BREEDING CHRONOLOGY OF LOUISIANA MOTTLED DUCKS AS INDICATED BY GONADS[a]

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Abstract: The breeding chronology of the mottled duck (*Anas fulvigula maculosa*) was investigated during a 2-year study in southwest Louisiana. Gonadal measurements were recorded from 37 hunter-killed and 158 collected mottled ducks. A correlation analysis revealed that the ratios of combined testis length to body weight and oviduct width to body weight most accurately revealed reproductive status for males and females, respectively. A quadratic model produced the most significant regression of reproductive status on time for both sexes in 1978 and 1979. Mottled ducks remained sexually quiescent until early January when gonadal recrudescence began. Peak breeding condition for females occurred during mid to late April, about 2 weeks after the peak condition of males.

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The mottled duck is the only species of waterfowl that regularly breeds in the marshlands of coastal Louisiana in large numbers (Smith 1961). Mottled ducks are considered a "trophy" species by many hunters (Smith 1961) and during the 1978 hunting season composed an estimated 2.4% of the 2-million bird state harvest (U.S. Fish and Wildlife Service 1979).

Management of any game species requires detailed life history information. Without life equation data, biologists can only guess as to the appropriate annual harvest and over-exploitation or underutilization of the resource may result. Baseline information on the nesting chronology of the mottled duck is not available. The wariness of the bird, low nesting densities, and the vastness of the coastal marshes have all contributed to the lack of mottled duck life history research. Therefore, 1 objective of a 2-year study on the mottled duck in Louisiana was to determine breeding chronology by gonadal examination of hunter-killed and collected ducks. Similar documentation of the reproductive cycle of the mallard (*Anas platyrhynchos*) has been provided by Hohn (1947) and Johnson (1961).

Weeks (1969) conducted a preliminary study on the breeding behavior of the mottled duck and found that 90% of the birds were paired by February; however, his sample sizes were too small to warrant valid conclusions regarding the gonadal cycle. A detailed study of the ecology of the mottled duck in coastal Texas is presently being conducted by C.D. Stutzenbaker, Waterfowl Program Leader for the Texas Parks and Wildlife Department (C.D. Stutzenbaker, personal communication, January 1978).

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METHODS

Study Area

Mottled ducks were collected weekly from January to June, 1978-79 on Rockefeller Wildlife Refuge and adjoining privately-owned fresh marshes. Located in Cameron and Vermilion Parishes, Rockefeller Wildlife Refuge consists of 34,400 ha bounded on the south by the Gulf of Mexico and on the north by the Grand Chenier ridge complex. The refuge lies in the chenier plain zone of the Louisiana gulf coast (O'Neil 1949) and consists primarily of brackish and intermediate marsh types (Chabreck 1972) with numerous impoundments. To supplement collection data, hunter-killed mottled ducks were examined during November and December of the 1978-79 waterfowl hunting season at 2 hunting clubs located in Cameron Parish: Little Pecan Club and Oak Grove Club.

Measurements

All mottled ducks collected were weighted to the nearest 0.1 g and their reproductive tracts removed and trimmed of nongonadal material. Gonads were weighed to the nearest 0.01 g and measured to the nearest 0.01 mm with a vernier caliper. Measurements recorded from male testes were individual testis weight, length, width, and breadth. Data recorded from female tracts were ovary weight, diameter of the largest follicle, number of ruptured follicular sacs, and oviduct weight, length, width, and convolution status.

Because of time constraints, less detailed data were obtained from hunter-killed mottled ducks. Each hunter-killed duck examined was aged by the bursa of Fabricius and classified as either reproductively active or inactive according to the size and condition of the reproductive tract. When the hunters permitted, reproductive tracts were removed and measured as described for collected ducks.

Analyses

Relationships between time and reproductive status were examined by correlation and regression. A correlation analysis was used to evaluate the degree of association between gonadal measurements and body weight. Reproductive status indicator variables most highly related to time were selected from the correlation matrix for placement in regression models. Since the response of breeding status over time was not expected to be linear, quadratic and cubic functions were also fitted. To model state of reproduction within a cycle more precisely, regressions were performed by year. Since mottled ducks pair for breeding in their first year (Weeks 1969), age differences were not considered in the analyses. The model providing the most significant fit was selected to characterize breeding chronology. Partial sums of squares for each independent variable in the model selected were evaluated to ascertain the influence of individual parameters.

RESULTS AND DISCUSSION

Hunter-Killed Ducks

The reproductive tracts of 37 hunter-killed mottled ducks were examined at the 2 hunting clubs. The ovaries of the 14 females (5 adults) examined were uniform in size and sexually quiescent. Four ovary weights (2 from adults) ranged from 0.22 g to 0.35 g and only 1 ovary (adult) showed initial signs of follicular enlargement. Oviducts of adult females appeared larger and more convoluted than did oviducts of juvenile birds; however this was not true for females collected during late winter and spring when sexual recrudescence occurred.

The testes of 3 males examined during the November sample exhibited preliminary signs of sexual recrudescence; the testes of 2 males were starting to enlarge while the testes of a third male showed increased vascularization. The remaining 17 males examined in the November sample were sexually quiescent. The testes of a paired male (Field No. 35 HKD) examined on 29 December were enlarged (weight = 1.2 g) and exhibited prominent vascularization. Combined testes weight of another male collected in December was 0.40 g compared to 0.10 and 0.17 g for weights of testes of November-collected ducks. Our data indicated that most mottled ducks were sexually quiescent during November and early December, with preliminary gonadal recrudescence starting during late December.

Collections

Reproductive data were recorded on 93 male and 65 female mottled ducks collected from January through June, 1978-79. Reproductive tracts partially damaged by pellets were included in data analyses.

Males.-A correlation analysis indicated that 8 of the testes measurements recorded were linearly related to changes in time ($P<0.01$); however, of the combined (sum of both testes) measurements, testis length was most highly related to time ($r = 0.63$; $P<0.01$). Since combined testis length was negatively related to body weight ($r = -0.49$; $P<0.01$), the ratio of combined testis length to body weight was employed as the reproductive status indicator for each male (dependent variable).

The quadratic model yielded the most significant regression of reproductive status on time or both years (Table 1). The models formulated (Table 1) explained 73% of the variation in reproductive status by year. Overall, male reproductive activity was linearly related to time in January and February, after which activity was constantly high until June (Fig. 1).

TABLE 1. The regression of combined testis length to body weight on time for mottled ducks collected in southwest Louisiana, January - June, 1978-79.

YEAR	SOURCE	DF	SUM OF SQUARES	F
1978	Total	46	0.022957	
	Regression	2	0.016695	58.65[A]
	Days	(1)	0.009104[B]	83.38[A]
	Days x Days	(1)	0.007591[B]	53.33[A]
	Error	44	0.006262	
Ratio[C] = -0.001961 + 0.001617 Days - 0.000007 Days^2				
1979	Total	37	0.013555	
	Regression	2	0.009910	47.57[A]
	Days	(1)	0.006737[B]	48.05[A]
	Days X Days	(1)	0.003173[B]	30.46[A]
	Error	35	0.003645	
Ratio[C] = 0.023244 + 0.001971 Days - 0.000008 Days^2				

[A]$P<0.01$.
[B]Partial Sum of Squares.
[C]Ratio = Combined testis length/body weight.

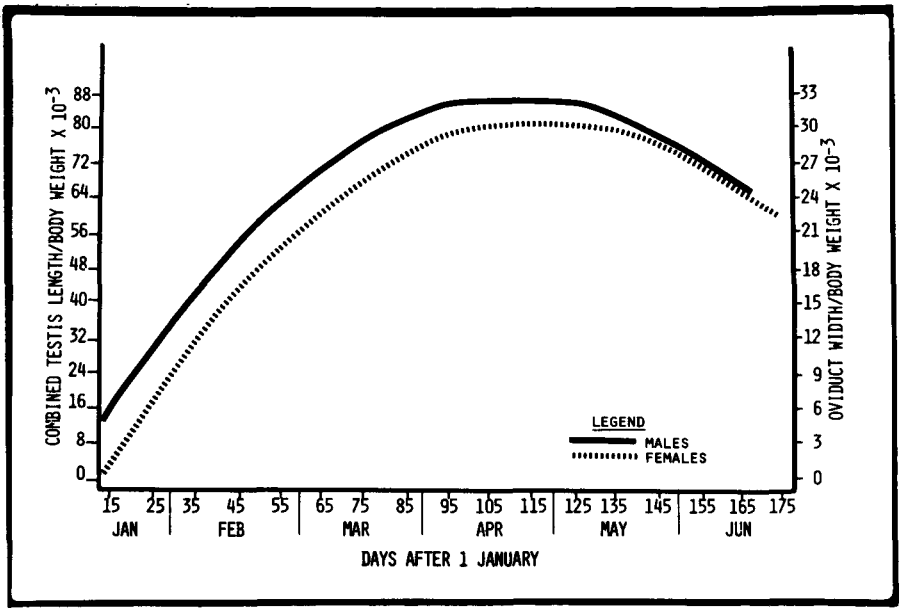

Fig. 1. Gonadal recrudescence of mottled ducks collected January-June, 1978 and 1979, Cameron Parish, Louisiana.

Females.-Of the reproductive variables measured, only oviduct-related measurements were linearly associated with time ($P<0.05$). Ovary weight and oviduct width were highly correlated ($r = 0.81$). A similar relationship was reported by Hohn (1947) and Johnson (1961) for mallards. However, in our study oviduct width was the parameter most highly correlated with days since 1 January ($r = 0.40$; $P<0.01$). Even though oviduct width was not linearly related to body weight, regression analyses indicated that a dependent variable which accounted for body weight provided the best fit. Therefore, the ratio of oviduct width to body weight was formulated as the breeding status variable for each female (dependent variable).

As with males, the quadratic model produced the most significant regression of reproductive status on time for both years (Table 2). Regression models explained 53% of the breeding status variation in 1978 but only 36% in 1979 (Table 2). The difference in model adequacy between years may partially be due to the slight decline in sample size for 1979.

Because of their solitary behavior, nesting females with mature ovaries may have been less likely to be collected than nonnesting, reproductively immature females. Our April-June collections included 6 reproductively inactive females (ovary weights 0.20 - 0.92 g). We have no data to indicate whether nonnesting females were actually collected out of proportion to their abundance. However, our delineation of breeding chronology, and specifically the period of high sustained reproductive activity, should not have been affected since the 6 reproductively inactive females appeared randomly collected within the April-June period.

Weeks (1969) concluded that mottled ducks neared physiological breeding readiness during February. Our data indicated that peak breeding condition occurred somewhat later and was attained differentially between sexes. Peak reproductive activity for females was reached about 2 weeks later (around 23 April) than for males (Fig. 1), after which

TABLE 2. The regression of oviduct width to body weight on time for mottled ducks collected in southwest Louisiana, January - June, 1978-79.

YEAR	SOURCE	DF	SUM OF SQUARES	F
1978	Total	33	0.005727	
	Regression	2	0.003050	17.66[A]
	Days	(1)	0.002101[B]	19.43[A]
	Days X Days	(1)	0.000949[B]	10.99[A]
	Error	31	0.002677	
Ratio[C] = -0.006079 + 0.000596 Days - 0.000002 Days^2				
1979	Total	30	0.004093	
	Regression	2	0.001479	7.92[A]
	Days	(1)	0.000576[B]	12.74[A]
	Days X Days	(1)	0.000903[B]	9.67[A]
	Error	28	0.002615	
Ratio[C] = -0.016187 + 0.000900 Days - 0.00004 Days^2				

[A]$P<0.01$.
[B]Partial sum of squares.
[C]Ratio = Oviduct width/body weight.

activity remained high until mid-June. Sufficient data were not collected to delineate gonadal regression. Although the quadratic model produced the most significant regression of reproductive status on time for all year-sex classes, the cubic model for males approached significance both years. This preliminary decline in reproductive condition (Fig. 1) may denote initial testis regression. In the mallard, testis regression is a lengthly process that begins during the post-nuptial molt and apparently is directly related to subsidence of territorial behavior (Johnson 1961).

Data collected by Hayden (1972) and Brady (1974) are helpful in defining gonadal regression. The gonads of 9 adult males and 4 adult females were examined from ducks collected in August-September, 1972 and 1973. Combined testis weights ranged from 0.10 g to 0.50 g ($\bar{x}$ = 0.23 g) and ovary weights ranged from 0.10 g to 0.20 g ($\bar{x}$ = 0.15 g). Apparently, gonadal regression began in mid-June and was completed by September.

When combined with data on brood mortality, information on breeding chronology will enhance the sound management of mottled duck populations. These data will allow more efficient establishment of hunting seasons, bag limits, and marsh management practices.

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