SOME ASPECTS OF BREEDING BIOLOGY OF THE BLUE-WINGED TEAL

Charles W. Dane

The Blue-winged Teal (*Anas discors*) was the subject of one of the first publications dealing with the breeding biology of a species of North American waterfowl (Bennett, 1938). Recent studies of the nesting chronology, clutch size, and incubation period of this species include the works of Hochbaum (1944), Sowls (1955), and Glover (1956). The present paper supplements information on these aspects of breeding biology.

Field work was done during the summers of 1961, 1962, and 1963 at the Delta Waterfowl Research Station (15 miles north of Portage la Prairie, Manitoba) which is adjacent to the Delta marsh at the south edge of Lake Manitoba. The climate in the area is subhumid. The mean annual temperature is 45.3°F and the annual precipitation is 20.1 inches at Winnipeg (60 miles ESE of Delta). The spring warming trend is variable and influences the time of spring arrival and the start of nesting of waterfowl (Sowls, 1955) and, as will be shown, the temperature may also influence the nesting chronology once a species has begun to nest. The daily mean temperatures and the daily lows at Winnipeg for the springs of 1962 and 1963 are graphed in Figures 1 and 2. Daily records kept by Nan Mulder at Delta show that the temperatures there are similar to those at Winnipeg.

Methods

In the first summer in the field, I searched for nests within approximately a one-mile radius of the research station; three-fifths of the area was covered by water. In order to flush hen teal and thus locate their nests, we used rock-filled oil cans attached to a rope which was dragged between two men or tractors. Laths or bamboo poles were used to beat the heavier vegetation. During the 1962 nesting season the same area was covered but we intensified our efforts in the area immediately around the headquarters.

Date of nest initiation.—A review of the reproductive cycle of waterfowl has been given by Weller (1964). Teal normally lay one egg a day, as do other dabbling ducks. Usually the egg is laid before 1000 hours. Thus, when a female was flushed from a nest with an incomplete clutch after 1000, I arbitrarily considered that the egg for that day had been laid. Although this procedure may not be completely accurate, it does provide a reasonable demarcation from which the date of clutch initiation can be obtained by backdating one day for each egg present in the nest.

When the eggs had already been incubated, the stage of incubation was discerned by candling the eggs. By backdating the number of days that

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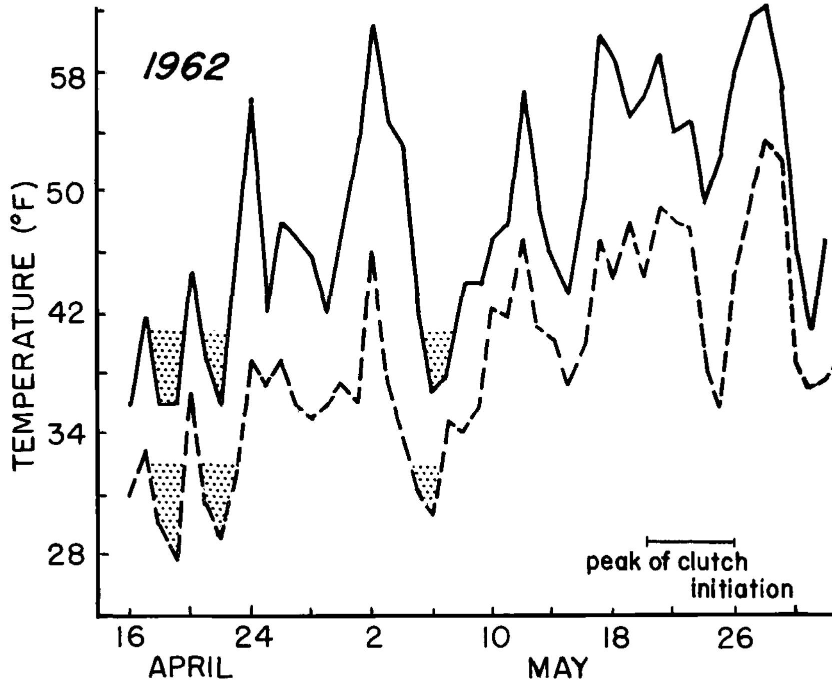

Figure 1. Daily mean (solid line) and minimum (broken line) temperatures for the spring of 1962. Stippling depicts mean temperatures below 41° F and minimum temperatures below 32° F.

posedly completed clutches but in which the number of eggs was obviously incubation had progressed when the nest was found plus one day for each egg in the clutch, I estimated the date of clutch initiation. Such estimates are thought to be accurate within one or two days.

Clutch size.—Blue-winged Teal lay between 10 and 13 eggs in their first clutch. Bent (1923: 114) listed a range of 6 to 15 eggs, but noted that nests most commonly contained 10 to 12 eggs. Bennett (1938: 48) reported an average clutch of 9.3 eggs in "normal" nests but, as Sowls (1955: 131) pointed out, Bennett's "normal" nests must have included some renests, which contain fewer eggs than first nests. Sowls (1955: 132), studying teal at Delta, reported an average of 10.6 eggs in nests completed prior to 15 June. This average is similar to that of 11.0 eggs per clutch which I obtained in this study from clutches initiated before 4 June.

The number of eggs per clutch was included in my calculations only when the clutch was complete (i.e., incubation had begun) and when there was no sign of predation. There were three nests which contained sup-

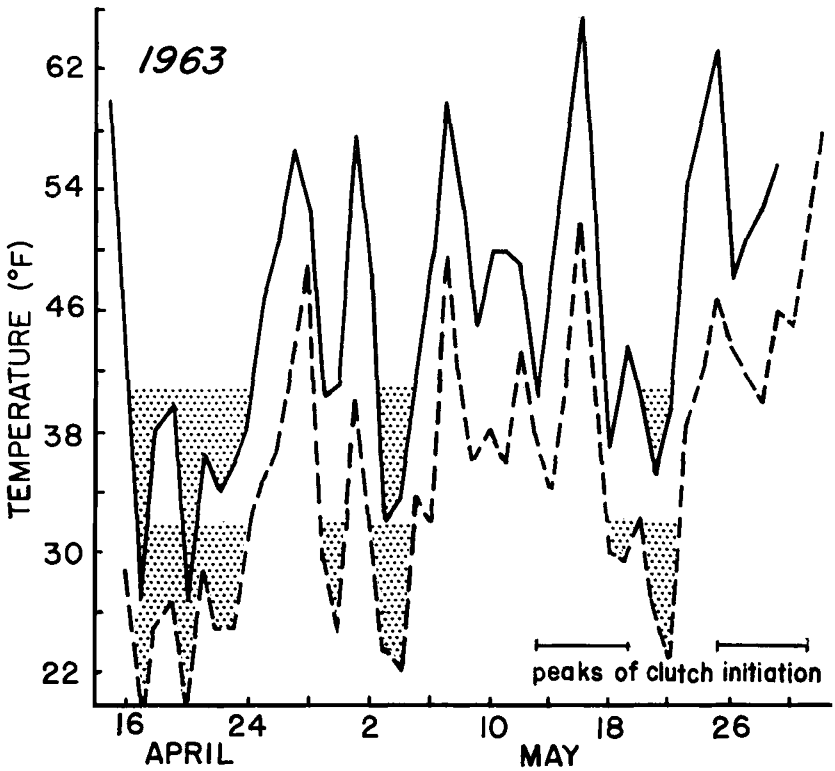

Figure 2. Daily mean (solid line) and minimum (broken line) temperatures for the spring of 1963. Stippling depicts mean temperatures below 41° F and minimum temperatures below 32° F.

low (e.g., six eggs for a clutch initiated on 1 June and, on two occasions, five eggs for clutches started on 2 June). These figures were omitted from the calculations.

Separation of first clutches and clutches resulting from renesting was based on nesting chronology curves (see Figure 3), and the period when few clutches were initiated was selected as the dividing point. Few clutches were started because most birds had initiated their first clutch and those that have clutches destroyed must repeat the physiological stages prior to laying again (Sowls, 1955). In 1962 and 1963, clutches initiated before 4 June were considered as first nesting attempts. This date is close to the one used by Sowls (1955: 132) who divided the nesting period by grouping clutches completed before and after 15 June.

Use of these division dates certainly results in the inclusion of at least a few early renests with the first clutch averages, and the first clutches of a few late nesting individuals probably are counted in the renesting category, although I think that even most first-year teal have started to lay by 4 June. From a related study, I have records of 24 hand-reared, first-year teal which initiated clutches prior to 4 June, 2 which began to lay on 4 June, and five clutches which were begun after 4 June but which were all known to be the result of renesting.

Incubation period.—As defined by Heinroth (1922) the incubation period is the time between the beginning of undisturbed incubation of a fresh egg and the completed hatching of that egg. Similar to most workers, I have adopted as a more practical measure of incubation period, the time from when the last egg is laid until it hatches. Thus, in estimating the incubation periods of wild birds, I have assumed that incubation begins when the last egg is laid.

The only incubation records considered valid were those obtained from clutches for which both the dates of initiation (i.e., the clutch was incomplete when first found) and of hatching were known. In some cases eggs were brought in from the field and placed promptly in an incubator and their hatching dates recorded.

Some incubating hens were nest-trapped, but this did not seem to cause undue absence from the nest. Further disturbance of the hen was avoided; their nests were not checked again until it was estimated that the eggs had been incubated 23 days. They were then checked every second day thereafter. Thus, by noting whether the eggs were pipped or recently hatched, I could accurately determine the hatching date.

RESULTS AND DISCUSSION

Nesting chronology.—Blue-winged Teal arrived at Delta on 24 April 1962 and 13 April 1963. The first clutch in each of these years was not started until 10 and 8 May, respectively. After the early arrival of teal in 1963, the weather turned cold and this was probably the reason for a delay in nesting until a date similar to that in 1962 (in 1962 the first clutch was begun three to four days after a cold snap on 6 and 7 May). Sowls (1955: 85–89) reported a correlation between clutch initiation by prairie dabbling ducks and mean daily temperature. A similar correlation was noted by Hanson and Browning (1959: 132–133) in their study of Canada Geese (*Branta canadensis*) and the relation of temperature to avian breeding is also discussed in reviews by Davis (1955), Marshall (1961), van Tienhoven (1961), and J. P. Rogers (The ecological effect of drought on reproduction of the Lesser Scaup, *Aythya affinis* [Eyton]. Ph.D. thesis, Univ. Missouri, 1962.).

Because my field work was begun late in the 1961 nesting season, I do

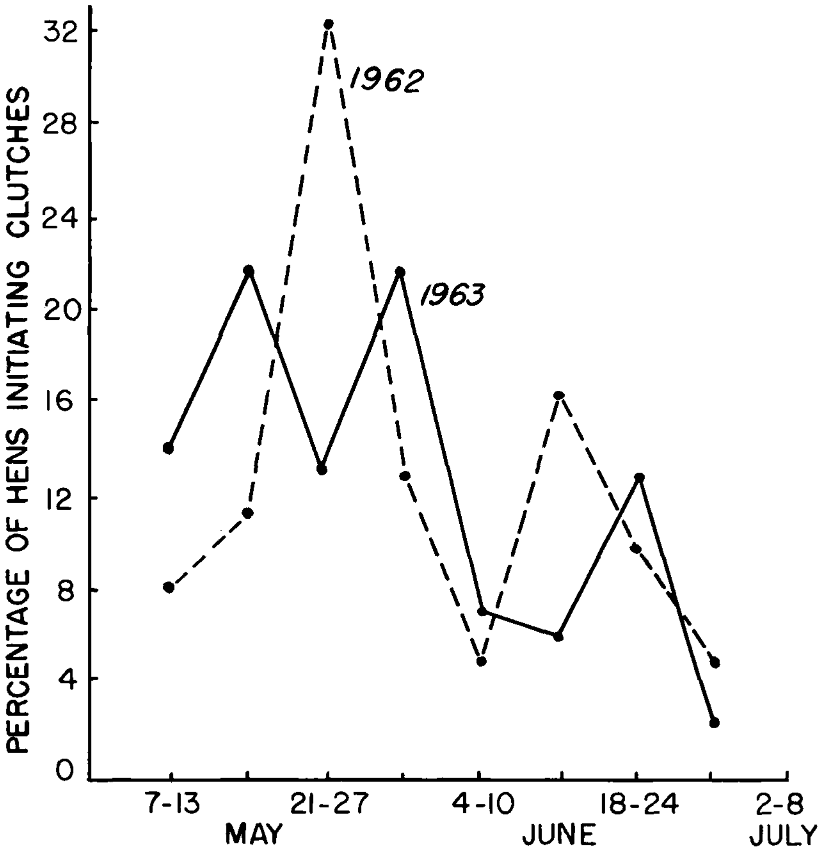

Figure 3. Nesting chronology of the Blue-winged Teal in 1962 (62 nests) and 1963 (95 nests). See Figures 1 and 2 for temperatures in the periods of clutch initiation.

not think that the data for that year can be compared with those for 1962 and 1963. Information for the last two years is graphed in Figure 3. The nesting chronologies for these years were very different. The 1962 chronology may be considered more "normal"; a similar curve is shown by Sowls (1955: 86) for the Blue-wing.

In 1962 there was a gradual increase in nesting activity, followed by a single, definite peak of nesting activity the week of 21–27 May. However, in 1963 two peaks were apparant in the period of initial nesting activity. The early arriving teal delayed their nesting until after the cold spell on 4 May. By this time, apparently a large proportion of the birds were physiologically ready for nesting; 14 per cent began laying the first week (7–13 May) and 22 per cent the following week. Then, in the third week (21–27 May) there was an obvious drop in nesting activity, followed by a week of resumed activity.

The dates of clutch initiation were determined accurately enough (within one or two days) to show there actually was reduction in the number of clutches initiated. For the four-day period of 21 through 24 May, only 4 nests were started by wild teal (one on 21 May and three on 23 May); even in the first four days of the nesting season 6 nests were initiated and the minimum for any other four-day period through 3 June was 10.

I think that the decreased nesting effort was a result of an environmental influence and that the two early peaks are not caused by different age groups nesting at different times. This conclusion is supported by the occurrence of only a single peak of early nesting activity in 1962 and by the fact that in 1963 the average date of clutch initiation by first-year females was only five days later than that of older females (C. W. Dane, The influence of age on the development and reproductive capability of the Blue-winged Teal [*Anas discors* Linnaeus]. Ph.D. thesis, Purdue Univ. 1965.) while the early nesting peaks in 1963 were two weeks apart. Low temperatures and excessive rain might have caused the delay in nesting; however, there was only a moderate rainfall on 20 and 21 May and none from 22 through 27 May. The most striking environmental changes were the low, daily mean temperatures on 18, 20, 21, and 22 May and extreme minimum temperatures on 21 and, particularly, 22 May (see Figure 2). No such cold period occurred in 1962.

Other studies have reported or implied that weather can cause an interruption of nesting or influence the rate of laying. Rogers (*op. cit.*: 38) suggested that a positive correlation between the number of Redhead (*Aythya americana*) nests initiated and daily temperatures was shown by Low's 1938 data (1945, figure 4), although Low commented only on the correlation between the beginning of nesting season and temperature. Hunt, *et al.* (1958: 19), reporting on hand-reared Mallards (*Anas platyrhynchos*) kept for egg production, noted a 20 to 25 per cent decrease in egg production "during periods of heavy and/or prolonged rainfall or when below freezing temperatures prevailed for the greater part of a 24-hour period" but stated that the birds "resumed a normal rate within a day or two" following these periods. Lack (1956: 330), in his discussion of the Common Swift (*Apus apus*), reported a delayed response to low temperature. He stated that "with sudden very cold weather, no new clutches are started 5 days later."

The mean daily temperature below 41° F from 18 to 22 May could have resulted in a delay or regression in ovarian development of those teal which had not reached the nest-building stage (which may begin three to four days before the start of egg laying), while those teal in the more advanced physiological stages (represented by nest building) continued their development and laid at the normal time. This reasoning would account for clutches being initiated until 20 May and few clutches being started from 21 through 24 May. However, the observed nesting chronology could also be explained by assuming that only the low minimum temperatures on 21 May and, especially, 22 May affected oviposition or ovarian development or both. This low might have resulted in delaying the laying of the first egg, and it may have taken 1 or 2 days for the hen to resume laying.

The extremely low temperature may also have affected laying by individuals who had already started their clutches. I had recorded the daily nesting activity of a captive female who had one egg in the nest on 21 May. She did not lay on 22 May but the next day resumed laying one egg a day. A wild female failed to lay one egg in the interval from 21 to 26 May but no other records of laying by wild birds are available for this period. Kuerzi (1941: 20) reported an interruption in egg laying by nine female Tree Swallows (*Iridoprocne bicolor*) during a prolonged cold period; eight of the nine failed to lay for three or more days.

Clutch size.—The average clutch size of teal which started laying before 4 June was 10.5 (based on 12 nests), 11.1 (32), and 11.0 (56) for the years 1961 through 1963, respectively. Corresponding averages for clutches begun after that date were 7.9 (13), 8.7 (19), and 8.4 (23). Sowls (1955: 132) reported an average of 10.6 eggs in clutches completed by 15 June and 8.8 eggs in those completed after that date.

A trend toward smaller clutches as the season progressed was observed in 1961, but because field work did not begin until after 8 June, early nests constituted a relatively small part of the sample, and the 1961 data were not used in subsequent calculations. In 1962 and again in 1963, it was apparent that early clutches ranged from 10 to 12 eggs and late clutches (those begun after 4 June) showed a decline as the season progressed. No apparent difference between the trends in the latter two years was noted, so the data were combined. The relationship between clutch size and date of clutch initiation for Blue-winged Teal is shown in Figure 4. A straight line regression plotted for the data from the beginning of the season through 4 June does not have a slope significantly different from zero. However, a t-test of the regression coefficient obtained from data between 4 and 30 June shows that the slope is significantly different from zero ($P < 0.01$).

The seasonal decline in clutch size was not the result of first-year birds beginning to nest late and laying smaller clutches. My study (Dane, *op. cit.*) on the influence of age showed that almost all first-year females,

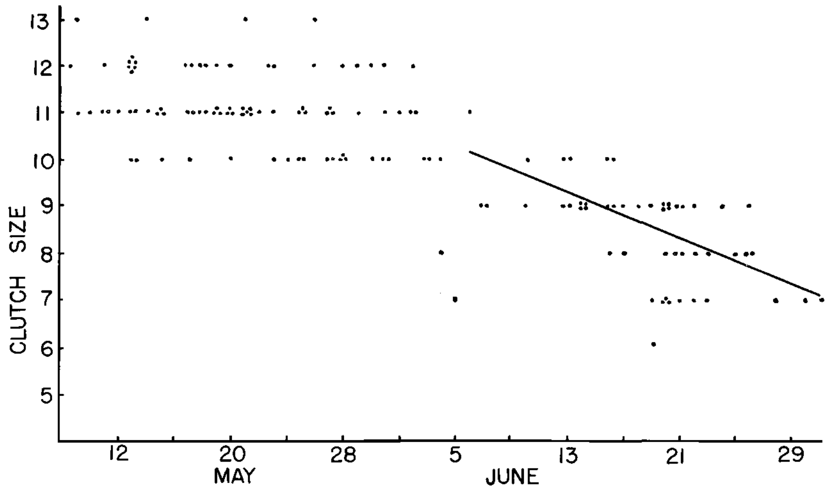

Figure 4. Relationship between clutch size and date of nest initiation in 1962 and 1963.

as well as those with previous breeding experience, initiated their first clutches before 4 June. However, my data are not sufficient to evaluate the possibility that first-year birds might renest significantly later and lay smaller clutches at that time. This could be one explanation for the late season decline, although Stotts and Davis (1960: 146) presented some data that suggest that the clutch sizes in renests of first-year and older Black Ducks (*Anas rubripes*) are similar.

Smaller clutches in waterfowl renestings have been reported for the Mallard, Pintail (*Anas acuta*), Gadwall (*Anas strepera*), Shoveler (*Spatula clypeata*), and Blue-winged Teal (Sowls, 1955: 130); for the Ring-necked Duck (*Aythya collaris*) (Mendall, 1958: 87, 121), and again for the Gadwall by Gates (1962: 58), who also noted progressively smaller clutches for third and fourth nests. Smaller clutches in nests initiated in the latter part of the season have been found in other waterfowl such as the Wood Duck (*Aix sponsa*) (Leopold, 1951: 212) and Cinnamon Teal (*Anas cyanoptera*) (H. E. Spencer, Jr., The Cinnamon Teal [*Anas cyanoptera* Vieillot]: its life history, ecology and management. M.S. thesis, Utah State Agricultural College [now Utah State University], 1953; p. 98). Spencer also said that very early clutches were reduced in size. Other studies, predominately of passerine birds, which reported smaller clutches in the latter part of breeding season have been reviewed by Davis (1955) and Lack (1954), and include a more recent study on British tits (Lack, 1958: 101).

Recent investigations of non-passerines which show a progressive decrease in clutch size through the entire season include those on the Gray Partridge (*Perdix perdix*) (Blank and Ash, 1960: 119), Black-legged Kittiwake (*Rissa tridactyla*) (Coulson and White, 1961: 209), Black Duck (Stotts and Davis, 1960: 145) and Velvet Scoter (*Melanitta fusca*) (Koskimies and Routamo, 1953: 68; Koskimies, 1957: 123). I think that Low (1945: 48), reporting on the Redhead, is the only other person studying ducks who has recorded a relatively constant clutch size during the first part of the season followed by a definite regression during the last half.

The immediate cause of reduced clutches in the latter part of the season is not thought to be exhaustion of the ovary. Gates (1962: 58) showed, by removing eggs from the nest of a Gadwall hen during the egg-laying stage, that this renesting duck had the capability to lay more eggs than would have been expected in a second clutch. The proximate controlling factor governing seasonal reduction of Blue-winged Teal clutch size may be temperature, as Stotts and Davis (1960: 145) suggest, or photoperiod. Several studies dealing with proximate factors influencing clutch size have been reviewed by Lack (1954), Davis (1955), and Gibb (1961).

Relative to ultimate factors controlling clutch size, Lack (1954) has summarized his view that clutch size, as determined by natural selection, is a result of a compromise between high reproduction and the success of adults in rearing their young. He says that the latter is dependent on food supply. Gibb (1961: 419), in agreeing with Lack on the importance of natural selection, reminds the reader that "selection must favor those individuals which produce the most offspring that survive to maturity." This may be more inclusive than just the ability of parents to feed their young and Lack (1954: 43) admits that application of his reasoning to "the case of ducks is much more puzzling, as the parents do not provide food for their young, or even help them to feed for themselves." However, he concludes from Leopold's (1951) study of the Wood Duck that the clutch size is not set by the number of eggs that the parent can incubate.

It is evident that each additional egg laid delays the time of hatching and subsequent development by one more day. This could affect the survival of the eggs or young by increasing nest predation, increasing mortality because young might have to travel further to reach water, and shortening the time for maturation before migration with the result that young would be forced to migrate in poorer condition.

Incubation period.—From information obtained in 1962, I suspected that the incubation period of the Blue-winged Teal was longer than sometimes reported. For 15 clutches placed in the incubator at 0 to 4 days

TABLE 1

INCUBATION PERIOD OF BLUE-WINGED TEAL CLUTCHES IN 1963[1]

Clutches brought into incubator			*Clutches incubated by wild females*	
Date of nest initiation	*Stage of incubation (days)*	*Incubation period (days)*	*Date of nest initiation*	*Incubation period (days)*
May 11	15	26	May 9	27
May 11	17	27	May 15	26
May 13	15	27		
May 20[2]	4	25	May 18[2]	25–26
May 20[2]	5	26		
May 23	6	24	May 27	24
May 23	7	24	June 21	23–24
May 23	3	26		
May 28	5	26		
June 6	6	23		
June 20	3	24		
June 20	6	24		
June 21	12	25		
June 21	12	24		
June 22	11	24		

[1] See text for details concerning determination of dates and incubation periods.

[2] Clutch started in the late May cold spell.

of development, the incubation period averaged 24.3 days. Because of the possibility of slight errors in estimating the stage of incubation this figure may not be completely accurate. The information reported hereafter includes only those clutches whose date of completion could be accurately calculated.

Three such clutches in 1962 were placed in the incubator when fresh and the incubation periods were 24.5, 24.5, and 25 days. These were slightly longer than the three incubation periods of 23, 23.5, and 24 days determined the same year from naturally hatched clutches. Table 1 lists the incubation times for 20 clutches in 1963. None of the clutches hatched in less than 23 days. The average incubation period for the 10 clutches started after the late May cold spell in 1963 and later placed in the incubator was 24.4 days, slightly longer than the 23 and 24 days required for the two clutches hatched in the wild. Two clutches which I observed with Jerome H. Stoudt in 1964 both required 23 days to hatch.

The Blue-winged Teal incubation period of 23 to 24 days, observed in this study, differs from that reported by several authors. Phillips (1923: 384) refers to Job (1915) when ascribing an incubation period of 21 to 23 days to the Blue-wing, and later Job (1923: 157) said, "careful incubation records of most species are hard to get, but Henry Cook has kindly supplied a good list from records of results on his place . . . all teals, 21 to 23 . . . ." However, methods of determination and individual records were not given. An incubation period of 21 to 23 days is also reported by Bent (1923: 115), Kortright (1943: 208), and Palmer (1949: 490). These works were compilations rather than original observations. Perhaps their figures were inferred from the incubation period of the Garganey (*Anas querquedula*), the European member of the blue-winged ducks. *The handbook of British birds* (Witherby *et al.*, 1943), a more reliable source for incubation periods, states that Garganeys incubate 21 to 23 days and Moody (1932: 52) lists 22 days. The former source (Witherby *et al.*, 1943: 253), however, reports an incubation length of 23 to 24 days for the Blue-winged Teal.

It is more difficult to reconcile the "average incubation period" of 21 days ("variation," 21 to 23 days) given by Hochbaum (1944: 90) with the 23 to 24 day period observed in this study. Both observations were made at Delta. Hochbaum's figures were compiled from the incubator records of Edward Ward and, although incubator procedures at Delta have undoubtedly changed since 1944, different incubator procedures should not result in an incubation period shorter than the shortest period in the wild. It is possible that the shorter observed periods resulted from eggs with one- or two-day embryos when placed in the incubator.

The previously mentioned late May cold spell apparently resulted in longer incubation periods for early nests in 1963 as reflected in Table 1, which shows incubation times for clutches laid before, during, and after the cold periods. The five nests initiated before the cold spell were not disturbed during this period, so there was no inattentiveness caused by humans. The hens of two of these nests, in which the eggs were allowed to hatch in the wild, were not trapped until four to six days after the cold spell, and it is my experience that trapping does not result in the females' remaining off the nest for an extended period.

This severe weather may have lengthened the incubation period in three ways. Of the five clutches initiated before the cold interval, three hens were still laying on 22 May and could have delayed a day before depositing their last eggs. This would have extended by one day the date on which the last egg was laid. If this occurred, my incubation figures for those clutches should be shortened by one day. The other two clutches initiated before 22 May would have been in the first day of incubation and the hens may have been inattentive, although low temperatures have been shown to lengthen attentive periods in passerine birds. Still, allowing a 1-day reduction in the calculated incubation periods for clutches initiated before the cold spell, the periods would have been 25, 25, 26, 26, and 26 days. These longer periods might be attributed to the chilling of the eggs, because similarly long periods of incubation were not observed in

1962 when temperatures were higher but presumably the drive to incubate was the same.

Kendeigh (1963: 460) demonstrated that "a definite sum total of heat above a temperature threshold is required for hatching a bird's egg." Fulfillment of this heat requirement after the last egg has been laid may require more than the normal amount of time if the start of incubation is delayed (Ryves, 1946: 49), if interruptions in incubation occur (Breckenridge, 1956: 19), and if eggs are exposed to lower temperatures (see reviews on the influence of temperature on hatching time by Kendeigh, 1940: 508; and Landauer, 1961: 15). The effect of season on the incubation period of several passerine birds has been reported and a few similar observations concerning waterfowl have been published. Mendall (1958: 90) in his monograph on the Ring-necked Duck noted that 11 early hatchings required about 27 days and 13 late hatchings, about 26 days. He stated that these observations may "involve seasonal differences in average air temperature" or "may substantiate somewhat the findings of Breckenridge" (i.e., longer incubation periods resulted from chilling of eggs during extended absences of the hen from the nest).

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SUMMARY

This study of Blue-winged Teal breeding biology was conducted at the Delta Waterfowl Research Station. The start of Blue-wing nesting appeared to be governed by air temperature, as pointed out by Sowls (1955). The first arrival of Teal was noted at Delta on 24 April in 1962 and 13 April in 1963 but the start of egg laying was about 9 May in both years. This was about four days after the last early May cold spell (daily mean temperature below 41° F or minimum temperature below 30° F). The nesting chronology curve of 1962 depicted a single peak of initial nesting activity but in 1963 two peaks were apparent in the period of initial nesting. The latter situation was the result of a reduction in nesting effort during the cold period of 21 to 24 May and the extreme low temperature on 22 May. One or both of these factors probably caused the birds to delay oviposition or effected a delay in ovarian development, or both.

The initial clutch of Blue-winged Teal ranged from 10 to 13 eggs. In

renests there was a trend toward progressively smaller clutches with advance of the season. A regression analysis of clutches begun after June 4 showed a significant downward linear trend. Although previous publications report an incubation period of 21 to 23 days for the Blue-winged Teal, this study established a 23 to 24 day normal incubation period for Blue-wings nesting in the wild at Delta, Manitoba. The incubation period for eggs placed in the incubator was 24.3 days. Apparently, the cold period of 21 to 24 May 1963 resulted in a slightly longer incubation period of 25 to 26 days.

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Department of Forestry and Conservation, Purdue University, Lafayette, Indiana. Present address: Northern Prairie Wildlife Research Center, Bureau of Sport Fisheries and Wildlife, Jamestown, North Dakota.