AGING RIO GRANDE WILD TURKEY POULTS, *MELEAGRIS GALLOPAVO INTERMEDIA* (SENNETT), BY PRIMARY FEATHER LENGTH AND GENERAL BODY CHARACTERISTICS

By

Robert Douglas McGuire

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1964

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 1970

AGING RIO GRANDE WILD TURKEY POULTS,

MELEAGRIS GALLOPAVO INTERMEDIA

(SENNETT), BY PRIMARY FEATHER

LENGTH AND GENERAL BODY

CHARACTERISTICS

Thesis Approved:

John A. Morrison
Thesis Adviser

Dale W. Goetz

J. C. Gilbreath

D. Durham
Dean of the Graduate College

ACKNOWLEDGEMENTS

I wish to express my appreciation to the following members of my committee: Dr. John C. Gilbreath and Dr. Rudolph J. Miller for their interest and review of the thesis, and Dr. John A. Morrison, Unit Leader of the Oklahoma Cooperative Wildlife Research Unit at Oklahoma State University, for reviewing the thesis and serving as my major adviser. I would like to thank Dr. Robert Morrison and Mr. Byron Brandt, Oklahoma State University, for their assistance in the statistical analysis of the data. I wish to thank George B. Wint, Superintendent of the Darlington Game Bird Farm, Oklahoma Department of Wildlife Conservation, El Reno, Oklahoma, for making that facility available to me. Special thanks go to Mr. James C. Lewis who supervised and assisted in collecting data for this and other studies I have undertaken on the Rio Grande wild turkey. I am deeply grateful for the technical advice and assistance in collecting data from Mr. Hugh Brown, Hatcheryman, Darlington Game Bird Farm. I wish to express my appreciation to the Oklahoma Cooperative Wildlife Research Unit for financial assistance.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

The wild turkey, Meleagris gallopavo, is an important game bird nationwide. It inhabits 42 states and is hunted in over one-half of them. In 1965 over 94,000 were killed throughout the nation from an estimated population of over 753,000 (Aldrich, 1967). In 1968 an estimated 3,044 turkeys were killed in Oklahoma from an estimated state population of 16 to 17 thousand birds (Charles Gilliam, Upland Game Supervisor, Oklahoma Department of Wildlife Conservation, viva voce).

There are six subspecies of wild turkey: Mexican, M. g. gallopavo (Linnaeus), Eastern, M. g. silvestris (Vieillot), Gould's M. g. mexicana (Gould), Rio Grande, M. g. intermedia (Sennett), Florida, M. g. osceola (Scott), and Merriam's, M. g. merriami (Nelson) (Aldrich, 1967). The only subspecies located in Oklahoma is the Rio Grande. The range of this subspecies extends from northern Vera Cruz and southern San Luis Potosí to Nuevo Leon, Tamaulipas and portions of Coahuila in Mexico, through Texas to northeastern New Mexico, western Oklahoma and southern Kansas. By 1963 releases of

1,911 Rio Grande wild turkeys had been made in 12 states outside the established range. These releases, designed to increase the range, were unsuccessful east of the Mississippi River (Glazener, 1967). Other releases are too recent to determine whether or not they will become established.

To understand the population dynamics of a species, which is necessary for proper management, a wildlife manager must determine its various age classes. He must have an accurate method for determining the age of any member if the entire population is to be classified reliably. The members of a population encounter different problems in adapting to the environment at different ages. We can identify the crucial problems of each age class only by identifying confidently the members of each class.

Most techniques for determining the age of wild turkeys are limited to distinguishing adults from juveniles. Differences in the depth of the bursa of Fabricius, weight of eye lens, leg color, tarsal scale smoothness, and plumage characteristics distinguish between adults and young-of-the-year.

Primary feather molting patterns in young-of-the-year are used to distinguish age classes among several of the gallinaceous birds (Petrides, 1942 and 1945; Wright and Haitt, 1943). This method has been modified for bobwhite quail, Colinus virginianus (Linnaeus), (Petrides and Nestler,

1943; Thompson and Kabat, 1950); blue grouse, Dendragapus obscurus (Say), (Boag, 1965; Smith and Buss, 1963; Bendell, 1955); rock ptarmigan, Lagopus mutus (Montin), (Weeden and Watson, 1967); willow ptarmigan, L. lagopus alleni (Linnaeus), (Westerskov, 1956; Bergerud et al. 1963); California quail, Lophortyx californica californica (Shaw), (Raitt, 1961); and ring-necked pheasants, Phasianus colchicus torquatus (Gmelin), (Woehler, 1953; Wagner et al. 1965).

Knoder (1959) modified this technique for aging Eastern wild turkey poults in which the mean lengths of the molting primary feathers are used (Figure 1). This technique is used to age poults between the ages of 7 through 190 days. Knoder's method is accurate to ± 3 or 4 days. The estimated age of autumn-shot poults is used to determine hatching dates within 10-day periods.

The objective of this study was to develop an aging technique for Rio Grance wild turkey poults, based on the mean length of primary feathers, that would enable biologists to determine peaks of nesting and hatching. My measurements of mean primary feather lengths were compared to Knoder's (1959) measurements for the Eastern wild turkey to determine if there was a statistically significant difference between the two subspecies. I also wished to learn if there were sex differences in primary feather lengths for the Rio Grande subspecies as is found in the Eastern wild turkey.

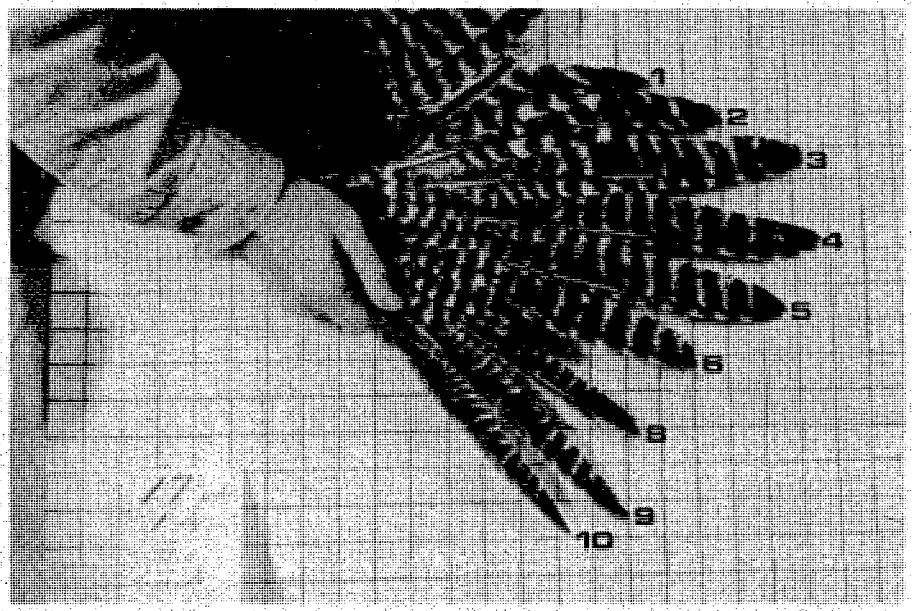

Figure 1. System of Numbering and Sequence of Molting of Primary Wing Feathers

CHAPTER II

MATERIALS AND METHODS

The parent stock, 6 males and 14 females, for the study were trapped in western Oklahoma by personnel of the Oklahoma Department of Wildlife Conservation. Seven adult females were trapped in Roger Mills County on March 25, 1968. Four adult females, three immature females, and six adult males were trapped in Woodward County on February 28, 1969.

All members of the parent stock were transported to Darlington Game Bird Farm in El Reno, Oklahoma, on the same day they were trapped. They were released in an enclosure measuring 76.5 x 45 x 5 ft. Fresh water was always available. They were fed Purina F & M except during the mating season when they were fed Purina Layeena (Table 1).

Eggs were collected daily and placed in a cooler at 55 F and 55 percent relative humidity. Eggs were set at weekly intervals if they were available (Table II). Incubator temperature was held at 99 3/4 F throughout the incubation period. The relative humidity was 64 percent for the first 25 days of incubation and 84 percent for the last three days. Hatching success was 45.5 percent.

TABLE I

NUTRIENT CONTENT OF FEEDS GIVEN TO POULTS

Feed Nutrients	Percentages		
	F & M	Starteena	Layeena
Sulfaquinoxaline	0.0175	0.0175	
Crude protein not less than	19.0000	30.0000	20.00000
Crude fat not less than	2.0000	2.5000	2.50000
Crude fiber not more than	12.0000	6.5000	7.00000
Calcium (Ca) not less than			2.30000
Calcium (Ca) not more than			3.30000
Phosphorus (P) not less than			0.80000
Iodine (I) not less than			0.00008
Salt (NaCl) not less than			0.40000
Salt (NaCl) not more than			0.90000
Added minerals not more than		4.5000	8.00000
Grain	66.9825	56.4825	54.79992
	100.0000	100.0000	100.00000

TABLE II

EGG SETTING AND HATCHING RECORD OF BROOD STOCK

Eggs Set		Number of Eggs			Date	
Number	Date	Infertile	Died	Hatched	Hatched	Remarks
5	5/16/68	0	0	5	6/13/68	
18	5/23/68	1	1	16	6/20/68	
9	5/30/68	1	5	3	6/27/68	
3	6/06/68	0	0	3	7/04/68	1 crippled at birth--sacrificed
						1 died 7/10/68
						1 died 7/11/68
12	6/20/68	3	5	4	7/18/68	
2	7/04/68	2	0	0		
10	7/11/68	10	0	0		
7	7/26/68	7	0	0		
66		24	11	31		

The poults were kept in Oakes Brood Batteries, Model B4 (Oakes Manufacturing Company, Incorporated, Tipton, Indiana). The temperature was kept at 95 F for the first week of the poults' lives and then lowered 5 F per week until room temperature was reached. The relative humidity was high but not regulated. Purina Starteena was fed to poults up to 8 weeks of age when their diet was changed to Purina F & M (Table I). Use of commercial feeds might result in some growth differences between game farm and wild poults.

At 8 weeks of age the poults were placed in outdoor enclosures measuring 20 x 10 x 6.5 ft. The roofs and lower halves of the sides of the enclosures were lined with 3-ft-wide strips of burlap to prevent injury and feather damage from contact with the pen wire. Poults were weighed on a Hanson Dietetic Scale, Model 1460, with 2-gram graduations, until they exceeded 1,000 grams in weight. After this period they were weighed in pounds and ounces on a Hanson Cook-O-Meter, Model 1310, having 10-pounds capacity. These weights were later converted to grams.

The feather measuring equipment employed in this study is a modification of a device designed and constructed by George B. Wint and Hugh Brown, Darlington Game Bird Farm, El Reno, Oklahoma (Figures 2 and 3). It provides ample space for taking various body and plumage measurements and for recording observations, and reduces the number of personnel

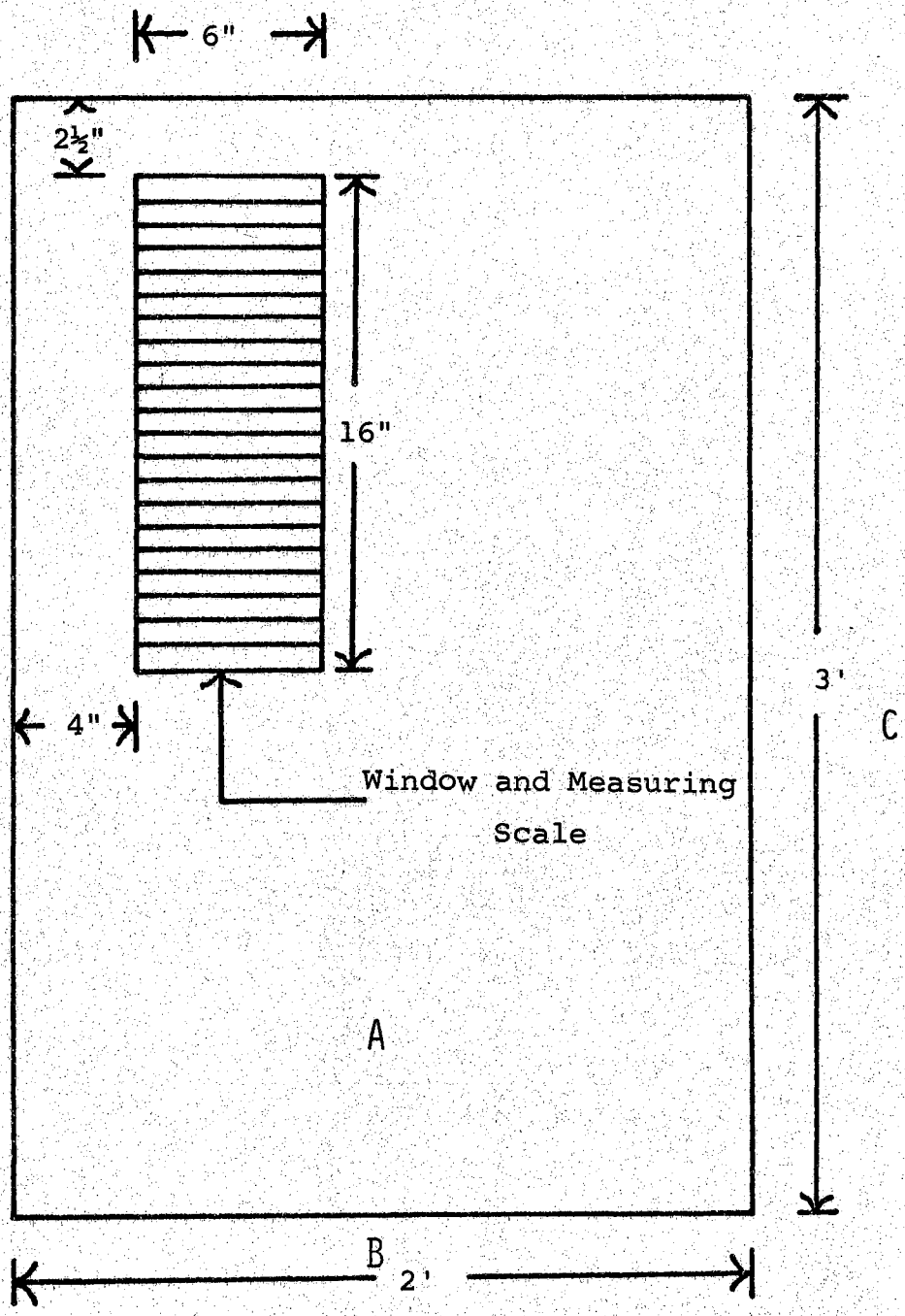

Figure 2. Top View of Primary Feather Measuring Device

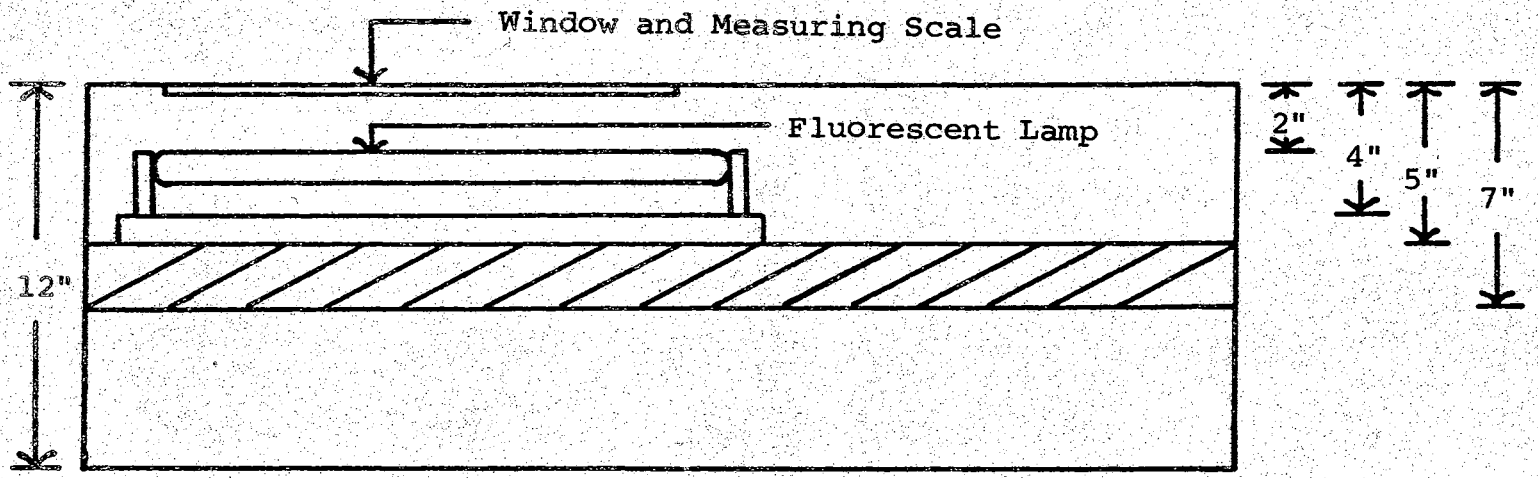

Figure 3. Side View of Primary Feather Measuring Device

involved in the operation. The device is light-weight, easily constructed, and inexpensive, being constructed of ¼-inch plywood with dimensions of 3 x 2 x 1 ft. A 350-mm scale is placed under a glass window, flush with the surface, in one corner of the upper surface. An 18-inch fluorescent lamp is mounted inside to illuminate the recessed scale, and by transmitting light through the primary feathers it aids in locating the point of emergence for each primary. The total cost is $10 to $12.

The poult is placed on its back, perpendicular to the long dimension of the window, at point A (Figure 2) on the end opposite the scale. The first observer, standing at point B at the end where the poult is placed, can hold the poult down with his forearms and stomach and take measurements. The second observer stands at the right side of the first observer at point C to hold the poult's legs and record measurements.

Weekly observations on the weight, primary feather length of the left wing, and general plumage change of each poult were commenced 27 June 1968 and concluded 10 January 1969. However, linear regression, the method of analysis used in this study, does not require regular measuring periods. Observations were recorded for poults from 7 through 197 days of age. Primary feathers were measured from the point of emergence from the skin to the feather tip. The

corresponding primary on the right wing was measured if the left one was broken.

Photographs of a randomly selected poult in a natural standing position in front of a one-inch grid background were taken weekly. Older poults were anesthetized with ether before being photographed. Photographs were also taken of the dorsal and ventral sides of the wing which was least damaged.

Other aging studies based on primary feather measurements indicated that a random sample of 50 to 100 poults was desirable. However, due to the effect of capturing the brood stock late in the trapping season, infertility among the brood stock, poult mortality, and feather damage, the sample size per week was small (Table III). Each poult was measured each week which eliminated the possibility of random sampling.

Tables of mean primary feather lengths were calculated. An IBM 360 Computer was used to calculate a linear regression of age on primary feather length.

Mr. Hugh Brown measured primary feather lengths of five male and five female Rio Grande turkey poults at the Darlington Game Bird Farm between 10 June and 16 December 1965. These poults were hatched, maintained, and measured under conditions similar to the treatment given to poults that I observed in 1968. Mr. Brown's data were made available to me to use in testing the analytical accuracy of the mean

TABLE III

SAMPLE SIZE OF KNOWN-AGE PENNED RIO GRANDE WILD TURKEY POULTS

Age (Days)	Sample size			Age (Days)	Sample size		
	Males	Females	Total		Males	Females	Total
7	3	9	12	113	4	9	13
14	4	9	13	116		4	4
21	4	13	17	120	4	9	13
28	4	13	17	123		4	4
35	4	13	17	127	4	9	13
42	4	9	13	130		4	4
45		4	4	134	4	9	13
49	4	9	13	137		4	4
52		4	4	141	4	9	13
56	4	9	13	144		4	4
59		4	4	148	4	9	13
63	4	9	13	151		4	4
67		4	4	155	4	9	13
70	4	9	13	158		4	4
74		4	4	162	4	9	13
77	4	9	13	165		2	2
81		4	4	169	4	9	13
84	4	9	13	172		2	2
88		4	4	176	4	9	13
92	4	9	13	179		2	2
95		4	4	183	4	9	13
99	4	9	13	186		2	2
102		4	4	190	4	9	13
106	4	9	13	197	3	9	12
109		4	4				

primary feather length and the linear regression model developed from my measurements. I randomly selected primary feather measurements from Mr. Brown's data without referring to the known age of the donor poult, estimated the age of the donor according to the table and the model, then checked the accuracy of my estimates by referring to the donor poult's known age.

CHAPTER III

RESULTS AND DISCUSSION

Mean Primary Feather Length Table

The Eastern wild turkey is the only subspecies for which the mean primary feather length Table has been developed (Knoder, 1959). The mean lengths of each of the post-juvenal primaries 1 through 7 are used to estimate the ages of poults between 35 and 165 days. Post-juvenal primary 8, used to age poults between 130 through 190 days, is the only criterion available for determining the hatching date of some juvenile turkeys shot during the late fall hunting season.

Knoder and others found that females molted primaries 7 and 8 significantly earlier than did males. They found a significant difference existing between sexes in the final length of post-juvenile primaries 1 through 7 provided a technique for distinguishing sex in wings mailed in by cooperating hunters. Leopold (1943) and Mosby and Handley (1943) stated that males retain junenal primaries 9 and 10 during the first winter, thereby providing a method for identifying yearling males killed during the spring hunting

season. Williams (1961) reported that only the 10th juvenal primary was retained in Florida wild turkeys. The validity of using Eastern poult primary feather measurements as criteria for estimating the ages of Rio Grande poults was tested by comparing mean primary feather lengths in my known-age Rio Grande birds with the primary lengths of known-age Eastern poults listed in Knoder's (1959: Tables 4 - 8) mean primary feather length Table. My measurements included 132 instances of feathers being measured at ages identical to ages measured by Knoder (underlined in Tables IV and V). These coincidental measurements were grouped as to sex and to molt (juvenal and post-juvenal) and compared between subspecies by Student's t-test. The measurements differ significantly ($P < 0.10$) in 60.6 percent of the comparisons (Table VI), indicating that the table of mean primary feather lengths for Eastern wild turkey poults (Knoder, 1959) cannot be used to estimate the age of Rio Grande wild turkey poults. This emphasizes the need for biologists to be cautious in applying to one subspecies techniques developed for closely related subspecies.

General Plumage Characteristics and Body Growth

General changes in plumage and body size also aid in aging Eastern wild turkey poults. At hatching the entire body is covered with down. Their only juvenal feathers are

TABLE IV

MEAN LENGTHS OF JUVENAL PRIMARY FEATHERS ACCORDING TO KNOWN-AGE AND SEX IN PENNED RIO GRANDE TURKEY POULTS

Age (Days)	Mean Length (mm) of Primary Feather Number																			
	1		2		3		4		5		6		7		8		9		10	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
7	53	53	58	56	59	56	59	55	56	55	52	50	46	43	7	5				
14	70	69	79	79	83	82	82	83	80	82	74	76	67	68	31	32				
21		66	85	73	104	92	110	99	110	102	108	97	102	91	90	72	32	28		
28		71	113	98	132	114	134	119	135	118	132	116	120	110	95	82	49	64	23	20
35				104		121		126		126		126	147	123	121	110	66	54	20	22
42					125										143	135	99	91	47	42
49															165	158	124	122	76	75
56															182	173	147	140	100	96
63															198	180	165	158	120	116
70															211	185	185	178	142	135
77																	204	193	160	154
84																	211	203	178	170
92																	231	207	194	180
99																	235	206	203	185
106																	235	208	206	186
113																	230	209	209	187
120																	236	204	210	187
127																	236	204	207	188
134																	235	205	208	188
141																	234		210	189

TABLE IV (continued)

Age (Days)	Mean Length (mm) of Primary Feather Number																	
	1		2		3		4		5		6		7		8		9		10	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
148																	234		210	187
155																	235		211	190
162																	233		211	191
169																	238		210	188
176																	240		212	189
183																			210	187
190																			213	188
197																			212	186

M - male
F - female

Underlined values are mean primary feather lengths compared to mean lengths of Eastern Poults of the same age (Table VI).

TABLE V

MEAN LENGTHS OF POST-JUVENAL PRIMARY FEATHERS ACCORDING TO KNOWN-AGE AND SEX IN PENNED RIO GRANDE TURKEY POULTS

Age (Days)	Mean Length (mm) of Primary Feather Number															
	1		2		3		4		5		6		7		8	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
21	28	31														
28	45	17														
35	67	59														
42	122	115	28	36												
49	161	155	86	93		14										
56	188	174	134	133	36	60										
63	209	190	174	170	92	103		30								
70	224	197	209	200	145	144	55	75		16						
77	234	107	244	224	109	188	109	121	35	66						
84	236	201	268	238	231	222	168	172	100	104		32				
92	237	192	279	242	262	237	212	207	154	152	37	82				
99	228	201	287	249	282	242	247	236	196	192	92	104		25		
106	238	197	287	244	259	250	276	259	235	224	141	149	9	68		
113	237	193		251		260	301	272	266	252	183	189	58	100		
120	238	194		251		262	321	271	294	271	225	221	112	146		
127	239	193		252		264	332	297	316	281	258	247	158	185		42
134	241	194					336	294	339	291	286	267	200	218	47	78
141	240	191					339		342	293	309	278	235	242	99	123
148	240	192					338		345	294	327	287	264	264	139	160

TABLE V (continued)

Mean Length (mm) of Primary Feather Number

Age (Days)	1		2		3		4		5		6		7		8	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
155	241	194							294		339	290	291	276	175	194
162		192							297		349	292	311	283	217	221
169		193							298			294	325	288	242	240
176		194											334		270	260
183		194													293	268
190		195													312	271
197		193														272

M - male
F - female

Underlined values are mean primary feather lengths compared to mean lengths of Eastern poults of the same age (Table VI).

TABLE VI

DIFFERENCE IN MEAN PRIMARY FEATHER LENGTH BETWEEN RIO GRANDE AND EASTERN TURKEY POULTS (STUDENT'S T-TEST)

		Total Number of Comparisons*	Significance at 0.10 Level	Non-Significant at 0.10 Level
Female	Juvenal	18	14	4
	Post-juvenal	50	28	22
Male	Juvenal	19	6	13
	Post-juvenal	46	33	13
		133	81	52

*Underlined values in Tables 4 and 5

the first 7 primaries which project slightly from their sheath by the end of the first day after hatching (Leopold, 1943; Nixon, 1962). One-day-old poults are 4 to 5 inches tall, but by the end of the third week they are 8 to 9 inches tall (Nixon, 1962). During the fourth and fifth weeks the secondaries become large enough to cover the primaries and mask them from view. Adult rectrices are noticeable at five weeks. By the end of the fifth week down remains on the head and neck regions (Nixon, 1962). The rectrice molt is completed after the principal post-juvenal molt, involving primaries 1 through 8, which begins at about 12 weeks and is completed by the 20th week (Mosby and Handley, 1943).

General plumage and body size changes were described to classify the Rio Grande wild turkey poults into general age classes (Table VII and Figures 4 - 13). Weights of known age poults are listed in Table VIII. These characteristics can be used to estimate the age of a Rio Grande poult for which the length of the most recently emerged primary feather cannot be determined.

Linear Regression Model

Correlation coefficients (Table IX), for data with the sexes combined, were computed for each combination of the two response variables for measurements of weight, age, and length of the most recently emerged primary feather. The

TABLE VII

PROMINENT CRITERIA FOR FIELD AGING JUVENILE RIO GRANDE TURKEY POULTS FROM 1 THROUGH 197 DAYS OF AGE

Age (Days)	Aging Criteria
Hatch	First seven primaries in sheath; primaries out of sheath by 24 hours; approximately 4 inches tall; Figures 4, 5, and 6.
2-7	Seven juvenal primaries; entire body covered with down; rectrices not apparent.
8-14	Eight juvenal primary present; approximately 5 inches tall; rectrices first appear; primaries extend past tail; head, neck, upper back, and breast still in down; Figure 7.
15-28	Ninth juvenal primary present; approximately 7 inches tall; down on head, neck, breast and thighs; Figure 8.
29-42	Tenth juvenal primary and first and second post-juvenal primary present; down only on head and neck; four pairs of adult rectrices about two inches long; approximately 11 inches tall; wing coverts replacing down; contour feathers replacing down on breast and back; Figure 9.
43-63	Post-juvenal primary 3 present; seven pairs of adult rectrices present; sparse down on upper neck and head; approximately 13 inches tall; Figure 10.
64-70	Post-juvenal primary 4 present; approximately 14 inches tall; Figure 11.
71-85	Post-juvenal primary 5 present; 8 pairs of rectrices present; approximately 16 inches tall; Figure 12.
86-99	Post-juvenal primary 6 present; approximately 19 inches tall; Figure 13.
100-106	Post-juvenal primary 7 present; 9 pairs of adult rectrices; males show dark-tipped breast feathers; females are buff tipped;
107-127	Post-juvenal primary 8 present.

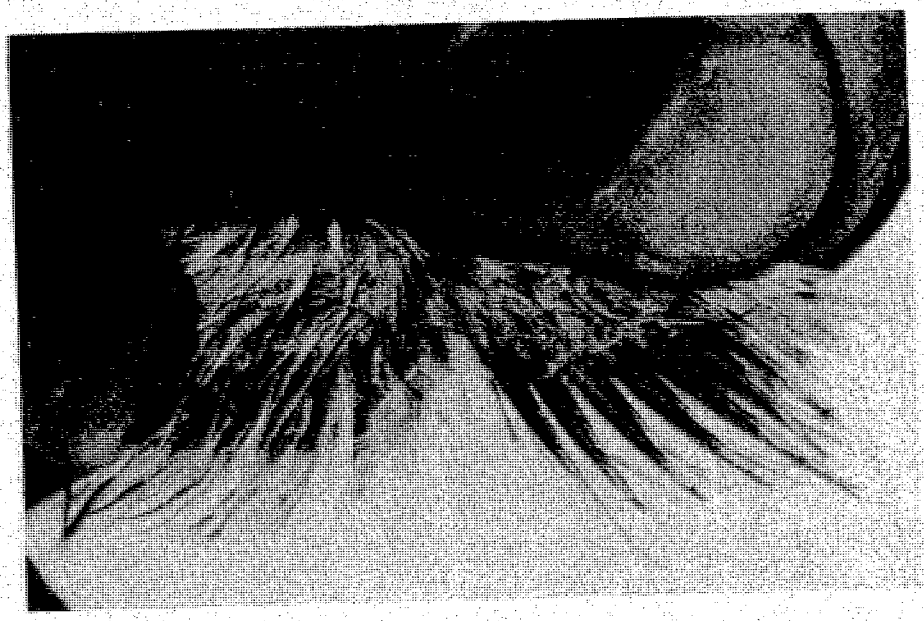

Figure 4. First Seven Primary Feathers Emerging from the Sheath on Newly Hatched Rio Grande Poult

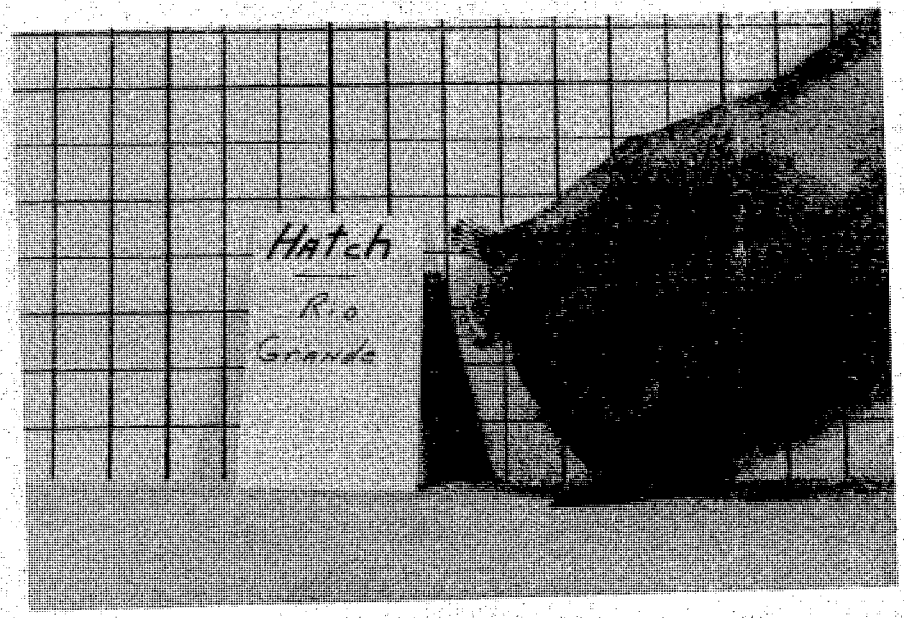

Figure 5. First Seven Primary Feathers out of Sheath on 24-hr. old Poult

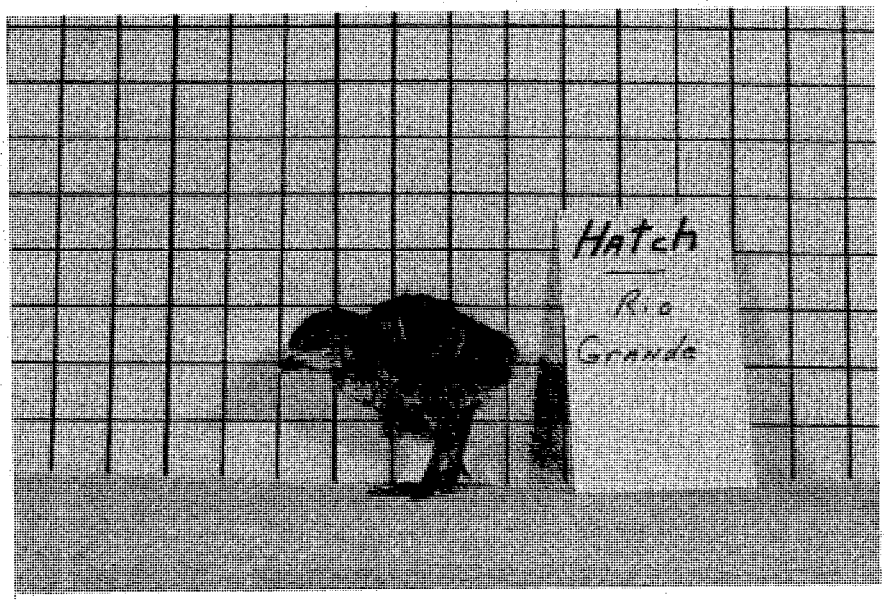

Figure 6. Newly Hatched Rio Grande Poult

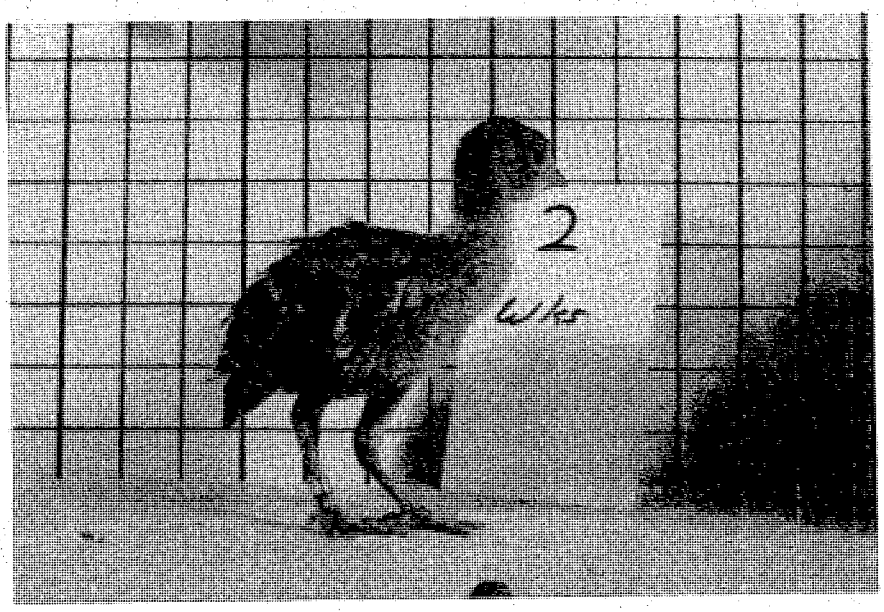

Figure 7. Rio Grande Poult, 14 days old

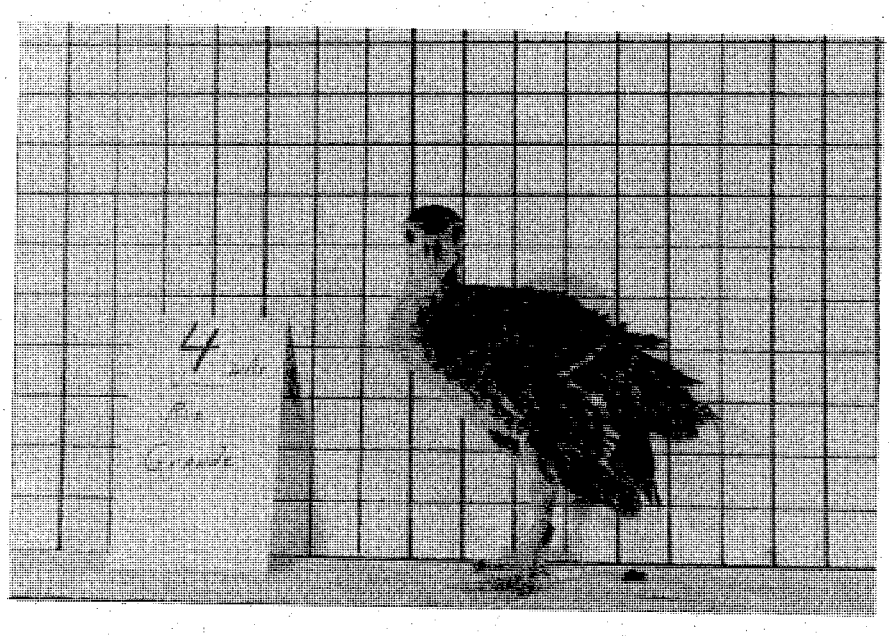

Figure 8. Rio Grande Poult, 28 days old

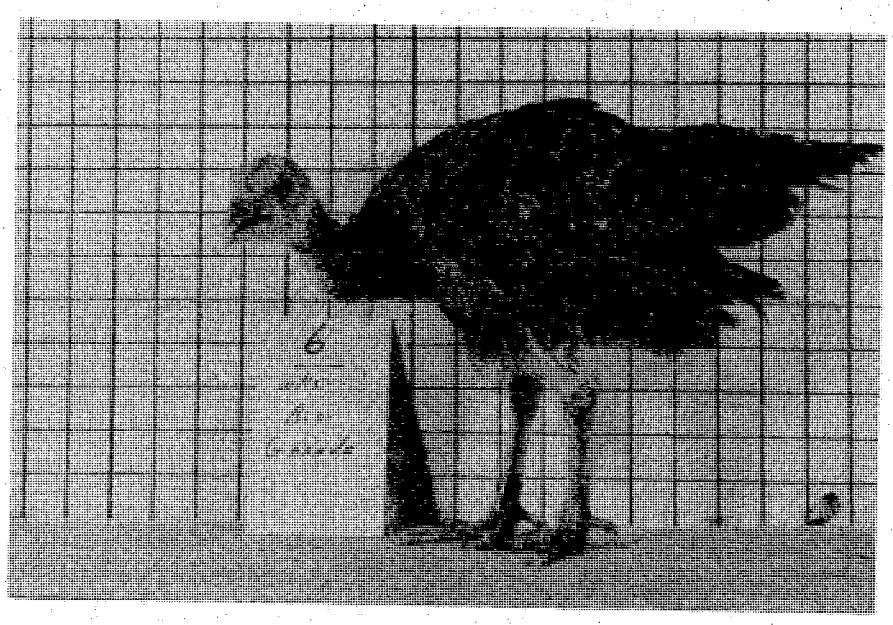

Figure 9. Rio Grande Poult, 42 days old

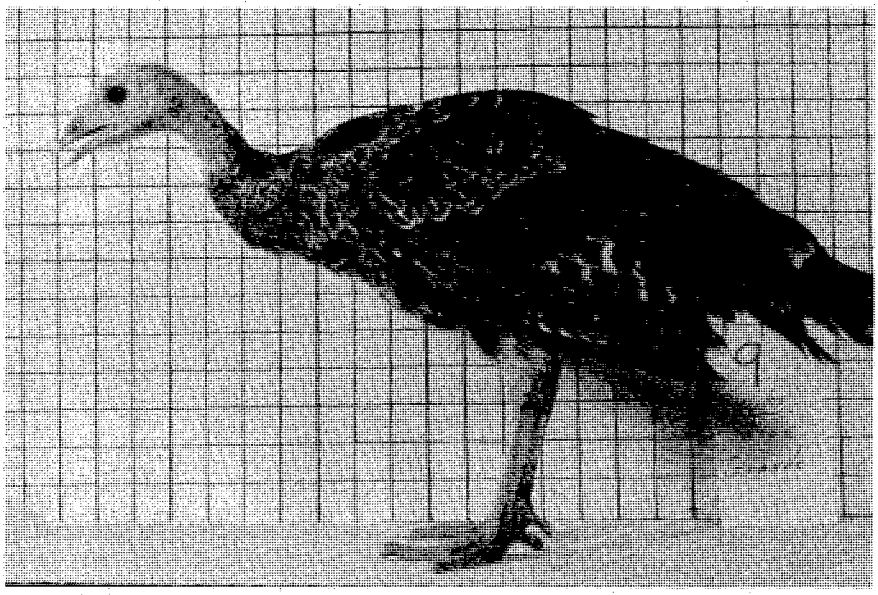

Figure 10. Rio Grande Poult, 63 days old

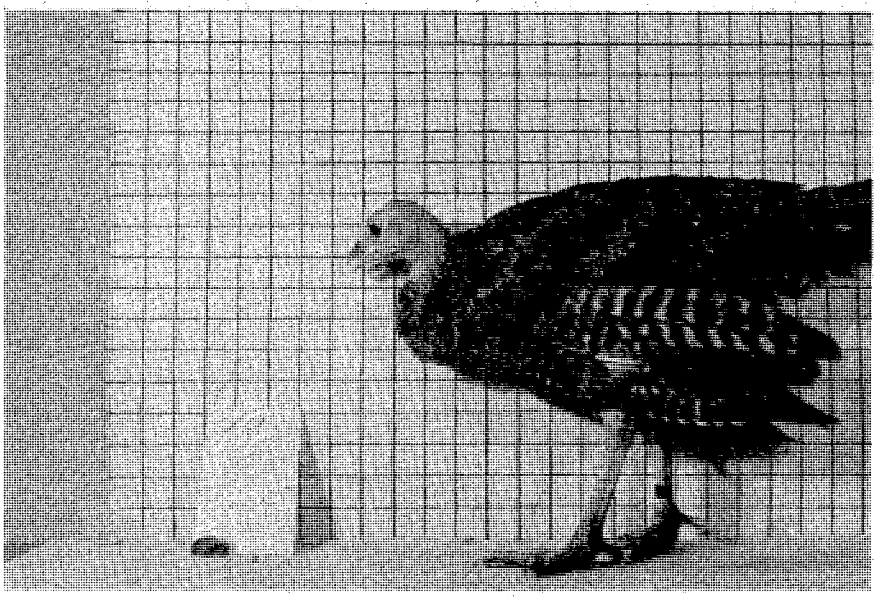

Figure 11. Rio Grande Poult, 70 days old

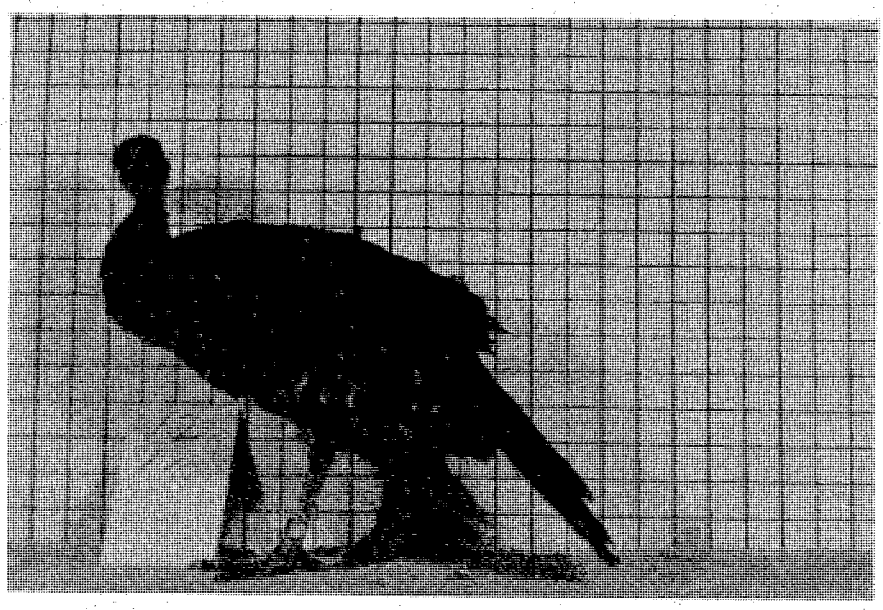

Figure 12. Rio Grande Poult, 85 days old

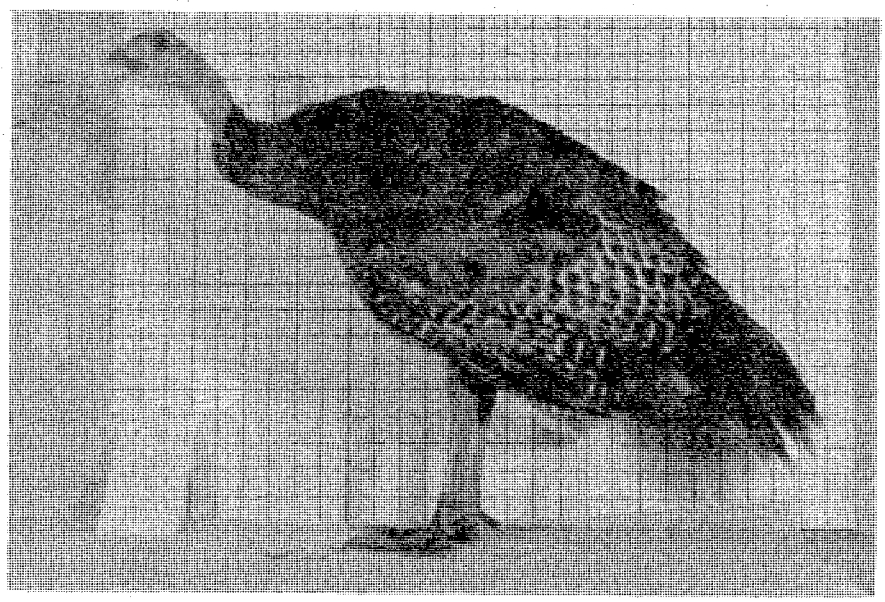

Figure 13. Rio Grande Poult, 99 days old

TABLE VIII

MEAN WEIGHTS (Gm.) OF PENNED RIO GRANDE POULTS ACCORDING TO KNOWN-AGE AND SEX

Age (Days)	Males	Females
7	70.10	66.60
14	137.30	110.14
21	245.75	183.82
28	368.25	271.73
35	475.50	355.82
42	587.50	475.00
49	674,50	526.63
56	782.00	622.75
63	1049.00	827.13
70	1261.75	971.50
77	1474.00	1098.38
84	1665.50	1240.38
92	1892.50	1375.00
99	2006.00	1527.50
106	2225.25	1584.13
113	2501.75	1793.00
120	2742.75	1885.25
127	2955.50	2020.00
134	3146.75	2144.00
141	3444.50	2285.63
148	3678.25	2441.63
155	3805.75	2448.75
162	3820.00	2537.38
169	3876.75	2537.13
176	3940.75	2636.63
183	3891.00	2703.88
190	3926.50	2753.50
197	3855.67	2739.38

TABLE IX

CORRELATION COEFFICIENTS BETWEEN AGE, WEIGHT, AND MOST RECENTLY EMERGED PRIMARY FEATHER LENGTH FOR RIO GRANDE POULTS, SEXES COMBINED

Most Recently Emerged Feather	Correlation Coefficients			Sample Size
	Age to Body Weight	Age to Feather Length	Body Weight to Feather Length	
8	0.7477	0.6665	0.8356	27
9	0.9814	0.6904	0.5430	5
1	0.5366	0.6520	0.5695	40
2	0.1570	0.4954	0.2258	26
3	0.2833	0.3860	0.4768	27
4	0.1819	0.5920	0.2601	21
5	0.6251	0.5563	0.2495	31
6	0.1130	0.3437	0.4230	31
7	0.3960	0.6696	0.2550	49
8	0.2573	0.6989	0.3480	152

highest correlations were between age and the length of the most recently emerged feather. All correlations were positive, but in most cases low. Low correlations were possibly due to the short period of time that a particular feather was the one most recently emerged and because of the small sample size for that period resulting from the small number of poults available for this study.

The higher correlations between poult age and the length of the most recently emerged feather in the known-age poults studied here indicated that linear regression of age on feather length would be a feasible method for estimating ages of unknown-age poults.

The most recently emerged feather was selected as the most useful feather for measurement because it shows the greatest amount of growth over a brief period of time. Measurements for juvenal primaries 1 - 7 were not analyzed because they are present at hatching, and any poult having them as the most recently emerged feathers was probably 1 week old or younger. In the sequence of primary feather emergence after hatching, primary 8 emerges first in the juvenal plumage and primary 9 follows. After post-juvenal molt commences, primary 1 is replaced first followed by 2 through 8 in that order.

Three linear regression models were tested with the measurements of both sexes combined. Poults cannot be aged

externally before they are approximately 16 weeks old, therefore a model which is applicable to both sexes is the most useful.

A. $\hat{Y} = \hat{B}_o + \hat{B}_1 X_1$

B. $\hat{Y} = \hat{B}_o + \hat{B}_1 X_1 + \hat{B}_2 X_2$

C. $\hat{Y} = \hat{B}_o + \hat{B}_1 X_1 + \hat{B}_2 X_2 + \hat{B}_3 X_3$

$\hat{Y}$ = estimated age in days

$\hat{B}_o$ = estimated age when X values are zero

$\hat{B}_i$ = slope of regression line (i = highest subscript)

X_i = primary feather length (mm) (i = 1 through 3)

The X value of the highest subscript (i.e., X_3 in Model C) is the measured length of the most recently emerged primary feather. The X value of the next highest subscript represents the length of the next most recently emerged feather, etc. Model A involves only the most recently emerged feather; Model B the two most recently emerged feathers; Model C the three most recently emerged feathers.

An F-test was used to determine which model contained a $\hat{B}_i$ value differing significantly from zero the greatest number of times at the 0.10 level. Results of these tests indicate that Model A, using only the most recently emerged feather, gives a significant difference a greater number of times (Table X), so it was chosen to analyze the data with the sexes treated both together and separately.

TABLE X

COMPARISON OF F-TABULATED AND F-CALCULATED $\hat{B}_i$ VALUES, IN THE THREE REGRESSION MODELS TESTED, SEXES COMBINED

Most Recently Emerged Feather	$F_{tab.10}$			F_{cal}		
	Model A	Model B	Model C	Model A	Model B	Model C
8	2.92	2.93	2.94	3.93*	21.74	1.96
9	5.54	8.53	39.86	2.73	3.94	5.04
1	2.85	2.85	2.86	28.10*	5.50*	1.10
2	2.93	2.94	2.95	1.17	3.02	12.58
3	2.92	1.04	2.94	0.87	2.93	0.16
4	2.99	3.01	3.03	10.25*	0.86	0.55
5	2.89	2.89	2.90	0.43	9.62*	0.02
6	2.89	2.89	2.89	3.89*	0.99	0.99
7	2.82	2.84	2.83	38.19*	0.27	13.56*
8	2.71	2.71	2.71	143.21*	41.74*	24.86*

*difference significant at 0.10 level

The second and third most recently emerged feathers made insignificant additions to the age estimate possibly because of the small amount of growth over the brief period of time they were measured.

When sexes were treated separately, another F-test was necessary to determine if $\hat{B}_1$ in Model A alone was significantly different from zero (Table XI). Results show 66 percent of the $\hat{B}_1$ values for males were significantly different ($P < 0.10$) and 70 percent of the $\hat{B}_1$ values for females. This indicates that these $\hat{B}_1$ values are valid for use in estimating age.

Student's t-test was then used to determine if the $\hat{B}_1$ value for a given most recently emerged feather for females was equal to the $\hat{B}_1$ value of the same most recently emerged feather for males (Table XII). Results show that in 66 percent of the comparisons there was a significant difference ($P < 0.10$) in the $\hat{B}_1$ value between males and females. This significant difference indicates that greater accuracy for estimating age can be accomplished if the sex of the poult can be determined and the $\hat{B}_o$ and $\hat{B}_1$ values (Table XIII) corresponding to the proper sex and most recently emerged feather are used.

The linear regression model can be used in the following manner:

TABLE XI

F-TABULATED AND F-CALCULATED $\hat{B}_1$ VALUES OF MODEL A, MALES SEPARATE FROM FEMALES

Newest Feather Number	$F_{tab.10}$		F_{cal}	
	Males	Females	Males	Females
8	4.54	2.99	5.67*	16.67*
9		5.54		2.73
1	3.46	2.89	2.47	26.83*
2	4.54	3.01	2.44	5.31*
3	3.78	3.03	8.24*	1.21
4	8.53	3.07	0.57	7,89*
5	4.54	2.94	11.86*	7.83*
6	3.28	3.03	33.69*	0.05
7	3.28	2.86	217.29*	22.74*
8	2.84	2.76	129.29*	66.25*

* significant at the .10 level

TABLE XII

TESTS OF EQUALITY BETWEEN $\hat{B}_1$ VALUES OF EACH SEX FOR EACH MOST RECENTLY EMERGED PRIMARY FEATHER, MODEL A

Most Recently Emerged Feather	$t_{tab.10}$	t_{cal}
8	1.714	32.832*
1	1.689	4.973*
2	1.717	- 1.476
3	1.714	2.211*
4	1.740	1.131
5	1.703	0.338
6	1.703	8.219*
7	1.680	1.836*
8	1.645	3.181*

* Significant at 0.10 level

TABLE XIII

$\hat{B}_o$ AND $\hat{B}_1$ VALUES FOR MODEL A, SEXES COMBINED AND SEXES SEPARATED

Most Recently Emerged Feather	Sexes Combined		Sexes Separated			
			Males		Females	
	$\hat{B}_o$	$\hat{B}_1$	$\hat{B}_o$	$\hat{B}_1$	$\hat{B}_o$	$\hat{B}_1$
8	6.82	0.3160	7.72	0.1728	6.58	0.3513
9	35.54	-1.2917			34.54	-1.2917
1	22.85	0.1810	23.18	0.1066	23.04	0.1981
2	42.51	0.0941	41.45	0.0732	43.03	0.0949
3	53.46	0.0895	51.30	0.1328	54.46	0.0667
4	64.28	0.1540	63.71	0.1004	64.80	0.1530
5	73.36	0.1430	71.18	0.1485	74.33	0.1324
6	89.83	0.0588	83.97	0.1484	92.72	0.0095
7	104.12	0.1070	105.46	0.1281	103.38	0.1056
8	133.40	0.1560	129.63	0.1783	134.93	0.1449

1. measure the most recently emerged feather in millimeters to get the X_1 value,
2. if possible, determine the sex of the poult,
3. turn to Table XIII and locate the $\hat{B}_o$ and $\hat{B}_1$ values for the most recently emerged feather that corresponds to the one measured,
4. multiply $\hat{B}_1$ times X_1 and add this product to $\hat{B}_o$ to determine the estimated age in days. An example in which the most recently emerged primary feather is postjuvenal 6:

$$\text{sex} = \text{unknown}$$
$$\hat{B}_o = 89.83$$
$$\hat{B}_1 = 0.0588$$
$$X_1 = 100 \text{ mm}$$
$$\hat{Y} = \hat{B}_o + \hat{B}_1 X_1$$
$$= 89.83 + (0.0588)(100)$$
$$= 95.71 \text{ days}$$

A quicker age estimate is obtained using Figures 14-21. Using the same information on sex and length of the most recently emerged feather as above, turn to Figure 15. On the horizontal scale locate the primary feather length corresponding to the one measured. Locate the point on line 6 just above the measured primary feather length. Locate on the vertical scale the point just opposite the point on line 6. The age estimate is 96 days.

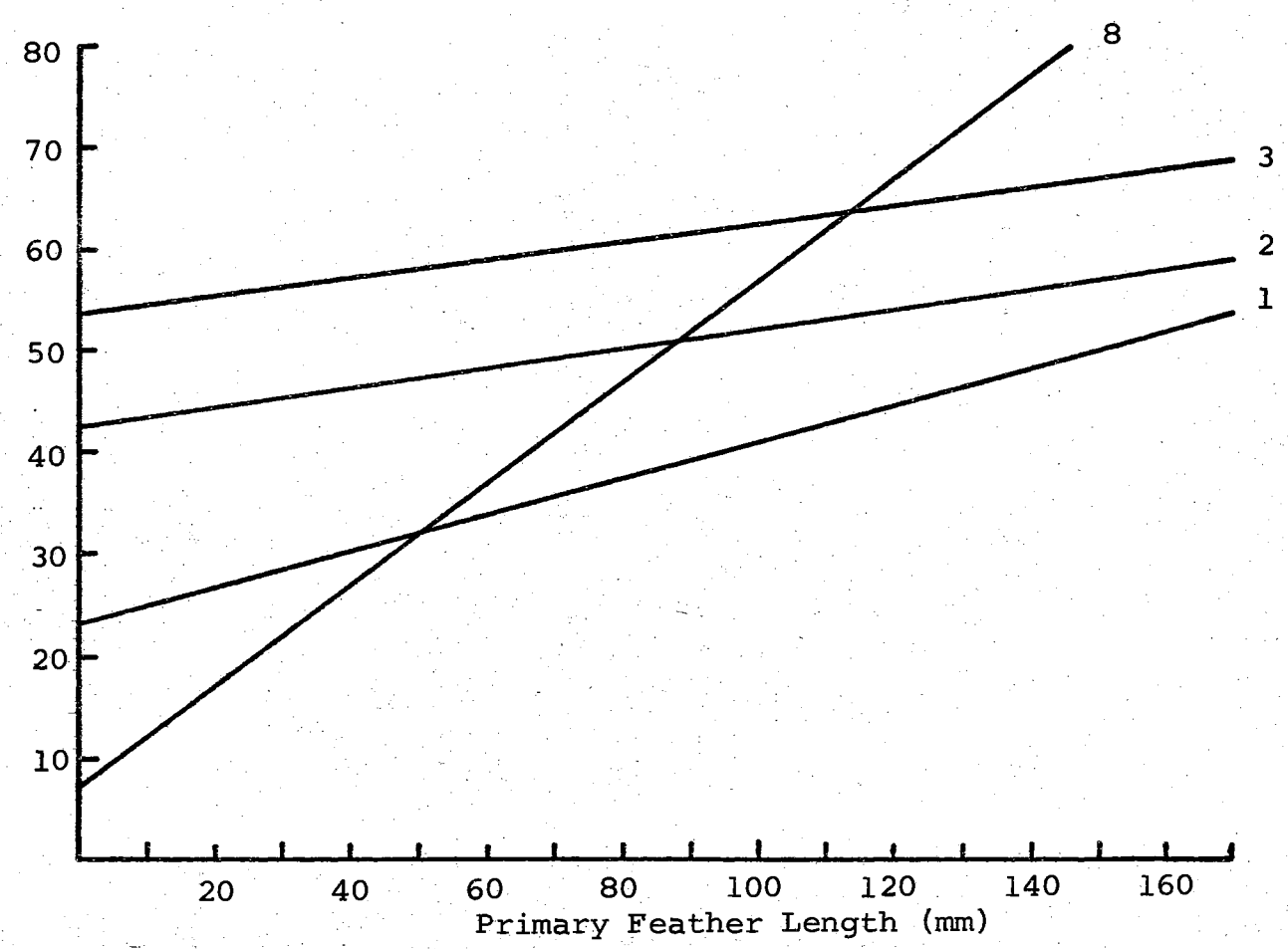

Figure 14. Regression Line for Growth of Juvenal Primary 8 and Post-juvenal Primaries 1 through 3, Sexes Combined.

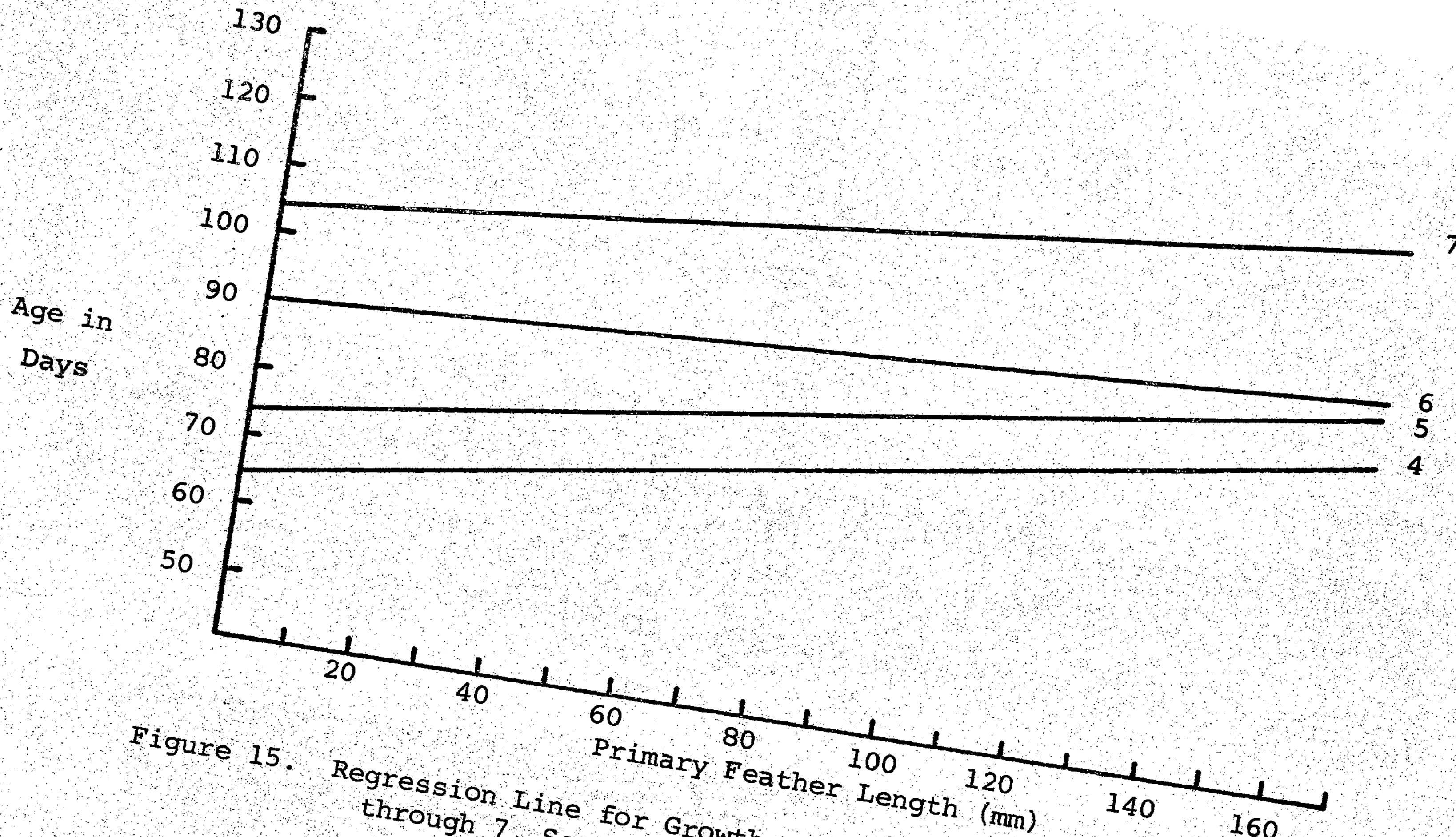

Figure 15. Regression Line for Growth of Post-juvenal Primaries 4 through 7, Sexes Combined

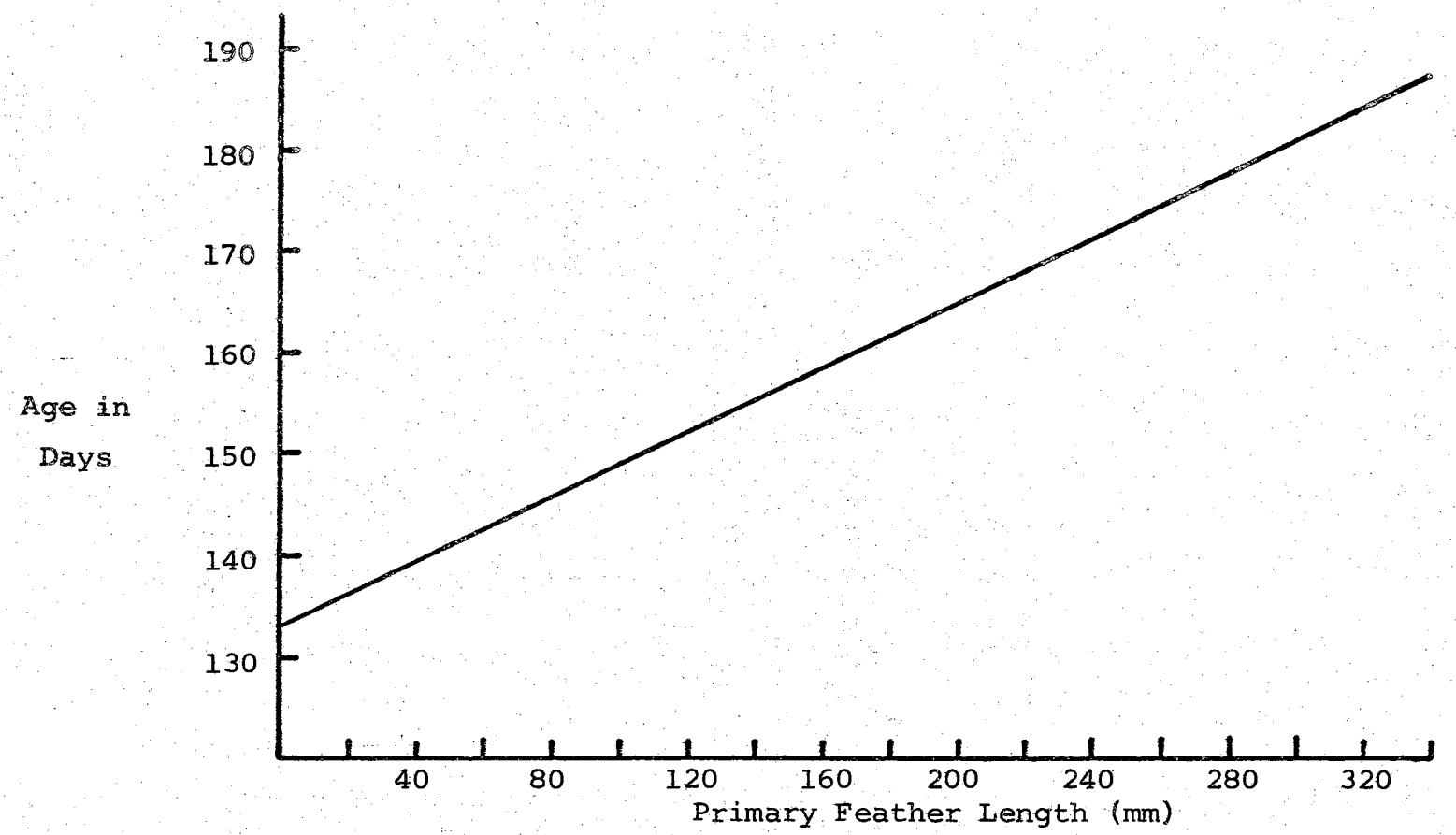

Figure 16. Regression Line for Growth of Post-juvenal Primary 8, Sexes Combined

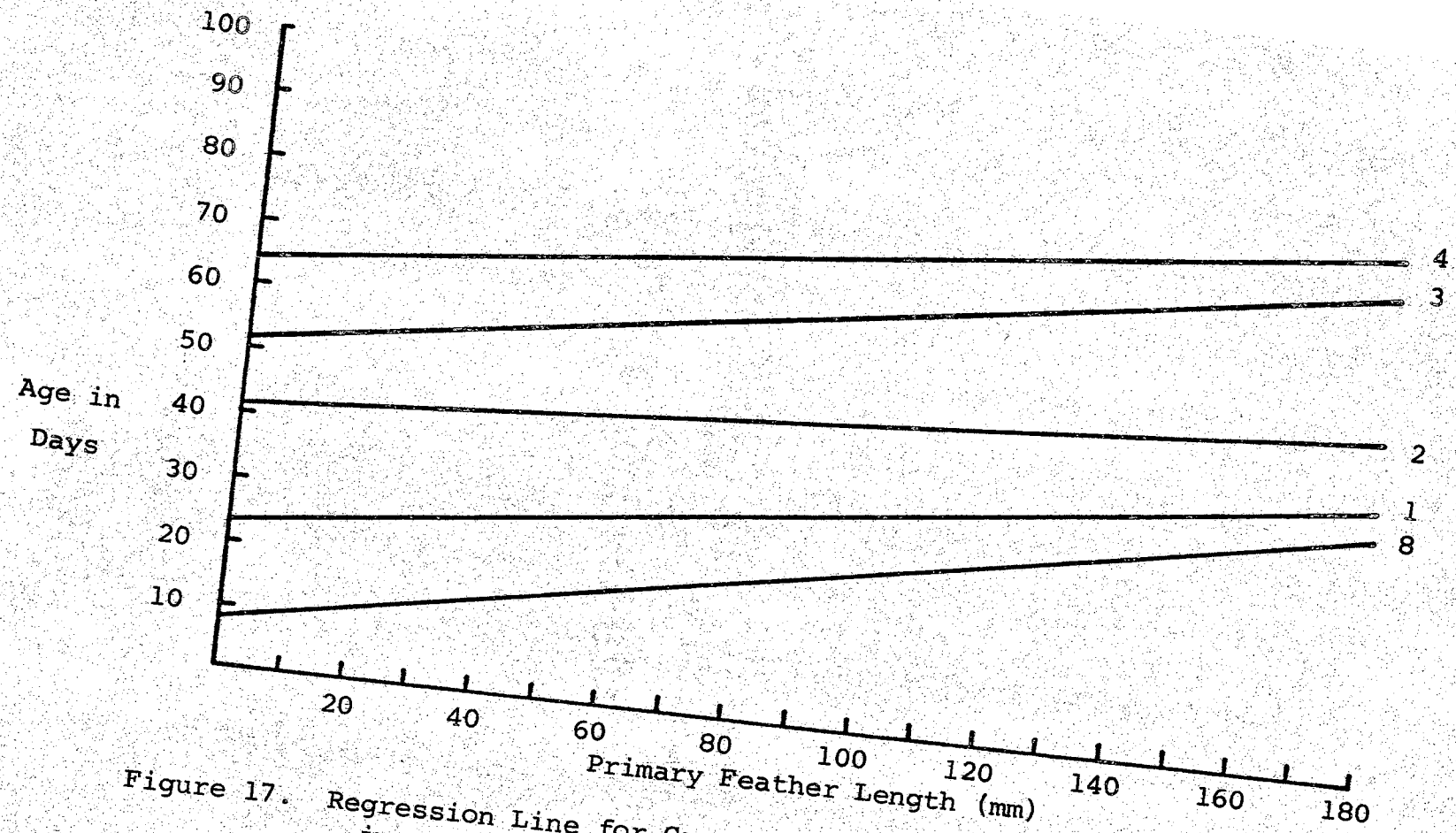

Figure 17. Regression Line for Growth of Juvenal Primary 8 and Post-juvenal Primaries 1 through 4, Males only

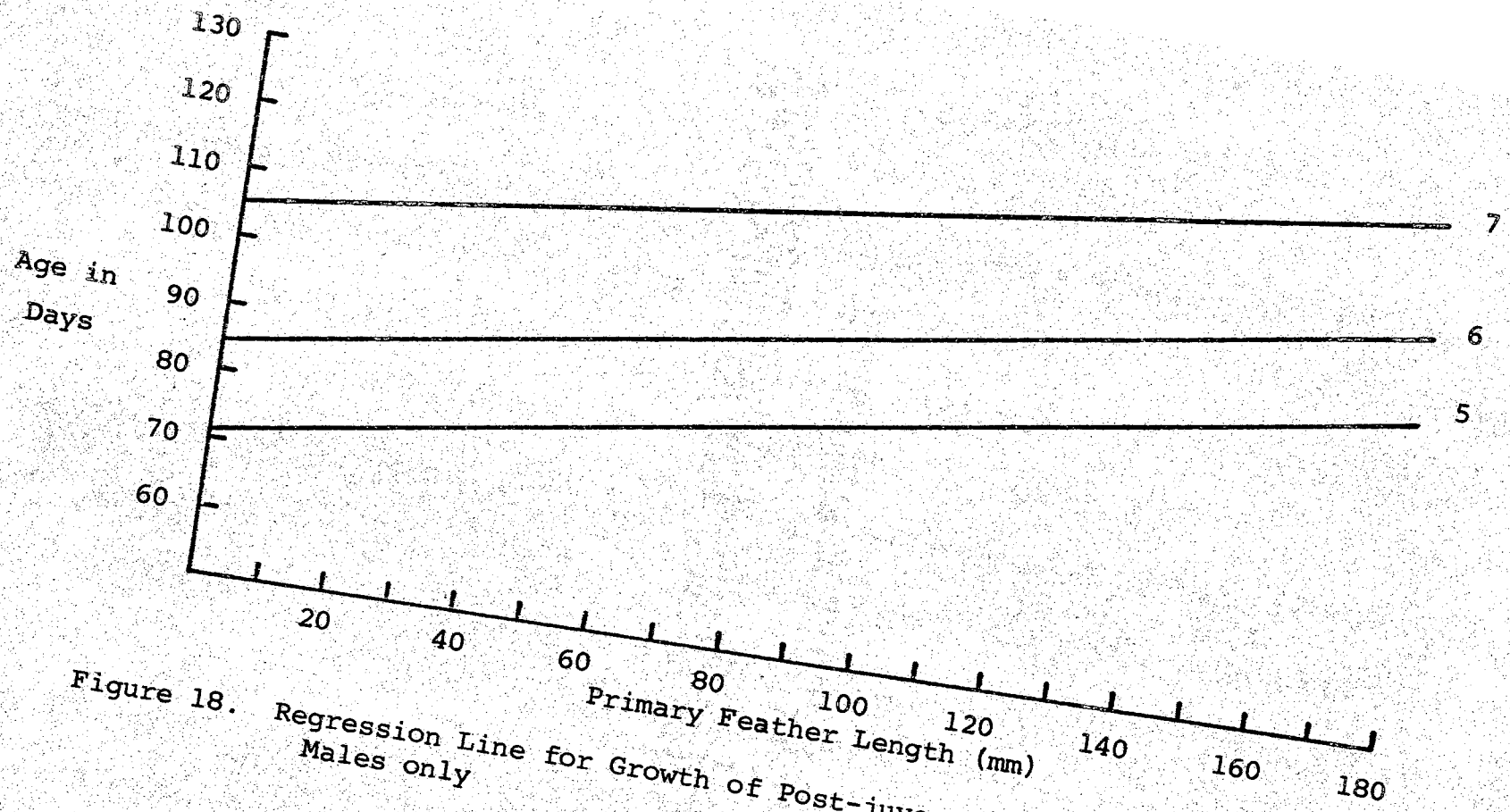

Figure 18. Regression Line for Growth of Post-juvenal Primaries 5 through 7, Males only

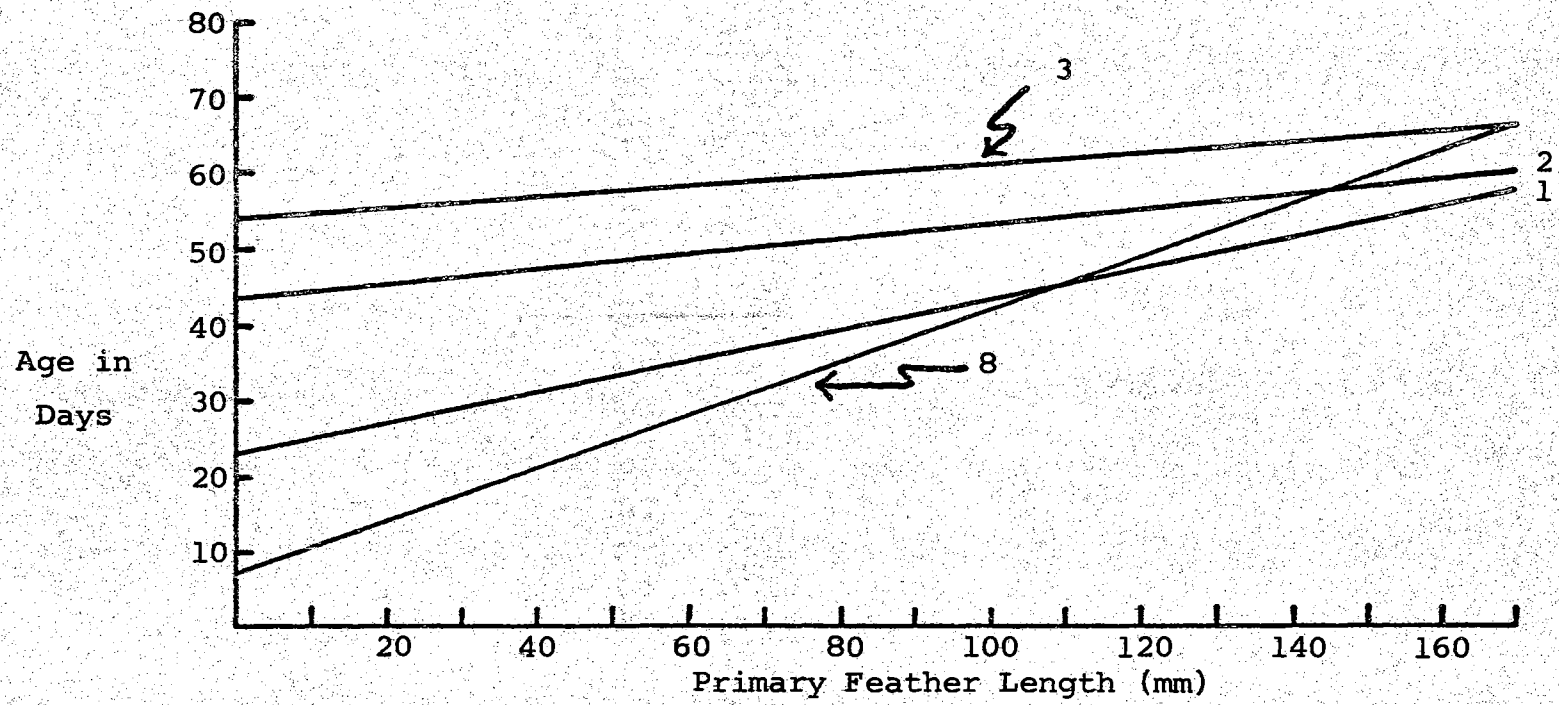

Figure 19. Regression Line for Growth of Juvenal Primary 8 and Post-Juvenal Primary 1 through 3, Females only

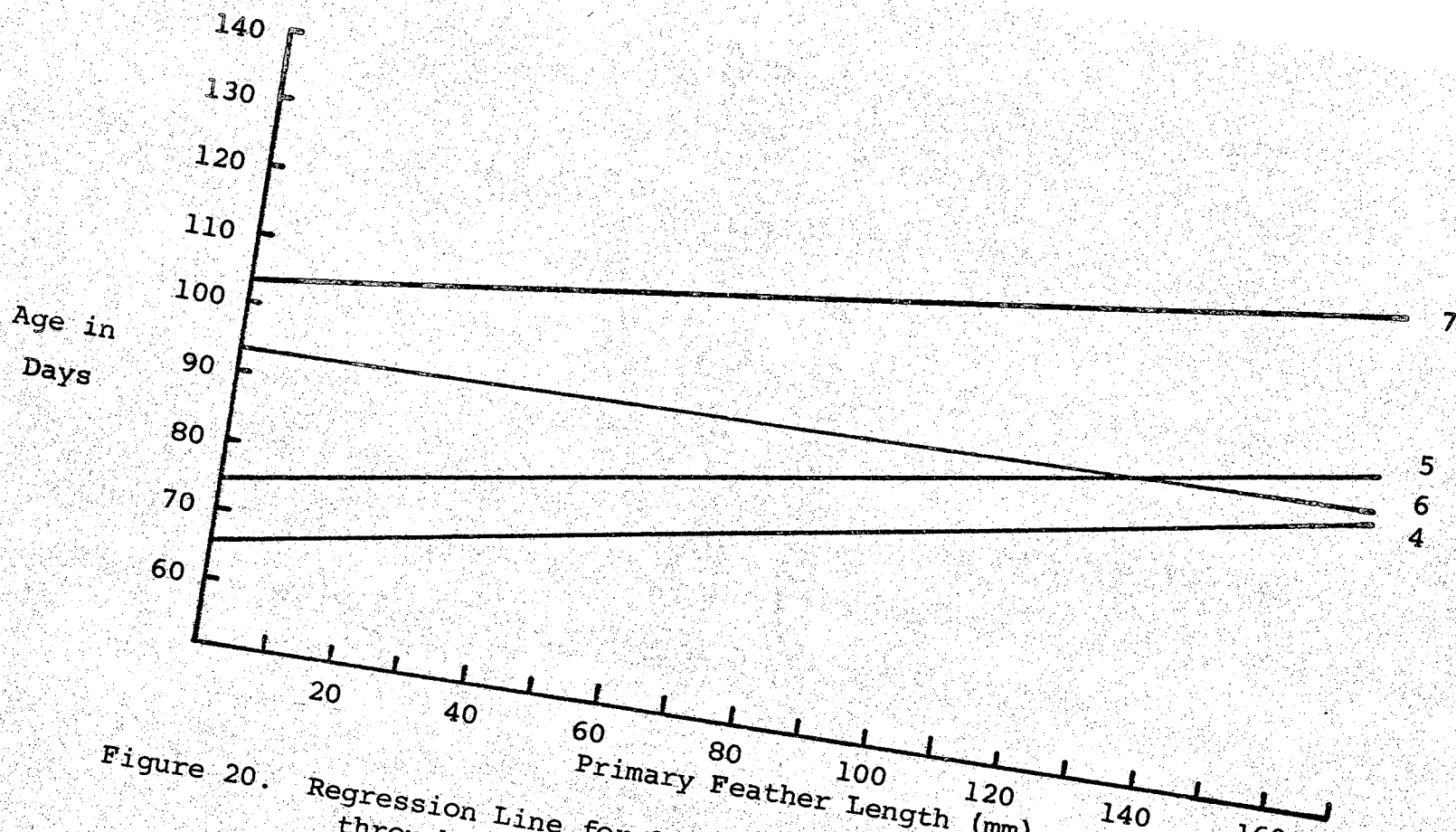

Figure 20. Regression Line for Growth of Post-juvenal Primaries 4 through 7, Females only

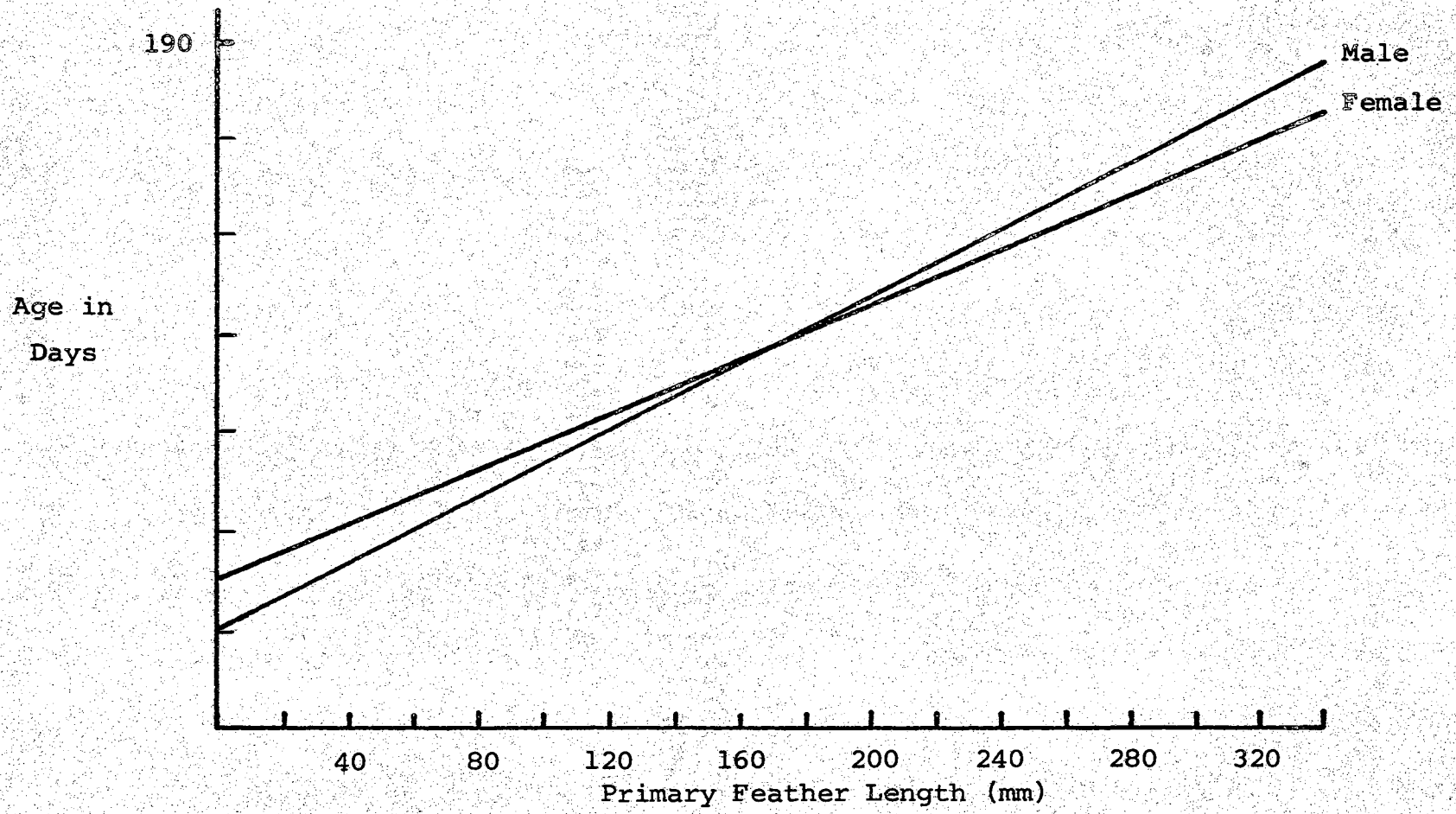

Figure 21. Regression Line for Growth of Post-juvenal Primary 8, Male and Female

To determine whether linear regression (Figures 14-21) or mean primary feather length (Tables IV and V) was the most accurate method for aging poults, the values obtained by each method from the 1968 poults were used to estimate the ages of five male and five female poults measured in 1965 at known-ages of 43, 78, 120, 162, and 197 days. While disregarding the known-age of each 1965 poult, I estimated its age according to the 1968 values in each method then checked the accuracy of my estimate ($\pm$ 7 days) by referring to the known age of the poult. With the linear regression model, sexes known, 48 percent of the males and 50 percent of the females were aged correctly (Table XIV). When the mean primary feather length Tables were used, sexes known, 35 percent of the males and 41 percent of the females were aged correctly. Birds were incorrectly placed in age classes by an amount of 0 to 7 days on 38 occasions (42.2 percent), by 8 to 14 days on 24 occasions (26.6 percent), by 15 to 21 days on 14 occasions (15.5 percent) and over 21 days on 14 occasions. Older poults were aged less accurately than younger poults. The low degree of accuracy suggests that neither method is particularly useful.

Results from a comparison of the two aging methods indicate that linear regression is more accurate than the mean primary feather length table for estimating the age of Rio Grande wild turkey poults. In the comparison performed here

TABLE XIV

COMPARATIVE AGE ESTIMATES OF KNOWN-AGE RIO GRANDE TURKEY POULTS USING MEAN LENGTH TABLE AND LINEAR REGRESSION

Linear Regression Model		Age (Days)									
		Actual	Est.	Actual	Est.	Actual	Est.	Actual	Est.	Actual	Est.
Males	#179	43	41	78	71	120	115	162	157	197	181
	#181	43	32	78	71	120	98	162	132	197	165
	#182	43	42	78	75	120	100	162	154	197	181
	#185	-	-	-	-	120	114	162	152	197	177
	#188	43	30	78	68	120	121	162	164	197	178
Females	#178	-	-	-	-	120	109	162	148	197	168
	#180	43	42	78	78	120	108	162	136		
	#184	43	45	78	74	120	112	162	142	197	170
	#186	43	38	78	71	120	93	162	136	197	157
	#189	43	37	78	72	120	117	162	163	197	192
Mean Length Table											
Males	#179	43	49	78	70	120	113	162	148	197	183
	#181	43	42	78	70	120	99	162	134	197	162
	#182	43	49	78	63	120	106	162	148	197	183
	#185	-	-	-	-	120	113	162	148	197	176
	#188	43	42	78	63	120	113	162	155	197	176
Females	#178	-	-	-	-	120	106	162	134	197	148
	#180	43	49	78	77	120	106	162	141		
	#184	43	49	78	77	120	106	162	148	197	176
	#186	43	49	78	70	120	106	162	148	197	169
	#189	43	49	78	63	120	113	162	162	197	197

- No measurements are available for this age

13 percent more males and 9 percent more females were aged correctly by linear regression than by mean length tables (Table XV). Statistical tests to determine if the accuracy of the regression is significantly greater are not available. An additional advantage of the linear regression method is that only the most recently emerged feather needs to be measured rather than all feathers as in the mean primary feather length table.

TABLE XV

CORRECT AND INCORRECT AGE ESTIMATES OF KNOWN-AGE RIO GRANDE TURKEY POULTS USING MEAN LENGTH TABLE AND LINEAR REGRESSION

Sex of Poults	Mean Length Table Estimate			Linear Regression Estimate		
	Number Poults Tested	Correct Estimates	Incorrect Estimates	Number Poults Tested	Correct Estimates	Incorrect Estimates
Males	23	8	15	23	11	12
Females	22	9	13	22	11	11
Totals	45	17	28	45	22	23

CHAPTER IV

SUMMARY

The primary objective of this study was to develop a technique for using primary feather length to age Rio Grande turkey poults. The data were analyzed using linear regression and mean primary feather length tables. Results of Student's t-tests show that of the two methods, poults could be aged most accurately using the linear regression model below.

$$\hat{Y} = \hat{B}_o + \hat{B}_1 X_1$$

$\hat{Y}$ = estimated age in days

$\hat{B}_o$ = estimated age in days when $X_1 = 0$

$\hat{B}_1$ = slope of the regression line

X_1 = length (mm) of most recently emerged primary feather

I developed a table of general characteristics with which Rio Grande turkey poults could be aged if the primary feathers could not be measured. Comparing the mean length of primary feathers of Eastern and Rio Grande wild turkey poults by Student's t-test showed a statistically significant

difference ($P < 0.10$).

From this study it can be concluded that the age of Rio Grande wild turkey poults can be estimated by using the linear regression model shown above. If the most recently emerged primary feather cannot be measured the poult can be placed in broad age classes based on its general plumage and body characteristics. Characteristics for Eastern wild turkey poults cannot be used to estimate the age of Rio Grande wild turkey poults.

Future workers should attempt to randomize and enlarge the sample. Regular measuring periods are not a necessity.

LITERATURE CITED

Aldrich, J. W. 1967. Taxonomy, distribution and present status. p. 17-44. In O. H. Hewitt (ed.). The wild turkey and its management. The Wildlife Society, Washington, D. C.

Boag, D. A. 1965. Indicators of sex, age, and breeding phenology in blue grouse. J. Wildl. Mgmt. 29 (1): 103-198.

Bendell, J. F. 1955. Age, molt, and weight characteristics of blue grouse. Condor 57:354-361.

Bergerud, A. T., S. S. Peters, and Raymond McGrath. 1963. Determining sex and age of willow ptarmigan. J. Wildl. Mgmt. 27(4):700-711.

Glazener, W. C. 1967. Management of the Rio Grande turkey. p. 453-492. In O. H. Hewitt (ed.). The wild turkey and its management. The Wildlife Society, Washington, D. C.

Knoder, Eugene. 1959. An aging technique for juvenal wild turkeys based on the rate of primary feather moult and growth. Proc. First Nat. Wild Turkey Symp., Memphis, Tenn., 159-176.

Leopold, A. S. 1943. The molts of young wild and domestic turkeys. Condor 45(4):133-145.

Mosby, H. S., and C. O. Handley. 1943. The wild turkey in Virginia: its status, life history, and management. Va. Comm. Game and Inland Fisheries. pp. 93-100.

Nixon, C. M. 1962. Wild turkey aging. Ohio Dept. Nat. Res., Game Research in Ohio 1:107-117.

Petrides, G. A. 1942. Age determination in American gallinaceous birds. Trans. N. Am. Wildl. Conf. 7:324-326.

Petrides, G. A., and R. Nestler. 1943. Age determination in juvenile bob-white quail. Am. Midl. Nat. 30:774-782.

Petrides, G. A. 1945. First-winter plumages in Galliformes. Auk 62(2):223-227.

Raitt, R. J., Jr. 1961. Plumage development and molts of California quail. Condor 63:294-303.

Smith, N. D., and I. O. Buss. 1963. Age determination and plumage observations of blue grouse. J. Wildl. Mgmt. 27(4):566-578.

Thompson, D. R., and Cyril Kabat. 1950. The wing molt of the bob-white. Wilson Bull. 62:20-31.

Wagner, F. H., C. D. Besadny, Cyril Kabat. 1965. Population ecology and management of Wisconsin pheasants. Wis. Cons. Dept., Tech. Bull. No. 34, Madison, Wis. 168 pp.

Westerskov, Kaj. 1956. Age determination and dating nesting events in the willow ptarmigan. J. Wildl. Mgmt. 20(3):274-279.

Weeden, R. B., and Adam Watson. 1967. Determining the age of rock ptarmigan in Alaska and Scotland. J. Wildl. Mgmt. 31(4):825-826.

Williams, Lovett E. 1961. Notes on wing molt in the yearling wild turkey. J. Wildl. Mgmt. 25(4):439-440.

Woehler, E. E. 1953. Post-juvenile wing-molt studies on penned pheasants. P-R Quart. Progr. Rep., Project No. 9-R: 17-23 (processed). Wis. Cons. Dept., Madison.

Wright, P. L., and R. W. Hiatt. 1943. Outer primaries as age determiners in gallinaceous birds. Auk 60:265-266.

VITA[v]

Robert Douglas McGuire

Candidate for the Degree of

Master of Science

Thesis: AGING RIO GRANDE WILD TURKEY POULTS, MELEAGRIS GALLOPAVO INTERMEDIA (SENNETT), BY PRIMARY FEATHER LENGTH AND GENERAL BODY CHARACTERISTICS

Major Field: Zoology

Biographical:

Personal Data: Born in Tulsa, Oklahoma, February 28, 1941, the son of Howard Edgar and Mary Ann McGuire.

Education: Attended grade school at Alluwe, Oklahoma; seventh grade at Roosevelt Junior High School, Coffeyville, Kansas; grades eight through twelve at Nowata, Oklahoma; received Associate of Arts degree at Northeastern Oklahoma A & M Junior College, Miami, Oklahoma; received the Bachelor of Science degree from Oklahoma State University in May, 1964; participant in National Science Foundation Academic Year Institute, Oklahoma State University for school year of 1967-68; Unit Fellow with the Oklahoma Cooperative Wildlife Research Unit at Oklahoma State University for school year of 1968-69.

Professional Experience: Began teaching career in August, 1964, at McLean High School, McLean, Virgania, and taught BSCS Green Version Biology for three years, including one year of Physical Science and one year of Chem Study.

Organizations: National Wildlife Federation; The Wildlife Society; Phi Sigma Society.