DOCTORAL DISSERTATION SERIES

TITLE A LIFE HISTORY STUDY OF THE SCARLET TANAGER (PIRANGA OLIVACEA)

AUTHOR KENNETH WADE PRESCOTT

UNIVERSITY OF MICHIGAN DATE 1950

DEGREE Ph. D. PUBLICATION NO. 1995



UNIVERSITY MICROFILMS
ANN ARBOR · MICHIGAN

A LIFE HISTORY STUDY OF THE SCARLET TANAGER (*PIRANGA OLIVACEA*)

By

Kenneth Wade Prescott

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in the
University of Michigan
1950

Committee in charge:

Associate Professor Josselyn Van Tyne, Chairman
Professor Lee R. Dice
Professor J. Speed Rogers
Professor A. Franklin Shull
Professor William C. Steere
Associate Professor George M. Sutton



Edwin S. George Reserve

A - Southwest Woods
B - Fishhook Marsh
C - Dollar Tamarack Swamp
D - West Woods
E - West Tamarack Swamp
F - South Woods
G - Big Cattail Marsh
H - Big Island
I - Big Woods
J - Buck Hollow
K - Hidden Lake
L - North Woods

TABLE OF CONTENTS

Page

LIST OF TABLES viii

LIST OF ILLUSTRATIONS x

Chapter

I. NOMENCLATURE AND DESCRIPTION OF THE SCARLET TANAGER 7

Nomenclature
Synonymy
Local names
Description
Adult male in spring and summer
Adult male in fall and winter
Young male in first autumn and winter
Young male in first nuptial plumage
Adult female
Nestling plumage
Color of feet, bill, and iris
Xanthochroism
Albinism
Reddish and yellowish wing coverts
Measurements
Summary

II. THE DISTRIBUTION AND MIGRATION OF THE SCARLET TANAGER 20

Distribution
Breeding range
Winter quarters
Migration
From the winter quarters
Arrival in Michigan
Departure from Michigan
Migration route
Method of migration
Susceptibility of migrating Scarlet Tanagers to cold
Weight and fat of Scarlet Tanagers
Summary

III. TERRITORY ESTABLISHMENT AND COURTSHIP BY THE MALE SCARLET TANAGER 31

Establishment of Territory

TABLE OF CONTENTS
(Continued)

Chapter — Page

III. (Continued)

Behavior of Newly Arrived Female
Male Behavior when the Female Arrives
Courtship
Courtship Display
Courtship Display and Threat Display
Role of Spring Foliage
Summary

IV. THE SCARLET TANAGER NEST 40

Nest Building
Choice of site
Sex building the nest
Time spent building
Gathering of nest material
Nest construction
Songs and other sounds during nest building
Nest Site
Site requirements
Concealment
Site on the branch
Nest height
The nest tree
Role of woods roads
Unusual nest sites
Location of Reserve Nests
Nest Description
Nest materials
Size and shape of nest
Measurements of nests
History of Nests
Nests No. 1 to No. 33
Summary

V. SCARLET TANAGER COPULATION 80

Copulation Before the Eggs are Laid
Copulation During the Incubation Period
Copulation During the Nesting Period
Copulation With a Strange Male
Summary

VI. THE SCARLET TANAGER EGG, CLUTCH, AND INCUBATION 87

Egg
Clutch
Incubation
Position of the incubating female on the nest

TABLE OF CONTENTS
(Continued)

Chapter — Page

VI. (Continued)

- Egg turning
- Preening on the nest
- Manner of leaving and returning to the nest
- General behavior of the incubating female
- Male activity during female's incubation

Incubation Rhythm

- Incubation rhythm in relation to each incubation day
- Incubation rhythm in relation to temperature
- Other factors in relation to the incubation rhythm

Summary

VII. THE SCARLET TANAGER NESTLING 121

Description of Nestlings

- Day of hatching
- One day old
- Two days old
- Three days old
- Four days old
- Five days old
- Six days old
- Seven days old
- Eight days old
- Weights of nestlings

Behavior of Nestlings

- Method of leaving the nest
- Weights of tanager nestlings when they leave the nest

Brooding

Food Brought to the Nestlings

Rate of Feeding the Nestlings

- Feeding of a Cowbird and tanager young
- Method of feeding the nestlings
- Manner in which insects may be prepared for feeding to nestlings
- Arrival, leaving, and position at the nest, of adults when feeding nestlings
- Time spent at the nest by the adults when feeding nestlings

Removal of Excreta

- Manner of removal
- Deposition of excreta when it is carried away from the nest
- General

Summary

TABLE OF CONTENTS
(Continued)

Chapter		Page
VIII.	FOOD AND FEEDING BEHAVIOR OF THE SCARLET TANAGER	190
	Food	
	Plant food	
	Molluscs	
	Annelids	
	Arachnids	
	Diplopods	
	Insects	
	Other Food	
	Feeding Behavior	
	Ground feeding	
	Arboreal feeding	
	Preparation of some insects for eating	
	Summary	
IX.	SONG AND OTHER SOUNDS GIVEN BY THE SCARLET TANAGER	201
	The Song	
	Song season	
	Early morning and late evening song	
	Song in flight	
	Female song	
	Male song	
	Role of the song	
	The "Chip-Churr" call	
	Uses of the "chip-churr" call	
	Number of "chip-churrs"	
	"Chip-churrs" at the nest	
	Other Sounds	
	Summary	
X.	OTHER BEHAVIOR OF THE SCARLET TANAGER	219
	Preening	
	Drinking and Bathing	
	Sunning	
	Anting	
	Summary	
XI.	TERRITORY DEFENSE, AND THE RELATIONSHIPS OF THE SCARLET TANAGER WITH OTHER ANIMAL SPECIES . . .	224
	Territory Defense Against Tanagers	
	Other Species	
	Invertebrates	
	Protozoans	
	Insects	

TABLE OF CONTENTS
(Continued)

Chapter — Page

XI. (Continued)

- Reptiles
- Other birds
  - Antagonistic species
  - Apparently neutral species
  - Predatory species
  - Nesting success and brood parasitism
- Mammals
- Summary

LITERATURE CITED 268

LIST OF TABLES

Table		Page
1.	The Weight and Fat Condition of Thirty-Six Male Scarlet Tanager Specimens	15
2.	The Weight and Fat Condition of Ten Female Scarlet Tanager Specimens	17
3.	Average Scarlet Tanager Weights (gms.)	18
4.	Number, and Length of, Nest-working Periods of Two Female Scarlet Tanagers	48
5.	Nest Site Data for 20 Scarlet Tanager Nests, 1947-1949	54
6.	Nest Site Data for 13 Scarlet Tanager Nests Found by Sutton, 1942-1946	55
7.	Heights (estimated) of 33 Scarlet Tanager Nests in the Literature	56
8.	Incubation Rhythms of 10 Scarlet Tanager Females	97
9.	Average Temperature and Incubation Ratio for Six Scarlet Tanager Females	101
10.	Daily Weights of Scarlet Tanager Nestlings . .	126
11.	Daily Weight Increase of Scarlet Tanager Nestlings	127
12.	Food Fed to Nestling Scarlet Tanagers	139
13.	Average Interval Between Feeding of Nestlings and Number of Feedings by Sex	142
14.	Total Number of Feedings of Nestlings at the Six Nests Given in Table 13	143
15.	Removal of Excreta by the Scarlet Tanager Pair	177
16.	Nest, Time, and Other Data Concerning the Removal of Excreta by the Adults at Five Scarlet Tanager Nests	178

LIST OF TABLES
(Continued)

Table		Page
17.	Method of Excreta Removal by the Scarlet Tanager in Relation to Day of Development of Young	183
18.	Minimum Number of Eggs Laid, Number of Young Hatched and Fledged, for Fifteen Scarlet Tanager Nests	255

LIST OF ILLUSTRATIONS

Figure		Page
	Frontispiece - Edwin S. George Reserve	ii
1.	Photograph of Blind	6
2.	Breeding Distribution of the Scarlet Tanager	21
3.	Scarlet Tanager Migration Route	26
4.	Southwest Woods in Spring, Territory No. 13	37
5.	Southwest Woods in Spring, Territory No. 1	37
6.	Southwest Woods in Spring, Territory No. 2	43
7.	Low Perches in Territory No. 13	43
8.	Nest Building Activity of Female Scarlet Tanager No. 6	46
9.	Nest Building Activity of Female Scarlet Tanager No. 13	47
10.	Nest Tree No. 2, Southwest Woods	50
11.	Sapling Nest Site, Territory No. 13, Southwest Woods	50
12.	Scarlet Tanager Nest No. 1, with Four Eggs	53
13.	Scarlet Tanager Nest No. 1	53
14.	Woods Road in Southwest Woods, Near Nest No. 3	59
15.	Woods Road in Southwest Woods, Near Nest No. 2	59
16.	Drawing of Southwest Woods Showing Locations of Nine Scarlet Tanager Nests	61
17.	Scarlet Tanager Nest Locations at the Edwin S. George Reserve	63
18.	Southwest Woods, Showing Part of Scarlet Tanager Territory No. 11	69
19.	Scarlet Tanager Territory No. 11	69

LIST OF ILLUSTRATIONS
(Continued)

Figure		Page
20.	Fishhook Marsh	75
21.	Average Ratios per Day of Incubation for 10 Scarlet Tanager Females	99
22.	Relation of Temperature and the Incubation Rhythm to the Days of Incubation	103
23.	Incubation Rhythm of Female No. 1, Days No. 1 and No. 2	107
24.	Incubation Rhythm of Female No. 1, Days No. 5, No. 6, and No. 7	108
25.	Incubation Rhythm of Female No. 1, Day No. 8, and Female No. 5, Day No. 7	109
26.	Incubation Rhythm of Female No. 5, Days No. 9, No. 11, and No. 12; Female No. 6, Day No. 2; and Female No. 13, Day No. 1	110
27.	Incubation Rhythm of Female No. 13, Days No. 1, and No. 2; Female No. 15, Day No. 1; Female No. 16, Day No. 1	111
28.	Incubation Rhythm of Female No. 10, Days No. 1, and No. 2	112
29.	Incubation Rhythm of Female No. 10, Days No. 3, and No. 4 (cont.)	113
30.	Incubation Rhythm of Female No. 10, Days No. 4, No. 5, and No. 6 (cont.)	114
31.	Incubation Rhythm of Female No. 10, Days No. 6, and No. 7	115
32.	Incubation Rhythm of Female No. 17, Days No. 8, No. 9, and No. 10 (cont.)	116
33.	Incubation Rhythm of Female No. 17, Days No. 10, No. 11, and No. 12.	117
34.	Incubation Rhythm of Female No. 17, Day No. 13; Female No. 18, Days No. 1, and No. 3 (Cont.) . .	118
35.	Incubation Rhythm of Female No. 18, Days No. 3, No. 4, and No. 5	119

LIST OF ILLUSTRATIONS
(Continued)

Figure		Page
36.	Incubation Rhythm of Female No. 3, Days No. 12, and No. 13	120
37.	Average Daily Weight of the Three Scarlet Tanager Nestlings of Nest No. 5	128
38.	Brooding Rhythm of Three Scarlet Tanager Females for the First Four Days of Development of the Young	136
39.	Parent Feeding, and the Time of Feeding, the Nestlings (2 tanager, 1 Cowbird) by Pair No. 2, Day No. 8, and Day No. 9 (cont.)	144
40.	Parent Feeding, and the Time of Feeding, Nestlings by Pair No. 2, Day No. 9 (cont.), and Day No. 10	145
41.	Parent Feeding, and Time of Feeding, the Nestlings (2 tanager and 1 Cowbird) of Nest No. 3 by Pair No. 3, Day No. 0, No. 2, No. 3, and No. 5 (cont.)	146
42.	Pair No. 3, Day No. 5 (cont.). Parent Feeding, and Time of Feeding, the Nestlings (1 tanager and 2 Cowbirds) by pair No. 8, Day No. 8, No. 9, No. 10 (cont.)	147
43.	Pair No. 8, Day No. 10 (cont.). Parent Feeding, and Time of Feeding the Nestlings (1 tanager and 1 Cowbird) by Pair No. 11, Day No. 2 (cont.) . .	148
44.	Feeding of Nestlings by Pair No. 11, Day No. 2 (cont.), No. 3, No. 4 (cont.)	149
45.	Feeding of Nestlings by Pair No. 11, Day No. 4 (cont.), No. 5, No. 6, No. 7, No. 8 (cont.) . . .	150
46.	Feeding of Nestlings by Pair No. 11, Day No. 8 (cont.), No. 9, No. 10 (cont.)	151
47.	Pair No. 11, Day No. 10 (cont.). Parent Feeding, and Time of Feeding the Nestlings (2 tanager) by Pair No. 17, Day No. 0, No. 1, No. 3 (cont.) . .	152
48.	Feeding of Nestlings by Pair No. 17, Day No. 3 (cont.) and Day No. 4	153
49.	Intervals Between Feeding of Young of Nest No. 3 in Relation to Days of Development	155

LIST OF ILLUSTRATIONS
(Continued)

Figure		Page
50.	Intervals Between Feeding of Young in Relation to Days of Development	157
51.	Comparison of the Intervals Between Feeding of Nestlings by a Female, with the Intervals by Two Pair of Tanagers	159
52.	Rate of Feeding in Relation to Days of Development, Nest No. 3	160
53.	The Feeding of a Tanager and Cowbird Nestling by Female No. 8	162

INTRODUCTION

The Scarlet Tanager (Piranga olivacea) is a colorful and fairly common bird which has long been known to ornithologists. There are many published accounts of its nest and eggs, as well as some excellent photographs of the adults at the nest. Yet little is known of its ecology and many details of its life history have been inadequately understood. The object of my study has been to discover the ecologic relationships between the Scarlet Tanager and other species, and to work out the details of its life history which, hitherto, have not been known.

Time and place of study. During the spring and summer of 1947, 1948, and 1949, I conducted a field study of the Scarlet Tanager at the Edwin S. George Reserve, Pinckney, Michigan. The Reserve is located in southern Livingston County, 20 miles northwest of Ann Arbor, Michigan. It includes 1,268 acres of moraine and basin topography. For a further description and history of the Reserve area see Rogers (1942:10, 31-41).

The areas in which I studied at the Reserve are principally confined to two oak-hickory woods, the Southwest Woods (25 acres) and Big Woods. These woods are fairly open, being mostly composed of mature trees. Approximately 90 per cent (Rogers, 1942:31) of the upland forest is composed of white oak (Quercus alba), black oak (Quercus velutina), and the shagbark hickory

(Carya ovata). Besides the many saplings of these trees in the woods, there are local thickets composed of sassafras (Sassafras albidum), witch hazel (Hamamelis virginiana), and hazelnut (Corylus americana). The huckleberry (Gaylussacia baccata) and blueberry (Vaccinium canadense) are also present. Fallen trees and branches furnish many low perches for the birds.

Dr. George M. Sutton has generously allowed me the use of the Scarlet Tanager notes which he compiled at the Reserve during the years 1934, 1935, 1936, 1940, 1942, 1944, and 1946. Many of the tanager nests which he found were in the tamarack (Larix laricina) swamps of the Reserve. Most of the older tamarack trees in these swamps have died and many remain standing as dead trees and stumps. However there is also a dense understory of young tamaracks, poison sumac (Rhus vernix), dog woods (chiefly Cornus racemosa and C. obliqua), chokeberry (Pyrus arbutifolia atropurpurea), etc. For a more detailed description of the tamarack swamps see Rogers (1942:35-36).

Methods. The first two years of this study I made weekly trips to the Reserve during late April and early May to determine the time of the Scarlet Tanager's arrival. Lawrence Camburn and Dr. Arthur E. Staebler were on the Reserve daily during this period and they were able to determine, more accurately than I, the tanager's arrival. In 1949 I lived at the Reserve, was able to be in the field every day, hence witnessed the actual arrival of the Scarlet Tanager.

After the Scarlet Tanager arrived I was in the field almost every day, each year of the study, until the end of the nesting

season. After the male tanagers arrived, I watched their behavior during territory establishments, recording notes while seated at a tree or concealed in shrubbery. I also made observations of various tanager pairs during courtship, mating, and nest building, from an observation point at the base of a tree. Once the nest was completed, and egg laying begun, I made subsequent observations from a blind of wood and cloth construction, approximately 6' x 5' x 4' (see Figure 1).

Observations outside of the blind were aided by the use of a 7x50 binocular, and occasionally by a 20x Argus Spotting Scope. Almost all observations from the blind were made with the Argus Scope. Because of the inaccessibility of many tanager nests, their height and distance from my blind, many of my observations could not have been made without the Argus Scope.

Whenever possible I timed the length of various observations and recorded it as minutes and seconds. Usually this was done by consulting the minute and sweeping second hands of my watch. However in the case of very short observations I was not able to turn my eye away from the scope and I estimated the seconds by counting, "one-thousand-one, one-thousand-two, etc." until the short observation ended. Therefore, sight observations of only a few seconds are approximate.

More detailed accounts of other methods used appear later in the introductory statements of the various phases of this study.

Manner of presentation. The Scarlet Tanagers and their nests which I observed during these three years are numbered chronologically, starting with nest No. 1, the first nest which I found in 1947. Throughout this study, nests are referred to as nest No. 1, nest No. 4, etc., and the tanagers of these nests are likewise numbered as female No. 1, male No. 4, etc. The nests are numbered and described under the topic "History of Nests". In the discussions that follow, a tanager may only be referred to as female No. 10, or male No. 18, etc., but if more detailed information is desired concerning the location, fate, or stage of the nest at the time of the observation, this may be obtained by referring to the section "History of Nests".

I have also arranged the data taken from Dr. Sutton's notes according to this plan. The last nest which I found was nest No. 20, and Dr. Sutton's 13 nests are numbered from No. 21 to No. 33 inclusive.

I have used Eastern Standard Time, expressing it always in four figures. According to this widely used system the 24th hour (midnight) is written 24:00, the ninth hour of the day (9:00 a.m.) is written 09:00, and the 14th hour of the day (2:00 p.m.) is written 14:00, etc.

Acknowledgements. I greatly appreciate Dr. Josselyn Van Tyne's interest in directing this work. His careful reading and criticism of this manuscript and of the summaries of each year's field observations have proven of immense value to me.

Dr. Sutton generously contributed his extensive knowledge

of Scarlet Tanager habits and made many valuable suggestions concerning field techniques. His ability to locate a Scarlet Tanager nest, when I had been unsuccessful, served to make each summer's work more fruitful than it otherwise could have been. In addition, Dr. Sutton's suggestion that I use his notes has resulted in my being able to present a more complete account of the Scarlet Tanager at the Reserve.

The funds for this work were made available as Edwin S. George Fellowships. I am indebted to Colonel George because this aid made it possible for me to spend much more time at the Reserve than I otherwise could have. The facilities of the Reserve are excellent. I am grateful for permission to carry out my investigation at the Reserve which has a fine population of nesting Scarlet Tanagers, and for permission to use the Reserve laboratory and its equipment as well as other Reserve housing facilities.

I am also indebted to Dr. J. Speed Rogers who helped in many ways. Most of the photographs which I have used for illustrations were taken by Dr. Rogers, and one was contributed by Mr. Kurt K. Bohnsack. I am grateful for being extended this privilege.

The first two years of this study I shared the Reserve's Argus Spotting Scope with other Reserve field workers. However, the last year Mr. and Mrs. Homer Hilton, of Ann Arbor, generously gave me an Argus Scope.

I wish to acknowledge help in the field given by Dr. Arthur E. Staebler, Harrison B. Tordoff, and Andrew J. Berger.

Mr. Lawrence Camburn helped in many ways, especially in noting the early spring arrival of the Scarlet Tanager. I sincerely appreciate the hospitality of the Camburn home, and the genuine interest in my work which Mr. and Mrs. Camburn have shown.



Fig. 1. Photograph of blind taken five feet from nest No. 1. The rectangular slot at the front was large enough to permit the use of a 7x50 binocular and I focused the spotting scope through the small hole to the right. In addition there were observation holes cut in the other three sides of the blind.

CHAPTER I

NOMENCLATURE AND DESCRIPTION OF THE SCARLET TANAGER

A. Nomenclature

The tanager family (Thraupidae) is found only in the new world. It is probably of South American origin (Mayr, 1946: 26-27). It contains 62 genera, 211 species, and 530 forms (Hellmayr, 1936). It is principally South American in distribution today, with only a few genera in Central America and but one genus in the United States and Canada. Of the four species found north of Mexico, two are principally western, the Western Tanager (Piranga ludoviciana), and Hepatic Tanager (Piranga flava); one, the Scarlet Tanager is eastern; and one, the Summer Tanager (Piranga rubra), is represented in the east by the nominate race and in the west by cooperi. Only the Scarlet Tanager breeds in Michigan. There is one record of the Summer Tanager in Michigan (Tordoff, 1949:112).

Synonymy. In the 10th edition of Systema Naturae, Linnaeus (1758:181) named a tanager Fringilla rubra. The name rubra was accepted for the Scarlet Tanager until the first edition of the A.O.U. Check-List (1886:291) applied rubra to the Summer Tanager (Piranga rubra). Vieillot (1819:293) had used the binomial Pyranga erythromelas for the Scarlet Tanager and the first A.O.U. Check-List (op. cit.) used the name Piranga

erythromelas (Vieillot). However Oberholser (1919:575) pointed out that Gmelin (1789:889) had used olivacea for the Scarlet Tanager. The fourth edition of the A.O.U. Check-List (1931:311) retained Piranga erythromelas but in the Nineteenth Supplement to the A.C.U. Check-List (1944:460) the Committee on Nomenclature accepted olivacea and the Scarlet Tanager has since been known as Piranga olivacea (Gmelin).

Local names. Trotter (1909:358) states that "scarlet" as applied to the Scarlet Tanager was first used by Edwards, who referred to it as the Scarlet Sparrow. Trotter also cites the following local names: Canada Tanager (Pennant), Summer Redbird (Catesby), Sandhill Redbird of Carolina (Bartram).

The following common names have also been used: Black-winged Summer Redbird (Swainson and Richardson, 1831:273), Black-winged Redbird (Wheaton, 1879:284), Fire-bird (De Kay, 1884:176), English Robin (Faxon, 1889:45), Pocket-bird (Davie, 1898:408), Black-winged Red Tanager (Brabourne and Chubb, 1912:418), and Barrows (1912:539) lists the Common Tanager and Red-bird as local names for the Scarlet Tanager.

B. Description

Adult male in spring and summer. Uniform scarlet, with deep black scapulars, wings and tail; under wing-coverts whitish with a margin of black feathers at the leading edge. Acquired by a partial prenuptial moult beginning March or April (Dwight, 1900:221).

Adult male in fall and winter. Upper parts yellowish olive-green; underparts yellowish with flanks shaded to olive-green; wings and tail black. Acquired by a complete post-nuptial moult beginning early in August (Dwight, 1900:221-222).

Sutton observed adult males at the Reserve undergoing the postnuptial moult on the following dates: July 24 (1936), July 31 (1940), and August 5 and 6 (1934). However, he has observed adult males in full breeding plumage on the following late dates: July 27 (1936), August 1 (1934), and August 12 (1935). Alexander F. Skutch saw a pair at the Reserve, August 29 (1946) which showed no evidence of moult. If the onset of the postnuptial moult, for a given tanager pair, is correlated with the fledging of its young, as suggested by Sutton (Todd, 1940:394), this would explain these irregular dates of moulting birds.

Young male in first autumn and winter. Similar to adult female; middle and greater wing coverts and rectrices margined with light yellow-green; by mid-September black appears on the lesser and middle wing coverts and the scapulars. Acquired by a partial postjuvenal moult beginning the middle of August (Dwight, 1900:221). Sutton has handled or observed at the Reserve, young males which were undergoing the postjuvenal moult on the following dates: July 23 (1934), July 24 (1936), July 31 (1936), and September 7 (1940).

The young male in first winter plumage has brownish-gray wings and tail which distinguishes it from the adult male with its deep black tail and wings.

Young male in first nuptial plumage. Similar to fully adult male but the scarlet body may have a more yellowish cast. Acquired by a partial prenuptial moult which does not involve the primaries, their coverts, the secondaries, and usually not the alulae (Dwight, 1900:221). Some of the secondaries and primaries may be moulted and replaced by new black feathers, but the brownish appearance of the wing distinguishes it from that of the fully adult male.

Adult female. Olive-green with slight yellowish tinge above, somewhat more grayish on back; wings and tail dusky brownish gray with dull olive-green edgings; under parts yellowish shaded to greenish-yellow on the flanks; under tail coverts bright yellow; under wing-coverts grayish white with a margin of dusky olive-green or olive-gray feathers on the leading edge. The female undergoes a partial pre-nuptial moult in March or April and a complete postnuptial moult in late summer but she has greenish plumage throughout the year.

Nestling plumage. Natal down, whitish-gray. Juvenal head and body plumage dull olive-green above; under parts whitish with tinge of yellow, more yellow posteriorly, and broadly streaked with grayish dusky; wings and tail grayish dusky with olive-green edgings; middle wing coverts and outer webs of greater coverts tipped with greenish-yellow forming two indistinct wing bands; under tail coverts bright yellow. The male nestling may be distinguished by darker scapulars and upper wing coverts (Sutton, letter). Acquired by a complete postnatal moult (Dwight, 1900:221).

Color of feet, bill, and iris. Feet blue-gray, becoming more dusky when older. Bill dark olive- or olive-brown to dull brown, lighter in an area toward tip of lower mandible and along cutting edge (Sutton, Univ. Mich. Mus. Zool. labels, Nos. 75040, 75043, 75044, 75045). Iris dark brown.

Xanthochroism. There have been reports of male Scarlet Tanagers with an unusual body plumage coloration of various shades of yellow and orange. Oberholser (1925:338) saw a breeding male with a "cadmium orange" plumage; Lakela (Roberts, 1941:574) reported seeing a "yellow-orange" Scarlet Tanager in late summer; Brewster (1878:62) reported a "rich orange" male collected by Maynard, May 27, 1869; and Trotter (1914:359) observed a mated male Scarlet Tanager with a "brilliant orange plumage".

Dwight (1900:221) states that the scarlet of the first nuptial plumage of the male is "sometimes pale or mixed with orange", while Chapman (1918:19) believes that occasional orange-bodied birds probably should be classed as "albinistic" individuals which lack a full share of pigment.

Albinism. Stone (1888:322) observed an albino Scarlet Tanager in company with several normally colored tanagers. He collected the bird, a female, and examined its plumage in detail. There were many pure white feathers, especially in the wings and tail. Some of the tail feathers were black, and some of the wing feathers were olive- or canary-yellow. The plumage above and below was bright yellow with one or two olive feathers in the back. The legs and bill were light pink. The presence

of so much yellow in the plumage of this albinistic bird suggests that the xanthochroistic birds mentioned above may have been partial albinos.

Reddish and yellowish wing coverts. There have been occasional reports of male Scarlet Tanagers with reddish or yellowish wing coverts. Audubon (4, 1838:389) examined several specimens with "glowing red" on the "smaller wing-coverts" which formed a band of red. Campbell (1940:161) reports males with red wing spots or bars. Plath (1931:127-128) captured an emaciated male with the lesser wing coverts tipped with red, forming a "symmetrical wing band".

An adult (not the first nuptial plumage) male collected May 20, 1875, by Gibbs at Kalamazoo (Univ. Mich. Mus. Zool. No. 30347) has a few parti-colored yellowish-red feathers on the middle wing coverts. Haven H. Spencer collected a sub-adult male (first nuptial plumage) May 6, 1949, (G.M.S. No. 10944) which has a few parti-colored bright yellow lesser wing coverts. And an adult male collected May 17, 1934, by Norman A. Wood (Univ. Mich. Mus. Zool. No. 73496) has bright parti-colored red feathers on the upper middle wing coverts, forming a wing bar.

I closely examined the wing coverts of 108 breeding males in the museum collection (Univ. Mich. Mus. Zool.) and the Max Minor Peet Collection. I find that the incidence of more or less red, orange, or yellow wing coverts is much higher than is generally supposed. To be sure, many of the abnormally colored feathers were not obvious and I needed to look closely

to find them. Of 60 adult males, 13 (23 per cent), and of 48 sub adult males, 16 (35 per cent), showed some red, orange, or yellow colored covert feathers. In a few cases only one such colored feather could be detected, and in others there were several such feathers. These feathers were only partially colored red, orange, or yellow.

Dwight (1900:221) states that Scarlet coverts are occasionally assumed in the renewal of the wing coverts of the male Scarlet Tanager at the first nuptial plumage. The specimens which I examined showed that a greater percentage of sub adults contained these colored covert feathers than did the adults. However, the fact that approximately 23 per cent of the adults which were not in the first nuptial plumage contained these abnormally colored covert feathers, indicates that this condition is by no means limited to the sub adult male Scarlet Tanager.

Measurements. The length of the adult Scarlet Tanager is about 6.5 to 7.5 inches. Ridgway (pt. 2, 1902:89) gives the skin measurements (in mm.) of adult male and adult female Scarlet Tanagers as follows: adult male (14 specimens)- length, 158.8-171.5 (163.6); wing, 91.9-99.3 (95.8); tail, 65-71.6 (68.3); exposed culmen, 14.5-15.7 (15.2); depth of bill at base, 8.9-9.7 (9.4); tarsus, 19.6-20.8 (19.8); middle toe, 13.2-15.5 (14); adult female (10 specimens)- length 157.5-170.2 (165.1); wing, 87.6-94.5 (92.7); tail, 64-70.4

(67.1); exposed culmen, 14.5-15.7 (15); depth of bill at base, 8.1-9.4 (8.9); tarsus, 17.8-20.8 (19.6); middle toe, 13-14.7 (13.7).

The weights, and other pertinent data, of 36 male Scarlet Tanagers are given in Table 1, and similar information is given for 10 female tanagers in Table 2. These data are compiled from three collections: (1) the University of Michigan, Museum of Zoology Collection (UMMZ), (2) the George M. Sutton Collection (GMS), and (3) the Max Minor Peet Collection (MMP).

TABLE 1

THE WEIGHT AND FAT CONDITION OF THIRTY-SIX
MALE SCARLET TANAGER SPECIMENS

Date	Gms. Wt.	Age	Locality	Collector	Coll. No.	Fat
May 2, 1938	----	ad.	Brooke Co., W. Va.	K.W. Haller	MMP-647	very
" 6, 1949	30.7	"	Washtenaw Co., Mich.	H.H. Spencer	GMS-10945	rather
" 6, 1949	29.2	"	" " "	" " "	" 10944	somewhat
" 7, 1949	29.9	"	Livingston " "	W.A. Lunk	" 10946	rather
" 8, 1938	29.8	"	Monroe Co., Tenn.	L.W. Wing	UMMZ-97146	---
" 9, 1938	----	"	Brooke Co., W. Va.	K.W. Haller	MMP-663	not
" 9, 1938	----	"	" " " "	" " "	" 664	fat
" 11, 1936	30.9	"	Washtenaw Co., Mich.	L.D. Case	" C256	very
" 12, 1949	29.9	"	" " "	R. Graber	GMS-10952	not
" 14, 1947	30.6	"	" " "	R.E. Morrill	UMMZ-114082	---
" 19, 1948	29.3	"	" " "	F.C. Blanchard	" 115953	---
" 20, 1939	30.7	"	Livingston Co., "	R.E. Morrill	MMP-541	---
" 24, 1933	31.0	"	Huron Co., "	J. Van Tyne	UMMZ-71153	fat
" 24, 1933	31.3	"	" " "	" " "	" 71152	fat
" 27, 1941	29.0	"	Oscoda " "	" " "	" 108690	---
" 27, 1941	28.8	"	" " "	" " "	" 108689	---
" 27, 1934	27.9	"	Livingston Co., "	R.E. Olsen	" 73528	little
" 30, 1935	30.1	"	Washtenaw Co., "	F.J. Hinds	" 84500	---
" 31, 1945	28.9	"	Oscoda Co., "	E.K. Miller	" 113895	---
June 5, 1938	28.2	"	Anderson Co., Tenn.	L.W. Wing	" 97379	---
" 9, 1940	31.0	"	Leelanau Co., Mich.	A.E. Staebler	" 110583	---
" 12, 1940	28.0	"	" " "	" " "	" 110584	---
" 16, 1940	31.0	"	" " "	" " "	" 110585	---
" 17, 1934	30.8	"	Jackson Co., Mich.	T.D. Hinshaw	" 74281	moderately

TABLE 1--Continued

Date	Gms. Wt.	Age	Locality	Collector	Coll. No.	Fat
June 20, 1938	----	ad.	Hancock Co., W. Va.	K.W.Haller	MMP-725	not
" 21, 1937	32.1	"	Charlevoix Co., Mich.	T.D. Hinshaw	UMMZ-96911	little
" 24, 1934	28.8	"	Oscoda Co., "	A.D. Tinker	" 74208	not
" 24, 1934	29.7	"	" " "	R.E. Olsen	" 74210	not
" 26, 1938	29.1	"	Chippewa Co., "	R.A. MacMullan	" 101542	---
July 1, 1938	31.2	"	" " "	T.D. Hinshaw	" 101543	little
" 13, 1934	28.9		Livingston Co., "	G.M. Sutton	" 75040	---
" 21, 1934	28.5	juv.	" " "	" " "	" 75044	---
" 23, 1934	27.9	ad.	" " "	" " "	" 75042	---
" 23, 1934	29.8	juv.	" " "	" " "	" 75043	---
" 24, 1934	30.0	ad.	Oscoda " "	N.A. Wood	" 74457	---
Aug. 5, 1934	29.0	"	Livingston " "	R.E. Olsen	" 75174	little
" 9, 1936	30.0	juv.	Jackson " "	P. Brodkorb	" 83424	---
" 26, 1936	30.4	im.	Leelanau Co., "	J. Van Tyne	" 83591	---
Sept. 1, 1938	29.6	"	Luce Co., "	R.E. Olsen	" 96320	little
" 2, 1935	31.7	ad.	Livingston Co., "	" " "	" 86384	"
" 14, 1948	33.0	im.	Washtenaw Co., Mich.	H.B. Tordoff	" 116443	"
" 22, 1949	42.8	"	" " "	" " "	" 117755	extremely

TABLE 2

THE WEIGHT AND FAT CONDITION OF TEN
FEMALE SCARLET TANAGER SPECIMENS

Date	Gms. Wt.	Age	Locality	Collector	Coll. No.	Fat
May 11, 1941	30.1	ad.	Washtenaw Co., Mich.	M.M. Peet	MMP- --	very
" 11, 1936	34.0	"	" " "	L.D. Case	" C257	---
" 12, 1949	29.5	"	" " "	R. Graber	GMS-10953	not
" 27, 1934	32.8	"	Livingston " "	R.E. Olsen	UMMZ-73529	little
" 30, 1935	30.2	"	" " "	H.K. Gloyd	" 84511	moderately
July 4, 1934	31.3	"	" " "	A.D. Tinker	" 74606	fairly
" 7, 1937	29.6	"	Charlevoix " "	R.E. Morrill	" 96913	---
" 13, 1934	27.4	"	Livingston " "	G.M. Sutton	" 75041	---
" 21, 1934	30.6	juv.	" " "	" " "	" 75045	---
" 31, 1930	26.0	ad.	Washtenaw " "	J. Van Tyne	" 65926	---
Aug. 10, 1940	30.8	juv.	Livingston " "	G.M. Sutton	" 106546	---
Sept. 14, 1939	29.4	ad.	Jackson " "	L.D. Case	" 107006	---

The average weights, during a five-month period, of 51 Scarlet Tanagers are given in Table 3. The number of specimens used to compute the average weight for each month is given in parentheses. It appears that after their arrival on the nesting area, the adults lose weight during the nesting season. This can presumably be correlated with their nesting activity and the burden of rearing young. Apparently the female's weight loss is greater than the male's. This may be due to the irregularity of her feeding during incubation (see Chapter V). The role of weight and fat deposition in relation to migration is discussed in Chapter II.

TABLE 3

AVERAGE SCARLET TANAGER WEIGHTS (gms.)

Month	Adult Male	Juvenal Male	Adult Female	Juvenal Female
May	29.87 (16)		31.32 (5)	
June	29.86 (9)			
July	29.50 (4)	29.15 (2)	28.98 (5)	30.60 (1)
August	29.00 (1)	30.20 (2)		30.80 (1)
September	31.07 (1)	35.13 (3)	29.40 (1)	

SUMMARY

1. The New World family Thraupidae is probably of South American origin. Its present day distribution is principally South American. One genus, composed of four species and five forms, is found in the United States and Canada.

2. A brief history of the Scarlet Tanager's synonymy is

given, and 12 local names for the Scarlet Tanager are listed.

3. The various plumages, and the moults by which they are acquired by the Scarlet Tanager, are described.

4. The color of feet, bill, and iris of the Scarlet Tanager is given.

5. Examples of xanthochroistic plumage of the male are given. This plumage may be the result of partial albinism or it may be a pale or yellowish first nuptial plumage.

6. The plumage of an albino Scarlet Tanager is described. The great amount of yellow in this plumage may indicate that the xanthochroistic birds are partial albinos.

7. A discussion of more or less colored (red, yellow or orange) wing coverts of the male Scarlet Tanager indicates that this condition is more common than is generally supposed. Of the specimens examined, a greater percentage of sub adults than adults showed this condition.

8. Measurements of 14 male, and 10 female Scarlet Tanager skins are given.

9. The weights, and other pertinent data, of 36 male Scarlet Tanagers are given in Table 1, and similar information for 10 female tanagers is given in Table 2. The average weights of these tanagers, by month, are given in Table 3.

10. Weight data from the specimens examined indicate that there is a loss of weight in the adult tanagers during the nesting season. Apparently the female's loss is greater than the male's and this may be due to her irregular feeding during incubation.

CHAPTER II

THE DISTRIBUTION AND MIGRATION OF THE SCARLET TANAGER

A. Distribution

Breeding range. Hellmayr (1936:287) gives the breeding range of the Scarlet Tanager as "eastern North America, from southern Saskatchewan, Manitoba, Ontario, and Quebec, New Brunswick, and Nova Scotia south to Kansas, northern Arkansas, Alabama, and Georgia, and the mountains of Virginia and South Carolina; . . ." Pitelka (1941:127) found that the Scarlet Tanager's breeding range is correlated with the deciduous forest biome and the sub-Canadian ecotone where a mixture of coniferous and deciduous climaxes occurs (see Figure 2).

In the southern portion of its breeding range the Scarlet Tanager has been found at rather high elevations. In mid-June Ganier and Clebsch (1944:65) found the Scarlet Tanager at three locations in the Unicoi Mountains (boundary between Tennessee and North Carolina) at altitudes between 4,300 and 4,800 feet. Lyle and Tyler (1934:56), in northeastern Tennessee, found a Scarlet Tanager nest with three eggs at an altitude of 5,000 feet and state that it is fairly common in woodland of the Transition and Canadian Zones. In New York, in the northeastern portion of its range (Eaton, 2, 1914:338), it is found in the Canadian Zone nearly to the summits of the higher mountains.

Obviously the Scarlet Tanager finds either deciduous forest or an ecotone between deciduous and coniferous forest at these higher altitudes; an ecological niche which satisfies its requirements.

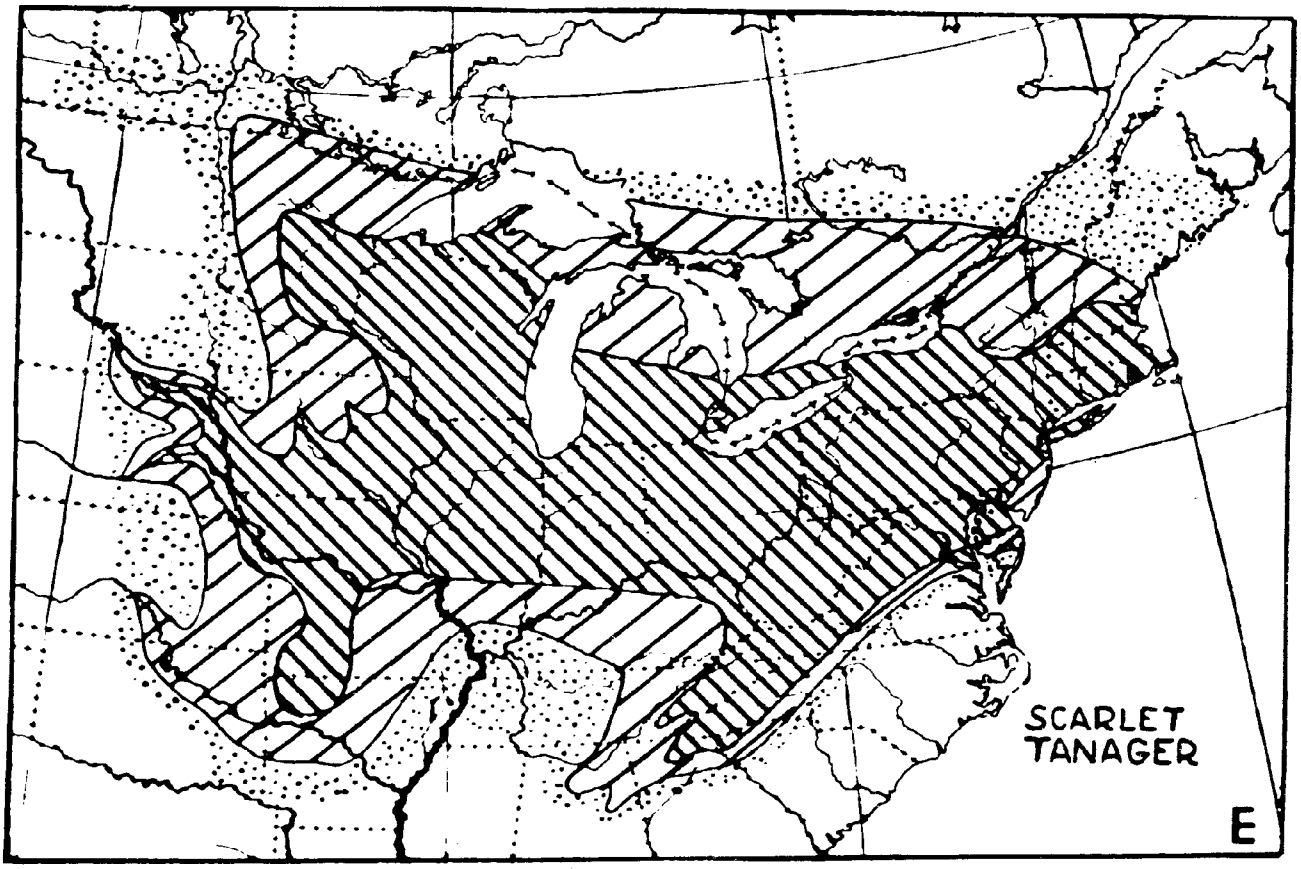


Fig. 2. Breeding distribution of the Scarlet Tanager. Closely spaced lines show the area of common, and widely spaced lines the area of uncommon, occurrence; dots indicate the area of rare occurrence in summer. (Pitelka, 1941:126)

Griscom (1949:84-86) gives an interesting discussion of a decline in the Scarlet Tanager population at Concord, Massachusetts. Brewster (Griscom, op. cit.) had termed the Scarlet Tanager common in the Concord area during the late 19th Century. However, Griscom found that the tanager population at Concord had declined steadily since that time. He correlated this decline with the cutting of old deciduous woods. The

presence of the Scarlet Tanager in white pines (Pinus strobus) in the Harvard Forest today may be due, he believes, to the rapid increase of this tree as the old woods were cut away. Griscom had found the Scarlet Tanager common in the deciduous hardwoods around New York City, although it avoided the coniferous woods. Palmer (1949:518) states that while the Scarlet Tanager is most often found in the mature deciduous woods of Maine, it is also found in fairly large white pines in areas where the deciduous growth is younger or composed of slender trees.

Winter quarters. The Scarlet Tanager winters in Colombia, Ecuador, Peru, and Bolivia (Brabourne and Chubb, 1912:418).

B. Migration

From the winter quarters. The migration of the Scarlet Tanager northward from its winter quarters in South America must commence early in March, for Jewel (1913:438) recorded one in Panama, March 16, and Gosse (1847:235) saw a male and female in Jamaica in March. A male was collected by Vaiden (1943:51) at Rosedale, Mississippi, March 27, and there is an April 1 record for Atlanta, Georgia (Oberholser, 1918:16). Lowery (1945:104–105) gives the following earliest dates of the Scarlet Tanager at seven southern regions: coastal Louisiana, April 3; coastal Mississippi, April 3; Pensacola, Florida, April 5; Baton Rouge, Louisiana, April 15; Memphis, Tennessee, April 16; Nashville, Tennessee, April 6; and Athens, Georgia, April 11. The average arrival of the Scarlet Tanager in the southern

states appears to be mid-April (Bennett, 1909:111; Ganier, 1936:7; Kopman, 1915:183; and Oberholser, 1918:16).

Arrival in Michigan. The Scarlet Tanager arrives in southern Michigan late in April or early in May (Barrows, 1912:539-540). The earliest arrival recorded for Ann Arbor, during the period 1880-1905, was April 4, 1893, and during the period 1906-1930, April 19, 1912 (Wood and Tinker, 1934:50). The average date of arrival for six years at Detroit was May 5, and the earliest date was April 29, 1906 (Oberholser, 1918:17).

The Scarlet Tanager arrives at the Edwin S. George Reserve the first or second week of May. In 1947 the first tanager, a male, was seen by Camburn, May 10, in Southwest Woods. A male tanager (same ?) was seen there by Staebler, May 11, and by Berger the following day. May 18, I found many male and female Scarlet Tanagers at the Reserve.

May 1, and May 8, 1948, I searched in vain for the Scarlet Tanager at the Reserve. But May 12, 1948, Sutton and Staebler saw a male tanager in Kelly Woods, just outside the Reserve fence. May 13, 1948, Camburn saw a male Scarlet Tanager in Big Woods and the following day he saw two males and a female in Big Woods. It should be noted that Camburn's female tanager was observed two days after the first male which was observed by Sutton and Staebler.

I lived at the Reserve the spring of 1949, and was able to watch daily for the Scarlet Tanager in late April and early May. I saw the first male tanager May 5, in Big Woods, and May 6, I saw two male tanagers in Big Woods and at least two in Southwest

Woods. My first observation of a female Scarlet Tanager was May 8, in Southwest Woods, three days after I had seen my first male.

Departure from Michigan. The majority of the Scarlet Tanagers depart from Michigan by mid-September (Swales, 1904: 37). Swales had not seen the Scarlet Tanager in Michigan later than October 2. Oberholser (1918:17) gave the average date of the last observed Scarlet Tanager at Detroit as October 3. Exceptionally late October dates for the Scarlet Tanager have been made by Taverner and Swales (1908:79) at Point Pelee where they collected three specimens October 14, 1906, and by Magee (1926:163) who trapped a female and observed a male nearby, at Sault Ste. Marie, October 21, 1923. Late dates given by Wood and Tinker (1934:50) are October 3, 1907, and October 8, 1922.

There is only little information concerning the Scarlet Tanager's fall arrival and departure from the southern states, and I have not found information on the time of arrival at its winter quarters. Apparently the Scarlet Tanager reaches the southern states from late September to mid-October and it has been seen there even later (Howell, 1932:435; Kopman, 1915:183; Scott, 1889:324; Weston, 1941:568).

Migration Route. Figure 3 shows the approximate boundaries of the Scarlet Tanager migration route from its winter to its summer quarters. Cooke (1915:25) states that the widest portion of the Scarlet Tanager's breeding range extends 1,900 miles from New Brunswick to Saskatchewan, and that the migration route narrows southward to an 800-mile belt from eastern Texas

to the Florida peninsula. These boundaries become even more constricted in Central America, where the route is approximately 100 miles wide. Hellmayr (13, 1936:287) states that the migration route of the Scarlet Tanager is "chiefly along the east coast of Central America." Bond (1936:377) makes clear the fact that the species is of "very rare occurrence in the West Indies on migration, except in Cuba." According to Cooke (1905:11) the Scarlet Tanager passes from North to Central America through a narrow belt between Central Cuba and Yucatan.

Method of migration. The Scarlet Tanager migrates by night (Audubon, 4, 1838:389; Cooke, 1915:5; and Dutcher, 1906: 148). It probably migrates in company with other passerine birds (Peterson, 1948:165). Lowery (1945:102) found 27 dead Scarlet Tanagers at Baton Rouge the morning of April 21, 1933. He believes that these tanagers died in a thunder and hail storm the preceding night. The storm occurred about two hours after sunset (1945:106) and this is excellent evidence that a considerable number of Scarlet Tanagers, at least 27, were migrating by night.

Lowery (1945:102) believes that the Scarlet Tanager is a trans-Gulf migrant and that the northward migrating tanagers, in clear weather, proceed well inland before coming down. However, if they meet unfavorable weather as they approach land, they come down near the coast.

Susceptibility of migrating Scarlet Tanagers to cold. Apparently the Scarlet Tanager is susceptible to sudden drops of temperature and large numbers may die (Audubon, 4, 1838:389;

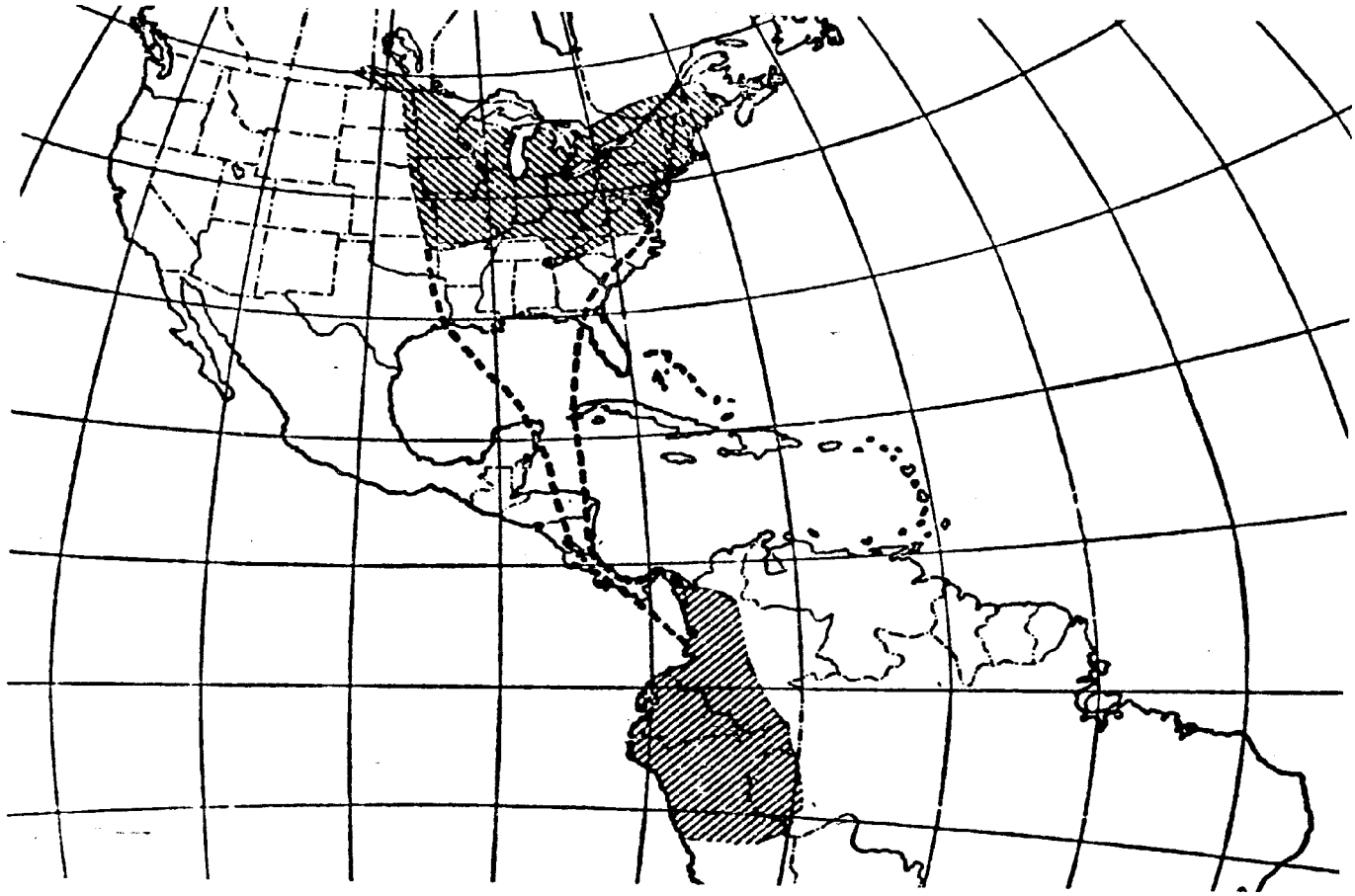


Fig. 3. The breeding range, winter route, and migration route of the Scarlet Tanager. (Cooke, 1915:32)

Baird, Brewer, Ridgway, 1, 1905:437). Hancock (1888:433) found a male Scarlet Tanager in a helpless condition in Chicago, May 12, after a night of abnormally low temperature.

Weight and fat of Scarlet Tanagers. In view of Wolfson's recent work (1945:95-127) on the role of fat deposition in relation to migration, I believe it is of value to call attention to the weights and fat condition of the Scarlet Tanagers given in Tables 1 and 2 (see Chapter II). As shown in Chapter I, adult Scarlet Tanagers lose weight during the nesting season. September tanagers, on the other hand, show an increase in weight, correlated with fat deposition, prior to migration. Tordoff's immature male taken September 22, 1949, was "extremely fat" and weighed 42.8 grams. As far as I know this is the heaviest recorded Scarlet Tanager weight, and presumably the bird was taken just prior to the time it would have migrated.

Some of the Scarlet Tanagers taken in May (see Tables 1 and 2) were described as being "somewhat fat", "rather fat", "fat", or "very fat". This is difficult to understand, for I would expect the tanagers to have little or no fat upon completion of their spring migration. Samuel A. Arny (letter) informs me that Scarlet Tanagers taken at Baton Rouge, Louisiana, seldom show any fat in the spring, but that they are "exceedingly fat" in the fall. It is possible that the May tanagers described as fat may not have used all their stored energy during migration, or they may have been collected several days after their arrival and had time to feed and build up fat. It is also possible that the collectors have used different standards of comparison in

describing the fat condition of their tanagers. Let us take the weight and fat condition of the May females in Table 2 as an example: Graber's female weighed 29.5 grams and was described as being "not fat"; Peet's female weighed 30.1 grams and was "very fat"; Gloyd's female weighed 30.2 grams and was "moderately fat"; and Olsen's female weighed 32.8 grams and had a "little fat". It is difficult for me to believe that such a wide range of fat condition could exist among birds so similar in weight. Assuming that increases in weight of the adult Scarlet Tanager are the result of increases in fat deposition, it appears to me that the recorded weights are more significant in describing the fat condition than are the words which have been used. There can be no doubt that Tordoff's male was "extremely fat" for it weighed 42.8 grams. But what of Case's male that weighed 30.9 grams and was described as being "very fat"? Estimates of fat condition may be misleading unless they are further substantiated by weights.

It would be of interest to know the weights of Scarlet Tanagers on their wintering grounds, and their weights and fat conditions there prior to, and after, migration. It would also be of interest to learn the weights and fat condition of the Scarlet Tanager when it reaches the southern states. Additional August and September data would undoubtedly give a clearer picture of the fat condition and weight of the Scarlet Tanager prior to migration.

SUMMARY

1. The Scarlet Tanager breeds in eastern North America from southern Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia south to Kansas, northern Arkansas, Alabama, Georgia, and the mountains of Virginia and South Carolina.

2. The Scarlet Tanager's breeding range is correlated with the deciduous forest biome and the sub-Canadian ecotone of coniferous and deciduous forests.

3. The Scarlet Tanager nests at high altitudes in deciduous forest or in a mixture of coniferous and deciduous forests.

4. Griscom has shown that the population of Scarlet Tanagers in the Concord region declined as the old deciduous woods were cut away. Its occurrence in white pines may be due to the rapid increase of this tree as the deciduous woods were cut away.

5. The Scarlet Tanager winters in northwestern South America.

6. It is not known when the Scarlet Tanager migrates northward from its winter quarters, but some individuals may leave in early March, and most of them may leave in late March or early April.

7. Northward-migrating Scarlet Tanagers arrive in the southern states in mid-April.

8. The Scarlet Tanager nesting population reaches the Ann Arbor area in mid-May (sometimes earlier).

9. The Scarlet Tanager leaves Michigan in mid-September (sometimes later).

10. Southward-migrating Scarlet Tanagers reach the southern states from late September to mid-October. It is not known when the Scarlet Tanager reaches its winter quarters.

11. The migration route of the Scarlet Tanager passes south between Central Cuba and Yucatan, and along the east coast of Central America.

12. The Scarlet Tanager migrates by night and probably in company with other passerine birds.

13. The Scarlet Tanager is susceptible to cold and many may die if there is a sudden drop in temperature.

14. A discussion of the weight and fat condition of the Scarlet Tanager in relation to its migration is given. It is suggested that weights, rather than a word description, may give a more reliable estimate of the Scarlet Tanager's fat condition. Some tanagers possess a little fat when they arrive in Michigan, and some have been described as being "fat" and "very fat" but it is not known if this is less fat than they had before they began their migration.

CHAPTER III

TERRITORY ESTABLISHMENT AND COURTSHIP BY THE MALE SCARLET TANAGER

Establishment of territory. As stated in the preceding chapter, the male Scarlet Tanager arrives on the Reserve before the female. Each male settles in an area of woods shortly after his arrival and advertises his claim to that area by almost constant singing from conspicuous perches, high in the crown of mature trees. Goss (1891:498) noticed this early tendency of the males to sing loudly from the "topmost branches" of the trees.

Not infrequently two males settle in adjacent sections of the woods. They alternate loud, clear songs, and each often seems to peer in the direction of the other. Soon one of the males, sometimes both, will close the distance between them and they then alternately sing loud, hurried songs. Then one of the males becomes the aggressor, assuming the threat-display attitude with wings held slightly out from the body, wing tips below the tail, and with the tail slightly elevated. He calls "chip" and "chip-churr" several times and then flies toward the other male, driving him away. Often both males exchange call notes and fly at each other. In such areas of territorial strife, the loudly singing males frequently interpose sharp

call notes between their songs.

Many of these encounters take place before the female arrives and consequently the tanager territories are well established by the time she arrives, although a male may accompany a newly arrived female beyond his territorial boundaries. For this reason the Scarlet Tanager territorial boundaries must not be thought of as invisible lines which males will not cross. The boundaries are more strictly adhered to later in the nesting cycle (see Territory Defense), but even then a Scarlet Tanager male may occasionally enter another tanager territory.

The behavior of the male Scarlet Tanager during territorial establishment agrees with the five part procedure described by Nice (1937:57) for the Song Sparrow (Melospiza melodia). In "assuming the role" the male tanager uses the display posture; in "staking out the claim" he sings from high exposed perches; the "chase" and the "fight" also occur and Nice's fifth part, "the proclamation of ownership...", is evidenced by subsequent singing and territorial defense against other male tanagers.

Behavior of newly arrived female. When the migrating female Scarlet Tanager reaches the Reserve she is undoubtedly attracted to a particular woods area by hearing the loudly singing male. His presence on the high conspicuous perch also serves to attract her.

The newly arrived female is quiet and appears to spend much time feeding. She flies from perch to perch in the woods

and does not recognize territorial boundaries. She may be perched near one male tanager and suddenly fly to another male in an adjacent territory. Possibly this may be in response to the song of a nearby male, or in response to seeing a male tanager in an adjacent territory. I observed this behavior of female No. 14 approximately a week after her arrival, when an unmated male tanager sang and flew to conspicuous perches near territory No. 14. Her nest was partially constructed but she temporarily left male No. 14 and flew to the unmated male. Returning a few minutes later she copulated with male No. 14 and resumed her nest building activity. At that time male No. 14 accompanied her, leaving his territory, and chased the other male from the tree in which the female had perched (tree not in territory No. 14). However male No. 14 then returned to his territory and sang loud songs while his female remained with the other male.

Male behavior when the female arrives. When the female Scarlet Tanager arrives there is a marked difference in the male tanager's behavior. Formerly he sang from high perches, alternating songs with other males, etc., and at such times the Scarlet Tanager seemed to be the dominant bird in the woods. The day that I entered the woods to continue observations of territory establishment and could not see nor hear a male for some time, I knew that the female had arrived. One day the Scarlet Tanager seemed to be the dominant bird, and the next day it appeared that it had left.

With the arrival of the female the male Scarlet Tanager

abandons his high perches for lower ones and only rarely in the nesting season that follows does he again sing from such high perches. Goss (1891:498) also noticed this changed behavior by the male Scarlet Tanager. The male accompanies the female tanager as she feeds. He rarely sings when near her and when he does sing his songs are soft, short, and sung from the lower tree branches. Occasionally the male and female tanagers exchange very soft high pitched calls which sound to me like "sweeeeeee, sweeeeeee, sweeeeeeet". The "eee" ending appears to rise, while the "eet" ending drops slightly.

If the female tanager leaves the male's territory he may try to drive her back, or by displaying, attempt to attract her back, but failing in this he may accompany her into the neighboring territory until challenged and chased back by the second male tanager.

Courtship. In courtship behavior the male Scarlet Tanager neither calls nor sings but flies to many perches six inches to four feet from the ground and occasionally as high as ten feet. Usually these lower perches are dead sticks and fallen branches projecting from the forest floor. Twice I saw a male descend to the ground and walk or hop about for 10 seconds.

The female confines herself to a higher level in the trees, 20 to 30 feet, and I often saw her at that height in a tree directly above, or slightly to one side of, the male. If the male makes a flight of any considerable distance, the female flies after him immediately, but always 20 to 30 feet higher, and she alights above him at that height. Often the male flies

from low perch to low perch in a large semi-circle which seems to follow the natural contour of cleared areas, and the female, staying higher in the trees, follows him. Often she alights above the male's perch just as he flies to another perch. She definitely follows the course outlined by the male, but at a higher level in the trees.

Once I observed courtship behavior involving one male and two female Scarlet Tanagers. The male was perched on a bare branch projecting from the ground at a height of three feet, when a female flew to an oak sapling near the male. She lit on a bare branch 20 feet above the ground. Suddenly the male crouched low to the branch, with his black wings held slightly away from the body and the tips well below the tail, which was held rigid and high. He seemed to point slightly to the left of the female. Another female then appeared, and perched at a height of 10 feet in a tree adjacent to the first female. The male continued this display posture pointing alternately at the females. Then both of the females flew to the same perch, eight inches high and three feet from the male. He continued his display as before, pointing steadily in the direction of the females. After approximately 40 seconds both females flew up into an oak tree and perched at a height of 15 feet. The females did not appear to be hostile toward each other. The male then flew up to the same branch and lit about three feet from the nearest female. He did not display nor did he appear antagonistic toward either of the females. A minute later one of the females left, flying a hurried "zig-zag" flight. She

was harried closely by the male, who in turn was followed by the second female tanager.

One reason this observation is of interest is that the females came so close to the displaying male. Perhaps this was the result of two females, rather than one, being attracted to the male.

Courtship display. The male Scarlet Tanager's black wings when carried normally almost obscure the scarlet back, but when held slightly away from the body and pointed below the tail, a relatively large and brilliant scarlet rectangular patch is exposed. This rectangular patch is sharply defined on the sides by the black wings, and terminates abruptly at the black tail. When the head and neck are held rigid and straight out from the body an even longer rectangular patch results. Repeated observations of the female above the male, peering down, and flying immediately after the moving male, suggest to me that she is attracted by some behavior of the male and I attribute this to the display of the rectangular scarlet patch. The use of low display perches by the male Scarlet Tanager affords the female the best possible view of the rectangular scarlet patch.

Courtship display and threat display. These two kinds of display appear essentially the same, with wings held out from the body and wing tips below the tail. In threat display the tail is held higher and dips noticeably as the "chip" and "chip-churr" call is given; hurried songs may also be used. Courtship display is used by the male to attract the female, whereas both sexes use the threat display in protest against



Fig. 4. Southwest Woods in Spring, Territory No. 13. (photo. by J. Speed Rogers)



Fig. 5. Southwest Woods in Spring. Territory No. 1. (photo. by J. Speed Rogers)

the presence of other tanagers or certain other animal species (see Chapter XI).

Role of spring foliage. Roberts (1920:238) mentioned that the Scarlet Tanager arrived just as the oak trees were coming into bloom. At the Reserve many of the trees are in the bud stage and many of the leaves are just beginning to break forth when the Scarlet Tanager arrives (see Figures 4, 5, and 6).

At this stage the deciduous woods are well lighted and have a bare open appearance with excellent visibility. Because of this, rival males are better able to keep track of each other than if the woods were heavily foliaged and I believe that territory establishment is thus facilitated. In addition the courtship display of the male may be more easily seen by the female.

SUMMARY

1. Shortly after his arrival the male Scarlet Tanager advertises his claim to a section of the woods by almost constant singing from conspicuous perches high in the crown of mature trees.

2. Recently arrived male Scarlet Tanagers in adjacent woods areas alternate songs and engage in territorial disputes. Their territories are well established when the female tanagers arrive. A male may, however, accompany a newly arrived female beyond his territorial boundaries.

3. The newly arrived female presumably is attracted to a

particular woods by the loud-singing and conspicuous male.

4. The newly arrived female spends much time feeding and flying from perch to perch in the woods. She may not confine these flights to one male's territory.

5. The behavior of the male changes markedly when the female arrives. He abandons his high singing perches, sings less often and less loudly, and perches lower in the trees.

6. During courtship the male is quiet. From very low perches he displays his head, neck, and back plumage as a scarlet rectangular patch. The female flies from tree to tree peering down, through the leafless branches, at the displaying male.

7. Scarlet Tanager courtship display and threat display appear to be essentially the same, although call notes and songs are used with the latter. Courtship display is used by the male to attract the female, while threat display is used by both sexes against other tanagers and other animal species.

8. Good visibility in the budding woodland facilitates territorial establishment and courtship by the Scarlet Tanager.

CHAPTER IV

THE SCARLET TANAGER NEST

A. Nest Building

Choice of site. The female Scarlet Tanager undoubtedly chooses the nest site. But she is influenced in one, possibly in two, ways by the male. First, she is definitely attracted to a woods area, with suitable nesting sites, by the singing and displaying male (See Chapter III). In addition, she may select a site within the open area outlined by the male during courtship display. This latter hypothesis has not been demonstrated and it would be interesting if field workers who observe Scarlet Tanager courtship display could later locate the tanager nest and correlate it with the display area.

Sex building the nest. My observations indicate that the female constructs the nest without any aid from the male. This is substantiated by the observations of Campbell (1940:161), Christy (1931:44), Darnton (1934:6), Hales (1896:261), and Sutton (Todd, 1940:593). Roberts (2, 1936:332), however, suggests that the male Scarlet Tanager may help a little.

Sutton (op. cit.) states that nest building starts promptly after courtship and mating are completed. My observations indicate that the female Scarlet Tanager begins nest construction within a week after her arrival to the tanager territory.

Time spent building. According to Sutton (op. cit.) the Scarlet Tanager nest is built in a remarkably short time and frequently in little more than a day. Roberts (op. cit.) described Scarlet Tanager nest building as requiring only a few hours, and in the case of one nest that he watched being built it took "about eight hours of leisurely work". However, Harlow (1914:89) watched a female Scarlet Tanager begin building a nest the morning of July 21, and he judged it to be completed July 27, although the first egg was laid July 29. Harlow's female tanager took at least seven days to build her nest.

My observations of nest building indicate that more than one day is required to construct the nest. A few observations of female No. 6 indicated that she took at least two days and probably more, to build her nest during the third week of May, 1948. Female No. 14 took at least four days to construct her nest in mid-May, 1949. Nest No. 13 was at least a third completed when I observed the female working on it May 10, 1949, and she was still working on this nest May 14. She laid her first egg the morning of May 16 and it is possible that she also worked on the nest May 15. Therefore, female No. 13 took at least six days to construct her nest.

These observations of nest building activity were from early morning (approximately 07:00) until about 10:30. I do not know whether these females continued nest building activity during the rest of the day, but they slowed down noticeably by mid-morning and I did not observe the females return to the

nest during continued morning observations after 10:30. The female Song Sparrow (Nice, 1943:210) builds her nest during early morning, and it is usually "pretty well completed" in two days and lined on the third and possibly the fourth day. The female Oven-bird (Hann, 1937:168) constructed her nest chiefly in the forenoon, building the main nest body in approximately two days but the lining was added leisurely after that.

It is possible that Scarlet Tanager nests built later in the season, after previous unsuccessful nesting attempts, may be constructed in fewer days than my early May observations indicate. Perhaps the observations of Sutton and Roberts (above) were made at later nests; if so, this might explain the discrepancy between our estimates.

Gathering of nest material. Female Scarlet Tanagers utilize the fallen branches and other low perches on the forest floor when they search for nest material (see Figure 7). They fly from the lower tree perches to these fallen branches and then to the forest floor. While most of the material is gathered from the ground, occasionally females attempt to break off twigs from these fallen branches and on two occasions I saw female No. 6 try, unsuccessfully, to break a twig off a tree branch at a height of 30 feet. Once after female No. 13 tried unsuccessfully to break twigs loose from a tree branch she flew to the ground, collected some grass stems, and flew with them to her nest.

Nest material usually is collected in the immediate vicinity of the nest tree, but I have seen females flying as far as 150



Fig. 6. Southwest Woods in Spring. Territory No. 2. (photo. by J. Speed Rogers)



Fig. 7. Low Perches in Territory No. 13, Southwest Woods. (photo. by J. Speed Rogers)

feet from the nest in gathering material. In returning with nest material, the females fly directly back to the nest tree and occasionally directly to the nest.

I observed female No. 13 tugging at dead grass stems which were still firmly rooted to the ground. She stood on the ground stretching her head and neck upward to grasp the grass near its tip, then she either tried to fly away with it or tugged and beat her wings in an attempt to break it loose. Occasionally she succeeded in pulling it loose. Usually the female Scarlet Tanager collects nest material from the forest floor. She appears to exercise care in the choice of these items for she often drops material after she has carried it for a few seconds and selects other pieces. Occasionally she picks up and rejects several grass stems in rapid succession before keeping one. Grass stems, which she selects, vary in length from four to ten inches.

Occasionally the male accompanies the female on these collecting trips but I have never observed a male to gather nest material or help in any way with nest building. He often flies with the female toward the nest but always stops well short of the nest tree, or flies around it.

Nest construction. When the female arrives at the partially completed nest, she does not try to work with the material which she has just brought, but drops it on, or in, the nest. Then the new material becomes part of the uncompleted nest, all of which needs attention. She hops on, or into, the nest and compresses the material and moulds it into shape by

forcing her body against the sides and bottom. She seems to force her breast tightly against the sides and by pushing with her legs she apparently exerts considerable force against the frail, partially completed nest. By forcing her body and breast against the sides from various angles she gives the nest its rounded shape.

After she has moulded the nest she remains in the nest and works with the loose ends of the material which protrude from the nest in many directions. She grasps them near the free distal end, and bends them back over the nest rim, and pushes them into the nest side. She spends much of her time working the loose pieces into the nest. When she works on the inner nest bottom, her head and upper breast disappear below the nest rim and her tail points obliquely up into the air, with the bright yellow undertail coverts conspicuous against the green leaves.

The female does not spend long periods working at the nest (see Figures 8 and 9). The longest working period which I have observed was two and a half minutes. But almost every trip to the nest is followed by a brief period, from .25 to 2.5 minutes, during which she moulds the nest and works with the loose ends. The female ordinarily spends most of her time in the morning feeding. But when she is occupied with nest building, during periods of an hour or more, she works industriously and makes a considerable number of trips to the nest with material. May 23, female No. 6 made one trip to the nest with material, and worked on the nest every 2.1 minutes. Female No. 13 made one trip

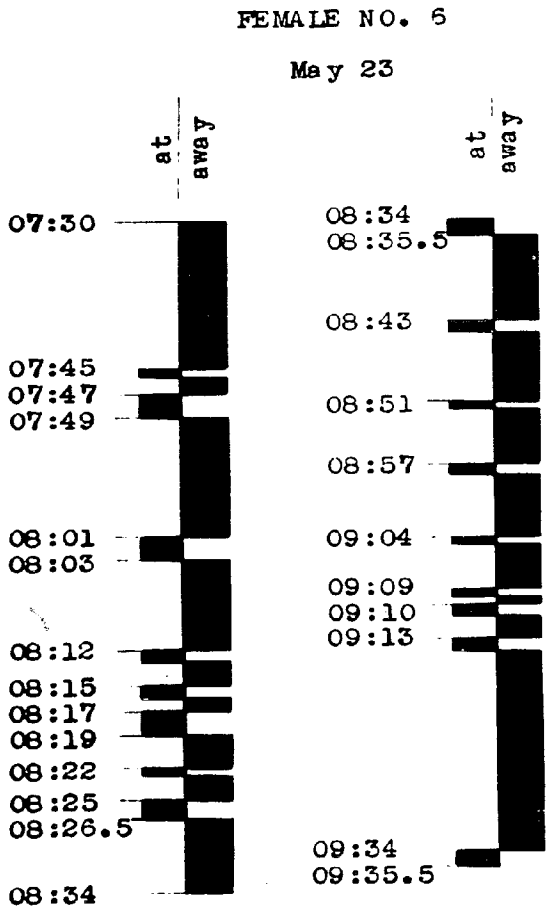


Fig. 8. Nest building activity of female Scarlet Tanager No. 6. Blocks to the left of the center line indicate length of work periods on the nest, and blocks to the right indicate intervals between work periods. (Nest about half completed)

FEMALE NO. 13.

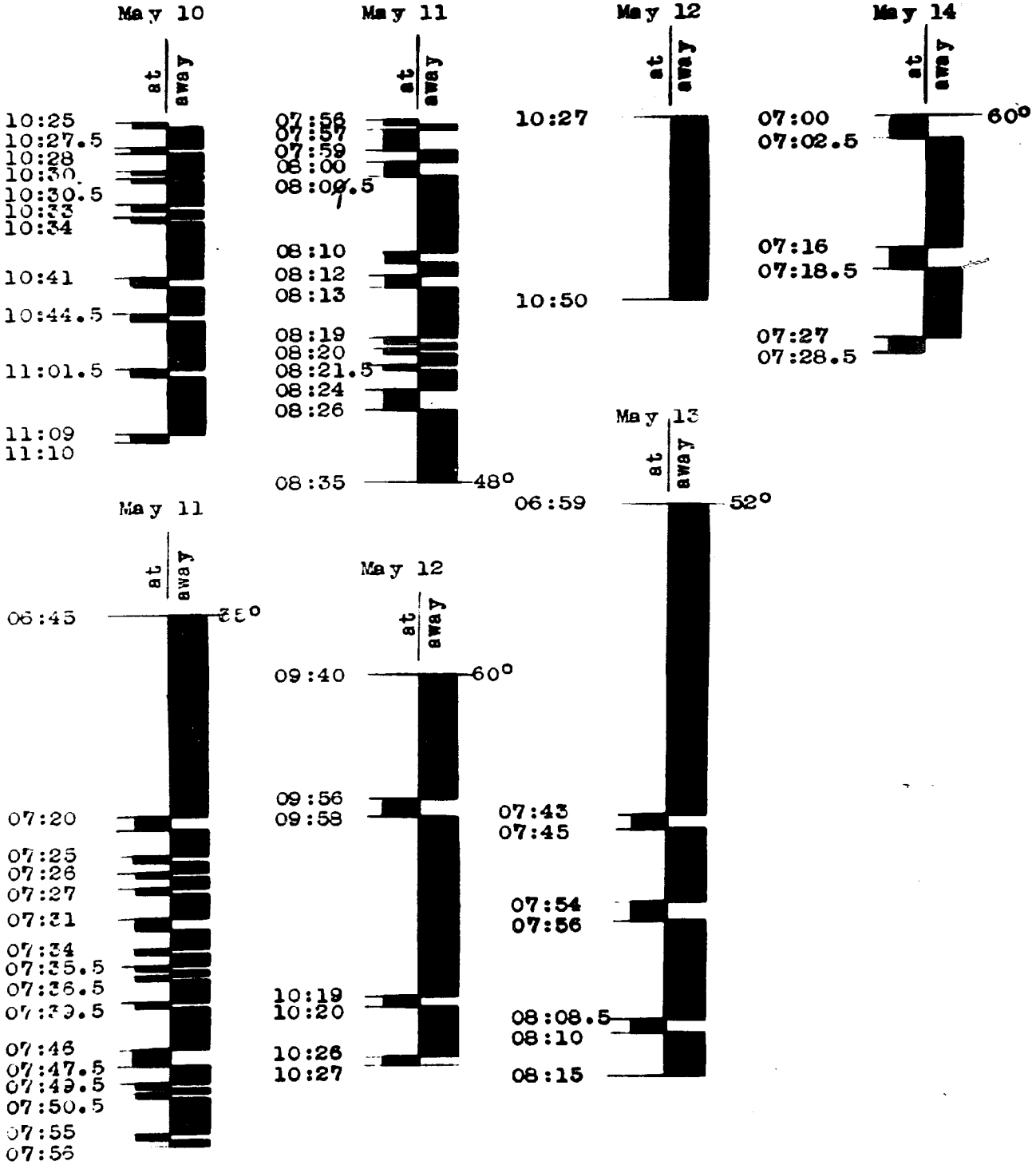


Fig. 9. Nest building activity of female Scarlet Tanager No. 13. Nest less than half completed May 10. The first egg laid May 16.

every 4.4 minutes May 10, every 2.6 minutes May 11, every 10.0 minutes May 12, and she made one trip every 2.7 minutes May 13. If such a rate of work was continued throughout the day, it does seem possible that the female Scarlet Tanager could construct a nest in a day's time as indicated by Roberts and Sutton (above).

Table 4 gives the length, and average length, of nest-working periods for two female Scarlet Tanagers. The data for female No. 13 shows that the average working period lengthens as the nest nears completion. This is correlated with the fact that trips the first few days are mainly utilized in bringing material to the nest site. However <u>every</u> trip, which I have observed, was followed by a brief working period. As the nest nears completion there are fewer trips to the nest with material, and the trips are followed by longer working periods.

TABLE 4

NUMBER, AND LENGTH OF, NEST-WORKING PERIODS OF TWO FEMALE SCARLET TANAGERS

Female: Date	Length of Periods (min.) 1/4	1/2	1	1 1/2	2	2 1/2	Average
Female No. 10							
May 23	1	4	6	3	3	0	1.103
Female No. 13							
May 10	3	3	4	0	0	0	.625
May 11	0	14	3	3	2	0	.841
May 12	0	0	2	0	1	0	1.333
May 13	0	0	0	2	2	2	2.000

Songs and other sounds during nest building. The male resumes singing during nest building. His songs are loud and strong and sung from low to medium high perches in his territory. Female No. 6 uttered three short songs, with her bill closed, when she was perched on a fallen branch and looking for nest material. Occasionally when she flew toward her nest, with nest material in her bill, she gave short, soft, whistle-like calls (the pitch rising at the end). When female No. 13 was looking for nest material, and perched on a fallen branch, she also gave a similar call.

B. Nest Site

Site requirements. There are four characteristics of the nest site which almost all Scarlet Tanager nests have in common. Nests are placed (1) in a leaf cluster, or at least with several leaves shading the nest, (2) on a nearly horizontal branch, with (3) a clear unobstructed view to the ground below, and (4) there are clear open flyways from adjacent trees to the nest. All but one of my 20 nests exhibited these four factors. The exception was nest No. 17 which was placed in a thick cluster of leaves in the crown of a white oak sapling. However, there were clear open flyways down to this nest from the high mature trees which surrounded it. Only one of Sutton's 13 nests, No. 30, was placed in a sapling crown. He informs me that, in general, his nests also had the four site requirements but that his tamarack nests had fewer leaves at the nest site. However, the tamarack nests were definitely well shaded, deriving some of



Fig. 10. Nest Tree No. 2 (hickory to right of center), Southwest Woods. (photo by J. Speed Rogers)



Fig. 11. Sapling Nest Site, Territory No. 13, Southwest Woods. (photo. by J. Speed Rogers)

their shade from nearby broadleaved trees.

The nearly horizontal branch may be a descending or ascending branch. Characteristically it is one of the main secondary tree branches. The hickory tree to the right of center in Figure 10 (nest tree No. 2) shows a typical Scarlet Tanager nest site. The leaf clump near the end of the slightly descending branch at the right of the hickory, with a clear space to the ground below, and the clear flyways to the leaf clump from the surrounding trees, illustrate the four site requirements for the Scarlet Tanager nest. The trunk or terminal branch of a sapling bent sharply to one side may serve as a horizontal branch. If the other three site requirements are also met the sapling may serve satisfactorily for the site of a Scarlet Tanager nest. Figure 11 shows such a sapling in territory No. 13.

Concealment. In general the nest is not well concealed except when it is placed in a very dense leaf cluster. Of my 20 nests I considered six to be well concealed, nine to be poorly concealed, and the remaining five I considered to be but fairly well concealed.

Site on the branch. The nest is rarely placed next to the trunk or at the extreme tip of the nest branch (see Tables 5 and 6). The average distance from the trunk for 19 of my nests was approximately 9.5 feet, and the average distance from the tip of the branch was approximately 6.5 feet. The average distance from the trunk for 12 of Sutton's nests was slightly more than 8.5 feet (see Table 6). In 14 of my nests the nest

was farther from the trunk than from the tip of the nest branch. These data show that the nest site is usually well out from the trunk and usually more than half of the branch's length.

The nest is built at the junction of two or more smaller branches with the main horizontal branch. Occasionally a leaf petiole or very small branch may serve as a point of attachment for the nest. These smaller branches (see Figures 12 and 13) may serve a dual purpose. Some of the nest material may be woven around the smaller branch (this is especially so when a leaf petiole grows directly from the horizontal branch), which serves to anchor the nest, and the branch junctions may serve as a support cradle for the nest. Usually these smaller branches have many leaves growing near their base which serves to conceal and shade the nest.

Nest height. Table 5 gives the actual or estimated height of my 20 nests. I determined the actual heights of 14 nests by dropping a weighted line from the nest branch to the ground. The line had a knot tied at every inch, and pieces of differently colored cloth marked the foot divisions of the line. In this way I was able to determine the height of these 14 nests to the nearest inch. Their average height was 31.3 feet. The other six nests were inaccessible to me and I estimated their height. The average height of these six nests was 41.7 feet. The average estimated height of Sutton's 13 nests (see Table 6) was 19.9 feet.

Table 7 gives the estimated (?) height, nest tree, and authority for 33 nests which I have found in the literature.



Fig. 12. Scarlet Tanager nest No. 1, with four eggs (one Cowbird).



Fig. 13. Scarlet Tanager nest No. 1. Note that it is placed on a horizontal branch, at a junction of smaller branches, and that there are several leaves at the nest site.

TABLE 5

NEST SITE DATA FOR 20 SCARLET TANAGER NESTS, 1947-1949

Nest No.	Nest Tree	DBH	Nest Height		Nest Branch	Feet from		Feet from	
			Meas.	Est.		Trunk	Tip	Road	Path
1	White Oak	15"	28'3"		horizontal	4'2"	5'	163'	
2	Hickory	16"	53'7"		descending	8'	2'	over	
3	White Oak	18"	21'1"		horizontal	9'	6'	18'	
4	" "	7"		35'	"	6'	3'	130'	
5	Wild Cherry	1"	5'1"		"	7'	3'	125'	
6	Black Oak	14"	33'		"	13'	3'	21'	
7	" "	19"	28'6"		"	10'	2'	over	
8	Crataegus	3"	12'		"	7'	3'	110'	
9	Black Oak	21"		45'	vertical	15'	10'	210'	over
10	" "	9"	32'		slt. ascend.	8'	10'	340'	over
11	White Oak	9"	33'6"		ascending	8'	12'	261'	over
12	" "	15"	22'4"		horizontal	14'	3'	27'	
13	" "	6"	10'4"		slt. ascend.	6'	4'	54'	11'
14	" "	14"		60'	ascending	18'	10'	33'	
15	Black Oak	11"	41'11"		ascending	6'	15'	35'	
16	White Oak	11"	40' 2"		slt. ascend.	9'	12'	35'	
17	" "	2½"	14' 3"		terminal crown	0	0	70'	
18	Black Oak	5"		30'	ascending	3'	2'	over	
19	" "	18"		45'	ascending	20'	8'	25'	
20	White Oak	15"		35'	descending	10'	15'	350'	30'

TABLE 6

NEST SITE DATA FOR 13 SCARLET TANAGER
NESTS FOUND BY SUTTON, 1942 and 1946

Nest No.	Nest Tree	DBH	Estimated Nest Height	Nest Branch	Feet From Trunk	Ground Under Nest	
						Wet	Dry
21	Tamarack	13"	20'	horizontal	10'	x	
22	"	10"	15'	"	6'	x	
23	White Oak	-	18'	"	7'		x
24	Red Oak	12"	25'	ascending	15'		x
25	Tamarack	5"	17'	-	2'6"	x	
26	"	-	30'	horizontal	9'	x	
27	"	16"	35'	"	9'	x	
28	"	8"	11'	descending	6'	x	
29	White Oak	16"	28'	-	10'		x
30	Red Cedar	-	8'6"	crown	0		x
31	White Oak	-	15'	horizontal	12'		x
32	Black Oak	-	25'	sloping	8'		x
33	Red Maple	3½"	11'	horizontal	10'		x

TABLE 7

HEIGHTS (ESTIMATED) OF 33 SCARLET TANAGER NESTS IN THE LITERATURE

Authority	Nest Height	Tree
Barnes (1914:60)	7'	Oak
Burleigh (1911:180)	75'	Chestnut
" (1923:96)	15'	---
" (1923:96-97)	15'	Beech
" (1927:231)	45'	Black Gum
" (1932:82)	6'	---
Christy (1931:44)	50'	Slippery Elm
Darlington (1914:89)	21'	Black Oak
" (1914:89)	15'	Oak
Hales (1896:261)	10'	Norway Spruce
Harlow (1914:89)	18'	Yellow Birch
Harrower (1910:29)	40'	Hemlock
Leister (1920:205)	12'	---
" (1920:204)	35'	Elm
" (1920:204)	25'	Hemlock
Miller (1926:149)	6'	Dogwood
" (1926:149)	7'	Ironwood
Mulliken (1899:18)	40'	Hemlock
Norris (1892:21)	25'	White Oak
" (1892:22)	12'	Apple
" (1892:22)	9'	"
" (1892:22)	20'	Beech
" (1892:22)	10'	Pine
" (1892:22)	20'	Dogwood
" (1892:22)	30'	Linden
" (1892:22)	20'	White Oak
" (1892:22)	25'	Hickory
" (1892:21)	15'	Oak
" (1892:21)	20'	Ironwood
" (1892:21)	15'	Oak
Price (1935:35)	15'	Birch
Reed (1904:278)	4'	Oak
Smithwick (1893:29)	25'	---

These nests range in height from 4 to 75 feet, with an average height of 21.1 feet.

I do not believe that height is a controlling factor in the choice of the nest site by the female Scarlet Tanager. The four site requirements which I have given may be found at a wide range of heights, and the height of the nest varies accordingly.

The nest tree. The estimated DBH (diameter of tree at breast height) of 28 Scarlet Tanager nest trees at the Reserve is given in Tables 5 and 6. The DBH of 19 of these nest trees was nine inches or greater, and nine of these were under nine inches. This shows that at least 68 per cent of the Reserve nests were placed in large trees.

Of the 33 Scarlet Tanager nests found at the Reserve, approximately 39 per cent were in white oaks, approximately 24 per cent in black oaks, and 18 per cent were placed in tamaracks (see Tables 5 and 6). Six of Sutton's nests were in tamarack trees. He informs me that these tamarack trees were near broad leafed deciduous trees which furnished additional shade for the nests. He has never found a nest in a tree group composed of only tamarack trees.

Role of woods roads. Many nests described in the literature have been on horizontal branches above woods roads. Here the birds have had a clear, unobstructed view below and about them. Such nests are, of course, more likely to be detected than are nests in a remote part of the woods. Three of my 20 nests (see Table 5) were placed over a woods road and three were placed over a path or deer runway. In addition, five of my nests were situated on branches close enough to the woods road,

or path, so that the open space above the road and path may have been a factor in the choice of the nest site (see Figures 14 and 15). I do not believe that the Scarlet Tanager shows a preference for roads or paths, as such, in selecting a nest site. I believe that these partially fulfill the nest site requirements, because they provide the requisite open space.

Unusual nest sites. There are reports in the literature of Scarlet Tanagers nesting in orchards and very close to dwellings, as well as in the built-up portion of Washington, D.C. (Oberholser, 1925:338). Lucas (1884:103) found several nests in apple trees and stated that he had never seen a nest in any other sort of tree. Vickers (1911:164) found a pair nesting in a pear tree near his "door-yard", and Burns (1937: 125) found the Scarlet Tanager a familiar sight for "several seasons", in the fruit trees about his home. Hales (1896:261) found a pair nesting at a height of 10 feet at a distance of 10 feet from his home.

Six of Sutton's nests (see Table 6) were placed over wet ground, which seems unusual to me. Yet Harlow (1914:89) found a Scarlet Tanager nest 18 feet above a trout stream. And Wheelock (1905:83) observed a nest in a tnagle of wild grape-vine at the foot of a bluff above Lake Michigan where the spray from the lake dashed over the nest with "every easterly gale".



Fig. 14. Woods road in Southwest Woods, north of junction near nest No. 3. (photo by J. Speed Rogers)

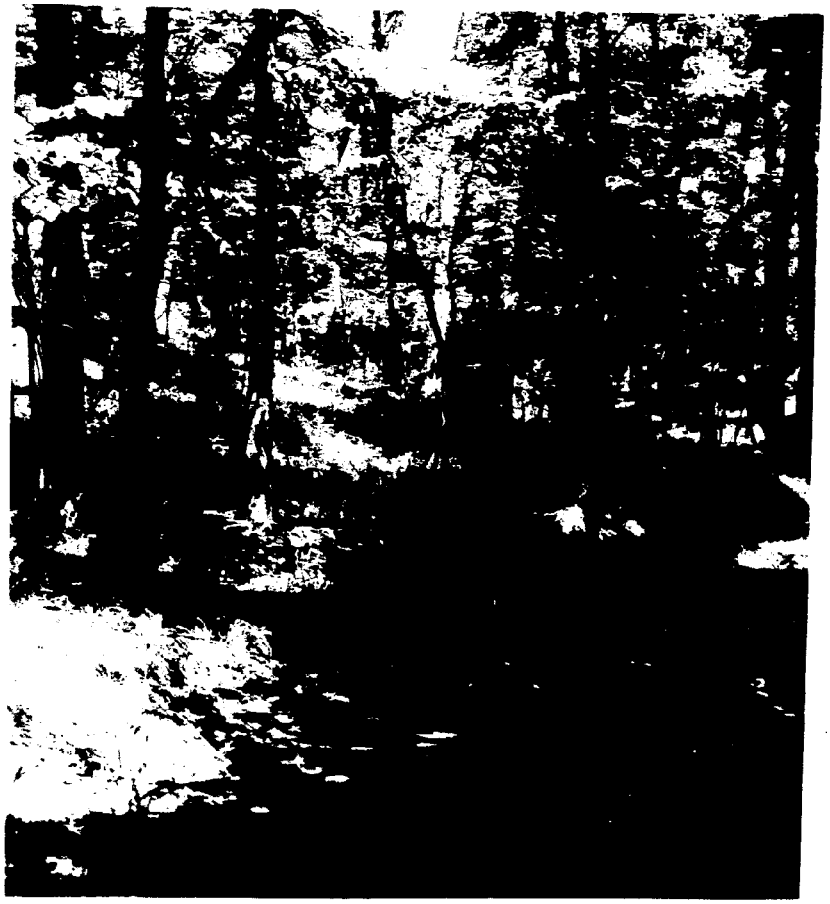


Fig. 15. Woods road in Southwest Woods, slightly north of nest No. 2. (photo. by J. Speed Rogers)

C. Location of Reserve Nests

Sutton and I have plotted the approximate position of our 33 Scarlet Tanager nests on an aerial photograph of the Reserve (see Figure 17). Figure 16 shows, in greater detail, the location of the nine nests studied in Southwest Woods.

It can be seen from Figure 16 that there are certain "favored" areas of Southwest Woods where the Scarlet Tanager nests. These areas are the most open sections of the woods. This is especially so in the southeast portion of the woods where a tanager nest was found each year of the study. The southwest portion of the area has many smaller trees crowded together and there are few suitable open areas for the Scarlet Tanager nest. This is also the case in the northeast portion, although here there are some large mature trees and an occasional open space. I have not found nests nor observed Scarlet Tanager pairs in either of these two areas and I believe that this is due to the scarcity of suitable nesting sites.

D. Nest Description

Nest materials. The Scarlet Tanager nest is mainly composed of grass, plant stems, and rootlets: Audubon (4, 1838:390), Forbush (1929:130), Roberts (1936:330), and Sutton (Todd, 1940:593). Hales (1896:262), Norris (1892:21-22), and Trautman (1940:395) list grasses and rootlets but not plant stems. Burleigh (1927:231) and Reed (1904:278) list rootlets and plant stems but not grass. There are many other references in the literature to the use of these three materials for the Scarlet Tanager nest body and nest lining.

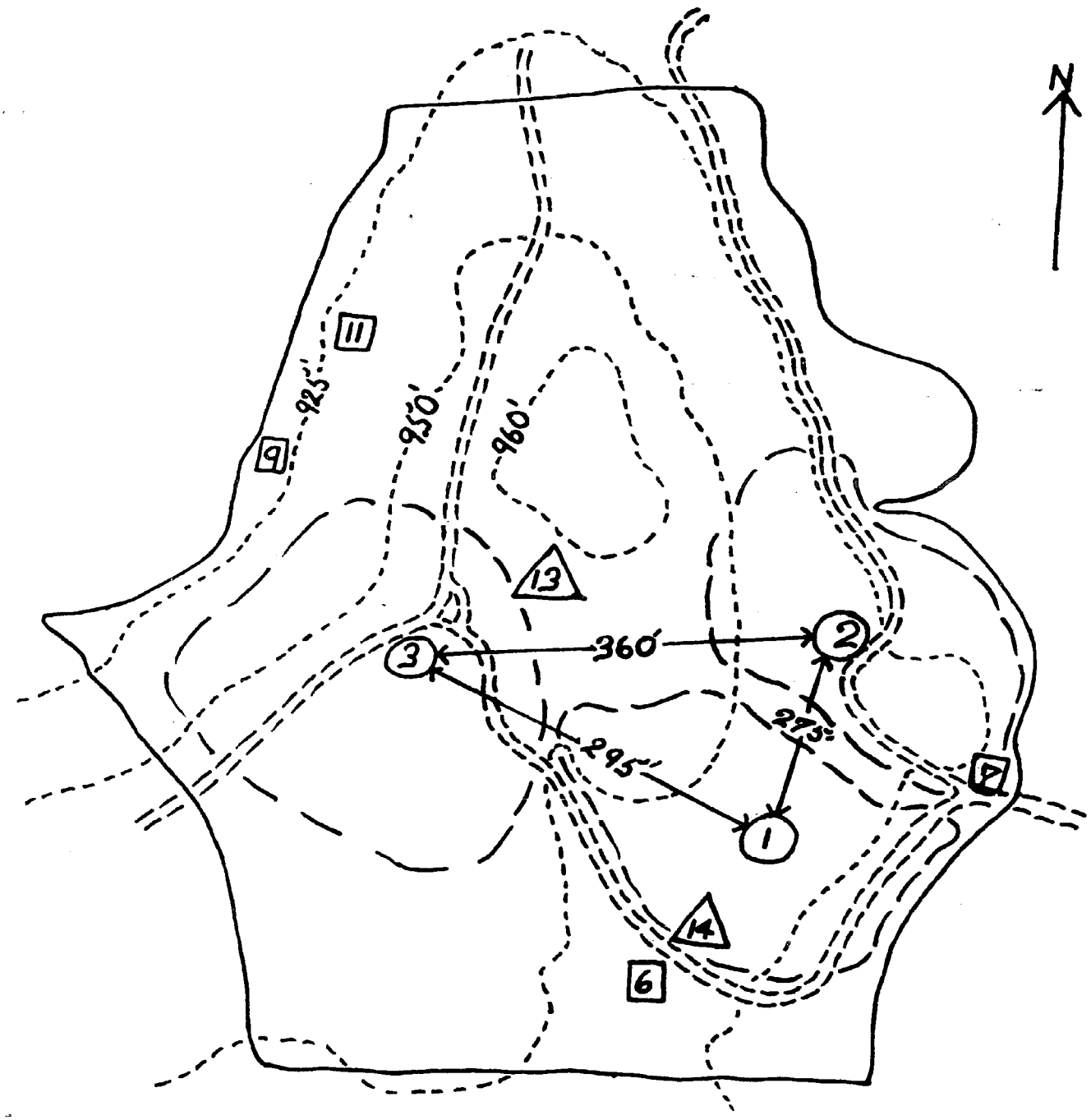


Fig. 16. Drawing of Southwest Woods Showing Locations of Nine Scarlet Tanager Nests.

(#) - 1947 tanager nests

[#] - 1948 tanager nests

△# - 1949 tanager nests

---------- - contour lines

= = = = = = - woods roads

— — — — — - approx. territories

⟷ - dist. between nests

Also there are many references to the use of twigs in the Scarlet Tanager nest body: Audubon (4, 1838:390), Davie (1898: 408), Forbush (1929:130), Norris (1892:21-22), Phillips (1893: 52), Reed (1904:278), Roberts (1936:330), and Trembly (1892:229).

Taverner (1934:378) lists leaves as a Scarlet Tanager nest material and Sutton (Todd, 1940:593) lists leaf stems. Bark is listed as a nest material by Davie (1898:408) and Forbush (1929:130). Pine needles are given as a nest material by Phillips (1893:52) and Roberts (1936:330). Norris (1892:21-22) found that cotton and straw had been used, and Hales (1896:262) found string woven into a Scarlet Tanager nest.

Size and shape of nest. The Scarlet Tanager nest is coarsely woven, fairly shallow but not flat, and slightly asymmetrical (see Figures 12 and 13). Light may be seen through the loose interstices and, occasionally, from the ground below, one may see the outline of an egg through the loose nest bottom. However, Hales (1896:262) described a Scarlet Tanager nest as being "like a cup of basket work, beautifully woven".

Measurements of nests. Oberholser (1896:317) gives the measurements (in inches) of four Scarlet Tanager nests. The average measurements of these four nests are: height 2.88, depth 1.69, inside top diameter 2.63x2.38, inside middle diameter 2.44x2.26, outside top diameter 5.00x3.81, outside middle diameter 5.44x4.19, outside bottom diameter 3.75x3.00, width of rim 1.58 x.46.



Fig. 17. Scarlet Tanager nest locations at the Edwin S. George Reserve.

E. History of Nests

The following histories of the 33 Scarlet Tanager nests include a brief description of the nest site, and a short account of the nest progress from the day each was found until the nest was broken up or the young were fledged.

Nest No. 1. Southwest Woods, 1947. Placed at a height of 28'3" in a white oak, 15" DBH, in the fork of a horizontal limb, 4'2" from the trunk and 4 to 6 feet from the outermost tip of the branch. The woods road was 163 feet away. The nest was loosely constructed of stems and rootlets, which readily allowed light through the interstices. There were a few leaves shading the nest, although in general it had an exposed appearance.

When I discovered the nest, June 9, it appeared completed though empty. June 12, it contained three tanager eggs and one Cowbird (Molothrus ater) egg. There were four tanager eggs and one Cowbird egg June 13, but movements of the nest branch during my climbing, caused one tanager egg to roll out of the nest. There were two tanager eggs and two Cowbird eggs in the nest June 16. Staebler and I constructed a tree blind in an adjacent tree overlooking the nest. The female twice attempted to visit the nest, while we were working, but each time she left the nest tree without settling on the nest. June 20, the eggs were cold and the nest deserted.

Nest No. 2. Southwest Woods, 1947. Placed in a tall hickory, 16" DBH, 53'7" high, 8 feet out from the trunk and 2 feet from the tip of a downward sloping branch of a horizontal

limb, which overhung a woods road. The nest was rather compactly built, although light was visible through the interstices. It was placed in a dense clump of leaves, which almost obscured it from below, and so hid it from above that I could not see exactly what was in it when I stood on the nest-limb.

I was able to discern two tanager eggs in the nest June 21. July 7, the nest contained two tanager and one Cowbird young. The three young left the nest July 11.

Nest No. 3. Southwest Woods, 1947. Placed in a white oak, 18" DBH, 21'1" high, on a horizontal branch 9 feet from the main trunk and 6 feet from the tip of the branch. The nest tree was 18 feet from a fork of two woods roads.

The nest contained one young Cowbird and three tanager eggs June 24. There were three young (one Cowbird and two tanagers) and one tanager egg on June 26. July 5, the nest was empty. On that day I observed the male and female feeding the Cowbird young in a sapling about 50 feet from the nest, but I was not able to locate the two young tanagers.

Nest No. 4. South Woods, 1947. Placed in the extreme tip of a white oak, 7" DBH, approximately 35 feet high on the horizontal portion of a vertical branch (the highest tree branch) which bent sharply to one side, 6 feet from the trunk and 3 feet from the branch tip. The nest tree was 130 feet from a woods road. The nest had leaves directly over it which offered good shade.

When Sutton and Rowland Wilson found this nest July 16, it contained two young, a Cowbird and a tanager. I watched the

tanager young leave the nest at 09:15, July 20. The Cowbird young was still in the nest the afternoon of July 20.

Nest No. 5. Big Woods, 1947. Placed in a 1" DBH Prunus sapling, 5'1" above the ground. The sapling, which bent over so strongly that it paralleled the ground, was half way up the slope of a kettle. The nearest woods road was 125 feet away. The nest, constructed of stems and rootlets, was very loose and flimsy.

When Sutton found this nest July 14, it was empty and he thought it had been deserted. When he returned on July 19, however, the set of three tanager eggs was complete. The three young hatched July 30. The following day I found the remains of a tanager egg shell on the ground beneath the nest. On August 7 one of the young birds jumped from the nest, but it was obviously not fledged and I put it back into the nest. The nest was empty on August 8. The young may have fledged successfully, but on August 9 Sutton and I searched in vain for the young birds or their parents. I believe the young had been taken by a predator.

Nest No. 6. Southwest Woods, 1948. Placed in a black oak, 14" DBH, 33 feet high, on a horizontal limb 13 feet from the trunk and 3 feet from the branch tip. The nest tree was 21 feet from a woods road.

The female was constructing the nest May 23. It appeared to be completed the nest time I visited the area May 26. May 28, it contained four eggs (two tanager and two Cowbird). June 7, the nest was empty, the eggs having been removed by a predator.

Nest No. 7. Southwest Woods, 1948. Placed in a black oak, 19" DBH, 28'6" high, on a horizontal branch at a distance of 10 feet from the trunk and 2 feet from the tip. It was in a dense clump of leaves and overhung a woods road.

Tordoff discovered this nest June 5, when the female flew from the nest. The nest was empty when I inspected it June 7. Subsequent observations from my blind on June 7, and 9, showed that the nest was deserted.

Nest No. 8. Big Woods, 1948. Placed in a Crataegus, 3" DBH, at a height of 12 feet on the main sapling trunk which bent over horizontally. The exposed nest was 7 feet out on the bent portion and 3 feet from the branch tip. The nearest woods road was 110 feet away.

When Sutton discovered this nest June 14, it contained three young (two Cowbird and one tanager) of approximately the seventh day of development. June 16, the tanager young was out of the nest, but I replaced it for further observations. One Cowbird and the tanager young were out of the nest June 17. They were replaced that day, and permanently left the nest June 18.

Nest No. 9. Southwest Woods, 1948. Placed in a black oak, 21" DBH, at a height of approximately 45 feet, on a vertical secondary branch 15 feet from the trunk and 10 feet from the tip of the secondary branch. It was situated in a very dense leaf clump. A deer runway was directly under the nest, but the nearest woods road was 210 feet away.

I found this nest June 20. The following day one young

Cowbird left the nest. There were no other young in the nest and I could not see other young in the nest tree or vicinity.

Nest No. 10. Big Woods, 1948. Placed in a black oak, 9" DBH, 32 feet high, on a slightly ascending branch 8 feet from the trunk and 10 feet from the tip. The nest was placed in a dense leaf clump, although the nest was exposed from the north. The nearest woods road was 340 feet from the nest, although the nest overhung a deer runway.

I discovered this nest as I observed the female feeding in the nest tree June 20. It was empty at that time. Subsequent checking of this nest did not reveal that it was being used until the morning of June 27, when it contained a Cowbird egg. At 09:50, June 28, the nest contained one Cowbird egg and two tanager eggs. These were incubated regularly until they were removed by a Crow (Corvus brachyrhynchos), July 4.

Nest No. 11. Southwest Woods, 1948. Placed in a white oak, 9" DBH, 33'6" high, on a 30° ascending branch, 8 feet from the trunk and 12 feet from the branch tip. The nest was partially exposed, overhanging the same deer path as, and about 150 feet from, nest No. 9. The nearest woods road was 261 feet away.

When Tordoff found this nest July 12, it contained a Cowbird young and tanager young of the first day of development. Both young left the nest July 21.

Nest No. 12. Big Woods, 1948. Placed in a white oak (double), 15" DBH, on a horizontal branch 22'4" from the ground, 14 feet from the trunk and 3 feet from the branch tip. The nest



Fig. 18. Southwest Woods, showing part of Scarlet Tanager Territory No. 11. (photo. by J. Speed Rogers)



Fig. 19. Scarlet Tanager Territory No. 11. (photo by K. Bohnsack)

overhung the woods-swamp edge 27 feet from a woods road. While the nest was plainly visible from below, a very dense clump of leaves completely covered the top of the nest.

When Sutton found this nest July 18, it contained three or four young birds, but he did not remove them from the nest to ascertain what they were. On July 24, there were only two young birds in the nest, a Cowbird and a tanager. They both left the nest that day when I attempted to remove the tanager for weighing.

Nest No. 13. Southwest Woods, 1949. Placed in a white oak, 6" DBH, 10'4" high, 6 feet from the trunk and 4 feet from the tip of a slightly ascending branch. A rarely used deer runway was 11 feet away.

May 10, the female was working on the less than half completed nest. It appeared completed, May 15. The first two tanager eggs were laid the morning of May 16, and 17. The morning of May 18, a female Cowbird removed one of the tanager eggs and laid a Cowbird egg in the nest. Approximately an hour later the female tanager laid her third egg, but the clutch only contained two tanager eggs and one Cowbird egg. The fourth tanager egg was laid the morning of May 19. When I inspected the nest May 20, the female did not leave until my hand almost touched the nest. Then she left hurriedly and broke a tanager egg. I removed the broken egg but she deserted the nest.

Nest No. 14. Southwest Woods, 1949. Placed in a white oak, 14" DBH, approximately 65 feet high, on a 60° ascending

branch, 18 feet from the trunk and 10 feet from the tip of the uppermost large branch. The woods road was 33 feet away.

May 14, I observed the female working on her less than half completed nest. The nest looked nearly completed May 16. This nest was so inaccessible and in such a dense clump of leaves that I did not make subsequent observations of it.

Nest No. 15. Big Woods, 1949. Placed in a black oak, 11" DBH, 41'11" high, 6 feet from the trunk and 15 feet from the tip of a 65° ascending branch. The woods road was 35 feet away.

May 21, the empty nest appeared completed. May 23, it contained three eggs (two tanager and one Cowbird ?). May 24, it contained two tanager and two Cowbird eggs. May 25, the nest was empty.

Nest No. 16. Big Woods, 1949. Placed in a white oak, 11" DBH, 40'2" high, 9 feet from the trunk and 12 feet from the tip of a slightly ascending branch. The woods road was 35 feet away.

The nest was less than half completed May 29, but appeared completed May 31. The four tanager eggs were laid the mornings of June 1-4. The afternoon of June 4, a Crow ate the eggs.

Nest No. 17. Big Woods, 1949. Placed in a white oak sapling, 2½" DBH, 14'3" high, in a very dense leaf clump at the terminal fork of the trunk and a smaller branch. Several mature trees near the sapling had fallen and there was quite a cleared area around the sapling, which grew on a very steep hill above Buck Hollow and 70 feet from the main traveled Reserve road.

The nest contained three tanager eggs, June 5. One egg hatched prior to 08:45, June 11, and another egg hatched between 20:30, June 11, and 08:40, June 12. The afternoon of June 12, I found the third tanager egg broken on the ground directly below the nest. It contained a well developed embryo. June 15, a Crow took the young tanagers from the nest.

Nest No. 18. Big Woods, 1949. Placed in a dense clump of wild grape leaves growing on a black oak, 5" DBH, approximately 30 feet high, 3 feet from the trunk and 2 feet from the tip of an ascending branch. The nest overhung the edge of the main traveled Reserve road.

June 11, the female was collecting nest material from the ground and working on the nearly completed nest. Because the nest was inaccessible I do not know how many eggs the nest contained, but she began incubating June 14. The afternoon of June 18, a Blue Jay (Cyanocitta cristata) jabbed its beak into the nest and apparently broke an egg(s) for the female deserted.

Nest No. 19. Big Woods, 1949. Placed in a black oak, 18" DBH, approximately 45 feet high, 20 feet from the trunk and 8 feet from the tip of an ascending branch. The main traveled Reserve road was 25 feet away.

June 26, the nest contained young. They apparently left the nest June 27.

Nest No. 20. Big Woods, 1949. Placed in a white oak (double), 15" DBH, 35 feet high, 10 feet from the trunk and 15 feet from the tip of a descending branch. The tree was on a small point of land which jutted out into Buck Hollow, and the

nest overhung the wet swamp ground. There was a deer runway 30 feet away, and the main traveled Reserve road was 350 feet away.

This nest was empty when I found it June 26, and was not subsequently used, but it was obviously a fresh 1949 nest.

Nest No. 21. Dollar Tamarack Swamp, 1942. GMS No. 1. Placed 20 feet above wet ground in a tamarack, 13" DBH, approximately 40 feet high, on a horizontal branch 10 feet out from the trunk.

When Sutton found this nest July 10, it contained two quite well developed young Cowbirds. July 12, the nest was empty.

Nest No. 22. West Tamarack Swamp, 1942. GMS No. 2. Placed 15 feet above wet ground in a tamarack, 10" DBH, approximately 50 feet high on a horizontal branch 6 feet out from the trunk.

July 22, Sutton found this nest. It contained one Cowbird almost ready to leave the nest. After banding it the Cowbird would not remain in the nest.

Nest No. 23. Big Woods, 1942. GMS No. 3. Placed in a white oak at an approximate height of 18 feet, on an almost horizontal branch, 7 feet out from the main trunk and directly above a woods road.

This nest contained three well incubated tanager eggs, July 24. August 7, the nest was empty. Sutton believes some predator took the eggs or young.

Nest No. 24. Near the north fence, 1942. GMS No. 4. Placed in a red oak (Quercus rubra), 12" DBH, at an approximate height of 25 feet on an ascending branch 15 feet out from the

main trunk.

July 28, it contained three well developed tanager young, almost ready to leave the nest. July 29, all three left the nest as Sutton banded them (one got away unbanded).

Nest No. 25. Big Tamarack Swamp, 1946. GMS No. 5. Placed 17 feet above very wet ground in a leaning tamarack, 5" DBH, approximately 27 feet high, and 2½ feet out from the trunk.

Frances Hamerstrom found this nest May 24, when it was partially completed. June 15, she found that the nest had been deserted, apparently before it had been completed.

Nest No. 26. Big Tamarack Swamp, 1946. GMS No. 6. Placed 30 feet above wet ground in a tamarack, 16" DBH, approximately 60 feet high on a horizontal branch, about 9 feet out from the trunk.

Sutton found this nest May 28, but it appeared to have been deserted between that date and June 3.

Nest No. 27. Big Tamarack Swamp, 1946. GMS No. 7. Placed in the same tamarack as nest No. 26, but 5 feet higher. Sutton found the female sitting on the nest June 3, and he believes that this is a re-nesting of the pair that built nest No. 26. June 27, the nest appeared empty.

Nest No. 28. Fishhook Marsh, 1946. GMS No. 8. Placed at the marsh edge in a tamarack, 8" DBH, approximately 11 feet above very wet ground, and 6 feet out from the trunk on a descending branch.

This nest contained three fresh tanager eggs May 30. June 2, it contained two tanager eggs and one Cowbird egg.



Fig. 20. Fishhook Marsh. The Scarlet Tanager may nest in a tamarack tree which is near broad-leafed deciduous trees as shown here. Nest No. 28 was placed in one of these tamaracks, which is at the edge of Southwest Woods shown in the background. (photo. by J. Speed Rogers)

June 17, the nest was empty and Sutton believes that the eggs or young were taken by a predator.

Nest No. 29. West Tamarack, 1946. GMS No. 9. Placed in a white oak, 16" DBH, approximately 28 feet above dry ground, 10 feet out from the trunk.

Sutton found this nest June 4, and four days later he saw the female on the nest. June 22, the nest was empty and Sutton believes that the eggs or young were destroyed.

Nest No. 30. Big Woods, 1946. GMS No. 10. Placed at a height of 8½ feet in a thin red cedar (Juniperus virginiana) growing in the Big Woods.

June 8, this nest contained three tanager eggs when Sutton found it, and June 22, there were three young in the nest. The three tanager young were observed in the nest June 25, but they had left the nest by June 27.

Nest No. 31. Near Big Cattail Marsh, 1946. GMS No. 11. Placed in a large white oak, 15 feet above the ground, on a horizontal branch 12 feet out from the trunk.

When Sutton found this nest June 21, it was only partially constructed. July 3, he found a Mourning Dove sitting on the nest. Sutton was not able to examine the nest, but the Mourning Dove appeared to be incubating.

Nest No. 32. Big Woods, 1946. GMS No. 12. Placed in a slender black (?) oak on a sloping branch 8 feet out from the trunk and 25 feet above the ground. The tree stood at the side of the main hogback road in the Big Woods.

Sutton found this nest June 22, but did not climb to it.

He saw the female on the nest the mornings of June 25, 29, and 30. The fate of this nest is not known.

Nest No. 33. Big Woods, 1946. GMS No. 13. Placed 11 feet above dry ground in a small red maple (Acer rubrum), 3½" DBH, about 30 feet high, on a horizontal branch 10 feet out from the trunk.

Sutton found this nest June 23, but did not examine its contents. June 25, when he pulled the branch down to examine the nest, two young tanagers flew away.

SUMMARY

1. The female Scarlet Tanager undoubtedly chooses the nest site. This choice may be influenced by the male in one, or possibly, two ways. The singing and displaying male attracts her to a woods area, and his display in open woods areas during courtship may draw her attention to a suitable nest site.

2. The female Scarlet Tanager builds the nest without any aid from the male. She begins to construct her nest within a week after her arrival.

3. Apparently the female Scarlet Tanager constructs the nest during the morning hours. There are reports that the female builds her nest in a remarkably short time, in one case eight hours. My observations indicated that it takes four to seven days to construct the Scarlet Tanager nest.

4. The nest material is gathered from the forest floor in the vicinity of the nest, in some cases as far as 150 feet from the nest.

5. The female Scarlet Tanager works on the nest for short periods, from .25 to 2.5 minutes. Statistics are given to show how often females No. 6 and No. 13 made trips to the nest during nest building.

6. Bar diagrams (Figures 8 and 9) show the nest building activity for females No. 6 and No. 13. A summary of these work periods is given in Table 4.

7. The four characteristics of the Scarlet Tanager nest site are: nests are placed (1) in a leaf cluster, or at least with several leaves shading the nest, (2) on a nearly horizontal branch, with (3) a clear unobstructed view to the ground below, and (4) there are clear open flyways from adjacent trees to the nest.

8. In general, the Scarlet Tanager nest is not well concealed.

9. The Scarlet Tanager nest is usually placed well out from the trunk and usually more than half of the branch's length. It is usually placed at the junction of two or more smaller branches with the horizontal branch.

10. Nest site data from the 33 Scarlet Tanager nests at the Reserve are given in Tables 5 and 6.

11. The average measured height of my 14 Scarlet Tanager nests is 31.3 feet, the average estimated height of my other six nests is 41.7 feet. The average estimated height of Sutton's 13 nests is 19.9 feet. The average estimated (?) height of 33 nests given in the literature is 21.1 feet.

12. I do not believe that height is a major factor in the

choice of a nest site by the Scarlet Tanager.

13. Approximately 39 per cent of the 33 Scarlet Tanager nests at the Reserve were placed in white oaks, approximately 24 per cent in black oaks, and approximately 18 per cent were placed in tamaracks.

14. I do not believe that the Scarlet Tanager shows a preference for roads or paths in selecting a nest site.

15. Scarlet Tanager nests have been found in the built-up portion of Washington, D.C., in orchards, and very near homes. Nests have been also found over water, over wet ground, and where spray from waves occasionally dashed over the nest.

16. The Scarlet Tanager nest is a coarsely woven, fairly shallow, but not flat, slightly asymmetrical nest which is composed mainly of grass, plant stems, rootlets, and twigs.

17. The average measurements of four Scarlet Tanager nests are given.

18. A brief history of the 33 Scarlet Tanager nests, which were found at the Reserve, is given. Their location at the Reserve is shown in Figures 16 and 17.

CHAPTER V

SCARLET TANAGER COPULATION

Scarlet Tanager copulation takes place in the trees, on an exposed, usually horizontal branch, in the nest vicinity. The perches used ranged in height from 2 to 60 feet, with an average height of 23 feet. I have observed the Scarlet Tanager pair copulating before the eggs were laid, during the incubation period, and while the Scarlet Tanager pair had young in the nest. Song Sparrow (Nice, 1943:178) copulation always took place on or near the ground. Nice (1943:171, 178) observed copulation of the Song Sparrow as early as two weeks before the nest was completed, during the periods of nest building and egg laying, and after the young had left the nest. The Oven-bird (Hann, 1937:154) copulates either on the ground or up in the trees, but usually on the ground.

The male Scarlet Tanager does not display and attract the female to him, although he may occasionally give the display before and after the copulatory act. I have only three observations of a male (No. 8) displaying before attempting to copulate, and only once did the display result in the copulatory act. He copulates with the female after an invitation from her which signifies that she is ready and will receive him. She crouches low on the branch, bill pointing upward, and rapidly

flutters her half open wings. The male immediately jumps into the air, hovers over the female, with his body at about a 60° angle to the female, and his tail projects upward at about a 40° angle. He does not grasp the female's crest, but maintains contact with her by very rapid, flycatcher-like, wing beats. The copulatory act is completed in two to five seconds.

Copulation before the eggs are laid. I observed pair No. 1 to copulate three times on June 7, approximately three days before the first egg was laid. Each time, the male made a long flight, 40 to 60 feet, and lit beside the female who was perched on an exposed hickory branch, about 25 feet above the ground. The first time he perched about six inches from her, and the second time about two feet from her. Each time he remained perched about two minutes before copulating. The invitation was given by the female when she crouched and fluttered, after which the male flew to her and copulated. After they copulated at 11:30, the male perched six inches away from the female for two minutes and then they copulated again. At the completion of the last copulatory act, the male flew directly to another tree, and the female flew in the opposite direction. They copulated again at 12:30. This time he flew to the same branch, and perched six feet from the female after copulation, and then he flew away.

Pair No. 13 copulated May 12, when the nest was partially completed, the first egg being laid May 16. She flew from her nest, where she had been working, to the nest branch. Then she flew to an oak, 10 feet from the nest tree, and perched on a

bare branch at a height of 35 feet. The male flew to the same branch. She crouched, fluttered, and he flew to her and copulated for about three seconds. Then he perched about five inches from the female who continued to flutter on the branch. He immediately flew to her and copulated again, remaining in contact with her about two seconds. Then he flew to a branch about seven feet above her. She remained on her perch, preening, for about two minutes. May 14, this female (No. 13) flew from her nest to a dead, exposed branch, 20 feet from the nest at a height of 25 feet. Male No. 13 flew to the branch and copulated with her. Then he flew to another tree, 15 feet away, and gave the display posture, rigidly pointing away from the female who had remained at her perch. Then they both flew away.

When nest No. 14 was less than half completed, pair No. 14 copulated near the nest at a height of 45 feet. At its completion the male lit on the branch one foot away from the female. A few seconds later he copulated with her again. After this the female shook her body and ruffled out her feathers.

Copulation during the incubation period. Pair No. 1 copulated at 06:30, four days after their clutch was completed. Both flew to the nest tree, then she flew 15 feet from the nest to a hickory. The male followed and copulated with the female who fluttered on the limb. She flew immediately to the nest tree and was followed by the male.

Copulation during the nestling period. The copulatory behavior of pair No. 8 is unusual not only because it occurred

on the sixth and seventh day of development of the young, but because of the frequency and repetition of the act. They copulated three times June 17, at 16:06, 16:57, and 17:43. On June 18, they copulated twice at 05:41, once at 06:44, three times at 11:54, and once at 13:54.

The height of these copulatory perches were: 2 feet, 5 feet, 6 feet, 10 feet (twice), and 18 feet. The distances from the nest tree were: 6 feet (twice), 15 feet, 40 feet, and the others about 30 feet. On 6 occasions they copulated immediately after the female had fed the young. The other four times the male accompanied the female as she flew toward the nest carrying food to the young, and copulated with her when she paused at a tree on her way to the nest.

The copulatory acts were similar to that described above. The female usually flew to the branch where the male was perched. In each instance they remained perched on the same branch for two to eight seconds before they copulated.

At 17:43, June 17, after feeding young, the female flew 15 feet to male No. 8 and perched alongside him on a branch three feet from the trunk, at a height of five feet. He hovered over her, copulating for two to three seconds, and as he left her, she flew 20 feet to a sapling and perched at a height of five feet. He flew to a branch, jutting up from the ground, pointed at her, and with wing tips well below the tail, displayed his scarlet plumage. As she watched, he flew to her, fluttering above her in copulatory position, but she hopped

aside. Then he returned to the branch on the ground and displayed again, this time facing away from her. Female No. 8 was not interested, evidently, for she flew 100 feet away and began feeding.

After feeding the Cowbird young at 05:41, June 18, the female flew six feet to a branch, at a height of 10 feet, and was immediately joined by the male, who lit 12 inches from her. Facing away from the female, with wings held stiffly below the tail, he allowed her a glimpse of his scarlet back, then whirled, hopped into the air, and hovering over her, copulated for two to three seconds. She retained her position on the branch and he returned to his previous perch. Turning, he faced her, then flew into the air and copulated again for two seconds. However before he had completed this act, she flew downward, leaving him fluttering in the air.

Later that day, at 11:45, pair No. 8 flew toward the nest. She went on to feed the young, but he stopped and perched in a nearby tree. After feeding the young, she left the nest and perched next to him at a height of 18 feet. He immediately fluttered over her and copulated for two to three seconds. Returning to his perch, he paused for five to eight seconds, then repeated the act, which lasted three to four seconds, and then returned to his perch. About four seconds later he flew above her and copulated for one to two seconds, but she flew while he was still in the copulatory position.

Later, at 13:54, she fed the nestlings, turned and looked in the direction of the male, who was perched nearby on an

exposed branch, and crouching low she began to flutter her wings. She remained fluttering on the nest rim for four to five seconds and then flew directly to his perch. As she lit, still fluttering, he instantly sprang into the air and copulated for two to four seconds. After this he perched next to her, but she continued fluttering. He mounted her again but she flew after he had been above her for about a second.

Copulation with a strange male. May 25, when her nest was almost completed, female No. 6 copulated in territory No. 6 with a male (unpaired?) from a neighboring territory. She called "chip-churr" and flew to a broken dead branch at a height of 60 feet. The strange male had been singing about 100 yards away from the female, but he immediately flew to her. A moment later they copulated. However, just as they completed the act, male No. 6 silently chased the intruding male from territory No. 6.

SUMMARY

1. Scarlet Tanager copulation takes place in the trees, on an exposed, usually horizontal, branch in the vicinity of the nest. The copulatory perches varied in height from 2 to 60 feet, and the average height was 23 feet.

2. I have observed copulation before the eggs were laid, during the incubation period, and while the Scarlet Tanager pair had young in the nest.

3. The male does not display and attract the female to him. I have only three observations of a male displaying

before attempting to copulate, and only once did it result in the copulatory act.

4. The male copulates with the female after an invitation from the female which apparently signifies that she is ready and will receive the male.

5. The female issues the invitation to copulate by crouching low and by rapidly fluttering her half open wings.

6. The male hovers over the female, his body at about a 60° angle to the female, and his tail projects upward at about a 40° angle. He does not grasp the female's crest, but maintains contact with her by very rapid, flycatcher-like wing beats.

7. The copulatory act is completed in two to five seconds.

8. On one occasion a female (No. 6) copulated with a strange male. At the completion of the act male No. 6 chased the strange male from territory No. 6.

CHAPTER VI

THE SCARLET TANAGER EGG, CLUTCH, AND INCUBATION

A. Egg

The Scarlet Tanager egg is greenish-blue with reddish-brown spots or flecks. The ground color may "vary from a well marked shade of greenish-blue to a dull white" with only the least tinge of blue, and "the spots of brownish and obscure purple color" (Baird, et al., 1, 1905:437). Davie (1898:408) states that the eggs are greenish-blue, speckled, spotted, and blotched with rufous brown, more or less confluent, in some chiefly at the large end, and that the markings have a reddish tint.

The average size of the 10 egg measurements given by Davie (1898:408) is .95 x .63 inches; of three eggs listed by Smithwick (1893:29) is .89 x .62 inches. Chapman (1937:495) gives the average size as .88 x .68 inches; Roberts (2, 1936: 330) gives .94 x .66 inches; and Coues (1905:348) gives the average size as .95 x .65 inches.

B. Clutch

The average Scarlet Tanager clutch is four, although later nests (re-nestings) in the season may have only three eggs. The smallest recorded clutch is two Scarlet Tanager eggs (Norris, 1892:21). The largest recorded clutch of Scarlet

Tanager eggs is five (Harlow, 1914:89). Norris (loc. cit.) recorded a clutch with four tanager eggs and one Cowbird egg, and another with four tanager eggs and two of the Cowbird. Todd (1940:594) recorded a clutch with three tanager eggs and four Cowbird eggs. The largest clutch that I know of is one found by Mulliken (1899:18) which contained four tanager eggs, and five Cowbird eggs.

The average number of eggs per clutch for my nests is 3.5 eggs. A summary of the minimum number of eggs laid in 14 of my nests is given in Table 18 (see Chapter XI). Eight of these clutches, which were completed prior to June 15, had an average clutch size of 4.1 eggs, and the six nests which were completed after June 15 had an average clutch size of 2.6 eggs, indicating that the number of eggs per clutch declines as the nesting season advances.

C. Incubation

Incubation is performed entirely by the female, as recorded by Allen (1932:292), Burns (1915-a:278), Hales (1896:261), and others. The length of the incubation period has been given as about 12 days (Burns, 1937:125), 13 days (Dugmore, 1904:152), and 13 to 14 days (Allen, 1932:292).

Unfortunately I do not have adequate field observations to accurately determine the incubation period. Many of my nests were broken up or deserted before the eggs hatched (see History of Nests, Chapter IV). Most of my nests were placed so far out on the horizontal branch that it was not only difficult to determine the actual number of eggs, but impossible to mark

the eggs. Moreover, some of my nests were found after the clutch had been completed. If the young of nest No. 2 left on the ninth day of development (July 11), and the clutch was complete June 21, then the maximum possible incubation period would be 13 days. The eggs of nest No. 5 hatched July 30. The nest was empty when Sutton found it July 14, but it contained its full clutch of three tanager eggs when he next checked the nest July 19. These eggs hatched July 30. These data indicate a 13- or 14-day incubation period.

My observations indicate that the female begins to incubate the day the last egg is laid. She spends little or no time on the nest until the clutch is complete, but with the laying of the last egg she begins a definite incubation rhythm. I do not believe that she spends the night on the nest until after the clutch is complete. I have accepted the 13-day incubation period given by Dugmore (op. cit.), which has also been accepted by Roberts (1936:330) and Bergtold (1917:102). All my computations of the female tanager incubation rhythm are based on a 13-day incubation period.

Position of the incubating female on the nest. While the female is on the nest her tail usually projects horizontally over the nest rim, with the wing tips resting along each edge of the tail. Occasionally the tail may project upward at an angle as great as 75 degrees. Female No. 5 often assumed the latter position with both wing tips crossed to the right of her tail; at times with the left wing tip pointing high, and with the right tip resting horizontally.

Occasionally when direct sunlight strikes the drab, protectively colored plumage of the female, her feathers appear quite yellowish in contrast to the green leaves protecting the nest. When the female Scarlet Tanager stretches her neck to peer at a disturbance, or look for the male, her yellowish throat contrasts with the dead brown color of the nest with its green leaf border. And often the bright yellow under tail coverts are conspicuous against the brown nest.

The directions that the incubating female faced seem to be correlated with the position of my blind. My blind was located north of nest No. 1. The 51 recorded directions which female No. 1 faced after her arrival to the nest show that the majority allowed her constant surveillance of my blind. These directions were:

Northwest	2	time(s)
North-northwest	17	"
North	5	"
North-northeast	15	"
Northeast	3	"
East	4	"
Southeast	1	"
South	3	"
West	1	"

My blind was also placed north of nest No. 10. The directions that female No. 10 faced, after her arrival to the nest, were such that she usually had my blind well within her range of vision. The directions female No. 10 faced were:

North	2	time(s)
Northeast	41	"
East	9	"
South	2	"
West	2	"
Southwest	6	"

The incubating female Scarlet Tanager often changes her position, and direction, on the nest. Sometimes as much as 180 degrees, at other times as little as 10 to 15 degrees. Many times she turns and faces in the direction of the feeding or singing male. She seems aware of his activity, occasionally rising in the nest and peering in his direction. When the male flies to another portion of the territory, she may change her position in the nest and face toward the male at his new perch.

Egg turning. Frequently the female stands up in the nest to inspect and turn her eggs, making from two to six pushing motions with her beak. Typically she stands high in the nest, neck arched, head near the nest bottom, closely examining the contents first with one eye then with the other. After pushing and turning the eggs, she straightens up, cocks her head from side to side, and peers at the nest contents with either eye. In settling on the nest she fluffs out her breast feathers and wriggles her wings several times. Female No. 1 went through this egg-turning procedure once every 1.3 hours of nest observation.

Preening on the nest. Females often preen on the nest. Observations of female No. 10, on June 28, from 09:51 to 15:41, show the female preened at the following times: 14:01, 14:53, 14:55, 15:02, 15:07, 15:14, 15:16, 15:19, 15:20, 15:23, and 15:31. Some of these preening periods were short, only of two to six seconds duration, but others, at 14:54, 15:02, and 15:23, were between 20 and 30 seconds. The periods at 14:07, and 15:16 were between 40 to 50 seconds in length.

Preening of the breast, flank, and wing feathers was generally accomplished without rising or changing position on the nest. However the female often stood up, stretching far beneath her to reach feathers on the abdomen, or reaching far back to preen the tail. After preening, she gently rocked her body from side to side, and fluffed the breast and flank feathers as she settled over her eggs.

Manner of leaving and returning to the nest. All females had one characteristic in common: when they left the nest, it was a hurried departure rarely involving more than one perch before taking flight. Generally this flight was directly away from the nest tree to an adjacent tree. Of 25 recorded observations of female No. 1 leaving the nest, 14 times she hopped from the nest to a small twig projecting out and above the nest; five times she left directly from the nest, slipping over the side or standing up and diving over the side; three times she hopped to the nest rim, leaving from there; and twice she hopped from the nest to the nest branch before she flew. Female No. 3 generally left from the nest branch at a point behind the nest. Three times she dove over the nest side, and once she flew from the nest rim. Each female appeared to follow an individual routine in leaving the nest, which she invariably used except when leaving in a hurry.

The manner of returning to the nest was usually hurried and secretive, with little time spent on the nest branch or in that portion of the tree containing the nest. Invariably females gave one quick look at the nest contents before settling.

Of 40 recorded observations of female No. 1 returning to the nest, 14 times she lit on the nest branch and then hopped to the nest; 13 times she lit on a small twig, projecting out and above the nest; nine times she lit on the rim; and four times she lit on a small branch below the nest. Female No. 3 usually lit on the nest branch, and often near its extremity under the cover of leaves, sneaking up to the nest and sliding quickly over the eggs. Female No. 5 invariably lit on a branch below the nest branch, often peered at my blind, and hurried up to the nest. Occasionally she hopped out of the nest onto the limb and turned again to look at the blind before she finally settled on her nest. Once she swooped down from a 40-foot perch, breaking her dive about two feet below the nest, and lit on the nest (five feet above the ground).

General behavior of the incubating female. While on the nest the female seems to reflect the state of her environment. If it is quiet, with no disturbance, she is quiet; a creaking tree, the snapping of a branch as it is broken, a turtle pushing through dead leaves, or the sound of quarreling birds, cause her to raise her head alertly and look in that direction. If the disturbance persists, she may leave, perhaps in fright or to investigate.

Often the female yawns, pointing her beak upward and opening it wide. She often shuffles her wings, fluffs out her feathers, and at times seems to work her feet back and forth in the nest. This behavior seems to mark an uneasiness, which is followed by much turning of her head, as if looking for the

male. Invariably she leaves after such periods of uneasiness.

Male activity during female's incubation. The male Scarlet Tanager never incubates the eggs. Generally he confines himself to his usual activity of feeding, singing, and territorial defense. He rarely visits the nest when the female is absent, but when he does he stays but a very short time, cocking his head to one side as he looks at the nest contents, and he leaves at the appearance of the female. I could not determine any hostile behavior on her part, yet the male leaves as soon as she appears. The male and the female rarely appear at the nest together, but at such times he leaves immediately, having had time for little more than a glance at the nest. As he leaves, the female hops into the nest and resumes incubating.

Occasionally the male feeds the incubating female, at such times she does not leave the nest. Usually she opens her wings and flutters just before, or while, receiving the food. I have records of the male feeding the female, while she was on the nest, for four of the six days of observed incubation behavior at nest No. 1. He fed her at 12:37, June 12; 11:05, June 13; and 05:38, June 17. The most frequent feedings were the morning of June 19, when the male fed her at the following times: 05:15, 05:22, and 05:36. He always lit above the nest, usually on a twig which projected slightly above the nest, and fed her, bending down and thrusting well into her open mouth. Usually she stretched forward to receive the food, but she did not in any other way change her position on the nest. At each of the above feedings, female No. 1 was given an adult insect.

At nest No. 10, the male fed a blackberry to the incubating female at 11:48, and 13:29, June 28. The following day, at 18:25, he fed her a de-winged black-bodied dragonfly. July 1, he fed the female on the nest at the following times: 10:49, 10:59, 11:40, 13:30, and 14:26. He fed her so hurriedly that it was difficult to identify the food; however at times I was able to determine that he fed her adult insects, and at other times, blackberries. The evening of July 3, he fed her at 20:04, and at 20:24 (very little light in the woods). Female No. 10 was fed on the nest July 4, at 05:14, and was fed blackberries at 08:42, 08:51, 08:56, and at 09:01. At 09:35 he attempted to feed her again, but a Crow interrupted this feeding as it lit on the nest branch (see Crow, Chapter XI). This male fed the female from perches on the nest branch, nest rim, and from a twig above the nest. A few times he remained perched on the nest branch, two to three feet from the fluttering female on the nest, and did not feed her until she left the nest and flew to him. Male Scarlet Tanagers usually remained at the nest about two to four seconds when feeding the female on the nest, but always flew as soon as she had taken the food.

When the incubating female tanager left her nest, she usually flew to the tree or branch where the male was feeding. If she flew to another tree, he almost always joined her, and they searched the leaves for food or flew away together. Many times, when she flew from her nest to a tree nearby, he flew to her and fed her as she fluttered on the branch. Occasionally two or three weak, "bill-closed" songs, given by the male from

trees near the nest, seemed to be a sign for the female to leave the nest. Nervously turning her head in that direction she would dive over the nest rim and perch a few feet from the male, who immediately fed her. I believe that this occasional feeding of the female, by the male, as soon as she alights, may account for her being able to get sufficient food when she is off the nest for such short intervals as .5 to 1.5 minutes.

D. Incubation Rhythm

By incubation rhythm I mean the alternation of attentive and inattentive incubating periods. The incubation rhythm, for a given day of incubation, can be computed by dividing the average minutes which the female spends on the nest, by the average minutes she is away from the nest. This ratio (min. on/ min. off), gives a statistic which represents the incubation rhythm of a female for a given day of incubation.

Incubation rhythm in relation to each incubation day. The notes, which I took in my blind, recorded, to the nearest half minute, the time when the female Scarlet Tanager left and returned to her nest during the period of incubation. From these data I have computed the incubation rhythm of 10 Scarlet Tanager females. This information is given in table 8.

I have averaged the incubation rhythms of these 10 female Scarlet Tanagers for each of the 13 incubation days. These average ratios, plotted against the day of incubation are shown in Figure 21. The average ratio for the third day was obtained from observations of females No. 10 and No. 18. The observations of female No. 10 were made from early morning until 09:41

(third day). The temperature varied from 60 degrees to 64 degrees during this observation period. The observations of female No. 18 were made from 17:35 until night (third day), and the temperature was fairly constant at about 64 degrees. I believe that these low temperatures may account, in part, for the peak of the third day shown in Figure 21. The average ratio for the peak of the eleventh day was obtained from the incubation rhythm of females No. 5 and No. 17. Here again low temperatures may explain, in part, the peak on the eleventh day.

TABLE 8

INCUBATION RHYTHMS OF 10 FEMALE SCARLET TANAGERS

Female	Day of Incubation					
	1	2	3	4	5	6
No. 1						
Av. min. on	19.28	14.50			10.53	18.68
Av. min. off	8.66	4.90			3.35	2.93
Ratio on/off	2.23	2.96			3.14	6.40
No. 6						
Av. min. on		13.60				
Av. min. off		4.60				
Ratio on/off		2.96				
No. 10						
Av. min. on	23.00	21.58	22.50	19.40	22.00	13.05
Av. min. off	5.00	2.58	2.45	3.63	3.83	9.25
Ratio on/off	4.60	8.36	9.18	5.34	5.74	1.41
No. 13						
Av. min. on	28.10	30.63				
Av. min. off	8.30	11.40				
Ratio on/off	3.39	2.87				
No. 15						
Av. min. on	16.80					
Ave. min. off	4.10					
Ratio on/off	4.10					

TABLE 8--Continued

Female	Day of Incubation 1	2	3	4	5	6
No. 16						
Av. min. on	30.33					
Av. min. off	6.00					
Ratio on/off	5.05					
No. 18						
Av. min. on	13.75		23.70	20.21	75.00	
Av. min. off	7.46		10.30	6.44	70.50	
Ratio on/off	1.85		2.30	3.14	1.06	

Female	Day of Incubation 7	8	9	10	11	12	13
No. 1							
Av. min. on	17.83	18.83					
Av. min. off	4.67	3.17					
Ratio on/off	3.83	5.78					
No. 3							
Av. min. on						16.80	22.00
Av. min. off						6.40	6.70
Ratio on/off						2.63	3.28
No. 5							
Av. min. on	15.61		13.16		24.50	19.00	
Av. min. off	8.39		14.20		11.50	15.00	
Ratio on/off	1.86		0.93		2.13	1.27	
No. 10							
Av. min. on	39.67						
Av. min. off	6.17						
Ratio on/off	6.43						
No. 17							
Av. min. on		29.50	25.83	17.95	24.43	18.65	18.71
Av. min. off		4.25	2.29	2.60	3.29	3.39	7.77
Ratio on/off		6.94	11.31	6.90	7.43	5.50	2.41

If observations could be made of many female Scarlet Tanagers during the entire daylight period, for each of the 13 days of incubation, I believe that there would be an increase

Average Ratios per Day of Incubation
for
Ten Scarlet Tanager Females

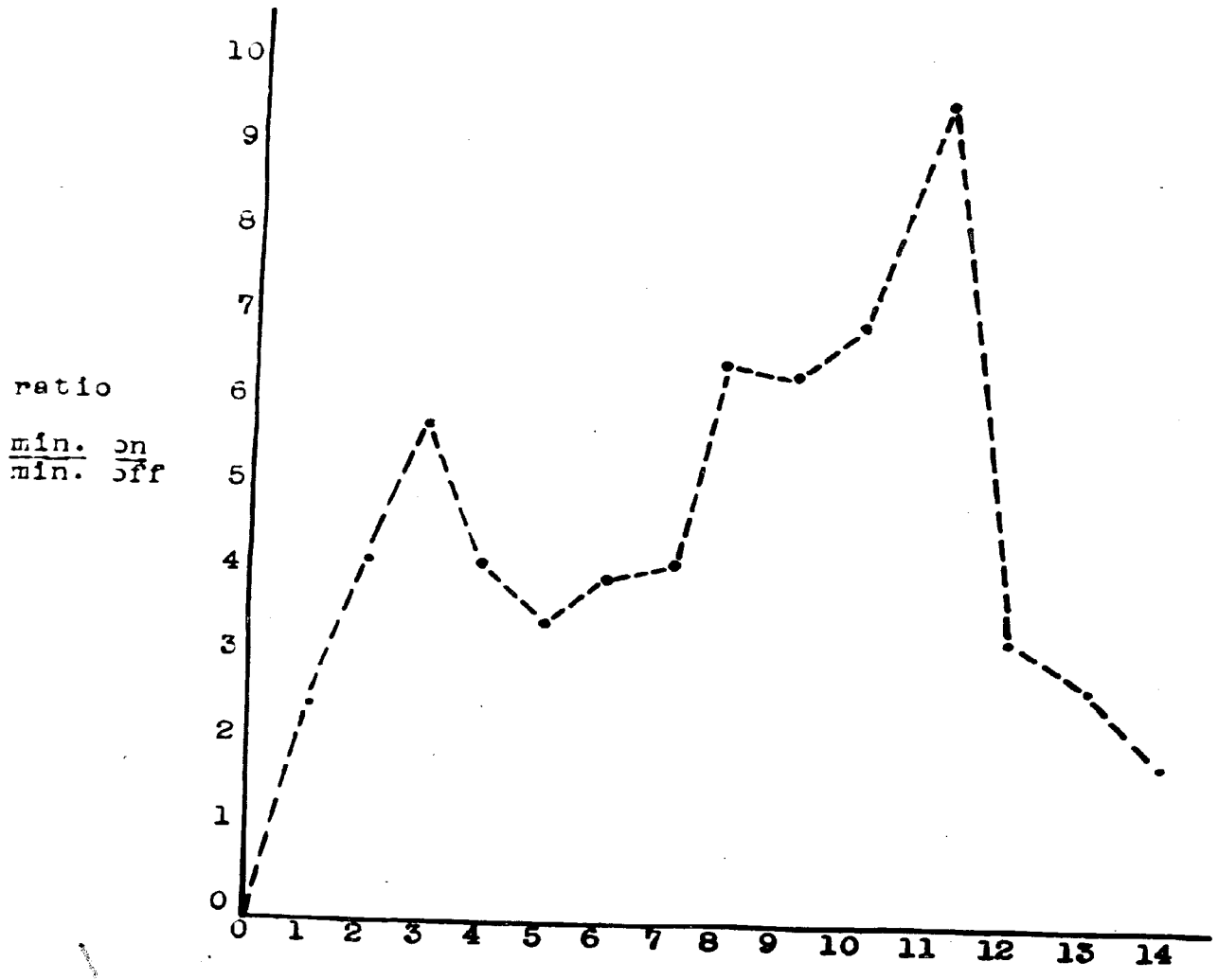


Figure 21

of attentive periods from the first day of incubation up to the eleventh day. Figure 21, allowing for the peaks of the third and eleventh day, seems to show this trend. I am unable to explain the lowered ratios of the twelfth and thirteenth (day of hatching) day. I would have expected the ratio of attentive to inattentive periods to increase up until the day of hatching, but apparently this is not the case.

Incubation rhythm in relation to temperature. Variations in temperature also affect the incubation rhythm of the incubating female Scarlet Tanager. Unfortunately I did not record temperatures during my first year's field work. However the last two years, I recorded the temperature at hourly intervals, during my observations of the incubating females. I used a simple outdoor thermometer. It contained a red liquid, evidently an alcoholic solution, which was quite sensitive to slight temperature variations in the woods. I leaned the thermometer against a twig on the ground, and always kept it in the shade. I do not believe that my temperature recordings, taken near the ground, and in the shade, represent the temperature at the Scarlet Tanager nest. At times the nest received direct sunlight, and there probably was considerably more air movement in the trees than at my thermometer which was partially protected by the blind. However, such temperature recordings probably reflect the temperature changes in the woods environment in the vicinity of the nest, and I believe that they may be thought of as reflecting similar temperature changes at the nest. Table 9 gives the average temperature, day of incubation,

span of observations, and the incubation ratio, for six Scarlet Tanager females. The average daily temperatures and the incubation rhythm (ratio min. on/min. off) for females No. 10 and No. 17 are plotted as Figure 22. In general this figure shows that as the temperature drops, the incubation ratio rises, and as the temperature rises the incubation ratio falls. Moreover, this figure shows that the effect of temperature on the incubation ratio is independent of the effect caused by the day of incubation (see preceding discussion - Incubation rhythm in relation to each incubation day). Temperature is a factor which affects the incubation rhythm of the incubating female Scarlet Tanager.

TABLE 9

AVERAGE TEMPERATURE AND INCUBATION RATIO
FOR SIX SCARLET TANAGER FEMALES

Female No.	Day No.	Span of Observations	Ave. Temp.	Ratio On/off
13	1	06:10–09:14	69.25	3.39
13	2	04:54–07:35½	43.50	2.87
15	1	08:34½–10:19	58.67	4.10
16	1	15:49–17:38	79.33	5.05
10	1	10:03–15:39	75.83	4.60
10	2	15:50–18:15	67.33	8.36
10	3	05:26½–09:41½	61.60	9.18
10	4	09:39–13:54	67.21	5.34
10	5	13:18½–15:27	67.66	5.74
10	6	12:03–19:29	80.33	1.41
10	7	05:00–09:35	67.00	6.43
17	8	09:01½–12:24	75.40	6.94
17	9	08:51½–09:36	56.00	11.31
17	10	09:16–12:41½	62.20	6.90
17	11	09:00–12:14	64.87	7.43
17	12	08:55½–12:32½	73.40	5.50
17	13	09:39½–19:48½	82.37	2.41
18	1	09:13–11:20	79.00	1.85
18	3	16:54–19:44	64.75	2.30
18	4	16:32–19:45	67.00	3.14
18	5	16:54–19:01	76.67	1.06

Other factors in relation to the incubation rhythm. At times direct sunlight may strike the Scarlet Tanager nest. I have never observed a female Scarlet Tanager to leave the nest when direct sunlight strikes her, even though she appears to become very hot and uncomfortable, often holding her bill open and panting. In spite of her apparent discomfort, and the fact that attentive periods tend to shorten as the temperature rises she does not leave the nest while it is in direct sunlight. She may stand high in the nest, with her wings partially open, shading the nest, or she may partially crouch in the nest without being actually in contact with the eggs but still furnishing shade. Occasionally she hops up to the nest rim, then back on the nest a few seconds later. She is definitely uneasy at such times, but apparently reluctant to leave the nest.

The female Scarlet Tanager tends to incubate for longer periods of time when it is raining. This may be due, in part, to the lowered temperatures which accompany rain. However females have left the nest during a rain, when rain drops were not actually falling on the incubating female. Yet she rarely leaves if the rain drops fall on her, and if she does, she returns within several seconds. During a very heavy rain, female No. 17 partially opened her wings and rested them on the nest rim. The wings sloped downward from her back, and as the water struck her it rolled from her back, down the wings, and dripped to the ground without running into the nest.

Hunger must also play an important role in regulating the female's incubation rhythm. This is a rather intangible factor

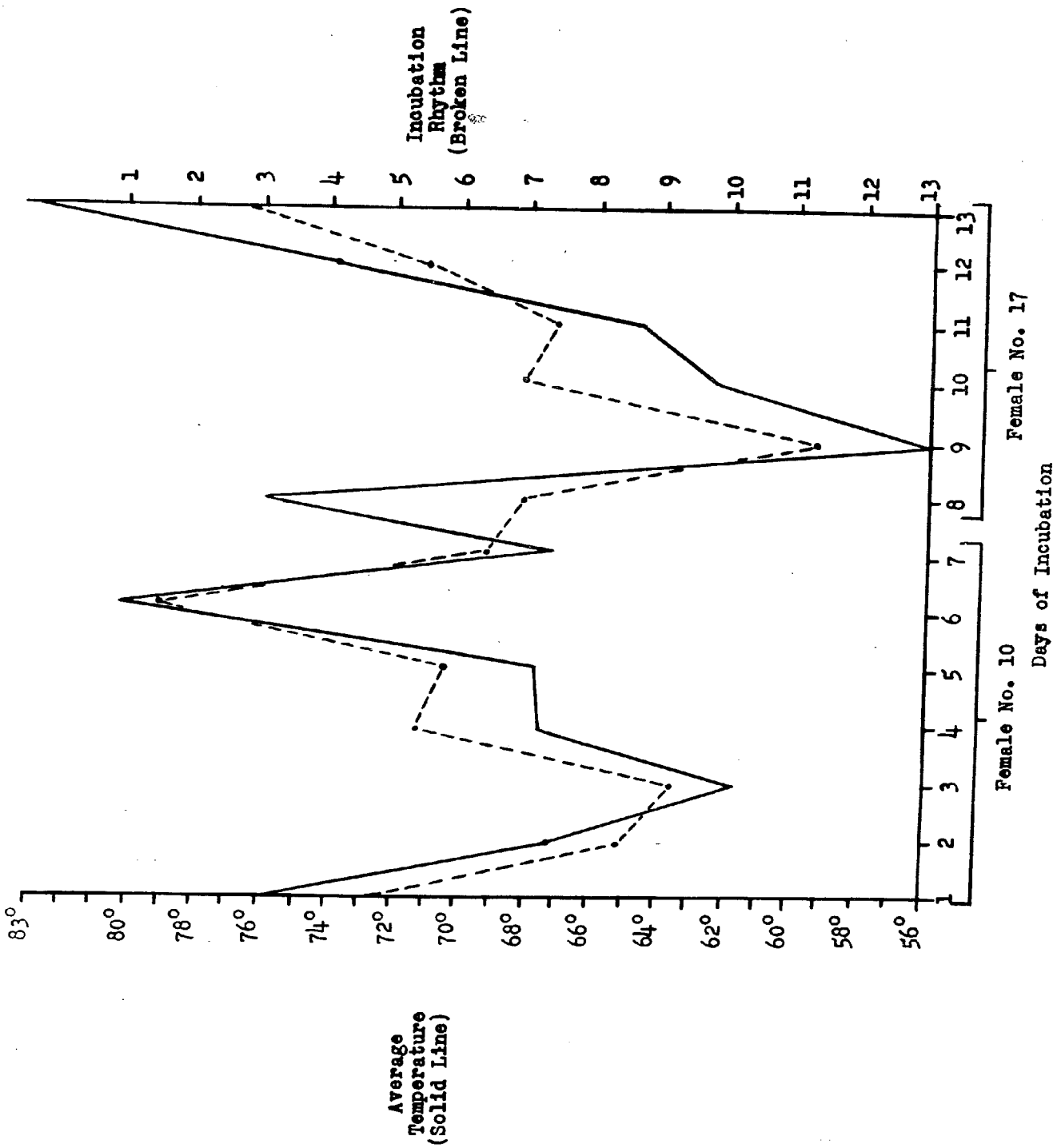


Fig. 22. Relation of temperature and the incubation rhythm to the days of incubation.

and I cannot show its actual role. However there is a tendency for a female to incubate for longer periods of time if she is fed occasionally by the male while she incubates.

There must be many other factors which influence the female's incubation rhythm. The need for exercise, presence of other species in the territory, response to the male in nearby trees, and undoubtedly my arrival to the blind must affect her in some way. However I am unable properly to evaluate these factors.

Actual recorded incubation rhythms. Figures 21 to 36, which appear at the end of this chapter show, graphically, the actual incubation rhythm of 10 Scarlet Tanager females. The periods on, and off, are given to the nearest half minute. Temperatures, where kept, are given for approximately hour intervals. The foregoing discussion of incubation rhythm is largely based on the data given in these figures. I have made a special effort to construct these bar diagrams so that the actual time periods can, if desired, be re-computed and re-analyzed by others.

SUMMARY

1. The Scarlet Tanager egg is greenish-blue with reddish-brown spots or flecks.

2. The size of the Scarlet Tanager egg is approximately .93 x .63 inches.

3. The average clutch size is four eggs, although later nests may have only three eggs.

4. Incubation is performed entirely by the female.

5. The incubation period is apparently 13 days.

6. The female frequently stands up in the nest to inspect and turn her eggs. She makes several nudging motions with her beak in moving and turning the eggs.

7. Females often preen on the nest.

8. When the female leaves her nest it is a hurried departure, rarely involving more than one perch before she flies.

9. Each female appears to follow an individual routine in leaving the nest, which is used except when leaving hurriedly.

10. The female usually returns to her nest hurriedly and secretively.

11. The male Scarlet Tanager occasionally feeds the female as she incubates.

12. When the female flies from her nest to feed in nearby trees she is often fed by the male. This may account for her being able to get sufficient food when she is off the nest for very short periods.

13. Incubation rhythm is the alternation of attentive and inattentive incubating periods. It can be computed by dividing the minutes which the female spends on the nest, by the minutes she is off the nest.

14. There is a trend of increased attentive periods from the first day of incubation up to the eleventh day, and a decline the last two days.

15. As the woods temperature drops, the incubation ratio rises, and as the woods temperature rises, the incubation ratio

falls.

16. Bar diagrams show the incubation rhythm of 10 Scarlet Tanager females.

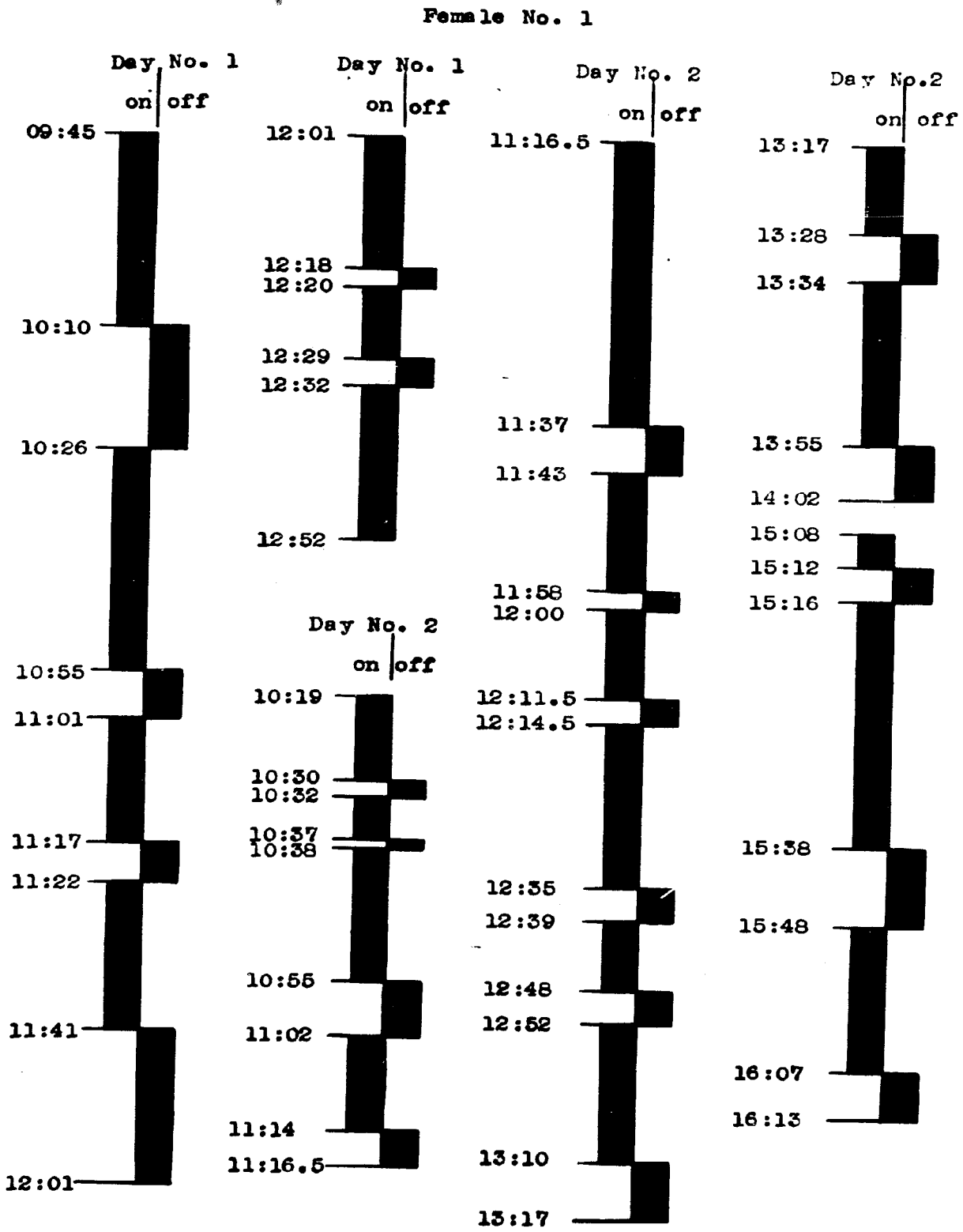


Fig. 23. Incubation rhythm of female No. 1, days No. 1 and No. 2.

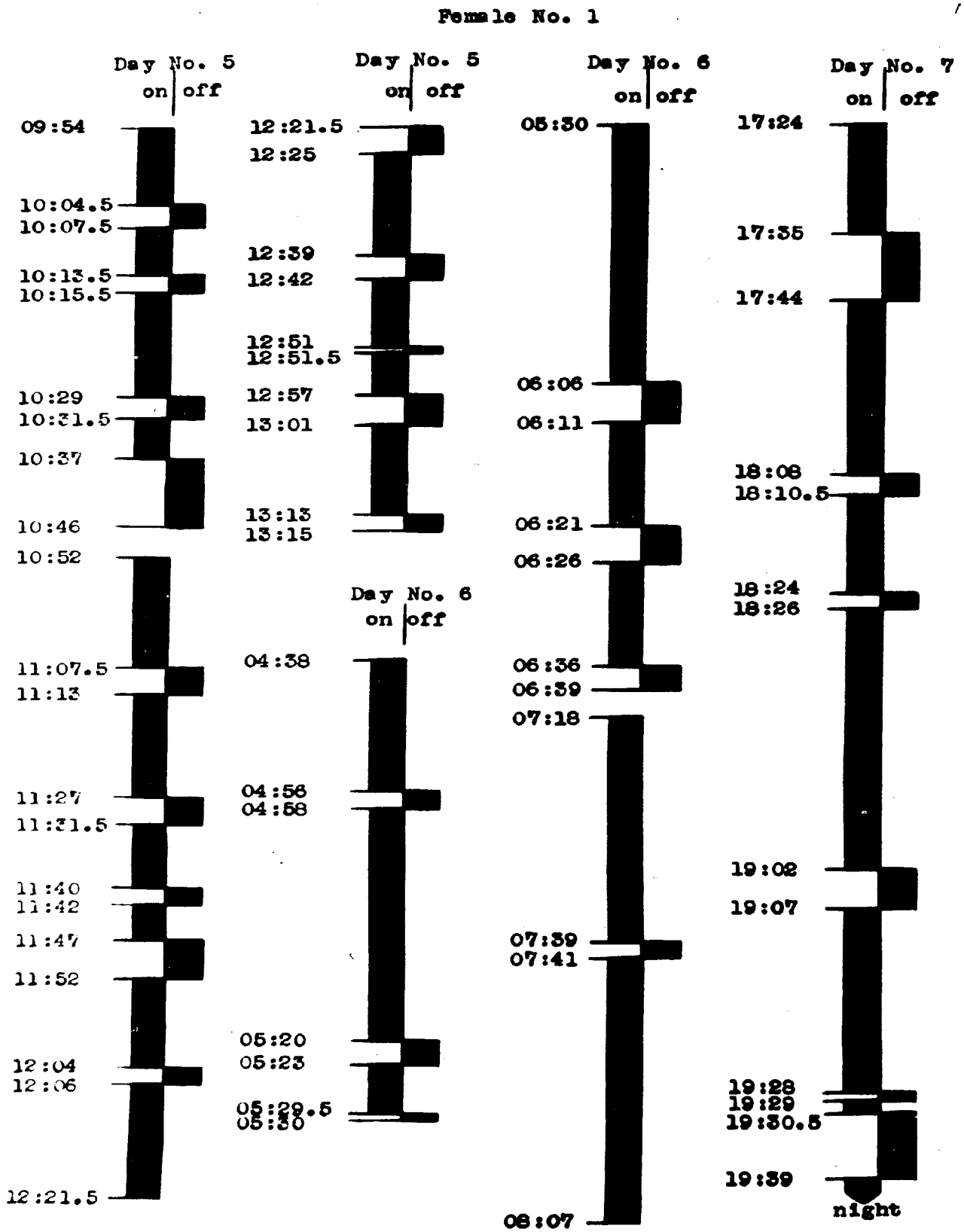


Fig. 24. Incubation rhythm of female No. 1; days No. 5, No. 6, and No. 7.

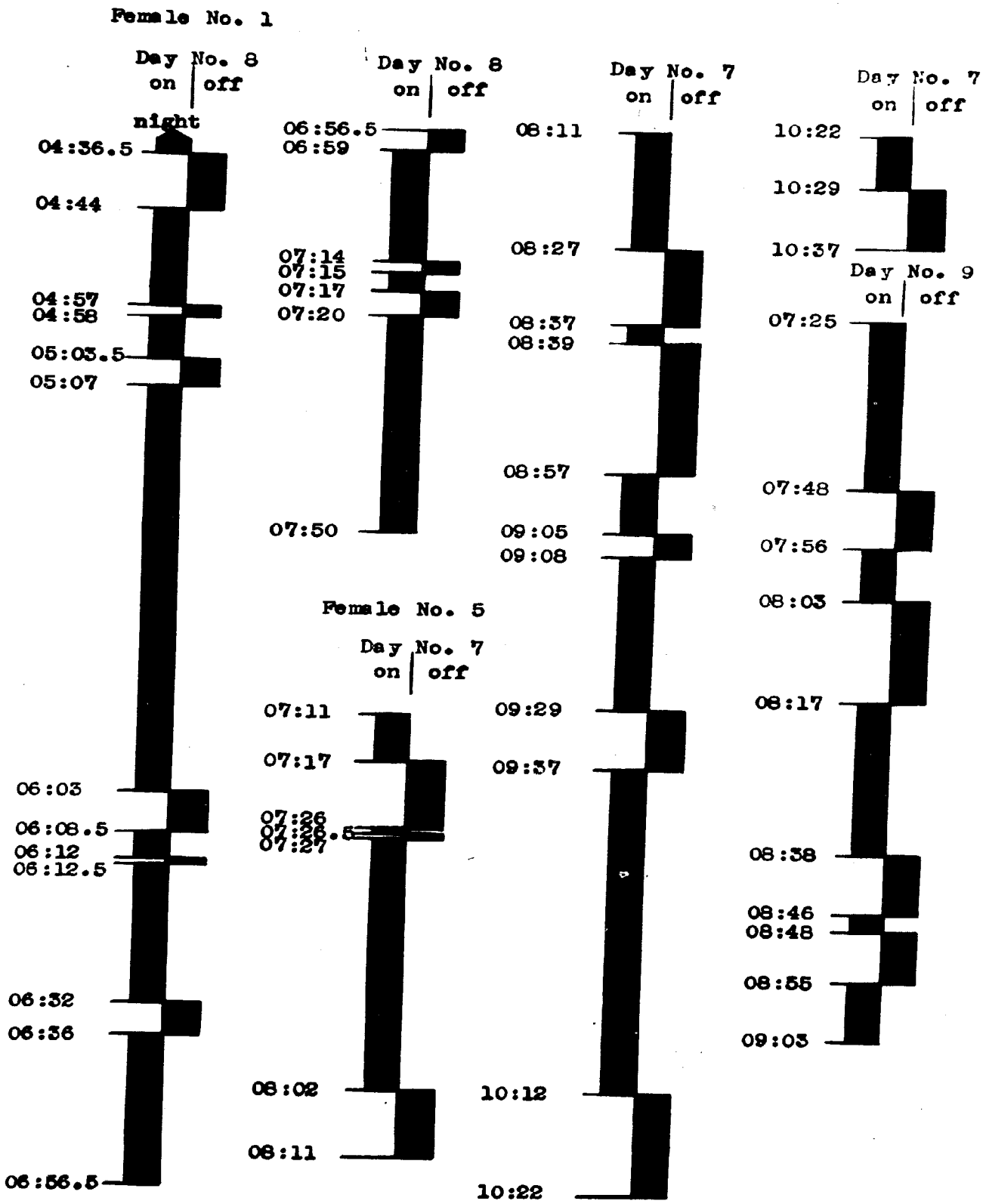


Fig. 25. Incubation rhythm of female No. 1, day No. 8; female No. 5, day No. 7.

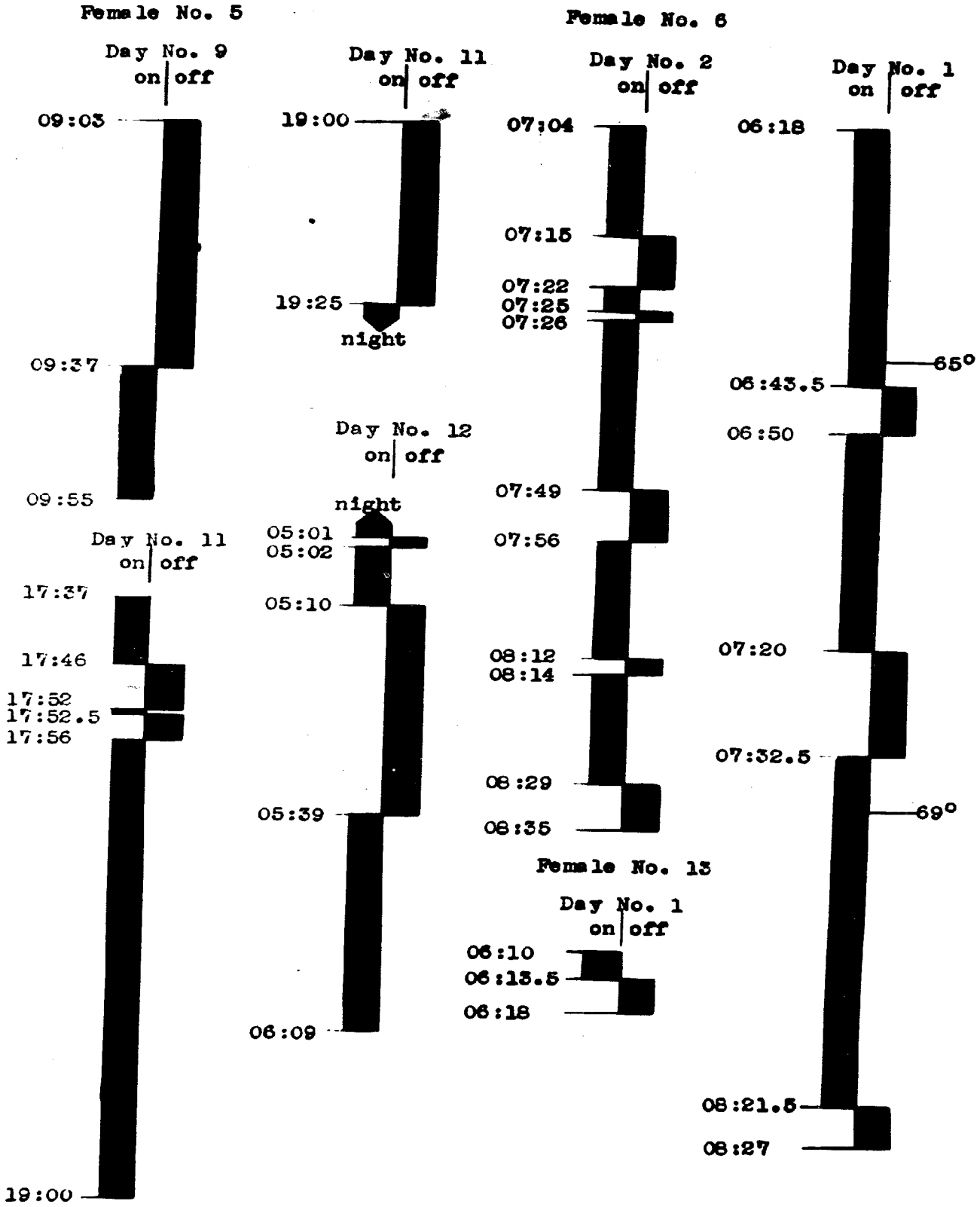


Fig. 26. Incubation rhythm of female No. 5, days No. 9, No. 11, and No. 12; female No. 6, day No. 2; and female No. 13, day No. 1 (cont.)

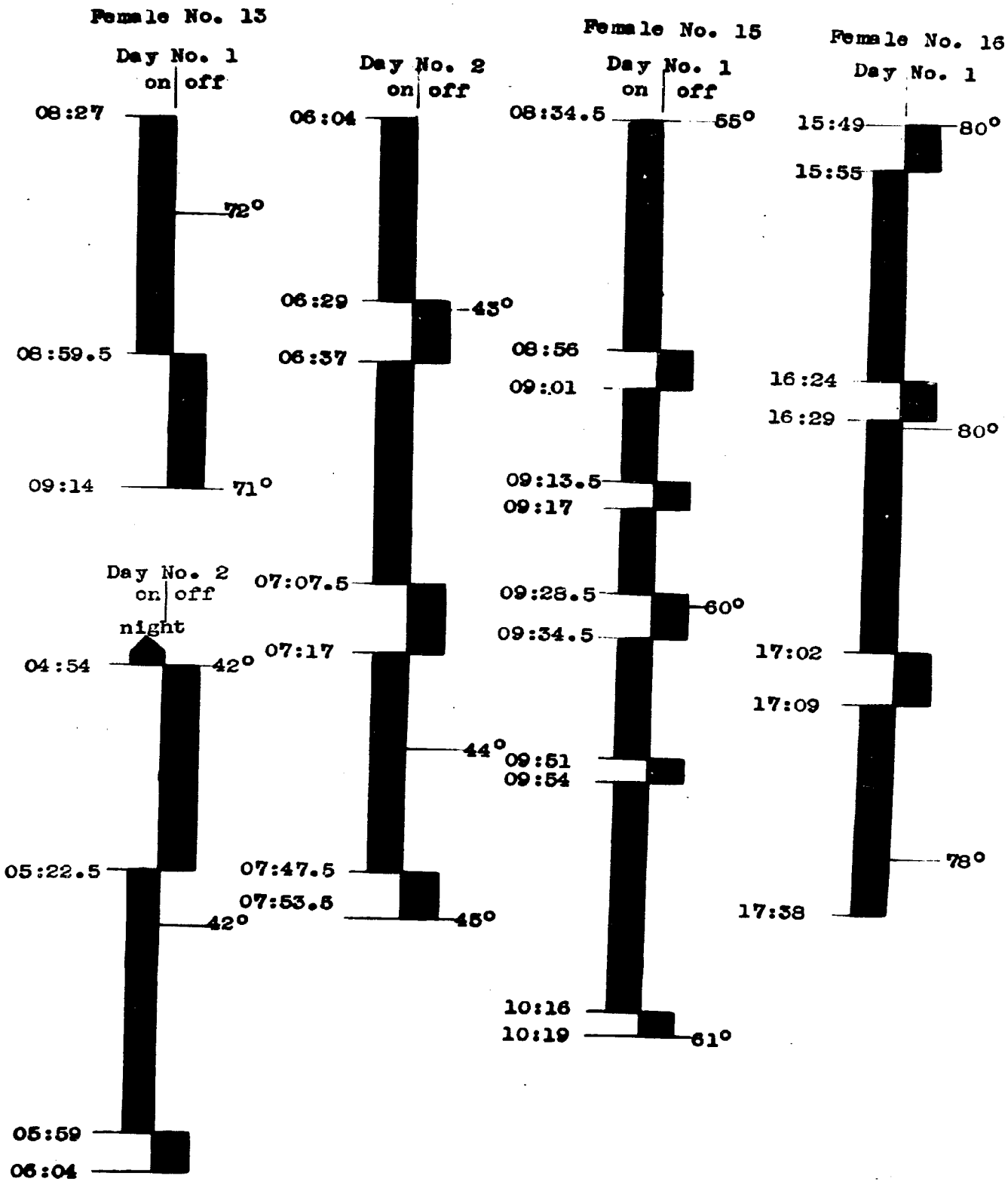


Fig. 27. Incubation rhythm of female No. 13, days No. 1, and No. 2; female No. 15, day No. 1; female No. 16, day No. 1.

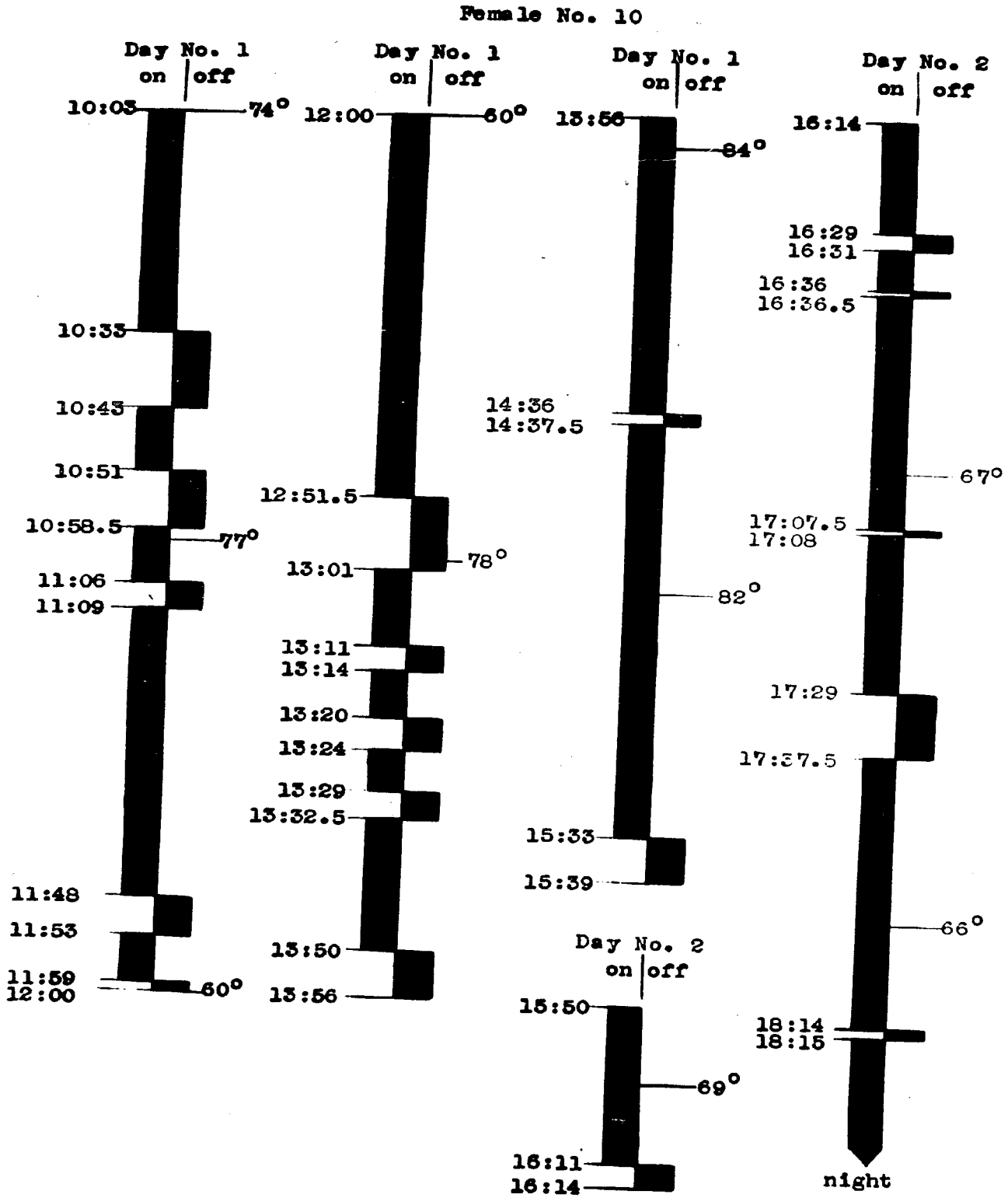


Fig. 28. Incubation rhythm of female No. 10, days No. 1, and No. 2.

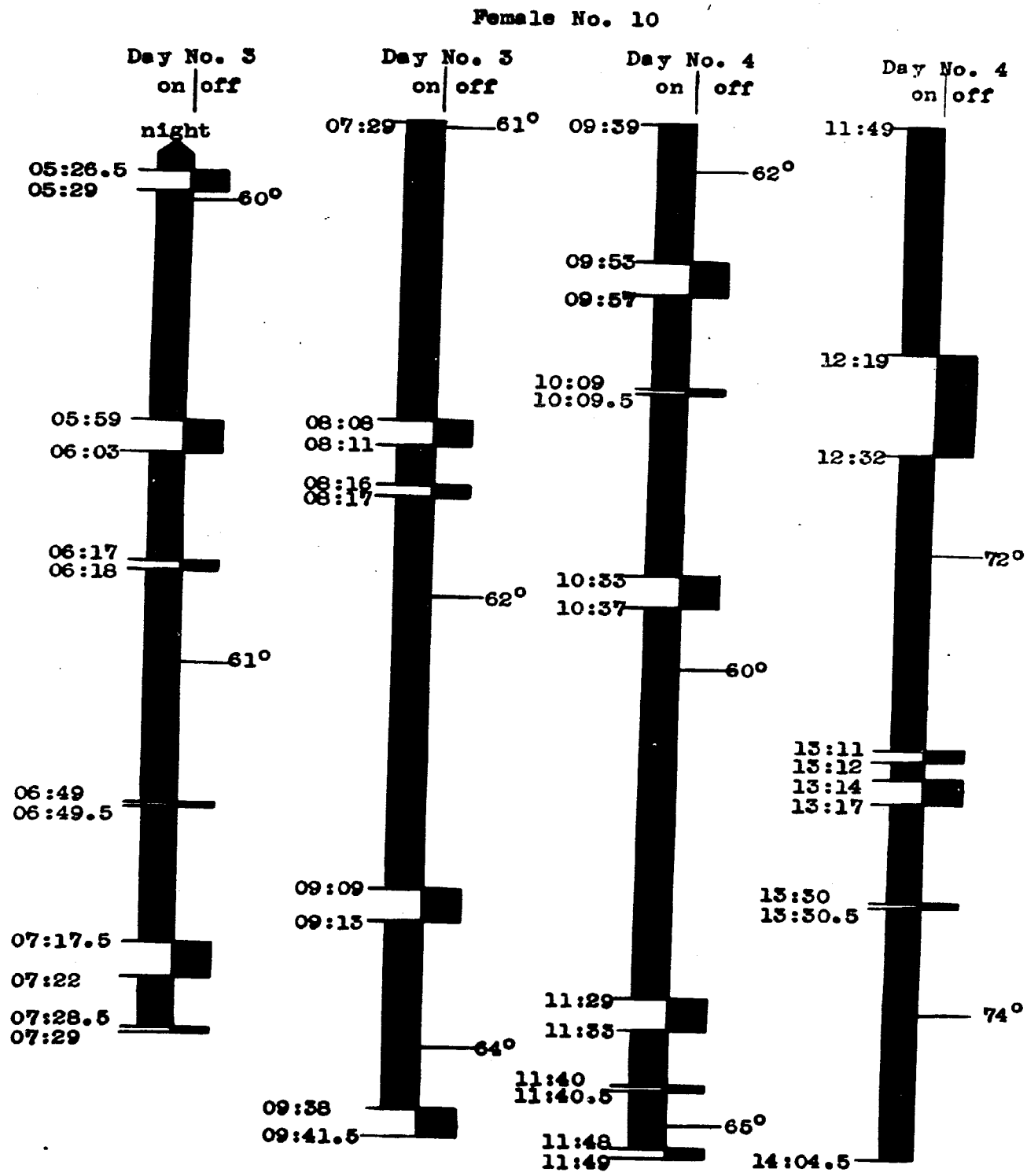


Fig. 29. Incubation rhythm of female No. 10, days No. 3, and No. 4 (cont.)

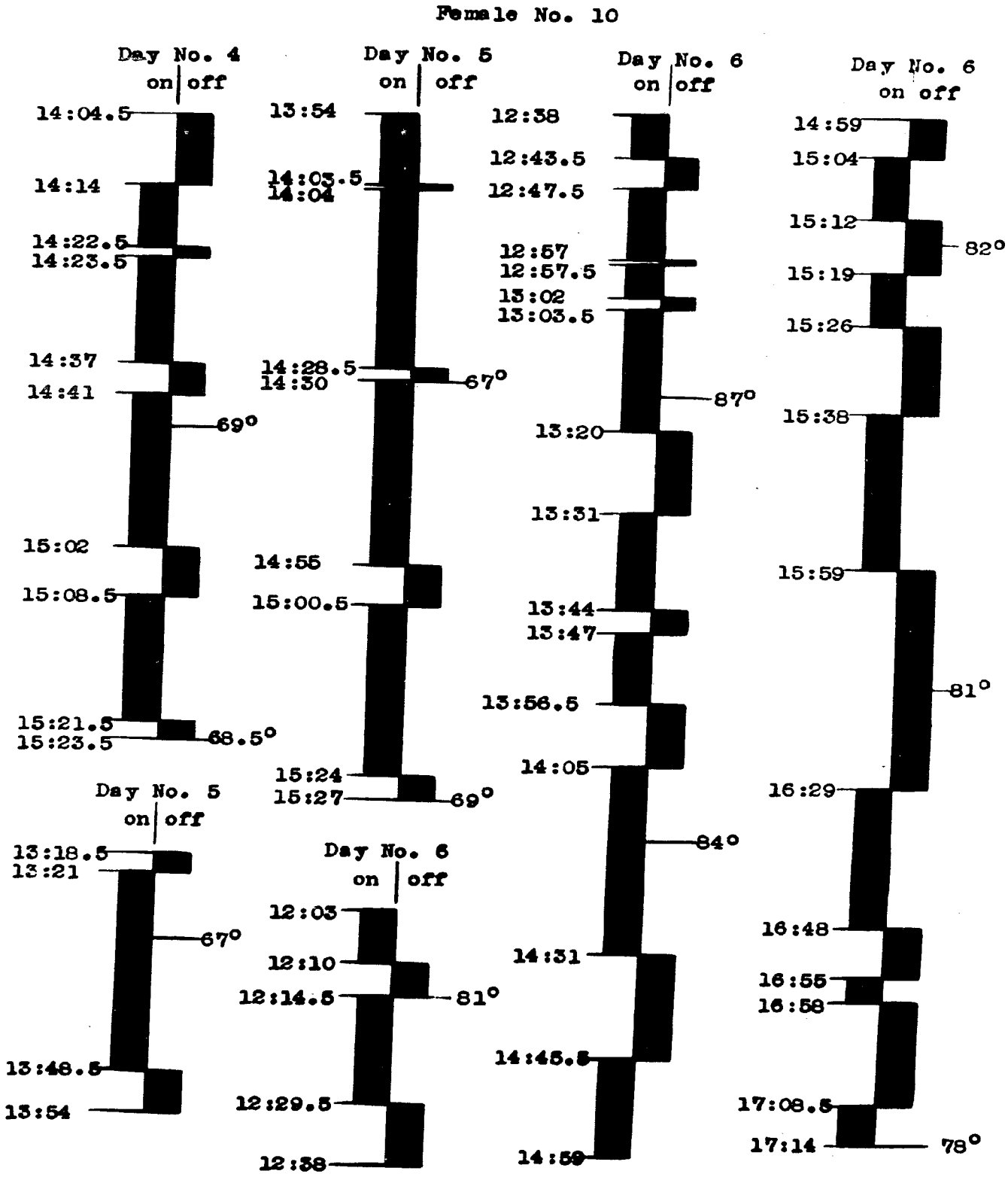


Fig. 30. Incubation rhythm of female No. 10, days No. 4, No. 5, and No. 6 (cont.)

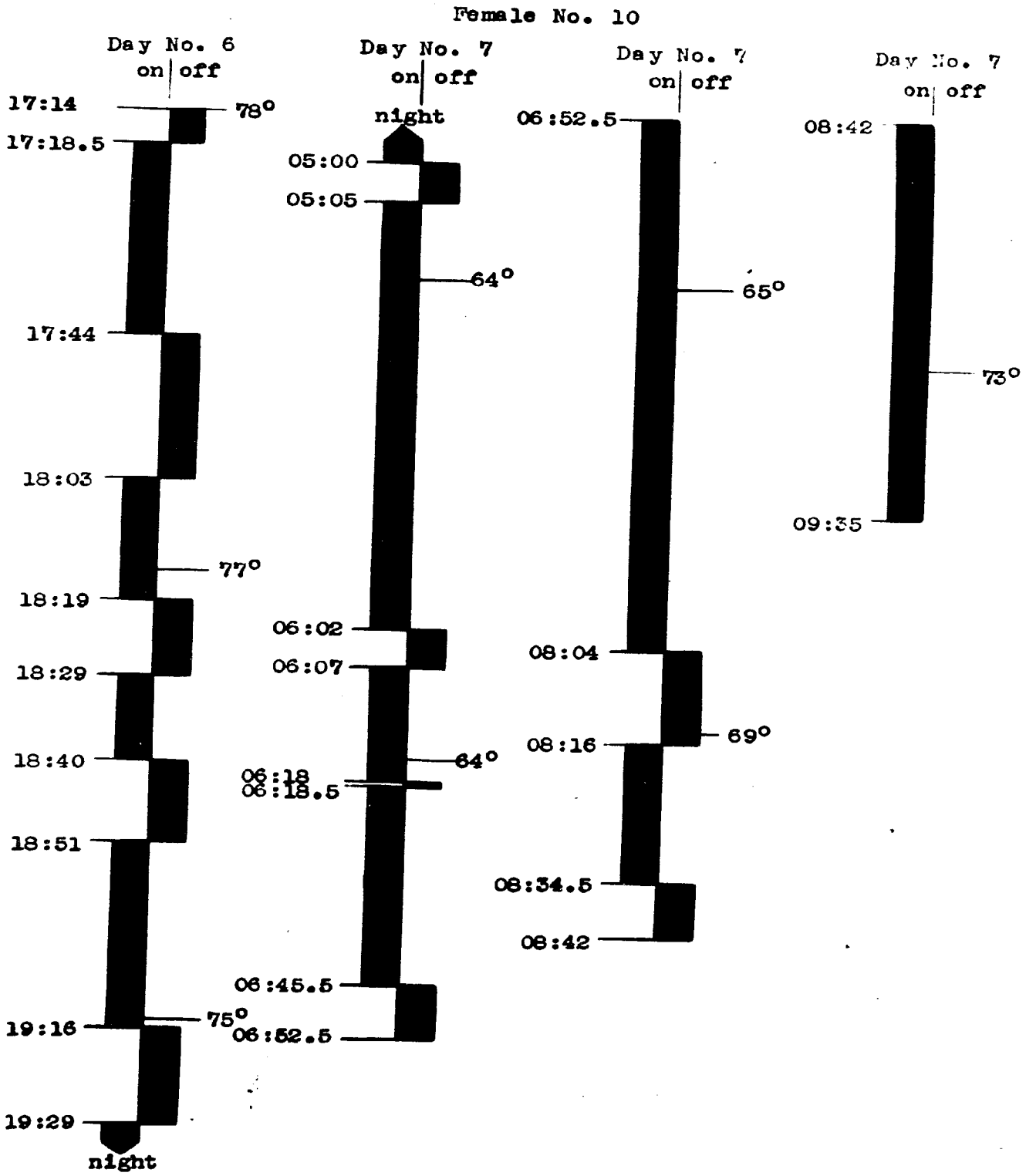


Fig. 31. Incubation rhythm of female No. 10, days No. 6, and No. 7.

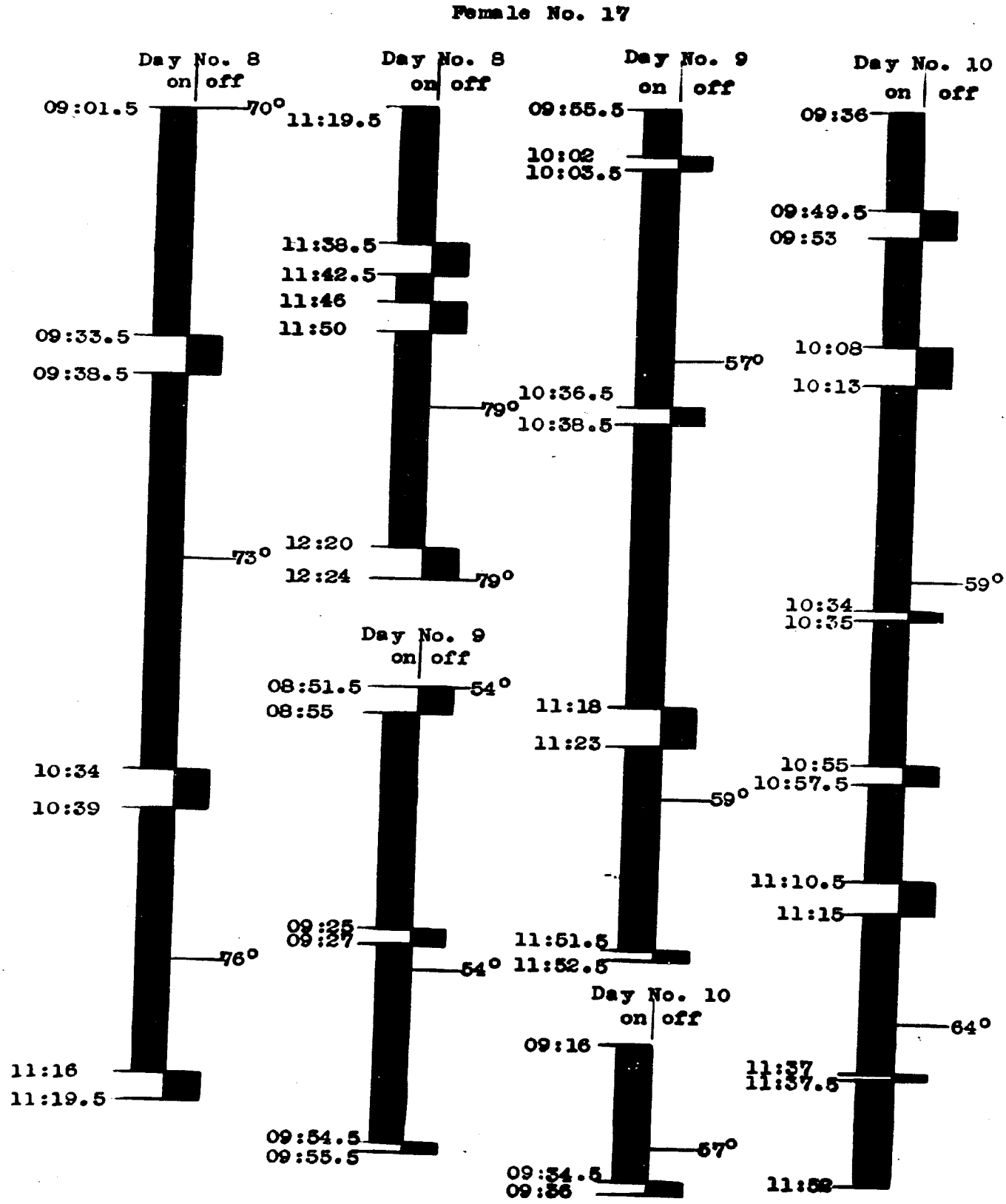


Fig. 32. Incubation rhythm of female No. 17, days No. 8, No. 9, and No. 10 (cont.)

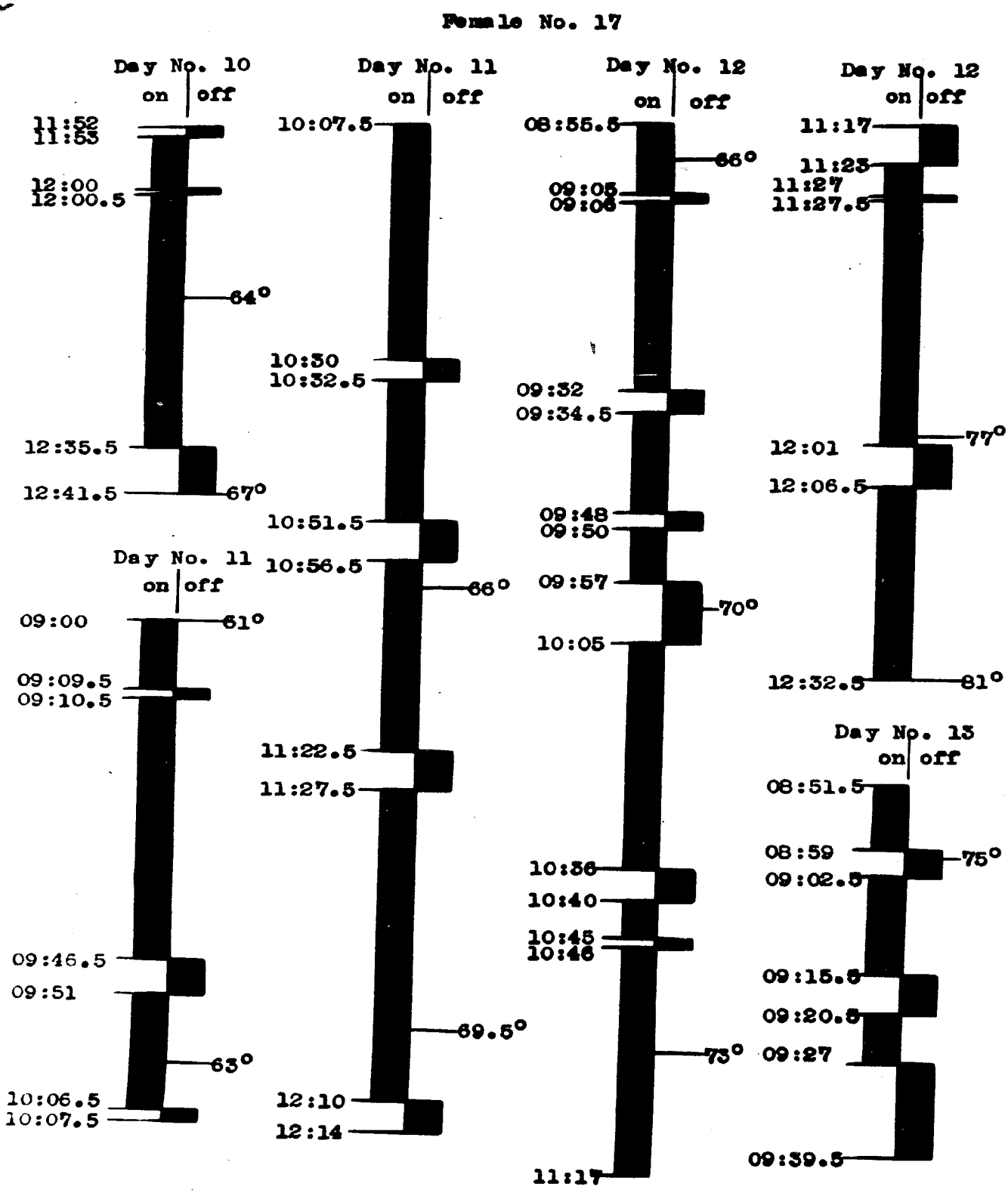


Fig. 33. Incubation rhythm of female No. 17, days No. 10, No. 11, and No. 12.

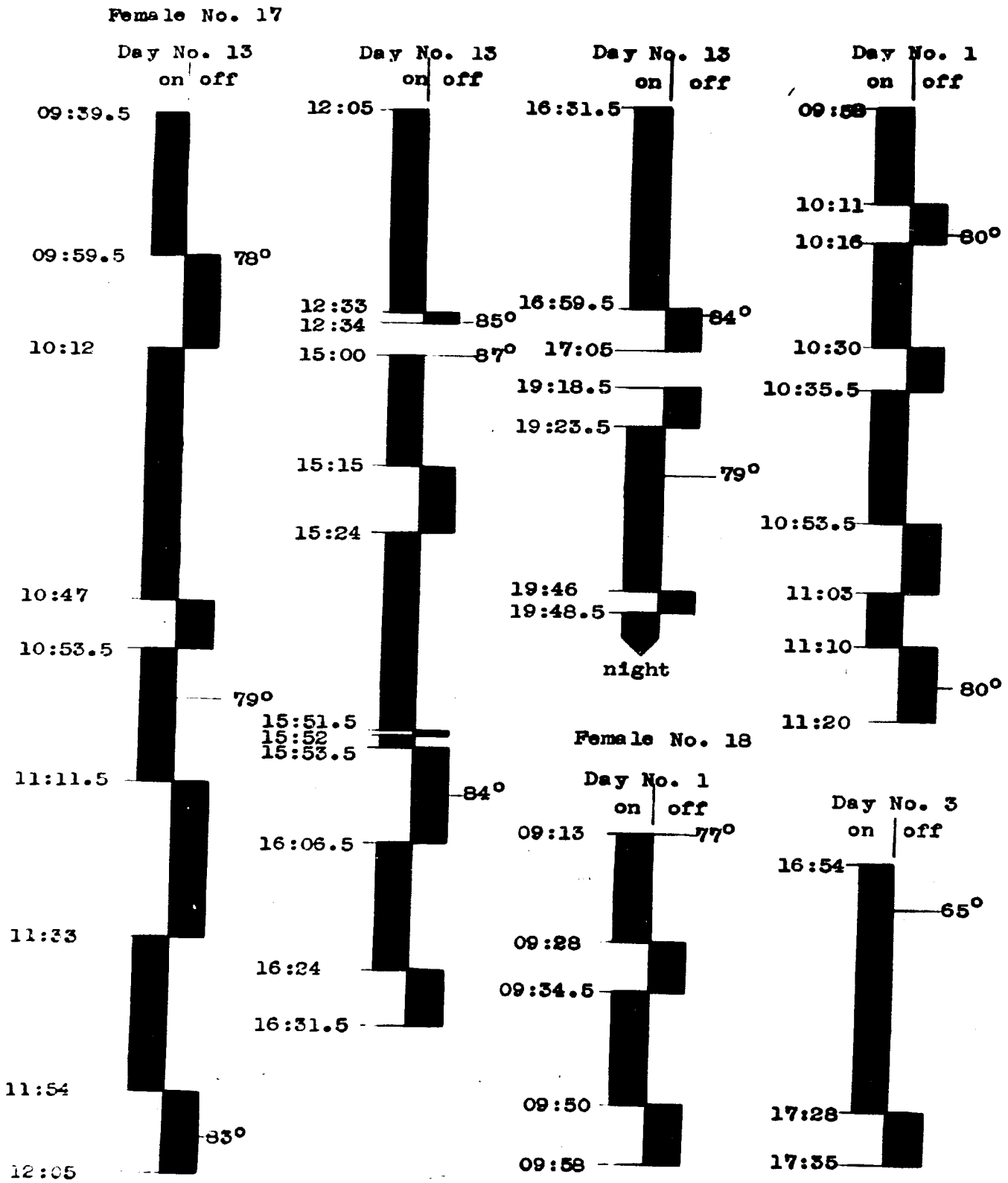


Fig. 34. Incubation rhythm of female No. 17, day No. 13; female No. 18, days No. 1, and No. 3 (cont.)

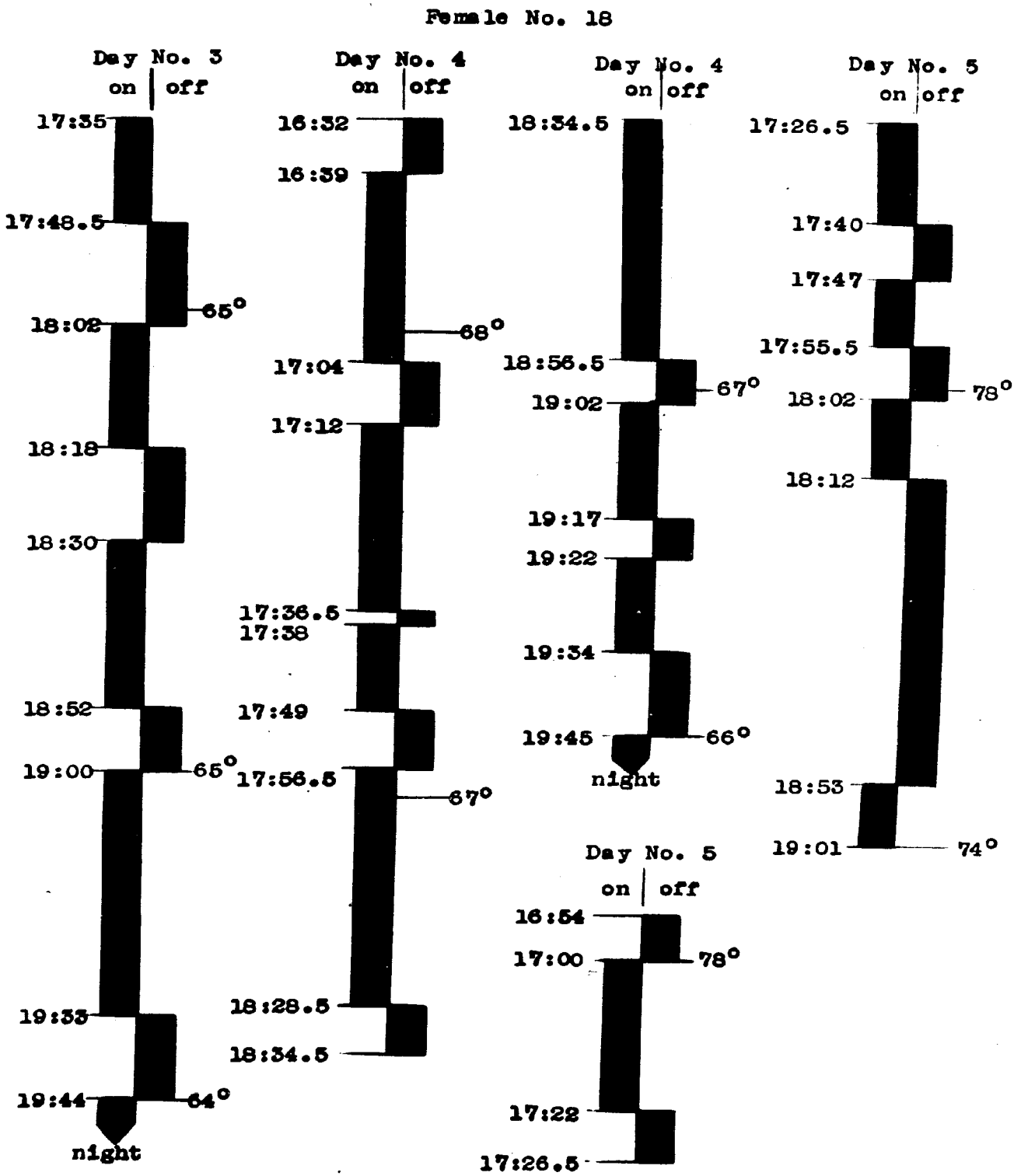


Fig. 35. Incubation rhythm of female No. 18, days No. 3, No. 4, and No. 5.

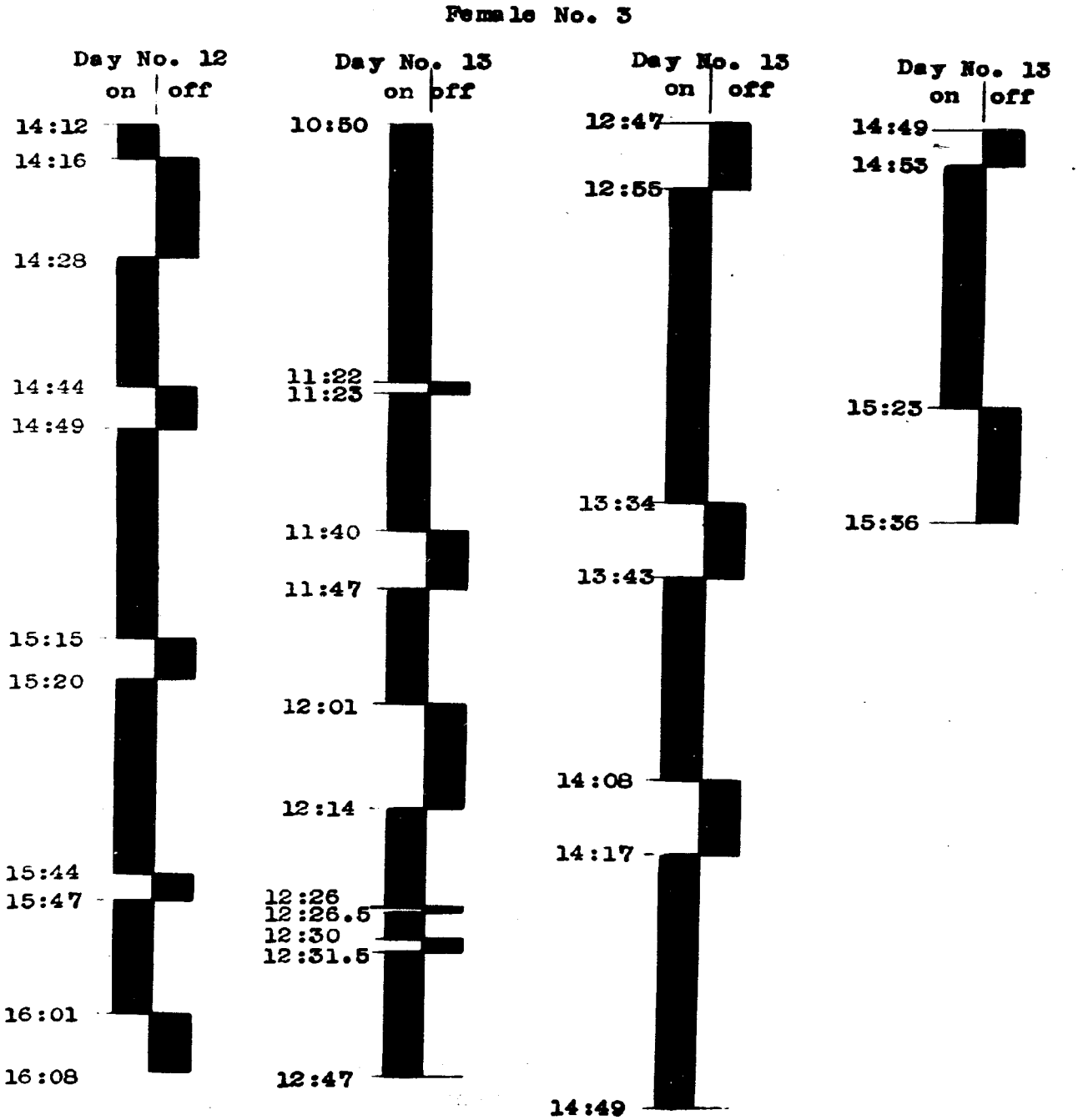


Fig. 36. Incubation rhythm of female No. 3, days No. 12, and No. 13.

CHAPTER VII

THE SCARLET TANAGER NESTLING

A. Description of Nestlings

Scarlet Tanager nest No. 5 was low and accessible (see History of Nests, Chapter IV). The three tanager-egg clutch of this nest hatched and I was able to record the daily weights, daily growth, and behavior of the nestlings until the ninth day of development, when the nestlings probably were taken by a predator. The following account is based on my observations of the three tanager nestlings of nest No. 5.

Day of hatching. Average weight, 2.97 grams. Small tufts of grayish-white down on head, and on dorsal pterylae. Flesh color orange; viscera can be seen through the skin of abdomen. Eye slits closed. Mouth lining bright orange-yellow; egg tooth present. Young move weakly when placed on the weighing pan, unable to hold head up for more than a few seconds; much movement of head from side to side; any forward body movement is done on all fours, with wings and feet rapidly moving. Tapping of the nest causes young to gape, but independently of each other, the head weaving weakly as it is pointed upward.

One day old. Average weight, 4.73 grams. Tufts of white down as before. Small black line separating eyelids. Flesh color is orange-yellow. Viscera show through skin of abdomen. Mouth lining orange; egg tooth present. A high "peep" is

audible when nestling is held in the hand and close to the ear. All gape when nest is touched.

Two days old. Average weight, 6.91 grams. Pin feathers beneath wing skin show as line of primaries and secondaries. Flesh color is yellow; viscera still show plainly through skin of abdomen. Eyes closed; slit appears as a wide black line separating the lids. Mouth lining orange; egg tooth present, appearing darker than rest of the beak. Heads held high when gaping, steadier than before; when placed on their backs, they squirm working wings and feet vigorously and are able to roll over onto the abdomen. They defecate when placed on the cold surface of the weighing pan. They gape when the nest is touched, and a high faint "peep" is audible three to four feet from the nest.

Three days old. Average weight, 9.02 grams. Primaries and secondaries appear to be coming through the skin. Skin color yellowish; viscera still show through skin of abdomen. Beak color is yellowish, with tip darker than rest of beak; egg tooth still apparent; mouth lining orange. Feet and legs are whitish. Opening between eyelids a slit-like opening, a wide black line; eyeball can be seen through the slit. The high "peep" call is audible at four to five feet from the nest. Young may defecate when removed from the nest and when placed on the cool pan. Feet constantly being opened and closed, many grasping movements both when against a surface and when young are held in the air.

Four days old. Average weight, 11.61 grams. Lateral

feather tracts on abdomen are yellowish; dark dorsal tract at neck and on back; well formed rows of primaries and secondaries. Skin now appears a tan color. Eyelid opening still a black line, though wider than before. The edge of the mouth appears whitish; culmen and tip of beak dark; mouth lining orange. Feet and legs dull white. Young rest low in the nest with beaks on the nest rim. Independent gaping. When placed in the weighing pan they work wings and feet constantly; the wings which are raised horizontally and half opened are pushed forward and away from the body; the head is raised but slightly from the bottom of the pan during these movements. Feet open and close rapidly; they are able to grasp rootlets of the nest and hold firmly.

Five days old. Average weight, 14.07 grams. Skin color tan. Eye slits open about half way, the eyeball very watery. Edge of mouth appears bright yellow, tongue is reddish, and the mouth lining orange. Tip of beak appears light. Young rest head and beak on the nest rim and in hot weather may hold beak half open. Feet grasp very well holding firmly to the nest bottom when lifted from the nest. In the weighing pan wings are opened and closed rapidly as feet and legs slide over the pan surface; an occasional fluttering wing movement; young move about until head rests on the edge of weighing pan, then become quiet. May not gape for food when nest is touched.

Six days old. Average weight, 15.53 grams. Short yellowish tail feathers appear; head has dark feather growth; ventral tracts are yellowish-white; little feather growth at femoral tract; some feathers under eye; primaries and secondaries emerge

from sheath. Skin color tan; viscera slightly visible through skin of abdomen. Eyes wide open as young follow my movements. Edge of mouth is white; the mouth lining yellow-orange; the beak tip dark. Feet and legs are dull, a bluish color with a slight pinkish tinge. In pan, feet and legs are held underneath the body, head held high, wings held almost normally although slightly out from the body. May gape and "peep" for food when handled.

Seven days old. Average weight, 16.51 grams. Many yellow and white feathers on ventral tracts; greenish feathers on dorsal tract; bright yellow under tail feathers, longer than before; some flakes cast off when young are handled. Skin color a pinkish-tan. Edge of mouth is white; the beak dark. They turn and watch me, and may gape as I approach the nest. They are able to stand up, head high and normal, wings drooping so that primaries touch the ground. When placed on the ground, crawl with head low and fluttering wing movements. After five minutes they appear quite at ease, watching my movements, and are not afraid of my fingers. When standing at rest the tarsus is completely on the ground. They give many food "peeps", some with the mouth closed; those given with the mouth open are fairly loud and demanding. When wings are opened they are opened wide and full. Feet grasp very well, and when young are carried they constantly open and close toes firmly on my fingers.

Eight days old. Average weight, 19.00 grams. Under tail feathers are bright yellow, 1/8 inch long; dark feathers cover

head; much down gone, still some over eyes and on back; breast almost completely feathered, whitish-gray streaks on the flanks, yellowish streaked feathers on abdomen. Eyes wide and normal. Edge of mouth white, although it appears yellow when gaping due to inner yellowish mouth lining. The tip of beak is darker than the rest. Feet and legs gun-metal, as before, with slight pinkish tinge. May gape for food when nest is touched. Are able to stand up without resting on the full tarsus; head held erect, though at times pulled in between the wings which are held normally, although they tend to droop and occasionally touch the ground. Able to maintain balance when placed on a stick perch even though the stick is slowly rotated between fingers, wings opening and closing rapidly to keep balance. Young are able to fly a few feet, barely able to clear the ground. Much calling and if excited they may hop out of the nest.

Weights of nestlings. The average weights used in the preceding discussion were computed from the three nestlings of nest No. 5. Figure 37 is a graphic representation of their average weights in relation to the days of development. Their individual weights, and those of two nestlings of nest No. 17, are given in Table 10 below.

Both nests contained only tanager young. It appears that the two young of nest No. 17 gained weight more rapidly than did the three young of nest No. 5. Both young of nest No. 17 were heavier on the fourth day of development than the three young of nest No. 5. It is possible, although by no means

certain, that the more rapid increase of the two tanager nestlings (nest No. 17) may be because the food was apportioned to two, rather than three, nestlings.

TABLE 10

DAILY WEIGHTS OF SCARLET TANAGER NESTLINGS

Nest	Day of Development	Nestling A	Nestling B	Nestling C	
No. 5	0	2.93	3.26	2.73	grams
" 5	1	4.86	4.84	4.48	"
" 5	2	7.15	6.73	6.85	"
" 5	3	9.52	9.26	8.28	"
" 5	4	11.90	12.29	10.65	"
" 5	5	14.90	14.11	13.19	"
" 5	6	15.63	15.25	15.70	"
" 5	7	16.35	16.38	16.81	"
" 5	8	18.44	19.22	19.35	"
No. 17	1	4.3	4.3	-	grams
" 17	2	6.5	6.1	-	"
" 17	3	9.25	10.0	-	"
" 17	4	12.5	12.9	-	"
" 17	5	15.7	-	-	"

The daily weight increase of the five tanager nestlings is given in Table 11. These data show that after the first day of development, the young of nest No. 17 gained more weight each day than did the young of nest No. 5. The least daily gain in weight was .72 grams by nestling "A" of nest No. 5, and the greatest daily gain was 3.9 grams by nestling "B" of nest No. 17.

TABLE 11

DAILY WEIGHT INCREASE OF SCARLET TANAGER NESTLINGS

Nest	Day of Development	Nestling A	Nestling B	Nestling C	
No. 5	1	1.93	1.58	1.75	grams
" 5	2	2.29	1.89	2.37	"
" 5	3	2.37	2.53	1.43	"
" 5	4	2.38	3.03	2.37	"
" 5	5	3.00	1.82	2.54	"
" 5	6	0.73	1.14	2.51	"
" 5	7	0.72	1.13	1.11	"
" 5	8	2.09	2.84	2.54	"
No. 17	1	1.2	1.88	-	grams
" 17	2	2.75	3.9	-	"
" 17	3	3.25	2.9	-	"
" 17	4	3.2	-	-	"

B. Behavior of Nestlings

The first three days of development, the nestlings' activity is concerned primarily with eating and resting. They gape weakly when the parent bird appears with food. Immediately after feeding, their feebly waving heads disappear below the nest rim, where they resume resting, huddled together in the bowl of the nest under the brooding female.

On the third day the young gape strongly when the parents arrive with food, and often they move about under the female as she broods. On this day a young at nest No. 11 poked its head far out between the breast feathers of the brooding female. She cocked her head to one side, holding her left eye close to the wavering head, and with gentle movements of her beak pushed him down underneath her. When four days old the young often poke

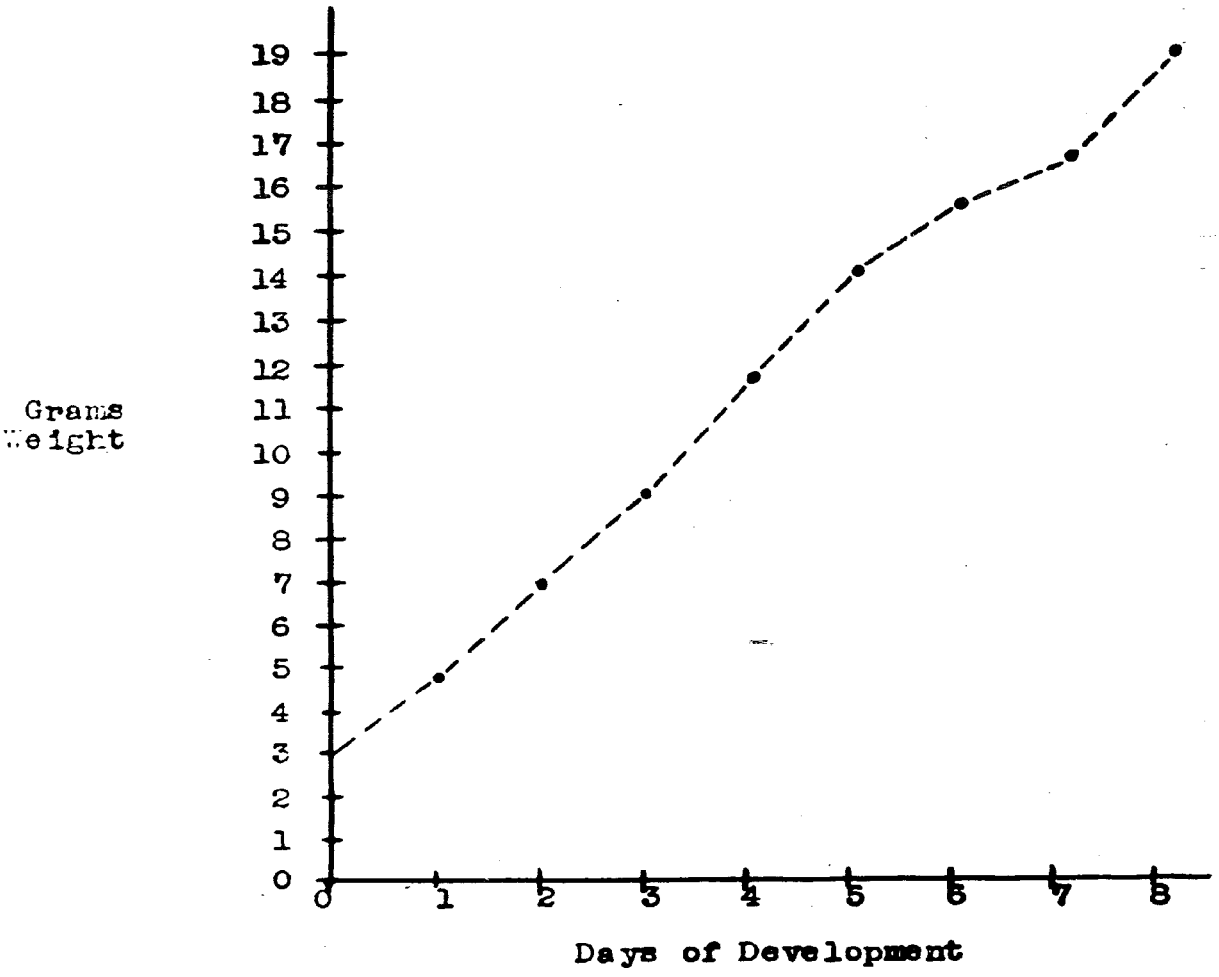


Fig. 37. Average daily weight of the three Scarlet Tanager nestlings of nest No. 5.

their heads free from the female and rest their heads on the nest rim. At such times the female stands high, with her legs widespread, or half crouches in the nest with breast and flank feathers fluffed out in an effort to cover the young. I particularly remember a young tanager, four days old, of nest No. 11, with his head projecting out between the feathers of the female in such a manner that one whitish flank feather rested over his head like a visored cap.

On the fifth day the young stand upright in the nest, although weakly at first, stretch their wings, and often gape at each other's movements. Attempts to climb up the sides of the nest invariably end in a tumble against the other young, with subsequent gaping and moving of all the young. By the sixth day most of their random movements have given way to preening behavior. The afternoon of the sixth day young of nest No. 11 preened four times in 40 minutes. These were my first observations of preening for this nest. Thereafter the young spend much time preening body feathers, pulling primaries through their partially open bill, and occasionally reaching back to the stub of tail. It is not unusual for them to lose their balance when preening, or to be pushed off balance by other nestlings.

On the ninth day one young of nest No. 11 stood up in the nest and beat his wings very rapidly. These were very strong, flight-like wing beats. He did this twice, stretching his neck high above the nest rim. One young of nest No. 2 climbed to the rim, stretched his head and neck toward a twig above the

nest and beat his wings rapidly, apparently making a concerted effort to reach that perch; his feet however continued to grasp the inner nest rim firmly and he kept falling on the rim. Wing exercising is most noticeable when parents have fed the young. Then the nestlings stand high in the nest, flutter their wings, and jostle each other trying to face the parent bird. They are physically able to leave the nest at this time.

Method of leaving the nest. Young tanagers leave the nest on approximately the ninth or tenth day of development; although they may delay as late as the eleventh day. The young of nest No. 3 left the nest on the ninth day of development and those of nest No. 11 on the tenth day.

I do not believe that the parents deliberately try to coax the young from the nest. Indeed, the opposite seemed to be the case at nest No. 2. Occasionally when a young tanager would clamber up on the nest rim, beating his wings rapidly and giving the appearance of toppling out of the nest at any moment, a parent would appear and hurriedly thrust food in its mouth. This seemed to satisfy the young's uneasiness and it would settle back in the nest. This happened many times at nest No. 2. It appeared to me that these parents, by constant and rapid feeding, prevented the young from leaving the nest, when they were actually physically able to do so.

No such anxiety was exhibited by the parents at nest No. 11. On the contrary, it seemed to be the indifference of the parents that caused the nest-leaving. One time, after feeding, the female flew to the bare perch a foot northeast of the nest.

She remained there facing away from the nest for approximately 25 seconds, oblivious of the Cowbird nestling, who climbed over the tanager young and stood on the northeast rim, fluttering his wings and buzzing loudly. After the adult female flew, the Cowbird once again climbed across the tanager and hopped up on the west rim of the nest. The west rim was flush with the ascending nest branch. The Cowbird hopped out onto the nest branch. As he awkwardly worked his way up the nest branch, grasping leaf petioles with his feet for support, he slipped once and almost fell off the branch. He ventured as far as eight inches from the nest, returned four inches, and then turned and made his way further up the nest branch. On a portion of the branch without leaf petioles he fell off and fluttered to the ground. The parents did not appear in the nest tree during the Cowbird's leaving, although they flew to the area, about 50 feet from the nest tree, where the Cowbird had landed on the ground. The tanager young remained in the nest, although he seemed to watch closely the Cowbird's actions.

Nine minutes later, at 08:34, the tanager young hopped out of the nest at the junction of the west rim and branch, remaining there for two to three minutes. As it moved away from the nest, on the nest branch, it lost balance and almost fell. But it safely reached a leaf petiole four inches from the nest and remained there, preening, for a few minutes. It then returned to a leaf petiole, one inch from the nest. At 08:53, with wings fluttering, it gave a jump and lit on a nest-branch petiole six inches from the nest. It almost fell in executing

this maneuver. At 09:02, after having been fed by the male, the young tanager preened itself vigorously. It returned to the petiole, one inch from the nest, and at 09:48½ hopped over the west rim and into the nest. One-half minute later it flew to a petiole four inches from the nest and preened again. A light rain fell at 09:53. By then the nestling had worked its way 12 inches from the nest to a section of the nest branch that bent sharply upward. Here it perched, feet wide apart, each foot grasping a different petiole, and remained under the protection of two leaves, until the sprinkling stopped at 09:56. During these three minutes it remained motionless, pointing its beak upward at a 45 degree angle. In this position the streaked breast and greenish back blended deceptively with the leafy foliage.

Shifting feet nervously at 10:08, the nestling apparently tried to return toward the nest. It stuck its head between two petioles that projected upward and barred its return, but was unable to squeeze through. Then the nestling tried to go upward, on the sharply ascending branch, but, losing balance, fell and flew toward my blind. It lit in a small tree, 60 feet from my blind, at a height of 20 feet, midway on an exposed portion of a branch (less than an inch in diameter). The adult female seemed excited, giving hurried "chip" notes, and flew directly to the nestling after it landed. The young tanager remained there, preening, until a light rain at 10:49. Shuffling its feet sideways, the nestling worked inward and stopped under the protection of leaves. It remained on the branch until 12:26,

when I attempted to capture it. In both instances, when the nestling sought protection under leaves, while light rain was falling, no rain drops struck the nestling although many did strike the leaves above it.

The day after I weighed the young tanager and the two Cowbird young in nest No. 8, I found the tanager on the ground directly under the nest in a depression of the grass. There were 8 to 10 fecal sacs in the depression. I replaced the nestling in the nest for further feeding observations. The following day the tanager young was gone, although the two Cowbirds were still in the nest. Berger and I found the tanager on a dead branch, two feet off the ground in a group of fallen dead branches, approximately 40 feet from the nest tree. We found fecal sacs on the ground under the tanager nestling and on the ground within several feet of the nestling, indicating that it had moved around to different perches.

After weighing the young we placed them in the nest and retired to my blind. Ten minutes later one of the Cowbird nestlings fluttered to the ground, and eight minutes after that the young tanager fluttered to a branch one foot below the nest. The female's frequent feeding trips to the Cowbird young undoubtedly attracted the tanager nestling, for it soon worked its way to a twig four inches from the nest. When female No. 8 fed the tanager nestling at this perch, the other Cowbird young buzzed and fluttered in the nest. Soon it hopped out of the nest and perched next to, but slightly above, the tanager nestling. In subsequent feedings, the fluttering Cowbird kept

sliding down the twig, crowding the tanager nestling and caused it to lose balance and be in danger of falling. Soon the tanager was forced off the twig onto a smaller, weaker twig, but even there the Cowbird soon crowded against the tanager nestling. As the female alternately thrust food into the mouths of the two nestlings, the Cowbird pushed violently against the tanager with its wings, and once tried to climb up on the tanager nestling's back. These jostling tactics resulted in a flutter of wings as both young fell to the ground.

The young from nest No. 2 had a remarkably good power of flight, when they left the nest. One tanager young, leaving this nest (53 feet high), flew approximately 45 feet on its maiden flight and perched expertly upon the first branch it tried. I judge that it lost about three feet in altitude during the flight. A Cowbird young, flying from this nest, lost altitude rapidly as it flew and lit in a sapling about 20 feet from the ground.

Approximately an hour after the young tanager of nest No. 4 left, Sutton discovered it about 30 feet from its nest, and at nest height, in an adjacent tree. This young successfully rebuffed all capturing attempts of Sutton, Wilson, and myself for an hour and a half. It made several short flights, never losing altitude; in fact when we abandoned the chase, Sutton believed that it was higher than when we started our efforts to bring it down to a lower perch where we could capture it. These efforts consisted of throwing countless sticks in the general direction of the apparently unperturbed fledgling.

Weights of tanager nestlings when they leave the nest. The

weights of three tanager nestlings of nest No. 5, the day before they would apparently have been physically able to leave the nest, were: 18.44, 19.22, and 19.35 grams. The first day that the tanager nestling left nest No. 8 it weighed 20.2 grams (Cowbird A, 27.6, and Cowbird B, 27.0 grams). The next day it weighed 21.1 grams. The weight of a tanager nestling at nest No. 12, that flew about 120 feet from the nest (when I attempted to take it from the nest), was 19.7 grams. Apparently tanager nestlings weigh from 19 to 22 grams the day that they leave the nest. The tanager young, when they leave the nest, weigh approximately 70 per cent of the adult weight. Young Oven-birds (Hann, 1937:178, 179) also weigh about 70 per cent of the adult weight when they leave the nest.

C. Brooding

The female broods the nestlings for about three days after they hatch. Her periods on the nest gradually decrease, and her periods off the nest gradually increase, until on about the fourth day she spends less time on the nest than off. Thereafter she spends practically no time, during the day, on the nest. However she may brood the young (perhaps it would be better to say, protect the young) during rain at any time while they remain in the nest. Figure 38 shows the average brooding rhythm of three Scarlet Tanager females. The average ratios of the minutes spent on the nest divided by the minutes spent off the nest, is plotted against the first four days of development for the nestlings. This shows a decrease in the time spent on the nest by these three females, until on the fourth day less time was spent

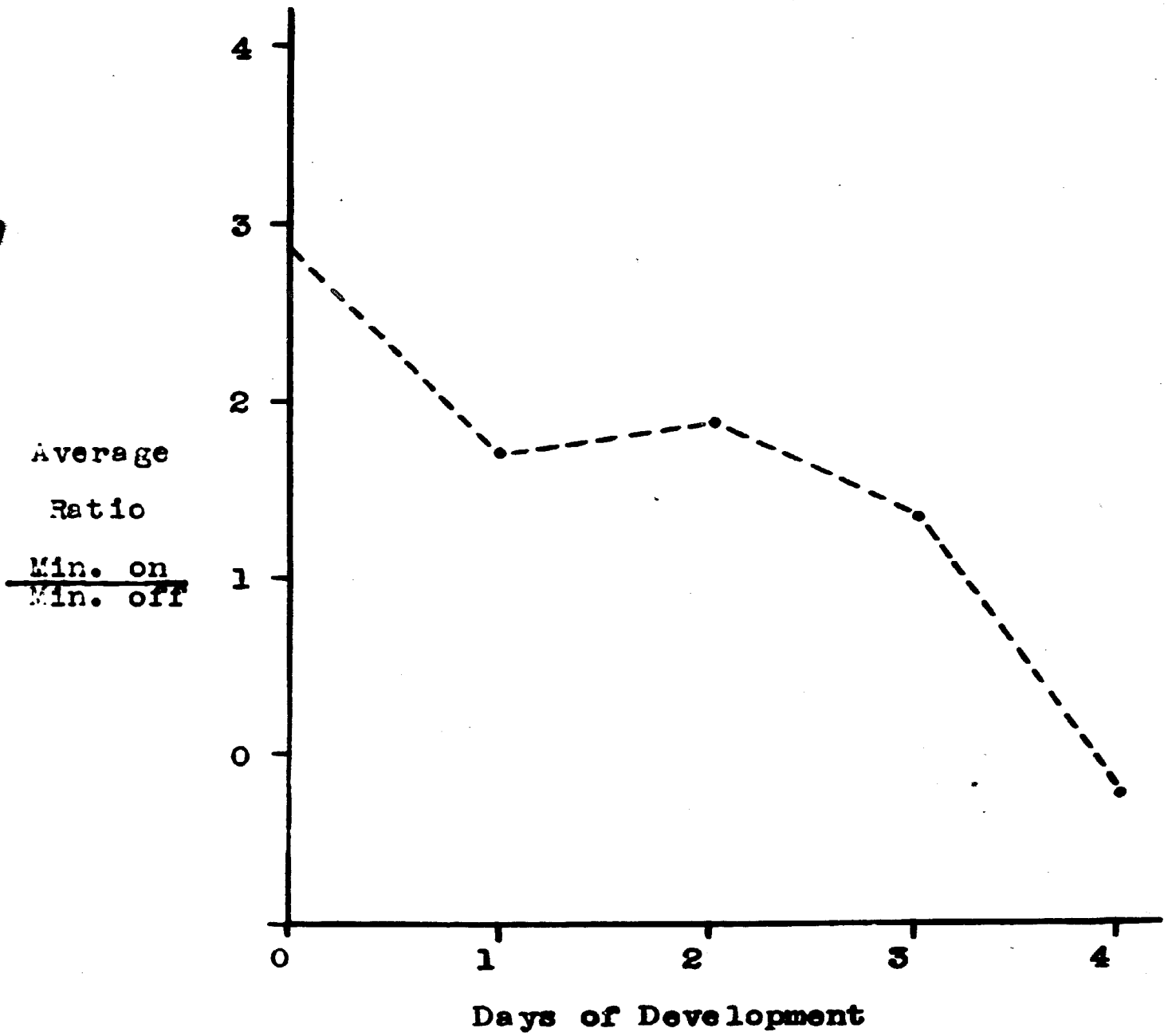


Fig. 38. Brooding rhythm of three Scarlet Tanager females for the first four days of development of the young.

on the nest than off.

The female broods the young during the hours of darkness as long as they remain in the nest. She returns to the nest for night brooding during the last hour of light, often as the light becomes very faint on the nest. Generally her period away from the nest, prior to brooding, is much longer than the preceding intervals between feedings. Female No. 8 fed the Cowbird nestling at 20:27 as the light in the woods was fading rapidly, and then remained perched on the nest rim for 20 to 30 seconds. She repeatedly nudged the Cowbird young with her beak (tanager nestling out of the nest). At 20:31, when it was so dark that her back and the nest rim appeared to me as one, she settled low on the nest for the night.

During the brooding period the male seems to assume the burden of feeding, often bringing food to the young, when the female is on the nest. At such times she may rise and remain standing in the nest as he feeds, she may hop out to the nest rim and watch him feed the young, or (as is most often the case) she may fly from the nest tree. The male occasionally gives food to the female, who then feeds it to the nestlings. However, once when male No. 3 gave food to the female on the nest, she flew away with the food in her beak. At times the brooding female eats the food given to her by the male.

The day before the nestlings left nest No. 11, the female tried to settle over her young during a very heavy rain. However, one nestling protruded from her slightly fluffed breast feathers. Two minutes later she stood up, moved her wings,

fluffed her feathers out, and tried again to settle over the young, but one nestling remained partly exposed and finally moved completely out from under the female. It then pressed tightly against the female's side and undoubtedly received some protection from her for she held her wings slightly open. When female No. 11 partly stood up to take food from the male, the nestling tried to move closer to him, and became exposed to the rain again. After eating, she tried to get both nestlings under her, moving her wings and feet, twice losing balance and regaining it with a quick wing beat. By holding her wings slightly out and poking at the young with her beak she finally managed to get both of them underneath her.

D. Food Brought to the Nestlings

Table 12 gives a summary of the food matter fed to the nestlings of six Scarlet Tanager nests. The feedings represented by this table are but a small percentage of all the feedings observed, for most of the time I was unable to identify the food matter fed. This lack of identification is due to many factors, i.e., too rapid feeding, parent facing away from the blind, view obstructed by leaves, and in some cases the food matter may have been too small to be identified. However, I believe that Table 12 may be thought of as giving a fairly accurate representation of the general type of food matter fed to the nestlings. Nestlings less than a week old examined by King (Judd, 1900:419) had eaten caterpillars, bugs, and grasshoppers. Sutton (Todd, 1940:594) states that the young are fed "almost wholly" on leaf-consuming caterpillars.

TABLE 12

FOOD FED TO NESTLING SCARLET TANAGERS

Day of Development	Nest No.	Description of Food Fed to Nestlings	Number Fed
0	3	Green larva	1
		Insect bits	1
0	17	Small white larva	1
		Dragonfly (head, wings, and legs removed)	1
1	11	Insect bits	1
1	17	Small green larva	1
2	3	Worm, 2-3" (annelid ?)	1
2	11	Green larva	3
		Other larva	3
		Insect bits	4
		Long-legged insect	1
		Dragonfly (head and wings removed)	1
		Other insect	1
		Red berry	1
		Blueberries	several
3	3	Larva	3
3	11	Dragonflies	6
		(2 black-bodied with wings and legs removed; 1 mottled green with wings and legs removed)	
		Other insect	1
4	11	Green larva	1
		Small dragonfly	1
		Wasp	1
		Other insect	1
5	3	Larva: black	7
		green	2
		other larva	2
		Insect bits	1
		Slug	1
5	11	Larva	1
		Moths	3
		(1 small; 1 medium sized, tan, wings removed; 1 with head, wings and legs removed)	
		Other insect	1

TABLE 12--Continued

Day of Development	Nest No.	Description of Food Fed to Nestlings	Number Fed
6	11	Green larva	2
		Moth (head, wings, and legs removed)	1
		Dragonflies (wings and legs removed)	2
7	3	Bright green larva	2
		Hairy caterpillar	1
		Diapheromera	1
		Other insect	1
7	5	Blueberries	main food
7	8	Green larva	3
7	11	Insect	1
8	2	Insect bits	1
		Blue-bodied dragonfly	1
		Other insect	1
8	5	Blueberries	main food
8	11	Flying ant	1
		Wasp	1
		Other insect	1
9	2	Insect bits	2
		Phlangida	2
		Hymenoptera	2
		Diptera	1
		Flying ant	1
		Other insects	3
9	8	Larva: black	1
		bluish	1
		drab green, 1" long	1
		dark green	2
		Other insect	1
9	11	Green hairy caterpillar	1
		Other larva	1
		Berry	1
10	2	Hymenoptera	2
		Other insects	9
10	8	Larva: bright green	3
		long white	1
		others	7
		Black pupa	1
		Tipulid (wings removed)	1
		Dragonfly (wings removed)	1
		Other insect	1

The food fed to the young can be arranged in four general groups: larval insect forms, insect bits, adult insects, and berries. I use the word "insect bits" to designate that food material which appeared to me to be pieces of insects, or perhaps a mass of small insects, or both, which the feeding bird held in a partially open beak and fed to the nestling with repeated thrusts. I have not observed berries to be fed on the first two days of development, but other than that the four types of food seem to be fed on each of the days of nestling development.

There is no trend from the feeding of soft larval forms to adult insect forms as the nestlings increase in age. Hann (1937:182) found that the food of young Oven-birds, following hatching, consisted chiefly of green and brown geometrid larvae, and that small earthworms were also fed. As the young Oven-birds grew older, adult insects (crane-flies, moths, ants and beetles) were added.

It should be pointed out that the nestlings of nest No. 5 were fed blueberries almost exclusively the seventh and eighth day of development. I was unable to determine the source of these berries. However blueberries grew at the wood-swamp edge 30 feet from nest No. 11 and this may have been the source for pair No. 11. Blueberries were available within 20 feet of nest No. 12, yet I never observed the adults to feed on them, or feed them to the nestlings.

The adult Scarlet Tanagers get insects, and larval forms of insects, from trees, and perhaps from the ground, within

its territory. Often they get them from trees adjacent to the nest tree. Rarely the female obtains food from the nest tree, even on the nest branch, which she feeds to the nestlings.

TABLE 13

AVERAGE INTERVAL BETWEEN FEEDING OF NESTLINGS AND NUMBER OF FEEDINGS BY SEX

Nest No.	No. of Young		Day of Development	Av. Int. in Min.	No. of Feedings	
	Tan.	Cowbird			Male	Female
2	2	1	8	3.11	18	37
2	2	1	9	3.58	45	67
2	2	1	10	2.63	37	77
3	2	1	0	16.40	8	8
3	2	1	2	15.00	7	2
3	2	1	3	10.25	16	5
3	2	1	5	11.75	14	5
3	2	1	7	9.66	8	11
8	1	2	8	3.13	0	25
8	1	2	9	8.11	0	20
8	1	2	10	5.57	0	87
9	0	1	10	6.22	5	5
11	1	1	1	14.00	2	5
11	1	1	2	17.46	13	17
11	1	1	3	20.00	8	6
11	1	1	4	9.22	13	15
11	1	1	5	11.20	9	7
11	1	1	6	16.58	12	6
11	1	1	7	12.65	10	4
11	1	1	8	10.30	15	14
11	1	1	9	14.57	6	12
11	1	1	10	15.50	7	15
17	2	0	0	30.75	4	9
17	2	0	1	20.00	4	7
17	2	0	3	14.05	12	10
17	2	0	4	14.42	6	2

TABLE 14

TOTAL NUMBER OF FEEDINGS OF NESTLINGS AT THE SIX NESTS GIVEN IN TABLE 13

Nest No.	No. of Feedings	
	Male	Female
2	100	181
3	53	32
8	0	132
9	5	5
11	95	101
17	26	28
Total	279	479

E. Rate of Feeding the Nestlings

In Figures 39 to 48 I have recorded the parent feeding the nestlings and the time at which they fed the nestlings. The interval between feeding by the tanager pair, to the closest one half minute, is averaged to obtain the average interval between feedings for the days of development of the nestlings. The feeding interval varied from 30.75 minutes for nest No. 17 on the day the first young hatched, to 2.63 minutes at nest No. 2 which contained one Cowbird and two tanager nestlings which, later in the day, left the nest.

Table 13 is a summary of the data given in Figures 39 to 48. It gives the average interval (in minutes) between feedings, number of feedings (by male or female), the number of young per nest, and their day of development, for six Scarlet Tanager nests. Table 14 shows the total number of feedings by the adult male and the female, for each of the six nests.

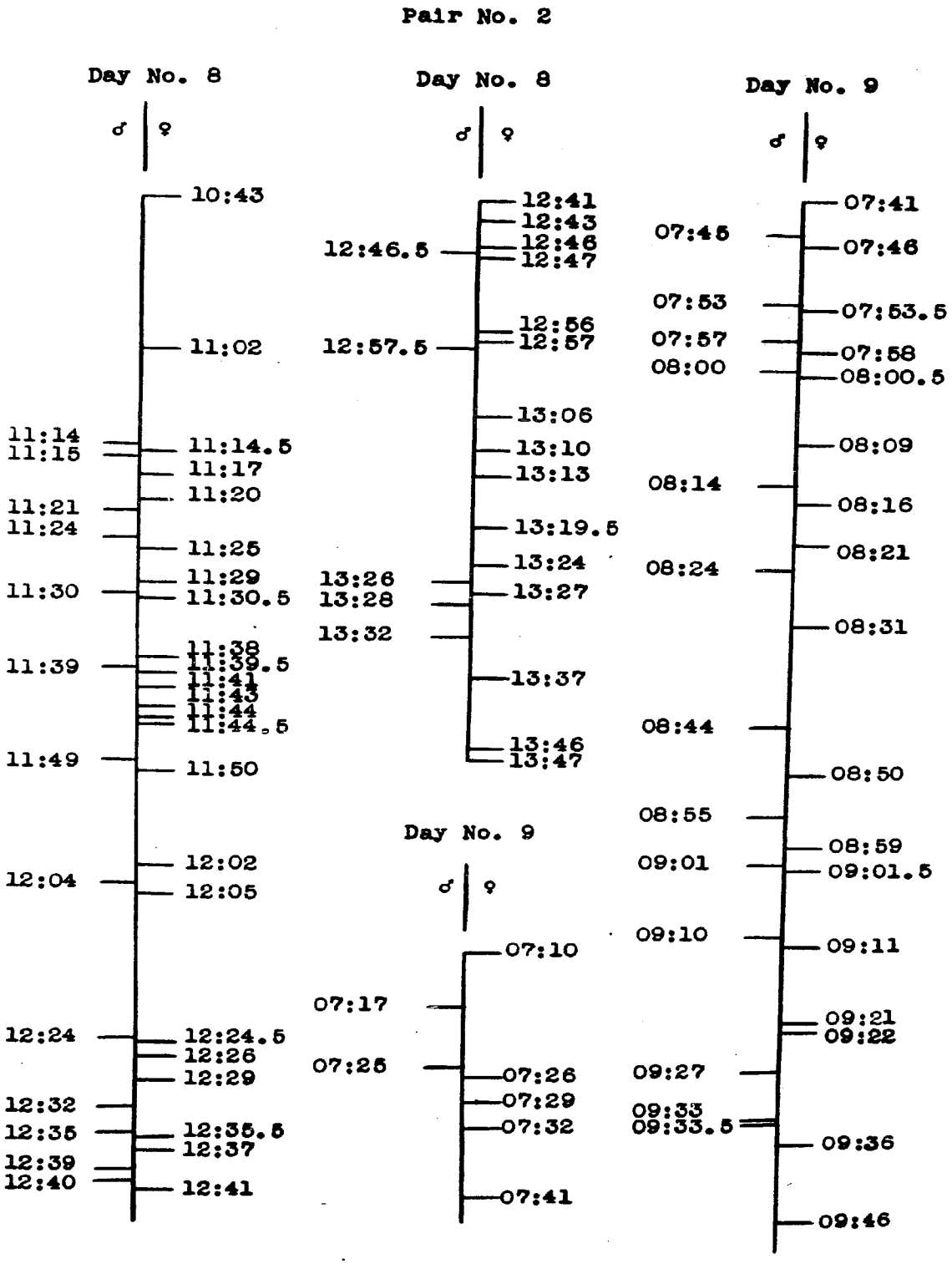


Fig. 39. Parent feeding, and the time of feeding, the nestlings (2 tanager, 1 Cowbird) by pair No. 2, day No. 8 and day No. 9 (cont.)

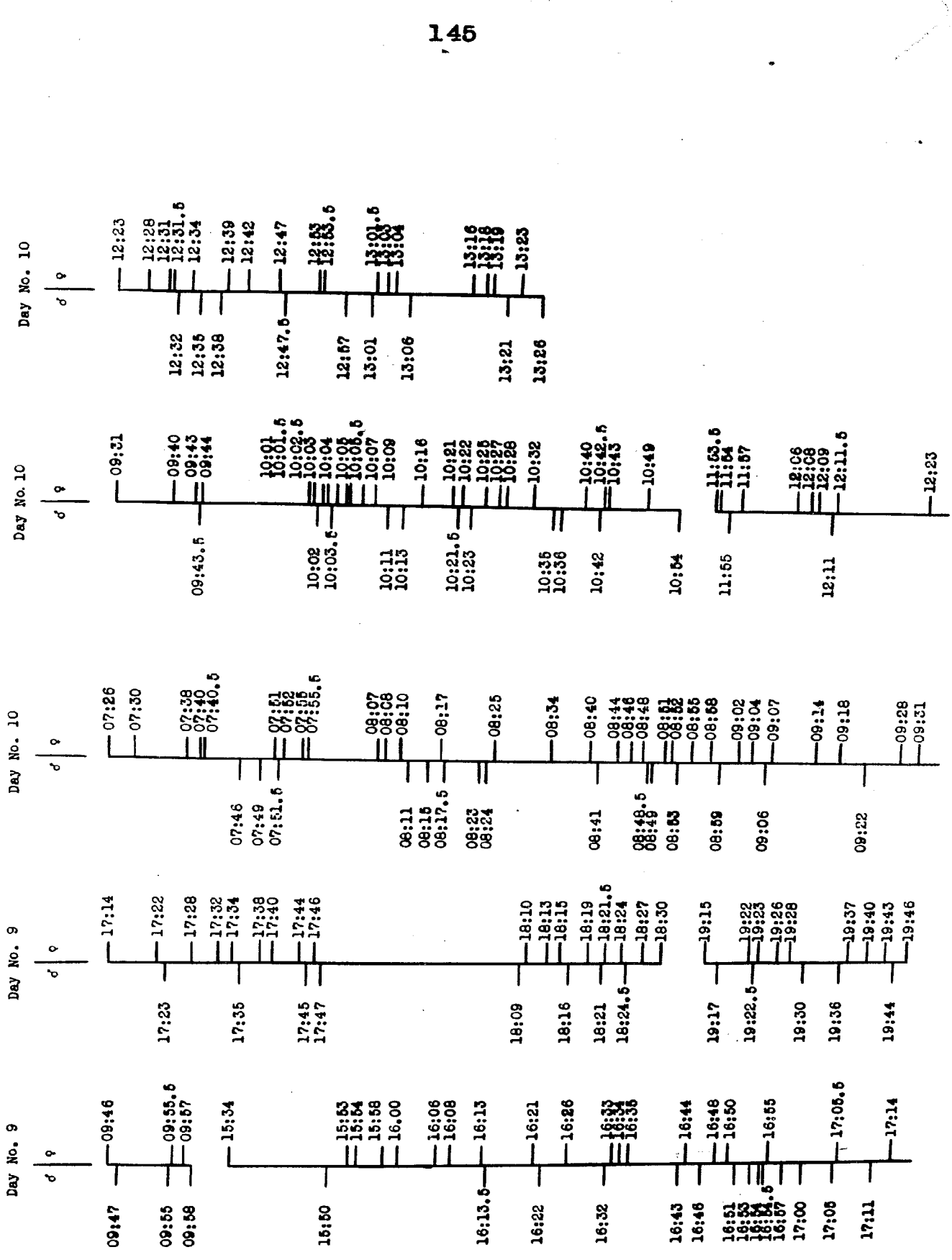


Fig. 40. Parent feeding, and the time of feeding, nestlings by pair No. 2, day No. 9 (cont.), and day No. 10.

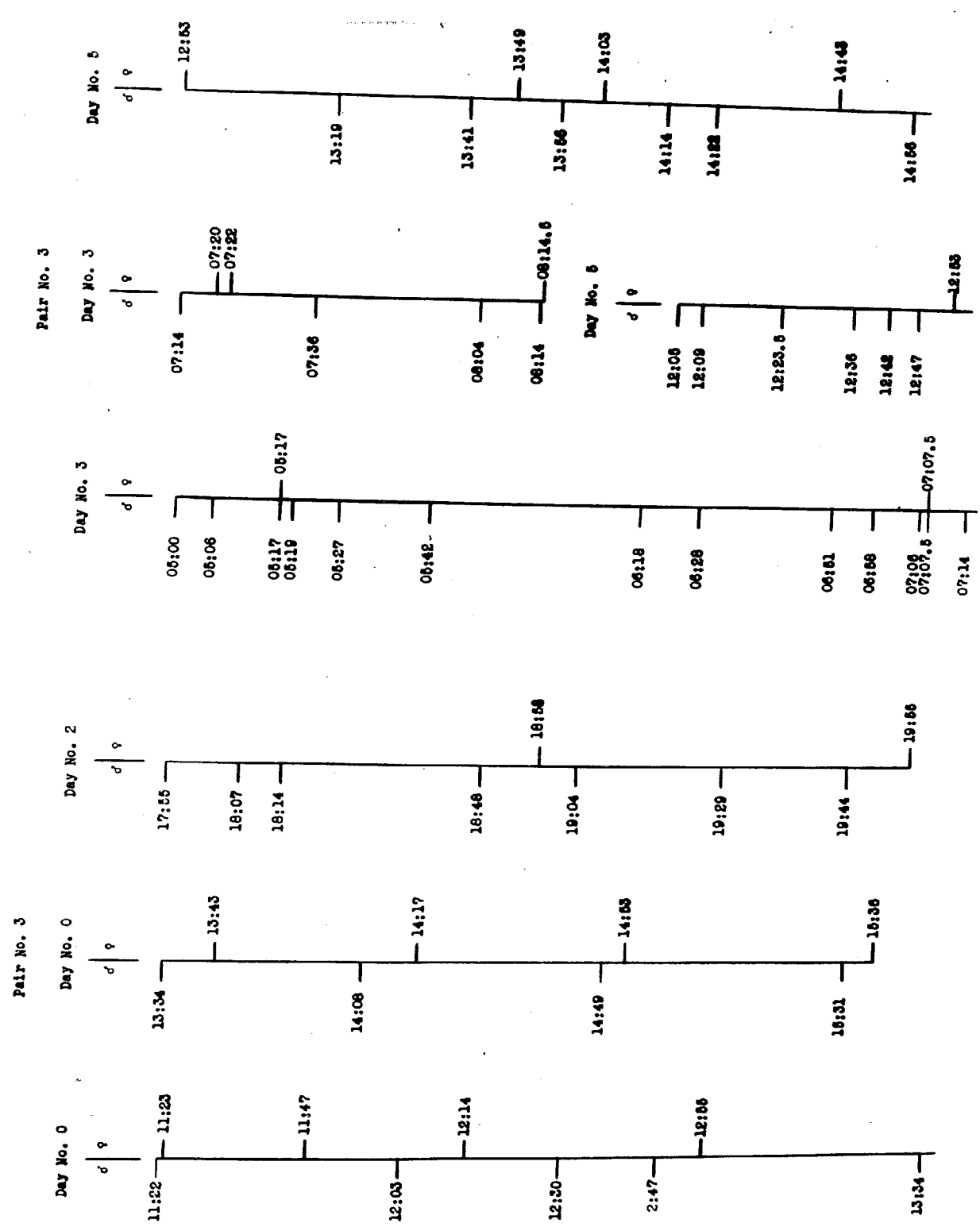


Fig. 41. Parent feeding, and time of feeding, the nestlings (1 tanager and 1 Cowbird) of nest No. 3 by pair No. 3, day No. 0, No. 2, No. 3, and No. 5 (cont.)

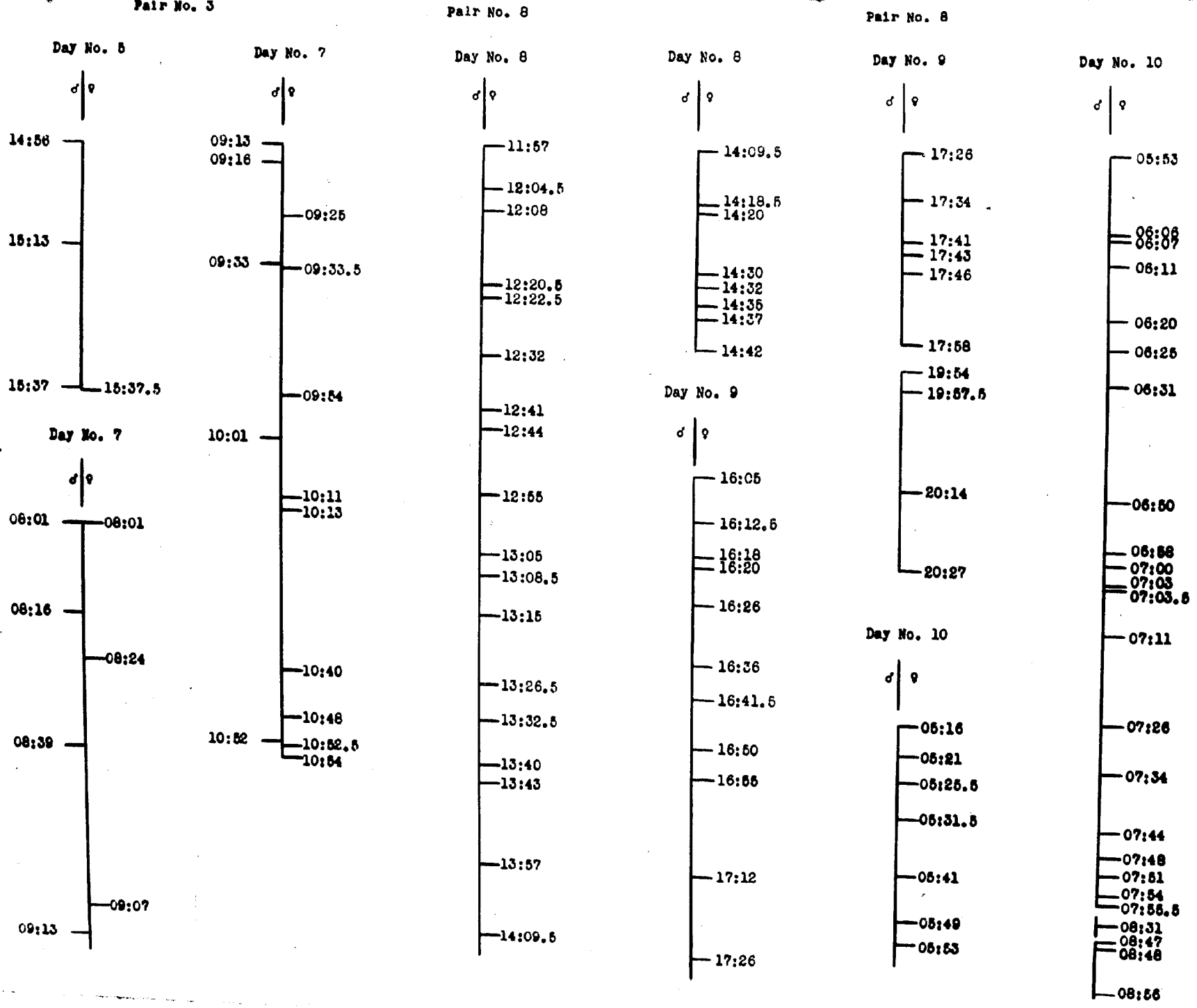


Fig. 42. Pair No. 3, day No. 5 (cont.). Parent feeding, and time of feeding, the nestlings (1 tanager and 2 Cowbirds) by pair No. 8, day No. 8, No. 9, No. 10 (cont.)

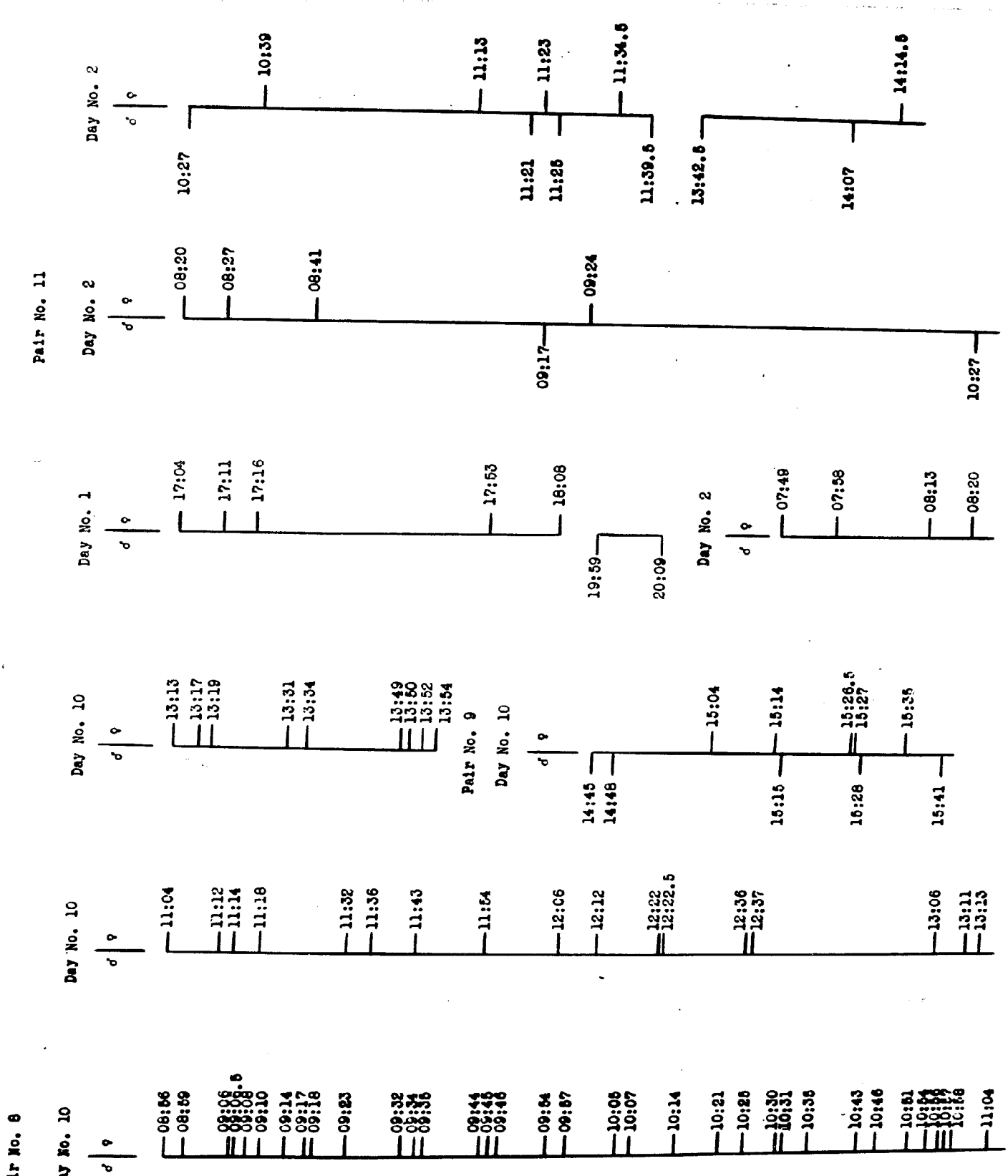


Fig. 43. Pair No. 8, day No. 10 (cont.). Parent feeding and time of feeding the nestlings (1 tanager and 1 Cowbird) by pair No. 11, day No. 2 (cont.)

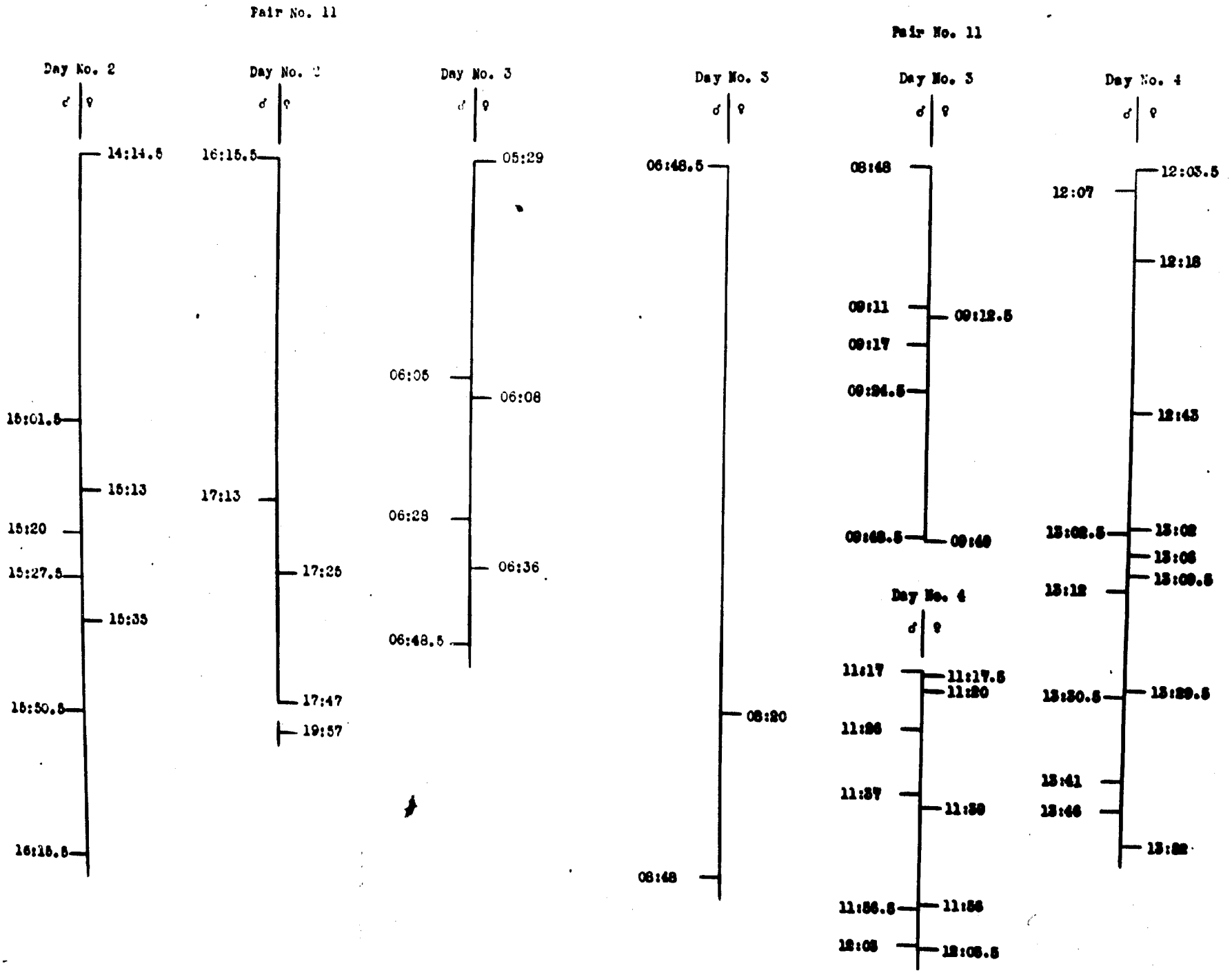


Fig. 44. Feeding of nestlings by pair No. 11, day No. 2 (cont.), No. 3, No. 4 (cont.)

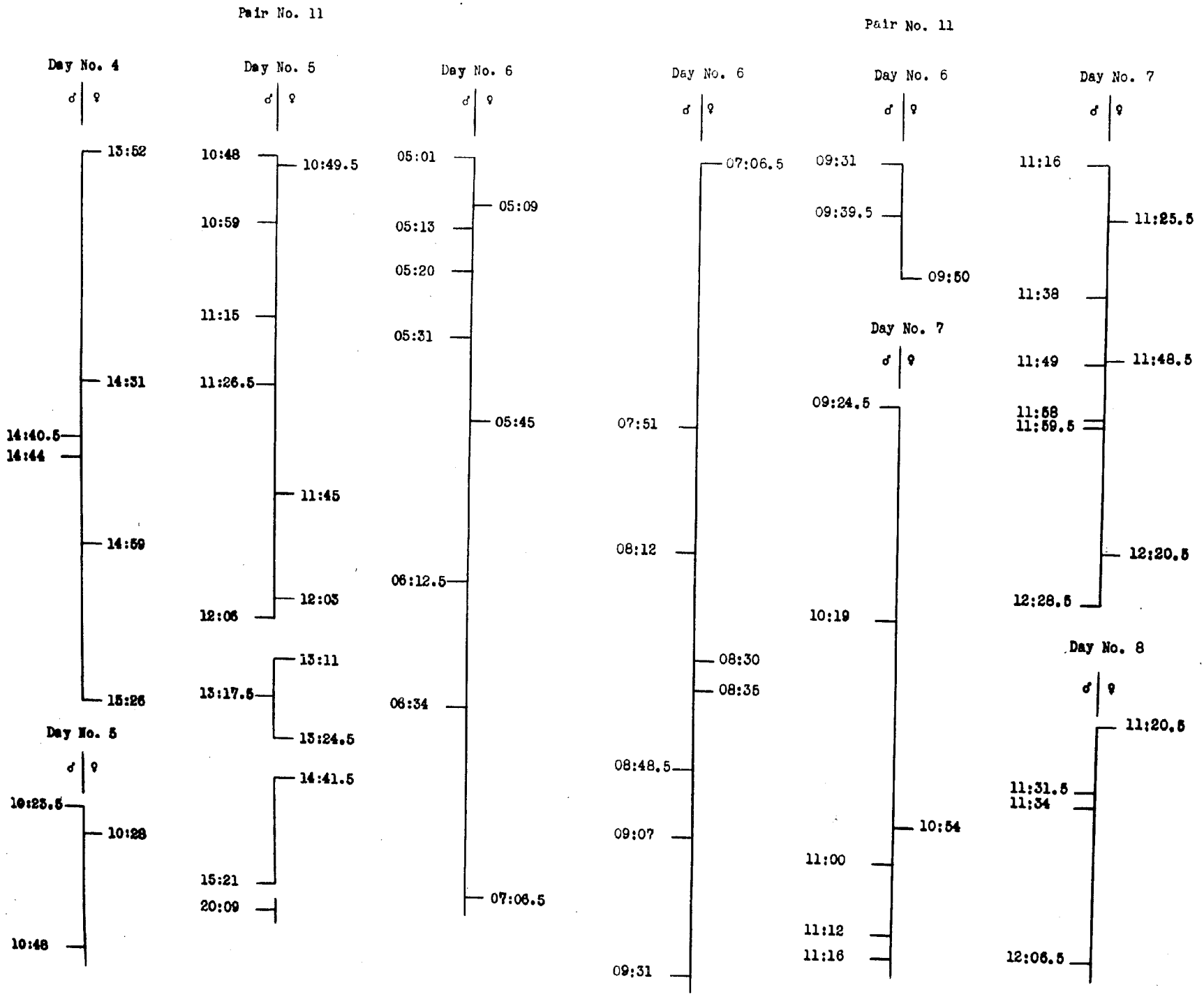


Fig. 45. Feeding of nestlings by pair No. 11, day No. 4 (cont.), No. 5, No. 6, No. 7, No. 8 (cont.).

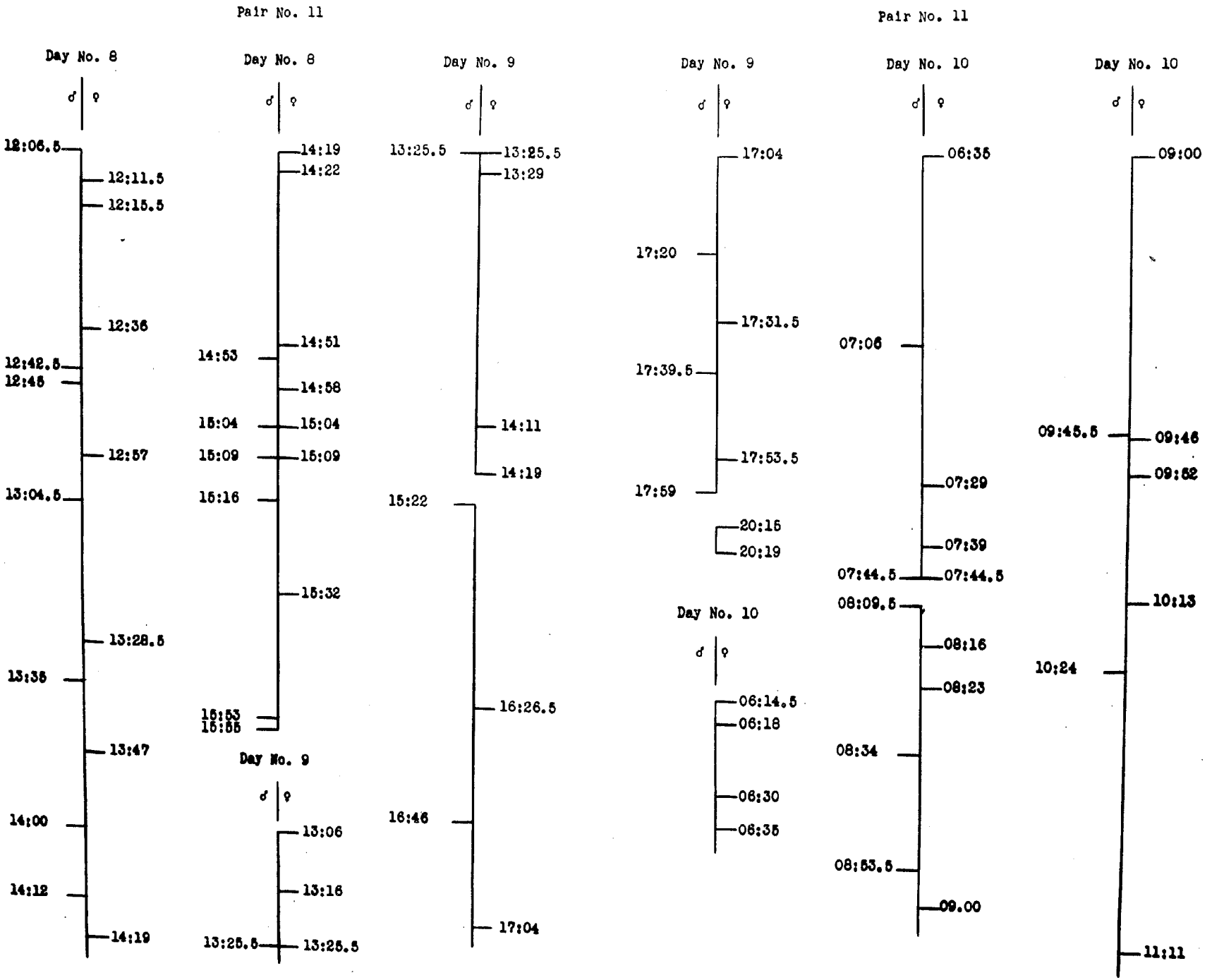


Fig. 46. Feeding of nestlings by pair No. 11, day No. 8 (cont.), No. 9, No. 10 (cont.).

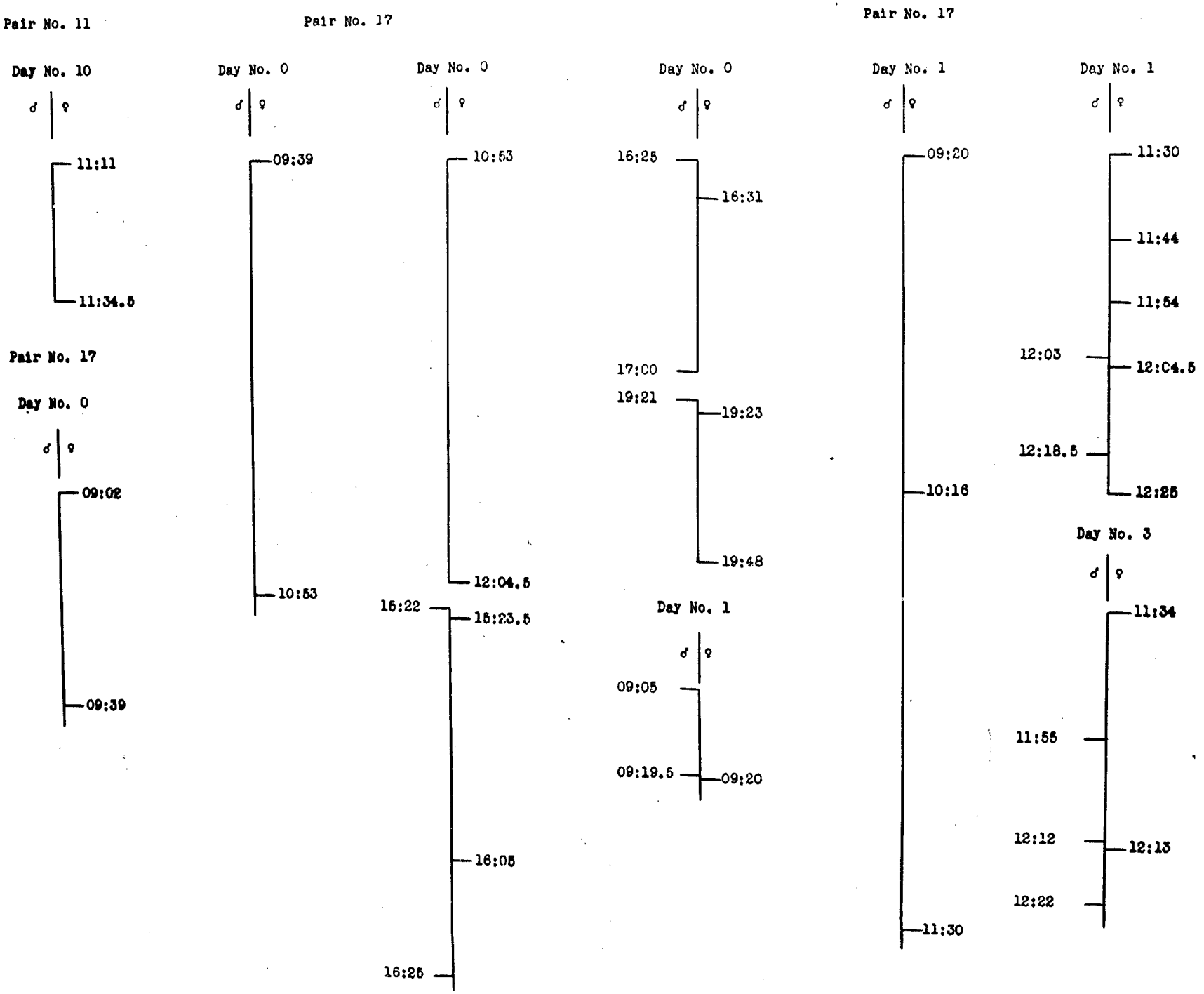


Fig. 47. Pair No. 11, day No. 10 (cont.). Parent feeding, and time of feeding the nestlings (2 tanager) by pair No. 17, day No. 0, No. 1, No. 3 (cont.)

Pair No. 17

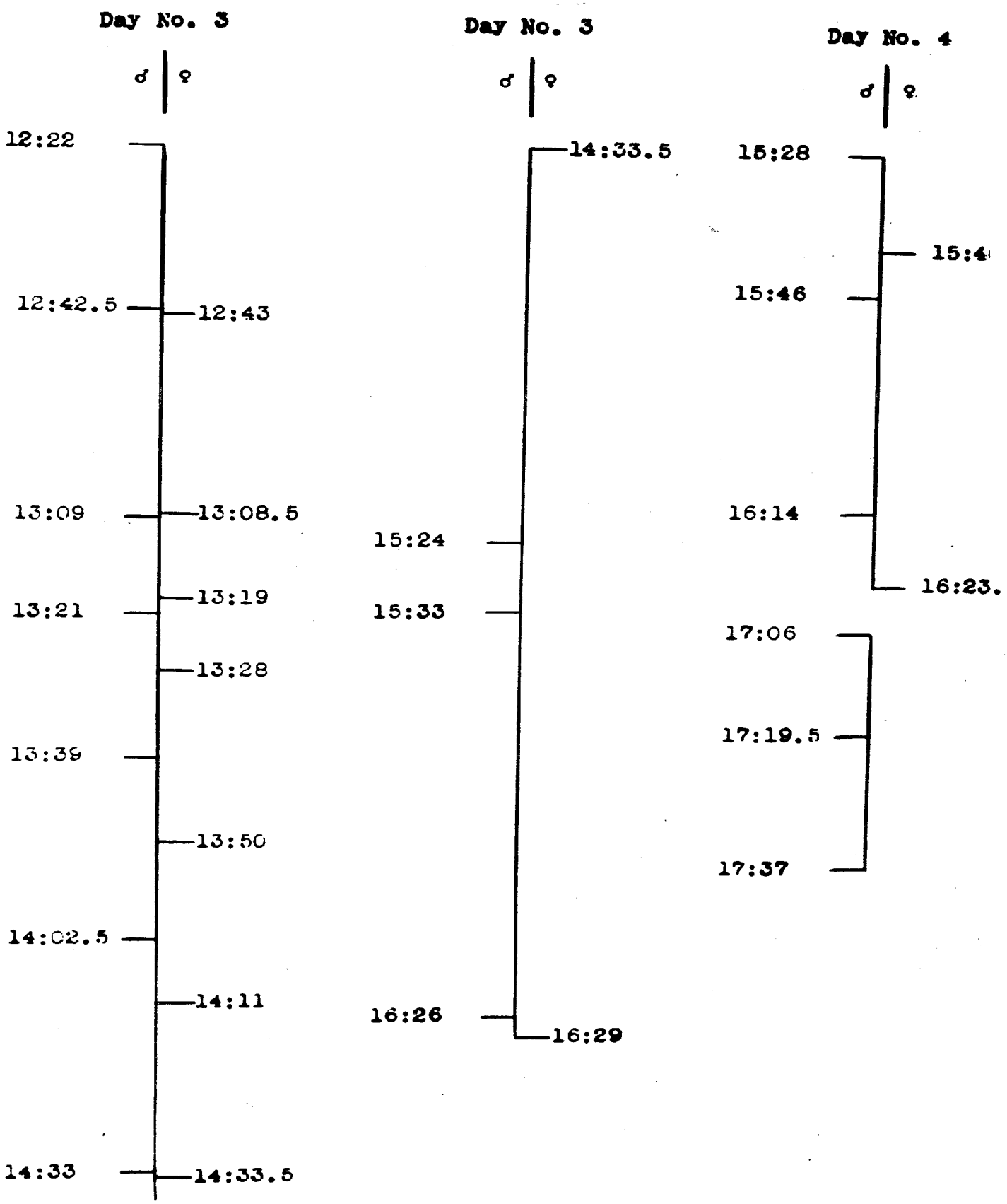


Fig. 48. Feeding of nestlings by Pair No. 17, day No. 3 (cont.) and day No. 4.

The only male tanager, of those observed, that fed the nestlings more times than the female, was male No. 3. However, male and female No. 9 fed an equal number of times, and males No. 11 and No. 17 fed almost as often as did the females. At nest No. 2 64 per cent of the observed feedings were by the female. I never observed male No. 8 to feed the nestlings. Of the 758 times that I observed a nestling being fed, the female Scarlet Tanager made 63 per cent of the feedings.

Obviously the various tanager pairs share differently the burden of feeding the nestlings. Moreover, there is a marked difference in the role assumed by the different males; i.e., male No. 3 fed the nestlings 62 per cent of the feedings, while male No. 8 was never observed to feed the nestlings. While nest No. 8 was a low, exposed nest I cannot believe that this alone accounted for the failure of male No. 8 to feed the nestlings, for at times he did appear in the nest tree, and many times he flew to perches very near the nest tree.

Figure 49 shows the average intervals between the feeding of young by tanager pair No. 3 in relation to the age of the young. This graph shows that the male feeds more frequently (shorter intervals between feedings) than the female, during the first six days of development of the nestlings. On about the sixth day the female fed more frequently. The longer intervals between her feedings for the first five days can undoubtedly be correlated with the fact that much of this time she broods the young. Apparently the typical relationship between the adults, when both feed the nestlings, is for the

Intervals Between Feeding Of Young
of Nest No. 3
In Relation to Days of Development

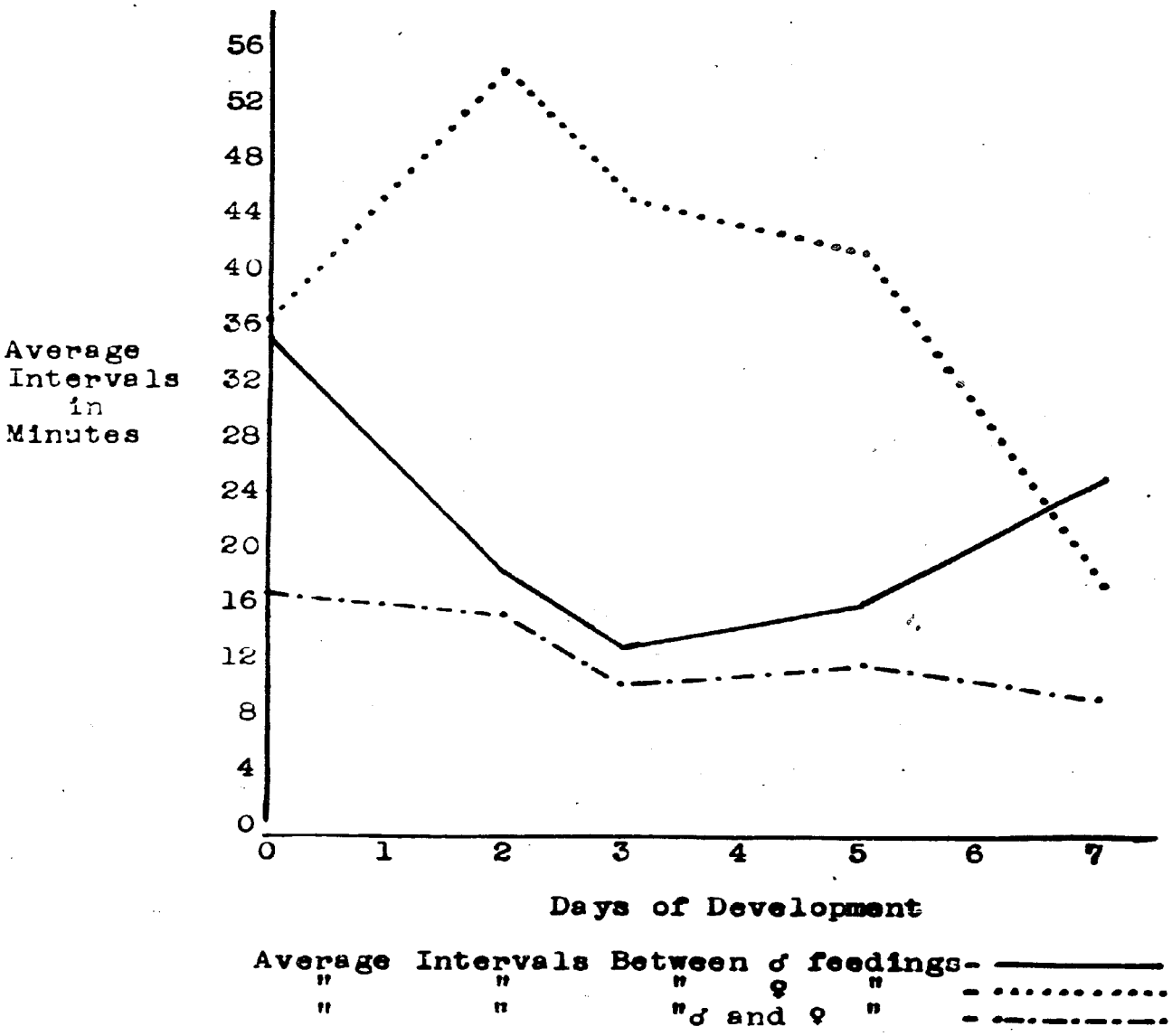


Figure 49

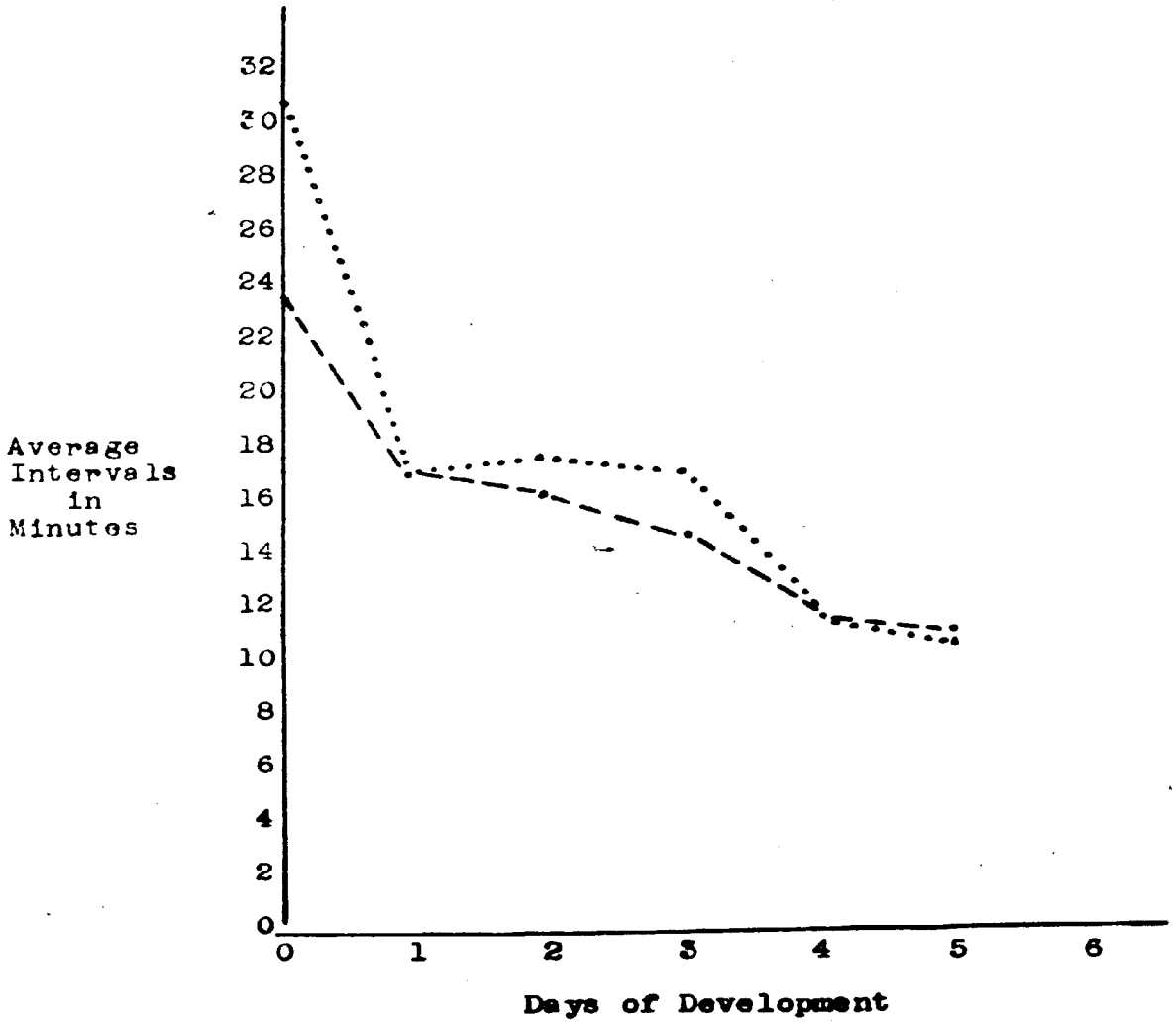
male to assume the burden the first five or six days, then the female feeds more frequently until the young leave the nest. Figure 49 shows that there is a trend for the intervals between all feedings, by male or female, to decrease as the nestlings grow older. As the nestlings increase in size, and their need for more frequent feedings increases, the intervals between feedings decrease correspondingly. And as the male's feedings become less frequent, the female's feedings increase more than enough to compensate for this loss, so that the end result is for the intervals between feedings for the nestlings to decrease as the young increase in age.

Figure 50 gives the feeding intervals for three Scarlet Tanager pairs (No. 3, No. 11, and No. 17) for the first five days of development of the young, and the intervals, during the same period, for the two pairs (No. 11, and No. 17) each of which had two young in the nest. This shows that the intervals between feedings, for nests with two young, tend to be greater than for those nests having three young.

Figure 51 gives the feeding intervals for pair No. 11 (two young), pair No. 2 (three young), and for pair No. 8 (three young). I have mentioned earlier that I never observed male No. 8 feed the nestlings. I believe it is of interest that the intervals between feedings for female No. 8 alone, are considerably less than those for male and female No. 11, and only slightly greater than those for male and female No. 2.

The intervals between feedings, as shown in Figure 49, might be considered misleading because they do not take into

Intervals Between Feeding of Young in Relation to Days of Development



Intervals for Three Scarlet Tanager Pairs-·-·-·

consideration the actual number of feedings by each sex, i.e., a few rapid feedings with a low interval index might represent only a small percentage of the total number of feedings. Therefore I have computed feeding ratios based on the number of feedings and hours of observations. That is, the ratio of the number of daily feedings by sex, divided by the daily hours of observations. A graph based on this manner of computation is shown in Figure 52.

The graph showing intervals between feedings (Figure 48) and that showing the feeding ratios (Figure 52) agree in that they both show that the male assumes the dominant role in the feeding of the young for approximately the first six days, then becomes less attentive and this is paralleled by an increase in attentiveness by the female.

At nest No. 3 the female brooded for three days and this undoubtedly accounts for her low feeding ratio for the first three days, but after that day she became more attentive and, on the seventh day, had a higher feeding ratio than the male. The slight decline of the combined male and female feeding ratios on the second day is due in part to an intermittent rain, which evidently slowed the male's feeding of the young, and in part to the brooding behavior of the female. In general the combined male and female feeding ratios, for nest No. 3, shows an increase from day of hatching to the day of leaving.

Feeding of a Cowbird and tanager young. On June 17 and 18, 1948, I had an opportunity to observe the individual feeding of a Cowbird and tanager young by female No. 8. After

Comparison of the Intervals Between Feeding of Nestlings by a Female, with the Intervals by Two Pair of Tanagers.

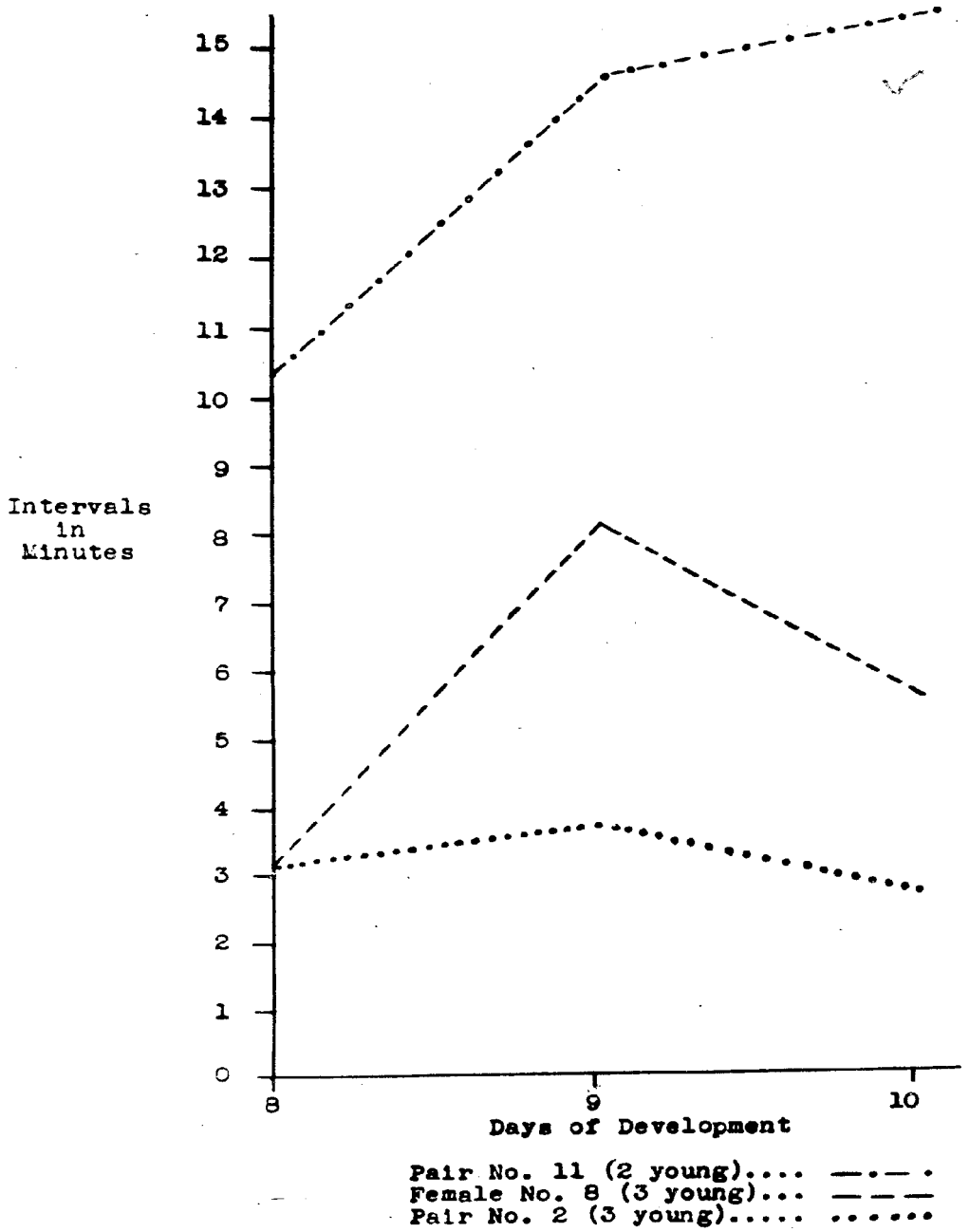


Figure 51

Rate of Feeding in Relation to Days of Development
Nest No. 3

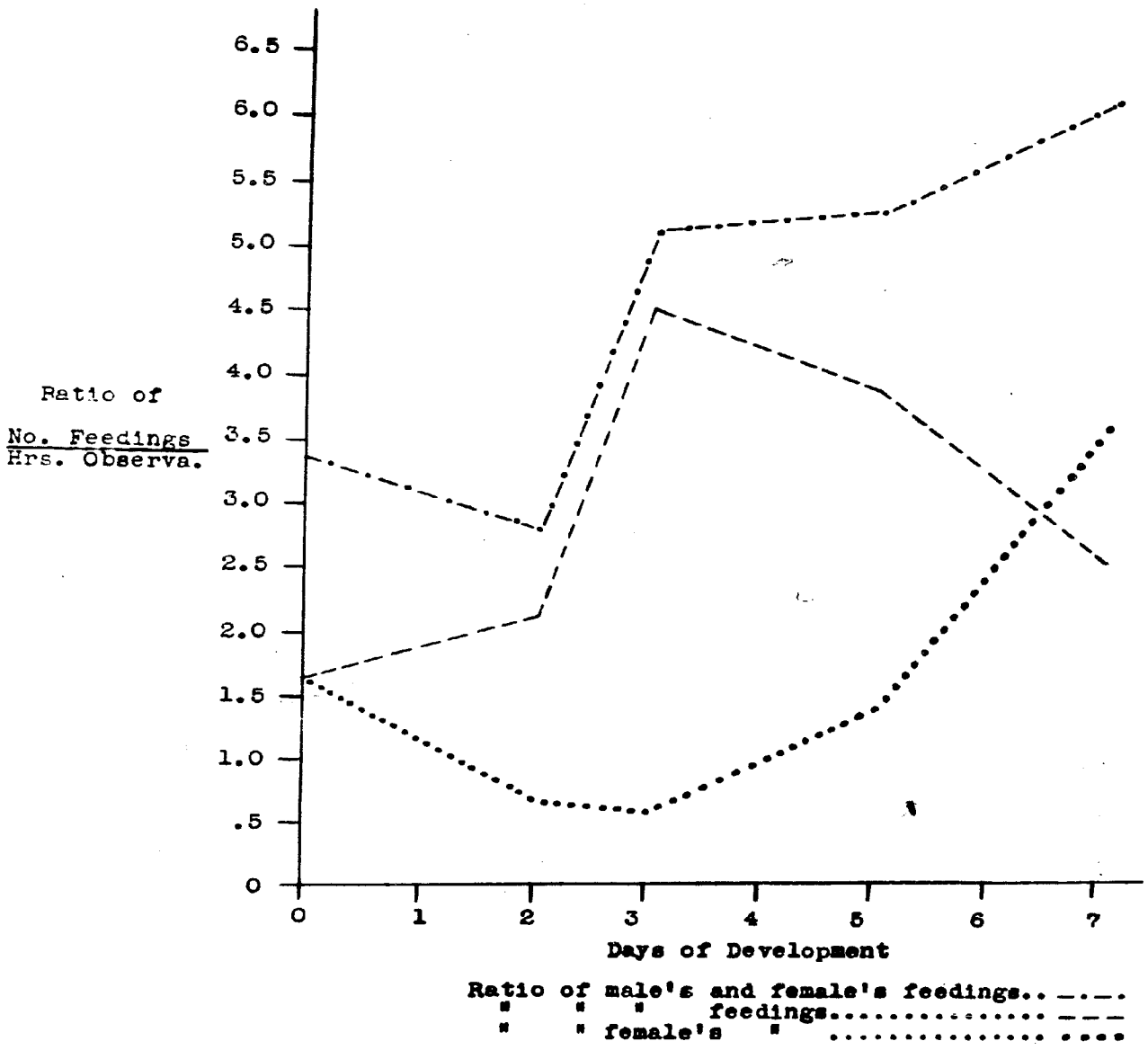


Figure 52

weighing the three young of nest No. 8, June 17, at 15:30, I replaced them in the nest and returned to my blind for further observations. Ten minutes later one of the Cowbird young fluttered to the ground almost directly below the nest, and eight minutes later the tanager young left the nest and descended to a branch one foot below the nest, leaving the other Cowbird young alone in the nest. The Cowbird and tanager young remained in the nest tree in full view from my blind throughout the remainder of June 17, and the following day until 08:56.

When female No. 8 flew to the nest tree to feed the young, she would either feed the noisy, buzzing, scrambling Cowbird in the nest, or the peeping, fluttering tanager young. Figure 53 shows the time of feeding, and the intervals between feedings, for the Cowbird and tanager young in the nest tree. The Cowbird was fed approximately 56 per cent of the time on both days. Yet an examination of female No. 8's feeding behavior shows that she went directly to the Cowbird to feed 50 per cent of the time, and directly to the tanager young 25 per cent of the time. The remaining 25 per cent of the time she thrust first into the gaping mouth of the Cowbird young and then, when the Cowbird young refused the food, took it to the tanager young (percentages are approximate). Thus the Cowbird young had access to approximately 75 per cent of the food brought to the nest tree by the female. The Cowbird young was closest to the nest, actually in the nest for one of the days, while the tanager young was out of, and below, the nest. This factor, plus the demanding, aggressive, buzzing and

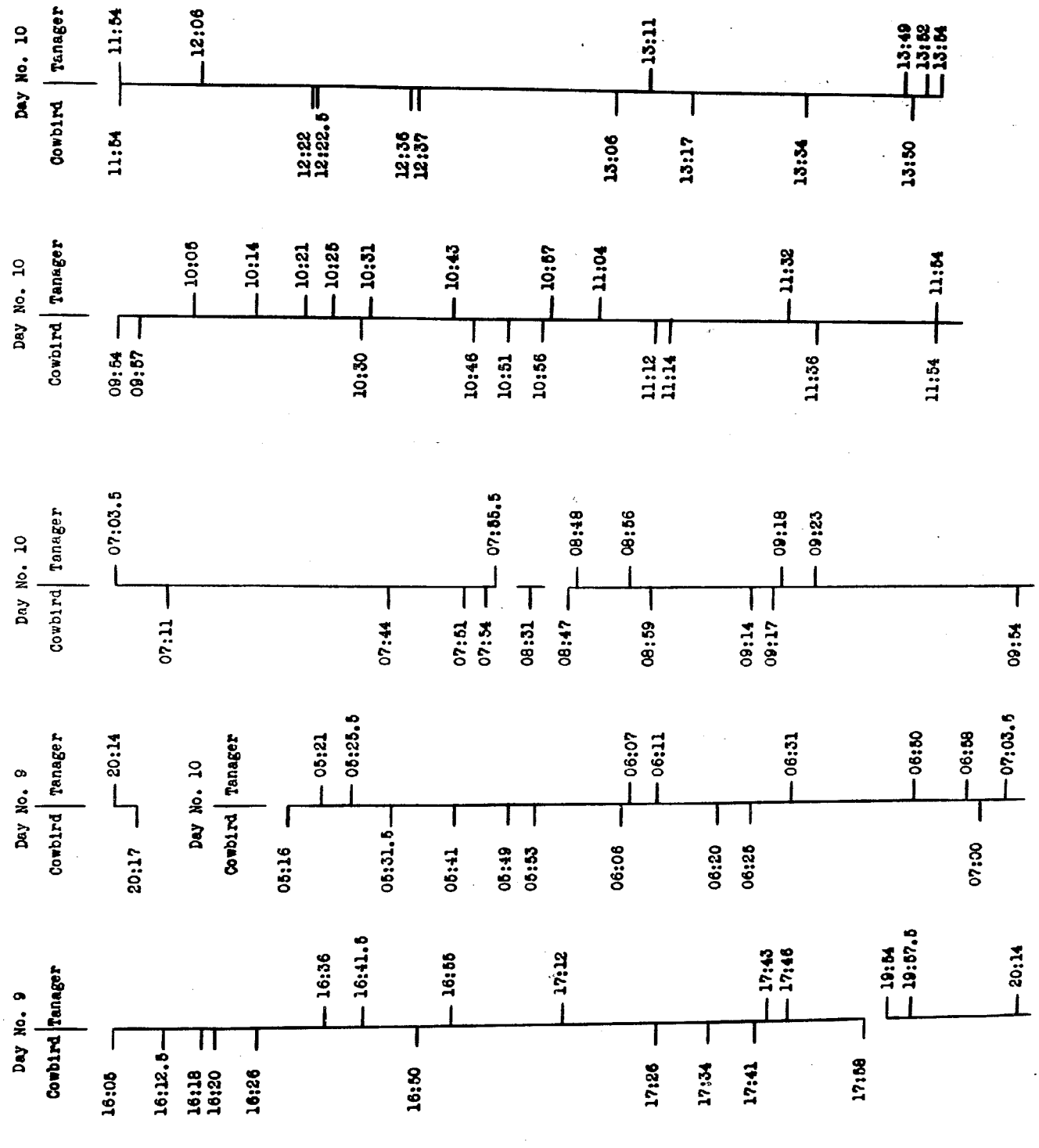


Fig. 53. The feeding of a tanager and Cowbird nestling by female No. 8.

fluttering of the Cowbird young, seemed to have been more attractive to the female tanager than the begging of her own young.

Method of feeding the nestlings. The method of feeding the young at nest No. 3, the first two days, strongly resembled regurgitation. The food was generally carried in a closed or slightly open beak. Sometimes when the parent thrust its beak into the open mouth of a young, I noticed throat constrictions and pulsations of the adult which lead me to believe that the food was carried in the adult's throat and worked up into the beak for feeding to the young. After feeding the young, the parent frequently opened and closed its beak two to five times and appeared to make pushing movements with its tongue. At the same time I noticed constricting movements in the upper throat region, after which more food was fed. Once female No. 3 fed the young and settled on the nest, then her throat pulsated three or four times and she produced an elongated two inch whitish larva, torn and partially cut up, which she fed to a nestling which poked his head up in front of the still brooding female. I have observed similar behavior by other Scarlet Tanager adults when feeding newly hatched young. Wheelock (1905:64) suggested that the Scarlet Tanager fed its young by regurgitation the first few days after hatching.

The dipping of the nest, when the parent bird alights on the nest or nest branch, is sufficient stimulus for the young to raise their heads and gape, swinging their heads from side to side, weakly the first two days but strongly and demanding

thereafter. In nests containing Cowbird young, the "buzzing" of the Cowbird for food is continuous during feeding. This "buzzing" completely drowns out the tanager nestlings' "peep", and later as the Cowbird grows in strength and size, it may push and climb over the young tanagers in an attempt to face the adult bird when it arrives at the nest.

At first there seems to be a marked tendency on the part of the adult Scarlet Tanager to feed the nearest gaping mouth, especially if only one young is fed, or if only one food object is fed. Later as the young grow older, and the feeding intervals are shorter, food is thrust into two or three gaping mouths and sometimes repeatedly into two gaping mouths until one young retains the food. Food which is placed in an open nestling's mouth is usually removed by the adult if the nestling does not swallow it at once. The adult may offer it again to the same young or to another young. Once, after feeding a nestling, female No. 3 removed the food from the still open mouth and gave it to another young. Occasionally a curled-up large larva seemed difficult for the young to swallow, and it was repeatedly thrust into open mouths until it uncurled and then was immediately taken by the first young to which the straightened larva was presented.

The low, exposed position of nest No. 8 afforded me an excellent opportunity to observe the feeding of young, in particular the manner of thrusting. This female rarely fed young on the first thrust. She often alternated thrusts between the gaping young, and many times continued to thrust after she

had released the food in an open mouth. Once she thrust a green larva alternately into two mouths, "a-b-a-b", then again to "b" which retained it. Another time, after placing food in the mouth of "b", she removed it and then gave it to "b" again, and a moment after releasing the food, she thrust again in the nestling's still open beak. Later she fed young "b" and after this feeding she thrust, with beak empty, twice in "a", once in "b", and once in "c". At another time, she fed a Cowbird young on the fifth thrust, then gave two more pushing thrusts as if forcing the food further down into its still open mouth.

The behavior of female No. 8 when the Cowbird young was in, or near, the nest and the tanager young below the nest, is important for it seems to indicate a decided preference, on the female's part, for taking food to the Cowbird young. On June 17, 1948, at 16:55, she thrust thirteen times into the Cowbird's mouth (the Cowbird had been fed three times in the preceding 30 minutes), then dropped down to the tanager young and fed it on the first thrust. Again at 17:45, after thrusting four times to the Cowbird which would not retain the food, she flew down to the tanager and fed it on the second thrust. At 19:57½, female No. 8 thrust seven times to the Cowbird, then flew to the tanager and fed it a large insect, which seemed difficult for the tanager nestling to swallow. June 18, at 06:11, the female held a coiled green larva over the Cowbird, which buzzed and fluttered weakly with its beak and eyes partially closed. She left him, flying outward in a two to three foot circle, and returned to offer the larva again, unsuccessfully, to the Cowbird.

Then, flying to the branch below, she fed the larva to the tanager nestling on the first thrust. At 09:18, on the third thrust, she dropped a long green larva in the Cowbird's mouth. The Cowbird did not swallow it, whereupon she removed the larva and fed it to the tanager, which retained it on the first thrust. I have more similar observations, which rather definitely indicate that the female was most often attracted to the Cowbird young and that the tanager young was usually fed only after the Cowbird had refused food.

Some further feeding observations of female No. 8 on June 18, 1948, may be of interest. At 05:49, she placed a long, white larva in the Cowbird's mouth. The Cowbird young, with beak open, managed to hold one end of the larva. The female, holding the opposite end, stretched it taut and then released the larva, which jerked back into the still open Cowbird mouth, after which the Cowbird swallowed the larva. At 06:06, female No. 8 placed a bright green larva, half an inch long, in the Cowbird's mouth. However this larva fell out of the Cowbird's mouth onto the nest rim. The female immediately picked the larva up and offered it again to the Cowbird, which retained the larva on the second thrust. Female No. 8, at 06:20, twice offered a bright green coiled larva to the Cowbird young. On the third thrust the Cowbird pulled the larva from the female's beak. At 06:31, the female attempted to feed a dragonfly (wings and legs removed) to the tanager young, but it apparently had difficulty in swallowing the long insect, so female No. 8 removed the dragonfly, hopped to the branch above and thrust

directly down, and into, the tanager's mouth, rather than from the side as she had previously tried. This thrust, from directly above, was successful. At 08:48, she held a one-inch stiff, black pupa in her beak, which she offered once to the Cowbird, and six times to the tanager young, unsuccessfully. After flying in a short three foot circle, she returned and thrust it seven times into the tanager's mouth, until the pupa broke in the female's beak. She then fed half of it to the tanager and the remaining half to the Cowbird. At 10:30, female No. 8, with her beak full of loose food material, made four alternate thrusts in the tanager and Cowbird mouths, until the Cowbird retained most of the food. However some of the food fell toward the ground, and female No. 8 instantly dove after it. I could not see whether she caught it, but she lit on a perch three feet above the ground, and then flew directly to the nest tree and fed the tanager nestling.

Manner in which insects may be prepared for feeding to nestlings. I have listed, in Table 12, moths and dragonflies as food for the nestlings. The adults had removed the wings and legs, and in a few the heads, of some of these insects before they were fed to the nestlings. The removal of these insect body parts by the adult tanagers, prior to feeding the young, was rather difficult to observe. However, I once observed female No. 8 preparing an insect before she offered it to a nestling. She caught a tipulid and took it to the trunk of a fallen tree, DBH 14 inches, approximately 15 feet from my blind. She placed the tipulid on the trunk, picked it up in her beak,

and laid it on the trunk again, so that the tipulid faced away from her. Then, with two quick beak movements, she tore off its wings, which floated to the ground. Then she picked up the insect and flew 12 feet to a bush, where she gave a "whistle" note, then to another perch, where she sang one soft song. After that she flew directly to the tanager in the nest tree and fed the wingless tipulid to the tanager nestling on the first thrust. This is the only observation that I have of adults removing insect parts before they fed the insect to the nestling. However, I have observations of adults removing wings, and legs from an insect before eating the insect. This is discussed later (see Chapter VIII). Undoubtedly the adults removed insect parts in a similar manner when they prepared some of the insect food for feeding to the nestlings.

Arrival, leaving, and position at the nest, of adults when feeding nestlings. At nest No. 2, the male's perch, from which he fed the young, was a twig above the nest. He looked down into the nest as he fed. Female No. 2 usually fed from the nest branch, arching her neck and head up over the nest rim as she fed the young. After feeding the nestlings, these parents invariably looked into the nest, or if in a position below the nest, hopped up to the nest and searched it for fecal sacs, or waited for the young to extrude the feces. There was a tendency for both adults to fly directly from the nest after feeding the nestlings.

At nest No. 3 the male usually left the nest by going up, perch by perch, through the nest tree. However, if he carried

a fecal sac, he flew directly from the nest. Female No. 3 generally flew directly from the nest, although occasionally she hopped outward on the nest branch to its extremity and flew from there. In arriving with food at nest No. 3 the adult birds generally lit very close to the nest, on the nest branch, or on a nearby twig. At nest No. 2 the female often flew to the same height in the nest tree as the height of the perch from which she had flown. Therefore she lit in the nest tree at a height varying from 20 to 60 feet. Then she hopped, or flew, from branch to branch until she reached the nest.

As suggested above, each male and female appeared to have a rather definite pattern of behavior as regards their arrival at, and departure from, the nest. This pattern includes not only the manner of arrival and departure, but apparently the direction of arrival and departure also. I kept a compass on my knee and whenever possible recorded the compass direction of the adult's arrival and departure. The following information is for female No. 8, during June, 1948, when she arrived at the nest with food for the young:

Thirty-four Arrival Directions

West	29	time(s)
Northwest . .	2	"
East	2	"
South	1	"

Thirty-six Departure Directions

North	7	time(s)
Northeast . .	7	"
East	1	"
Southeast . .	1	"
Southwest . .	5	"
West	7	"
Northwest . .	11	"

Twenty-three Directions Faced When Feeding Young

Northwest	3 time(s)
West	20 "

My blind was located south of nest No. 8. This may explain, in part, the apparent reluctance of female No. 8 to fly from the south toward the nest, and to fly southward when leaving the nest. For in leaving the nest she showed a pronounced tendency to fly in a general direction varying from northwest to northeast, or 90 degrees of the available 360 degrees. The directions she faced, when feeding the nestlings, allowed her to watch my blind. She never had her back to my blind when she fed the nestlings. The closest tree to the nest tree, was located west of the nest. This was an important factor for 29 of her arrivals to the nest tree were from this tree located near, and to the west, of nest No. 8.

Notes on position of feeding, and directions of arrival at, and departure of the adults from, nest No. 11 during July, 1948, show a similarity in this behavior to female No. 8. The "branch" referred to in the summary below, was a bare branch located 12 inches above the nest and approximately two feet northeast of the nest.

Forty-three Arrival Directions

Direction	Male	Female	Total
Northeast	0	2	2
East	1	5	6
Southeast	0	3	3
Southwest	20	10	30
West	2	0	2

One Hundred Five Departure Directions

Direction	Male	Female	Total
Northeast	14	6	20
Branch (NE)	26	8	34
East	5	1	6
South	0	1	1
Southwest	2	1	3
West	18	23	41

Fifty-five Directions Faced When Feeding Young

Direction	Male	Female	Total
North	0	2	2
Northeast	0	2	2
East	0	8	8
Southeast	0	5	5
Southwest	22	8	30
West	4	0	4
Northwest	1	3	4

My blind was located approximately northeast of nest No. 11. The female flew to the nest only seven times from a northeast or east direction, and the male only once. This indicates that pair No. 11 only rarely took food to the nestlings from the general vicinity of my blind. The reason that these adults so often left the nest flying in a northeast direction, toward my blind, was the presence of the bare branch approximately two feet northeast of the nest. However, they always veered sharply to one side when they flew from this branch, and as a result they did not pass directly over my blind. The most frequent direction used, when flying from the nest, was west and away from my blind. However, these adults often had their backs toward my blind as they fed the nestlings. I believe that the preceding discussion has made it clear that my blind

was a part of the Scarlet Tanager's environment which may have affected, possibly in more ways than I have indicated, the behavior of the Scarlet Tanager pair.

Time spent at the nest by the adults when feeding nestlings. When a Scarlet Tanager lit at the nest with food in its beak, I glanced at the sweeping second hand of my watch, and again, noted the time when that tanager left the nest. In this way I was able to record the approximate number of seconds spent at the nest by the parents. Such time records must not be thought of as indicating that all the time was spent in feeding, for much of the time was spent in looking at the nestlings, pecking at the nest, removing fecal sacs, etc. Inasmuch as the male had, during earlier stages of nesting, shown such a reluctance to remain in the nest tree, I was anxious to observe his behavior during this phase of the nesting cycle. Male No. 3 spent more time at the nest, after feeding trips, than did female No. 3. Male No. 2 spent slightly less time at the nest than did female No. 2.

Many of the visits to the nest with food were of only one or two seconds duration, others for a longer period of time. I was not able to time all the visits made to the nest, but approximately 75 per cent were recorded. The daily averages, in seconds, for two of my nests, are given below.

Nest	Day	Seconds at Nest Male	Female
No. 3	0	79.37	19.25
" 3	2	40.00	4.00
" 3	3	20.73	12.00
" 3	5	19.15	35.00
" 3	7	5.00	4.50
No. 2	8	6.60	5.05
" 2	9	5.93	7.08
" 2	10	2.14	3.64

These data for the male show a rather definite correlation between the number of feedings and the age of the young. That is, visits to the nest by the male shortened as feeding frequency increased and as the young became older. However, this trend is not as definite for the female.

F. Removal of Excreta

The excreta of nestling Scarlet Tanagers and Cowbirds are enclosed in mucous sacs. I refer to these sacs as fecal sacs. The fecal sac is whitish in color, and tough enough to withstand being grasped by the bill of the adult bird. On rare occasions a sac may break when it is being carried away by an adult.

Nice (1943:42–43) gives a brief discussion of defecation by passerine birds. She states that in general, passerine excreta lose the mucous covering as soon as the nestling leaves the nest, and thereafter the excreta resemble that of the adult. She believes that this may be correlated with increased exercise and irregular feedings. My limited observations of Scarlet Tanager young out of the nest suggest to me that this

may not always be the case for the tanager. Earlier in this chapter (Method of leaving the nest.) I mentioned that the tanager young of nest No. 8 had spent the night on the ground under the tanager nest. The next morning I found 8 to 10 fecal sacs in a depression of the grass where the young had spent the night. Undoubtedly the young had exercised little, if any, since it left the nest. Perhaps it fell directly to the ground from the nest rim. However, the following day Berger and I found this nestling on a branch approximately 40 feet from the nest tree. We found fecal sacs under the nestling's perch (two feet above the ground) and within 6 to 10 feet of the nestling. Obviously this nestling had exercised considerably, but it still passed excreta in the form of fecal sacs. Therefore it seems possible to me that the Scarlet Tanager young may continue to pass excreta in the form of fecal sacs several days after it leaves the nest.

However, the diet may have an effect on the mucous covering of the excreta. The nestlings of nest No. 5 were fed almost exclusively on blueberries during their seventh and eighth day of development. Their excreta, on these two days, was watery, bluish in color, and not given off in sac form, and the adults did not attempt to carry away the watery excreta. Nest No. 5 was stained blue by their discharge. Prior to the seventh day they had passed excreta in the form of fecal sacs, apparently similar to the fecal sacs passed by the nestlings of other tanager nests.

Manner of removal. There are two ways in which the fecal sacs are removed from the Scarlet Tanager nest. The adults may eat the fecal sac, or take it in their beak and fly away from the nest with it. Occasionally a nestling may "up-end" at the nest rim in such a manner that the sac may fall over the nest rim, but this is unusual and cannot be considered an important method of removal.

The usual procedure is for the adults to feed, then wait for the young, which had just been fed, to "up-end" and extrude a fecal sac. Invariably this sac is taken by the parent before it touches the nest. On the day of hatching, and occasionally a day or two later, the nestling may not "up-end" immediately after feeding. The adult stimulates the nestling by gentle pecking at the posterior end of the nestling. One or two pecks seems to be sufficient stimulus for the nestling and lowering its head deep into the nest, and raising its wavering rump high into the air, it gives off a fecal sac. A typical sequence of events is: (1) adult lands on the nest or nest branch, this jar of the nest stimulates the young to gape widely for food; (2) adult thrusts food into the open nestling mouth, perhaps stimulated by the orange mouth lining color, outlined by the whitish beak edge, and the white, downy wavering head; (3) young swallows food either after it is placed in its mouth or after an additional peck in the open mouth by the adult, both the food object and the peck by the adult serve as a stimulus for the swallowing reflex; (4) adult changes position so that its head is above the nestling's rump and it appears to wait expectantly;

(5) nestling points head low in the nest and raises its rump high (perhaps after a peck by the adult) and wiggles its rump from side to side; (6) the appearance of the white fecal sac being extruded from the orange-skinned rump (later anal aperture is surrounded by yellowish feathers) appears to be the stimulus for the adult to take the fecal sac.

The nestling does not give off excreta after every feeding, and occasionally a nestling not fed may pass a fecal sac when the adult is at the nest. For this reason the adults often closely inspect the nest, pushing the nestlings to one side, and searching the nest for excreta. Occasionally the adult may eat one or two fecal sacs, which laid in the nest, besides taking one from a nestling.

I observed the removal of 182 excreta at five tanager nests. Female Scarlet Tanagers removed 59.34 per cent of these. Sixty-one per cent of her removals were by carrying the excreta away from the nest, while 56.76 per cent of the male's removals were by carrying the excreta away from the nest. Of all excreta removals, 59.34 per cent were by carrying away from the nest, and 84.07 per cent of all excreta removals were preceded by feeding of the young by the parent. The data for these five nests is given in Table 15 below.

TABLE 15

REMOVAL OF EXCRETA BY THE SCARLET TANAGER PAIR

Nest No.	Sex Removing		Fed?		Disposal	
	Male	Female	Yes	No	Ate	Carried
2	6	27	29	4	5	28
3	21	13	19	9	14	20
8	0	28	26	2	5	23
11	39	33	64	6	35	37
17	8	7	15	0	15	0
Totals	74	108	153	21	74	108

In Table 16, I have included the data pertinent to the removal of excreta by the adults at five Scarlet Tanager nests. This table shows which sex removed the excreta, whether the young were fed at that time, and the manner in which the excreta were disposed. This table only indicates if the excreta were eaten or carried. If the male or female ate the sac at the nest it is so recorded in the "ate" column; if they took the fecal sac in their beak, flew and carried it elsewhere for disposal, it is entered in the "carried" column.

TABLE 16

NEST, TIME, AND OTHER DATA CONCERNING THE REMOVAL OF EXCRETA BY THE ADULTS AT FIVE SCARLET TANAGER NESTS

Nest No.	Day	Time	Sex Removing		Fed?		Disposal	
			Male	Female	Yes	No	Ate	Carried
2	8	11:14	x		x			x
		12:18	x			x		x
		12:32	x		x		x	
		13:06		x	x		x	
		Totals	3	1	3	1	2	2
2	9	07:10		x	x			x
		07:32		x	x			x
		07:49		x		x		x
		08:50		x	x			x
		09:01½		x	x			x
		09:10	x		x			x
		09:44		x		x		x
		15:53		x	x			x
		16:18		x		x		x
		16:33		x	x			x
		17:32		x	x			x
		17:35	x		x			x
		18:10		x	x			x
		18:13		x	x			x
		18:19		x	x		x	
		18:30		x	x		x	
		19:28		x	x			x
		19:37		x	x			x
		Totals	2	16	15	3	2	16
2	10	07:55		x	x			x
		08:25		x	x		x	
		08:46		x	x			x
		10:01½		x	x			x
		10:16		x	x			x
		10:27		x	x			x
		10:28		x	x			x
		12:09		x	x			x
		12:23		x	x			x
		13:03		x	x			x
		13:21	x		x			x
		Totals	1	10	11	0	1	10
3	2	19:04	x		x		x	
		19:29	x		x			x
		Totals	2	0	2	0	1	1

TABLE 16--Continued

Nest No.	Day	Time	Sex Removing		Fed?		Disposal	
			Male	Female	Yes	No	Ate	Carried
3	3	05:27		x		x	x	
		05:52		x		x	x(3)	x
		05:55	x		x			x
		06:09		x		x	x	
		06:18		x		x	x	
		07:07½		x	x		x	
		07:14	x		x			x
		07:36	x		x		x(3)	
		08:14		x	x		x	
		Totals	3	6	5	4	11	3
3	5	12:05	x		x			x
		12:23½	x		x			x
		12:36	x		x			x
		12:42	x		x			x
		13:19	x		x			x
		13:41	x		x		x	x
		13:56	x		x			x
		14:14	x		x			x
		Totals	8	0	8	0	1	8
3	7	08:14	x			x		x
		08:24		x	x			x
		08:45		x		x		x
		09:13	x		x			x
		09:51		x		x	x	
		10:01	x		x			x
		10:13		x	x			x
		10:43	x			x		x
		10:49	x			x		x
		Totals	5	4	4	5	1	8
8	8	11:57		x	x			x
		12:08		x	x		x	
		12:13		x		x		x
		12:20		x	x			x
		12:38		x		x		x
		12:44		x	x			x
		12:55		x	x			x
		13:08½		x	x		x	
		13:26½		x	x			x
		13:40		x	x			x
		13:57		x	x			x
		14:09		x	x		x	
		14:20		x	x		x	
		14:37		x	x			x
		14:42½		x	x		x	
		Totals	0	15	13	2	5	10

TABLE 16--Continued

Nest No.	Day	Time	Sex Removing		Fed?		Disposal	
			Male	Female	Yes	No	Ate	Carried
8	9	16:20		x	x			x
		16:50		x	x			x
		17:34		x	x			x
		17:58		x	x			x
		Totals	0	4	4	0	0	4
8	10	05:53		x	x			x
		06:20		x	x			x
		07:11		x	x			x
		07:44		x	x			x
		10:56		x	x			x
		11:14		x	x			x
		12:01		x	x			x
		12:36		x	x			x
		13:49		x	x			x
		Totals	0	9	9	0	0	9
11	1	16:05		x		x	x	
		16:13	x			x	x	
		16:45½	x			x	x	
		17:21	x		x		x	
		18:08		x	x		x	
		19:59	x		x		x	
		20:09	x		x		x	
		Totals	5	2	4	3	7	0
11	2	07:49		x	x		x	
		08:17½		x		x	x	
		10:39		x	x		x	
		11:31	x		x		x	
		11:25	x		x			x
		11:39½	x		x		x	
		13:42½	x		x		x	
		15:13		x	x		x	
		15:35		x	x		x	
		15:50½	x		x		x	
		17:13	x		x		x	
		17:25		x	x		x	
		Totals	6	6	11	1	11	1
11	3	06:05	x		x			x
		06:08		x	x		x	
		06:36	x		x			x
		06:38		x	x		x	
		08:20		x	x		x	
		08:48	x		x		x	

TABLE 16—Continued

Nest No.	Day	Time	Sex Removing		Fed?		Disposal	
			Male	Female	Yes	No	Ate	Carried
11	3	09:01½		x		x	x	
		09:48½	x		x		x	
		09:49		x	x		x	
		Totals	4	5	8	1	7	2
11	4	11:17½		x	x			x
		11:37	x		x		x	
		12:03	x		x		x(2)	
		13:06		x	x			x
		13:09½		x	x			x
		13:29½		x	x		x	
		13:52		x	x		x	
		14:40½	x		x			x
		14:44	x		x			x
		15:26		x	x		x	
		Totals	4	6	10	0	6	5
11	5	10:48	x		x			x
		10:49½		x	x			x
		11:15	x		x		x	x
		Totals	2	1	3	0	1	3
11	6	05:01	x		x			x
		05:09		x	x			x
		05:13	x		x		x	
		05:31	x		x			x
		06:12½	x		x		x	
		06:35		x		x		x
		07:06½		x	x			x
		07:51	x		x			x
		08:12	x		x			x
		09:07	x		x			x
		Totals	7	3	9	1	2	8
11	7	10:54		x	x			x
		11:16	x		x			x
		11:48½		x	x			x
		11:59½	x		x			x
		Totals	2	2	4	0	0	4
11	8	11:31½	x		x			x
		12:06½	x		x			x
		12:36		x	x			x
		12:42½	x		x			x
		14:12	x		x			x
		14:19		x	x			x
		14:58		x	x		x	

TABLE 16—Continued

Nest No.	Day	Time	Sex Removing		Fed?		Disposal	
			Male	Female	Yes	No	Ate	Carried
11	8	15:04		x	x			x
		15:53	x		x			x
		15:55	x		x			x
		Totals	6	4	10	0	1	9
11	9	16:46	x		x			x
		17:53½		x	x			x
		20:15		x	x			x
		Totals	1	2	3	0	0	3
11	10	06:30		x	x			x
		09:46		x	x			x
		Totals	0	2	2	0	0	2
17	0	15:23½		x	x		x	
		19:21	x		x		x	
		19:48		x	x		x	
		Totals	1	2	3	0	3	0
17	1	09:05	x		x		x	
		09:20		x	x		x	
		10:16		x	x		x	
		11:54		x	x		x	
		Totals	1	3	4	0	4	0
17	3	11:34		x	x		x	
		12:22	x		x		x	
		13:21	x		x		x	
		16:26	x		x		x	
		Totals	3	1	4	0	4	0
17	4	15:40		x	x		x	
		15:46	x		x		x	
		16:14	x		x		x	
		17:06	x		x		x	
		Totals	3	1	4	0	4	0

Most of the excreta (82.86 per cent) are eaten by the adults during the first four days of development of the young. During the last six days most of the excreta (85.71 per cent)

are carried away from the nest. The removals of excreta, for the five Scarlet Tanager nests, have been arranged in Table 17 to show this trend.

TABLE 17

METHOD OF EXCRETA REMOVAL BY THE SCARLET TANAGER IN RELATION TO DAY OF DEVELOPMENT OF YOUNG

First Four Days				Last Six Days			
Nest	Day	Ate	Carried	Nest	Day	Ate	Carried
No. 3	2	1	1	No. 2	8	2	2
" 3	3	11	3	" 2	9	2	16
" 11	1	7	0	" 2	10	1	10
" 11	2	11	1	" 3	5	1	8
" 11	3	7	2	" 3	7	1	8
" 11	4	6	5	" 8	8	5	10
" 17	0	3	0	" 8	9	0	4
" 17	1	4	0	" 8	10	0	9
" 17	3	4	0	" 11	5	1	3
" 17	4	4	0	" 11	6	2	8
				" 11	7	0	4
Totals		58	12	" 11	8	1	9
				" 11	9	0	3
				" 11	10	0	2
				Totals		16	96

Deposition of excreta when it is carried away from the nest. At nest No. 2 the adults flew with excreta somewhat to the left of my blind, crossing a big open space, and then lit in large oaks and hickories, which were approximately 84 feet from the nest tree. They perched on the large bare limbs of the trees at about the same height as their nest (53 feet). Occasionally a fecal sac dropped to the ground after they perched with it. I never actually saw them drop the excreta.

At nest No. 3 there seemed to be two lines of flight

followed by the male, when carrying fecal sacs from the nest, one in a northeasterly direction, and the other in a southwesterly direction. Both were natural open flyways with only a few obstacles. I never saw him drop the excreta as long as he was within my vision, and I was able to watch him for a distance of 100 feet in one direction, and about 25 feet in the other direction. Female No. 3 always took southerly flights when she carried fecal sacs from the nest. Once male No. 3 hopped up through the nest tree with a fecal sac in his beak. Otherwise their flights were directly away from the nest as soon as they took the excreta in their beak.

Female No. 8 made two flights with excreta as far as 100 feet from the nest, but the rest of the time she flew to trees which were closer to the nest, often as near as 20 feet. She seemed to fly on the average of 40 feet, and generally perched with the fecal sac at a height of 20 feet. Because of this I was better able to observe her method of disposal of fecal sacs than of the other adult tanagers. She always flew directly from the nest to a branch, gently placing the fecal sac on the branch, and immediately flew away. She placed excreta on small branches, usually from 1.5 to 2 inches in diameter, and she usually lit midway on the branch. Once the dipping of the small branch, as she left, caused the fecal sac to drop to the ground. Otherwise the fecal sacs remained on the branch where female No. 8 placed them. There was no favorite branch, but many in the area were used.

General. After feeding the Cowbird nestling, female No. 8 stretched forward, pointing at the posterior end of the Cowbird and waited about two seconds, then she took the fecal sac as it came out. At another time, when she bent toward the Cowbird nestling, it turned facing away from her and raised its rump until it was a fraction of an inch from her beak, and then the Cowbird extruded the fecal sac. Once the tanager young shifted slightly, as female No. 8 waited to take the fecal sac, and the excreta fell into the air. However, the female caught it before it struck the nest. This female continued to take excreta from both the Cowbird and tanager young and carry it away even after they had both left the nest. Her behavior at this time was exactly as if the young were standing up in the nest, or on the nest rim. She fed, bent down, peered, and if a sac appeared, she took it.

Occasionally after feeding, an adult tanager turned and appeared to be ready to fly from the nest. But the raised, humping back of a young projecting above the nest caused the adult to turn and take the fecal sac as it was protruded. Once female No. 11 grapsed a fecal sac as it was extruded and seemed to hold it tightly, remaining motionless, until the young lowered its rump and left the excreta in her beak. When male No. 2 fed a young and quickly hopped above the nest and bent toward the young, it voided the fecal sac over the nest rim. Male No. 2 dove from his perch and followed the fecal sac down toward the ground approximately 40 feet. I was unable to tell if he caught it, but this indicates a strong urge by the

adults to remove excreta from the nest.

The removal of an excreta by female No. 17 is interesting. She flew to her nest approximately one minute after a Crow had taken her young from the nest. After peering at the empty nest she ate a fecal sac which she found on the bottom of the nest.

In general the ground under the tanager nest is free of excreta. A very great percentage of the excreta is removed by the parents before it can accumulate and fall to the ground. Rarely the older nestlings "up-ended" and "shot" feces over the nest rim to the ground below. In the case of nest No. 5, the sides of the nest and several places on the ground under the nest were colored by a purplish, excreta discharge (young were fed blueberries).

SUMMARY

1. Nestling Scarlet Tanagers weigh approximately 2.97 grams the day of hatching, and weigh between 19 to 22 grams when they leave the nest. A discussion of the daily development of three tanager young is given.

2. The first three days of development, the nestling's activity is concerned primarily with eating and resting. They gape strongly on the third day. On the fourth day the young poke their heads free from the brooding female and rest their heads on the nest rim. On the fifth day they stand upright in the nest, stretch wings, etc. By the sixth day most of these random movements have given way to preening behavior. Thereafter they exercise their wings, preen often, and become more

and more active until they leave the nest on the ninth or tenth day.

3. The adults do not try to coax the young from the nest. Detailed observations of one nestling leaving the nest show that it is a gradual process and that the young may return to the nest after leaving it. Tanager nestlings have a good power of flight when they fly from the nest, or nest branch, but the Cowbird nestlings have a poor flight and lose height rapidly when they fly from the nest. I was not able to determine if the Cowbird and tanager nestlings were the same age when they left the nest. There may have been at least a day difference in their ages.

4. The female Scarlet Tanager broods the nestlings about three days after they hatch. Her periods on the nest gradually decrease, and her periods off the nest gradually increase, until on about the fourth day she spends less time on the nest than off. She may brood, or shield, the young when it rains as long as they remain in the nest. She broods the young during the hours of darkness as long as they remain in the nest.

5. The male tanager assumes the burden of feeding while the female broods the young. However, he feeds less frequently as the young increase in age. The female feeds more frequently as the male's feedings diminish, so that the number and frequency of feedings increase as the young increase in age.

6. Table 12 gives a list of the food matter which I observed being fed to the nestlings. Larval forms, and adult insects, occasionally supplanted by wild berries, constitute the nest-

ling's food. There is no trend from the feeding of soft larval forms the first few days, to the feeding of adult insects as the young increase in age.

7. Figures and tables are given to show the rate of feeding, and intervals between feeding, of the nestlings by the adults. Of 785 times that I observed a nestling being fed, 63 per cent of the feedings were by the female tanager.

8. A detailed account, and a figure showing the feeding intervals, of the feeding of a Cowbird nestling and a tanager nestling is given. The Cowbird had access to approximately 75 per cent of the food brought to the nest tree by the female tanager.

9. The manner in which the adults fed the nestlings for the first two days of their development strongly resembled regurgitation. I believe that some of the food was carried in the adult's throat and was worked up into the beak for feeding to the young.

10. Female tanager No. 8 seldom fed food to the nestlings on the first thrust. In general, if food was not swallowed immediately it was taken from the gullet and either offered again to the nestling by the adult, or given to another.

11. Parts of insects (heads, wings and legs of dragonflies, wings of moths and tipulids, etc.) are removed before being fed to the nestlings.

12. Adults follow a regular pattern of behavior as they arrive at and leave the nest, and as they feed the nestlings.

13. The adults spend little time (one to 79 seconds) at

one feeding of the nestlings. The length of a feeding lessened as the young increased in age and as the intervals between feedings became shorter.

14. The nestlings give off excreta in the form of fecal sacs. They may continue to do this a day or two after they leave the nest. A diet of blueberries affected the excreta of some nestlings so that it was given off as a bluish, watery discharge rather than in a mucous sac.

15. Adults either eat the fecal sacs, or fly from the nest with them. Rarely the older nestlings may "up-end" and "shoot" a fecal sac over the nest rim.

16. Many fecal sacs which are carried away from the nest are placed on tree branches 20 to 100 feet from the nest.

17. Of 182 nestling excreta which I observed to be removed (i.e., carried off or eaten), the female removed 59.34 per cent. Of these she carried off 61 per cent. The male carried off 56.76 per cent of the excreta he removed. Of the 182 excreta removed, 59.34 per cent were by carrying off.

18. Most of the excreta (82.86 per cent) were eaten by the adults during the first four days of development of the young. However, the last six days most of the excreta (85.71 per cent) were carried away from the nest.

19. Usually, the ground under the Scarlet Tanager nest is free of excreta.

CHAPTER VIII

FOOD AND FEEDING BEHAVIOR OF THE SCARLET TANAGER

A. Food

There are many references in the literature to the food of the Scarlet Tanager. Some of these are based on the analysis of stomach contents, and a few of the references are based on actual observations of feeding. I do not intend to give an exhaustive account of all the references to the Scarlet Tanager's food which I have found. However I shall list, to the best of my knowledge, all the food which the Scarlet Tanager has been known to eat.

Plant food. Audubon (4, 1838:393) found the remains of seeds in the stomachs of two male Scarlet Tanagers. Barrows (1912:541), Jones (1903:157), and others have stated that seeds are eaten by the Scarlet Tanager. Jones actually saw a Scarlet Tanager "cutting" the tender buds from elm trees and eating them. There are many references to fruit and berries as a food item: blackberries (Judd, 1900:419); cherries (Howell, 1932:436, Judd, loc. cit.); grapes (Audubon, 4, 1831:390; Burns, 1915-b: 232); huckleberries (Howell, loc. cit.); June-berries (Nehrling, 1896:7); mulberries (Holt, 1918:359, Howell, loc. cit.); raspberries and service-berries (Judd, loc. cit.); strawberries (Howell, loc. cit.); and whortle-berries (Nuttall, 1832:468).

Molluscs. Nauman (1926:159) observed a male Scarlet Tanager eating slugs. McAtee (1926:67) reports that snails are eaten by the Scarlet Tanager.

Annelids. Warriner (1940:49) observed five Scarlet Tanagers feeding on worms and grubs that had been turned up by a plow. The tanagers flew back and forth between the open plowed field and a nearby woods. Forbush (1907:214) states that the tanager follows the plow, picking up earth worms. When Clarke (1911: 193) offered an angleworm to a disabled male Scarlet Tanager, it ate the worm "without hesitation".

Arachnids. King (Butler, 1897:987) found eleven spiders in the stomach contents taken from 29 Scarlet Tanagers. Forbush (1907:214) states that a few spiders are destroyed by the Scarlet Tanager. McAtee (1926:67) reports that the Scarlet Tanager eats daddy long-legs, and spiders.

Diplopods. McAtee (loc. cit.) also lists millipedes as a Scarlet Tanager food.

Insects. Odonata (dragonflies). The only reference I have found to this insect as a food of the Scarlet Tanager is by King (loc. cit.) who found one when he examined the stomach contents of 29 Scarlet Tanagers. This is surprising, for my observations indicate that the dragonfly is frequently taken, both as food for the nestlings and as adult food.

Orthoptera (grasshoppers and locusts). These have been reported as food of the Scarlet Tanager by Forbush (1907:213), Warren (1890:251), and King (loc. cit.). Aughey (Barrows, 1912:541) found 37 locusts in the "craw" of a Scarlet Tanager.

Isoptera (white ants, termites). These have been found by McAtee (1926:67), and Judd (1902:98) as a Scarlet Tanager food item.

Heteroptera (bugs). Forbush (1907:214) states that the Scarlet Tanager takes bugs from the ground, grass, and shrubbery. King (loc. cit.) found 6 bugs in 29 tanager stomachs, and McAtee (1926:67) states that the Scarlet Tanager feeds on cicadas, leaf hoppers, spittle insects, tree hoppers, jumping plant lice, and scale insects.

Megaloptera (dobsonfly). Forbush (1907:214) saw a male Scarlet Tanager swallow a hellgramite (Corydalus cornutus) larva head first, and apparently entire.

Lepidoptera (butterflies and moths). There are many reports in the literature of larval forms as Scarlet Tanager food. Caterpillars have been reported by Judd (1900:419), Howell (1911:69), and others. Forbush (3, 1929:133) reports the observations of his assistant, Mosher, to the effect that two Scarlet Tanagers ate newly hatched gypsy moth caterpillars for 18 minutes, at an average rate of 35 per minute, or approximately 630 in the 18 minutes. Miller (1934:301) saw a female Scarlet Tanager pecking "half-heartedly" at tent caterpillars. Forbush (loc. cit.) observed that a Scarlet Tanager removed every tent caterpillar from a bush partially defoliated by them.

The Scarlet Tanager also takes adult lepidoptera as food. Forbush (1907:214) states that the protectively colored nocturnal moths, such as those of the genus Catocala, which remain motion-

less on tree trunks during the day, are taken by the Scarlet Tanager. Forbush found that even the largest moths, such as the cecropia and the luna are taken. McAtee (1911:283) found that the Scarlet Tanager was an enemy of the brown-tailed moth. Brecher (1946:47) saw a female Scarlet Tanager carrying a butterfly in her bill for five minutes.

Diptera (flies). King (loc. cit.) found six diptera in the tanager stomachs which he examined. Of the 29 Scarlet Tanager stomach contents listed by Warren (1890:251), seven contained flies.

Coleoptera (beetles). There are many reports of beetles and their larva as a principal food of the Scarlet Tanager. The stomach contents listed by Warren (loc. cit.) include 24 beetles. And of 13 other tanagers collected from maple and hickory trees, Warren found that the only food present in their stomachs was black beetles. King (loc. cit.) found 47 beetles in the stomach contents he examined; this was slightly less than 50 per cent of the food he analyzed.

The darkling beetle (Helops micans), the sad flower beetle (Euphoria melancholica), and the soldier bug (Nezara hilaris), have been reported by Judd (1902:30) as Scarlet Tanager food. McAtee (1908:47), and Forbush (3, 1929:133) list the potato beetle (Leptinotarsa decemlineata) as tanager food, and Brotherton (1890:69) states that the Scarlet Tanager was the first bird noticed in Michigan to eat the potato beetle. Forbush also lists the leaf-rolling beetles, bark beetles, and click beetles as Scarlet Tanager food. King (loc. cit.) found the

click beetle in his tanager stomach analysis. Leaf-eating beetles, and wood-boring beetles have been listed by Forbush (1907:214) and McAtee (1926:67). King (loc. cit.) lists curculios as a Scarlet Tanager food. Eaton (3, 1914:338) saw as many as 12 to 15 male Scarlet Tanagers feeding on May beetles and their larvae in a plowed field.

Hymenoptera (bees, wasps, etc.). Bees, hornets, and wasps have been reported as Scarlet Tanager food by Judd (1902:98), and Nuttall (1832:468). Judd also lists parasitic wasps and the pine sawfly as tanager food. Forbush (1907:214) and King (loc. cit.) found that ichneumon flies had been taken by the Scarlet Tanager.

Ants have been reported by Forbush (3, 1929:133), and King (loc. cit.) as tanager food. (See also Anting, Chapter X)

Other food. Bailey (1914:89) states that the Scarlet Tanager was fond of doughnut crumbs which he placed on his feeding station. Scarlet Tanagers which fed at Thompson's feeders (1949:81) were quite particular, for of the food placed there, they only ate peanut-butter paste. For a list of food fed to my tanager nestlings see Table 12 (Chapter VII).

B. Feeding Behavior

Much of the Scarlet Tanager's time is spent in feeding, although the periods of intensified searching for food generally occur during the early morning and late afternoon hours. The male often sings as he looks for food. When the female leaves her nest, she begins feeding immediately, occasionally in the nest tree, but usually in adjacent trees. The feeding activity

of the pair is increased when there are young in the nest, and appears to be continuous throughout the day. Feeding usually takes place in the trees at a level of 20 to 40 feet, although I have observations of tanagers feeding in saplings as low as 2 feet from the ground, and in the case of pair No. 3 as high as 60 feet. Scarlet Tanagers occasionally feed on the ground.

Ground feeding. Occasionally I have observed tanagers on the ground, searching, and apparently feeding. R. Wilson (Sutton's notes) saw female No. 4 take a moth and another insect from the forest floor. The morning of May 18, 1947, I observed two males (in different woods areas) on the ground. They appeared to be searching the leaves and grass, and I believe that they were feeding.

Once I observed male No. 6 catching insects very close to the ground. He flew to a series of perches which were about a foot to three feet above the ground. He made short flights from these perches, just skimming the tips of the forest grass, and appeared to be capturing very small insects which flew from the grass blades.

Arboreal feeding. There are two general types of arboreal feeding: (1) a careful searching of leaves, twigs, and branches for adult insects and larval forms, and (2) flycatcher-like flights for adult insects. I repeatedly observed both the male and female in oak and hickory trees near the outer tips of limbs, pecking at the leaves and twigs. Generally they investigated thick clumps of green leaves. Often they followed a limb out from the trunk to its leafy tip, examining the branch and

leaves from various angles, and they appeared to peck at some of the places which they had carefully scrutinized.

June 13, female No. 1 took an insect off a dead hickory branch, and small white, moth-like insects flew away from the spot. She darted after some of them. I have observed both the male and female tanagers pecking two or three times at dead limbs, and at exposed portions of branches, and then they appeared to take food.

On July 7, 1947, I observed an unusual method of feeding by male No. 1. He was searching the leaves and branches of an oak, when he came upon a spider web at the tip of a low branch. A small moth, apparently dead, was caught in the web. Male No. 1 pecked once, taking the moth in his beak and swallowed it immediately. He then pecked twice more at the web, apparently taking other insect(s), but I was unable to see what he took.

A few moments later, male No. 1 took a large two- to three-inch hairy caterpillar from a branch. However he appeared to have some trouble swallowing it. The caterpillar was able to firmly grasp the branch, while in the tanager's beak, and the male had to tug in order to pull the caterpillar free. Then he appeared to have trouble getting all of the caterpillar in his beak. He pressed his beak and the caterpillar against the branch, on which he was perched, to aid him in securing a better grip on, or possibly to kill, the caterpillar. Then he was able to swallow it.

Occasionally tanagers fly to a tree trunk and perch vertically against the trunk as they take an insect from the trunk.

Female No. 6 jumped against an oak trunk, grasping the bark with both feet and, holding her wings open, she took an insect from the bark. A half hour later she jumped up from a branch and lit against the trunk, pausing with wings closed, as she took an insect from the tree trunk. At other times they may take insects from a tree trunk without perching on the trunk. Female No. 1 made a short, 14-inch flight from a twig to the trunk of a large hickory and, while in the air, took an insect off the trunk. Then she returned to her original twig perch. I observed female No. 3 to take an insect from a hickory trunk in a similar manner.

Preparation of some insects for eating. After male No. 9 caught a dragonfly, he flew with it to a dead branch. As he swallowed it head first, the insect's wings protruded from his beak. When female No. 18 had caught a medium-sized, dull brown moth, she flew to a branch (two inches in diameter) and perched with her feet on either side of the branch, rather than at right angles to the branch. She touched her beak and the moth to the branch several times until the moth had been moved in a position so that its head was in her beak, and the moth's wings pointed out of, and away from, the tanager's beak. As she gulped the moth, the moth's wings were forced closer together by the sides of the tanager's beak. With a few, seemingly difficult gulps, she swallowed the moth. A few days later I observed this female to perch on a branch (1.5 inches in diameter), as above, and swallow a brown moth.

Undoubtedly this is the usual manner of eating these larger

adult insects, yet I have some observations of a more elaborate method of preparing them for eating. Once female No. 9 tore the wings off a large insect, two- to four- inches long, and ate the wingless insect as the wings floated gracefully to the ground. I saw female No. 6 fly to a large oak limb carrying a damsel fly in her beak. She rubbed her beak and the insect against the branch, then holding it on the branch with her right foot, she pecked at it three times. One wing floated down at each of the first two pecks, and something else, possibly a leg, after the third peck. June 5, 1949, I watched a male as he sang from a high (60-foot) perch. Suddenly he dove down toward me and, at a height of 20 feet and only 15 feet from me, captured a large dragonfly. Pulling up from his dive he landed on a large (four-inch diameter) hickory limb. He held the insect with his feet, and pecked off the wings, legs, and possibly its head. Then he flew with it to another perch, ate it, and then resumed singing.

Occasionally the Scarlet Tanager may have trouble holding one of these large insects after it is caught. After female No. 9 had captured a large winged insect, she flew with it to a 25-foot perch. However, she dropped the insect and it fell to the ground. Female No. 9 dove straight down after it. She flew with it to a stump and placed the insect on the stump, but again it flew to the ground. The female tanager darted to the ground, retrieved the insect, and returned to the same stump. She placed it on the stump, pecked hard at it and then flew away with it.

Sutton (field notes) observed a male eating a chokeberry (Pyrus arbutifolia atropurpurea). At another time he saw an adult female slowly eating a chokeberry. She ate deliberately and dropped the pit out of her mouth after she had chewed off the skin.

SUMMARY

1. The Scarlet Tanager eats seeds and many fruits and berries. There is one account of a tanager eating elm buds.

2. The non-insect invertebrates which the Scarlet Tanager has been known to eat are slugs, snails, worms, spiders, and millipeds.

3. The Scarlet Tanager eats many larval and adult insects. Examples of the following insect orders have been cited: Odonata, Orthoptera, Isoptera, Heteroptera, Megaloptera, Lepidoptera, Diptera, Coleoptera, and Hymenoptera.

4. Doughnut crumbs and peanut butter have been eaten by the Scarlet Tanager at feeding stations.

5. The Scarlet Tanager searches for food sporadically throughout the day, although periods of intensified searching occur during the early morning and late afternoon hours.

6. The Scarlet Tanager occasionally feeds on the ground.

7. There are two general types of arboreal feeding: (1) a careful searching of leaves, twigs, and branches for adult insects and larval forms, and (2) flycatcher-like flights for adult insects.

8. Scarlet Tanagers usually search the thick clumps of green leaves for food. I have also observed them to take food from dead branches, and from the tree trunks. Moreover, they make many flycatcher-like flights to capture adult flying insects.

9. One male tanager was observed to take a moth, and possibly one or two other insects, from a spider web.

10. Some of the larger insects are swallowed entire, although occasionally the wings and legs are removed before they are swallowed.

CHAPTER IX

SONG AND OTHER SOUNDS GIVEN BY THE SCARLET TANAGER

A. The Song

The literature abounds with descriptions of the Scarlet Tanager song. Of all those I have read, I believe that Peterson's (1947:220) concise description is the best. He describes the Scarlet Tanager song as "four or five short, nasal phrases, robin-like in form but hoarse (like a robin with a sore throat)". This adequately describes the average Scarlet Tanager song. However often the song may consist of only one phrase, and at other times there may be more than five phrases. The same song pattern appears to be repeated many times. Saunders (1935:237) gives an excellent description of the song. He describes it as a rather hoarse, high-pitched whistle, consisting of 8 to 12 notes or slurs, with slight pauses between them, and each on a pitch different from the preceding one.

The Scarlet Tanager song has been described as being similar to the Robin by many authors (Allen, 1932:291: Peterson, loc. cit.; Saunders, loc. cit.; and others). It has been likened to the Rose-breasted Grosbeak's song by Cook (1929:258) and Nauman (1938:95). The latter author says that the only difference between the Scarlet Tanager song and the Rose-

breasted Grosbeak song, is that the tanager has a harsh note or burr in its song, and Nauman implies that the tanager sings a Scotch version of the Grosbeak's song. Nuttall (1832:467) states that the tanager's song has some resemblance to that of the Red-eyed Vireo. While the tanager's song is somewhat similar to the song of these three species, I believe it is easily distinguishable from them.

Several authors have diagrammed the Scarlet Tanager's song on the musical staff. While this method of representation is not particularly enlightening to me, it may be to others. To those who may wish to use this aid in interpreting the Scarlet Tanager's song, such representations may be found in Arlton (1949:147) and Cheney (1891:36). Saunders (1935:237) gives another type of diagramatic representation.

Song season. In a preceding chapter (No. III), I pointed out that the newly arrived male Scarlet Tanager sings from conspicuous perches. Burns (1937:125) says that the tanager song is coincident with its arrival and continues until the middle of July, being heard occasionally through late July and August. I have heard the tanager song at the Reserve during early August. Burns (loc. cit.) heard a tanager, in winter plumage, sing as late as September 5. Other September singing dates, as given by Saunders (1948:381), are: September 3, 5, 6, 14, and 22. As far as I know the latest fall record for a singing Scarlet Tanager is September 23 (Bagg, 1937:646). This tanager was in complete winter plumage.

Allen (1932:292) infers that the reason for the constant

singing of the Scarlet Tanager throughout the breeding season is that the tanager seldom is successful with its first nesting attempt, and further that most Scarlet Tanagers have two broods. I certainly agree that many of the Scarlet Tanager's first nesting attempts are unsuccessful. However I have no acceptable evidence, from my work or that of others, that the Scarlet Tanager raises two broods a season.

Early morning and late evening song. Wright (1913:512-537) has given a good account of the early morning and evening song of approximately 57 species of birds. July 8, the Scarlet Tanager was the tenth species, in the order of earliness, which he observed to sing in the early morning. It sang at 03:16 (sunrise 04:11), (p. 517). Of six Scarlet Tanager song records, the average time of the first song before sunrise was 51 minutes (p. 532). And of 57 species, for which he recorded early morning songs, the Scarlet Tanager ranked 20th (p. 532). Of 53 species, for which he recorded late evening songs, the Scarlet Tanager was one of the last heard to sing. Of three records, the average Scarlet Tanager song was 31 minutes after sunset (p. 536).

Song in flight. I have not found a reference to Scarlet Tanagers singing while in flight. This unusual occurrence was first called to my attention by William A. Lunk, when he told me of hearing a Scarlet Tanager sing while in flight at Morgantown, West Virginia. July 31, 1948, Lunk gave me an extract of his field notes for May 30, 1941, at Morgantown. The tanager which Lunk observed flew across a pasture, and

directly above Lunk, on a long extended flight to a woods. He heard the tanager give three songs "differing little or none from the typical song".

Thereafter I continually watched for song by males while they were in flight. May 16, 1949, I was so fortunate as to hear a male Scarlet Tanager sing while in flight. I had watched this male for some days and I am confident that it was unmated May 16, and I believe it was still unmated two weeks later. I observed this male as he sang from high conspicuous perches on the uppermost branches of the tall oak and hickory trees. Once as he flew from one tree to another nearby, he sang one full and complete song, and then gave a sharp "chip-churr" call before alighting.

Female song. As far as I know there are only two references in the literature to female tanagers singing. Leister (1920:206) first noted this, generally considered, rare happening. He observed that a female Scarlet Tanager often gave a "little song", which was very similar to that of the male but lower in tone. This observation is perhaps more unusual in that the tanager was perched on a wire. I have never seen a Scarlet Tanager perched on a wire, even though telephone wires passed through the territories, and near the nest trees, of two tanager pairs at the Reserve. Burns (1937:125) heard a tanager, "in the plumage of a female", sing exactly like a male that was following her. He watched this tanager for some time and was confident that it was a female, and that she did sing.

In my work at the Reserve, I have observed nine female

Scarlet Tanagers singing. This represents approximately 65 per cent of the paired females which I observed from my blind. I cannot say that the other females did not sing, merely that I never observed them to sing. I believe that most female tanagers may sing at some time during the nesting season. Field workers who make a bird census based on the number of singing males heard, might do well to bear in mind that a Scarlet Tanager song may be uttered by a female tanager, and that an exchange of songs by two unseen males might actually be the songs of a paired male and female tanager.

In view of the fact that little is known about the female Scarlet Tanager's singing behavior, I believe that it is worth while to go into this matter in some detail. The first female song I heard was that of female No. 3, July 2, at 10:52, as she lit in the nest tree with food in her beak for the young.

July 20, Sutton took me to nest No. 4, which contained young, and I was able to observe that female sing. Her song was similar to the song of singing males, although it seemed a little softer. I believe that her song averaged fewer phrases than her mate's song, yet at times she sang a longer song with more phrases than the male usually did. July 17, Sutton was "delighted to hear the female sing a full and beautiful song while she hunted food, when she visited the nest, etc.". He noticed that she sang even when her bill was more or less full of insects. To Sutton, male No. 4's song was stronger and a trifle harsher than the female's song. Sutton told me that at times this male and female sang back and forth, apparently

answering each other, although there were periods when she sang continuously with but an occasional call note from the male.

The description of male No. 5's song would suffice for that of female No. 5, for I found it impossible to differentiate between their songs. Unless I actually saw the bird singing I could not record the song as being that of the male or female. Her song was as loud and sharp as her mate's. Perhaps because of incubation duties, and subsequent caring for her young, she did not sing as frequently as her mate.

Female No. 6 uttered three songs as she was gathering nest material from the ground. Her beak was filled with nest material at that time. Female No. 8 often sang as she searched for food. Most of her songs were short, and given with her bill closed, for this reason her songs were not strong and did not carry far. There was only one short phrase to female No. 13's song. She sang hurriedly and her song had a high, squeaky quality, not in the least pleasing to me.

June 20, at 17:30, female No. 9 sang approximately 20 songs as I watched her searching for food. The following day I recorded the following songs per minute for this female:

15:08–15:09 s,s,s,s,s.
15:09–15:10 s,s.

I often heard the male and female tanagers singing together in territory No. 11. This male and female definitely seemed to be answering each other's songs. The female often turned and looked at the male as he sang and then answered immediately. Some of the song exchanges of this pair are ("s" represents a

song; "N,E" represents the direction of the singing bird from my blind when it sang; spaces between two "s" indicate that the other bird sang):

July 17,	09:27–09:28	Male	NE	s,s,s, s, s. (loud, rapid)
		Female	N	s, s, (soft)
	09:29–09:30	Male	NE	s, s, s.
		Female	NNE	s, s,
	09:30–09:31	Male	NE	s, s,s.
		Female	NNE	s,s,
	10:55–10:56	Male	E	s, s, s, s,s.
		Female	NW	s, s, s,s, (weak, short)
	10:58–10:59	Male	NE	s, s,s,s,
		Female	N	s, s, s,s,s. (weak, short)
	10:59–10:60	Male	E	s, s,s.
		Female	NE	s, s,
July 20,	06:34–06:35	Male	E	s, s, s, s.
		Female	E	s, s,s,s.
	07:25–07:26	Male	N	s, s, s, s,s.
		Female	E	s,s,s,s, s, s.
	07:26–07:27	Male	N	s, s, s, s,s.
		Female	E	s,s, s, s, s.

Male song. In general, singing was fairly constant throughout the day during the hours of light, from courtship until hatching of the young, at which time the male took on added parental duties, which seemed to interfere with his singing periods. Singing seemed stronger and more frequent during the morning and evening hours and more sporadic during the heat of the day, yet observations over a number of days failed to show any one period of the day which might be called a rest- or song-free period. Burns (1937:125) states that the tanager seems to enjoy hot weather singing, and that it may be heard at intervals all day long. According to Bicknell (1884:326) wet weather

seems to discourage singing, although he has heard the Scarlet Tanager singing on hot sultry mornings when most of the other birds were quiet. However, I once heard male No. 17 singing while it was raining lightly.

I recorded the number of songs per minute (s/min.) for many of the male Scarlet Tanagers at the Reserve. For my purposes I construed a song to be a continuous voice, i.e., a phrase followed by several seconds of silence, I scored as one song, if two phrases ran together without a break, I also counted that as one song, etc. With the onset of the first song I noticed the position of the sweeping second hand of my watch and allowed it one complete revolution of 60 seconds, meanwhile recording the number of songs in my notebook as s/min. Later by close examination of my second hand, and when a male was singing with regularity, I was able to time to the nearest second the length of the songs.

The following s/min. were recorded for male No. 1 during the incubation period:

June 12, 11:05-12:44 7,3,4,6,5,2,3,5,5,3,15,7,2.

June 13, 10:24-12:04 5,5,4,4,3,3,5,4,6,2,4,3,2,6,4,5,2,2,7, 1,8,4.

June 17, 05:10-08:10 4,8,6,5,3,5,3,4,7,9.

June 18, 05:50-08:17 2,4,1,1,2,1,3,2,6,5,6,2,2,2,8,7,7,4,6, 5,9,3,2,2.

The following s/min. were computed for male No. 3 during the nestling period:

June 24, 14:55-16:04 5,2,5,5.

June 28, 04:01-04:18 8,7,6,5,6,7,7,6,6,6,7,6.

Song length in seconds for male No. 1 during the incubation period were ("s" is a song not timed):

June 13, 12:41-12:42 6,4,3,6,4,6,3,8,3,4,3.

June 13, 15:28-15:30 4,3,4,3,1,10,2,2,5,5,6,7,4,5,2.

June 17, 08:09-08:10 5,s,s,2,s,3,s,3,2.

June 18, 19:46-19:48 2,6,2,3.

June 18, 20:04-20:05 s,s,s,2,6,8,17.

Song length in seconds for male No. 3 during the nestling period were:

June 27, 19:59-20:00 2,3,2,2,2,2,2.

June 28, 07:43-07:44 s,s,2,3,1,2.

I believe that the above data is sufficient to give a picture of the male Scarlet Tanager's song frequency and length. It is evident that there is an individual variation, both in song length and s/min., of male tanagers. When I made observations at nests in southwest woods during 1947, I often heard males No. 1, No. 2, and No. 3 singing. Invariably I could tell when male No. 1 was singing, although I found it difficult to differentiate between the songs of No. 2 and No. 3.

Role of the song. The song is probably used primarily to maintain territorial claims, and the most frequently used singing perches of males were often near the boundary of that portion of their territory which faced the territory of adjacent tanagers. However many of the male's songs were given from conspicuous perches in full view of the female on the nest and may function as an "all's well" sign to the female. The role of song in establishing the territory has been discussed

earlier (Chapter III).

It is more difficult to determine the role of the female Scarlet Tanager song. It does not serve to advertise territorial boundaries, as far as I have been able to determine. At times, especially when the paired male and female exchange songs it seems that it is a means of ascertaining the other's presence and, perhaps, position. This also may be the case when she sings while collecting nest material or looking for food.

B. The "Chip-churr" Call

The Scarlet Tanager is probably as well known for its "chip-churr" call as for its brilliant coloration. Apparently Audubon (4, 1838:389) was one of the first to record the tanager's call as "chip-churr". I am amazed at the phonetic representations that have found their way into the literature since that time. Butler (1897:987) refers to the call as "chuck-ah" or "chuck-ur"; Darlington (1914:89) as "jep-there"; Dawson (1903:107) as "chic-burr" or "chip-bird"; Nehrling (1896:6) as "chip-a-raree"; and Ridgway (1889:216) as "chip-a-ree". Bicknell (1884:326) even suggested a "clear case of geographic variation" concerning the Scarlet Tanager's call. Of course it is difficult to express in words, the call or song of birds. This was made quite clear to me the day that Sutton and I listened to a calling male tanager. The male unmistakably, and most distinctly said "chip-churr", as far as I was concerned, yet Sutton stood next to me and was equally as certain that the male most clearly called "chip-purr".

The "chip" of the "chip-churr" call is given with a sharply opened and closed beak, and is formed in the upper region of the throat, close to the mandible. A distinct swelling can be seen there just before the beak is opened and the "chip" is forcibly ejected. It is a highnote, in comparison to the second portion of the call. As the note is given, the tail dips down slightly and sharply, quickly snapping back to its original position as the beak closes.

The "churr" of "chip-churr" is formed deep in the throat. A full rounded, swollen, out-pouching is formed midway in the throat region. The beak is opened gently and held open wider and for a longer time than for the "chip". The tail dips downward more deliberately than for the "chip", and is held at the bottom of the dip as long as the "churr" sound lasts, then it snaps back to its original position.

Uses of the "chip-churr" call. The first indication of the unusual in tanager territory is heralded by a soft "chip-churr", either from the male or female or from both. This call is one of uneasiness at the presence of some disturbing factor, and does not always imply danger or fright. If the disturbance persists or approaches the nest, the "chip" becomes sharper and shorter than before (hurried and loud songs by the male may be interposed). If this is to no avail the "churr" becomes more guttural and raspy, and many sharp "chip" notes are given, which are not followed by a "churr". It is this single "chip" note, which I believe to be the danger signal, especially when given sharply. The female may give one or more single "chip"

notes as she leaves her nest in fright. A single "chip" note from the male causes the female to turn sharply on her nest and look intently in his direction.

Thirty-three minutes after being fed by the male, female No. 1 began calling "chip-churr" softly, looking all around, and four minutes later she gave three more soft calls. She had been on the nest well over her average incubation time, and had previously been fed by the male while she incubated. I believe that in this instance she used the call to attract the male, even though he failed to appear and she subsequently flew in search of food. I observed this same call and similar behavior during incubation by other female tanagers.

Number of "chip-churrs". The number of "chip-churrs" per minute (cc/min.) was computed in the same manner as that described above for computing s/min. Cc/min. during incubation were:

male No. 1, June 13, 11:02-11:48 7,2,4,2.
" " 1, " 13, 16:00-16:08 28,28,30,31,19.
" " 5, July 28, 08:00-08:02 25,25.

It was difficult to compute cc/min., for generally songs or "chips" were interposed. Frequently, during the day, the sounds given by tanagers involved a composite series of songs (s), "chip-churrs" (cc), and "chips" (c). Five typical series are:

male No. 1, June 16, 10:49 4cc,s,cc,s,cc,s,3cc,s,s,c,s,s,c.
" " 1, " 16, 11:53 s,3cc,s,c,s,s,cc,s.
" " 2, " 24, 14:28 4cc,c,2cc,c.
" " 3, " 28, 04:14 s,cc,s,2cc,s,2cc,s,cc,s,2cc,s,cc.
female " 5, July 28, 07:23 8cc,c,cc,c,7cc,c,3cc,c,6cc.

"Chip-churrs" at the nest. Females often called "chip-churr" or "chip" when returning to their nest, and the calls were usually given when but a few feet from the nest. These call notes were usually soft, except when the female was frightened, or when returning to her nest after territorial defense. Sutton (notes) describes the nest "chip" as a single "chip" or "chuck". Female No. 1 once gave 21 "chip-churrs" as she approached her nest. She uttered the last call when one foot from her nest, which contained eggs. Nothing unusual had happened as far as I could determine. When female No. 3 stood up in her nest to inspect the young she gave three soft "chips" and eight minutes later she gave two more soft "chips".

Female No. 5 seemed thoroughly frightened by my blind and gave many calls as she looked at it. Before settling on her eggs at 07:07, July 24, she gave the following series of calls: 6cc,2cc,c,11cc,c,2cc,c,29cc,c,20c,11cc,c,9cc,c,8cc,c. July 28, at 17:26, when she settled on her eggs, she gave the following calls:

8c,cc,7c,3cc,2c,cc,3c,cc,c,2cc,c,2cc,2c,6cc,c,2cc,2c,
13cc,c,8cc,c,4cc.

Later that day, at 18:08, when approaching her nest she called:

3c,cc,3c,3cc,c,3cc,2c,5cc,c,10cc,2c,2cc,c,6cc,c,cc,2c,
26cc,c,cc,c,16cc,c,cc,c,cc,2c,3cc,c,3cc,2c,3cc,c,3cc,c,
cc,7c,3cc,c,cc,3c,3cc,c,4cc,c,2cc,c,cc,c,8cc,2c,cc,c,cc,
2c,2cc,2c,2cc,c,3cc,4c,cc,c,3cc,c,cc,3c,3cc,c,3cc,c,3cc,
7c,7cc,c,7cc,5c,cc,2c,cc,c,3cc,c,3cc,3c,5cc,c,8cc,c,8cc,
c,13cc,2c,3cc;

and then settled on her nest. All these calls were given in trees only 10 to 15 feet from her nest, or in the nest tree. I have notes of many more such series of this female as she

approached the nest, and also when she called on the nest.

Female No. 5's calls given on the nest were loud, sharp, and demanding when the series began, but became softer toward the end of the series, until the "churr" could not be heard. However, it was possible to see the formation of the "churr", even though I could not hear it, by the "out-pouching" of her throat, and by the dipping of her tail. At the extreme end of the series even the "chip" was so faint that it was difficult to hear, although again the swelling of the throat and dipping of the tail showed me that she still called.

C. Other Sounds

The Scarlet Tanager has a wide variety of sounds which it gives, from time to time, which cannot be thought of as a song or as a variation of its "chip-churr" call. Sutton (notes) heard a tanager give a strange "oriole-like" note which he has written as "hoo-ree". All of the tanagers which I observed had a distress call which they gave when frightened and which they often gave as they attacked an intruder. I can best describe this call simply as a screech, a high-pitched drawn-out screech which descended in pitch at the end. Female No. 5 sprang from her eggs, screeching, when a squirrel approached her nest (see Relation with other species), and she gave this call repeatedly while the squirrel remained near her nest. Female No. 1 also abruptly left her eggs, screeching as she flew, but I was unable to determine the cause of her fright. A similar screech was given when either the male or female attacked an intruder during defense of their territory or nest. This distress call

was recognized by many birds of the community, and many collected at the scene of the disturbance.

During courtship and early during the nesting cycle the Scarlet Tanager pair often gave a soft "sweeeeee" call, the sound rising in pitch at the end. At times they gave a soft call which sounded to me like "zee-a-zee", "see-seee", and "see-a-deee". Often, before copulation, the female tanager gave soft, short, begging notes, the pitch rising rapidly at the end. Many times these calls (given in this paragraph) were barely audible to me, even when the birds were close by or over head. Often when the male and female flew together, or fed together, they gave a series of short notes which I can only describe as "twittering".

Both the male and female have a nasal, whistle-like call, slightly descending in pitch. The male often gave this call, softly, when arriving to the nest with food for the young. He appeared to give this call when the female remained on the nest, and it seemed to me that this was a signal for her to leave, or to stand up so that the male could feed the nestlings. In one instance, as a female was standing up and nudging the nestlings with her beak, the male gave this call. She looked up hurriedly and dove over the nest side as the male lit on the nest rim with food for the young.

When Sutton (notes) banded two young Scarlet Tanagers they gave a rather loud cry which he has written as "chu-eer". Often when I handled young tanagers, six to eight days old, they gave a loud, high, shrill call. The hunger call of the

Scarlet Tanager nestling is a "peep" which rises sharply in pitch. I have written one nestling's call as: "cheeeeep, cheeeep, chee, chee, cheep, cheeep, cheeeep", with the pitch rising rapidly at the end of each note. Sutton (notes) has written the tanager nestling's call as "churr-u-wee". The Scarlet Tanager nestling's call, no matter how it is written, is a marked contrast to the lower and buzzing call of the Cowbird nestling.

SUMMARY

1. The Scarlet Tanager song is a series of short, nasal, slurring, robin-like phrases (one to seven). It may also be thought of as having a rather hoarse, high-pitched whistle-like quality.

2. The tanager's song has been described as being similar to that of the Robin, Rose-breasted Grosbeak, and the Red-eyed Vireo. However, I believe it is easily distinguishable from them.

3. The Scarlet Tanager song may be heard from the day the male arrives until the end of the tanager nesting season. Later song dates in September are given.

4. The Scarlet Tanager song may be heard before sunrise and after sunset. Data from Wright are given.

5. Two examples of the Scarlet Tanager song in flight are given.

6. There have been two references in the literature to

singing female tanagers. Approximately 65 per cent of the females, which I studied at the Reserve, were observed to sing. Females at the Reserve have been observed to sing while gathering nest material, while feeding, during the incubation period, and during the nestling period.

7. The male tanager sings throughout the day. Singing seemed stronger and more frequent during the evening and morning hours, however, I do not believe there is a rest- or song-free period during the day. Males have been observed to sing during hot, sultry weather, and during a light rain.

8. A record of the number of songs per minute, and the length in seconds of the male tanager's songs is given.

9. The role of the male's song is primarily to proclaim territorial rights, however, it probably also functions as an "all's well" sign to the female on the nest. The exchanges of songs by a paired male and female tanager may serve as a means of ascertaining the other's presence, and perhaps, position.

10. The most frequently used Scarlet Tanager call is "chip-churr". This call is one of uneasiness at the presence of some disturbing factor, and does not always imply danger or fright. The single "chip" note is the danger signal. Data showing the number of "chip-churrs" per minute and a series showing songs, "chip-churrs", and "chips" are given.

11. Females often called "chip-churr" or "chip" when returning to the nest.

12. There is a wide variety of other sounds given by the

Scarlet Tanager adult. The distress call is a high-pitched, drawn-out screech. During courtship and early during the nesting cycle, the tanager pair often gave a soft "sweeeeee" call. At other times they gave a soft call which sounded like "zee-zee", "see-seee", and "see-a-dee". Often before copulation the female gave soft, short begging notes. The male often gave a soft, nasal, whistle-like call when arriving with food for the nestlings. This seemed to be a signal for the female to leave, or stand up and allow the male to feed the nestlings.

13. The tanager nestlings give a loud, high, shrill call when handled. Their nestling food call is a marked contrast to the lower and buzzing Cowbird nestling food call.

CHAPTER X

OTHER BEHAVIOR OF THE SCARLET TANAGER

A. Preening

Preening by the Scarlet Tanager is undoubtedly similar to that of other passerine birds. I have observed the Scarlet Tanager preening at three different situations: (1) feeding activity may be interrupted by a brief preening interval, often of only a few seconds' duration, (2) adults may fly to an exposed perch and, for longer periods, direct all of their attention to preening, and (3) the female may preen while on the nest.

The time spent preening generally varied from a few seconds to a minute. However, I observed one female preening in the nest tree for periods as long as two, three, and seven minutes. The preening perch is always an exposed perch, usually not in the nest tree, and invariably it is in the direct sunlight, or at least in diffuse sunlight. The tanagers which I observed almost always preened the wings, and usually the breast and tail. At times opening of the wing, prior to preening it, seemed to be a stretching movement.

One female preened, for seven minutes, on a dead branch three feet above her nest, June 13, at 15:41. She worked her beak between the wing primaries and secondaries from underneath, pulling the feathers through her beak one at a time for their

full length. She also preened the outside of the wing, especially at the shoulder. She ran her beak through the breast, abdomen, back, rump, and tail feathers. As she preened, her feathers were fluffed out with a noticeable part down the middle of the abdomen and breast. When finished, she scratched the left side of her head with her left foot by lifting her leg over the wing.

The female Scarlet Tanager often preens on the nest while incubating and while brooding the young. Usually she remains in a sitting position on the nest and, for a few seconds, preens her breast and flank feathers, occasionally reaching back to her tail feathers. However, at times she stands up in the nest and preens her plumage thoroughly. Incubating female No. 16 preened, while on the nest, 5 times in 35 minutes. June 28, incubating female No. 10 preened, on the nest, 13 times in 108 minutes. Her preening periods were generally less than 10 seconds, although I recorded preening periods as long as 22, 26, and 47 seconds. June 30, female No. 10, while on the nest, preened 5 times in 63 minutes, and July 1 she preened 9 times in 109 minutes. She was incubating eggs on both of these days. The longest preening period I recorded for her was 90 seconds, July 1.

B. Drinking and Bathing

Bailey (Chapman, 1932:496) infers that the Scarlet Tanager bathes in the "still forest pools". There is a small pool of water in the southwest corner of Southwest Woods. I have never seen the tanagers fly to this pool, or to the other bodies of

water that bound the woods on the east. Fairbanks (1915:382) states that Scarlet Tanagers occasionally came to a little fountain in the yard; presumably to drink or bathe. The only observation that I have which might be considered bathing, is that of female No. 11. During a very heavy rain, this female flew to a bare branch 2.5 feet from the tree trunk. She was partially shielded by the tree trunk, but a steady stream of water fell on her from the leaves above, and some rain drops struck her directly. She opened her wings, slightly, fluttering her wings rapidly, then preened her feathers, the rump, flanks, and abdomen. Then she fluffed out her feathers. Several more times she fluttered her wings rapidly, and once she held them out horizontally and slowly flapped them. To all appearances this female was bathing. All her feathers were wet, and she had quite a wet, bedraggled appearance. This "preen-bathing" activity lasted for 3.5 minutes.

Gosse (1847:235) observed a migrating male Scarlet Tanager to fly down to the river bank and drink water. May 29, Eifrig (1904:103) saw a male tanager drink from a street mudpuddle. The only observation that I have of a Scarlet Tanager drinking water is that of female No. 11 as she "preen-bathed". Twice she pointed her beak upward, holding it wide open for approximately six seconds and appeared to be swallowing rain drops. I actually saw her catch one large drop.

C. Sunning

Eaton (2, 1914:339) states that the Scarlet Tanager is frequently seen sunning on the tops of dead trees in the forest,

or at the edge of a ravine. It seems to me that most of the tanagers which I observed, combined sunning with preening. That is, they perched in the sun for a few moments, fluffed out their feathers, preened for a few seconds, then sat in the sun a short time longer. However one male unmistakably sunned himself during mid-May. He was perched in direct sunlight on a top-most exposed branch of a tall tree. He partially opened his wings, slightly fluffed out his feathers, and pointed his open bill directly at the sun. He maintained this position for at least a minute.

D. Anting

Groskin (1943:56-58) gives a very lengthy and detailed description of two Scarlet Tanagers anting. These birds anted for more than an hour. Some of the time one of the tanagers ate the ants. Burleigh (1912:363) gives an interesting account of a Scarlet Tanager eating ants. According to Burleigh this tanager hung its tail into a tree crotch and then ate the ants that had attached themselves to its tail. It is quite possible that Burleigh misinterpreted this tanager's behavior. At that time anting behavior, as it is considered today, had not been described. Certainly his description of this tanager's behavior rather definitely suggests that the bird was anting.

SUMMARY

1. The Scarlet Tanager preens at three different situations: (1) feeding activity may be interrupted by a brief preening interval of only a few seconds' duration, (2) adults may fly to an exposed perch and, for longer periods, direct all of their attention to preening, and (3) the female may preen while on the nest.

2. The time spent preening varied from a few seconds to a minute. However I observed a female to preen as long as seven minutes.

3. The preening perch is usually not in the nest tree, and invariably it is in direct sunlight.

4. The female Scarlet Tanager often preens on the nest while incubating and while brooding young. These preening periods are generally less than 10 seconds, although I have observed periods as long as 22, 26, 47, and 90 seconds.

5. Very little is known of the tanager's bathing and drinking behavior. I observed a female tanager to "preen-bathe" during a heavy rain storm, and she caught rain drops in her beak and swallowed them.

6. The Scarlet Tanager suns from high exposed branches, and may also sun while preening in the sunlight.

7. Scarlet Tanagers have been known to ant. An early observation of a Scarlet Tanager eating ants, may actually have been anting behavior.

CHAPTER XI

TERRITORY DEFENSE, AND THE RELATIONSHIPS OF THE SCARLET TANAGER WITH OTHER ANIMAL SPECIES

The habitat occupied by the Scarlet Tanager is a section of the oak-hickory association which is also attractive to many other animal species. Some species live within the same area as the tanager and others may, from time to time, enter the tanager's area. The Scarlet Tanager reacts with antagonistic behavior to many of these, and some react antagonistically toward the Scarlet Tanager. But not every meeting of antagonistic species results in a conflict. And on occasions a supposedly neutral species may attack, or be attacked by, the Scarlet Tanager. In many cases it is proximity to the nest which is the deciding factor.

Scarlet Tanagers establish claim to the territory by singing, and announce their disapproval of intrusion by interposing "chip-churrs", with songs or by a scolding of sharp "chips" and "chip-churrs" (see The "chip-churr" call, Chapter IX). If this is not sufficient warning to the intruder, both the male and female may adopt the typical display posture (see Courtship display and threat display, Chapter III) which for some species seems formidable enough and they may leave without further ado. If this is to no avail, tanagers, male or female, boldly fly at, and attempt to drive the intruder away. This may or may

not involve bodily contact.

Territory defense against tanagers. The establishment of the tanager territory has been discussed in Chapter III. Once nesting has begun, the Scarlet Tanager territory boundaries are well recognized by the tanagers concerned. The continual singing of the males, from conspicuous perches within the territory, undoubtedly serves to advertise ownership of a section of the woods. The exchange of songs by tanager males of adjacent territories serves as a method of territory defense without chasing or fighting by the males. One typical record of a song exchange between two males is (numbers identify the male singing; hyphen shows that songs overlapped; first number of hyphenated numbers indicates which male sang first):

June 26, 10:45 to 10:49
2,3,2–3,2,3,2,2,3,2,2–3,2,3,2,
3,2,2–3,2,2–3,3,3,3,3,3–2,3,3,3.

Defense of the territory against other tanagers by singing must be very successful, for I have very few observations of a tanager invading an adjacent territory after nesting has begun. July 2, while inspecting nest No. 3, the male and female tanagers were close by, posturing and scolding me. I saw another male (No. 1?) alight in a small oak 30 feet from the nest. Male No. 3 immediately turned and flew directly toward the intruder and hotly chased male No. 1 from territory No. 3. I did not hear a sound from either male. Male No. 3 was gone approximately 5 to 10 seconds, then he returned and continued scolding me as before.

The morning of June 21, while standing near nest No. 2, and being scolded by the male and female, I heard "chip–churrs"

from the direction of territory No. 1. Male No. 1 gradually approached territory No. 2 and called from a tree about 100 feet from nest No. 2. He was in territory No. 2 but was not challenged by that pair which was concerned with scolding me.

The only other observations I have of territory defense against another tanager is that of male No. 8. I heard a sharp song, and looked just in time to see male No. 8 chase another male from territory No. 8. The males were never in close contact, and the intruding male kept several yards ahead of male No. 8 as they flew away.

Other species. Throughout my field work I attempted to record every species of animal that entered the tanager territory and further to note the resultant behavior. These observations, supplemented by appropriate references to published data, are arranged according to the following outline:

A. Invertebrates
B. Reptiles
C. Other Birds
   1. Antagonistic species
   2. Apparently neutral species
   3. Predatory species
   4. Brood parasites
D. Mammals

A. Invertebrates

Protozoans. Herman (1944:106) lists the Scarlet Tanager as parasitized by Plasmodium.

Insects. The relation of the Scarlet Tanager to insects is mainly that of predator to prey (see Chapter IX). Peters (1933:73) lists the large bird-fly (Ornithomyia avicularia Linn.) and Peters (1936:25) lists both the bird-fly (Ornithomyia

anchineuria Speiser) and the bird-louse (Philopterus subflavescens Geof.) as external parasites of the Scarlet Tanager.

Vaiden (1943:51) examined a male Scarlet Tanager in an emaciated condition taken March 27, 1939, at Rosedale, Mississippi. He found two ticks, one on the lower eye-lid, and another at the base of the upper mandible.

B. Reptiles

I observed a large Blue Racer (Coluber constrictor flaviventris) sunning on a log in the territory of pair No. 1 (female tanager incubating). The tanagers seemed not to notice the Blue Racer as it rushed away from me. At another time, as I observed incubating female No. 1, a Garter-snake (Thamnophis ordinatus) leisurely made its way through the grass and leaves between my blind and the nest. Apparently the pair took no notice of the Garter-snake.

Female tanager No. 1 (incubating) seemed disturbed by the slow, yet noisy movements of a Box Turtle (Terrapene carolina) as it crawled over the dead leaves on the forest floor. She stretched her neck far over the nest rim and watched its progress even after I no longer could hear the turtle.

C. Other Birds

Antagonistic species.

If a bird species has once been observed to react antagonistically with the Scarlet Tanager it is included in this category. This has been done even though there may be other observations of the species when antagonistic behavior was

not observed.

Ruby-throated Hummingbird (Archilochus colubris). I have many observations of a Hummingbird flying through a Scarlet Tanager territory without any show of alarm from the tanagers. A female Hummingbird even made several trips to a Hickory 15 feet from nest No. 3 and removed lichens to carry to her nest. The tanagers paid no attention to her. Yet when female tanager No. 11 was feeding in a tree 15 feet from a Hummingbird nest (25 feet from the tanager nest) the female Hummingbird attacked her three times. The Hummingbird rose into position at a point about seven feet from, and above, female No. 11 and then dove at the tanager's head with great speed and a loud "whirr" of wings, which made the female tanager crouch. After the third dive the female tanager fled.

Flicker (Colaptes auratus). Male tanager No. 1 flew toward a calling Flicker when the Flicker began to "drum" on a tree in the tanager territory. While the noisy Flicker remained in territory No. 1 the male tanager stayed close by, singing loudly and giving sharp "chip-churr" calls.

Hairy Woodpecker (Dendrocopos villosus). Male tanagers protested a "drumming" and calling Hairy. However a pair of Hairy Woodpeckers quietly investigating a dead tree, at a distance of 50 feet from tanager nest No. 10, were not challenged by the tanagers. July 17, 1947, while observing activity at tanager nest No. 4, R. Wilson saw "the female fly at a Hairy and drive him for 50 feet, from tree to tree; the Hairy went as low as eight feet at times". Two minutes later Wilson saw

male No. 4 "with great 'chipping' pursuing the Woodpecker".

Downy Woodpecker (Dendrocopos pubescens). Here again it was the calling and "drumming" behavior of a woodpecker, the Downy, that was protested by the Scarlet Tanager. However, on June 9, 1947, male No. 1 also protested the presence of a pair of quiet Downy Woodpeckers near the tanager nest. And June 16, 1947, male No. 1 flew to a branch slightly above a Downy who had flown to a sapling 10 to 15 feet from the tanager nest. He postured, looked down intently at the intruder, and the Downy immediately flew away.

Crested Flycatcher (Myiarchus crinitus). With one exception the presence of a Crested Flycatcher in the tanager territory always meant a conflict between the two species. The exception was in territory No. 13 (female tanager incubating) when a loudly calling Crested was not challenged by the tanagers.

Male tanagers often chased the Crested Flycatcher. May 17, 1948, male No. 6 chased a Crested about 50 feet, until it perched, turned and faced the tanager and gave its loud "wheep" call. The Crested then flew about 300 feet away, continually calling. The tanager did not follow but flew back toward the middle of his territory and joined the female tanager.

July 16, 1948, male No. 11 and a Crested Flycatcher, flying at each other, tumbled to the ground from a height of 40 feet. It seemed that the Crested was the victor, for the tanager was the first to fly away after they fell to the ground. The Crested remained, perched on a branch eight inches above the ground, and watched the retreating tanager. This conflict

took place about 15 feet from the tanager nest.

In one instance I observed a Crested Flycatcher to attack a female tanager. May 20, 1948, when female No. 6 was on a perch four feet above the ground a calling Crested dove at her. Approximately two minutes later the Crested dove at her again. Male tanager No. 6 was about 50 feet away, apparently in full view of this attack, but did not in any way protest.

Wood Pewee (Contopus virens). The Pewee often passed peacefully through, or fed peacefully in, the tanager territory. Usually, however, the Scarlet Tanagers did not allow it in the tanager nest tree. One time, July 24, 1947, I observed an unchallenged Pewee close to a tanager nest. The Pewee flew to two perches near nest No. 5, at a distance of 10 and 5 feet, and even darted closer to the nest as it caught an insect in the air a few feet from the incubating female tanager. In contrast to this, male No. 6 made two dashes at a Pewee, which had flown as close to the tanager nest as 15 feet, forcing the Pewee further from the nest with each attack.

A pair of Pewees built a nest approximately 30 feet from tanager nest No. 17 (the Pewee nest was approximately one-third finished June 6, 1949). The female tanager was incubating and apparently paid no attention to the Pewees. Male No. 17, however, spent much of his time singing in the Pewee tree, often on the Pewee nest branch, and a great many times attacked a Pewee driving it as far as 100 feet through the woods. Once male No. 17 preened on the Pewee nest branch after it had chased a Pewee from this branch. Occasionally male No. 17 sang vigorously

from the Pewee nest branch after frightening a Pewee away, and at times he also sang from perches a few feet above, and peered down at, the Pewee nest.

When the Pewees began to incubate, the male tanager often drove the incubating bird off its nest, and once both birds, fighting, tumbled from the nest and fell several feet (Pewee giving a low guttural-nasal call). As they separated the Pewee was chased approximately 200 feet by the male tanager and then, when male No. 17 perched, another Pewee dove at him.

Once the male Scarlet Tanager flew to the Pewee nest tree when both Pewees were in the tree. One of the Pewees dove at male No. 17, which, after cringing to the branch, pursued the Pewee. Male No. 17 immediately returned to the Pewee tree and was attacked by the other Pewee which drove the tanager to a neighboring tree, but then male No. 17 turned on the Pewee and drove him through the trees.

It appeared to me that the Pewees gained in aggressiveness after their nest was completed, and during the time of their incubation they actually attacked the tanager or returned the tanager attack in the Pewee nest tree. I never saw the Pewees attack the tanagers in the tanager nest tree. When tanager nest No. 17 was broken up (see Crow) the Pewee nest was not bothered. June 19, I discovered that the Pewee nest had been torn off the branch, with only a little of the nest foundation remaining. (See also Fox Squirrel)

Olive-sided Flycatcher (Nuttallornis borealis). C. F. Stone (Burtch, 1928:39) saw a Scarlet Tanager engage this fly-

catcher in "battle". When the flycatcher appeared to be getting the worst of it its mate came and drove the tanager away.

Black-capped Chickadee (Parus atricapillus). Chickadees occasionally entered the Scarlet Tanager territory and almost always were ignored by the tanagers. A Chickadee even came as close to nest No. 2 as seven inches, being above and looking down at the nestlings without causing any defensive behavior by the tanagers which were feeding in trees nearby. However, July 16, 1948, I noticed male No. 11 peering down at a Chickadee which was three feet below him. When the Chickadee flew closer to the nest (18 feet) the male tanager immediately darted at him, noisily colliding with a clump of leaves. The Chickadee hastily left the nest vicinity.

White-breasted Nuthatch (Sitta carolinensis). In general the Nuthatch was tolerated within the tanager territory by Scarlet Tanagers. Its "honking" in the territory produced no tanager reaction. An unmolested Nuthatch even approached within 15 feet of brooding female No. 11. However, several hours earlier male No. 11 had flown 30 feet to a branch 10 feet from a Nuthatch which was in the vicinity of the tanager nest. Suddenly the tanager dashed at the Nuthatch. It hopped to the opposite side of the trunk to escape, but the tanager whirled around the trunk and chased the Nuthatch away.

Catbird (Dumetella carolinensis). June 6, 1949, a Catbird lit in a tree about 20 feet from nest No. 17. Suddenly the male tanager appeared, flew directly toward the Catbird, and lit on the branch next to it. The Catbird immediately flew

from the area.

Veery (Hylocichla fuscescens). Often at dusk a singing Veery slowly worked through tanager territory No. 8. Once it sang from a low perch in a tree approximately 10 feet from nest No. 8, which contained young. Tanager pair No. 8 did not protest against the Veery. However, incubating female No. 18 attacked a Veery which was calling in this tanager's territory. She turned in her nest, arched her neck over the nest edge, and peered toward the calling Veery. Then she dove from the nest, flying directly at the Veery, and chased it away. (See also Blue Jay)

Black and White Warbler (Mniotilta varia). Black and White Warblers rarely appeared in the Scarlet Tanager territory. Tanager pair No. 11 did not protest the presence of this species in their territory. Once it passed within 30 feet of nest No. 11, which contained young, and as it left the territory the Black and White Warbler perched in a sapling where male No. 11 was feeding. Male No. 11 looked at, but did not attack, the warbler. (See also Fox Squirrel)

On one occasion incubating female No. 18 allowed a male Black and White Warbler to feed in trees adjacent to the tanager nest tree. However, 29 minutes later, after chasing away a Rose-breasted Grosbeak (Pheucticus ludovicianus) (see Grosbeak), she darted at the warbler and forced him to fly from his perch. In escaping he flew to the tanager nest tree, but left as female No. 18 flew toward him.

Cowbird (Molothrus ater). Both the male and female Scarlet

Tanager recognize the female Cowbird as an enemy. Male No. 3 and a pair of Vireos (Vireo olivaceus) attacked a female Cowbird at a Vireo nest (Prescott, 1947:210). Male No. 3 pecked at the Cowbird on the Vireo nest, causing the Cowbird to flee. While they usually attack the female Cowbird at sight, I have never seen the male Cowbird attacked by the tanagers. Hann (1937:201) states that the Oven-bird (Seiurus aurocapillus) does not recognize the Cowbird at sight as an enemy, while Nice (1937:158) says that Song Sparrows (Melospiza melodia) are disturbed by the presence of adult Cowbirds in their territory and attack the female Cowbird as she approaches the nest.

In spite of the fact that the Scarlet Tanagers do recognize the female Cowbird as an enemy she often slips into the territory, even to the nest, apparently without being seen by the tanagers (see Brood parasite). For some reason Cowbirds have not been attacked in the tanager territory even at times when I felt certain their presence must have been known to the tanagers. May 12, 1949, three Cowbirds, two male and a female, noisily flew into tanager territory No. 13 and remained approximately four minutes in a tree 15 to 20 feet from the nest tree. And three minutes later a male Cowbird "squeaked" loudly in a tree 200 feet from the tanager nest. In neither instance were the Cowbirds attacked.

The preceding two observations in territory No. 13 occurred when the nest was not yet completed. However, a day earlier (May 11) male No. 13 twice attacked a female Cowbird. Once when female No. 13 was working on her nest she looked up, gave

an alarm "chip", and flew to a nearby tree where she gave two more "chips". Male No. 13 immediately appeared and drove a female Cowbird from the nest tree, staying in close contact with her as they dodged through low saplings. And a half hour later this male tanager chased a female Cowbird from a tree approximately 60 feet from the tanager nest.

Female Cowbirds have been driven from the tanager nest when the nests already contained a Cowbird egg. On the afternoon of June 13, and the morning (08:00) of June 16, male No. 1 drove a female Cowbird from the nest tree.

Occasionally the female Cowbird approaches the tanager nest when it contains a young Cowbird. Once at nest No. 2, and at nest No. 3, a female Cowbird lit next to the nest and looked at the gaping, "buzzing" young Cowbird. Each time the female Cowbird only remained a few seconds and left unchallenged. But another time, at nest No. 3, a female Cowbird flew to a young Cowbird fledgling which fluttered on a branch and called for food. She was immediately driven away by both the male and female tanager. I have never noticed food in the Cowbird's bill when she approached the nestlings.

Summer Tanager (Piranga r. rubra). Thompson (1949:81) observed the behavior of the Summer and Scarlet Tanagers at her feeding station. She saw them fly back and forth at each other many times. Apparently the outcome of this struggle resulted in the establishment of dominance by the Scarlet Tanager over the Summer Tanager, for "afterwards the Scarlet Tanager was in complete control and even chased the Summer Tanager later in the

season".

Cardinal (Richmondena cardinalis). The Cardinal was a frequent visitor to the Scarlet Tanager territory. In general its presence was tolerated by the tanagers. But its strong call appeared to make incubating female tanagers uneasy and they often changed position on the nest in order to face the calling Cardinal. And it seemed that male tanagers resented the noisy Cardinals, for they frequently flew near the Cardinal and sang spiritedly.

Once a male Cardinal and a male tanager actually fought. I looked upward as I heard flapping noises and heard calls. I saw male No. 1 and a male Cardinal fly apart and perch at a point 25 feet above the ground. They were about three feet apart with the tanager slightly higher and between the Cardinal and the nest tree. Each seemed to be antagonistically straining toward the other. Then they noticed me and the struggle was over. I believe that this struggle originated in the tanager nest tree. The nest, at that time, was empty, having just been completed. (See also Fox Squirrel)

Rose-breasted Grosbeak (Pheucticus ludovicianus). I have four observations of this species in Scarlet Tanager territory. As I inspected nest No. 3 a male Grosbeak flew to a tree 20 feet from the nest tree. The tanagers, protesting my presence, did not attack, and may not have seen, the Grosbeak. And at nest No. 13 a male Grosbeak sang from a high perch in the tanager territory but was not molested.

Pugnacious female Scarlet Tanager No. 18 definitely

resented the presence of a female Grosbeak in her territory. Once she flew a distance of 120 feet and dashed at a female Grosbeak which had alighted in a tangle of wild grapevine 15 feet from the tanager nest. The Grosbeak flew and perched about 100 feet away but was immediately attacked by No. 18. Twenty-eight minutes later the incubating female tanager flew directly from her nest, giving a "screeching" call, and chased a female Grosbeak from the territory. Then female No. 18 returned and attacked a Black and White Warbler (Mniotilta varia).

Apparently neutral species.

Below is a list of apparently neutral species which I have observed, or heard, in the Scarlet Tanager territory (plus published references). I say "apparently neutral" for while I have never observed antagonistic behavior between these species and the Scarlet Tanager it is quite possible that such behavior might have occurred, or may occur in the future. (In the following list those species designated with a "*" were observed in the nest tree; those "**" were observed within 10 feet of the tanager nest).

List of Apparently Neutral Species

Yellow-billed Cuckoo (Coccyzus a. americanus)

Black-billed Cuckoo (Coccyzus erythropthalmus)*

Phoebe (Sayornis phoebe)**

Least Flycatcher (Empidonax minimus)*

Tufted Titmouse (Parus bicolor)

Robin (Turdus migratorius)

Yellow-throated Vireo (Vireo flavifrons)

Red-eyed Vireo (Vireo olivaceus)

Magnolia Warbler (Dendroica magnolia)

Black-throated Green Warbler (Dendroica virens)*

Cerulean Warbler (Dendroica cerulea)**

Oven-bird (Seiurus aurocapillus) (See Fox Squirrel)

Yellow-throat (Geothlypis trichas)

Baltimore Oriole (Icterus galbula)

Towhee (Pipilo erythrophthalmus)

Chipping Sparrow (Spizella p. passerina)

I believe that information concerning some of these "neutral" species is worthy of consideration. Appropriate discussions may give a clearer picture of the inter-relationships that exist between the Scarlet Tanager and the "neutral" species.

Black-billed Cuckoo (Coccyzus erythropthalmus). A Black-billed Cuckoo constructed a nest in a tanager nest tree 15 feet above, and on the opposite side of the tree, from nest No. 13. I first saw the Cuckoo in this territory May 19, 1949, when it appeared and called in territory No. 13 at three different times (tanager clutch completed May 19).

The Cuckoo began to construct its nest May 20. It flew to a tree adjacent to the nest tree. There, at a height of 20 feet, it grasped a six-inch dead twig and tugged for three to five seconds until the twig snapped loose from the branch. It flew to the tanager nest tree and placed it at the junction of two branches at the site mentioned above. This was the first piece of nest material. Tanager pair No. 13 were in the

territory and, in my estimation, could not have missed seeing this Cuckoo's activity. Later that morning tanager nest No. 13 was deserted.

I believe a short summary of this Cuckoo nest is of value. May 23, at 09:30, it was completed and a Cuckoo was settled on the nest. May 27, at 08:30, the Cuckoo nest was torn loose, hanging downward from the crotch, and portions of four Cuckoo egg shells were found on the ground underneath the nest. The shells had many small holes, which were punctured inward.

Least Flycatcher (Empidonax minimus). It should be mentioned that this flycatcher appears to be the most abundant species in the Crataegus area (vicinity of territory No. 8) of Big Woods. They are very pugnacious and appear to be constantly quarreling with their own, and other, species. Yet I have never observed antagonistic behavior between this species and the Scarlet Tanager.

Yellow-throated Vireo (Vireo flavifrons). A Yellow-throated Vireo, with food in its beak, approached a Cowbird fledgling from tanager nest No. 8. It did not feed the fledgling but flew after approaching to within six feet of the Cowbird. The Scarlet Tanager pair were nearby but, as far as I could determine, they did not protest.

Red-eyed Vireo (Vireo olivaceus). The Red-eyed Vireo was a frequent visitor to, and its territory often embraced part of, the Scarlet Tanager territory. In general the Vireo pair occupied a lower stratum of the community. However, I cannot suggest a stratum boundary between the two territories since the

tanager was often seen at perches near the Vireo nest, and the Vireo often flew to higher perches in the tanager territory. A male Scarlet Tanager even cooperated with a Vireo pair in attacking a female Cowbird at a Vireo nest (Prescott, 1948:210).

Black-throated Green Warbler (Dendroica virens). Hemphill (1933:48) found a Black-throated Green Warbler nest on the opposite side of the tree from a Scarlet Tanager nest. The tanager nest contained four fresh eggs.

Chipping Sparrow (Spizella p. passerina). Hales (1896:261) observed a male Scarlet Tanager feeding nestling Chipping Sparrows. The male fed them in the nest "for a number of days" until the tanager young hatched.

Predatory species.

The following species discussion deals with those predatory species observed in the Scarlet Tanager territory and, where it occurred, an account of predation of the Scarlet Tanager. Evidence from published accounts is also included.

Cooper's Hawk (Accipiter cooperii). While I have no observations of this hawk in the Scarlet Tanager territory, Sutton has often seen them at the Reserve. He has found the Cooper's Hawk nesting in Big Woods and believes that it should be considered as a possible predator upon the tanager.

Pigeon Hawk (Falco c. columbarius). Lawrence (1949:21) saw a Pigeon Hawk devouring prey, and directly below the perch she found a freshly severed head of a male Scarlet Tanager.

Screech Owl (Otus asio). Allen (1924:13) showed that the Scarlet Tanager was an important food item in the diet of the

Screech Owls which he studied. He found that more female than male Scarlet Tanagers were taken and that more adult birds (of all species taken) were fed to the young owls than young or immature birds.

In spite of the fact that eight Scarlet Tanagers were fed to the Screech Owls, the tanager population in the vicinity remained constant, both during the year of his study and the following year. Allen believed that the Screech Owls did their hunting close to home and he suggested that mate replacement accounts for the constant population of birds, including tanagers, in the vicinity.

Barred Owl (Strix varia). On several occasions I saw a Barred Owl in Big Woods not far from tanager territory No. 18. I believe that male tanager No. 18 was missing during my observations of its nest. I suggest that this owl may have taken the male Scarlet Tanager.

About 10:00, June 24, 1949, Dana Snyder was making a bird census of Big Woods. A Barred Owl flew from tree to tree well ahead of Snyder. I had been seated at the base of a tree for approximately 45 minutes and had not heard nor seen Scarlet Tanagers during that time. But when the Owl flew to a tree near me a pair of tanagers immediately began to call "chip-churr". They called continually for about five minutes from various perches well above the Owl, then were quiet the last three minutes while the Owl remained. These Scarlet Tanagers obviously recognized the Barred Owl as an enemy. However, Bolles (1890: 112) states that the Scarlet Tanagers "never showed any special

emotion" when they saw his captive Barred Owl.

Long-eared Owl (Asio otus wilsonianus). Of a quart of pellets collected by Jones (1934:38) under the nest of a Long-eared Owl, three were found to contain Scarlet Tanager remains.

Short-eared Owl (Asio f. flammeus). Kumlien and Hollister (1903:69) found Scarlet Tanager feathers in the bottom of a Short-eared Owl's nest which contained three young.

Blue Jay (Cyanocitta cristata). Both the male and female Scarlet Tanagers recognize the Blue Jay as an enemy. The presence of, or the call of, the Blue Jay elicits defensive behavior, or at least signs of uneasiness, from the tanagers.

May 18, 1949, as I watched a pair of Scarlet Tanagers in Southwest Woods, a Blue Jay flew to a limb and perched approximately two feet from a male tanager. In this case the jay seemed to resent the presence of the tanagers, for it lunged at the male tanager causing him to fly. The Blue Jay then approached the female tanager and lunged at her but she did not move. After preening his wings for a few seconds the Blue Jay again flew at the female tanager, causing her to fly.

I heard violent wing clashes and the angry screams of a Blue Jay at nest No. 11. Looking out from my blind I saw a Blue Jay, with a male and female tanager above him, being forced to the ground 15 feet from the nest tree. Jumping up from the ground the jay flew to a nearby branch overhanging the swamp. As he alighted both the male and female tanager dove at him and appeared to hit him with their wings, for I heard a sharp clashing sound at the end of their dives. The Blue Jay at once

fled across the open swamp. The female tanager returned to her nest and young, but the male tanager persisted and chased the Blue Jay some three hundred feet.

May 11, at 06:45, when nest No. 13 was about half finished, two Blue Jays flew into the territory. One perched next to the nest tree. Male No. 13 appeared and lit 15 feet above the jay. His feathers were fluffed out, and he gave "chip" alarm notes as he looked down at the Blue Jay. Female No. 13 flew to the jay tree and also gave alarm "chips". When the jay flew to a branch 10 feet above the nest, the male tanager dove and hit him. The Blue Jay flew and was closely pursued for 50 feet by male No. 13. At times he was only inches away from, or actually touching, the jay.

In my one observation of Blue Jay predation it seemed that the tanager was, in part, responsible. June 18, 1949, incubating female No. 18 launched herself directly from her nest and dove at a Blue Jay which was perched on a bare branch some 90 feet away. Her dive caused the Jay to cringe closely to the branch. When she dove at the Blue Jay again he flew upward and directly toward nest No. 18, stopping in the nest tree at about half the nest height. It then proceeded, branch by branch, up the tree to the tanager nest, closely followed by protesting female No. 18 which continually gave "chip-churrs". The Blue Jay went to the nest, looked in and gave one hurried, but strong, peck at the contents. No eggs were removed by the jay, although I believe an egg(s) was punctured because the nest was subsequently abandoned.

It is obvious to me that in attacking the Blue Jay by a direct flight from her nest, female No. 18 revealed her nest location. The previous night a Blue Jay had not been attacked nor had the jay located the nest, when it passed close to nest No. 18 on the opposite side of the woods road. It should be mentioned that on both occasions the passage of the Blue Jay through territory No. 18 was marked by its being accompanied by a protesting Veery (Hylocichla fuscescens).

Warren (1890:251) states that the Blue Jay "not unfrequently" robs Scarlet Tanager nests when the tanagers are absent. And Everhart (Warren, 1890:251) is referred to as having known instances where the jays, after devouring the eggs or young tanagers, have torn up the nests.

Crow (Corvus brachyrhynchos). The Crow is recognized by both the male and female Scarlet Tanager as an enemy. The incubating female tanager often changes position on her nest in order to face the direction of Crows calling in the distance, and she settles low on the nest when Crows are near. The tanagers do not sing or call when Crows are in, or very near, the tanager territory.

Inconspicuousness is the protective reaction of the Scarlet Tanager to the Crow. This is in marked contrast to their attacking reaction to the Blue Jay (see Blue Jay). Yet there is a conflict in the male tanager between the "urge for inconspicuousness" and the "urge to feed mate" and in the female tanager a conflict between the "urge for inconspicuousness" and the "urge to flee". These conflicts may result in a plundered

nest for the Scarlet Tanager and food for the Crow.

Allen (1932:292) infers that Crows know just where to find the Scarlet Tanager nest. My observations indicate that the Crows do not know just where to find it, nor do they diligently search the trees, branch by branch, to locate a nest. The Crow's method of locating tanager nests utilizes two cues; the auditory and the visual, both of which are supplied by the Scarlet Tanager. The nest itself may serve as a secondary, or final cue, once the general location has been disclosed by the tanagers.

There are, insofar as my observations have shown, two ways in which the Crow locates the tanager nest. First the Crow may wait and watch until the tanagers fly to or from the nest. Once the nest location is thus revealed the Crow's flight to the nest is rapid and direct. The Crow's "lookout" perch may be in or near the tanager territory. Singing, calling, and defensive behavior of the Scarlet Tanager against other species probably serves to call the attention of the Crow to the tanager nest area.

Secondly, several Crows may fly from tree to tree using a hunt and frighten method of nest location. As the Crows fly from perch to perch (10 to 25 feet height), their rustling wings and raucous calls present a frightening effect. And several noisily "cawing" Crows in the vicinity produces a considerable din which appears to be amplified as it echoes through the woods. In this manner the Crows actually frighten the female tanager from her nest. Such noise and confusion

results in the "urge to flee" and the nest location is often revealed to the nearest Crow.

My discussion of Crow predation on the Scarlet Tanager is divided into two categories according to the method in which the tanager nest was located by the Crow. I have used time intervals in the discussion of nest No. 10 because I believe it gives a more complete picture of the predation than a general discussion.

Wait and watch. June 30, 1948, Crows called raucously several hundred feet south of nest No. 10. The incubating female turned her head from side to side and once stretched her neck and peered to the south. July 1, two adult and two young Crows worked their way through territory No. 10. One adult Crow lit on a branch at a height of 20 feet (15 feet from nest No. 10). The female was off her nest and neither of the tanagers appeared nor could I see them in the area. Being inconspicuous the tanagers did not give a cue to the nest's location and the Crow did not locate nest No. 10, even though being only 15 feet from it.

The following observations of nest No. 10 were made July 4, 1948:

07:03-07:12 An adult Crow walked on the ground near my blind, once as close as 12 feet. It was noisily calling as it searched the ground, leaves, etc. for food. When two young Crows appeared it fed them. (female No. 10 incubating)

07:30 Six Crows in the immediate area of my blind.

07:33 A Crow perched 15 feet from nest No. 10. The Crow

was quiet and female No. 10 was not frightened from the nest.

07:36 Four Crows were directly below the nest; they quietly flew from the ground to the lower tree branches. (female very low on the nest)

07:39 Crows were not in the immediate area.

07:40 Crows flew back into the tanager territory.

08:03 Crows left the area.

08:04 Female tanager left her nest. She returned shortly thereafter and continued her incubation rhythm until 09:35. During this hour and a half she was fed blackberries five times by male No. 10.

09:35 One Crow occasionally calling two to three hundred feet from the nest. Male No. 10, with a blackberry in his beak, lit at the nest rim. Two to three seconds later a Crow lit on the nest branch. Both the male and female tanager rushed silently from the nest. The Crow hopped up to the nest, looked in, and thrust its beak into the nest and removed a tanager egg. Then it removed the Cowbird egg. The Crow's beak was slightly open as it leaned over the nest and I could see the Cowbird egg intact toward the base of its beak. The third time the Crow reached into the nest it came up with a tanager egg at the beak tip; a delicate blue framed between two black lines. The Crow flew directly to a calling young Crow. I could not see what happened, but the voice of the hungry young appeared to sound choked and lower as if food had been pushed into its gape.

June 15, 1949, I witnessed the removal of two Scarlet

Tanager young by a Crow(s) at nest No. 17. The adult tanagers had made frequent trips that afternoon to feed their four-day-old young. These trips were interrupted when female No. 17 brooded her young during the occasional short periods of light rain. She had brooded the young for approximately five minutes before she left the nest at 17:36. At 17:37 male No. 17 fed the young. At 17:50, as female No. 17 flew to the nest tree (to feed young?), a Crow flew first to a tree 30 feet from the nest, then to a perch 10 feet from the nest and finally directly to the sapling crown which contained the nest. As the weak crown of the sapling waved and dipped the Crow poked through the protective leaves above the nest and grasped one young with its beak and flew away with it. Approximately a minute and a half later a Crow (I believe the same one) flew to the sapling crown and took the other young.

In this instance I had not known that a Crow was in the area. It must have watched quietly from a distance, in a tree behind my blind, until the activity of the tanagers indicated the presence of, and later the position of, the nest.

Hunt and frighten. June 4, 1949, at 17:30, I heard the "cawing" of Crows several hundred yards from nest No. 16 and their calls indicated that they were gradually coming closer. The incubating female half stood up, stretched her neck toward the disturbance, then settled low on the nest. One Crow flew to a tree about 100 feet from the nest, but downhill so that it was below the nest. The Crow "cawed" loudly and strongly and seemed to pump its half open wings in an effort to give

more volume to its call. At times the wings seemed to slap its side giving an additional noise. As it "cawed" the Crow looked from tree to tree. All this confusion appeared to be too much for female No. 16 and she dove over the nest side. I am certain she was frightened, not only by the pugnacious behavior of this Crow, but also by the total din caused by several other Crows in the vicinity, all of which behaved in a manner similar to that described for this one Crow.

As the female tanager left her nest the Crow stopped "cawing" and flew immediately and directly to the nest branch, alighting three feet from the nest. Male No. 16 flew near and loudly called "chip-churr" as the Crow moved to the nest edge. The Crow pecked down through the protective leaves which covered the top of the nest. Three more pecks and egg albumen streamed through the porous nest bottom. The Crow did not fly away with an egg in its beak. The group of Crows remained in the general area for approximately 10 minutes, "cawing" loudly in the manner just described and making short noisy flights from branch to branch at a low (6-15 foot) elevation.

I have emphasized the predatory behavior of the Crow, for I believe it should be of interest to ornithologists who are concerned with other bird species of the oak-hickory community. There is no doubt in my mind that the nests of other birds are broken up by the Crow, in a manner similar to that described for the Scarlet Tanager.

House Wren (Troglodytes aëdon). Occasionally authors suggest, or indirectly indicate, that the Wren has destroyed

Scarlet Tanager eggs, but I have not found an actual account of such predation. Leister (1920:204), in an interesting account of photographing the Scarlet Tanager, found three tanager eggs smashed on the ground with "several little holes...which gave evidence that a mischievous House Wren was the culprit".

Brood parasitism.

The Scarlet Tanager is a fairly common victim of the Cowbird and is parasitized throughout most of its range (Friedmann, 1929:232). However, of the 42 species which Hicks (1934:386) found to be parasitized by the Cowbird, the Scarlet Tanager was one of the less frequent hosts. Of 22 Scarlet Tanager nests described by Norris (1892:21-22), from various places in the country, only seven contained Cowbird eggs.

The effect of brood parasitism is considered later. First I shall discuss the more general relationships involved.

Finding the nest. I believe that the female Cowbird learns the Scarlet Tanager nest location by watching the female tanager as she builds, or carries material to, the nest. Hann (1937: 201) found that the female Cowbird watched the Oven-bird during nest building and learned the Oven-bird nest location. The female Cowbird cannot determine when the nest is finished or when the tanager begins to lay without occasionally visiting the nest. She watches at a distance, undetected, until there are no tanagers in the nest tree and then dashes to the nest branch by a hurried, direct flight. I have called attention to similar observations of the Cowbird in the section "Antagonistic species". In addition the following observation illustrates the

manner in which a female Cowbird examines a prospective nest.

At 11:25, June 9, 1947, there were no eggs in nest No. 1. A female Cowbird flew directly to the nest tree and lit 20 feet from the nest branch. Then she flew directly to the nest. She peered into, and held her head down into, the nest. She hopped in and appeared to settle her body in the nest. Standing up in the nest, she looked in various directions, jumped out to an adjacent twig and stretched her neck high as she looked at the surrounding trees. She peered into the nest again before flying away. Apparently tanager pair No. 1 did not see the Cowbird, for they did not challenge her. The Cowbird did not lay an egg, but three days later this nest contained a Cowbird egg.

Removal of host egg and deposition of Cowbird egg. My only observation of Cowbird laying in a Scarlet Tanager nest occurred at nest No. 13, May 18, 1949. I inspected this nest at 04:40 and it contained two tanager eggs. Female No. 13 had not spent the night on her nest. At 04:58 (sunrise 04:36), a female Cowbird flew directly to the nest tree. She lit in a clump of leaves with a crash, and the leaf clump bobbed up and down noticeably. She delayed there, a few feet above the nest, for 10 seconds. Then she flew to the nest branch, a foot from the nest, and delayed motionlessly for five seconds. She went to the nest, paused on the rim as she looked into the nest, then stepped into the nest. She placed her head and beak into the nest, lifted her head up, and then flew.

Four to six seconds later the female Cowbird returned.

This time she flew to a bare branch below the nest, quickly moved up to the nest rim and settled on the nest. She remained on the nest only three to four seconds, then flew rapidly away.

I immediately left my blind and examined the nest. I found that one of the marked tanager eggs was missing and that the nest contained a warm Cowbird egg. I could not find the tanager egg, or shell fragments, under the nest so I must infer that the female Cowbird took the tanager egg away from the nest on the first trip. The visibility was poor and when the female Cowbird flew from the nest the first time she flew slightly away from the blind and I could not definitely see the tanager egg in her beak. Roberts (2, 1936:325) obtained a photograph of a female Cowbird removing a Scarlet Tanager egg. Perched on the nest edge the Cowbird had thrust her bill into the tanager egg and lifted it up when the picture was snapped.

The Cowbird laid her egg in tanager nest No. 13 at approximately 04:59, May 18 (sunrise 04:16). Cowbird egg deposition in Ann Arbor Oven-bird nests (Hann, 1937:201) for May 23 and 24, occurred at approximately 04:55 (sunrise 04:28).

My observations would seem to indicate that the Cowbird does not lay in tanager nests until at least one tanager egg is present. However, Sutton (1920:67) found a Cowbird egg in a partially completed Scarlet Tanager nest. The Cowbird does not always remove a tanager egg from the tanager nest.

Removal of Cowbird egg. I found shell fragments of a Cowbird egg (no signs of embryological development) on the ground under tanager nest No. 17. Inasmuch as this is one of my few

nests which did not contain a Cowbird egg, and the fact that the fragments were directly under the tanager nest, I believe that, in some way, the Cowbird egg had been removed from this tanager nest.

While observing the behavior of the young at nest No. 11, July 17, 1948, I observed an accidental removal of a Cowbird egg. As one of the young was being fed in nest No. 11 (at 08:30) it moved its body close to the rim and partially raised its wings. Somehow these random movements forced a Cowbird egg up from the nest bottom to the rim where it became lodged in, or suspended by, the irregular, protruding nest twigs. When the young moved away, the Cowbird egg remained on the inner edge of the northeast rim. From her feeding position on the southwest rim the female tanager held her head on one side and looked at the egg. She merely looked, however, and then flew.

She returned and fed the young at 08:34. Her landing on the nest, and the subsequent motions of the young as they were fed, failed to dislodge the egg from its precarious position on the inner nest rim. When one of the young stretched its wings, upward, the egg was jarred a little, but it retained its position. The female, remaining on the west rim after feeding the young, was evidently puzzled by the presence of the egg. Five minutes after feeding the young she hopped into the nest, but stayed in the western half of the nest and closely examined the egg with one eye at a time. The young moved and gaped at her. Finally she settled, high and facing southeast, and held her left wing slightly away from her as she regarded the egg. A few moments

later she settled low and normally. Now the egg was out of sight and no longer bothered her. I do not believe the egg, in its precarious position, had been moved during these activities.

At 08:48 the female hurriedly jumped up and left the nest leaving over the nest rim, as she usually did when the male came to feed young from the west, and in passing over the rim she dragged her wing and it just barely brushed the egg. This movement was enough to take the egg out of its position on the inner rim, and it rolled up and over the rim where it became caught on the loose twigs just below the outer rim on the outside of the nest.

The male tanager lit at the west rim at 08:49 and fed the young. His landing jarred the egg, but the jar was not sufficient to cause it to become loose and fall. After feeding he bent over to look more closely at the egg. At this moment the egg broke through its fragile supports and fell to the ground. Examination of this Cowbird egg remains disclosed that the egg had not undergone embryological development.

Sutton (1920:67, and letter) collected a Scarlet Tanager nest with a Cowbird egg completely buried in the lining. He believes that a Cowbird had laid an egg in the nest before it was completed.

Data concerning parasitized nests. I was not able to determine accurately the number of eggs, Cowbird, or Scarlet Tanager, laid in all of my tanager nests. Many of the nests were inaccessible and in addition many already contained eggs or young when found (see History of nests, Chapter IV).

Table 18 gives an estimate of the number of eggs laid, Cowbird and Scarlet Tanager, with an actual count of the young hatched and fledged. The estimate of eggs laid is based, in some instances, on repeated observations of nest contents during egg laying, and in other instances, on the number of young found in the nest. Therefore the column "Eggs Laid" in Table 18 must be thought of as representing the minimum number of eggs laid and must not be considered an accurate count.

TABLE 18

MINIMUM NUMBER OF EGGS LAID, NUMBER OF YOUNG HATCHED AND FLEDGED, FOR FIFTEEN SCARLET TANAGER NESTS

Nest	Eggs Laid		Date Clutch Complete	Young Hatched		Young Fledged	
	Tan.	Cowb.		Tan.	Cowb.	Tan.	Cowb.
1	4	2	June 12	0	0	0	0
2	2	1	June 21-22	2	1	2	1
3	3	1	June 13-14	2	1	2	1
4	1	1	June 25-26	1	1	1	1
5	3	0	July 16-17	3	0	0	0
6	2	2	May 27-28	0	0	0	0
8	1	2	May 25-27	1	2	1	2
9	?	?	?	?	?	?	1
10	2	1	June 28	0	0	0	0
11	1	2	June 29-30	1	1	1	1
12	1	1	June 29-30	1	1	1	1
13	3	1	May 20	0	0	0	0
15	2	2	May 24	0	0	0	0
16	4	0	June 4	0	0	0	0
17	3	1	May 30-31	2	0	0	0
15 Nest Totals	32	17		13	7	8	8

Nesting success and the effect of brood parasitism. Eight of my 20 Scarlet Tanager nests were successful. However, I do not know the fate of nests No. 14 and No. 20. Thus approximately 44 per cent of my nests were known to be successful. Five of Sutton's 13 nests were successful, but it is impossible to determine the fate of the other nests which he found. My seven successful nests fledged 8 tanager young and 8 Cowbird young. However, I do not know how many, if any, tanager young were fledged from nest No. 9. Sutton's five successful nests fledged at least 6 tanager young (nests No. 21 and 22 may also have contained tanager young), and 3 Cowbird young. The eight tanager young fledged from my nests represent 25 per cent of the number of tanager eggs which I know to have been laid. But the eight Cowbird young fledged represent approximately 47 per cent of the number of Cowbird eggs which were laid in tanager nests. Thus it appears, from the tanagers I studied, that the tanagers were more successful in fledging Cowbird young than tanager young. However, in Sutton's nests there were twice as many tanager young fledged, as Cowbird young.

The effect of brood parasitism on the Scarlet Tanager is manifested in two ways: (1) actual removal of tanager eggs, and (2) Cowbird places burden of rearing its young on the tanager. Two additional factors are also considered: (1) desertion by the Scarlet Tanager as a result of Cowbird parasitism, and (2) relative incubation length of the Cowbird and tanager.

Actual removal of tanager eggs. In my one observation of Cowbird laying, the female Cowbird removed a tanager egg from the nest. No generalization can be drawn from this isolated

example. Sutton (1920:67) found a Scarlet Tanager nest which contained three tanager eggs and one Cowbird egg. Later this nest contained two tanager eggs and three Cowbird eggs.

The female Cowbird usually removes an Oven-bird egg (Hann, 1937:213) and about one-third of the times that Cowbird females laid in Song Sparrow (Melospiza melodia) nests they removed a host egg (Nice, 1937:164).

Reduction in number of Scarlet Tanager eggs per clutch. The average number of eggs for my tanager nests is 3.5 eggs per nest. Therefore, I shall assume the statistic 3.5 as representing the average clutch size for my Scarlet Tanager nests.

The average clutch of 12 tanager nests containing Cowbird eggs (see Table 18) is 3.5. Yet the average number of tanager eggs for these 12 nests is 2.1. It appears that the Cowbird eggs complete the clutch at the expense of tanager eggs. These brief data indicate a loss of 1.4 Scarlet Tanager eggs per parasitized nest.

Only two of my nests contained more Cowbird eggs than tanager eggs. The following authors record more Cowbird eggs than tanager eggs in Scarlet Tanager nests: Mulliken (1899:18) found four tanager and five Cowbird eggs in a nest; Hess (1910: 26) found tanagers incubating only Cowbird eggs (tanager eggs undoubtedly removed by female Cowbird(s)), and one of his nests contained four Cowbird but no tanager eggs; and Stoner (1919:80) found a nest containing three Cowbird eggs and only one tanager egg.

Burden of rearing Cowbird young. I do not believe that the Cowbird inflicts injury on the Scarlet Tanager after the eggs hatch. Tanager young in nests with Cowbird young appeared to be as healthy and vigorous as young tanagers from an unparasitized nest. If the nest was successful the tanager young were fledged irrespective of the ratio of Cowbird to tanager young. Some successful nests which I studied contained two tanager to one Cowbird, one tanager to one Cowbird, and one tanager to two Cowbird young.

Consideration of the behavior of Cowbird young in the nest is included with the discussion of Scarlet Tanager young (see Chapter VII).

Desertion. If the egg-laying habit of the Cowbird causes the Scarlet Tanager to desert, then this should be considered another detrimental effect of Cowbird parasitism. Friedmann (1929:232) feels that it has not been proven that the tanager will desert if a Cowbird egg is laid in its nest. Wheelock (1905:63) believed that a Scarlet Tanager deserted because a Cowbird laid eggs in the tanager nest. My experience indicates that the Scarlet Tanager quite readily accepts the Cowbird egg and apparently is unaware of any difference between the tanager and Cowbird egg. Although the Cowbird and tanager eggs are similar in size and shape, the white Cowbird egg contrasts (to me) markedly with the bluish-green tanager egg. I have no evidence of desertion caused by the Cowbird.

Relative incubation periods. Nice (1937:153) found that Cowbird eggs in Song Sparrow nests hatched in 11, 12, 13, and

in one case, 15 days. I was not able to determine the length of incubation for the Cowbird egg in the Scarlet Tanager nest. The female tanager continues the incubation rhythm (see Incubation) for some time after the eggs hatch so that the day early hatching of the Cowbird egg(s) should not affect, and apparently has not affected, the remaining tanager eggs. However, Elder (1921:187) found a Scarlet Tanager nest with a Cowbird young and two tanager eggs that did not hatch. It is impossible to determine whether this was a result of infertile eggs, or of failure by the female tanager to incubate after the Cowbird egg hatched.

D. Mammals

I have observed five species of mammals in the Scarlet Tanager territory.

Fox Squirrel (Sciurus niger rufiventer). Allen (1932:292) infers that squirrels seem to know just where to find the Scarlet Tanager nest. However, I have no direct evidence of nest predation by squirrels. Incubating female tanagers seem aware of the activity of Fox Squirrels in the tanager territory and often appear uneasy when the squirrels are near.

An observation of a Fox Squirrel at nest No. 5 indicates that the Scarlet Tanager, as well as other birds of the oak-hickory community, regard the Fox Squirrel as an enemy. The morning of July 24, 1947, incubating female tanager No. 5 fled, "screeching", from her nest. A Fox Squirrel had climbed a sapling, about five feet from the nest sapling, and paused on a branch four feet above the nest when female No. 5 fled. The

squirrel moved closer to the nest. Female No. 5 continued to "screech" from a perch about 20 feet away as the squirrel reached out toward the nest branch. However the squirrel did not jump to the nest but ran to a tree 15 feet away.

The continued "screeches" of female No. 5 had attracted several other birds which were antagonistic to the intruding squirrel. A Black and White Warbler lit on the tanager nest branch and scolded the squirrel; a male Cardinal flew directly toward the "screeching" female, then perched and occasionally called as it watched the squirrel; two or more Oven-birds were on the ground near the nest looking up at the squirrel; and a Pewee dashed at an unidentified bird which flew over the tanager nest. During this activity the quiet squirrel remained clinging to a tree trunk, jerking its tail back and forth.

A moment later the Fox Squirrel dashed directly to the nest sapling and climbed out on the thin nest limb. As the squirrel climbed the sapling the female tanager dove at him, then she perched a few feet above the squirrel and continued to call as before. A Pewee dove at the Fox Squirrel as it paused on the nest limb, but this did not seem to bother the squirrel. Seven minutes after its arrival to territory No. 5, the Fox Squirrel ran up a tree approximately 40 feet from the nest. Once again it became quiet in the Scarlet Tanager territory.

The Fox Squirrel was so close to the poorly concealed nest on two different occasions that I feel certain the squirrel must have seen it. I cannot decide if the Fox Squirrel was "interested" in the nest with tanager eggs or if, as it seemed

to me at the time, the squirrel was "enjoying" the confusion caused by his presence near the nest. However the tanager young were taken from this nest by an unknown predator 14 days later.

Gray Squirrel (Sciurus carolinensis). The evening of June 27, 1947, male No. 3 called "chip-churr" many times as this squirrel climbed a tree next to the nest tree. However July 13, 1948, pair No. 11 did not protest the presence of a Gray Squirrel 20 feet from their nest tree.

Red Squirrel (Tamiasciurus hudsonicus). May 28, 1948, a Red Squirrel ran to a stump below the branch of nest No. 6. It sat there and "chattered". The female tanager flew to a perch above the squirrel and called "chip" and "chip-churr" several times, and male No. 6 sang nearby. The pair of tanagers obviously resented this squirrel's presence in the territory.

Chipmunk (Tamias striatus). A female Scarlet Tanager reacted to a Chipmunk as if it were a threat to her young Cowbird. Her attacks on the Chipmunk were so frequent and successful that I was not able to determine if the Chipmunk was looking for the calling Cowbird young or if the Chipmunk just happened to be near the young.

June 18, 1948, a Cowbird young of nest No. 8 had left the nest and fluttered to various perches close to the ground near a fallen tree. Female No. 8 made regular feeding trips to it. The fallen tree, about 30 feet from nest No. 8, seemed to be close to the burrow of a Chipmunk, for on previous days I had seen it run alongside, or on top of, the fallen tree. If the tanagers saw the Chipmunk on those occasions they did not protest.

However, the morning of June 18, the Cowbird young had perched within a few feet of this fallen tree. At 09:30 female No. 8 dove through the branches and struck a Chipmunk which was running under the branches of this tree and was two to three feet from the Cowbird young. She perched on the fallen branches, four to six inches off the ground, and twice dove at the Chipmunk when it started out from under the tree. The Chipmunk dashed to a nearby stump and as it reached the top she dove and hit the Chipmunk. It ran down the stump, around the bottom, and up to the top again. As it reached the top she dove and hit the Chipmunk. It ran down the stump and disappeared.

At 09:33 she attacked the Chipmunk again. Then she perched six inches above and a foot away from it. As it ran out from under a branch she dove through the fine branch twigs and chased the Chipmunk through the branches for 15 to 20 feet until it disappeared under the tree trunk; then she returned to her nest. Male No. 8 was in the vicinity but did not join her in these attacks.

Again at 09:37 she dove at the Chipmunk and it disappeared under the tree trunk. She perched on top of the fallen tree and dove at the Chipmunk as it appeared, but it retreated under the trunk immediately. Female No. 8 hopped from one side of the trunk to the other and peered over each side. When the Chipmunk ventured out she dove and hit it. This time the Chipmunk sought refuge under the tree and remained there.

During these attacks female No. 8 "screeched" loudly. Occasionally her call had a "rasping" sound. When she hopped

from side to side on the tree trunk she held her wing tips well below the tail, and her crown feathers were raised to form a crest. Once, when she was perched on the trunk, she sang a short "bill-closed" song.

Raccoon (Procyon lotor). Raccoons were present in Big Woods and I once saw one not far from the tanager territory No. 18. I have no observations of the inter-relationships that might have existed between this animal and the Scarlet Tanager.

Deer (Odocoileus virginianus). Deer often appeared in the Scarlet Tanager territory but always became suspicious of my blind and left immediately. Apparently the tanagers never paid any attention to them. The role of deer paths in nest site selection is mentioned elsewhere (see Nest Site).

SUMMARY AND CONCLUSIONS

1. The Scarlet Tanager is parasitized by at least five invertebrates; one Protozoan, three Insects (two bird-flies and a bird-louse), and Arachnids (ticks).

2. Two snakes (Blue Racer and Garter-snake) and a turtle (Box Turtle) were not attacked by the Scarlet Tanager in its territory.

3. Sixteen species of birds in the oak-hickory community are described as having had antagonistic behavior relations with the Scarlet Tanager.

4. A female Ruby-throated Hummingbird attacked a female Scarlet Tanager. At other times the Hummingbird and the tanager got along peacefully.

5. The Scarlet Tanager resented the calling and "drumming" activity of the Flicker, Hairy, and Downy Woodpeckers. Both the Hairy and the Downy were attacked by the tanager.

6. The Crested Flycatcher and the Scarlet Tanager almost always engaged in a conflict when the former appeared in the tanager territory.

7. The Pewee was often allowed in the tanager territory but was not tolerated near the nest tree. A pair of Pewees nesting approximately 30 feet from a tanager nest were often attacked, even on their nest, by the male Scarlet Tanager.

8. Stone recorded a conflict between the Olive-sided Flycatcher and the Scarlet Tanager.

9. Chickadees were generally tolerated in the Scarlet Tanager territory, but one was attacked, 18 feet from the tanager nest, by a male Scarlet Tanager.

10. In general the White-breasted Nuthatch was tolerated by the Scarlet Tanager, but one was attacked by a male tanager.

11. A Catbird left the nest area when a male Scarlet Tanager perched next to it.

12. The Veery was tolerated in the Scarlet Tanager territory, but a female tanager chased a Veery.

13. The rare visits of the Black and White Warbler to the Scarlet Tanager territory were generally uncontested.

14. The Scarlet Tanager pair recognized the female Cowbird as an enemy and usually attacked her at sight.

15. Thompson observed a conflict between the Summer and Scarlet Tanagers. The Scarlet Tanager apparently established

a dominance over the Summer Tanager.

16. Quiet Cardinals were generally tolerated in the Scarlet Tanager territory, but both the male and female tanagers resented the calling Cardinal. A Cardinal in the tanager nest tree was attacked by a male tanager.

17. A female Rose-breasted Grosbeak was attacked and chased by a female Scarlet Tanager.

18. Sixteen apparently neutral species are listed and six of these are discussed.

19. An unchallenged Black-billed Cuckoo constructed a nest in a Scarlet Tanager nest tree.

20. No antagonistic behavior was observed between the common and usually pugnacious Least Flycatchers and the Scarlet Tanager.

21. A Yellow-throated Vireo, with food in its beak, was allowed to approach a Cowbird young from a tanager nest.

22. Two Hawks (Cooper's and Pigeon), and four Owls (Screech, Barred, Long-eared, Short-eared) are discussed as predators on adult Scarlet Tanagers.

23. The Blue Jay, Crow, and the House Wren are discussed as predators of the Scarlet Tanager nest.

24. The Crow is apparently the most destructive nest predator. It destroyed two Scarlet Tanager nests by removing eggs, and one nest by removing the young.

25. "Wait and watch" and "hunt and frighten" are discussed as two ways in which the Crow locates the tanager nest.

26. The fate of 18 of my 20 nests is known, and 8 of these

were successful. These 8 nests fledged 8 tanager young and 8 Cowbird young. This represents 25 per cent of the tanager eggs laid, and 47 per cent of the Cowbird eggs laid. The tanagers that I studied were more successful in fledging Cowbird young than tanager young. However, twice as many tanagers as Cowbirds were fledged from Sutton's nests. The effect of the Cowbird, as a brood parasite, on the nesting success of the Scarlet Tanager, is discussed.

27. The female Cowbird locates the nest by watching the nest building activity of the female tanager. She occasionally inspects the nest to find when it is completed and when the female tanager begins to lay.

28. The actual removal of a tanager egg, and the laying of a Cowbird egg is discussed. It is suggested that the Cowbird does not lay in tanager nests until at least one tanager egg is present. The accidental removal of a Cowbird egg from a Scarlet Tanager nest is discussed.

29. The detrimental aspect of brood parasitism is caused by two factors: (1) actual removal of tanager eggs by the female Cowbird, and (2) reduction of number of tanager eggs per clutch due to the presence of Cowbird egg(s). Both these aspects have the result of reducing the number of tanager young fledged per nest. There is no loss of tanager young due to the presence of Cowbird young in the nest.

30. The average clutch size of Scarlet Tanager nests is considered to be 3.5. The average clutch size of my tanager nests containing Cowbird eggs was 3.5. The average number of

tanager eggs per parasitized nests was 2.1, which indicates a loss of 1.4 tanager eggs per parasitized nest.

31. Evidence for desertion of Tanager nests due to Cowbird nest laying activity is not conclusive. I do not believe desertion occurs due to this cause.

32. Cowbird eggs in Scarlet Tanager nests may hatch the day before, or the day that, the tanager eggs hatch. The day early hatching apparently does not affect the development of tanager young.

33. Five species of mammals are discussed as occurring in the Scarlet Tanager territory. Both the Fox Squirrel and the Chipmunk were attacked by the Scarlet Tanager.

LITERATURE CITED

Allen, Arthur A.

1924 A Contribution to the Life History and Economic Status of the Screech Owl (Otus asio). Auk, 41, No. 1, Jan., 1924:1-16.

1932 The Tanager's Story. Bird-Lore, 34, No. 4, Aug., 1932:287-295.

A.O.U.

1886 Check-List of North American Birds. American Ornithologists' Union, New York.

1931 Check-List of North American Birds. American Ornithologists' Union, Lancaster, Pa.

1944 Nineteenth Supplement to the American Ornithologists' Union Check-List of North American Birds. Auk, 61, No. 3, July, 1944:441-464.

Arlton, Alexander V.

1949 Song and Other Sounds of Birds. Eklund Print. Co., Hoquiam, Wash.

Audubon, John James

1838 Ornithological Biography. Vol. 4. Adam and Charles Black, Edinburgh.

Bagg, Aaron Clark, and Samuel Atkins Eliot, Jr.

1937 Birds of the Connecticut Valley in Massachusetts. Hampshire Bookshop, Northampton, Mass.

Bailey, Guy A.

1914 The Electric Current in Bird Photography. Bird-Lore, 16, No. 2, Mar.-Apr., 1914:85-93.

Baird, S. F., T. M. Brewer, and R. Ridgway

1905 A History of North American Birds. Vol. 1. Little, Brown, and Co., Boston, Mass.

Barnes, R. Magoon

1914 Collecting Bird Eggs. How I Began. I. Ologist, 31, No. 3, Mar. 15, 1914:58-60.

Barrows, Walter Bradford

1912 Michigan Bird Life. Mich. Agric. College, Lansing, Michigan.

Bennett, Frank Marion

1909 A Tragedy of Migration. Bird-Lore, 11, No. 3, May-June, 1909:110-113.

Bergtold, W. H.

1917 A Study of the Incubation Periods of Birds. Kendrick-Bellamy Co., Denver, Colo.

Bicknell, Eugene P.

1884 A Study of the Singing of Our Birds. Pt. 4. Auk, 1, No. 4, Oct., 1884:322-332.

Bolles, Frank

1890 Barred Owls in Captivity. Auk, 7, No. 2, Apr., 1890:101-114.

Bond, James

1936 Birds of the West Indies. Acad. of Nat. Sci., Philadelphia, Pa.

Brabourne, Wyndham W., and Charles Chubb

1912 The Birds of South America. Vol. 1. R. H. Porter, London.

Brecher, Leonard C.

1946 Notes on the Nesting of the Scarlet Tanager. Kentucky Warbler, 22, No. 4, Fall, 1946:46-50.

Brewster, William

1878 Descriptions of the First Plumage in Various Species of North American Birds. Pt. 5. Bull. Nuttall Ornith. Club, 4, No. 1, Jan., 1879:39-46.

Brotherton, Wilfred A.

1890 Notes by Wilfred A. Brotherton, Observer for Station, Rochester, Mich., Bureau of Ornithology and Mammalogy, U. S. Department of Agriculture. Oologist, 7, No. 3, Mar., 1890:68-69.

Burleigh, Thomas D.

1911 Some Unusual Nesting Sites. Oologist, 28, No. 11, Nov., 1911:180.

1912 The Scarlet Tanager. Oologist, 29, Oct., 1912:363.

1923 Notes on the Bird Life of Allegheny County, Pennsylvania. Pt. 1. Wilson Bull., 35, No. 2, June, 1923:79-99.

1927 Further Notes on the Breeding Birds of Northeastern Georgia. Auk, 44, No. 2, Apr., 1927:229-234.

1932 Notes on the Breeding Birds of Fayette County, Pennsylvania. Cardinal, 3, No. 4, July, 1932:73-83.

Burns, Frank L.

1915 a Comparative Periods of Deposition and Incubation of Some North American Birds. Wilson Bull., 27, No. 1, Mar., 1915:275-286.

1915 b The Cape May Warbler (Dendroica tigrina) as an Abundant Autumnal Migrant and as a Destructive Grape Juice Consumer at Berwyn, Pa. Auk, 32, No. 2, Apr., 1915:231-233.

1937 The Song Periods of some Common Southeastern Pennsylvania Birds in Comparison with Their Seasonal Reproductive Cycles. Oologist, 54, No. 10, Oct., 1937:114-130.

Burtch, Verdi

1928 Nesting of the Olive-sided Flycatcher. Oologist, 45, No. 4, Apr., 1928:38-40.

Butler, Amos William

1898 The Birds of Indiana. Dept. of Geology and Nat. Resources, Indianapolis, Indiana.

Campbell, Louis W.

1940 Birds of Lucas County. Toledo Zool. Soc., 1, No. 1, Oct., 1940:1-225.

Chapman, Frank M.

1918 Notes on the Plumage of North American Birds. Bird-Lore, 20, No. 1, Jan.-Feb., 1918:19-20.

1937 Handbook of Birds of Eastern North America. D. Appleton-Century Co., New York.

Cheney, Simeon Pe

1891 Some Bird Songs. Auk, 8, No. 1, Jan., 1891:32-37.

Christy, Bayard H.

1931 Nesting of Red-bellied Woodpecker in Beaver County. Cardinal, 3, No. 2, July, 1931:44-45.

Clarke, William Cogswell

1911 Disabled Birds. Bird-Lore, 13, No. 4, Jul.-Aug., 1911:191-195.

Cook, H. P.

1929 Translating Notes into Words. Bird-Lore, 31, No. 4, Jul.-Aug., 1929:257-259.

Cooke, Wells W.

1905 Routes of Bird Migration. Auk, 22, No. 1, Jan., 1905:1-11.

1915 Bird Migration. U. S. Dept. Agr. Bull. No. 185, Apr. 17, 1915:1-47.

Coues, Elliott

1903 Key to North American Birds. Vol. 1. Dana Estes and Company, Boston, Mass.

Darlington, E. J.

1914 Scarlet Tanager. Oologist, 31, No. 5, May, 1914:89-90.

Darnton, Iris

1934 Breeding Scarlet Tanagers. Foreigner, 1, Pt. 1, Jan., Feb., Mar., 1934:5-10.

Davie, Oliver

1898 Nests and Eggs of North American Birds. David McKay, Philadelphia, Pa.

De Kay, James E.

1844 Zoology of New-York or The New-York Fauna. Pt. 2, Birds, Carroll and Cook, Albany, N. Y.

Dugmore, Arthur Radclyffe

1904 Bird Homes. Doubleday, Page and Co., New York.

Dutcher, William

1906 The Scarlet Tanager. Bird-Lore, 8, No. 4, Aug., 1906:147-150.

Dwight, Jonathan Jr.

1900 The Sequence of Plumages and Moults of the Passerine Birds of New York. Annals N. Y. Acad. Sci., 13, No. 1, Oct., 1900:73-360.

Eaton, Elon Howard

1914 Birds of New York. Vol. 2. N. Y. State Mus. Memoir 12, 1914:1-719.

Eifrig, G.

1904 Birds of Allegany and Garrett Counties, Western Maryland. Auk, 21, No. 2, Apr., 1904:234-250.

Elder, Harry E.

1921 The Cowbird: A Parasite. Bird-Lore, 23, No. 4, July-Aug., 1921:185-191.

Fairbanks, Cornelia Taylor

1915 Our Ways with the Wild Birds. Bird-Lore, 17, No. 5, Sept.-Oct., 1915:381-382.

Faxon, Walter

1889 On the Summer Birds of Berkshire County, Massachusetts. Pt. 1. Auk, 6, No. 1, Jan., 1889:39-46.

Forbush, Edward Howe

1907 Useful Birds and Their Protection. Mass. State Board Agri.

1929 Birds of Massachusetts and Other New England States. Vol. 3. Mass. Dept. of Agri.

Friedmann, Herbert

1929 The Cowbirds A Study in the Biology of Social Parasitism. Charles C. Thomas, Springfield, Ill.

Ganier, Albert F.

1936 Arrival of Spring Migrants at Nashville. Migrant, 7, No. 1, Mar., 1936:6-7.

1944 Summer Birds of the Unicoi Mountains. Migrant, 15 No. 4, Dec., 1944:61-65.

Gmelin, Johann Friedrich

1789 Systema Naturae. 13th ed., Pt. 2. Delamolliere, Ludguni.

Goss, Nathaniel Stickney

1891 History of the Birds of Kansas. Geo. W. Crane and Co., Topeka, Kansas.

Gosse, Philip Henry

1847 The Birds of Jamaica. John Van Voorst, Paternoster Row, London.

Griscom, Ludlow

1949 The Birds of Concord. Harvard Univ. Press, Cambridge.

Groskin, Horace

1943 Scarlet Tanagers 'Anting'. Auk, 60, No. 1, Jan., 1943:55-59.

Haines, Charles D.

1923 Making Friends with a Tanager. Bird-Lore, 25, No. 5, Sept.-Oct., 1923:319.

Hales, Henry

1896 Peculiar Traits of Some Scarlet Tanagers. Auk, 13, No. 3, July, 1896:261-263.

Hancock, Joseph L.

1888 Impeded Migration and Destruction of Birds at Chicago. Auk, 5, No. 4, Oct., 1888:432-434.

Hann, Harry W.

1937 Life History of the Oven-bird in Southern Michigan. Wilson Bull., 49, No. 3, Sept., 1937:145-337.

Harlow, Richard C.

1914 Peculiar Nesting of the Scarlet Tanager. Oologist, 31, No. 5, May, 1914:89.

Harrower, David E.

1910 Nesting of the Blackburnian Warbler (Dendroica fusca) in the Pocono. Cassinia, 14, 1910:28-32.

Hellmayr, Charles E.

1936 Catalogue of Birds of the Americas. Field Mus. Nat. Hist. Zool. Series, 13, Pt. 9, Oct., 1936:1-458.

Hemphill, Frederick A.

1933 Two Nests in Same Tree. Oologist, 50, No. 3, Mar., 1933:48.

Herman, Carlton M.

1944 The Blood Protozoa of North American Birds. Bird-Banding, 15, No. 3, July, 1944:89-112.

Hess, Isaac E.

1910 One Hundred Breeding Birds of an Illinois Ten-Mile Radius. Auk, 27, No. 1, Jan., 1910:19-32.

Hicks, Lawrence E.

1934 A Summary of Cowbird Host Species in Ohio. Auk, 51, No. 3, July, 1934:385-386.

Holt, Ernest G.

1918 Birds and Mulberries. Auk, 35, No. 3, Jul., 1918: 359-360.

Howell, Arthur H.

1911 Birds of Arkansas. U. S. Dept. Agr., Biol. Surv. Bull. No. 38, Oct., 1911:1-100.

1932 Florida Bird Life. Fla. Dept. Game and Fresh Water Fish.

Jewel, L. L.

1913 Some North American Birds in Panama. Auk, 30, No. 3, July, 1913:422-429.

Jones, E. M.

1934 The Long Ears of the Pine Grove. Oologist, 51, No. 4, Apr., 1934:38-39.

Jones, Lynds

1903 The Birds of Ohio. Ohio State Acad. Sci., Special Papers No. 6.

Judd, Sylvester D.

1900 The Food of Nestling Birds. Dept. Agr. Yearbook, 1900:411-436.

1902 Birds of a Maryland Farm. Biol. Surv. Bull. No. 17, 1902:1-116.

Kopman, H. H.

1915 List of the Birds of Louisiana. Part VII. Auk, 32, No. 2, April, 1915:183-194.

Kumlien, Ludwig, and Ned Hollister

1903 The Birds of Wisconsin. Bull. Wis. Nat. Hist. Society, 3, Nos. 1, 2, and 3, Jan., Apr., July, 1903:1-143.

Lawrence, Louise de Kiriline

1949 Notes on Nesting Pigeon Hawks at Pimisi Bay, Ontario. Wilson Bull., 61, No. 1, Mar., 1949:15-25.

Leister, C. W.

1920 Photographing the Scarlet Tanager. Bird-Lore, 22, No. 4, Jul.-Aug., 1920:203-207.

Linnaeus, Carl

1758 Systema Naturae. 10th ed., Pt. 1. L. Salvii, Holmiae.

Lowery, George H. Jr.

1945 Trans-Gulf Migration of Birds and the Coastal Hiatus. Wilson Bull., 57, No. 2, June, 1945: 92-121.

Lucas, W. H.

1884 Jottings from West Stratford, Conn. Young Oologist, 1, No. 7, Nov., 1884:103.

Lyle, Robert B., and Bruce P. Tyler

1934 The Nesting Birds of Northeastern Tennessee. Migrant, 5, No. 4, Dec., 1934:49-57.

McAtee, Waldo L.

1908 Food Habits of the Grosbeaks. U. S. Dept. Agri. Bureau Biol. Surv. Bull. No. 32.

1911 Economic Ornithology in recent Entomological Publications. Auk, 28, No. 2, Apr., 1911:282-287.

1926 The Relation of Birds to Woodlots in New York State. Roosevelt Wild Life Bull., 4, No. 1, Oct., 1926:7-152.

Magee, M. J.

1926 Summary of Trapping and Banding Operations in Northern Michigan. Wilson Bull., 38, No. 3, Sept., 1926:162-167.

Mayr, Ernst

1946 History of the North American Bird Fauna. Wilson Bull., 58, No. 1, Mar., 1946:3-41.

Miller, Ansel B.

1934 Cuckoos and Caterpillars. Bird-Lore, 36, No. 5, Sept.-Oct., 1934:301.

Miller, Gerrit S. Jr.

1897 Some Abnormal Color Markings. Auk, 14, No. 3, July, 1897:275-278.

Miller, Lyle

1926 Nests of the Scarlet Tanager. Oologist, 43, No. 11, Nov., 1926:149.

Mulliken, W. Earle

1899 A Peculiar Set of Eggs of the Scarlet Tanager. Bull. Mich. Ornith. Club, 3, No. 2, 1899:18.

Nauman, E. D.

1926 An Appreciation of the Scarlet Tanager. Wilson Bull., 38, No. 3, Sept., 1926:159.

1938 Nauman Letters. Oologist, 55, No. 8, Aug., 1938:93-95.

Nehrling, Henry

1896 Our Native Birds of Song and Beauty. Vol. 2. George Brumder, Milwaukee.

Nice, Margaret Morse

1937 Studies in the Life History of the So g Sparrow I. Trans. Linn. Society N. Y., 4, 1937:1-247.

1943 Studies in the Life History of the Song Sparrow II. Trans. Linn. Society N. Y., 6, 1943:1-329.

N(orris), J. P.

1892 A Series of Eggs of the Scarlet Tanager. Ornith. and Oologist, 17, No. 2, Feb., 1892:21-22.

Nuttall, Thomas

1832 A Manual of the Ornithology of the United States and of Canada. Hilliard and Brown, Cambridge.

Oberholser, Harry C.

1896 A Preliminary List of the Birds of Wayne County, Ohio. Ohio Agr. Experim. Sta., Tech. Ser., Bull., 1, No. 4, July, 1896:243-354.

1918 The Migration of North American Birds. II. The Scarlet and Louisiana Tanagers. Bird-Lore, 20, No. 1, Jan.-Feb., 1918:16-19.

1919 Piranga erythromelas versus Piranga olivacea. Auk, 36, No. 4, Oct., 1919:575-576.

1921 Washington Region. Bird-Lore, 23, No. 1, Jan.-Feb., 1921:34-35.

1925 Washington Region. Bird-Lore, 27, No. 5, Sept.-Oct., 1925:338-339.

Palmer, Ralph S.

1949 Maine Birds. Mus. Comp. Zool. Bull., Vol. 102.

Peters, Harold S.

1933 External Parasites Collected from Banded Birds. Bird-Banding, 4, No. 2, Apr., 1933:68-75.

1936 A List of External Parasites from Birds of the Eastern Part of the United States. Bird-Banding, 7, No. 1, Jan., 1936:9-27.

Peterson, Roger Tory

1947 A Field Guide to the Birds. Houghton Mifflin Co., Boston, Mass.

1948 Birds Over America. Dodd, Mead and Company, New York.

Phillips, Charles L.

1893 A Lucky Day. Oologist, 10, No. 2, Feb., 1893:51-52.

Pitelka, Frank A.

1941 Distribution of Birds in Relation to Major Biotic Communities. Amer. Midl. Nat., 25, No. 1, Jan., 1941:113-137.

Plath, Karl

1931 Abnormal Plumage of the Scarlet Tanager. Auk, 48, No. 1, Jan., 1931:127-128.

Prescott, Kenneth Wade

1947 Unusual Behavior of a Cowbird and Scarlet Tanager at a Red-eyed Vireo Nest. Wilson Bull., 59, No. 4, Dec., 1947:210.

Price, Homer F.

1935 The Summer Birds of Northwestern Ohio. Oologist, 52, No. 3, Mar., 1935:26-36.

Reed, Chester A.

1904 North American Birds Eggs. Doubleday, Page and Company, New York.

Ridgway, Robert

1889 The Ornithology of Illinois. Vol. 1. Rokker, State Lab. of Nat. Hist., Springfield, Ill.

1902 The Birds of North and Middle America. Pt. 2. U. S. Nat. Mus. Bull. No. 50.

Roberts, Thomas S.

1920 Minneapolis (Minnesota) Region. Bird-Lore, 22, No. 4, July-Aug., 1920:228-229.

1936 The Birds of Minnesota. Vol. 2. Univ. of Minnesota Press.

1941 Minnesota Region. Audubon Mag., 43, Nov.-Dec., 1941: 573-574.

Rogers, J. Speed

1942 The Crane Flies (Tipulidae) of the George Reserve, Michigan. Univ. Mich. Mus. Zool. Misc. Publ. No. 53, 1942:1-128.

Saunders, Aretas A.

1935 A Guide to Bird Songs. D. Appleton-Century Co., New York.

1948 The Seasons of Bird Song. Revival of Song After the Postnuptial Moult. Auk, 65, No. 3, Jul., 1948:373-383.

Scott, W. E. D.

1889 A Summary of Observations on the Birds of the Gulf Coast of Florida. Pt. 4. Auk, 6, No. 4, Oct., 1889: 318-326.

Smithwick, Thos. A.

1893 A Collection of North Carolina Birds Eggs. Ologist, 10, No. 1, Jan., 1893:28-30.

Stone, Witmer

1888 An Abnormal Scarlet Tanager. Auk, 5, No. 3, July, 1888:323.

Stoner, Emerson A.

1919 Cowbird Study in Iowa. Ologist, 36, No. 5, May, 1919:80-81.

Sutton, George Miksch

1920 Annotated List of the Birds of Brooke County, W. Va. Pt. 2. Ologist, 37, No. 6, June, 1920:64-68.

Swainson, William, and John Richardson

1831 Fauna Boreali-Americana. Pt. 2, Birds. John Murray, London.

Swales, Bradshaw H.

1904 A List of the Land Birds of Southeastern Michigan. Pt. 3. Bull. Mich. Ornith. Club, 5, No. 2, June, 1904:37-43.

Taverner, P. A., and B. H. Swales.

1908 The Birds of Point Pelee. Pt. 4. Wilson Bull., 20, No. 2, June, 1908:79-96.

Taverner, P. A.

1934 Birds of Canada. National Mus. Canada, Bull. 72, Biol. Ser. No. 19.

Thompson, Sue Roughton

1949 Scarlet Tanager Nests at Chapel Hill, Orange County, N.C. Chat, 13, No. 5, Nov., 1949:81.

Tinker, A. D.

1911 Observations on the Spring Migration (1910) at Ann Arbor, Michigan. Wilson Bull., 23, No. 1, Mar., 1911:28-34.

Todd, W. E. Clyde

1940 Birds of Western Pennsylvania. Univ. Pittsburgh Press,

Pittsburgh, Pa.

Tordoff, Harrison B.

1949 Summer Tanager in Michigan. Wilson Bull., 61, No. 2, June, 1949:112.

Trautman, Milton B.

1940 The Birds of Buckeye Lake, Ohio. Univ. Mich. Mus. Zool. Misc. Publ. No. 44, May 7, 1940.

Trembly, Chas. C.

1892 A Ramble in May. Oologist, 9, No. 10, Oct., 1892: 228-229.

Trotter, Spencer

1909 An Inquiry into the History of the Current English Names of North American Land Birds. Auk, 26, No. 4, Oct., 1909:346-363.

Trotter, William Henry

1914 An Abnormally Colored Scarlet Tanager. Bird-Lore, 16, No. 5, Sept.-Oct., 1914:359.

Vaiden, M. G.

1943 Notes on Mississippi Birds. Migrant, 14, No. 3, Sept., 1943:50-52.

Vickers, Ernest Walters

1911 A List of Birds Observed in a Rural Dooryard. Oologist, 28, No. 10, Oct. 15, 1911:162-165.

Vieillot, Louis Jean Pierre (not seen)

1819 Nouveau Dictionnaire d'Histoire naturelle, Nouvelle édition, 28, 1819:293. Par une Société de Naturalistes et d'Agriculteurs. 24 Tom.

Warren, B. H.

1890 Report on the Birds of Pennsylvania. 2nd ed. Commonwealth of Pennsylvania, Harrisburg, Pa.

Warriner, Benj. R.

1940 Corinth Chat. Migrant, 11, No. 2, June, 1940:49.

Weston, Francis M.

1941 Pensacola (Fla.) Region. Audubon Mag., 43, Nov.-Dec., 1941:568-569.

Wheaton, J. M.

1879 Report on the Birds of Ohio. Ohio Geol. Surv., 4, Pt. 1, 1879:189-628.

Wheelock, Irene G.

1905 Regurgitative Feeding of Nestlings. Auk, 22, No. 1, Jan., 1905:54-70.

Wolfson, Albert

1945 The Role of the Pituitary, Fat Deposition, and Body Weight in Bird Migration. Condor, 47, No. 3, May-June, 1945:95-127.

Wood, Norman A., and A. D. Tinker

1934 Fifty Years of Bird Migration in the Ann Arbor Region of Michigan 1880-1930. Univ. Mich. Mus. Zool. Occ. Papers, No. 280, May 21, 1934.

Wright, Horace W.

1913 Morning Awakening and Even-song. Second Paper. Auk, 30, No. 4, Oct., 1913:512-537.