird in winter and early spring than in the summer. During the nesting season, the chip-notes of an individual may be followed in a wooded area without ever catching a glimpse of the bird. It definitely senses that it is being followed. To identify an individual, it is best to remain outside its territory in hopes that it will sing from a visible perch or continue in its normal activities.

At the other extreme, some individuals will nest close to scenes of human activity without the slightest suggestion of concern. Cardinals are found near sidewalks traversed by hundreds of people daily. Since the Cardinal's first appearance at East Lansing, some individuals have exhibited this behavior. The second nest recorded for the campus was found in June, 1911, five feet from the ground in plain view from a path traveled by hundreds of students at all hours (Barrows, 1912:530). During the spring of 1953 a nest was located by South Campbell Dormitory only ten feet from a sidewalk used by more than 1000 students daily (Fig. 10). The nest was located four feet from the ground in a Forsythia (Forsythia viridissimma) which had not yet leaved out and provided only flowers for protection. Both these nests were partially

successful in fledging young. In April, 1954, a nest was located by an entrance of the West Junior High School in Lansing.

In Jackson a nest was built in an ornamental cedar by the front door of a home. The female did not always flush when the door was opened. The residents stopped using the door for fear the birds might desert the nest.

It was difficult to flush the female from the nest in those places where they were located near scenes of human activity. For example, at the nest near Campbell Hall the female allowed the edge of the nest to be touched without leaving. In this instance she was allowed to remain on the nest undisturbed. The young were evidently hatching at the time, for when the nest was visited two days later, the nestlings were more than a day old. Both male and female would call excitedly, perching within a few feet of the author's head when the young were banded. At the other extreme, a nest in wilder areas may be deserted if the female is frightened away even if the nest is never approached closely. As a general rule, however, attending adults are fairly tolerant of intruders.

The Cardinal exhibits some rather unusual social habits in their relations with other passerines. Although individuals of the same sex usually show some belligerence, there are at least three known instances of double nestings. One

of the most amazing of these was reported by Brackbill (1952:307); in Catonsville, Maryland, a pair of Cardinals and a pair of Song Sparrows used the same nest simultaneously. The nest belonged to the Cardinals but was given a Song Sparrow lining. Both females laid eggs and, on occasions, both attempted to incubate at the same time, the Cardinal sitting on top of the Song Sparrow.

Hawlsey (1951:515) reported a double nesting of Cardinals at Warrensburg, Missouri. From April 12 to April 20 two females sat on the same nest or attempted to do so. Also in June, 1936, in Marshall, Missouri, two females incubated on the same nest, facing in opposite directions (Hawlsey, 1951:515). Kent (1952:230) reported a similar occurrence in June, 1951, of two females and a male attending the same nest. Only one female was observed incubating the eggs at a time. The nest was broken up after twelve days.

From the above discussion it is apparent that the Cardinal may at times exhibit extreme tolerance of individuals of the same sex and species as well as of individuals of other species of birds. It may also show little fear of man and nest close to human habitations. This trait is of particular significance in connection with range expansion, since such expansion is closely correlated with man's modification of his own environment.

DISCUSSION

It has been mentioned by many workers that the northward expansion of range of Carolinian species may be attributed to the reoccupation of territory lost during the Pleistocene. Results of this study on the Cardinal indicate that the increase of suitable habitats due to man's activities has provided the necessary openings which allowed the bird to establish itself in areas outside the range that it occupied before the advent of white man.

The bright red plumage and prominent appearance of the bird offer advantages for study over species which often go unnoticed because of their more conservative colors and retiring habits. Although very shy during the nesting and post-nesting season, the Cardinal is quite conspicuous once the foliage is lost. During the winter months a Cardinal feeding on the ground where there is some snow, cannot help catching the casual observer's eye. An additional advantage is that the bird frequents human habitations and is so easily recognized by the layman.

With the exception of a few records in summer, first observations of the bird in a new area have been made in winter. The first sight records show males to be more common than females, but this apparent condition is apt to be the

result of the greater conspicuousness of the male. For this reason the author believes that the literature gives an exaggerated picture of the predominance of males in new areas. When the Cardinal is first noticed at feeding stations or in residential districts, observations show an equal number of males and females, whereas records from rural areas generally show a predominance of males. These first sight records of males are undoubtedly due to their bright plumage.

Winter records of the Cardinal were accepted as reliable for purposes of this study since in the northern areas where it is making its advancement reports of all bright red birds would almost certainly be Cardinals. Because summer records might possibly relate to the Scarlet Tanager (Piranga olivacea), however, these were not used unless they were made by a reliable and experienced worker. Also, the whistling powers of the Cardinal are diagnostic, and cannot go long unnoticed. Because it does much winter singing, the possibility of its detection is greatly enhanced. The song on clear mornings is audible at distances up to one-half mile.

Because of its conspicuous appearance and song habits, the progress of the Cardinal into new areas has been noted and recorded in the literature. A bird which makes such a marked impression is more apt to give an observer incentive to talk about this experience, thus enhancing the possibilities of the word reaching an authority who then may investigate the record.

The obvious sexual dimorphism exhibited by the species has many practical applications. To be able to identify the males and females with ease and accuracy has not only helped the author, but enabled many observers to note sexes when discussing occurrences and habits. By reading recovery letters about banded immatures or nestlings, the sex of many could be determined from the description given by the recoverer. This aided greatly in trying to determine whether males or females had a greater tendency to leave their place of hatching. During the nesting and courtship periods there were few times when the question of sex determination became a problem. Although the female may occasionally sing as proficiently as the male, once a singing individual is sighted, the sex can be quickly determined. When the winter flocks were about to break up, the first indications of pairing and courtship behavior could be detected. The sex ratios of winter flocks could also be readily determined.

The two major questions raised by this study are:

1) Why has the Cardinal been able to extend its range?
2) How was this accomplished?

The question of why a bird is able to extend its range might be answered in several ways: 1) the development of a favorable climate in the area of expansion, 2) the development of a favorable habitat in that area, or 3) a reoccupation

of an area from which the species had been temporarily eliminated due to unfavorable changes in climate or habitat.

In southern Michigan the Cardinal did not become a nesting resident in appreciable numbers until 1900. The greater part of the settlement and deforestation of Michigan took place from 1880 to 1910. It has already been pointed out that it was during this period that the Cardinal first was noticed as a nesting bird in the southern part of the Lower Peninsula. The northern half was not developed to the same extent as the lower part, and accordingly the bird was absent. The first reports of the Cardinal in the northern half of the Lower Peninsula appeared during the 1920's. The recovery letter previously quoted from Harbor Springs mentions groups of Cardinals in that area in April, 1939, and it appeared on the Christmas bird count from Boyne City (Table III) in 1951. With the bird absent from the jack-pine country and present in the areas along the northwestern shore where extensive fruit orchards are located, it is again illustrated that man's modification of an area has provided a favorable Cardinal habitat.

The Long Island and Massachusetts records illustrate this principle more dramatically. The appearance of the bird only in the past ten years or so on Long Island (Table III), correlated with the recent settlement of the area, illustrates the importance of the availability of favorable habitat.

TABLE III SELECTED INFORMATION ON THE CARDINAL FROM THE CHRISTMAS COUNTS

	1909	1925	1949	1950	1951	1952
Montreal, Que.	0	0	0	0	0	0
Quebec, Que.	-	-	0	0	0	0
Barrie, Ont.	-	-	-	-	1	0
Blenheim, Ont.	-	-	40	35	27	21
Hamilton, Ont.	-	0	76	88	113	104
Kingston, Ont.	-	-	0	0	1	0
London, Ont.	0	11	124	90	147	-
North Bay, Ont.	-	-	-	0	0	0
Point Pelee, Ont.	-	-	23	45	23	35
St. Thomas, Ont.	-	-	9	14	56	106
Toronto, Ont.	0	1	21	55	70	109
W. Elgin, Ont.	-	-	3	61	40	202
Cape Ann, Mass.	-	-	0	0	0	0
Cape Cod, Mass.	-	-	0	0	0	0
Holyoke, Mass.	-	0	0	0	0	0
Lynn, Mass.	-	-	0	0	1	0
Newburyport, Mass.	-	-	0	0	0	0
Northampton, Mass.	-	-	0	0	1	0
Pittsfield, Mass.	-	-	-	0	2	0
Provincetown, Mass.	-	-	0	0	0	0
Quincy, Mass.	-	-	0	0	0	0
Ware, Mass.	-	-	0	0	0	0

TABLE III Continued

	1909	1925	1949	1950	1951	1952
Wellesley, Mass. 1-1888	-	0	0	0	-	0
Hartford, Conn.	-	0	0	0	0	0
Westport, Conn.	-	-	6	5	19	23
Brooklyn, N. Y.	0	0	3	2	2	0
Orient Point, N. Y.	1	0	-	0	0	-
Smithtown, L. I., N.Y.	-	0	0	2	3	2
S. Nassau Co., L.I., N.Y.	-	-	6	8	7	5
Western Long Island, N.Y.	-	-	0	3	2	0
Bronx-Westchester, N.Y.	-	0	6	7	4	1
Buffalo, N.Y.	0	0	16	13	29	17
Cortland, N.Y.	-	-	0	0	2	0
Croton Pt., N.Y.	-	-	5	1	4	-
Elmira, N.Y.	-	-	-	16	27	-
Ft. Plain, N.Y.	-	-	0	0	0	0
Geneva, N.Y.	-	-	4	13	18	19
E. Aurora, N.Y.	-	-	14	12	-	25
Jamestown, N.Y.	-	0	5	6	14	10
Keuka Pk., N.Y.	-	-	6	4	-	-
Manhatten, N.Y.	5	-	1	1	4	-
Monticello, N.Y.	-	-	-	0	0	0
Olean, N.Y.	-	-	7	2	5	0
Port Chester, N.Y.	-	-	4	3	28	24
Albany Co., N.Y.	-	-	0	0	0	0
Rochester, N.Y.	-	-	31	20	48	49

TABLE III Continued

	1909	1925	1949	1950	1951	1952
Rockland Co., N.Y.	-	-	35	80	73	49
Lake Placid, N.Y.	-	-	0	0	0	0
Schenectady, N.Y.	-	-	0	0	0	0
Staten Island, N.Y.	-	-	25	25	37	13
Syracuse, N.Y.	-	-	-	2	3	8
Troy, N.Y.	-	-	0	0	0	0
Barnegat, N.J.	-	4	9	19	33	25
Boonton, N.J.	-	-	34	25	50	42
Bridgeton, N.J.	-	-	-	34	19	65
Cape May, N.J.	-	-	85	98	149	278
Princeton, N.J.	-	10	51	84	34	54
Harrisburg, Pa.	-	-	70	144	159	205
Chase, Md.	-	-	59	112	69	77
Buckeye Lake, Ohio	-	27	313	196	307	351
Cincinnati, Ohio	-	-	642	698	1323	893
Huntington, W. Va.	-	-	199	255	574	265
Ann Arbor, Mich.	-	6	63	20	9	11
Battle Creek, Mich.	-	0	33	26	63	42
Bay City, Mich.	-	-	5	6	6	7
Boyne City, MIch.	-	-	0	0	3	-
Detroit, Mich.	0	0	125	208	144	171
E. Lansing, Mich.	-	-	23	21		
Imlay City, Mich.	-	-	53	3	79	53
Kalamazoo, Mich.	-	-	36	62	79	55

TABLE III Continued

	1909	1925	1949	1950	1951	1952
Muskegon, Mich.	-	-	3	2	7	5
Owosso, Mich.	-	-	30	18	9	-
Chicago, Ill.	-	-	45	48	51	-
Appleton, Wis.	-	-	2	2	5	3
Green Bay, Wis.	-	-	6	1	2	10
Lake Geneva, Wis.	-	-	1	6	1	11
Land O' Lakes, Wis.	-	-	-	0	-	-
Madison, Wis.	-	-	-	30	52	54
Seneca, Wis.	-	-	14	6	4	11
Waukesha, Wis.	-	-	1	2	7	11
Duluth, Minn.	-	-	0	1	0	
Minneapolis, Minn.	-	0	17	5	5	9
Walker, Minn.	-	-	1	2	1	0
Sioux City, Iowa	-	0	51	38	83	28
Bismarck, N.D.	-	-	0	0	0	0
Canton, S.D.	-	-	9	5	5	-
Huron, S.D.	-	-	-	6	6	0
Sioux Falls, S.D.	-	-	31	30	36	32

However, where the land is not completely suitable for agriculture and areas remain forested, the Cardinal appears only as an occasional visitor. Although Massachusetts contains many isolated habitats which presumably could support Cardinals, these are not extensive enough to maintain the species. Thus, throughout the period when the bird was making advances in other areas, its status in Massachusetts has remained fairly constant.

This study has emphasized habitat as the important factor which has enabled a species of tropical origin to extend its range northward. Although the shorter summers and unpredictable spring weather affect nesting activities, the food and cover needs of the bird are satisfied in Michigan wherever human activity has altered the landscape.

When this particular study was undertaken, the author was unaware that two other similar studies were in progress. A winter flocking study in south-eastern Ohio (Land:1952) and a more detailed work on winter flocks and their movements in Monongalia County, West Virginia (Hundley:1952) were done concurrently, and both studies had similar conclusions. The author's winter flocking study of the Red Cedar Woodlot was carried out in a similar fashion, but lacked the large numbers of banded individuals involved in the other two studies. The behavior of the Cardinal in Michigan was similar except the flocks were smaller than reported in the southern studies.

All three of these studies reveal a similar phenomenon which other banders have noticed: the appearance of new individuals in the area during most of the early winter. This was either unaccounted for in the other studies, or the new individuals were merely mentioned as roaming strays. Examination of all the banding returns for the Cardinal in the files of the Fish and Wildlife Service indicates that 99.77 per cent of the individuals remain within or near the area where they are hatched, although this percentage is no doubt high because most birds outside the banding area are never trapped. Casual observations of a flock give no indications that many of its individuals may be unattached. Most banded individuals are seen at intervals during the flocking period, and it is perhaps at the times of absence that they might be found in other nearby areas. Thus, a single banding station over the late fall and winter may indicate that at least half of the population consisted of strays. However, these Cardinals which occur in a banding trap only once are very probably residents of nearby areas.

Hundley (1952:80) discovered through observations during two winter seasons that individuals were frequently found at distances of one to one and three-tenths miles from the place of banding. The data in the Chicago area (Fig. 13) indicate that if a larger area could be studied, some of the individuals

would be found to move for distances of as much as eight miles. In all cases where there were no barriers the Cardinal showed no directional preference for such movements. Thus, wanderings of a bird around a "home" territory no doubt occur rather frequently; these probably account for the appearance of the majority of the new individuals in any given area. It seems likely that an individual moving more than two or three miles will remain in the new area. An adult female (B-202321; see Table II) banded on August 8, 1930, at Lake Forest, was first recovered at Waukegan on October 15, 1931, and returned at the same locality on March 9, 1932, October 30, 1932, May 17, 1933, and again on August 21, 1933. Unfortunately most of the other recoveries in the Chicago area were of dead birds, and no further records of them were available.

This concept is believed to be important for permanent movements of some sort must be considered with respect to the range expansion. Since Cardinals are reported from outlying areas as remaining for several months, it appears that individuals which have made short-range and major movements tend to remain in the new area.

In the northern half of Michigan nesting records are lacking. However, where several individuals are seen in winter, it seems probable that there would be some attempt to nest near the areas where they are seen during mid-winter.

On the basis of banding data two individuals out of every 1,000 may be expected to travel distances of over 25 miles. Thus, in the Cardinal population as a whole, there is probably a great mixing of individuals even though this percentage is small.

The roaming flocks during the late fall and early winter partially account for small groups of Cardinals occurring in an area for the first time. Although males are reported more frequently in winter, a close examination of the data indicates that females are often the first to occupy a new area.

Movements predominately occur during the fall. There are more records of immatures making movements than adults and, because of the difficulty of recognizing juveniles in late fall, the number of young birds moving is probably even greater. It seems probable that the young of the year would be more apt to wander since they have not previously established territories.

To account for the extension of range, and the occurrence of the Cardinal in the northern districts outside its "normal" range, the occasional strays must be taken into consideration. Individuals which have strayed many miles into new ranges probably do not nest, for it is unlikely that a mate could be found in such an area. The average longevity

of the Cardinal is probably no more than two years. Thus the possibility of another bird of the opposite sex occuring in the same area is slight.

If an area becomes ecologically suitable for the Cardinal within 20 miles of its present breeding range, it can be expected to occupy that area within a few years. As the northern extension of its range has spread farther from the centers of greater Cardinal population, its progress is retarded. Thus, the relatively rapid range expansion during the early 1900's was probably due to the proximity of this southern center of population.

On the basis of this study it would seem that the northward expansion of range in Michigan has been the result of a combination of short-range and major movements into the ecologically suitable habitats.

SUMMARY

The northward spread of the Eastern Cardinal in the past half-century has been of considerable interest to many people. The conspicuousness of the bird makes it easily recognizable by the layman, thus adding to the validity of reported new occurrences. The purpose of this study was to determine as many as possible of the factors contributing to the bird's movement into areas outside its previous range.

Field work was carried out from the spring term of 1952 to the winter term of 1954. A banding station was maintained on the campus and observations were made in nearby woodlots. All of the available returns of the Cardinal in the files of the Fish and Wildlife Service at Laurel, Maryland were personally examined, and the literature was reviewed to determine the manner in which the northward extension of range took place.

The several related genera, endemic to South America, suggest a South American origin for the group to which the Cardinal belongs.

Prior to the recent extensive expansion of range, the approximate northern boundary of the main population of the subspecies cardinalis was from southeastern Iowa through Illinois, Indiana, Ohio, southern Pennsylvania and southern New Jersey.

The Cardinal entered Michigan in significant numbers during the 1880's. By the early 1900's it was established as a breeding resident throughout the southern counties as far north as East Lansing. In the 1920's it was seen in the Upper Peninsula. Although at the present time there are records of strays in Canada to the north, it is still considered a stray in the Upper Peninsula. It is found as far north as Cadillac and Houghton Lake. It is reported from sections along Lake Michigan as far north as Wilderness State Park.

While this extension of range was taking place in Michigan, an even greater expansion occurred to the northwest in the Mississippi Valley and contiguous areas. In the east the general habitat has been little changed and even today the Cardinal is considered a stray in Massachusetts as it was over 70 years ago. It did not breed commonly on Long Island until after the building boom of the 1940's.

The Cardinal has a great variety of songs, but there are five basic types of which the others appear to be modifications. The sexually dimorphic characteristics have helped in making more accurate observations of the activities of each sex.

The Cardinal does not exhibit much belligerence during the establishment of its territories. Most of the territorialism in Michigan consists of frequent singing during the late winter and early spring. When later territories are

established, they are formed among those already present. The bird exhibits a willingness to give up certain fringe areas of its territory.

The Cardinal prefers wooded areas along streams and swamps during the fall and winter. Some may remain on the nesting territory provided there is adequate food and cover in winter.

Nests are constructed in the available cover, and a variety of materials is used. The nesting season is long, sometimes extending from the second week of April to the end of September.

Small fall groups contain many juveniles, and in some cases are family groups of late summer nestings. These groups tend to merge into larger flocks of 15 to 20 individuals by late fall in the more northern states and become even larger in favorable habitats in the more southern states. In an area of good winter cover a flock may be present almost every day, though some of the individuals in the group change frequently. Juveniles probably follow roaming flocks for greater distances than do adults.

The bird is remarkably sedentary. Only 0.23 per cent of the 6,000 banding recoveries in the files of the Fish and Wildlife Service indicate movements of over 25 miles. Movement is not confined to any particular direction. Both males

and females make distance flights and immatures tend to move more frequently than adults. However, immatures are likely to nest within two miles of the place of hatching.

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