A NESTING STUDY OF THE STARLING NEAR GUELPH, ONTARIO

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The Starling (*Sturnus vulgaris*) has been the subject of considerable research because it is a common and economically important bird. Important quantitative studies of the Starling's breeding biology have been made in Europe such as those by Kluijver (1935; 1938), Dunnet (1955), and Anderson (1961). Most studies have been summarized by Lack (1948*a*) and by Kessel (1957). Only two quantitively significant studies have been made so far in North America (McAtee, 1940; Kessel, 1957).

This report concerns a three-year study (1956–58) made at the Ontario Agricultural College near Guelph, Ontario. Our chief interest was to gather statistics pertaining to the productivity of a Starling population, but other aspects of the birds' breeding habits were also investigated. The study area was situated six miles southeast of Guelph, Wellington County, Ontario.

In this area most of the natural, mixed deciduous-coniferous forest has been replaced by farmland. Agriculture consists mainly of mixed farming, with hay, spring or fall wheat, row crops, and fallow predominating. Poor soils are in permanent pasture. Relatively few fruit and vegetable crops are grown.

About 2 per cent of the area consists of marshes, swamps, and ponds; about 10 per cent is forested by sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), eastern hemlock (*Tsuga canadensis*), white elm (*Ulmus americana*), white cedar (*Thuja occidentalis*), black ash (*Fraxinus nigra*), white birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*).

The mean temperatures from 1921 to 1950 for the months of January and July were 20.7°F (–7°C) and 67.9°F (20°C), respectively. The average annual precipitation is about 33 inches.

Methods

Nest boxes (16 × 6 × 6 inches inside) were made of plywood. The upper 6 inches of one side was hinged and latched, and served as a door. The entrance hole was 2 inches in diameter centered 3 inches below the roof on the front side.

In the spring of 1956, 180 boxes were placed in the study area (Figure 1) on the sides of farm buildings, trees, and electric poles at heights from 7 to 16 feet above the ground. Most were located about farm buildings in groups of 3 to 7, but some singly; 26 boxes were placed in the outer fringes of a 16-acre woodlot.

In the spring of 1957, 65 of the outlying boxes were moved closer to the college to reduce the amount of traveling involved. No changes in distribution were made in 1958. Each box was visited an average of 13 times in each breeding season. Additional visits were made at night to band nesting females.

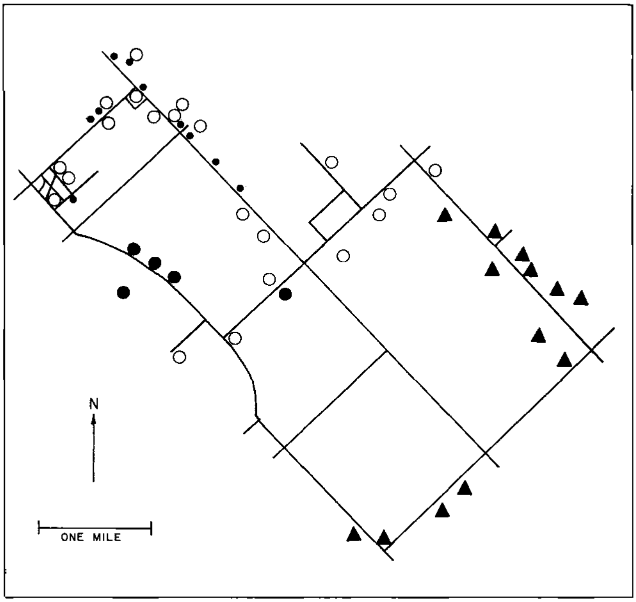

Figure 1. A map of the study area showing roads and location of nest boxes. Small closed circles represent single boxes used all three years. Other symbols represent colonies of boxes: open circles, 1956–58; closed circles, 1957–58; triangles, 1956.

TIME OF BREEDING

Characteristically, there are two breeding periods, the first commencing in April and the second in June. Between these two distinct periods, a number of clutches are laid which we designate as intermediate clutches. Some of these are renesting attempts of birds that lost their first broods. Intermediate clutches were distinguished from late first clutches and early second clutches by reference to egg-laying dates of known clutches for banded females.

Several workers have found that most of the few Starlings that breed in their first year are females. However, some first-year males do breed (Kluijver, 1935: 142; Kessel, 1957: 308). First-year Starlings can be distinguished from adults (two years or older) by measurement of their hackle feathers (Kessel, 1951). At Guelph, 13 per cent of the 295 breeding females that were aged were first-year birds (Table 1); 5 had been banded as nestlings and their ages at the start of egg laying were 311, 345, 345, 345, and 346 days. The youngest of these had hatched from an intermediate clutch. All 5 laid first clutches.

Some first-year birds raise two broods in a season. Kessel (1953) re-

TABLE 1
BREEDING OF FIRST-YEAR FEMALE STARLINGS

Year	Per cent first-year ♀♀[1] (and total number ♀♀)		
	First clutches	*Intermediate clutches*	*Second clutches*
1956	13 (56)	0 (7)	20 (69)
1957	19 (125)	24 (17)	17 (53)
1958	7 (114)	0 (8)	4 (79)
1956–58	13 (295)	13 (32)	13 (201)

[1] Average for all clutches was 13 per cent.

ported that five first-year Starlings unsuccessfully attempted second broods. In our study, 8 of 20 first-year females that had reared first broods started second broods, and 5 were successful. (Throughout this paper, a successful nesting attempt is considered to be one from which at least one young was fledged.)

The question of the number of broods which Starlings rear in a season has been reviewed by Kessel (1953). In continental Europe up to 35 per cent of first broods are followed by second broods. Dunnet (1955) found that in Scotland 59 to 70 per cent of successful first broods were followed by second broods. Anderson (1961), continuing Dunnet's study, discovered that there were no second broods in some years. In North America, Kessel (1953) found that, at Ithaca, New York, over 93 per cent of successful first broods were followed by second broods. At Guelph, this average was 92 per cent and annual variations in the ratio were small (Table 2). Starlings which laid intermediate clutches never renested in the second brood period.

EGG LAYING

Average dates for the onset of egg laying were 4 May 1956 (153 clutches), 29 April 1957 (140), and 23 April 1958 (147), a considerable spread in time (Figure 2). In the three years, the average date for the beginning of second clutches followed that for first clutches by 40, 44, and 42 days. Small standard deviations for egg-laying dates for first clutches demonstrated the marked synchrony displayed by Starlings in their nesting habits. Nesting at Craibstone, Scotland, followed a similar pattern except that it began one and two weeks earlier (Dunnet, 1955: 632; Anderson, 1961).

Kessel (1957: 270) has pointed out that environmental factors affect reproductive periodicity. There is experimental evidence that the reproductive cycle in male Starlings is influenced by photoperiod (Burger, 1949, 1953). The final recrudescence of gonads in the spring is dependent on the photic stimulation of long days, but Burger (1948) also showed

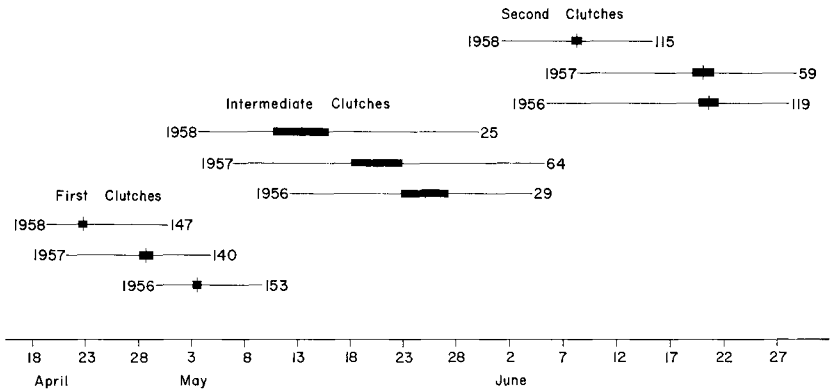

Figure 2. Dates for the onset of egg laying by Starlings at Guelph, 1956–1958. Vertical lines represent the means and horizontal lines the observed ranges; boxes include two standard deviations either side of the mean.

that temperatures influence the spermatogenic response to long days, with high temperatures augmenting the response.

Nesting is earlier in years with warm springs than in years with inclement spring weather. Kessel (1957: 271) made an extensive analysis of the relationship between egg-laying dates and environmental temperatures, concluding that annual variations in breeding dates are largely a result of temperature differences. She found at Ithaca, New York, that average temperatures during the last third of March are particularly important, with egg laying occurring markedly earlier when average temperatures exceed 40°F in this period. She also concluded that the minimum threshold level for the inducement of rapid gonadal development appears to be between 40° and 43°F, and that the birds must be exposed to these mean temperatures for at least 17 days before laying.

Analyses of the possible effect of temperature on egg-laying dates were made at Guelph. Although some Starlings arrived on the study area in late February, the major influx occurred about mid-March; therefore, only temperatures for late March and April were considered in most analyses. Data were obtained from a meteorological station located within the study area. The spring of 1956 was cold and the two following springs were successively milder. Data in Table 3 suggest a relationship between egg-laying dates and average temperatures for the period 22–31 March and the period from 1 April to the mean egg-laying date, supporting Kessel's observations. If the minimum threshold for the inducement of rapid gonadal development is about 40°F, our data show that the fewest number

TABLE 2

THE OCCURRENCE OF SECOND CLUTCHES OF STARLINGS

Item	*Year*			
	1956	*1957*	*1958*	*1956–58*
Number of successful first clutches	123	78	120	321
Per cent of above followed by second clutches	92	89	93	92

of days with this or higher mean temperatures required for egg laying was 11 (Table 4) or 6 days less than Kessel found.

We also attempted to correlate egg-laying dates with the average number of hours of sunshine daily and with the average daily amount of solar radiation. A fair correlation between egg-laying dates and the former is suggested for the period 22–31 March, but no correlation could be established with the amount of solar radiation (Table 3). Sunshine *per se* may be more important to the phenology of egg laying than is the amount of solar radiation.

CLUTCH SIZE

Clutch size shows geographical, seasonal, and annual variations. First clutches averaged 5.2 ± SE .03 (N = 1,592) in Holland and 4.9 ± .11 (105) in northern England (Lack, 1948*a*). At Ithaca the average was 5.5 ± .05 (199); the differences between all means are statistically significant (Kessel, 1957: 278). Annual variations in mean clutch size were significant both in the Dutch study and the one made at Ithaca. At Guelph, first clutches averaged 5.6 ± .05 (395), and were similar in size to Ithaca clutches. There were annual variations in the mean size of first clutches: 5.6 ± .11 (127) in 1956; 5.5 ± .09 (136) in 1957; and 5.7 ± .08 (132) in 1958. Analysis by the Kruskal-Wallis test (Steel and Torrie, 1960) showed that the differences are significant ($P < .05$).

Second clutches averaged smaller than first clutches. Kluijver (*in* Lack, 1948*a*) found an average of 4.3 ± .09 (193) in Holland, which is significantly larger than Ithaca clutches which averaged 4.1 ± .09 (110) (Kessel, 1957: 278). At Guelph, second clutches, averaging 5.0 ± .06 (277) were significantly larger than second clutches both in Holland and at Ithaca ($P < .001$). Clutches in 1956, 1957, and 1958 averaged 5.2, 4.8, and 4.9 eggs, respectively. A comparison of means by *t* tests showed that the 1957 clutches were significantly smaller than the 1956 clutches ($P < .01$), but the difference between 1957 and 1958 clutches was not significant.

A comparison of the size of first and second clutches of 102 banded

TABLE 3
RELATIONSHIP OF DATE OF FIRST CLUTCHES AND CLIMATOLOGICAL CONDITIONS

Daily average measurements	*Period of observation*		
	22–31 March	*1 April–mean date*[1]	*15 March–mean date*[1]
Temperature			
1956	27.6	39.7	—
1957	34.5	44.4	—
1958	37.8	47.6	—
Hours of sunshine			
1956	3.3	4.3	—
1957	5.0	3.9	—
1958	7.9	8.3	—
Solar radiation (g cal/sq. cm)			
1956	—	—	396.5
1957	423.6	—	373.8
1958	391.3	—	374.2

[1] Mean date refers to the average date of the laying of the first egg of first clutches. These were: 4 May 1956, 29 April 1957, and 23 April 1958.

females showed that 65 per cent laid smaller second clutches; 22 per cent laid clutches of the same size; and 13 per cent laid larger second clutches.

In this study, 75 intermediate clutches which were laid in May averaged 5.2 ± .13 eggs. Comparable clutches at Ithaca and Holland were 5.0 and 4.9, respectively (Kessel, 1957: 277).

Some studies have shown that first-year Starlings lay smaller clutches than adults (Kluijver *in* Lack, 1947: 313; Kluijver, 1935: 154). We found that first clutches for adults averaged 5.6 ± .07 (252) as compared with clutches of 5.1 ± .22 (36) for first-year birds, the difference being significant ($P < .05$). However, second clutches in the two age groups are similar in size: 5.0 ± .08 for 160 adults, and 5.1 ± .19 for 24 first-year birds.

NUMBER OF YOUNG

First broods.—Brood size varies considerably. Data for England, Holland, Switzerland, Germany, and the United States, have been summarized

TABLE 4
RELATIONSHIP OF EGG LAYING AND DAILY MEAN TEMPERATURES ABOVE 40°F

Item	*Year*		
	1956	*1957*	*1958*
Earliest date with mean temperature of 40° F	12 April	26 February	29 March
Date of first egg	30 April	21 April	19 April
Number of days with mean temperature at or above 40°F before date of first egg	12	11	16

TABLE 5
SIZES OF CLUTCHES AND BROODS OF STARLINGS AT GUELPH, ONTARIO, AND ITHACA, NEW YORK[1]

Item	*Ithaca*		*Guelph*	
	N	$M \pm SE$	*N*	$M \pm SE$
First clutches	199	5.5 ± .05	395	5.6 ± .05
First broods	230	4.5 ± .09	288	4.7 ± .07
Intermediate clutches	42	5.0	75	5.2 ± .13
Intermediate broods	41	3.5	77	3.7 ± .14
Second clutches	110	4.1 ± .09	277	5.0 ± .06
Second broods	78	2.9 ± .13	161	3.6 ± .13

[1] Brood size refers to counts of young which were 16 days or older.

by Lack (1948*a*) and Kessel (1957: 287). The averages for first broods in Europe ranged from 4.2 young in England to 4.6 in Germany. Broods at Ithaca averaged 4.5 young. At Guelph, where counts were made of young 16 days or older, first broods averaged 4.7 young (Table 5), a larger number than for Ithaca broods ($P < .05$). Since hatching successes of Guelph and Ithaca clutches were about equal, a lower nestling mortality at Guelph is indicated. We found that the size of first broods varied from year to year with averages of 5.1 ± .11 (120), 4.6 ± .15 (77), and 4.3 ± .14 (91) for 1956–58. A comparison of means by *t* tests showed that 1957 and 1958 broods were significantly smaller than in 1956 ($P < .01$), but that there was no significant difference between the size of 1957 and 1958 broods. The decline in brood size in 1957 and 1958 resulted from annual variations in hatching success and nestling mortality (see later).

Second and intermediate broods.—In European studies summarized by Lack (1948*a*) and Kessel (1957: 287) intermediate and second broods are not differentiated, but are classified as "late" broods. They ranged in size from 3.1 in Germany to 4.0 in Switzerland. Comparable Guelph broods averaged 3.6 ± .08 (231) and are significantly larger than Ithaca "late" broods which averaged 3.1 ± .11 (119) ($P < .001$).

When second and intermediate broods are considered separately, a similar picture is obtained. Our second broods averaged 3.6 young (Table 5) and are significantly larger ($P < .001$) than Ithaca broods of 2.9 young (Kessel, 1957: 288). Annual variations in the size of second broods at Guelph were not significant: 3.7 ± .17 (58) in 1956; 3.3 ± .18 (37) in 1957; 3.7 ± .17 (66) in 1958. Of intermediate broods at Guelph, 77 averaged 3.7 young and similar broods at Ithaca averaged 3.5 young (Table 5).

TABLE 6

NESTING SUCCESS OF STARLINGS AT GUELPH

Year	*Eggs to hatching*		*Eggs to fledging*		*Young to fledging*		*Nest success*	
	Eggs laid (N)	*Per cent hatched*	*Eggs laid (N)*	*Per cent fledged*	*Young hatched (N)*	*Per cent fledged*	*Nests with eggs (N)*	*Per cent successful*[1]
				First clutches				
1956	501	99	608	91	452	99	153	82
1957	315	91	423	80	230	95	109	73
1958	604	86	622	78	428	89	126	81
1956–58	1,420	92	1,653	83	1,110	94	388	79
				Intermediate clutches				
1956	55	89	78	77	46	89	21	71
1957	135	84	189	67	83	87	60	72
1958	64	91	33	88	35	94	16	63
1956–58	254	87	300	72	164	89	97	70
				Second clutches				
1956	149	87	294	67	80	94	98	61
1957	209	80	168	70	121	88	63	59
1958	446	83	302	76	252	89	110	70
1956–58	804	83	764	71	453	89	271	61
				All clutches				
1956–58	2,478	88.2	2,717	78.6	1,727	92.3	756	71

[1] Successful nests were considered to be ones in which at least one young was fledged. Desertions were not included in these figures.

NESTING SUCCESS

Hatching success.—Kessel (1957: 307) found that 91 per cent of the eggs in first clutches hatched and 80 per cent of those in second clutches hatched. Similar success, based on nests in which at least one egg hatched, was noted at Guelph, averaging 92 and 83 per cent for first and second clutches, respectively. Hatching success for first clutches showed annual variations: 99 per cent in 1956, 91 per cent in 1957, and 86 per cent in 1958. The differences are significant between the years 1956 and 1957 ($P < .001$), between 1956 and 1958 ($P < .001$), and between 1957 and 1958 ($P < .05$). Annual variations in the percentage of second-clutch eggs which hatched were not significant (Table 6).

The data for first clutches suggest that hatching success is related to the earliness or lateness of the nesting season, since it was highest in 1956 when Starlings began nesting in May and lowest in 1958, the year in which they began nesting the earliest.

The relationship between hatching success and clutch size was examined for first and second clutches. Data in Table 7 suggest that hatching success tended to decline for clutches exceeding six in first clutches and five in second clutches. It is perhaps significant that clutches of six and five,

TABLE 7

RELATIONSHIP OF CLUTCH SIZE TO HATCHING AND FLEDGING SUCCESS IN STARLINGS

Clutch size	*Hatching success*		*Fledging success*	
	Number of eggs	*Per cent hatched*[1]	*Number of eggs*	*Per cent fledged*[1]
		First clutches		
3	15	87	18	78
4	108	92	116	89
5	415	92	445	81
6	618	93	678	85
7	224	90	308	83
8	40	80	88	77
		Second clutches		
2	6	83	4	75
3	30	97	15	80
4	172	81	136	70
5	385	84	345	74
6	168	81	186	68
7	35	89	70	64
8	8	38	8	75

[1] Based on nests in which at least one egg hatched or at least one young was fledged.

which are modal for first and second clutches, respectively, showed essentially the highest hatching success. This trend was also carried through in the percentage of eggs from which fledglings were reared. The exceptions to these statements are likely the result of small samples.

Nestling survival and mortality.—The survival rate of nestling Starlings is high. Kessel (1957: 307) at Ithaca found that 87 per cent of first brood young and 82 per cent of second brood young were fledged in successful nests. At Guelph (Table 6) these percentages, based on nests in which at least one young was fledged, were 94 per cent and 89 per cent, and were significantly higher for first broods ($P < .001$) and for second broods ($P < .05$) than those for Ithaca. Fledging success for intermediate broods at Guelph was 89 per cent. It should be noted for Table 6 that, since complete information is not available for all nests observed each year, the data for various headings are not directly interrelated.

Annual variations in fledging success for eggs that hatched in first broods at Guelph were: 99 per cent (1956), 95 per cent (1957), 89 per cent (1958). The level of significance for the differences between pairs of years are as follows: 1956–57 ($P < .05$), 1957–58 ($P < .01$), 1956–58 ($P < .001$). In view of the phenology of nesting, late breeding appears to favor nestling survival. We could not visit nests often enough to obtain accurate records of nestling mortality. However, our general observations corroborate those of Dunnet (1955: 647), indicating that two main patterns of mortality occur: (1) nestlings which hatched later than others

TABLE 8

LOSSES OF NESTS IN EGG LAYING AND INCUBATION (E-I) AND NESTLING (N) PERIODS

Period	*Number of nests*	*Cause and number of failures*			*Per cent failing*	*Per cent successful*[2]
		Predation	*Desertion*[1]	*Unknown*		
			First clutches			
E–I	452	15	30	47	20	86
N	333	5	13	13	8	95
			Intermediate clutches			
E–I	107	2	5	11	17	88
N	89	2	4	10	18	87
			Second clutches			
E–I	322	6	19	53	24	82
N	207	6	26	31	30	82
			All clutches			
E–I	881	23 (12)[3]	54 (29)	111 (59)	21	85
N	629	13 (12)	43 (39)	54 (49)	18	89

[1] Presumably as a result of disturbance by our activities.

[2] Including as successful those nests that were deserted.

[3] Numbers in parentheses are percentages.

in the brood, and hence were smaller, often died within a few days, probably from malnutrition, and (2) individuals which died at any age up to about 16 days for no apparent reason. Little mortality occurred among older nestlings.

Egg-to-fledgling ratios.—This ratio has been widely used as a gauge of nesting success. It is the percentage of eggs which produce fledglings (Table 6) and was 83, 72, and 71 per cent for first, intermediate, and second broods, respectively, for successful nests. For all nests the average ratio was 78.6 per cent, which is significantly larger than the Ithaca ratio of 76.1 per cent (Kessel, 1957: 307). Comparable ratios for Maryland, in the United States (McAtee, 1940), and for Holland (Lack, 1948*a*) were 86.9 per cent and 81.0 per cent. Both are significantly larger than the Guelph ratio ($P < .001$).

Desertion and predation.—The preceding ratios were based on nests in which at least one egg hatched or at least one young was fledged; however, many nesting attempts failed completely. An analysis of nest losses is shown in Table 8 where we have divided nesting activities into two phases—laying and incubation, and nestling.

We found that 21 per cent of all nests were lost during egg laying and incubation. Predation by red and gray squirrels (*Tamiasciurus hudsonicus* and *Sciurus carolinensis*) caused at least 12 per cent of the losses. The incidence of predation was probably greater than these data indicate, but was unrecognized for lack of evidence. Desertions resulting from our activities were estimated at 29 per cent of the total failures. When such desertions are included as successful nests, incubation was completed in 85 per cent of all nests. We could not account for 59 per cent of the nest losses.

Fewer nests were lost after the young had hatched (18 per cent); however, the proportion attributed to predation by squirrels remained about 12 per cent. Our nocturnal visits to the boxes to examine breeding birds resulted in a greater number of desertions (39 per cent). If these desertions are included as successful nests, young were fledged in 89 per cent of the nests in which eggs had hatched.

The average per cent of successful nests for all nests with eggs was 71 per cent (Table 6), and was consistently lower for second broods than for first broods. Kessel (1957: 308) reported a higher ratio (78.6 per cent), but the two statistics may not be comparable because of differences in study methods. For example, the incidence of desertion may be related to the number of visits made to the nests.

DISCUSSION

The results show that several aspects of the Starling's breeding biology show geographical variation. It is remarkable that such differences should exist between populations at Guelph, Ontario, and Ithaca, New York, which are separated by less than 200 miles and are ecologically similar.

First clutches at Guelph and Ithaca were similar in size, but were larger than those in Holland and northern England. Our second clutches were larger than corresponding clutches at Ithaca and in Holland. It appears that North American Starlings lay more eggs than do their European counterparts.

It is interesting to speculate as to whether this increase in clutch size has a genetic basis. Unfortunately, we do not know the exact European origin of our stock nor have we records of changes in clutch size since its introductions in 1890 and 1891. Lack (1947: 319; 1948*a*, *b*) advanced the theory that clutch size has evolved in accordance with the number of young that members of a species can raise, as determined by the availability of food. Such a mechanism may explain the North American situation where Starlings encountered an almost unlimited range and a more or less unoccupied niche. The nature and degree of competition between Starlings and other species for food and cover requires study. However, Dunnet (1955: 656) who studied the relation between family size, food availability, and food utilization in Starlings, found no evidence to support Lack's theory and concluded that some other factor must control clutch size.

The possibility that geographical variations may be attributable to environmental factors cannot be excluded. When we can explain annual variations in clutch size, we may have a clue to which factors are important.

Davis (1958) found discrepancies between the number of post-ovulatory follicles and the number of eggs in the nests of some females. He thought that the failure of Starlings to deposit all their eggs in the nest might account for some seasonal changes in clutch size.

Since first-year birds lay smaller first clutches than do adults, changes of sufficient magnitude in the age-class structure of the breeding population would affect the mean clutch size. We found annual variations in the size of first clutches which appear to be related to variations in the age composition of the population (Table 1). More information is needed about the age-class structure of Starling populations.

There are also geographical variations in brood size. First broods at Ithaca were comparable in size to first broods in Holland. First broods at Guelph were larger than those at Ithaca because of a higher nestling survival rate. Second and "late" broods at Ithaca are smaller than comparable Dutch and Guelph broods. The differences between the sizes of Guelph and Ithaca second broods are a result of the smaller clutches and higher nestling mortality at Ithaca.

At Guelph, annual variations in hatching success and nestling survival were noted only for first broods. A late breeding season appears to favor survival of eggs and nestlings and Anderson's (1961) data on hatching success support this conclusion.

In general, the Starling population at Guelph exhibited a higher rate of productivity than the population at Ithaca, mainly because of the larger second broods. Studies in North America indicate a higher level of productivity among Starlings than in Europe, because first broods are larger and the incidence of second broods is greater. Since the European studies were made in regions with oceanic climates and the North American ones in regions with continental climates, some of the differences reported may result from differences in the two climatic types affecting population structure.

Although our study was too brief in duration to provide conclusive evidence, the influence of certain meteorological factors on the phenology of nesting is suggested. We found that nesting occurred earlier in years with mild spring weather, which corroborates the findings of Kessel (1957: 271) and others. We also found some evidence that the amount of sunshine may influence nesting dates. Nesting occurred earlier in years when the weather was sunny during the last third of March. The effect of light on gonadal development is thought to involve a pituitary-gonadal mechanism (Burger, 1949). Our observations support Burger's suggestion that the effectiveness of light may increase with high intensities. Aside from experimental evidence, field observations lead us to think that sexual display among Starlings occurs more frequently and is more intense during periods of sunshine. We think that the influence of sunshine on the breeding cycle of birds merits more attention.

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SUMMARY

The breeding biology of the Starling was studied at Guelph, Ontario, over a three-year period (1956–58) by examining 180 nest boxes. We found that 13 per cent of the breeding females that were aged were first-year birds. An average of 92 per cent of successful first broods were followed by second broods.

Average dates for the onset of egg laying were 4 May 1956, 29 April 1957, and 23 April 1958. Nesting occurred earlier in years with high spring temperatures and when sunny weather prevailed.

The average sizes of first, intermediate, and second clutches were 5.6, 5.2, and 5.0, respectively. We found significant annual variations in the size of both first ($P < .05$) and second ($P < .01$) clutches for two of the years.

First, intermediate, and second broods averaged 4.7, 3.7, and 3.6 young, respectively. First broods for 1957 and 1958 were significantly smaller than 1956 first broods ($P < .01$).

The percentage of eggs hatching averaged 92 per cent for first clutches and 83 for second clutches. The percentage of young to fledge were 94 and 89 for first and second broods, respectively. Annual variations in both hatching success and survival of nestlings for first broods appear to be related to the phenology of nesting; these were highest when nesting began late and lowest in an early nesting season.

The egg-to-fledgling ratios in successful nests (in which at least one young fledged) were 83 and 71 per cent for first and second broods, respectively. For all nests examined the ratio was 79 per cent.

The Guelph Starling population exhibited a higher rate of productivity than populations of Ithaca, New York, and of European countries for which comparable data were available.

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